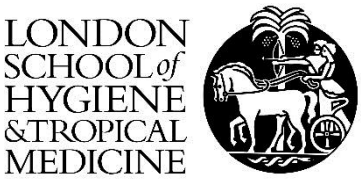

Use of electronic health records to investigate vaccination inequalities in older individuals in England

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Declaration

`I, Anu Jain, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.'

Anu Jain

27/04/2018

“You have the right not to be unlawfully discriminated against in the provision of NHS services including on grounds of gender, race, disability, age, sexual orientation, religion, belief, gender reassignment, pregnancy and maternity or marital or civil partnership status.”

NHS Constitution for England 2015

Abstract

The aim of this thesis was to measure inequalities in the burden of vaccine-preventable disease and vaccine uptake amongst older individuals in England, using primary care electronic health records (EHR) linked to hospitalisation and deprivation data. Social factors previously associated with vaccination amongst older individuals in Europe were first determined by conducting a comprehensive systematic review. Methods were developed to identify and investigate the recording of these factors in the linked UK EHR data. These methods were then applied in two cohort studies, focussing on herpes zoster (a common debilitating condition in older populations), to identify the social determinants of (a) zoster incidence in the decade before zoster vaccine introduction, 2003-2013 and (b) uptake of zoster vaccination in 2013-15 (the first two years after vaccine introduction).

The methodological study showed that, among 591,037 individuals aged ≥65 years, completeness of recording of individual social factors varied from 1.6-80%. The ethnic distribution, and prevalence of deprivation, living alone, living as a couple and care home residence, were all comparable with data from the 2011 English Census.

In the first cohort study of 862,470 older individuals, those at higher risk of zoster in the pre-vaccination era included females, those in care homes, those of White ethnicity and non-immigrants, with increased zoster incidence in these groups ranging from 10-100%. Known clinical risk factors for zoster (co-morbidities and immunosuppressive treatment) explained little of these increased risks. In the second cohort study of 35,333 individuals, social factors associated with lower uptake of zoster vaccination included: care home residence (adjusted odds ratio (aOR):0.64 (95% confidence interval: 0.57-0.73)), living alone (aOR:0.85 (0.81-0.90)), and being of non-White ethnicity (for example: Black ethnicity versus White ethnicity: aOR:0.61 (0.49-0.75)). Uptake decreased by increasing deprivation: aOR (most deprived areas versus most affluent): 0.69 (0.64-0.75). Lower uptake was also seen amongst females in the older catch-up group.

The findings from this thesis should help inform specific interventions to mitigate zoster vaccine inequalities, including amongst doubly disadvantaged groups (with higher zoster burden and lower vaccine uptake) such as care home residents. The methods developed

can also be used to examine other health inequalities in older UK populations. Future linkages to other data sources, such as the Census, would further enhance the availability of information for studies of the social determinants of health.

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List of abbreviations

A&E	Accident and emergency
aOR	adjusted odds ratio
aRR	adjusted rate ratio
CI	confidence interval
CPRD	Clinical Practice Research Datalink
CSDH	Commission on Social Determinants of Health
DMARD	Disease Modifying Anti-rheumatic Drugs
E&W	England and Wales
EHR	Electronic health records
GP	General practitioner
HES	Hospital Episode Statistics
HIV	Human immunodeficiency virus
ICD	International Classification of Diseases and Related Health Problems
IMD	Index of multiple deprivation
IRR	incidence rate ratio
LSOA	Lower Layer Super Output Area
NHS	National health service
OPCS	Office of Population Censuses and Surveys
OR	odds ratio
PHE	Public Health England
PHN	post-herpetic neuralgia
QOF	Quality and Outcomes Framework
SR	systematic review
SUS	Secondary Uses Service
THIN	The Health Improvement Network
UK	United Kingdom
UTS	Up to standard
WHO	World Health Organization

Background section

This thesis utilises routinely collected primary care electronic health care records linked to hospitalisation and deprivation data to ascertain inequalities in burden of vaccine-preventable disease and vaccine uptake amongst older individuals in England. The focus of the thesis is on herpes zoster and it describes the disparities for zoster burden and zoster vaccine uptake.

The background section for this thesis has two chapters:

Chapter 1 gives a general outline of health inequalities and their impact on older individuals. It also summarises the biology and epidemiology of herpes zoster. The existing knowledge of the association of social factors with herpes zoster disease burden and vaccination is also discussed, highlighting the gaps in our understanding which provided the rationale for this PhD research. The end of the chapter describes the aims and objectives, and the overall structure of this thesis.

Chapter 2 presents a systematic review and meta-analysis of the association of social factors with vaccine uptake amongst older individuals.

Chapter 1. Background

1.1 Health inequalities and their social determinants

1.1.1 Definition

Health inequalities can be defined as systematic differences in health amongst different population groups.[1] These inequalities may arise due to genetic or biological variations (for example, women have uterine problems but men do not) or from autonomous choices (such as choosing an unhealthy lifestyle), or they may be socially produced and therefore unfair and modifiable (for example, if access to a particular treatment varies between different income groups).[1-3] Health inequalities, as illustrated in the last example, which are unjust, avoidable, and amenable to interventions result in health inequities, a term that has an ethical and moral basis.[3-5] However, in the public health context, the terms health inequity and inequality are often used interchangeably and are considered to be synonymous, as the element of unfairness is implicit in both terminologies.[3] In this thesis, in which the focus is on investigating socially generated differences in health, the term health inequalities is used for the most part, except when describing studies that have specifically used the term health inequities.

The World Health Organisation's (WHO) Commission on Social Determinants of Health (CSDH) in 2010 proposed a conceptual framework describing the inter-relationships between the social determinants of health inequities (Figure 1-1).[4] On the left of the figure (Figure 1-1) are structural determinants: socioeconomic and political contexts (such as public policies and societal values) that stratify society into a set of socioeconomic positions based on an individual's income, occupation, education, gender and ethnicity. These structural determinants of health inequities operate through a set of intermediary determinants, comprising individuals' material circumstances (such as housing and employment conditions, ability of buy food), biological/behavioural factors (such as substance misuse, physical exercise) and psychosocial factors (such as relationships and social support).[4] The resulting health inequities can further disadvantage individuals who are

already socially disadvantaged, for example by affecting their income or employment (as shown by the reverse arrow in the Figure 1-1). The actions required to mitigate health inequities should ideally act on both structural and intermediary factors to have a larger impact.[4]

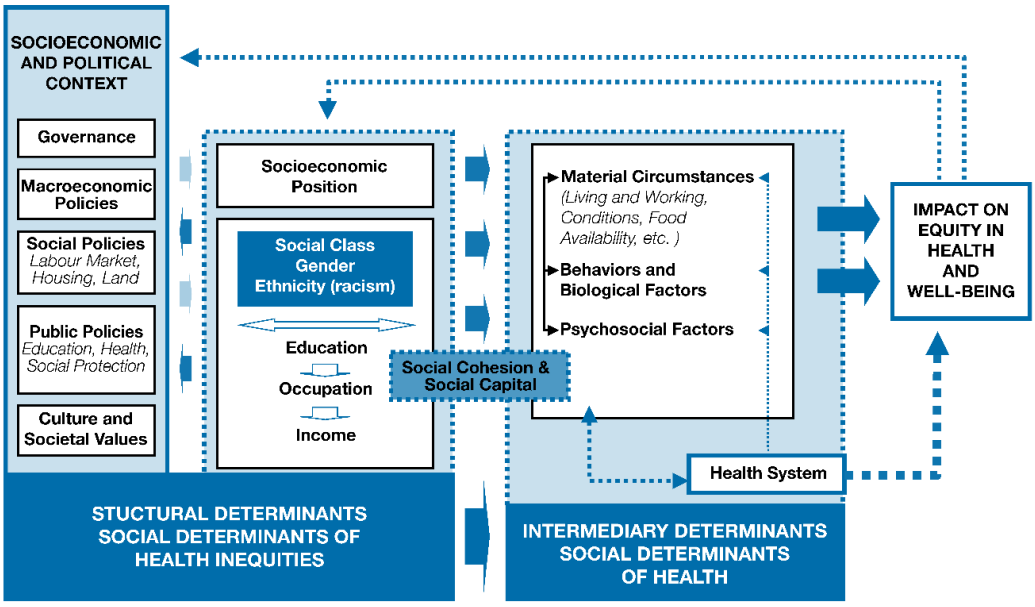

Figure 1-1 Conceptual framework of social determinants of health*

* Reproduced from[4]

1.1.2 Health inequalities and older individuals

A population group particularly vulnerable to health inequalities is older individuals.[6] The number of older individuals is growing rapidly world-wide due to increases in life expectancy, and the proportion of individuals aged ≥60 years is expected to nearly double, from ~12% in 2012 to 22% in 2050.[7, 8] In the European Union, the number of individuals aged ≥65 years is predicted to increase by 53%, from ~19% in 2014 to ~29% by 2080.[9] However, this increase in life expectancy does not necessarily translate into an increase in healthy life expectancy, a term that takes into account both mortality and morbidity and provides a comprehensive measure of disability-free years, with implications for a country's health and social care expenditure.[10, 11] Healthy life expectancy acquires significance as older individuals are at

increased risk of disability not only because of a higher prevalence of chronic conditions but because they are also predisposed to higher mortality and morbidity due to infectious diseases.[11, 12] This increased susceptibility to infectious diseases is due to the age-related decline in immune function (immunosenescence) and may also result from the detrimental effect of chronic conditions and their treatments on immune functions.[12]

Health inequalities in general have been described for both life expectancy and healthy life expectancy amongst older individuals.[13] A 2015 systematic review reported the association of socio-demographic factors such as gender, ethnicity, level of education, socioeconomic class and behavioural factors with disparities in both mortality and disability i.e. healthy life expectancy amongst older individuals.[14] In England, gender and socio-economic differentials (social class, education, wealth and income) have been found to be associated with both life expectancy and healthy life expectancy amongst individuals aged ≥50 years.[13] Psycho-social factors such as living alone are also known to be associated with higher morbidity and mortality amongst older individuals.[15] Studies have shown that the burden of certain infectious diseases have a socio-economic gradient making older individuals from disadvantaged social strata more prone to infections, resulting in inequalities of infections-related mortality and morbidity.[16-19]

1.1.3 Reducing health inequalities

Achieving health equality remains a challenging global ambition for governing bodies and health care providers. Reducing health inequalities is an ethical and social obligation. In the UK, promoting equality and reducing inequality in health remains a statutory requirement enshrined under two separate laws: Health and Social Care Act 2012 and Equality Act 2010.[20, 21] It is also acknowledged as one of the people's rights as set out in the National Health Service (NHS) constitution, an absolute objective set by the UK Department of Health and other national bodies, and it is a common theme in the area of health improvement for public health.[22-28]

An important action to reduce health inequalities amongst the older individuals is to first identify their social determinants and then plan specific interventions. In fact, one of the WHO's CSDH recommendations to tackle health inequalities was to set up global and

national surveillance systems to measure these inequalities, and also monitor the equality impact of any interventions.[5] This also includes promoting universal healthy ageing by reducing disabilities resulting from both chronic and infectious diseases. For the latter, a key intervention to reduce morbidity and mortality in all age groups (including older individuals), is vaccination.[29, 30] Vaccines administered to older individuals include seasonal influenza vaccine and pneumococcal vaccine for pneumonia. More recently, a vaccine targeting zoster amongst older individuals was introduced.

1.2 Herpes zoster

1.2.1 Aetiology

Herpes zoster or shingles is a neurocutaneous disease, which occurs due to reactivation of latent varicella-zoster virus, a double-stranded DNA human herpesvirus. Chicken pox or varicella is a common childhood infection that occurs due to primary infection with varicella-zoster virus. Following this primary infection, the virus remains dormant in the host's nerve cells.[31] The reactivation of the dormant virus in form of zoster occurs due to waning of virus-specific immunity and the virus then migrates along the nerve cell to reach the skin, giving rise to its characteristic clinical features, as detailed below.[31, 32]

1.2.2 Clinical characteristics of zoster

Zoster is characterised by a painful unilateral vesicular rash in the affected dermatome.[33] Patients might also experience pain or sensitive skin in the affected area 2-3 days prior to the rash.[32, 33] The symptoms generally last for ~2-4 weeks. In some cases, the pain persists leading to the commonest complication of zoster: post-herpetic neuralgia (PHN), which occurs in ~5-30% of individuals with zoster.[34, 35] The pain of PHN may be associated with long-term morbidity and can significantly affect quality of life.[32, 36] Other less common but serious complications of zoster include stroke, encephalitis, visual impairment following ophthalmic zoster, secondary infections of the rash and other neuro-muscular conditions.[32, 37]

1.2.3 Zoster disease burden and risk factors

The lifetime risk of zoster is ~10%-30% in the general population with the overall zoster incidence rate ranging from 3-5/1000 person-years.[32, 35, 38]. Individuals may also experience more than one episode of zoster, the risk of recurrence varying from 1% to 6%.[31, 35] The risk of zoster increases sharply after the age of 50 years with nearly 1 in 2 people experiencing zoster by the age of 85 years; the age-specific zoster incidence varying from 6-8/1000 person-years (aged 60 years) to 8-12/1000 person-years (aged 80 years).[31, 32, 35]

The quality of life and ability to perform activities of daily living amongst older individuals could be adversely affected by the pain associated with acute zoster, and for some frail individuals it may also lead to permanent loss of independent living.[39, 40] The risk of zoster-related complications and their severity, zoster-related hospitalisations and deaths also increases amongst the older age groups, giving rise to a much higher disease burden.[35, 41] For example, both the risk of PHN and severity of PHN symptoms increases with age.[35, 42] The higher morbidity resulting from zoster and its complications amongst older individuals is also associated with considerable healthcare costs.[41, 43] During 2004-2013 the average annual hospitalisation costs in England for individuals aged ≥60 years was estimated to be 10 million (95% confidence interval (CI): 9.8-10.4) based on 2013-2014 national tariff.[43]

As stated in **Section 1.1.2**, increasing age is associated with higher zoster burden due to an age-related decline in immune functions: immunosenescence.[12, 32, 44, 45] Zoster-specific immunity is also hypothesized to be related to the age at which chickenpox is acquired, as individuals acquiring chickenpox later in life may have immunity lasting to older age and thus lower risk of zoster.[44, 45]

Conditions that compromise immune function are major risk factors for zoster. For example, higher risk of zoster is observed in patients with severe immunosuppression due to conditions such as leukaemia, lymphoma, HIV infection, bone marrow transplant and immunosuppressive therapies such as chemotherapy, radiotherapy and steroids.[44-46] In a large matched UK case-control study, some autoimmune conditions such as inflammatory bowel disease, rheumatoid arthritis and systemic lupus erythematosus, and chronic conditions associated with moderate immunosuppression such as asthma, chronic

obstructive pulmonary disease, chronic renal disease and diabetes, were also identified to be associated with increased zoster risk.[44]

The association of socio-demographic factors with zoster incidence is described in **Section 1.3.2**.

1.2.4 Diagnosis and treatment of zoster

A clinical diagnosis of zoster, based on its typical clinical features (**Section 1.2.2**), is usually accurate.[47] The most common differential diagnosis of zoster includes recurrent herpes simplex virus infection.[46, 48] Laboratory confirmation is usually obtained by detecting the viral DNA using polymerase chain reaction, which offers rapid confirmation with high sensitivity and specificity.[48, 49] This is seldom done for diagnostic purposes, except for atypical presentation of zoster, for example amongst immunocompromised individuals.[47] Other diagnostic tests include serological testing for VZV virus antibodies and antigens but they have lower sensitivity and specificity compared to the polymerase chain reaction test.[48, 49]

Studies that have looked at the accuracy of the clinical diagnosis have shown high positive predictive values.[50, 51] A Dutch study compared the clinical diagnosis in primary care with serological testing amongst older immunocompetent individuals.[50] Of the total 260 zoster cases diagnosed clinically, 236 cases were serologically confirmed, giving a positive predictive value of 91%.[50] The authors acknowledged that the positive predictive value might have been even higher had a more sensitive confirmatory test such as a polymerase chain reaction test been used.[50] In an earlier German study conducted in a dermatology clinic, which utilised a polymerase chain reaction test as the reference test to confirm the clinical diagnosis, all 65 clinically diagnosed cases of zoster were confirmed, giving a positive predictive value of the clinical diagnosis as 100%.[51]

An important challenge in treating zoster is early initiation of antiviral therapy. Treatment with oral antiviral agents, if initiated within 72 hours of the onset of rash, may reduce the duration of symptoms.[52, 53] However, it is known that most patients do not present to their doctor in time to benefit from the treatment.[47] The effectiveness of antiviral therapy, as perceived by the patients, is also reported to be low.[39] A 2014 Cochrane review also found the effect of antiviral treatment in preventing PHN, an important zoster complication, to be inconclusive.[54]

Due to the limitations of current therapeutic options, zoster prevention becomes central to minimise its burden amongst older individuals.

1.2.5 Prevention of zoster: zoster vaccine

In view of the impact that zoster has on older people and the limitations of available treatment (**Section 1.2.4**), zoster prevention becomes important. The Joint Vaccine Working Group of the European Union, which provided vaccination guidelines for individuals aged ≥60 years, recommended zoster vaccination to reduce morbidity and promote healthy ageing in 2009.[55] At present, two types of zoster vaccines are available: a live zoster vaccine (Zostavax®) and an inactive zoster subunit vaccine (Shingrix®).[56, 57] The inactive vaccine, approved by the US Food and Drug Administration in October 2017 and also by the US Advisory Committee on Immunization Practices, is not yet approved for use in the UK.[56, 58]

In UK only the live zoster vaccine (Zostavax®) is currently available.[59, 60] The efficacy of Zostavax® to reduce the incidence of zoster and PHN was reported as 51.3% (95% CI: 44.2%-57.6%) and 66.5% (95% CI: 47.5%-79.2%), respectively.[61] This was later confirmed in the post-licensure vaccine effectiveness studies.[62, 63] A 2016 Cochrane review, which combined 13 studies on both live (N=10) and inactive zoster vaccines (N=3), also concluded vaccination to be effective amongst older individuals: the risk ratio for zoster incidence amongst the vaccine recipients (reference group: placebo) was 0.49 (95% CI: 0.43-0.56).[64]

In order to reduce the zoster disease burden amongst older individuals and based on clinical, epidemiological and vaccine-effectiveness data, in 2010 the UK Joint Committee on Vaccination and Immunisation recommended a single-dose zoster vaccination programme for older individuals.[59, 65, 66] The national zoster vaccination programme was introduced in September 2013, which targeted people aged 70 years (the routine/ main target cohort) and a catch-up programme for older individuals up to the age of 79 years.[59, 67, 68] The eligibility for the vaccine was determined based on the an individual's age on 1st of September of the year, for example in 2013, individuals aged 70 years on 01/09/2013 were targeted as a part of the routine cohort (Table 1-1).[68] The vaccine was also sequentially rolled out to the catch-up cohort as follows: individuals aged 79 years on 01/09/2013, those aged 78 years and 79 years on 01/09/2014 for the year 2014-2015, and to those aged 78 years on 01/09/2015 for

the year 2015-2016.[68-70] Moreover, in 2015-2016, there were three additional cohorts consisting of individuals who had missed vaccination in the previous two years and were aged <80 years (Table 1-1); in contrast there were no additional cohorts in 2014-2015 due to vaccine shortages.[70, 71]

Based on the UK Green Book guidance- the zoster vaccine, which is a live vaccine, is contraindicated in individuals with immunosuppressive conditions. These include lymphoproliferative disorders (e.g. acute and chronic leukaemias, lymphomas), cellular immune deficiency, immunosuppression due to HIV infection, individuals on immunosuppressive treatment with high dose of corticosteroids, biological and non-biological immune-modulating treatments, cancer chemotherapy and radiotherapy.[60]

Table 1-1 Eligibility for zoster vaccine in the first three years of the UK national programme

Year: zoster vaccination programme		Age-based eligibility for zoster vaccine		
		Routine cohort	**Catch-up cohort**	**Additional cohorts**
1/09/2013 to 31/08/2014	Number of cohorts	1	1	None
	Age on 01/09/2013 (DOB)	70 years (DOB: 2/9/1942-1/9/1943)	79 years (DOB: 2/9/1933-1/9/1934)	-
1/09/2014 to 31/08/2015	Number of cohorts	1	2	None
	Age on 01/09/2014 (DOB)	70 years (DOB: 2/9/1943-1/9/1944)	79 years (DOB: 2/9/1934-1/9/1935) 78 years (DOB: 2/9/1935-1/9/1936)	-
1/09/2015 to 31/08/2016	Number of cohorts	1	1	3*
	Age on 01/09/2015 (DOB)	70 years (DOB: 2/9/1944-1/9/1945)	78 years (DOB: 2/9/1936-1/9/1937)	71 years (DOB: 2/9/1943-1/9/1944) 72 years (DOB: 2/9/1942-1/9/1943) 79 years (DOB: 2/9/1935-1/9/1936)

DOB date of birth

* Included individuals who missed vaccination in 2013/2014 and 2014/2015 and remained eligible till 80 years of age

1.2.6 Zoster vaccine uptake in England

In England, the zoster vaccination programme was rolled out via general practice with GPs encouraged to administer zoster vaccine at the same as time as the seasonal influenza vaccine.[72] A national zoster vaccine uptake surveillance was also established, the data for which is derived from the aggregated coverage data at the general practice-level using automated extraction methods.[68] Amongst the routine cohort, the annual uptake of 61.8% during the first year of introduction (2013-2014) was reduced to 59% and 54.9% during 2014-2015 and 2015-2016, respectively.[68-70] The annual uptake during 2013-2014 for the catch-up cohort (for individuals aged 79 years on 01/09/2013) was 59.6%, which also declined to 58.5% in 2014-2015.[68, 69] This decline in the uptake also persisted for the catch-up cohort aged 78 years, with uptake reduced from 57.8% (2014-2015) to 55.5% during 2015-2016.[69, 70] Thus, the national data for annual zoster vaccine uptake in England has shown a gradual decline in uptake amongst both the routine and the catch-up cohorts in the first three years of its introduction. Some of the reasons identified for the decrease in zoster uptake over these three years of vaccine introduction included decreasing public awareness about the vaccination programme and inefficient GP reminder-recall systems for identifying and calling eligible individuals for zoster vaccination during a busy seasonal influenza vaccination season.[70]

In each year of the first three years after zoster vaccine was introduced, the majority of vaccine uptake occurred by the end of January (Figure 1-2), which also marks the end of surveillance period for seasonal influenza vaccine.[68-70] This was not a surprising finding for two reasons. Firstly, seasonal influenza vaccine and zoster vaccine can be given simultaneously and GPs were encouraged to co-administer these vaccines.[60, 72] Secondly, the eligibility for zoster vaccine is determined by an individual's age in September, which also marks the start of seasonal influenza vaccination season, and thus co-administrating the two vaccines also becomes logistically convenient from the programme implementation point of view.[60, 73] Some US studies have also reported a higher uptake of zoster vaccine amongst those who had received seasonal influenza vaccine.[74, 75]

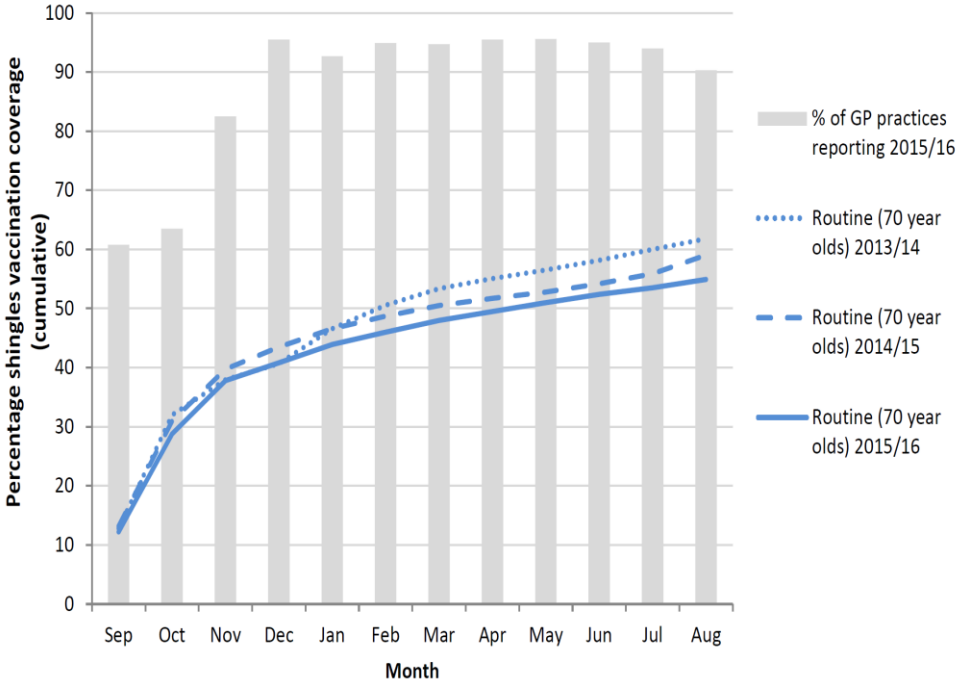

Figure 1-2 Monthly cumulative zoster vaccine coverage for routine cohorts (2013-2016)*

*Reproduced from[70]

1.3 Health inequalities and socio-demographic factors of zoster disease burden and zoster vaccine uptake

1.3.1 Socio-demographic factors

To achieve the overall goal of reducing health inequalities and to meet the requirements of equality laws in the UK (**Section 1.1.3**), the planning and implementation of any health intervention including vaccination programmes have to be effective and equitable.[20, 21] Thus to achieve an equitable zoster vaccination programme and determine its effect on disease burden, it is important to identify the socio-demographic factors associated with both zoster disease burden and zoster vaccine uptake in England. Identification of these factors is essential as it will subsequently help in monitoring any inequalities in specific socio-demographic groups and aid in planning actions to reduce these inequalities. In the following

two sections (**Sections 1.3.2** and **1.3.3**) socio-demographic factors associated with both zoster incidence and vaccination are discussed

1.3.2 Socio-demographic factors associated with zoster disease burden

The association of age with risk of zoster was discussed in **Section 1.2.3**. Other socio-demographic factors are detailed here. The risk of zoster is reported to be higher amongst females.[44, 45] This female preponderance of the disease could be due to a yet unknown genetic predisposition to the disease and/or a reflection of healthcare seeking behaviour.[45] Ethnicity is also associated with zoster: individuals of non-White ethnicity have a lower risk of developing zoster.[45, 76, 77] The protective effect of non-White ethnicity could be due to genetic factors or due to spending childhood in tropical countries where the average age at varicella infection is later than that observed in temperate countries; the reasons for this are unclear but may reflect the effect of environmental temperatures on VZV transmission.[78] The lower zoster risk amongst individuals of non-White ethnicity may also be contributed by immune-boosting due to repeated contacts with chickenpox amongst children in extended families.[45] However, the evidence for the association of zoster disease burden with other social factors such as immigration, marital status (a possible proxy for social support) and socio-economic status including education has been largely inconclusive.[32, 44, 45, 76, 79, 80]

The association of socio-demographic factors with zoster disease burden could be mediated in part by coexisting co-morbidities. Some socio-demographic groups might be predisposed to certain co-morbidities; these conditions and/or their treatments (**Section 1.2.3**) in turn may increase an individual's risk of zoster by their effect on cell-mediated immunity.[44] In a large matched UK case-control study some of these conditions (as described in **Section 1.2.3**) and therapies were identified to be associated with zoster.[46] In this study, these associations were still present after adjusting for socio-economic status but the independent association of socio-economic status with zoster incidence was not reported.[46]

In England, zoster is not a notifiable infection. In 2017, the impact of zoster vaccination programme on the incidence of zoster was reported but apart from age and gender, no other socio-demographic factors were evaluated.[81]

1.3.3 Socio-demographic factors associated with zoster vaccine uptake

Similar to the zoster disease burden, the association of socio-demographic factors with the uptake of zoster vaccine in Europe is not well described. In England, the data for the national zoster vaccine uptake surveillance provides information only on two social factors: gender and ethnicity.[68] A 2017 UK study utilised these national data and reported the association of zoster vaccination for the year 2014-2015, amongst individuals aged 70 years, with ethnicity and additionally with deprivation.[82] The zoster vaccine uptake was reported to be lower amongst those from the most deprived areas (reference group: least deprived) and those of Mixed (White and Black African) ethnicity (reference group: White-British).[82] However, in this study only 35.6% of the individuals with vaccine coverage data had ethnicity data available and the remainder were excluded from the study.[82] Moreover, these results have to be interpreted with some caution as no individual-based data were available in the study and thus ethnicity and vaccination data were allocated to the individuals in a manner to ensure that the number vaccinated in each ethnicity stratum matched the aggregated coverage data for that general practice; also the area-level deprivation data was based on the location of the general practice rather than the individual.[82] A Dutch study, in which free zoster vaccine (zoster vaccine is not offered routinely in the Netherlands) was provided concurrently with seasonal influenza vaccine found lower zoster vaccine uptake amongst those with higher education level but found no association of age or gender with uptake.[83]

Further data for the association of socio-demographic factors with zoster vaccination are available from other high-income countries from the non-European region such as the US, where the zoster vaccination was approved for use in 2006.[84] These US studies have reported higher uptake amongst females, those of non-Hispanic White ethnicity, married individuals and those with higher education and income levels.[74, 75, 85, 86] Similarly, in Alberta, Canada, where zoster vaccination is not a part of public funded immunisation programme, uptake was reportedly higher amongst females and those from higher income levels.[87] However, it is plausible that these findings may not be generalizable to the publicly funded health system in the UK. Also, zoster vaccine uptake has been low in the US (31.1% and 34.2% in 2014 and 2015, respectively) amongst individuals aged ≥65 years.[88, 89]

Another important social factor which may be associated with zoster vaccination is religion. The zoster vaccine (Zostavax®) consists of porcine gelatine which may compromise its acceptability amongst Muslim and Jewish religions.[90] However, so far the association of zoster vaccine uptake with religion has not been assessed in the UK.

1.3.4 "Double" inequalities

It is feasible that individuals from specific social groups with a higher burden of zoster may also have lower zoster vaccine uptake. This differential distribution of both burden and vaccine uptake in specific groups may make these individuals "doubly disadvantaged" by having a much higher zoster disease burden after the zoster vaccination programme is in place.

Identifying socio-demographic groups with not only burden or vaccination inequalities but also the "doubly disadvantaged" individuals amongst older individuals is therefore essential for planning preventative strategies to mitigate inequalities of zoster burden and to promote healthy ageing.

1.4 Electronic health records

This thesis utilised routinely collected anonymised primary care electronic health records (EHR) linked to hospitalisation and deprivation data (detailed in **Chapter 3**) to ascertain inequalities in zoster burden and zoster vaccine uptake amongst older individuals in England. The utility of these data to ascertain ethnicity-associated health inequalities in chronic disease burden have been examined.[91] My PhD thesis explored to what extent these large linked primary care EHR can provide information on socio-demographic factors including ethnicity associated with zoster disease burden and zoster vaccine uptake to supplement/enhance existing surveillance methods. As further discussed in **Chapter 3**, the advantages of using these linked datasets include their very large size allowing for longer follow-up time, the data are population-based that are collected prospectively and using these data also allow more efficient use of limited resources. Using EHR also provides an additional advantage of automating the monitoring processes to generate an ongoing cycle of assessment, intervention and re-evaluation.

1.5 Thesis rationale, aims and objectives

1.5.1 Thesis rationale

Infection-related mortality and morbidity, which are more likely amongst disadvantaged social groups, can be targeted by effective vaccination to promote healthy ageing and health equality.[16, 29, 55] Equitable healthy ageing can also help to minimise the negative impact of population ageing on a country's healthcare expenditure. Therefore, tackling inequalities in burden and vaccination of zoster, an infectious disease associated with significant impact on older individuals, becomes an important component to address overall health inequalities in this group. To accomplish this aim it is vital to first assess the magnitude of these inequalities, if any, which will subsequently inform the design of any appropriate interventions.

1.5.2 Aims and objectives

The overarching aim of this PhD was to ascertain inequalities in vaccine-preventable disease burden and vaccine uptake using routinely collected EHR and contribute towards achieving the goal of health equality and healthy ageing amongst older individuals.

Specific objectives were as follows:

Objective 1: To summarise and critically appraise the existing studies of the social determinants of vaccine uptake by reviewing the literature systematically.

Objective 2: To develop methodology for ascertainment of socio-demographic factors (including those identified from objective 1) and assess their availability in linked electronic health records.

These methods were then applied in **objectives 3** and **4** as follows:

Objective 3: To describe the association of socio-demographic factors with zoster disease incidence in England, by applying the methodology developed in **objective 2**.

Objective 4: To describe the association of socio-demographic factors with zoster vaccine uptake in England, utilising the methods developed under **objective 2**. The thesis objectives along with the studies designed to meet these objectives are outlined in Table 1-2.

Table 1-2 Objectives of the thesis

Objectives: primary	Study design	Study population	Exposures	Outcome(s)	Effect measure	Location in thesis
1. To summarise and critically appraise the existing studies of the social determinants of vaccine uptake by reviewing the literature systematically	Systematic review and meta-analysis	Older individuals from Europe	Socio-demographic factors	Vaccine uptake	Odds ratios, rate ratios	**Chapter 2**
2. To develop methodology for ascertainment of socio-demographic factors and assess their availability in the electronic health records	Cross-sectional study	Individuals aged ≥65 years in England	Socio-demographic factors including those identified from Objective 1	For all exposures: 1. Completeness of recording 2. Representativeness 3. Additional information gained by data linkages 4. Timeliness of recording of exposures deemed as time-varying	Not applicable (descriptive study)	**Chapter 6**
3. To describe the association of socio-demographic factors with zoster disease incidence in England	Cohort study	Individuals aged ≥65 years in England with no prior history of zoster	As above	First episode of zoster during the follow-up	Incidence rate ratios	**Chapter 7**
4. To describe the association of socio-demographic factors with zoster vaccine uptake in England	Cohort study	Individuals eligible for zoster vaccine	As above	Zoster vaccine uptake during follow-up	Odds ratios	**Chapter 8**

1.6 Structure of thesis

The structure of this thesis is based on the 'research paper' style format, including four research papers that are either published or submitted for publication and presented as chapters. The thesis comprises of nine chapters, which describe the Background, Methodology, Results and Discussion sections.

The overall rationale including the study questions, aims and objectives of the thesis are presented in this chapter. Table 1-2 summarises all the objectives of this thesis.

Chapter 2 presents the published systematic review and meta-analysis describing the social determinants of vaccine uptake amongst older individuals (**objective 1**).

Chapter 3 describes the EHR datasets utilised in the thesis and how three different study populations were defined to meet the thesis **objectives 2-4**.

Chapter 4 defines how the main exposures of interest, socio-demographic factors, were identified in the EHR.

Chapter 5 describes the ascertainment of the main outcomes in the EHR and how other variables of interest were identified.

Chapter 6 presents the published research paper describing the methodology for ascertaining and assessing the recording of socio-demographic factors in the EHR (**objective 2**).

Chapter 7 presents the published research paper describing the association of socio-demographic factors with zoster disease incidence amongst older individuals in England (**objective 3**).

Chapter 8 also presents a research paper (submitted for publication) investigating zoster vaccination inequalities amongst older individuals in England (**objective 4**).

The final **Chapter 9** summarises the overall study findings, an overview of strengths and limitations of the thesis, implications for public health and future research.

Chapter 2. Social determinants of vaccine uptake amongst older individuals in Europe: systematic review

This chapter forms the second part of the background section of this thesis and reports the work carried out to fulfil the first objective: to summarise and critically appraise the existing studies of the social determinants of vaccine uptake by reviewing the literature systematically. The details of this work, published in the journal Vaccine in 2017 (and herein referred to as "published review paper"), are provided in the next section. The supplementary material to the published review paper are presented in **Section 2.3**. As this published review paper identified studies available until 24/02/2016, I updated the review on 01/11/2017 to identify new studies available from 25/02/2016 until 31/10/2017. The findings from the update are described in **Section 2.4**.

2.1 Introduction to paper 1

This paper presents a systematic review of the association between socio-demographic factors and vaccine uptake amongst individuals aged ≥60 years, using meta-analyses to provide summary effect estimates when appropriate. The paper summarises data from 47 papers describing 44 studies from Europe identified from searches of Medline and Embase databases from inception to 24/02/2016. Living alone was identified as an important factor associated with lower vaccine uptake in this older age group. Other socio-demographic factors associated with lower uptake included not being married, being an immigrant, lower education, lower income and living in deprived areas.

The search strategy, conceptual framework, study selection criteria, quality assessment criteria, the flow chart of the studies included in the review, summary of the studies and details of quality assessment referred to as supplementary material in the paper are presented in **Section 2.3**.

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RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Anu Jain
Principal Supervisor	Prof. Sara Thomas
Thesis Title	Use of electronic health records to investigate vaccination inequalities in older individuals in England

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	Vaccine		
When was the work published?	2017		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	N/A		
Have you retained the copyright for the work?*	**Yes**	Was the work subject to academic peer review?	**Yes**

**If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	
Please list the paper's authors in the intended authorship order:	
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I developed the search terms and strategies, developed the inclusion and quality assessment criteria based on detailed advice from S Thomas and AJ van Hoek (my PhD supervisors) and I conducted all analyses. A random sample (10%) of the titles that I considered ineligible for inclusion in the review were also assessed by S Thomas and

	AJ van Hoek. I wrote the initial draft of the manuscript and revised it based on the comments by all other co-authors. The manuscript was peer-reviewed and I also incorporated comments from the reviewers in the final draft of the manuscript.

Student Signature: [redacted] **Date:** 01/02/2018

Supervisor Signature: [redacted] **Date:** 01/02/2018

2.2 Paper 1: Lower vaccine uptake amongst older individuals living alone: A systematic review and meta-analysis of social determinants of vaccine uptake

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Review

Lower vaccine uptake amongst older individuals living alone: A systematic review and meta-analysis of social determinants of vaccine uptake

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ABSTRACT

Introduction: Vaccination is a key intervention to reduce infectious disease mortality and morbidity amongst older individuals. Identifying social factors for vaccine uptake enables targeted interventions to reduce health inequalities.
Objective: To systematically appraise and quantify social factors associated with vaccine uptake amongst individuals aged ≥60 years from Europe.
Methods: We searched Medline and Embase from inception to 24/02/2016. The association of vaccine uptake was examined for social factors relevant at an individual level, to provide insight into individuals' environment and enable development of targeted interventions by healthcare providers to deliver equitable healthcare. Factors included: living alone, marital status, education, income, vaccination costs, area-level deprivation, social class, urban versus rural residence, immigration status and religion. Between-study heterogeneity for each factor was identified using I^2-statistics and Q-statistics, and investigated by stratification and meta-regression analysis. Meta-analysis was conducted, when appropriate, using fixed- or random-effects models.
Results: From 11,754 titles, 35 eligible studies were identified (uptake of: seasonal influenza vaccine (SIV) only (n = 27) or including pneumococcal vaccine (PV) (n = 5); herpes zoster vaccine (n = 1); pandemic influenza vaccine (n = 1); PV only (n = 1)). Higher SIV uptake was reported for individuals not living alone (summary odds ratios (OR) = 1.39 (95% confidence interval (CI): 1.16–1.68). Lower SIV uptake was observed in immigrants and in more deprived areas: summary OR = 0.57 (95%CI: 0.47–0.68) and risk ratio = 0.93 (95%CI: 0.92–0.94) respectively. Higher SIV uptake was associated with higher income (OR = 1.26 (95%CI: 1.08–1.47)) and higher education (OR = 1.05 (95%CI: 1–1.11)) in adequately adjusted studies. Between-study heterogeneity did not appear to result from variation in categorisation of social factors, but for education was partly explained by varying vaccination costs (meta-regression analysis p = <0.0001); individuals with higher education had higher vaccine uptake in countries without free vaccination.
Conclusions: Quantification of associations between social factors and lower vaccine uptake, and notably living alone (an overlooked factor in vaccination programmes), should enable health professionals target specific social groups to tackle vaccine-related inequalities.

Contents

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0264-410X/

1. Introduction

Vaccination is an important intervention to prevent infections amongst older individuals, who have increased susceptibility to infections and often experience more severe outcomes [1–3]. A successful vaccination programme depends not only on vaccine effectiveness and well-organized programme delivery but also on high vaccination uptake [3]. Inequalities in vaccine uptake amongst older individuals could be related to social factors: the social circumstances of living and working [4–6]. Determining the association between social factors and vaccine uptake helps to quantify any vaccination inequalities in specific population groups and assists health care providers in planning targeted interventions and making any necessary changes to vaccination programmes. The social factors affecting vaccine uptake may vary with age and with the type of vaccine [4–7]. A 2011 systematic review summarised the association of social determinants of health with uptake of a single vaccine (seasonal influenza (SIV)) for older individuals (aged $\geq$65 years), without quantitative synthesis [6]. This previous study found conflicting associations of factors such as education, marital status, ethnicity, socio-economic level and place of residence, without undertaking a comprehensive assessment of between-study heterogeneity [6].

The social factors associated with SIV uptake may be different from other vaccines used for older adults such as pneumococcal and herpes zoster vaccines that are not administered annually. The objective of this review was to systematically appraise and quantify the association of social factors with uptake of vaccines amongst individuals aged $\geq$60 years from Europe including a detailed between-study heterogeneity assessment when necessary. It was anticipated that the studies from the European region may be more homogenous compared to those from low-income settings, making data synthesis more feasible.

2. Methods

2.1. Search strategy

This review formed part of a larger search for studies exploring social determinants of vaccine uptake in Europe for all age groups. The wider search ensured that studies spanning different age groups, including subgroups of older individuals, were not potentially missed. The data sources comprised Medline and Embase, searched from inception to 24/02/2016. Search terms (text words and subject headings) were drawn up for four search concepts: social factors, the European region [8], vaccination and uptake. The search included articles, letters and conference abstracts published in English. Additionally, reviews of vaccine uptake (worldwide from the last five years) were searched to identify further European studies. The detailed search strategy is provided in Appendix-1. Reference lists of all eligible studies and reviews were also searched.

To identify social factors associated with vaccine uptake, we adapted the conceptual framework developed by the World Health Organisation's Commission on Social Determinants of Health (Appendix-2) [7] for tackling health inequalities globally. This framework provides a comprehensive approach for identifying complex relationships between social factors and inequality, and how to plan and implement interventions. We sought evidence for social factors relevant at an individual level or provided insight into individuals' environment that could assist healthcare providers to target specific social groups for equitable healthcare delivery. The following factors were identified as possible determinants of vaccine uptake: country of birth, religion, urban/rural residence, marital status, living arrangements (living with others versus living alone), and socio-economic position (education, income (individual or household), type of health insurance, area-level socio-economic status (SES), social class/occupation). For the purposes of this review, we did not examine factors that were possible mediators of the main factors of interest: knowledge, attitude and beliefs, access to healthcare and health status/co-morbidities (Appendix-2).

The titles and abstracts of the records retrieved were screened for full text assessment based on *a priori* inclusion criteria (Appendix 3). Studies reporting the effect of one or more social factor of interest on vaccine uptake amongst individuals aged $\geq$60 years from Europe [8] were potentially eligible. The outcome was any routine vaccination programme and/or one-off vaccination such as pandemic mass vaccinations or catch-up vaccinations; travel or occupational health vaccinations were excluded. Eligible study designs comprised cross-sectional, ecological, case-control or cohort studies. We further restricted to studies that quantified the relationship between social factors of interest with vaccine uptake by either reporting relative risks or providing raw data

for their calculation; studies presenting the results of hypothesis testing without reporting effect measures were described narratively. Multiple papers describing the same study population were included once. The abstracts of the records that appeared to meet these screening criteria were selected for a full text review.

The eligibility criteria were applied by one reviewer (AJ) to the titles/abstracts identified, for full-text assessment. A random sample (10%) of titles considered ineligible were screened independently by two other reviewers (ST and AJVH) (no disagreements were observed). Of the total records identified for full text review, the eligibility for 10% of the records for which eligibility was initially unclear was resolved by discussion (ST, AJ and AJVH).

2.2. Data extraction

Data were extracted by one reviewer (AJ). Information was extracted for: author, study characteristics (year, country, design, size, participants) vaccine types, social factors, effect estimates and confounders used for adjusted effect estimates.

2.3. Quality assessment

Quality assessment was performed by one reviewer (AJ) including detailed discussions with the second reviewer (ST), using the Cochrane approach for risk of bias adapted for observational data [9,10]. Risk of bias (categorised as low, high or unclear risk) was assessed for the following five domains: selection bias, missing data, misclassification of vaccination status, misclassification of social factors (including consideration of timeliness for time-varying social factors - marital status, living alone, rural/urban residence, area-level SES, income and insurance status), and confounding bias. Details of the bias assessment are provided in the Appendix-4.

2.4. Data analysis

Forest plots of effect estimates (odds ratios (OR) or risk/rate ratios (RR)) were generated for each social factor, stratified by vaccine type. Raw data were used to calculate ORs if effect estimates were unavailable. The effect estimates from the most appropriate model (ideally, controlling for confounding and not adjusted for mediating variables) were used when available, otherwise the unadjusted estimate was used. For social factors with more than two categories, reported estimates for the highest or lowest category were selected. To address varying choice of baseline exposure group in different studies, effect estimates for a comparable baseline were re-calculated when possible using raw data; if the exposure variable was binary, the effect estimates were reversed for studies that used a different baseline. Similarly, effect estimates for non-uptake of vaccination were reversed to obtain estimates for vaccine uptake. Studies were described narratively if such comparisons were impossible or if estimates from probit or linear probability models were presented.

Between-study heterogeneity was explored using I^2-statistics and the Cochrane Q-statistic [11]. When the I^2-statistic was $\leq$50% fixed effects meta-analyses [11] were conducted. When between-study heterogeneity ($I^2 > 50\%$) was identified for a particular factor, a random effects meta-analysis was conducted if effect estimates were all broadly in the same direction, but was not attempted when effect estimates were in opposing directions as the summary estimate was considered uninformative [11].

Between-study heterogeneity was explored as follows: stratifying by vaccine type (influenza vs other vaccine uptake), different effect measures (OR or RR), re-categorising exposures with >2 categories (when feasible) to maximise homogeneity of exposure definitions; restricting analyses to studies reporting adequately adjusted estimates (Appendix 4), and stratifying results by whether the vaccine was available free-of-charge in the country (to see whether costs of vaccination modified effect estimates).

Meta-regression analysis was conducted to further investigate heterogeneity for social factors with at least 10 studies, assessing: vaccine type (influenza vs other vaccine uptake); OR/RR as effect estimates; heterogeneity in the categories chosen for the social factor; confounding bias; whether the vaccine was available free-of-charge; and any over-adjustment of effect estimates (inclusion of hypothesized mediating variables in multivariable models).

Data were analysed using Stata 14 software package (StataCorp LP, College Station, TX, USA).

3. Results

A total of 11,754 titles were identified, of which 479 titles (including one title identified from references) were evaluated for full text review (Appendix-5) resulting in 35 eligible studies conducted between 1997 and 2015 (Appendix-6). Most were cross-sectional with five cohort studies and one case-control study. Three studies reported data for more than one European country [12–14], with the remaining 32 studies conducted in 11 countries (Table 1), Spain being the most frequent (n = 11) followed by the UK (n = 5). The studies ascertained uptake of SIV (n = 27), pneumococcal vaccine (PV) (n = 1), both SIV and PV (n = 5), SIV and pandemic influenza vaccine (n = 1), and SIV and herpes zoster vaccine (n = 1).

Amongst studies providing effect estimates education was the most frequent social factor investigated (n = 14), followed by living alone (n = 13), and country of birth (n = 11). The least studied factors were health insurance (n = 3) and religion (n = 1) (Table 1). Two studies reported effect estimates for some social factors but only statistical evidence (without effect estimates) for country of birth [15] and for private medical insurance [16] (Appendix-7). Nine additional studies [17–25] (Appendix-7) that did not provide effect estimates were summarised narratively.

3.1. Quality assessment

As shown in Table 2 and Appendix-8, studies had low risk of bias for outcome and exposure measurement but confounding bias was common. The confounding bias mostly resulted from lack of adjustment for at least one other social factor (Appendix-4) in multivariable models.

3.2. Social factors of vaccine uptake

3.2.1. Living alone

Of the nine studies considered for meta-analysis, six classified living alone as a binary variable, and for the other three [26–28] studies "living as a couple" was compared to living alone. Although results were heterogeneous, studies consistently showed increased uptake amongst those not living alone, with an overall 25% and 53% increase for SIV uptake after restricting analysis to adequately adjusted studies and stratifying by vaccine cost respectively (Fig. 1). Re-analysis of living arrangements as a binary variable (Fig. 1) did not reduce heterogeneity.

Two studies [29,30] categorised living arrangements differently. One (comparing smaller versus larger households) reported increased uptake amongst individuals from large households [29], whereas the other (living with children versus not living with children) [30] reported lower vaccine uptake amongst those living with children. The studies that used probit or linear regression models found negative associations between vaccine uptake and housing density [31] and those living with children [14]. The single

Table 1
Summary of studies reporting associations of social determinants with vaccine uptake (N = 35).

	First author	Country	Study period	Sample size	Study population	Vaccine	Social determinants and their association with vaccine uptake									
							SES (A)[a]	Inco[b]	SC[c]	COB[d]	Edu[e]	LA[f]	RS[g]	Reli[h]	Res[i]	HI[j]
Cross-sectional studies																
1	Abramson [32]	Israel	1997	626	People aged ≥65 years with a telephone and registered at the Jerusalem community centre	SIV				N*δ	N*		↓*	N*		
2	Aguilar [56]	Spain	2010–2011	104,427	Computerised vaccination records for all non-institutionalised individuals ≥65 years covered by Navarre Health Service	SIV				↓*					N*	
3	Barrett & Mc Hugh [33,47]	RoI	October 2009–February 2011	3,510	Community residents aged ≥65 years from The Irish Longitudinal Study on Ageing (TILDA)	SIV		↓			↓					↑
4	Bodekar [15]	Germany	March–June 2014	825	Respondents (aged ≥60 years) to a nationwide telephone survey	SIV					N					
5	Bohmer [37]	Germany	July 2008–June 2009	8,458	Respondents (aged ≥60 years) to a national telephone health survey	SIV		N*			N					
6	Burns [57]	UK	2001–2002	444	Adults aged ≥65 years interviewed at public places around Birmingham	SIV			↓*			↑*				
7	Carreno-Ibanez [58]	Spain	March–June 2014	76,782	Individual records from the primary care electronic records for people aged ≥60 years with chronic bronchitis or emphysema from the Autonomous Community of Madrid	PV				↓						
8	Chiatti [26,48,59]	Italy	December 2004–September 2005	25,183 (3,738 with COPD)	People (aged ≥65 years) from the "Healthstatus of the population and use of health services in Italy" survey (ISTAT 8) and a secondary analysis of individuals who self-reported a diagnosis of COPD	SIV		N*	↑*		N*	N*	↓*			
9	Christenson [34]	Sweden	December 2000–May 2001	7,631	Responders (aged ≥65 years) of a postal survey sent to people registered with the Stockholm County Council Population Register	SIV & PV					↑		↓			
10	Crawford [12]	UK and RoI	2004	2,033	Community residents (aged ≥65 years) surveyed as a part of "Healthy Aging Research Programme"	SIV			N*			N*	N*		N*	
11	Damiani [35]	Italy	September 1999–June 2000	24,564	Respondents (aged 65–89 years) to the Italian national survey	SIV		↑*	N*		N*		↓*			
12	de Souto [42]	France	May–July 2011	6,275	Residents from 175 nursing homes in the Midi-Pyrenees region	SIV & PV									SIV: N*; PV ↓*	
13	Jimenez-Garcia [60]	Spain	2003	6,134	Non-institutionalised participants (aged ≥65 years) in the Spanish National Health survey	SIV				N*						
14	Jimenez-Garcia [61]	Spain	June 2006–June 2007	7,835	Non-institutionalised respondents (aged ≥65 years) to the Spanish National Health survey	SIV				↓*						
15	Jimenez-Garcia [62]	Spain	November 2004–June 2005	1,629	Respondents (aged ≥65 years) to the "Madrid City Health Survey: ESCM 05"	SIV				N*						
16	Jimenez-Garcia [63]	Spain	July 2011–June 2012	5,725	Non-institutionalised respondents (aged ≥60 years) to the Spanish National Health Survey	SIV				↓*						
17	Jimenez-Garcia [64]	Spain	2012–2013	1,307,165	Records of people aged ≥60 years registered with the public health system of the Autonomous Community of Madrid	SIV				↓*						
18	Kroneman [29]	Sweden	April–May 2004 & March–April 2005	612	Respondents (aged ≥65 years) to a national telephone survey	SIV						N*				
19	Landi [13]	11 countries^	2001–2003	3,878	Participants from urban areas aged ≥65 years from 11 European countries that took part in the "Aged in Home Care (ADHOC) project" of EU	SIV		↑*				↑*				
20	Mamelund [36]	Norway	November 2008	354	Non-institutionalised participants aged ≥65 years of a national telephone survey	SIV		N			N	N				
21	Nexoe [65]	Denmark	September 1996 & February 1997	1,204	Respondents to postal questionnaires aged ≥65 years identified from the Civil Registration System	SIV						↑*				
22	Opstelten [45]	Netherlands	1999	666	Respondents to a postal questionnaire, aged ≥65 years and registered with 4 general practices in Amersfoort town	SIV and PV										↓*
23	Opstelten [49]	Netherlands	September 2007	1,221	Respondents to postal questionnaire, aged ≥65 years and registered with 3 general practices in Amersfoort town	HZ & SIV					↓*					
24	Pena-Rey [50]	Spain	January 2000	1,111	Participants (aged ≥65 years) in a women's social and health	SIV		↑*			N		↓*		N*	

Table 1 (*continued*)

	First author	Country	Study period	Sample size	Study population	Vaccine	Social determinants and their association with vaccine uptake									
							SES (A)[a]	Inco[b]	SC[c]	COB[d]	Edu[e]	LA[f]	RS[g]	Reli[h]	Res[i]	HI[j]
					survey in Galicia											
25	Sarria-Santamera [16]	Spain	1997	1,148	Non-institutionalised participants (aged ≥65 years) in the Spanish National Health survey (ENS)	SIV		N			N					
26	Schmitz [14]	15 countries	2004 & 2006	8,891	Respondents aged ≥65 years from the first and the second wave of the Survey of Health, Ageing and Retirement in Europe (SHARE)	SIV					↑*α	↓* α ζ	↑* α τ			
27	Shahrabani [31]	Israel	1999–2000	4,083	Respondents (aged ≥60 years) to the Health Survey of the Central Bureau of Statistics	SIV				↓* α ε	N* α	↓* α η	↓* α			
28	Sintes [28]	Spain	May 2005–January 2007	1,702	Non-institutionalised patients aged ≥65 years admitted with community acquired pneumonia to 3 acute general hospitals in Catalonia and Galicia	SIV & PV			SIV: N, PV: ↑		SIV: N, PV:↓	↑*			N	
29	Wershof Schwartz [43]	Israel	2008–2009	136,944	Individuals aged ≥65 years and registered with Maccabi Healthcare Services	SIV & PV	↓*			↓*					↑*	
Casecontrol study																
30	Van Essen [46]	TN	1993–1994	181	Respondents (aged ≥65 years) to a postal questionnaire, registered with seven family practices situated in a suburban area	SIV						N*				N*
Cohort studies																
31	Breeze [41]	UK	1997–2000	29,731	People aged >74 years with available flu vaccination records registered with general practices in the UK taking part in the "Trial of Assessment and Management of Older People in the Community Study"	SIV	N*	N*							N*	
32	Mangtani [27]	UK	2000	5,572	People aged >74 years from the "Trial of Assessment and Management of Older People in the Community"	SIV	N*	N*				↑	↓		↑*	
33	Martinez-Baz [30]	Spain	2010–2011	64,245	Individual records of non-institutionalised people aged ≥65 years and previously vaccinated in 2009–2010 Navarre	SIV				↓*		↓*θ			N*	
34	Sammon [44]	UK	August 2009–June 2010	353,921	Individuals aged ≥65 years in clinical risk groups and registered with a practice contributing to the General Practice Research Database at the beginning of the H1N1 vaccination campaign	SIV & PIV	SIV: N*β; PIV:↓* β									
35	Shah [66]	UK	June 2008–January 2009	387,568	Individual records of community and care (nursing and residential) home residents aged 65–104 years and registered with a practice contributing to The Health Improvement Network primary care database	SIV	↓*									
	Total number of studies (%)						5 (14%)	10 (29%)	5 (14%)	11 (31%)	14 (40%)	13 (37%)	9 (26%	1 (3%)	9 (26%)	3 (9%)

SES(A) – socio-economic status area [a] most deprived versus least deprived (reference group) except for [β]Sammon et al. (3rd quintile: reference group).
Inco – income [b] Highest income level versus lowest income level (reference group).
SC – social class [c] Lowest social class versus highest social class (reference group).
COB – country of birth [d] Immigrants versus native (reference group) ([δ]Abramson et al.: others versus those from Asia/Africa (reference group), [α]probit marginal probabilities [ε]Shahrabani et al. individuals from USSR (after 1990) versus native (reference group)).
Edu – education [e] Highest education level versus lowest education level (reference group).
LA – living arrangements [f] Not living alone versus living alone/smaller household size (reference group); [ζ]Schmitz et al. number of children in household (ordinal variable); [η]Shahrabani et al. housing density (ordinal variable); [θ]Martinez-Baz et al. living with children aged <15 years versus not living with children aged <15 years (reference group).
RS – relationship status [g] Not married versus married (reference group); [τ]Schmitz et al. no partner (reference group).
Reli – Religion [h] Not religious versus religious (reference group).
Res – Residence [i] Urban versus rural area (reference group).
HI – health insurance [j] Private insurance versus no private insurance (reference group).
SIV seasonal influenza vaccine PIV pandemic influenza vaccine PV pneumococcal vaccine HZ herpes zoster vaccine.
N – not associated with vaccine uptake. *adjusted estimates ↓ lower vaccine uptake ↑ higher vaccine uptake.
RoI – Republic of Ireland, COPD – Chronic Obstructive Pulmonary Disease.
^11 countries Czech Republic, Denmark, Finland, France, Germany, Iceland, Italy, The Netherlands, Norway, Sweden, UK.
∼15 countries Austria, Belgium, Czech Republic , Denmark, France, Germany, Greece, Ireland, Italy, The Netherlands, Poland, Spain, Sweden, Switzerland & Israel.

Table 2
Quality assessment of the studies included in the review.

Study type & Ref.	Social determinants and bias																														
			Area SES			Income			Social class			COB			Education			Living alone			Marital status			Religion			Residence			Insurance		
Cross-sectional	SB	OM	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD
[32]	L	L										L	L	U	L	L	U				L	L	U	L	L	U						
[56]	L	L										L	L	L													U	L	L			
[33, 47]	H	L				H	H	H							L	H	L													H	H	L
[15]	H	L													L	H	L															
[37]	H	L				L	L	U							L	H	U															
[57]	L	L							L	L	L							L	L	L												
[58]	L	L										L	H	L																		
[26, 48, 59]	U	L				L	L	L	L	L	L				L	L	L	L	L	L	L	L	L									
[34]	L	L													L	H	L				L	H	L									
[12]	H	L							L	L	U							L	L	U	L	L	U				L	L	U			
[35]	U	L				L	L	L	L	L	L				L	L	L				L	L	L									
[42]	H	L																									L	L	L			
[60]	U	L										L	H	L																		
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[13]	U	L				L	L	L										L	L	L												
[36]	H	L				L	H	H							L	H	L	L	H	L												
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[50]	L	L				L	L	L							L	H	L				L	L	L				L	L	L			
[16]	L	L				L	H	L							L	H	L															
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[28]	U	L							L	H	L				L	H	L	L	H	L*	L						L	H	L			
[43]	L	L	H	L	L							L	L	L													L	L	L			
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Case-control																																
[46]	L	L																L	L	L										L	L	L

Ref. – reference, SES – socioeconomic status, COB – country of birth, SB – selection bias, OM – outcome misclassification, EM – exposure misclassification, CB – confounding bias, MD – missing data, L – low risk of bias, U – unclear risk of bias, H – high risk of bias.
Red cell with letter H signifies high risk of bias.
Green cell with letter L signifies low risk of bias.
Yellow cell with letter U signifies unclear risk.
*Low risk of bias for pneumococcal vaccine.

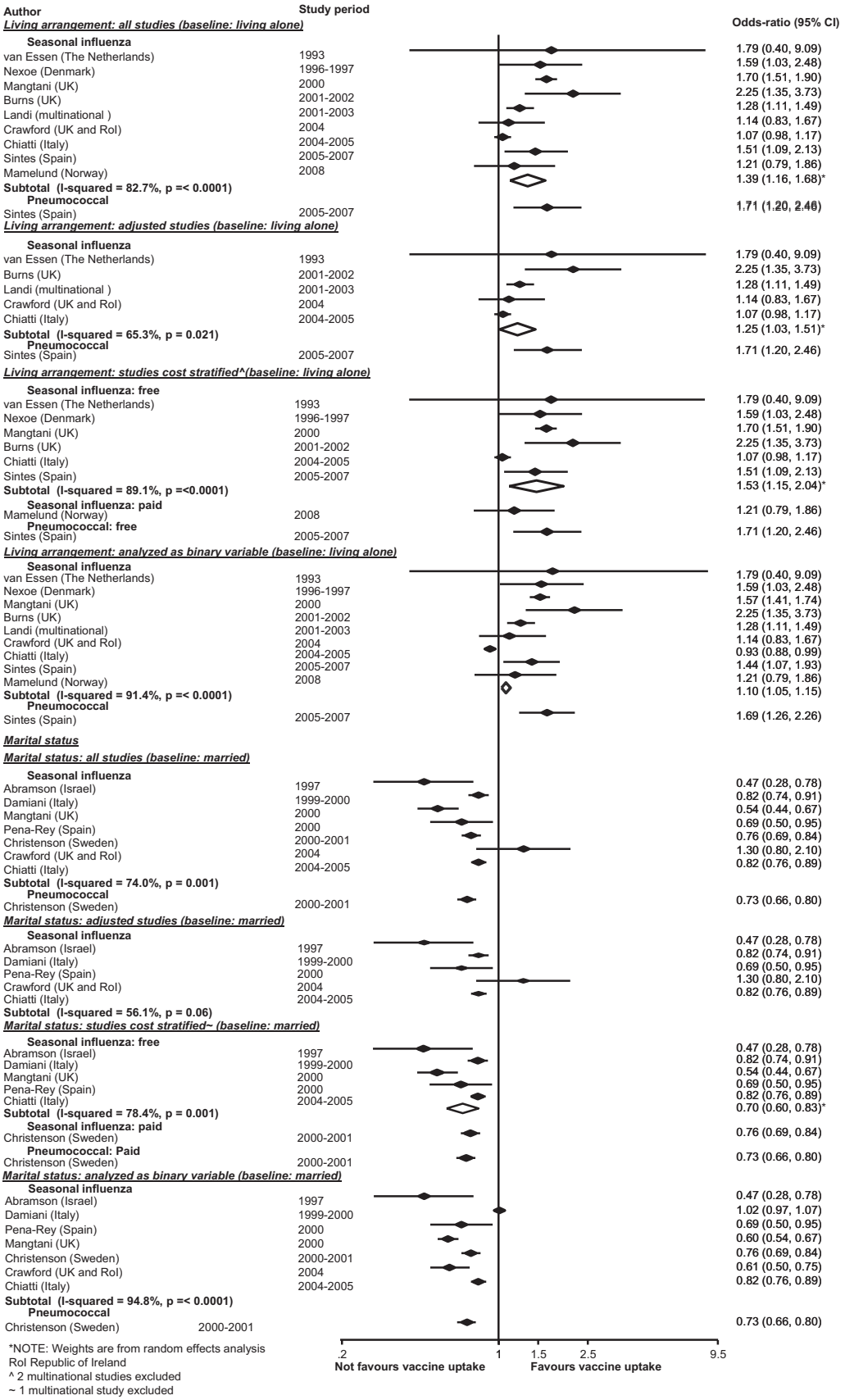


Fig. 1. Effect of living arrangements and marital status on vaccine uptake.

UK study that did not provide effect measures, found no association between living arrangements (categorised as a seven-level variable) and SIV uptake amongst patients admitted to a geriatric ward [20] (Appendix-7).

3.2.2 Marital status

Four of the seven studies considered in the meta-analysis categorised marital status as a binary variable, for the remaining three studies single status was compared to being married. After stratification by vaccine type, 18–53% lower vaccine uptake was observed amongst unmarried individuals in all studies except one [12] with notable between-study heterogeneity (I^2 = 74%, Fig. 1). Reclassifying marital status in three studies as a binary variable (unmarried versus married) did not reduce the between-study heterogeneity (Fig. 1). Heterogeneity was reduced but still appreciable after restricting analyses to adequately adjusted SIV uptake studies. Results were more homogeneous after stratifying by vaccine cost; in countries in which SIV was free-of-charge, overall uptake amongst unmarried individuals was 30% lower compared to married individuals (Fig. 1), echoing findings for living arrangements (Fig. 1). The studies that used linear probability [14] or probit models [31] also found higher SIV uptake amongst married individuals or those with a partner, as did one of the three Spanish studies that did not provide effect measures (uptake 47.8% vs 53%) [21]; the other two Spanish studies found no evidence for an association between marital status and SIV uptake [16,18] (Appendix-7).

3.2.3. Education

Twelve studies were considered for meta-analysis (Fig. 2). There was no consistent effect of higher education on vaccine uptake after stratification by vaccine-type (I^2 > 80%). Results were little changed after re-categorising education in seven studies as a binary variable (education up to ages 12–15 years and >15 years) [16,26,32–36] (Fig. 2). Restricting analysis to adequately adjusted studies resulted in a consistent direction of effect (Fig. 2) with a summary estimate of 5% higher uptake amongst those with the highest education level.

Interestingly, stratification by vaccination cost [32,34,35,37–40] showed marked differences. In countries where the vaccine was provided free-of-charge there was no overall effect of education. In contrast, in countries where a payment for vaccination was necessary, higher education was associated with an overall 67% increased odds of SIV uptake. (Fig. 2). A reverse effect (20% decreased odds of uptake) was seen in the single Irish study, where vaccine administration payments are means tested [39,40].

Two studies excluded from meta-analysis reported marginal probabilities: one found no evidence of an association of education level with SIV uptake [31] and the other (including fifteen countries) found low education level associated with lower SIV vaccination (linear probability model coefficient = −0.034) [14]. Four further studies did not provide effect estimates: a Greek study [24] showed higher uptake amongst those with at least primary education whilst three Spanish studies [18,21,22] reported no evidence of effect of education on SIV uptake (Appendix-7).

3.2.4. Household/individual income

The eight studies that reported ORs for income and SIV uptake showed no consistent effect (Fig. 2). Amongst the two studies [27,41] reporting RRs, there was no overall effect of income on SIV uptake (Fig. 2).

Despite remaining heterogeneity, results were more consistent after restricting to studies with adequate adjustment for confounding, with an overall 26% increased odds of SIV uptake amongst those with higher income, consistent with that observed for the effect of education (Fig. 2). Unlike the findings for education, in stratified analyses an overall 14% higher odds of SIV uptake amongst those with higher income was observed in countries offering free-of-charge vaccination [37,40] (Fig. 2). However, in a single Irish study [33] where vaccination payment was means tested [40], the effect of higher income was similar to that of higher education: those with higher income had lower odds of SIV uptake (Fig. 2). It was not possible to re-classify income status as a binary variable for comparison across studies, and the exploration of heterogeneity for this aspect was therefore not undertaken.

Four studies did not provide effect estimates for the association of income with vaccine uptake (Appendix-7). A second Irish study found uptake of both SIV and PV to be higher ($p < 0.001$) amongst individuals entitled to free vaccine (possessors of a medical card) compared to those who paid for vaccination [17]. Higher SIV coverage was reported for individuals with lower income in urban areas of Turkey where the vaccination was not available free-of-charge [19]. In contrast, two Spanish studies found no evidence of an association between income and SIV uptake [18,21].

3.2.5. Urban or rural area of residence

Eight of the nine studies (SIV n = 6, SIV and PV n = 3) with effect estimates reported the association of vaccine uptake with the location of individuals' own homes (urban or rural), whilst one French study [42] investigated the location of individuals' nursing homes (Fig. 3). No consistent direction of effect was observed for studies reporting ORs for the association of SIV uptake with residence. However, the studies that presented RRs for SIV uptake and ORs for PV uptake found an overall 11% and 15% increase in uptake respectively amongst urban residents (Fig. 3).

The location of nursing homes had no effect on SIV uptake, but (in contrast to individuals living independently) a lower uptake of PV was observed in residents in urban versus rural nursing homes (Fig. 3).

Between-study heterogeneity for SIV uptake could not be explained by restricting the analysis to adjusted ORs (Fig. 3) and all studies except one [12] offered free vaccination. Again, it was not feasible to re-categorise this exposure as binary variable.

A UK study that did not provide effect measures found no association between location of general practices and SIV uptake [23].

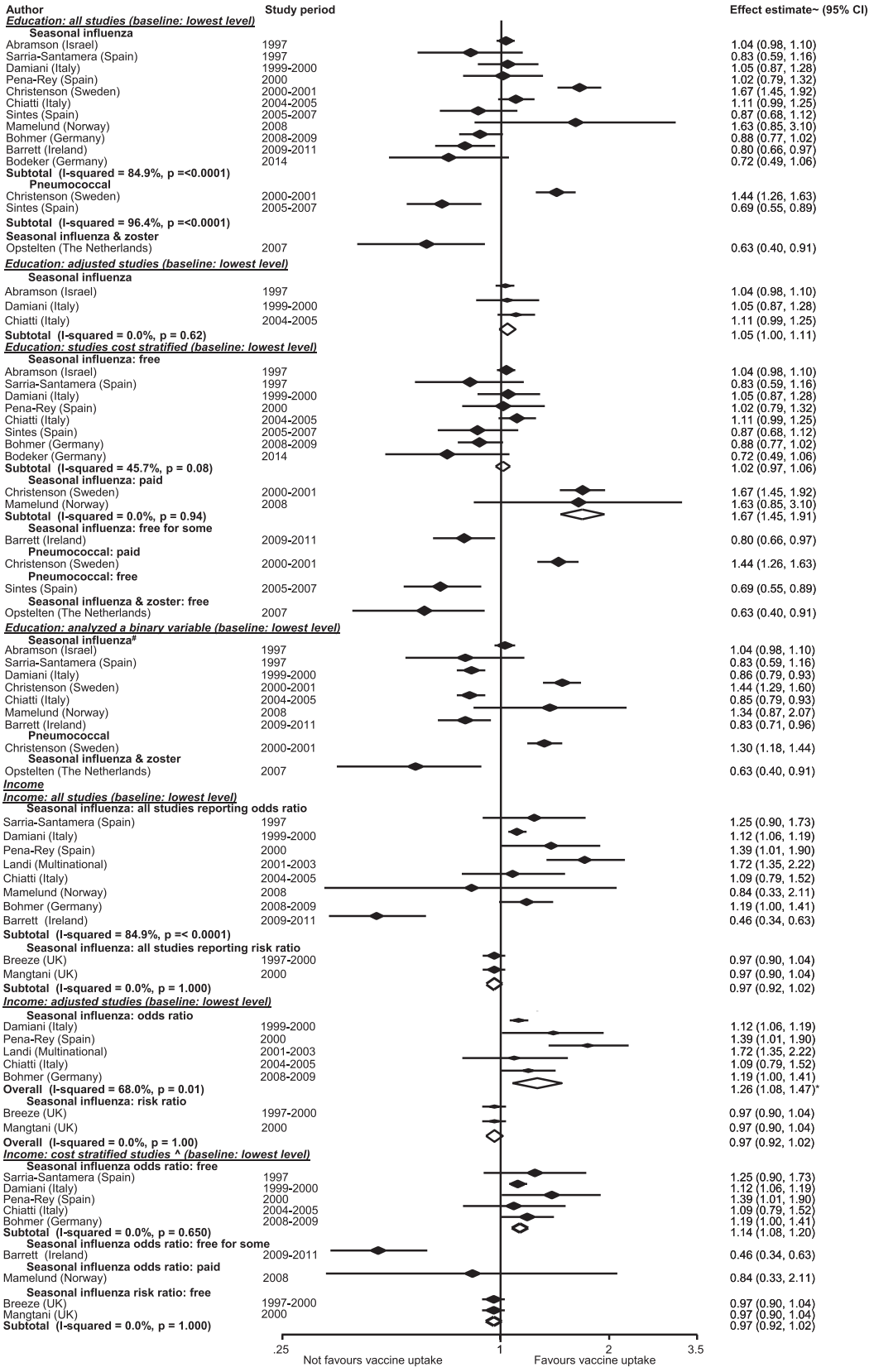
3.2.6. Area-level SES

Five UK studies reported the association of area-level SES with vaccine uptake (SIV alone n = 3, SIV and pandemic influenza n = 1, SIV and PV n = 1, Fig. 3). All but one study reported RRs [43]. The reference group for one study [44] was the third quintile of deprivation in contrast to the other four studies (the baseline group being the least deprived area).

The results were similar to the effect of household income (Fig. 2), with risk of SIV uptake modestly (7–11%) lower amongst those living in most deprived areas. This effect was seen consistently irrespective of vaccine type or measure of effect (Fig. 3) or using a different baseline group. All studies were from countries providing free-of-charge vaccination and it was not feasible to re-categorise this exposure.

3.2.7. Private medical insurance

Two [45,46] of the three studies considered in meta-analysis categorised insurance as a binary variable; one study [47] used a four-level variable (Appendix-6). The latter study compared individuals with private medical insurance to those without insurance as baseline. After stratification by vaccine types (Fig. 3), overall SIV uptake was 67% more likely amongst individuals with private medical insurance, but uptake of both SIV and PV was 62% lower (Fig. 3). One study [46] provided adequately adjusted estimates; all but one study [47] were conducted in countries that provided vaccine free-of-charge (Fig. 3). SIV uptake was 72% higher amongst



~All effect estimates are odds ratio unless specified otherwise
Subtotal (I-squared = 92.7%, p =< 0.0001) *NOTE: Weights are from random effects analysis ^One multinational study excluded

Fig. 2. Effect of education and income on vaccine uptake.

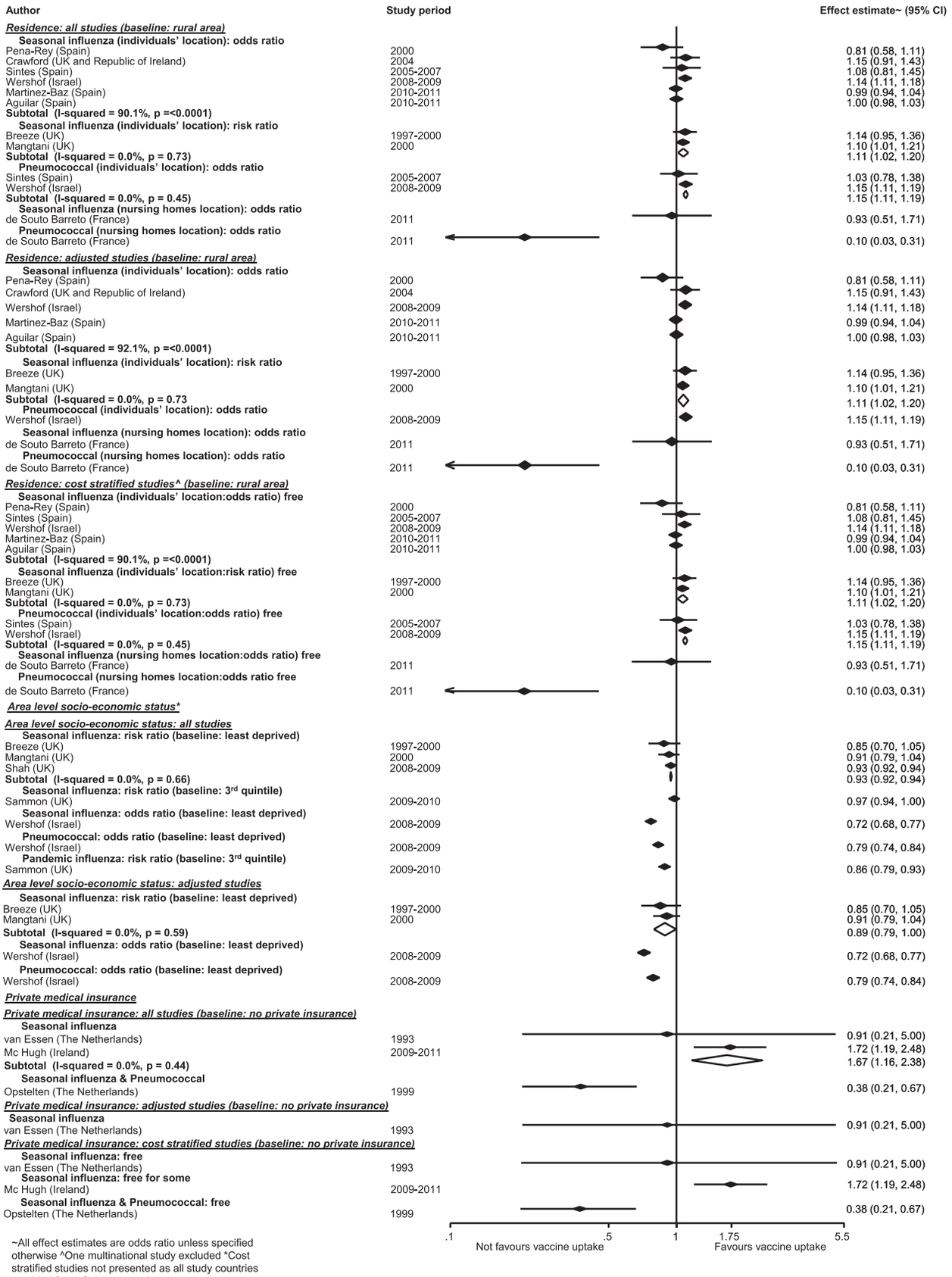
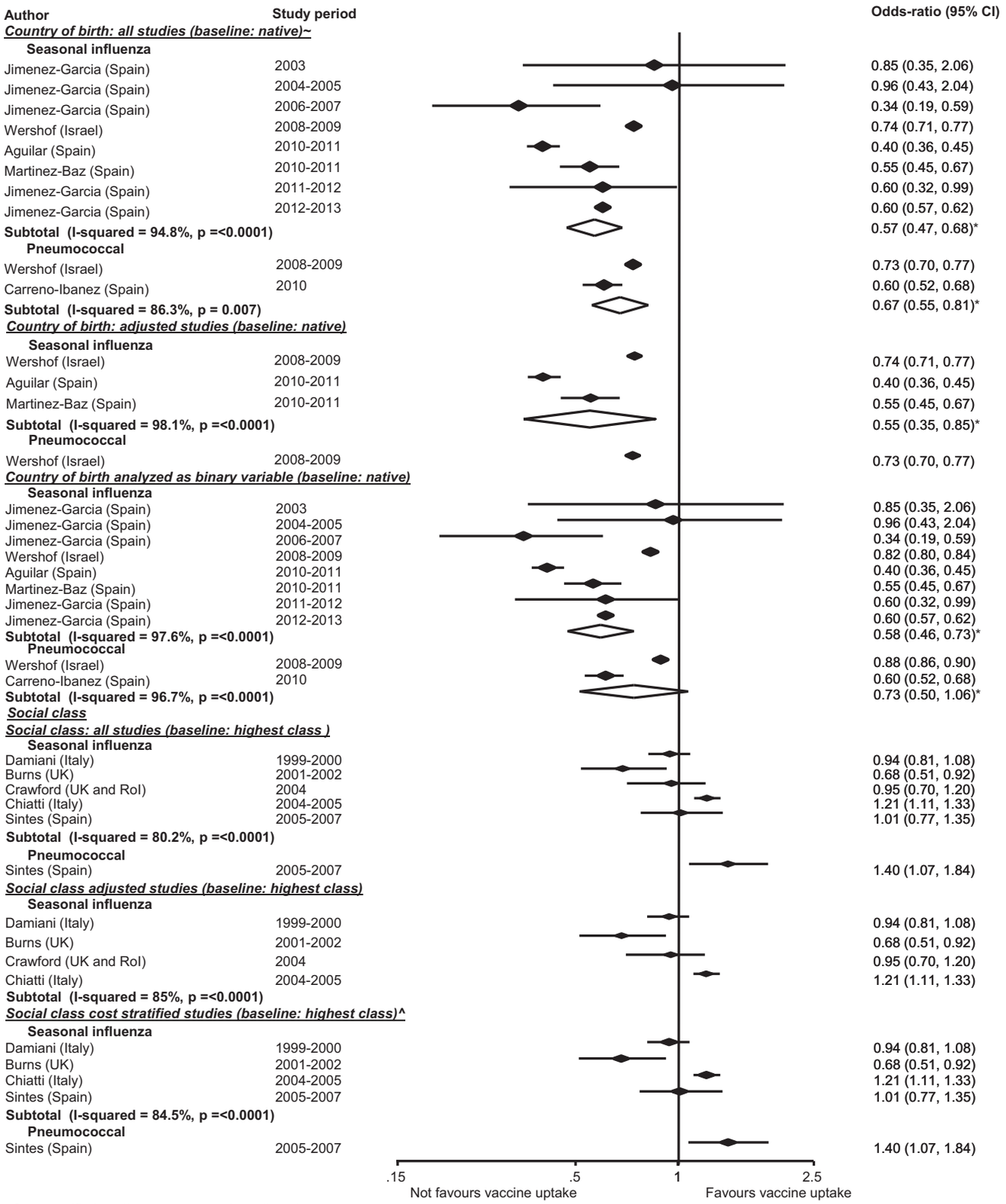


Fig. 3. Effect of residence, area level socio-economic status and medical insurance on vaccine uptake.



~Cost stratified studies not presented as all study countries offered free-of-charge vaccine
RoI Republic of Ireland *Weights are from random effects analysis
^ one multinational study excluded

Fig. 4. Effect of country of birth and social class on vaccine uptake.

those with private medical insurance was observed in the Irish study [47] where vaccination charges were means tested [40].

A Spanish study [16] that did not provide effect measures reported no evidence of association of private medical insurance with SIV uptake (Appendix-7).

3.2.8. Country of birth

Nine studies, all except one conducted in Spain, were considered for meta-analysis (Fig. 4). Overall, there was lower uptake of vaccination amongst immigrants irrespective of vaccine type, with uptake 43% and 33% lower for SIV and PV vaccines respectively (Fig. 4). The summary effect estimate was near-identical after restricting SIV studies to those with adequate adjustment of confounding, and after reclassifying country of birth in one study [43] as a binary variable (Fig. 4). Stratification based on vaccine costs was not required as all included countries offered free vaccinations.

Two studies from Israel with effect estimates were excluded from meta-analysis, one [32] used a different definition for country of birth (those born in Asia or Africa versus elsewhere) and the second used marginal probabilities to investigate immigration status; neither found an association with SIV uptake [31]. Two further studies did not provide effect estimates: an Israeli study [25] found statistical evidence for lower uptake of both SIV and PV amongst Russian speakers compared to Arabic speakers, whilst a German study found no evidence for lower SIV uptake amongst immigrants [15].

3.2.9. Social class/occupation

Five studies (SIV: n = 4, SIV and PV: n = 1) provided effect estimates for the association of social class with vaccine uptake (Fig. 4). There was no consistent effect seen for SIV uptake (I^2 = 80.2%), but the single study of PV uptake (from Spain) reported higher uptake amongst individuals from the lowest social class [28].

Between-study heterogeneity could not be explained after restricting to studies with adequate adjustment for confounding or stratifying by vaccine costs (Fig. 4), and this exposure could not be consistently re-categorised as a binary variable across studies to further explore between-study heterogeneity.

3.2.10. Religion

The one study that provided effect estimates [32], found no strong evidence for an association with SIV uptake (religious versus not religious: OR = 1.71 (95%CI:0.96–3.03)) Another study (no effect estimates provided) [25] reported an association of SIV uptake with place of residence that varied with individuals' religion: amongst Jewish individuals higher uptake was noted in rural areas compared to urban areas ($p < 0.04$) whilst the association was reversed amongst Muslim individuals(with higher uptake in urban (80%) compared to rural areas (76%) (Appendix-7).

3.3. Meta-regression

There were sufficient studies (n = 12) to further examine the reasons for heterogeneity for the association of education with SIV uptake [15,16,28,32–37,48–50].

Multivariable meta-regression analyses included vaccination cost (free versus paid), confounding bias (low or high risk of bias) and 'over-adjustment' (studies that included in multivariable analyses variables hypothesized to be on the causal pathway between education and vaccine uptake). There was strong evidence ($p < 0.0001$) that the association of education with vaccine uptake varied with vaccination costs: in studies from countries (Sweden and Norway) where the population had to pay for vaccination, the ORs were 1.93 times the ORs reported from countries where vaccines were available free-of-charge for some (e.g. Ireland) or all (e.g. Spain) of the population. There was some evidence ($p = 0.05$) that between-study heterogeneity could be explained by risk of confounding bias, but little evidence that it was explained by 'over-adjustment' ($p = 0.2$). All education studies reported ORs and investigated SIV vaccine uptake, and thus the type of effect estimate and vaccines were not examined. Each study categorised education differently making it infeasible to examine this the meta-regression model. Analyses were repeated after excluding the study reporting both SIV and zoster uptake (n = 11), revealing similar results, but the effect 'over-adjustment' could not be investigated in the reduced model due to collinearity.

4. Discussion

To our knowledge, this is first review to quantify systematically the effect of a wide range of social factors on vaccine uptake amongst older individuals in Europe. Not living alone, an important social factor for this population group, was associated with higher SIV (39%) and PV (71%) uptake. Marital status, which is likely to be highly correlated with living alone, also showed lower uptake of both SIV and PV amongst unmarried individuals in all except one study. Other characteristics associated with lower vaccine uptake included being an immigrant (43% and 33% lower uptake for SIV and PV respectively), and lower area-level deprivation (7% lower uptake for SIV), highlighting that vaccination inequalities continue to exist despite availability of free vaccines. The direction of effect for all these factors remained even after restricting the analyses to studies with low risk of confounding bias.

No consistent direction of effect was observed for education. However, restricting analyses to adequately adjusted studies showed a small (5%) overall increase of SIV uptake with higher education. The effect of income also initially appeared heterogeneous, but amongst adequately adjusted studies that measured ORs (and excluding the single study in which vaccines were not universally supplied free-of-charge), the effect of higher income was consistent with that of higher education. These findings concur with those from a study of individuals aged $\geq$50 years from 13 European countries, which reported lower utilisation of a range of preventative services, including SIV uptake, amongst those with lower income and education [51]. In contrast, there was no evidence of an effect of income for the two studies measuring RRs. This could in part be explained by ORs having more extreme values than RRs when the outcome is common [52]. Stratification by vaccine costs revealed contrasting results for education and income: unlike education, income-related inequalities persisted, with higher uptake amongst those with higher income in countries offering free-of-charge vaccination. Contrarily in Ireland (where vaccination payment are means-tested) [40], both lower income and lower education were associated with higher uptake.

Overall there was no consistent effect of social class on vaccine uptake; between-study heterogeneity could have resulted from differences in the definition used for this exposure, although data were not available to explore this further. The role of urban residence with vaccine uptake was also variable; although summary estimates for two SIV studies (measuring RRs) and for two PV studies (measuring ORs) indicated higher uptake in urban areas, most of the SIV studies showed inconsistent direction of effects for urban residence.

Some important determinants such as religion and access to private medical insurance were not consistently included across studies from different countries. Given increasingly diverse populations and differences in provision of healthcare across Europe, these determinants could be important end-points for future studies.

Living alone was identified as an important factor associated with lower vaccine uptake in this review and may be an indicator for social isolation [53]. Living alone has emerged as an important determinant of health in older populations. For example, in a 2010 systematic review, lack of social relationships was associated with a 50% increase in mortality, comparable to the increased risk resulting from smoking or obesity [54]. Similarly, a 2015 meta-analysis [53] found that living alone was associated with 32% higher mortality (OR 1.32, 95%CI 1.14–1.53). In 2013, approximately 13% of households in the European Union comprised individuals aged ≥65 years living alone [55]. With an increasingly ageing population, the numbers living alone are likely to rise, increasing the importance of preventative measures such as vaccinations. Interestingly in our review, living with children or increasing housing density in some studies was associated with lower SIV uptake, suggesting that not living alone also may have different effects on vaccine uptake depending upon household composition.

Our analysis is an important update (with nineteen additional studies) of the previous 2011 systematic review by Nagata et al., which assessed only SIV uptake amongst older individuals [6]. Our review extends the scope to all vaccines given routinely to older individuals, has provided the results of quantitative syntheses, and has carried out extensive investigation of between-study heterogeneity. Our review also included religion as a social factor, incorporates studies prior to 2011 that were not presented in this earlier review [6], and provides more detailed analyses of social factors such as country of birth, individual components of socio-economic position, marital status and living alone.

Our review has several strengths. A comprehensive search strategy was utilised to identify pertinent social determinants of SIV and other vaccine uptake amongst older populations. Stringent criteria for quality assessment were followed. Meta-analyses to obtain summary estimates, and detailed exploration of the causes of between-study heterogeneity using *a priori* stratification criteria and meta-regression, allowed insight into the complex relationships between various social determinants and vaccine uptake in different countries.

Our review also has some limitations. A number of the studies included in the review had high risk of confounding bias, and restricting analyses to studies presenting adequately adjusted effect estimates led to a reduced number of studies in these analyses. Our use of stratification revealed some causes of between-study heterogeneity. Meta-regression analysis, to further explore the causes for heterogeneity for factors other than education was not feasible due to insufficient numbers of studies. The multivariable meta-regression analyses for the effect of education indicated that both vaccine costs and confounding bias independently explained some of the heterogeneity in results. In this review the effect of social isolation or loneliness on vaccine uptake was not examined; individuals living alone may have strong social networks. The relationship between social isolation and vaccine uptake can perhaps be explored in future research. In addition, we hypothesized correlations between some social factors based on our conceptual framework, but it is possible that other complex inter-relationships between these factors may exist. Finally, we included only studies published in English language, which could have excluded some relevant data.

5. Conclusion

This is the first systematic review that quantifies the association of living alone, an important social factor for older individuals, with lower vaccine uptake. This, along with quantification of other factors such as immigration status, deprivation and education level, will help to target older individuals for interventions to mitigate vaccination inequalities. This review has also highlighted the limitations of existing studies in terms of study quality and between-study heterogeneity. As the role of social factors becomes increasingly recognised for equitable healthcare delivery, the findings of this review should provide guidance to healthcare providers for addressing vaccination inequality amongst older individuals. Our review should also help researchers to design future studies of higher quality with potentially more standardised definitions of social factors.

Conflict of interest statement

We have no conflict of interest to declare.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.vaccine.2017.03.013.

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2.3 Supplementary material to the published paper 1

Appendix 1 Search Strategy

Database(s): Ovid MEDLINE(R) 1946 to February Week 3 2016

#	Searches
1	exp Immunization Programs/
2	exp Vaccines/
3	exp Immunization/
4	1 or 2 or 3
5	(IMMUNI#ATION* or VACCIN* or IMMUNIS* or IMMUNIZ* or UNDER-IMMUNIS* or UNDERIMMUNIS* or UNDER-IMMUNIZ* or UNDERIMMUNIZ* or NON-IMMUNIS* or NONIMMUNIS* or NON-IMMUNIZ* or NONIMMUNIZ* or UNDER-VACCINAT* or UNDERVACCINAT* or NON-VACCINA* or NONVACCINA*).ti,ab.
6	decision making/ or choice behavior/ or exp refusal to participate/
7	exp "Patient Acceptance of Health Care"/
8	6 or 7
9	(ACCEPT* or AGREE* or BARRIER* or CHOOSE* or CHOSE or CHOICE* or COMPLIAN* or COVER* or DECISION* or DELAY* or DROPOUT* or DROP*-OUT* or HESITAN* or INCOMPLETE or INDECISION* or POSTPONE* or RECEIVE* or RECEIPT or REFUS* or RELUCTAN* or TIMELY or UPTAKE or UP-TO-DATE or UPTODATE or USAGE or UTILI#ATION or NON-COMPLIAN* or NONCOMPLIAN* or UNDER-UTILI#ATION or UNDERUTILI#ATION).ti,ab.
10	4 and 8
11	((IMMUNI#ATION* or VACCIN* or IMMUNIS* or IMMUNIZ* or UNDER-IMMUNIS* or UNDERIMMUNIS* or UNDER-IMMUNIZ* or UNDERIMMUNIZ* or NON-IMMUNIS* or NONIMMUNIS* or NON-IMMUNIZ* or NONIMMUNIZ* or UNDER-VACCINAT* or UNDERVACCINAT* or NON-VACCINA* or NONVACCINA*) adj10 (ACCEPT* or AGREE* or BARRIER* or CHOOSE* or CHOSE or CHOICE* or COMPLIAN* or COVER* or DECISION* or DELAY* or DROPOUT* or DROP*-OUT* or HESITAN* or INCOMPLETE or INDECISION* or POSTPONE* or RECEIVE* or RECEIPT or REFUS* or RELUCTAN* or TIMELY or UPTAKE or UP-TO-DATE or UPTODATE or USAGE or UTILI#ATION or NON-COMPLIAN* or NONCOMPLIAN* or UNDER-UTILI#ATION or UNDERUTILI#ATION)).ti,ab.
12	10 or 11
13	(AGEISM or (AGE adj3 DISCRIMINAT*)).ti,ab.
14	DEMOGRAPH*.ti,ab.
15	(EDUCAT* or LITERACY or LITERATE or ILLITERACY or ILLITERATE or LEARN*).ti,ab.
16	(ETHNICITY or ETHNIC or TRADITION* or (TRAVELLER* adj3 COMMUNIT*) or COMMUNIT*).ti,ab.
17	((FAMILY adj3 SIZE) or (BIRTH adj3 (ORDER* or INTERVAL*)) or PARITY or (MATERNAL adj3 AGE*) or (MOTHER* adj3 AGE*) or MARITAL or MARRIAGE* or MARRIED).ti,ab.
18	(INEQUALIT* or INEQUIT* or EQUIT* or EQUALIT* or DISCRIMINAT* or DISPARIT*).ti,ab.
19	(OCCUPATION* or JOB* or EMPLOY* or UNEMPLOY* or PROFESSION*).ti,ab.
20	(LIVING adj3 CONDITION*).ti,ab.
21	(MIGRATION or IMMIGRANT* or RELOCAT* or SETTLER* or REFUGEE* or DISPLACE* or ASYLUM*).ti,ab.
22	(MARGINALI* or MINORIT*).ti,ab.
23	(RESOURCEPOOR or RESOURCE-POOR or POOR or POVERTY or IMPOVERISHED or INCOME or WAGE or WAGES or AFFLUEN* or WEALTH* or FEE or FEES or COST* or AFFORD* or INSURANCE or INSURED or ((MEDICAL or PRESCRIPTION* or HOSPITAL or DOCTOR* or USER or CONSULT* or (VACCIN* adj3 ADMINIST*)) adj3 (FEE or FEES or CHARGE* or COST* or EXPENSE* or FUND*))).ti,ab.
24	(RACIAL or RACE).ti,ab.
25	(RELIGION* or RELIGIOUS or FAITH or ANTHROPOSOPHY or BUDDHIS* or CHRISTIAN* or CATHOLIC* or PROTESTANT* or (JEHOVAH* adj WITNESS*) or MUSLIM* or ISLAM* or HINDU* or JEWS or JEW or JUDAISM).ti,ab.

26	(RURAL or VILLAGE*).ti,ab.
27	(((GENDER or SEX*) adj3 (BIAS or DIFFEREN* or DISCRIMINAT*)) or SEXIS*).ti,ab.
28	(SLUM* or HOMELESS*).ti,ab.
29	(ANTI?VACCI* or ANTIVACCI* or ANTI-VACCI* or ANXIET* or ANXIOUS* or AWARE* or BEHAVIO?R or BEHAVIO?RAL or BELIEF* or BIAS* or CAUTIO* or CONCERN* or CONFIDEN* or CRITICIS* or DILEMMA* or DISBELIEF* or DISTRUST* or DOUBT* or EXPERIENCE* or FEAR* or KNOWLEDG* or LEARN* or MISUNDERSTAND* or MIS-UNDERSTAND* or MISCONCEPTION* or MIS-CONCEPTION* or MISTRUST* or MIS-TRUST* or MORALITY or MOTIVAT* or OPPOSITION* or PEER or PERCEPTION* or PRECONCEPTION* or PREJUDICE* or RUMO?R or RUMO?RS or SCARE* or SCEPTIC* or SOCIAL* or TRUST or UNCERTAIN* or UNDERSTAND* or UNWILLING* or WILLING*).ti,ab.
30	(((SOCIO-ECONOMIC or SOCIOECONOMIC) adj3 (FACTOR* or DETERMINANT* or DIFFERENCE*)) or (LIVING adj3 STANDARD*) or LIFESTYLE or LIFE-STYLE or SOCIO-DEMOGRAPH* or SOCIODEMOGRAPH* or DEPRIV*).ti,ab.
31	((AREA* adj3 RESIDEN*) or ((BUILD-UP or BUILDUP or BUILT-UP or BUILTUP) adj3 AREA*) or CITY or CITIES or INNERCIT* or INNER-CIT* or TOWN* or URBAN*).ti,ab.
32	(DIS-ADVANTAGE* or DISADVANTAGE* or UNDER-PRIVILEGE* or UNDERPRIVILEGE* or VULNERAB*).ti,ab.
33	((HEALTH or HEALTH-CARE or HEALTHCARE) adj3 (ACCESS* or AVAILAB*)).ti,ab.
34	((HEALTH or HEALTH-CARE or HEALTHCARE or HEALTH-STATUS or HEALTHSTATUS) adj3 DISPARIT*).ti,ab.
35	(CROSS-CULTUR* or CROSSCULTUR* or CULTURAL or ETHNOLOGY).ti,ab.
36	or/13-35
37	exp Sociology/
38	exp Social Behavior/
39	exp Vulnerable Populations/
40	exp cross-cultural comparison/
41	exp Cultural Characteristics/
42	exp cultural diversity/
43	exp Cultural Evolution/
44	exp Ethnology/
45	exp Religion/
46	exp Homeless Persons/
47	exp Health Services Accessibility/
48	exp Healthcare Disparities/
49	exp "Fees and Charges"/
50	exp Attitude to Health/ or exp Attitude to Death/
51	population characteristics/ or exp demography/ or exp "social determinants of health"/ or exp population/ or exp socioeconomic factors/
52	exp Population Groups/
53	education/ or exp health education/
54	exp Medically Uninsured/
55	exp cost of illness/
56	exp life style/ or exp morals/
57	exp Parity/
58	exp Maternal Age/
59	or/37-58
60	36 or 59

61	exp Albania/
62	(Albania or Albanian or Albanians).ti,ab.
63	exp Andorra/
64	(Andorra or Andorran or Andorrans).ti,ab.
65	exp Armenia/
66	(Armenia or Armenian or Armenians).ti,ab.
67	exp Austria/
68	(Austria or Austrian or Austrians).ti,ab.
69	exp Azerbaijan/
70	Azerbaijan*.ti,ab.
71	exp Belgium/
72	(Belgium or Belgian*).ti,ab.
73	exp Bosnia-Herzegovina/
74	(Bosnia*-Her#egovin* or "Bosnia* AND Her#egovin*" or BOSNIA* or HER#EGOVIN*).ti,ab.
75	exp Bulgaria/
76	(Bulgaria or Bulgarian or Bulgarians).ti,ab.
77	exp Croatia/
78	(Croatia or Croatian or Croatians).ti,ab.
79	exp Cyprus/
80	(Cyprus or Cypriot or Cypriots).ti,ab.
81	exp Czechoslovakia/
82	exp Czech Republic/
83	(Czech Republic or Czechoslovakia or Czech or Czechs).ti,ab.
84	exp Denmark/
85	(denmark or faeroe islands or Danish).ti,ab.
86	exp Estonia/
87	(Estonia or Estonian or Estonians).ti,ab.
88	exp Europe/
89	EUROPE*.ti,ab.
90	exp Finland/
91	(Finland or Finnish).ti,ab.
92	exp France/
93	(France or French).ti,ab.
94	exp "Georgia (Republic)"/
95	("REPUBLIC OF GEORGIA" or Georgian or Georgians).ti,ab.
96	exp "Macedonia (Republic)"/
97	(Germany or German or Germans).ti,ab.
98	exp "Republic of Belarus"/
99	("republic of belarus" or belarus or byelarus or belorussia or Belarusian or Belarusians).ti,ab.
100	exp Germany/

101	(Germany or German or Germans).ti,ab.
102	exp Great Britain/
103	(great britain or GBR or united kingdom or UK or northern ireland or scotland or channel islands or "isle of man" or British or Scottish or (wales not new south wales) or (england not new england)).ti,ab.
104	exp Greece/
105	(Greece or Greek or Greeks).ti,ab.
106	exp Hungary/
107	(Hungary or Hungarian or Hungarians).ti,ab.
108	exp Iceland/
109	(Iceland or Icelandic).ti,ab.
110	exp Ireland/
111	(eire or ireland or "republic of Ireland" or Irish).ti,ab.
112	exp Israel/
113	(Israel or Israeli or Israelis).ti,ab.
114	exp Italy/
115	(Italy or Italian or Italians).ti,ab.
116	exp Kazakhstan/
117	(kazakh or kazakhs or kazakhstan or kazakhstani).ti,ab.
118	exp Kyrgyzstan/
119	(kirgizstan or kyrgyz republic or kirghizia or kirghiz or kyrgyzstan or Kyrgyzstani).ti,ab.
120	exp Latvia/
121	(Latvia or Latvian or Latvians).ti,ab.
122	exp Liechtenstein/
123	(liechtenstein or leichtenstein).ti,ab.
124	exp Lithuania/
125	(Lithuania or Lithuanian or Lithuanians).ti,ab.
126	exp Luxembourg/
127	(luxembourg* or luxemburg* or luxemborg).ti,ab.
128	exp Malta/
129	(Malta or Maltese).ti,ab.
130	exp Moldova/
131	(Moldavia or "Moldavian s.s.r." or Moldova or "Moldavian ssr" or "Republic of Moldova" or Moldovan or Moldovans).ti,ab.
132	exp Monaco/
133	(Monaco or Monegasque).ti,ab.
134	exp Montenegro/
135	(Montenegro or Montenegrin or Montenegrins).ti,ab.
136	exp Netherlands/
137	(netherlands or holland or Dutch).ti,ab.
138	exp Norway/
139	(Norway or Norwegian or Norwegians).ti,ab.

140	exp Poland/
141	(Poland or (Polish adj3 (population or patient* or people))).ti,ab.
142	exp Portugal/
143	(Portugal or Portuguese).ti,ab.
144	exp Romania/
145	(Romania or Romanian or Romanians).ti,ab.
146	exp Russia/
147	exp USSR/
148	(Russia or Russian Federation or Russian or Russians).ti,ab.
149	exp San Marino/
150	(San Marino or Sammarinese).ti,ab.
151	exp Scandinavia/
152	(Scandinavia or Scandinavian).ti,ab.
153	exp Serbia/
154	(Serbia or Serbian or Serbians).ti,ab.
155	exp Slovakia/
156	(slovakia or slovak republic or Slovakian or Slovakians or Slovak or Slovaks).ti,ab.
157	exp Slovenia/
158	(Slovenia or Slovenian or Slovenians).ti,ab.
159	exp Spain/
160	(spain or balearic islands or canary islands or Spanish).ti,ab.
161	exp Sweden/
162	(Sweden or Swedish).ti,ab.
163	exp Switzerland/
164	(Switzerland or Swiss).ti,ab.
165	exp Tajikistan/
166	(tadjikistan or tadzhik or tadzhikistan or tajikistan).ti,ab.
167	exp Turkey/
168	(turkey or Turkish).ti,ab.
169	exp Turkmenistan/
170	(turkmen or turkmenistan or Turkmens).ti,ab.
171	exp Ukraine/
172	(Ukraine or Ukrainian or Ukrainians).ti,ab.
173	exp Uzbekistan/
174	(uzbekistan or uzbek or Uzbeks).ti,ab.
175	exp Yugoslavia/
176	(Yugoslavia or Yugoslav or Yugoslavs or Yugoslavian or Yugoslavians).ti,ab.
177	or/61-176
178	12 and 60 and 177
179	exp animals/

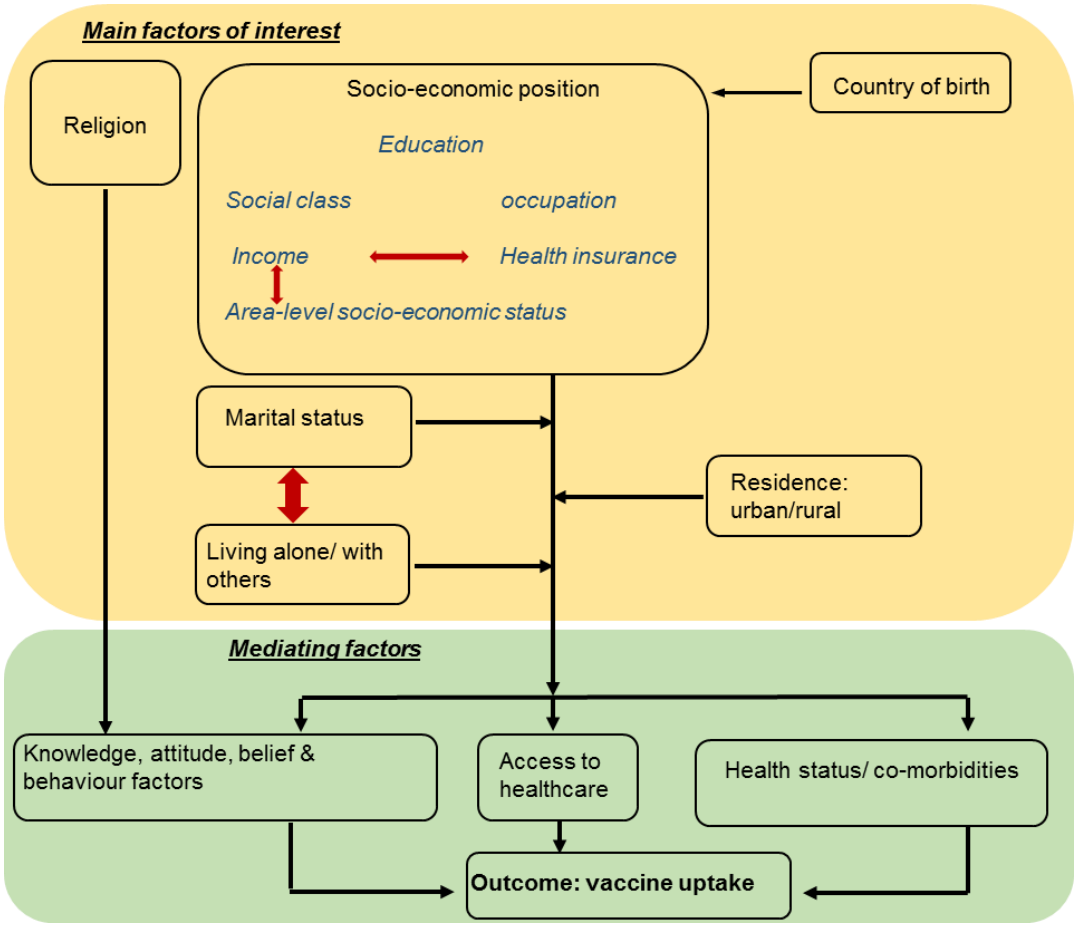
180	exp humans/
181	179 not (179 and 180)
182	exp case reports/
183	178 not 181 not 182
184	limit 183 to english language
185	exp Immunization Programs/
186	exp Vaccines/
187	exp Immunization/
188	185 or 186 or 187
189	(IMMUNI#ATION* or VACCIN* or IMMUNIS* or IMMUNIZ* or UNDER-IMMUNIS* or UNDERIMMUNIS* or UNDER-IMMUNIZ* or UNDERIMMUNIZ* or NON-IMMUNIS* or NONIMMUNIS* or NON-IMMUNIZ* or NONIMMUNIZ* or UNDER-VACCINAT* or UNDERVACCINAT* or NON-VACCINA* or NONVACCINA*).ti,ab.
190	decision making/ or choice behavior/ or exp refusal to participate/
191	exp "Patient Acceptance of Health Care"/
192	190 or 191
193	(ACCEPT* or AGREE* or BARRIER* or CHOOSE* or CHOSE or CHOICE* or COMPLIAN* or COVER* or DECISION* or DELAY* or DROPOUT* or DROP*-OUT* or HESITAN* or INCOMPLETE or INDECISION* or POSTPONE* or RECEIVE* or RECEIPT or REFUS* or RELUCTAN* or TIMELY or UPTAKE or UP-TO-DATE or UPTODATE or USAGE or UTILI#ATION or NON-COMPLIAN* or NONCOMPLIAN* or UNDER-UTILI#ATION or UNDERUTILI#ATION).ti,ab.
194	188 and 192
195	((IMMUNI#ATION* or VACCIN* or IMMUNIS* or IMMUNIZ* or UNDER-IMMUNIS* or UNDERIMMUNIS* or UNDER-IMMUNIZ* or UNDERIMMUNIZ* or NON-IMMUNIS* or NONIMMUNIS* or NON-IMMUNIZ* or NONIMMUNIZ* or UNDER-VACCINAT* or UNDERVACCINAT* or NON-VACCINA* or NONVACCINA*) adj10 (ACCEPT* or AGREE* or BARRIER* or CHOOSE* or CHOSE or CHOICE* or COMPLIAN* or COVER* or DECISION* or DELAY* or DROPOUT* or DROP*-OUT* or HESITAN* or INCOMPLETE or INDECISION* or POSTPONE* or RECEIVE* or RECEIPT or REFUS* or RELUCTAN* or TIMELY or UPTAKE or UP-TO-DATE or UPTODATE or USAGE or UTILI#ATION or NON-COMPLIAN* or NONCOMPLIAN* or UNDER-UTILI#ATION or UNDERUTILI#ATION)).ti,ab.
196	194 or 195
197	(AGEISM or (AGE adj3 DISCRIMINAT*)).ti,ab.
198	DEMOGRAPH*.ti,ab.
199	(EDUCAT* or LITERACY or LITERATE or ILLITERACY or ILLITERATE or LEARN*).ti,ab.
200	(ETHNICITY or ETHNIC or TRADITION* or (TRAVELLER* adj3 COMMUNIT*) or COMMUNIT*).ti,ab.
201	((FAMILY adj3 SIZE) or (BIRTH adj3 (ORDER* or INTERVAL*)) or PARITY or (MATERNAL adj3 AGE*) or (MOTHER* adj3 AGE*) or MARITAL or MARRIAGE* or MARRIED).ti,ab.
202	(INEQUALIT* or INEQUIT* or EQUIT* or EQUALIT* or DISCRIMINAT* or DISPARIT*).ti,ab.
203	(OCCUPATION* or JOB* or EMPLOY* or UNEMPLOY* or PROFESSION*).ti,ab.
204	(LIVING adj3 CONDITION*).ti,ab.
205	(MIGRATION or IMMIGRANT* or RELOCAT* or SETTLER* or REFUGEE* or DISPLACE* or ASYLUM*).ti,ab.
206	(MARGINALI* or MINORIT*).ti,ab.
207	(RESOURCEPOOR or RESOURCE-POOR or POOR or POVERTY or IMPOVERISHED or INCOME or WAGE or WAGES or AFFLUEN* or WEALTH* or FEE or FEES or COST* or AFFORD* or INSURANCE or INSURED or ((MEDICAL or PRESCRIPTION* or HOSPITAL or DOCTOR* or USER or CONSULT* or (VACCIN* adj3 ADMINIST*)) adj3 (FEE or FEES or CHARGE* or COST* or EXPENSE* or FUND*))).ti,ab.
208	(RACIAL or RACE).ti,ab.
209	(RELIGION* or RELIGIOUS or FAITH or ANTHROPOSOPHY or BUDDHIS* or CHRISTIAN* or CATHOLIC* or PROTESTANT* or (JEHOVAH* adj WITNESS*) or MUSLIM* or ISLAM* or HINDU* or JEWS or JEW or JUDAISM).ti,ab.
210	(RURAL or VILLAGE*).ti,ab.

211	(((GENDER or SEX*) adj3 (BIAS or DIFFEREN* or DISCRIMINAT*)) or SEXIS*).ti,ab.
212	(SLUM* or HOMELESS*).ti,ab.
213	(ANTI?VACCI* or ANTIVACCI* or ANTI-VACCI* or ANXIET* or ANXIOUS* or AWARE* or BEHAVIO?R or BEHAVIO?RAL or BELIEF* or BIAS* or CAUTIO* or CONCERN* or CONFIDEN* or CRITICIS* or DILEMMA* or DISBELIEF* or DISTRUST* or DOUBT* or EXPERIENCE* or FEAR* or KNOWLEDG* or LEARN* or MISUNDERSTAND* or MIS-UNDERSTAND* or MISCONCEPTION* or MIS-CONCEPTION* or MISTRUST* or MIS-TRUST* or MORALITY or MOTIVAT* or OPPOSITION* or PEER or PERCEPTION* or PRECONCEPTION* or PREJUDICE* or RUMO?R or RUMO?RS or SCARE* or SCEPTIC* or SOCIAL* or TRUST or UNCERTAIN* or UNDERSTAND* or UNWILLING* or WILLING*).ti,ab.
214	(((SOCIO-ECONOMIC or SOCIOECONOMIC) adj3 (FACTOR* or DETERMINANT* or DIFFERENCE*)) or (LIVING adj3 STANDARD*) or LIFESTYLE or LIFE-STYLE or SOCIO-DEMOGRAPH* or SOCIODEMOGRAPH* or DEPRIV*).ti,ab.
215	((AREA* adj3 RESIDEN*) or ((BUILD-UP or BUILDUP or BUILT-UP or BUILTUP) adj3 AREA*) or CITY or CITIES or INNERCIT* or INNER-CIT* or TOWN* or URBAN*).ti,ab.
216	(DIS-ADVANTAGE* or DISADVANTAGE* or UNDER-PRIVILEGE* or UNDERPRIVILEGE* or VULNERAB*).ti,ab.
217	((HEALTH or HEALTH-CARE or HEALTHCARE) adj3 (ACCESS* or AVAILAB*)).ti,ab.
218	((HEALTH or HEALTH-CARE or HEALTHCARE or HEALTH-STATUS or HEALTHSTATUS) adj3 DISPARIT*).ti,ab.
219	(CROSS-CULTUR* or CROSSCULTUR* or CULTURAL or ETHNOLOGY).ti,ab.
220	or/197-219
221	exp Sociology/
222	exp Social Behavior/
223	exp Vulnerable Populations/
224	exp cross-cultural comparison/
225	exp Cultural Characteristics/
226	exp cultural diversity/
227	exp Cultural Evolution/
228	exp Ethnology/
229	exp Religion/
230	exp Homeless Persons/
231	exp Health Services Accessibility/
232	exp Healthcare Disparities/
233	exp "Fees and Charges"/
234	exp Attitude to Health/ or exp Attitude to Death/
235	population characteristics/ or exp demography/ or exp "social determinants of health"/ or exp population/ or exp socioeconomic factors/
236	exp Population Groups/
237	education/ or exp health education/
238	exp Medically Uninsured/
239	exp cost of illness/
240	exp life style/ or exp morals/
241	exp Parity/
242	exp Maternal Age/
243	or/221-242
244	220 or 243
245	review.pt.

246	196 and 244 and 245
247	exp animals/
248	exp human/
249	247 not (247 and 248)
250	246 not 249
251	limit 250 to english language
252	limit 251 to last 5 years
253	252 not 184

Appendix 2 Conceptual framework for the systematic review.

The data for main factors were extracted (Red arrows show variables hypothesized as highly correlated)



Appendix 3 Study selection criteria

	Inclusion criteria
Population	Individuals from Europe aged ≥60 years from either community and/or hospital settings
Intervention/ exposure	Social factors of interest were: country of birth, religion, urban/rural residence, marital status, living arrangements (living with others versus living alone), education, income (individual or household), type of health insurance, area-level socio-economic status and social class/occupation
Comparison	Unvaccinated individuals
Outcome	Vaccine uptake (initiation or completion for routine vaccination and vaccination in pandemics, mass vaccinations, catch-up vaccinations)
Study design	Observational analytical studies including cross-sectional, ecological, case-control or cohort studies that measured exposure and outcome of interest in the study population and used statistical analyses. Letters and conference abstracts reporting quantitative data were included
Publications	Published on any date, language: English

Appendix 4 Details of bias assessment

In the selection bias assessment, response or follow-up rate (depending on the study design) had to be ≥70% to be classified a low risk of bias. If >30% data were missing, the study was considered to be at high risk of missing data bias. Vaccination status ascertained using records were considered at low risk of bias. For the purposes of this review self-reported vaccination was considered at low risk of bias.[67-69]

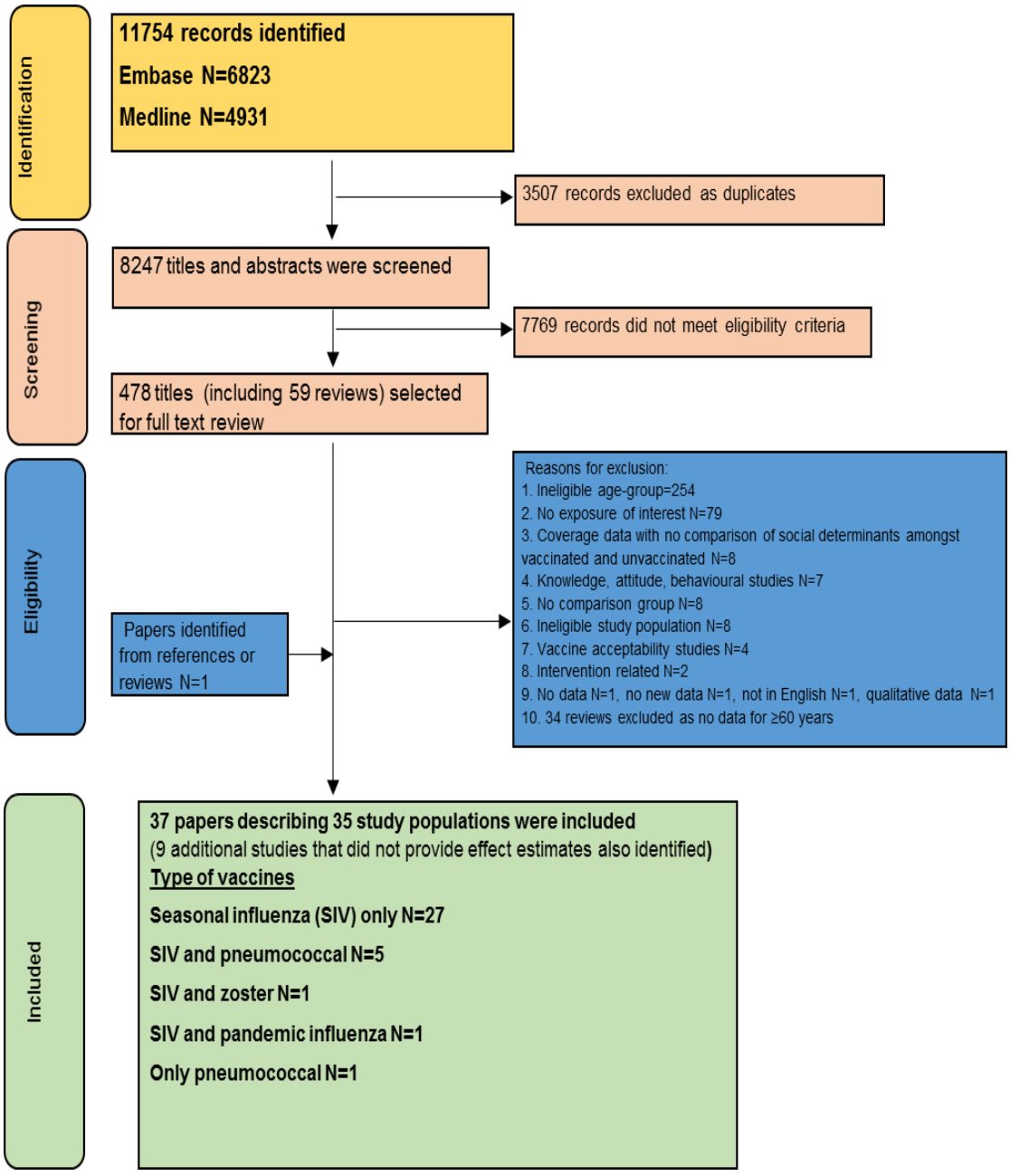
Variables that do not change over time, such as country of birth, religion, and (for this older study population) education and occupation were considered unlikely to be misreported by participants. However, the time-varying factors (such as marital status, living alone, place of residence, area-level SES, income and insurance) ascertained more than five years before the outcome were considered at high risk of bias for exposure misclassification.

For adequate adjustment for confounding all effect estimates needed to be adjusted for gender and at least one other main social factor (Appendix-2) to which the exposure of interest was not deemed to be strongly correlated. For example, effect estimates for the association between marital status and vaccine uptake were considered at high risk of confounding bias if they were only adjusted living arrangements (living alone/with others) and gender, as the former was likely to be strongly correlated with marital status.

References:

[67] Skull SA, Andrews RM, Byrnes GB, Kelly HA, Nolan TM, Brown GV, et al. Validity of self-reported influenza and pneumococcal vaccination status among a cohort of hospitalized elderly inpatients. Vaccine. 2007;25:4775-83.
[68] Rolnick SJ, Parker ED, Nordin JD, Hedblom BD, Wei F, Kerby T, et al. Self-report compared to electronic medical record across eight adult vaccines: Do results vary by demographic factors? Vaccine. 2013;31:3928-35.
[69] Williams WW. Surveillance of Vaccination Coverage Among Adult Populations—United States, 2014. MMWR Surveillance Summaries. 2016;65(No.SS-1):1-36.

Appendix 5 Flow chart of studies included and excluded in the review



SIV seasonal influenza vaccine

Appendix 6 Summary of the studies included in the review

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Cross-sectional studies					
Abramson[32] 2000	COB Education Relationship status Religion	SIV	COB (2)		Gender, country of birth, marital status, education, religiosity, chronic disease, exercise, physician visit in 3 months, knowledge and attitude questions
			Asia (excluding Israel)/ Africa	1 (AOR)	
			Others	1.61 (0.83-3.10)[e]	
			Education (2)		
			0-8 years	1 (AOR)	
			9+ years	1.04 (0.98-1.10)	
			Relationship status (2)		
			Unmarried	0.47 (0.28-0.78)*(AOR)	
			Married	1	
			Religion (2)		
			Religious	1 (AOR)	
			Not religious	1.71 (0.96-3.03)	
Aguilar[56] 2012	COB Location: residence	SIV	COB(2)		Age, gender, major chronic conditions, outpatient visits in the previous year, country of birth, area of residence, level of dependence, Hospitalisation in the previous year
			Native	1 (AOR)	
			Immigrants	0.40 (0.36–0.45)	
			Location: residence (2)		
			Urban (>10,000 people)	1.00 (0.98–1.03) (AOR)	
			Rural (any other)	1	
Barrett & Mc Hugh[33, 47] 2011 & 2015	Education Health insurance Income/ wealth	SIV	Education (3)		Unadjusted
			Complete primary education and only primary education 'primary/ none'	1 (Raw data)	
			Completed a junior certificate, or leaving certificate or	0.84 (0.71-1.00)	
			Completed a diploma, first degree or higher degree 'tertiary or higher'	0.80 (0.66-0.97)	
			Health insurance (4)		
			No additional cover (no medical card or private insurance)	1 (Raw data)	
			Medical Card only	4.41 (3.07-6.33)	
			Dual cover (medical card and private insurance)	4.63 (3.20-6.70)	
			Private Health Insurance only	1.72 (1.19-2.48)	
			Income/ wealth (4)		
			Low	1 (Raw data)	
			2nd quartile	0.73 (0.53-1.00)	
			3rd quartile	0.72 (0.53-1.00)	
			Highest	0.46 (0.34-0.63)	
Bodekar[15] 2015	Education	SIV	Education (3)		Unadjusted
			Low (9 years or less of school education)	1 (UOR)	
			Middle (at least 10 years of school education)	0.71 (0.47–1.08)	
			High (University entrance exam)	0.72 (0.49–1.06)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Bohmer[37] 2011	Education Income/ wealth	SIV	Education (3)		Unadjusted
			Low (ISCED level 1&2)	1 (UOR)	
			Medium (ISCED level 3&4)	0.96 (0.86–1.07)	
			High (ISCED level 5&6)	0.88 (0.77–1.02)	
			Income/ wealth		Age, sex, residence (Western Federal States & Eastern Federal States), household income and belonging to target groups, education
			Low (<70% of the median of the study sample)	1 (AOR)	
			Medium (70-120% of the median of the study) sample	1.30 (1.10–1.53)	
			High (>120% of the median of the study sample)	1.19 (1.00–1.41)	
Burns[57] 2005	Living arrangement Social class	SIV	Living arrangement (2)		Age, sex, living arrangements, household occupation status, transport to GP, chronic disease, smoking, alcohol consumption, seen national advertising campaign and explanation by GP regarding usefulness of vaccine and its side effects.
			Living with others	2.25 (1.35–3.73) (AOR)	
			Living alone	1	
			Social class (2)		
			Professional (National statistics social economic classifications system NSSECS I & II)	1* (AOR)	
			Non-professional (National Statistics Social Economic Classifications System NSSECS III -V)	0.68 (0.51-0.92)	
Carreno-Ibanez [58] 2015	COB	PV	COB(2)		Unadjusted
			Native	1 (UOR)	
			Immigrants	0.60 (0.52-0.68)*~	
Chiatti[26, 48, 59] 2010 & 2011	Education Income/ wealth Living arrangement Relationship status Social class	SIV	Education (4)		Gender, age group, family social class, education, chronic diseases, self-reported health, GP visit in last 30 days
			No title	1 (AOR)	
			Primary school degree	1.01 (0.94–1.10)	
			Intermediate degree	0.96 (0.87–1.06)	
			High school, bachelor or higher	1.11 (0.99–1.25)	
			Income/ wealth (4)		Gender, education, self-reported wealth, smoking status, marital status, GP visits in last 30 days, other chronic diseases, self-rated health status
			Low	1 (AOR)	
			Medium-low	1.37 (0.79–2.36)	
			Medium-high	1.28 (0.93–1.78)	
			High	1.09 (0.79–1.52)	
			Living arrangements (4)		Gender, age, education level (ordinal), self-reported household wealth (ordinal), marital status, informal and formal help, household size, smoking & respondent type
			Single person	1 (AOR)[γ]	
			Couple	1.07(0.98-1.17)	
			3-5 persons	0.84(0.76-0.92)	
			More than 6 persons	0.84(0.67-1.05)	
			Relationship status (2)		
			Married	1	
			Not married	0.82 (0.76 - 0.89) (AOR) [γ]	
			Social class (4)		Gender, age group, family social class, education, chronic diseases, self-reported health, GP visit in last 30 days
			Skilled and unskilled working	1.21 (1.11–1.33)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			Self-employed persons	1.18 (1.07–1.31)	
			White collar and small employers	1.01 (0.92–1.12)	
			Managers, professionals and entrepreneurs.	1	
Christenson[34] 2002	Education Relationship status	SIV & PV	SIV		Unadjusted
			Education (4)		
			Elementary school	1 (Raw data)	
			Junior secondary school	1.37 (1.20-1.56)	
			Upper secondary school	1.44 (1.23-1.67)	
			University/college	1.67 (1.45-1.92)	
			Relationship status (2)		
			Married/living with partner	1 (Raw data)	
			Widowed/living alone	0.76 (0.69-0.84)	
			PV		
			Education (4)		
			Elementary school	1 (Raw Data)	
			Junior secondary school	1.32 (1.17-1.50)	
			Upper secondary school	1.38 (1.19-1.59)	
			University/college	1.44 (1.26-1.63)	
			Relationship status (2)		
			Married/living with partner	1 (Raw data)	
			Widowed/living alone	0.73 (0.66-0.80)	
Crawford[12] 2011	Living arrangements Relationship status Location: residence Social class	SIV	Living arrangements (2)		Adjusted for gender, age, marital status, living status, social class, home location, geographical location
			Lives with others	1.14 (0.83-1.67)* (AOR)	
			Lives alone	1	
			Location: residence (2)		
			Urban	1.15 (0.91-1.43)* (AOR)	
			Rural	1	
			Relationship status (3)		
			Married	1 (AOR)	
			Single	1.3 (0.8–2.1)	
			Widowed	1.5 (1.1–2.3)	
			Social class (2)		
			Higher	1 (AOR)	
			Lower	0.95 (0.7–1.2)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Damiani[35] 2007	Education Income/ wealth Relationship status Social class	SIV	**Education (4)**		Age, gender, education, region of residence, self-assessed health status, chronic medical conditions, occupation class, smoking, marital status, self-assessed household income
			University degree	1.05 (0.87-1.28)* AOR	
			Upper secondary education	-	
			Lower secondary education	-	
			Without any qualification	1	
			Income/ wealth (2)		
			Very good/good	1.12 (1.06-1.19)*(AOR)	
			Poor/Very poor	1	
			Relationship status (4)		
			Married	1 (AOR)	
			Divorced/separated	1.12 (0.92–1.36)	
			Widowed	0.83 (0.77–0.88)	
			Single	0.82 (0.74–0.91)	
			Social class (5)		
			Middle class	1 (AOR)	
			Medium employer class	1.08 (0.93–1.24)	
			Upper worker class	1.02 (0.89–1.17)	
			Worker class	1.03 (0.90–1.18)	
			Unemployed class	0.94 (0.81–1.08)	
de Souto[42] 2014	Nursing home location	SIV & PV	SIV		Ownership, location, physicians/100 beds, physician training, living in special care, prescription re-examination, individual healthcare project, informatics system, age, sex, length of stay in the nursing home, disability in activities of daily living, number of medications, body mass index, number of diseases, diabetes, chronic pulmonary disease, heart failure, myocardial infarction, peripheral vascular disease, moderate–severe renal failure, dementia, hospitalisation in the last 12 months, disorientation regarding space and time (defined by a physician), pressure ulcers, and psychiatric diseases (other than depression).
			Location: nursing home (4)		
			Rural (<2000 inhabitants)	1 (AOR)	
			Low-urban (inhabitants ≥2000 - <10,000)	1.09 (0.67–1.78)	
			Intermediate-urban (inhabitants ≥10,000- <100,000)	0.90 (0.54–1.50)	
			High-urban (inhabitants ≥ 100,000)	0.93 (0.51–1.71)	
			PV		
			Location: nursing home (4)		
			Rural (<2000 inhabitants)	1	
			Low-urban (inhabitants ≥2000 - <10,000)	2.35 (1.00–5.50)	
			Intermediate-urban (inhabitants ≥10,000- <100,000)	0.56 (0.23–1.40)	
			High-urban (inhabitants ≥ 100,000)	0.10 (0.03–0.31)	
Jimenez-Garcia[60] 2006	COB	SIV	COB(2)		Age, gender, nationality and chronic conditions
			Native	1 (AOR)	
			Immigrants	0.85 (0.35-2.06)	
Jimenez-Garcia[61] 2008	COB	SIV	COB(2)		Age, gender, nationality and chronic conditions
			Native	1 (AOR)	
			Immigrants	0.34 (0.19-0.59)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Jimenez-Garcia[62] 2008	COB	SIV	COB(2)		Gender, age, health care worker (yes/no), nationality and co-morbidity
			Native	1 (AOR)	
			Economic immigrant (excluding people from EU, Canada and USA)	0.96 (0.43-2.04)*	
Jimenez-Garcia[63] 2014	COB	SIV	COB(2)		Age, sex, presence of chronic disease, health care worker (yes/no) and nationality
			Native	1 (AOR)	
			Immigrants	0.60 (0.32-0.99)	
Jimenez-Garcia[64] 2014	COB	SIV	COB(2)		Age, sex, country of origin, number of previous flu vaccinations received, uptake of 2009 pandemic vaccine and presence of chronic condition
			Native	1 (AOR)	
			Immigrants	0.60 (0.57-0.62)*	
Kroneman[29] 2007	Living arrangements		Living arrangements (2)[e]		Household size, gender, age, health professional opinion, health care system characteristics
			Household size: larger	1.38 (1-1.90) [e] (AOR)	
			Household size: smaller	1	
Landi[13] 2005	Income/ wealth Living arrangements	SIV	Income/ wealth (2)		Age, gender, living arrangements, economic status, compromised activities of daily living function, depression, impaired cognitive performance, malnutrition, comorbidities
			Has economic problems	1	
			No economic problems	1.72 (1.35-2.22)*(AOR)	
			Living arrangements (2)		
			Living alone	1 (AOR)	
			Lives with informal caregiver	1.28 (1.11-1.49)*	
Mamelund[36] 2011	Income/ wealth Education Living arrangements	SIV	Education (4)		Unadjusted
			18+years	1.63 (0.85-3.10) (Raw data)	
			17years	1.70 (0.87-3.30)	
			13years	1.43 (0.79-2.57)	
			10years	1	
			Income/ wealth (1000 Norwegian Krone) (4)		
			600+	0.84 (0.33-2.11) (Raw data)	
			400–599	1.06 (0.47-2.36)	
			200–399	1.04 (0.48-2.25)	
			0–199	1	
			Living arrangements (2)		
			2 person household	1.21 (0.79-1.86 (Raw data)	
			One person household	1	
Nexoe[65] 1999	Living arrangements	SIV	Living arrangements (2)		Adjusted for age, perceived barriers to vaccine, perceived benefits, perceived severity, living in a nursing home or sheltered housing, living together with another person, advised by GP, vaccinated in previous influenza seasons, living in Copenhagen.
			Living with someone	1.59 (1.03-2.48) (AOR)	
			Not living with someone	1	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Opstelten [45] 2001	Health insurance	SIV and PV	SIV & PV		Age, insurance, factors for perceived health, barriers, severity and
			Health insurance (2)		
			Private insurance	0.38 (0.21-0.67)[α]	
			No private insurance	1	
Opstelten [49] 2009	Education	HZ & SIV	HZ & SIV		Education, diabetes, factors for perceived barriers, severity, doctor's recommendation and compliance with recommendation
			Education (2)		
			High education (not defined)	0.63 (0.40-0.91)[α] (AOR)	
			Low education (not defined)	1	
Pena-Rey[50] 2004	Income/ wealth Education Relationship status Location: residence	SIV	Education (2)		Unadjusted
			<Primary	1 (Raw data)	
			≥Primary	1.02 (0.79-1.32)	
			Income/ wealth (2)		Age, income, size of place of residence, marital status, health self-perception, visit with a physician last 2 years, tetanus vaccination, caregiver (of children ,old people or sick people)
			≤ €6010	1 (AOR)	
			> €6010	1.39 (1.01–1.90)	
			Location: residence (3)		
			Urban: >20,000 people	0.81 (0.58-1.11)* (AOR)	
			Intermediate: 5000-20,000 people	-	
			Rural: <5000 people	1	
			Relationship status (2)		
			Not married	0.69 (0.50-0.95)*(AOR)	
			Married	1	
Sarria-Santamera[16] 2003	Education Income/ wealth	SIV	Education(2)		Unadjusted
			Finished education ≤ 15 years old	1 (Raw data)	
			Finished education>15 years old	0.83 (0.59-1.16)	
			Income/ wealth (3)		
			<€360.6	1 (Raw data)	
			€360.6-601	1.21 (0.89-1.64)	
			>€601	1.25 (0.90-1.73)	
Schmitz[14] 2011	Education Living arrangement Relationship status	SIV		**Linear regression coefficient[δ] (standard error)**	Age, chronic disease, self-assessed health, has partner, number of children in household, sex, education, current cognitive abilities (verbal fluency and recall), health behaviour (measured using alcohol intake, smoking, visit to dentist, eye exam, physical activity) and physician quality index
			Education		
			Education International Standard Classification of Education level between 0-2	- 0.034 (0.012) (Adjusted)	
			Living arrangements		
			Number of children in household	-0.024 (0.013) (Adjusted)	
			Relationship status		
			Spouse in household	0.047 (0.011) (Adjusted)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Shahrabani[31] 2006	COB Education Living arrangement Relationship status	SIV		**Probit marginal probabilities** [e]	Gender, chronic illness, hospitalisation, smoking, health management organisation, housing density, marital status, country of birth, education, Kibbutz membership
			COB(7)[e]		
			Israeli-born Jews	1 (Adjusted)	
			Asia-Africa	60-64 years: 0.019 75+years : -0.169	
			Europe-America	60-64 years: 0.055 75+ years: -0.108	
			USSR (before 1990)	60-64 years: -0.011 75+ years: -0.226	
			USSR (after 1990)	60-64 years: -0.195 75+ years: -0.436	
			Other (after 1990)	60-64 years: -0.117 75+ years: -0.111	
			Arabs	60-64 years: -0.035 75+ years: -0.116	
			Education (3)		
			Years of schooling 0–8	1 (Adjusted)	
			Years of schooling 9–12	60-64 years: -0.003 75+ years: 0.084	
			Years of schooling 13+	60-64 years: -0.001 75+years: 0.030	
			Living arrangements		
			Housing density (number of persons/ room ≤1.0-1.5+)	60-64 years: -0.064 (Adjusted) 75+ years: -0.046	
			Relationship status (3)		
			Married	60-64 years: 0.108 (Adjusted) 75+ years: 0.130	
			Not married	1	
Sintes[28] 2011	Social class Education Living arrangement Location: residence	SIV & PV	SIV		Unadjusted
			Education (2)		
			Primary or less	1 (UOR)	
			Secondary or more	0.87 (0.68–1.12)	
			Living arrangements (4)		Age, sex, risk of pneumonia, type of household, number of physician visits last year
			Alone	1 (AOR)	
			Partner (without children)	1.51 (1.09–2.13)	
			Children	1.22 (0.87–1.72)	
			Others	0.93 (0.56–1.56)	
			Location: residence (2)		Unadjusted
			Rural (<10 000 inhabitants)	1 (UOR)	
			Urban	1.08 (0.81–1.45)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			Social class (2)		Unadjusted
			According to the last job as unqualified or manual workers (classes iva, ivb, V)	1.01 (0.77–1.35) (UOR)	
			Others (classes I–III)	1	
			PV		
			Education (2)		Unadjusted
			Primary or less	1 (UOR)	
			Secondary or more	0.69 (0.55–0.89)	
			Living arrangements (4)		Age, sex, risk of pneumonia, social class, education, type of household, number of physician visits last year, influenza vaccination in last season
			Alone	1 (AOR)	
			Partner (without children)	1.71 (1.20–2.46)	
			Children	1.30 (0.91–1.88)	
			Others	1.08 (0.62–1.91)	
			Location: residence (2)		Unadjusted
			Rural (<10 000 inhabitants)	1 (UOR)	
			Urban	1.03 (0.78–1.38)	
			Social class		Unadjusted
			According to the last job as unqualified or manual workers (classes IVa, IVb, V)	1.40 (1.07–1.84) (UOR)	
			Others (classes I–III)	1	
Wershof Schwartz[43] 2013	Area SES COB Location: residence	SIV & PV	SIV		Age, gender, rural residency, socio-economic status, region of origin, years since immigration, Holocaust survivorship, number of chronic medical conditions, number of primary care visits in the past 5 years, primary physician's region of origin and gender
			Area SES (4)		
			Low	0.72 (0.68–0.77) (AOR)	
			Low–mid	0.74 (0.71–0.77)	
			Mid-high	0.82 (0.79–0.85)	
			High	1	
			COB(4)		
			Israel	1 (AOR)	
			Former soviet union	0.74 (0.71–0.77)	
			Western	1.13 (1.05–1.22)	
			Middle east	1.13 (1.07–1.19)	
			Location: residence (2)		
			Rural	1* (AOR)	
			Urban	1.14 (1.11-1.18)	
			PV		
			Area SES		
			Low	0.79 (0.74–0.84) (AOR)	
			Low–mid	0.79 (0.76–0.83)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			Mid-high	0.84 (0.81–0.87)	
			High	1	
			COB(4)		
			Israel	1 (AOR)	
			Former soviet union	0.73 (0.70–0.77)	
			Western	0.91 (0.84–0.98)	
			Middle east	1.21 (1.15–1.28)	
			Location: residence (2)		
			Rural	1* (AOR)	
			Urban	1.15 (1.11-1.19)	
Case control study					
van Essen[46] 1997	Health insurance Living arrangement	SIV	Health insurance (2)		Adjusted for gender, age groups, insurance, family characteristics, perceived health, perceived threat of influenza, perceived benefits and costs
			Social	1	
			Private	0.91 (0.21 to 5)[a]	
			Living arrangement (2)		
			Not living alone	1.79 (0.40-9.09)* [a] (AOR)	
			Living alone	1	
Cohort studies					
Breeze[41] 2004	Area SES Income/ wealth Location: residence	SIV		Risk ratios (95%CI)	Adjusted for year, gender, current age, Carstairs deprivation score, individual socioeconomic position and population density
			Area SES (5)		
			Carstairs' deprivation index Least deprived	1 (ARR)	
			Second quintile	1.05 (0.97-1.13)	
			Mid quintile	1.03 (0.94-1.13)	
			Fourth quintile	0.99 (0.83-1.18)	
			Most deprived	0.85 (0.70-1.05)	
			Income/ wealth (3)		
			Owner occupier with central heating	0.97 (0.90-1.04)* (ARR)	
			Owner-occupier without central heating, renter with central heating, renter	-	
			Supported housing	1	
			Location: residence		
			Urban density indicator <250 persons/km^2	1 (ARR)	
			Urban density indicator 250–1000 persons/km^2	0.99 (0.83-1.17)	
			Urban density indicator 1000–2500 persons/km^2	1.10 (0.94-1.30)	
			Urban density indicator urban (>2500 persons/km^2)	1.14 (0.95-1.36)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Mangtani[27] 2005	Area SES Income/ wealth Living arrangement Location: residence Relationship status	SIV		Risk ratios (95% CI)	
			Area SES (5)		Age, gender, practice factors, personal socio-economic position, area SES, location: residence
			Carstairs' deprivation index Least deprived	1 [δ] (ARR)	
			Second quintile	0.97 (0.91-1.03)	
			Mid quintile	0.92 (0.86-0.99)	
			Fourth quintile	1.02 (0.94-1.11)	
			Most deprived	0.91 (0.79- 1.04)	
			Income/ wealth (5)		Age, gender, practice factors, personal socio-economic position, area SES, location: residence
			Owner occupied with central heating	0.97 (0.90-1.04)*[δ] (ARR)	
			Owner-occupier without central heating	-	
			Renter with central heating	-	
			Renter without central heating	-	
			Supported housing	1	
			Living arrangements (5)		Unadjusted
			Alone	1 (Raw data)	
			With spouse only	1.70 (1.51-1.90)	
			With spouse and others	1.61 (1.18-2.20)	
			With son/daughter	1.06 (0.84-1.34)	
			With other	1.22 (0.95-1.56)	
			Location: residence (4)		Age, gender, practice factors, personal socio-economic position, area SES, location: residence
			Rural <250 persons/km^2	1 [δ] (ARR)	
			250–1000 persons/km^2	0.94 (0.85-1.03)	
			1000–2500 persons/km^2	0.95 (0.86-1.04)	
			Urban (>2500 persons/km^2)	1.10 (1.01-1.21)	
			Relationship status (3)		Unadjusted
			Married/ cohabiting	1 (Raw data)	
			Widowed/divorced/separated	0.61 (0.55-0.68)	
			Single	0.54 (0.44-0.67)	
Martinez-Baz[30] 2012	COB Living arrangement Location: residence	SIV	COB (2)		Age groups, gender, residence, country of origin, outpatient visits in the previous 12 months, major chronic conditions, diagnosis of any major chronic condition in the previous 12 months, hospitalization in the previous 12 months, high level of dependence, living with children <15 years
			Native	1	
			Immigrant	0.55 (0.45–0.67) (AOR)	
			Living arrangements (2)		
			Not living with children aged <15 years	1	
			Living with children aged <15 years	0.85 (0.77–0.94) (AOR)	
			Location: residence (2)		
			Rural	1	
			Urban	0.99 (0.94–1.04)	

First Author publication date	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Sammon[44] 2012	Area SES	SIV & PIV		Rate ratios (95% CI)	Sex, patient SES quintile, body mass index, alcohol consumption, smoking status, history of Guillain Barré syndrome, total number of underlying health conditions (1,2,>2), practice region
			SIV		
			Area SES (5)		
			Townsend score or the area indices of multiple deprivation Least deprived	1.05 (1.02-1.08) (ARR)	
			Second quintile	1.03 (1.00-1.07)	
			Mid quintile	1	
			Fourth quintile	0.97 (0.94-1.00)	
			Most deprived	0.97 (0.94-1.00)	
			Unknown	0.88 (0.81-0.95)	
			PIV		
			Area SES (5)		
			Townsend score or the area indices of multiple deprivation Least deprived	1.04 (0.98-1.10) (ARR)	
			Second quintile	1.05 (1.00-1.09)	
			Mid quintile	1	
			Fourth quintile	0.92 (0.88-0.97)	
			Most deprived	0.86 (0.79-0.93)	
			Unknown	0.85 (0.75-0.96)	
Shah[66] 2012	Area SES	SIV	Area SES (5)	Risk ratios (95% CI)	Age and sex
			Index of Multiple Deprivation (IMD) 2007 Least deprived	1 (ARR)$^{\epsilon}$	
			Second quintile	0.99 (0.98–0.99)	
			Mid quintile	0.97 (0.96–0.97)	
			Fourth quintile	0.95 (0.94–0.96)	
			Most deprived	0.93 (0.92–0.94)	

SD social determinants SIV seasonal influenza vaccine COB country of birth PV pneumococcal vaccine HZ herpes zoster SES socio-economic status CI confidence interval PIV pandemic influenza vaccine AOR adjusted odds ratio UOR unadjusted odds ratio ISCED International Standard Classification of Education ARR adjusted risk/rate ratios ^{e} not in meta-analysis *baseline changed ~ effect estimates for males used for meta-analysis as sample size bigger $^{\alpha}$ OR for refusing vaccination were reversed to get estimates for acceptance $^{\beta}$ Estimates from weighting scheme C $^{\gamma}$ effect estimates from model 2 $^{\delta}$ effect estimates from model 3 $^{\epsilon}$ effect estimates from model 2

Appendix 7 Summary of studies not providing effect estimates

First author	Country	Vaccine/s	Study period	Sample size	Study population	Vaccine uptake measures
All were cross-sectional studies						
Bedford[17]	Ireland	Seasonal flu and pneumococcal vaccine	Sept. 1998-Jan. 1999	450	Records of patients aged ≥65 years from two rural general practices, with a medical condition that predisposes to pneumococcal disease were invited for both vaccines	Medical card holders in one practice were more likely than non-holders in the same practice to have accepted either vaccine (p>0.001).
de Andres[18]	Spain	Seasonal influenza	2003	6134	Data for people aged ≥65 years drawn from the 2003 Spanish Health Survey	No evidence of difference in vaccination coverage reported based on education, monthly household income and relationship status.
de Lataillade[19]	Data for Turkey extracted (Multinational study)	Seasonal influenza	Feb.2006-March 2006	Not reported for participants aged ≥65	Respondents (aged ≥65 years) to a population survey of non-institutionalized people from an urban area	Lower income was associated with higher coverage for Turkish elderly respondents
Gosney[20]	UK	Seasonal influenza	Jan.-Feb.1998	649	All inpatients (aged 75-79 years) interview respondents from eight hospitals in Merseyside (Care of the Elderly wards)	No difference in living arrangements when comparing the vaccinated to the non-vaccinated groups.
Jimenez[21]	Spain	Seasonal influenza	1997	Not reported for elderly	Elderly respondents (aged ≥64 years) to a nation-wide study	Educated <16 years versus those with higher (university and non-university) education: proportional coverage 52.6% (95% CI: 49.1-56.1) and 53.1% (95%CI: 39.1-67.1%) respectively Monthly income €600 versus €1200: coverage 51.3% (95%CI: 47.5-55.1%) and 49.7% (95%CI: 42.7-56.7%) respectively. Married versus not married 53.4% (95% CI: 49.7-57.1%) and 47.8% (95%CI: 43.0-52.6%) respectively
Jimenez-Garcia[22]	Spain	Seasonal influenza	2007	5507	Older non-institutionalised participants (aged ≥60 years) in the 2007 "Madrid Regional Health Survey" and the 2007 Spanish National Health, from 13/17 Spanish autonomous communities.	Amongst those aged ≥ 65 years: **Madrid** Education (≤primary versus ≥secondary coverage 66.3% (64.2–68.4) versus 61.3% (57.2–65.3) **Rest of Spain** Education (≤primary versus ≥secondary) coverage 66.3% (63.7–68.9) versus 65.3% (59.1–71.5)
Nicholson[23]	UK	Seasonal influenza	1985-86	244	Survey of general practitioners in Trent regarding seasonal influenza vaccination programme	No significant difference in vaccination rates of urban and rural practices
Noula[24]	Greece	Seasonal influenza	Not reported	235	Community dwelling individuals aged ≥65 years	Higher education level was associated with being vaccinated (p=0.028)
Shemesh[25]	Israel	Seasonal influenza and pneumococcal vaccine	2002	1422	Community-dwelling respondents (aged ≥60 years) respondents to a survey conducted at a physical activity-oriented health fair	Seasonal influenza: Russian speakers versus Hebrew and Arabic speakers had lower coverage ($p < 0.001$). Amongst the Jewish population, residence in rural settings had higher coverage (71%) versus residence in urban areas (62%), $p < 0.04$). Pneumococcal vaccine: The highest coverage was reported by Arabic speakers (57.6%), while Russian speakers had the lowest (12.1%) coverage

First author	Country	Vaccine/s	Study period	Sample size	Study population	Vaccine uptake measures
Studies also included in the review						
Bodekar[15]	Germany	Seasonal influenza	March-June 2014	825	Respondents aged ≥60 years from a nationwide telephone survey	Immigration status was not associated with SIV uptake
Sarria-Santamera[16]	Spain	Seasonal influenza	1997	1148	Non-institutionalised participants (aged ≥65 years) to the Spanish National Health survey (ENS)	No differences were found by availability of private health insurance or marital status on vaccine uptake

Appendix 8 Quality assessment of the studies included in the review

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Abramson[32]	Low risk: rr78.7%	Low risk : self-reported SIV vaccination in latest SIV season	4	COB Education Religion Relationship status	All 4 SD (exposure data self-reported): low risk	All 4 SD: low risk as adjusted for gender, country of birth, marital status, education, religiosity, chronic disease, exercise, physician visit in 3 months, knowledge and attitude questions	Unclear risk: N/R	High risk as adjusted for chronic conditions
Aguilar [56]	Low risk: all pop	Low risk: data from recent records	2	COB	COB (data from records): low risk	COB & location of residence: low risk as adjusted for age, gender, major chronic conditions, country of birth, area of residence, level of dependence, outpatient visits and hospitalisation in the previous year	Low risk: no missing data reported	High risk as adjusted for chronic conditions
				Location of residence	Location: residence (data from records (date not reported): unclear risk			
Barrett & Mc hugh [33, 47]	High risk : rr 62% overall for the study	Low risk: self-reported 'have you ever had a flu shot'	3	Education	Education (self-reported): low risk as education is unlikely to change in this older age group at time of vaccination	All 3 SD: high risk as unadjusted effect estimates	Low risk for education: low risk as only 0.1% had missing data	Low risk as unadjusted
				Income/ wealth	Income/ wealth (self-reported): high risk as wealth could change over time and could be different at the time of vaccination		High risk for income: as ~45% had data missing	
				Health insurance	Health insurance (self-reported): high risk as insurance status could change over time		Low risk for insurance: no missing data reported	
Bodeker[15]	High risk: 16.2% rr	Low risk : self-reported SIV vaccine in last season	1	Education	Education (self-reported): low risk	Education: high risk as unadjusted estimates	Low risk : overall only 1.6% study population had missing data for education	Low risk
Bohmer [37]	High risk : 21% rr	Low risk: self-reported SIV vaccination in either or both of 2 seasons 2007-2009 depending on when individuals were interviewed	2	Education	Education & income/wealth (self-reported): low risk	Education: high risk as unadjusted effect estimates	Unclear risk: not reported	Low risk as unadjusted
				Income/ wealth	Income/ wealth (self-reported): low risk	Income/ wealth: low risk adjusted for age, gender, residence (Western federal states & Eastern federal states), household income and belonging to target groups, education		High risk as adjusted for chronic conditions

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Burns[57]	Low : 70% response rate	Low risk: self-reported SIV vaccination in last 12 months	2	Social class living arrangements	Social class & living arrangements (self-reported): low risk	Social class & living arrangements: low risk as adjusted for age, gender, living arrangements, social class, transport to GP, chronic disease, smoking, alcohol consumption and other factors	Low for both: <4% had missing data overall	High risk as adjusted for chronic conditions
Carreno-ibanez [58]	Low risk: all registered patients included	Low risk : PV vaccination from records	1	COB	COB (records): low risk	COB: high risk as unadjusted estimates	Low risk : <1% missing data	Low risk
Chiatti [26, 48, 59]	Unclear risk : N/R	Low risk: self-reported SIV vaccination in last 12 months	5	Education	All 5 SD (self-reported): low risk	Education: low risk adjusted for gender, age group, family social class, chronic diseases, self-reported health, GP visit in last 30 days	Low risk for all: overall only 1.7% had missing data	High risk as adjusted for chronic conditions
				Income/ wealth		Income/ wealth: low risk adjusted for gender, education, self-reported wealth, smoking status, marital status, GP visits in last 30 days, other chronic diseases, self-rated health status		
				Family social class		Family social class: low risk adjusted for gender, age group,education, chronic diseases, self-reported health, gp visit in last 30 days		
				Relationship status		Relationship status: low risk as adjusted for gender, age, education level (ordinal), self-reported income/ wealth (ordinal), relationship status, informal and formal help, household size, smoking & respondent type		Low risk
				Living arrangements		Living arrangements: low risk adjusted for gender, age, education level (ordinal), self-reported income/ wealth (ordinal), marital status, informal and formal help, household size, smoking & respondent type		
Christenson [34]	low risk : rr 78%	Low risk: self-reported recent SIV/ PV vaccine	2	Education Relationship status	Education & relationship status (self-reported): low risk	Education & relationship status: high risk as unadjusted	Low risk : data for education and pneumococcal vaccination missing for ~3% & marital status for <2% for both vaccines	Low risk as unadjusted

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Crawford [12]	High risk : rr 68%	Low risk: self-reported SIV vaccination in previous winter	4	Social class Living arrangements Relationship status Location of residence	All 4 SD (self-reported): low risk	All 4 SD: low risk as adjusted for gender, age, marital status, living arrangements, social class, location of residence, geographical location	Unclear risk: not reported	Low risk
Damiani [35]	Unclear risk: not reported	Low risk: self-reported SIV vaccinated in past 12 months	4	Income/ wealth Social class Education Relationship status	All 4 SD (self-reported): low risk	All 4 SD: low risk as adjusted for age, gender, education, region of residence, self-assessed health status, chronic medical conditions, social class, smoking, relationship status, income/ wealth	Low risk: no missing data reported	High risk
De souto[42].	High risk: rr 57%	Low risk: data for SIV vaccination from records	1	Location of nursing home	Location of the nursing home (online questionnaire completed by nursing home administrative staff staff): low risk	Low risk as adjusted for age, gender, nursing home ownership, location, chronic diseases, physician factors and other patient factors including medications	Low risk: 3%	High risk
Jimenez-garcia[60]	Unclear risk: overall rr 67.02% age specific rr not available unclear risk	Low risk: self-reported SIV vaccination in latest campaign	1	COB	COB (self-reported): low risk	High risk as model did not include any level 1 variable (adjusted for age, gender and chronic condition)	Low risk: no missing data reported	High risk
Jimenez-garcia[61]	Unclear risk: overall rr 65% age specific rr not available unclear risk	Low risk: self-reported SIV vaccination in latest campaign	1	COB	COB (self-reported): low risk	High risk as model did not include any level 1 variable (adjusted for age, gender and chronic condition)	Low risk: no missing data reported	High risk
Jimenez-garcia [62]	Unclear risk: 40% overall response rate overall rr, age specific rr not available	Low risk: self-reported SIV vaccination in latest campaign	1	COB	COB (self-reported): low risk	High risk as model did not include any level 1 variable (adjusted for gender, age-groups, health care workers and co-morbidity)	Unclear risk: not reported	High risk
Jimenez-garcia[64]	Low risk: data for all registered individuals were used	Low risk: data for SIV vaccine from records	1	COB	COB (data from records): low risk	High risk as model did not include any level 1 variable (adjusted for age-groups, gender, number of previous flu vaccine received, uptake of 2009 pandemic vaccine and presence of chronic condition that is an indication for vaccination)	Low risk: no missing data reported	High risk
Jimenez-garcia[63]	Unclear risk: 61% overall rr age specific rr not available	Low risk: self-reported SIV vaccination in latest campaign	1	COB	COB (self-reported): low risk	High risk as model did not include any level 1 variable (adjusted for age, gender and presence of chronic disease)	Low risk: no missing data reported	High risk

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Kroneman[29]	Unclear risk : rr not reported	Low risk : self-reported SIV vaccine in last season	1	Living arrangements	Living arrangements (self-reported): low risk	High risk as unadjusted for any level 1 variable (adjusted for gender, age, health professional opinion, health care system characteristics including out of pocket payment)	Unclear risk: missing data not reported	Low risk
Landi[13]	Unclear risk as rr was variable across countries from 43%-100%	Low risk : self-reported SIV vaccination status in last 2 years	2	Income/ wealth, living arrangements	Both SD (self-reported): low risk	Both SD: low risk as adjusted for age, gender, living arrangements, income/ wealth, compromised activities of daily living function, depression, impaired cognitive performance, malnutrition, comorbidities	Low risk: no missing data reported	High risk
Mamelund[36]	High risk: rr 68.9%	Low risk: self-reported recent SIV vaccination	3	Education Living arrangements Income/ wealth	All 3 SD (self-reported): low risk	All 3 SD: high risk as unadjusted	Education & living arrangements: low risk for missing data income: high risk ~34% had missing data	Low risk
Nexoe[65]	High risk : rr 58%	Low risk: self-reported recent SIV vaccination	1	Living arrangements	Living arrangements (self-reported): low risk	High risk as model unadjusted for gender or any other level 1 variable (adjusted for age, perceived barriers to vaccine, perceived benefits, perceived severity, living in a nursing home or sheltered housing, advice by GP, vaccinated in previous influenza seasons, living in Copenhagen)	Low risk 18% missing data	High risk
Opstelten[45]	High risk: rr 69%	Low risk: from recent records SIV & PV vaccination	1	Health insurance	Health insurance from recent records: low risk	High risk as adjusted for age, factors for perceived health, barriers, severity and cues to actions	Low risk: 19% missing data	High risk
Opstelten[49]	High risk: rr 69%	Low risk : recent records of SIV & hzv uptake	1	Education	Education (self-reported): low risk	High risk as unadjusted for gender or any other level 1 variable (adjusted for diabetes, factors for perceived barriers, severity and cues to actions)	Low risk : missing data for 18%	High risk
Pena-rey[50]	Low risk : rr 75.2%	Low risk: self-reported SIV vaccine in last season	4	Income/ wealth Relationship status Location of residence	All 4 SD (self-reported): low risk	Income, relationship status & location of residence: low risk as adjusted for age, income, location: residence, relationship status, health self-perception, visit with a physician last 2 years, tetanus vaccination, caregiver status	Low risk: missing data for income 19%, no missing data for residence, and education and only one person had marital status missing	High risk

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
				Education		Education: high risk as unadjusted		Low risk
Sarria-santamera[16]	Low risk : rr 85%	Low risk : self-reported SIV vaccination in last season	2	Education income/ wealth	Both SD (self-reported): low risk	Education & income: high risk as unadjusted	Low risk: no missing data reported	Low risk
Schmitz[14]	Unclear risk : rr 62% overall, age specific rr not available	Low risk : self-reported SIV vaccination in the previous year	3	Education relationship status living arrangements	All 3 SD (self-reported): low risk	All 3 SD: low risk as model adjusted for age, gender, education, living arrangements, health behaviour, relationship status, self-assessed health cognition, physician quality index	Unclear risk: missing data not reported	High risk
Shahrabani[31]	Unclear risk: rr not reported	Low risk : self-reported SIV vaccine in last 12 months	4	Education COB relationship status living arrangements	All 4 SD (self-reported): low risk	All 4 SD: low risk as adjusted for gender, living arrangement, relationship status, country of birth, education, chronic illness, hospitalisation, smoking, health management organisation, kibbutz members	Unclear risk: missing data not reported	High risk
Sintes[28]	Unclear risk : rr not reported	Low risk: records of SIV & PV uptake	4	Education	All 4 SD education, social class, living arrangements, location: residence (self-reported): low risk	Education, social class and location: residence: high risk as unadjusted	Low risk: missing data ~20%	Low risk
				Social class				
				Location of residence				
				Living arrangements (SIV)		Living arrangements (SIV): high risk as unadjusted for any other level 1 variable (adjusted for age, gender, risk of pneumonia, number of physician visits last year)		High risk
				Living arrangements (PV)		Living arrangements (PV): low risk as adjusted for age, gender, social class, education, risk of pneumonia, number of physician visits last year, influenza vaccination in last season		
Wershof schwartz[43]	Low risk; : took all patients enrolled with a healthcare service	Low risk : from recent records for both SIV & PV vaccinations	3	COB	COB (from records): low risk	All 3 SD: low risk as adjusted for age, gender, residence location, area socio-economic status, country of birth, number of chronic medical diseases and physician factors	Low risk: ~20% missing data	High risk
				Area SES	SES data was from records >10 years before the study period: high risk			
				Location ofresidence	Location of residence during study years from records: low risk			
Cohort								

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Breeze[41]	Unclear risk : follow-up rate not reported	Low risk: medical records for SIV vaccination	3	area SES	Area SES (recent records): low risk	All 3 SD: low risk as adjusted for year, gender, current age, area SES, income and location: residence	Low risk: 12% missing data	Low risk
				Income/ wealth	Income/ wealth (interview self-reported): low risk			
				Location of residence	Location of residence (area of residence assessed at study start): low risk			
Mangtani[27]	Low risk: low risk as 72.6% follow up	Low risk: medical records for SIV vaccination	5	Area SES	All 5 SD (self-reported and recent records): low risk	Area SES, income/ wealth, location: residence: low risk as adjusted for age, gender, practice factors, income/ wealth, area SES, location: residence	Low risk: 16.1% missing data	Low risk
				Income/ wealth				
				Area of residence				
				Relationship status		Relationship status: high risk as unadjusted		
				Living arrangements		Living arrangements: high risk as unadjusted		
Martinez-baz[30]	Unclear risk : follow-up rate not reported	Low risk: medical records for continued adherence for SIV vaccination	3 :	COB	COB (from records): low risk	All 3 SD: low risk as adjusted for age, gender, location: residence, COB, living arrangements, chronic conditions, hospitalisation in previous 12 months and dependence	Unclear risk: missing data not reported	High risk
				Living arrangements	Living arrangements & location: residence (from records date not reported): unclear risk			
				Location: residence				

First author	Selection bias	Outcome misclassification	SD number examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Sammon[44]	Unclear risk: follow-up rate not reported	Low risk: records for SIV and PIV uptake	1 :	Area SES	Area SES (from records date not reported): unclear risk	Area SES: high risk as unadjusted for any level 1 variable (adjusted for gender, body mass index, alcohol consumption, smoking status, history of Guillain Barré syndrome, total number of underlying health conditions (1,2,>2) and practice region)	Unclear risk: missing data for ≥65 year-old not reported	Low risk
Shah[66]	Unclear risk: follow-up rate not reported	Low risk: records SIV vaccination	1	Area SES	Area SES (from records date not reported): unclear risk	Area SES: high risk as unadjusted for any level 1 variable (adjusted for age and gender)	Low risk: SD data available for all individuals	Low risk
Case control								
Van essen[46]	Low risk:: rr 77% -91%	Low risk: recent records for SIV uptake	2	Health insurance Living arrangements	Health insurance (noted from recent records) & living arrangements (self-reported): low risk	Both SD: low risk as adjusted for gender, age groups, health insurance, living arrangements, perceived health, perceived threat of influenza, perceived benefits and costs	Low risk: missing data for 22.7%	High risk

SD social determinants COB country of birth N/R not reported SIV seasonal influenza vaccine COB country of birth PV pneumococcal vaccine HZ herpes zoster SES socio-economic status rr response rate

2.4 Literature review update: 2017

The search for the review was updated on 1/11/2017 using the same methodology as described in the published paper (**Section 2.2**). The details are described below.

2.4.1 Updated review: results

Nine additional studies, published between 25/02/2016 and 31/10/2017, were identified in the updated search (and herein referred to as "2017-updated search/review").[82, 92-99] Eight studies were cross-sectional[82, 92-95, 97-99] and one was a cohort study.[96] The studies reported the association of socio-demographic factors with seasonal influenza vaccine uptake (n=6),[92, 93, 95-97, 99] uptake of zoster vaccine (n=1),[82] pneumococcal vaccine uptake (n=1),[94] and uptake of both seasonal influenza and pneumococcal vaccine (n=1)[98] (Table 2-1). The socio-demographic factors of interest reported in these studies included education (n=5),[93, 94, 97-99] living arrangements (n=4),[92-94, 97] marital status (n=4),[93, 94, 98, 99] area of residence (n=4),[92, 97-99] individual or household income (n=4),[92, 97-99] area-level socio-economic status (n=2),[82, 96] and country of birth (n=1).[95] The studies included data from Spain (n=2),[93, 94] France (n=2),[92, 96] Poland (n=2),[97, 98] UK (n=1),[82] Denmark (n=1)[99] and Italy (n=1).[95] Of the nine studies identified in the 2017-updated review, four studies were hospital based.[93, 94, 97, 98] An overview of the studies is provided in Table 2-1 in the same format as the published review paper. The details of these nine additional studies are provided in Appendix 1.

2.4.1.1 Quality assessment of the additional studies

Consistent with the published review paper, the studies included in the 2017-updated review had low risk of exposure and outcome misclassification (Table 2-2 and Appendix 2) and high risk of confounding bias, mainly due to the unavailability of adjusted estimates in the studies.

Table 2-1 Updated literature review: Summary of additional studies published between 25/02/2016-31/10/2017 (N=9)

	Author	Country	Study period	Sample size	Study population	Vaccine	Social determinants associated with vaccine uptake						
							SES (A)[1]	Inco[2]	COB[3]	Edu[4]	LA[5]	MS[6]	Res[7]
	Cross-sectional studies												
1	Bocquier[92]	France	April-September 2008	7,088	Respondents (aged ≥65 years) of French National survey on health and disability (people with disabilities were over-represented using a sampling co-efficient)	SIV		N*#			↑*#		N*#
2	Dominguez[93]	Spain	November 2013-May 2014	1,038	Individuals aged ≥65 years, admitted via emergency departments to 19 different city hospitals in 7 regions for causes other than respiratory illnesses	SIV				N	N	↓	
3	Dominguez[94]	Spain	September 2013-September 2014	916	Individuals aged ≥65 years, admitted via emergency departments to 19 different city hospitals in 7 regions for causes other than respiratory illnesses	PV				↓	N	N	
4	Fabiani[95]	Italy	2012-2013	27,003	Respondents, aged ≥65 years, of a multi-purpose survey conducted to gather information about health service utilisation amongst Italian residents	SIV			↓*				
5	Ganczak[97]	Poland	November 2015- April 2016	230	Consecutive patients aged ≥65 years admitted to municipal hospital in city of Szczecin	SIV		N		N	N		↑
6	Gorska-Ciebiada[98]	Poland	2013	219	Patients aged ≥65 years with type 2 diabetes diagnosed at least a year previously and attending the medicine and diabetes outpatient clinics in a university hospital	SIV & PV		SIV:↑ PV: N		N		N	SIV:↑ PV: N
7	Hellfritzsch[99]	Denmark	February 2016	4,237	Individuals aged 65-79 years who participated in the 2006 public health survey conducted by Centre for Public Health, Denmark	SIV		N		N		N	N
8	Ward[82]	UK	2014-2015	178,808	Individuals aged 70 years on 01/09/2014 eligible for zoster vaccination between 1 Sept 2014-31 Aug 2015 and with available ethnicity data, extracted from GP records in England	HZ	↓						
	Cohort study												
9	Gallini[96]	France	2007-2009	5,269	Individuals aged ≥65 years selected from the French Health Insurance database containing claims for a 1/97th random sample of the French population.	SIV	N^						

SES(A) area-level socio-economic status Inco income COB country of birth Edu education LA living arrangements MS marital status Res residence SIV seasonal influenza vaccine N=study reported no association with vaccine uptake *adequately adjusted estimates based on confounding bias assessment # from the model unadjusted for chronic disease ↑ higher vaccine uptake reported ↓lower vaccine uptake reported PV pneumococcal vaccine HZ herpes zoster vaccine

1 most deprived (area-level) versus least deprived (reference) 2 Highest versus lowest income level (reference) 3 Immigrants versus native (reference) 4 Highest versus lowest education level (reference) 5 Not living alone versus living alone (reference) 6 Single versus married (reference) 7 Urban versus rural area (reference) ^ baseline 2nd and 3rd quartile

Table 2-2 Quality assessment of the additional studies identified between 25/02/2016-31/10/2017

	Social determinants and bias																						
Study type & Ref.	SB	OM	Area SES			Income			COB			Education			Living alone			Marital status			Residence		
Cross-sectional			EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD	EM	CB	MD
Bocquier[92]	L	L				L	L	L							L	L	L				L	L	L
Dominguez[93]	U	L										L	H	L	L	H	U	L	H	U			
Dominguez[94]	U	L										L	H	L	L	H	L	L	H	L			
Fabiani[95]	L	L							L	L	L												
Ganczak[97]	L	L				L	H	L				L	H	L	L	H	L				L	H	L
Gorska-Ciebiada[98]	U	L				L	H	L				L	H	L				L	H	L	L	H	L
Hellfritzsch[99]	U	L				L	H	H				L	H	L				L	H	L	L	H	L
Ward[82]	L	L	L	H	L																		
Cohort																							
Gallini[96]	L	L	U	H	L																		

Ref. reference SB selection bias OM outcome misclassification SES socioeconomic status EM exposure misclassification CB confounding bias MD missing data COB country of birth L low risk of bias U unclear risk of bias H high risk of bias

2.4.1.2 Association of social factors with vaccine uptake

A) Living arrangements

Four additional studies were identified in the 2017-updated search, which reported the association of living arrangement with vaccine uptake.[92-94, 97] Meta-analysis was repeated for previously identified studies with the addition of the studies identified in the 2017-updated search (Figure 2-1). Irrespective of the vaccine type and the measure of effect, all studies except one,[97] showed a consistent direction of effect, similar to the published review paper, with higher uptake of vaccine amongst individuals who were not living alone. As with the previous analysis, there was considerable between-study heterogeneity. The results remained unchanged when the analysis was restricted to the same five adequately adjusted studies as in the published review, the summary odds for seasonal influenza vaccine uptake were 25% higher amongst those not living alone compared to those living alone. When the studies were stratified by vaccine costs, the findings were again similar to the published review paper: the summary odds of seasonal influenza and pneumococcal vaccine uptake were 50% and 42% higher, respectively amongst individuals not living alone in countries where vaccines were available free-of-charge. In countries where seasonal influenza vaccination was paid for, no consistent effect of living arrangements on vaccine uptake was observed in the two studies (including one study[97] identified from the 2017-update).

To summarise, living alone was consistently associated with lower vaccine uptake in all except one study, similar to the findings from the published review.

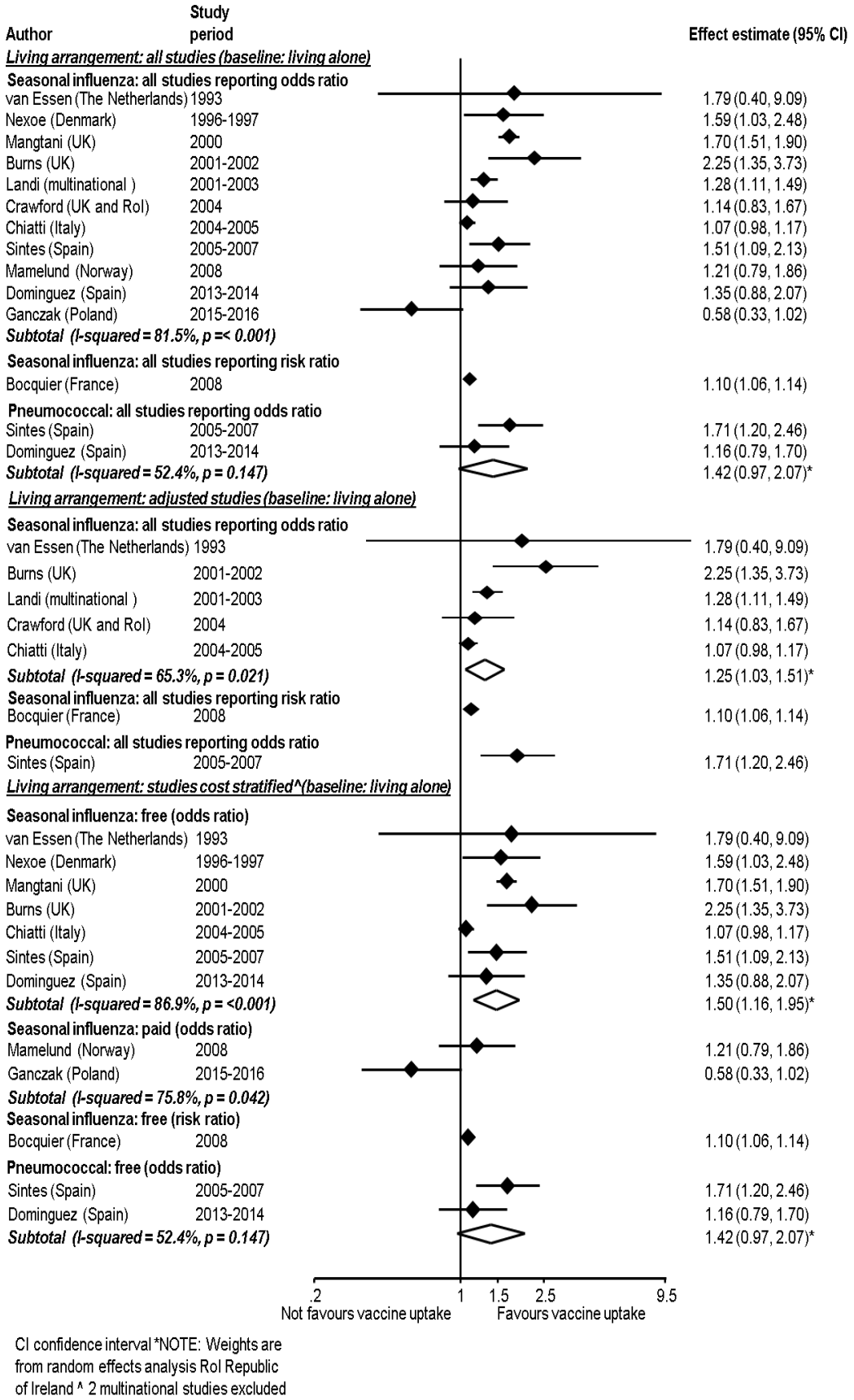


Figure 2-1 Association of living arrangements on vaccine uptake: including studies identified on updating the review

B) Marital status

The results of meta-analysis after including the four additional studies identified in the 2017-updated search are shown in the Figure 2-2.[93, 94, 98, 99] Inclusion of these additional studies did not change the findings for the uptake of seasonal influenza vaccine from the published review paper, the direction of effect remained that of lower uptake amongst unmarried individuals, with strong evidence of between-study heterogeneity. There was no evidence of between-study heterogeneity (I-squared=0.0%) for the three pneumococcal vaccine uptake studies (including the two recent studies[94, 98] identified in the 2017-updated search), with the summary estimate of 26% lower uptake amongst unmarried individuals. These observations reflected the findings of the association of living arrangements (discussed under (A) above). The findings of lower (17%-27%) summary odds for vaccine uptake amongst unmarried individuals after stratifying the studies based on vaccination costs and vaccine types, were similar to those reported in the published review paper.

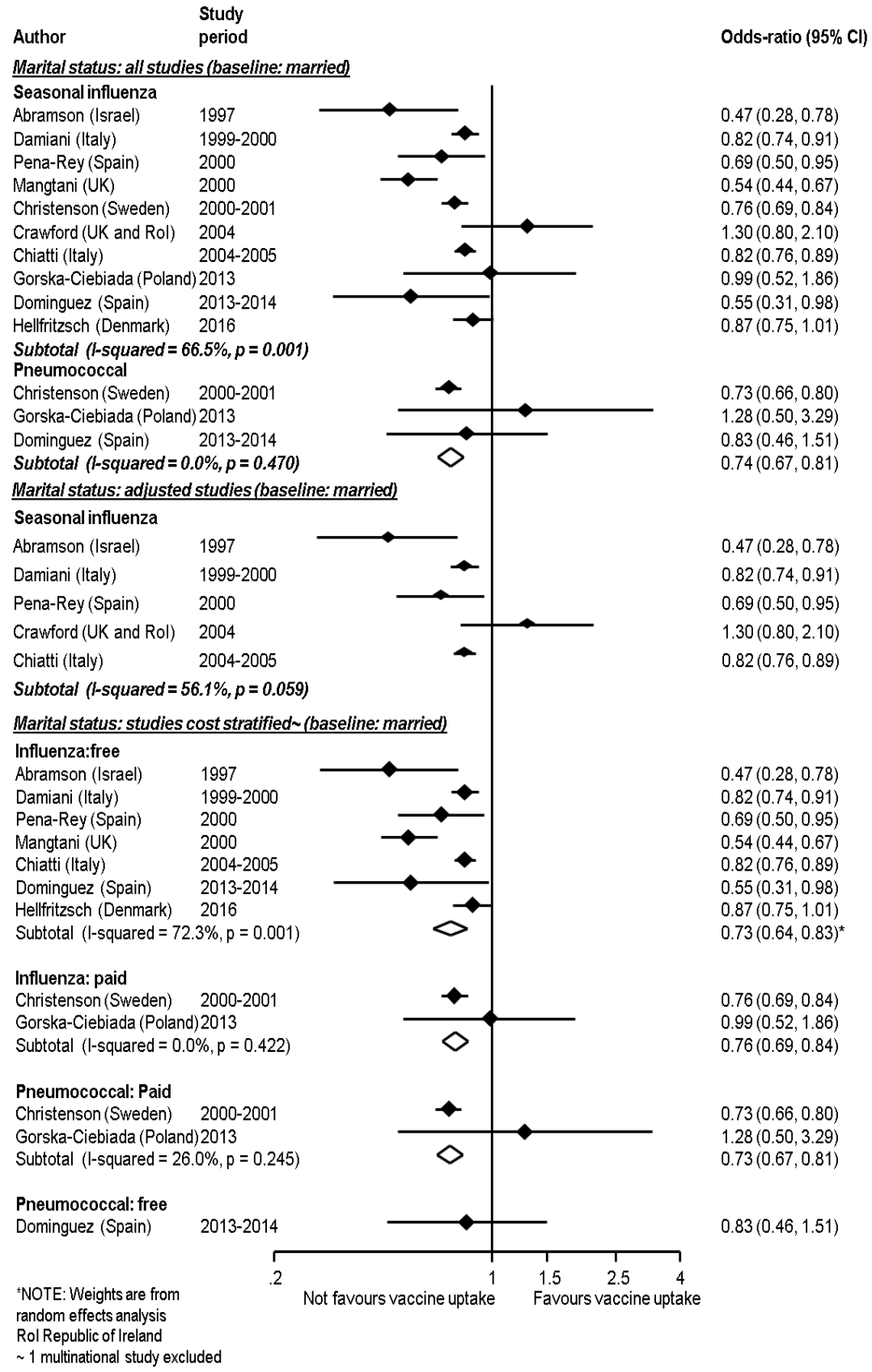


Figure 2-2 Association of marital status on vaccine uptake: including studies identified on updating the review

C) Education

The results of meta-analysis after including the five additional studies identified in the 2017-updated review are shown in Figure 2-3.[93, 94, 97-99] Again the findings from the published review paper remained unchanged with overall 5% higher odds of uptake amongst those with higher education level when the analysis was restricted to the same three adequately adjusted studies. The uptake of both pneumococcal and seasonal influenza vaccine was higher, by 43% and 68% respectively, amongst individuals with a higher level of education in countries where vaccines were paid for (Figure 2-3), echoing the results of the published review paper. The inclusion of three recent studies[93, 94, 99] also strengthened the findings of the published review for the countries where vaccines were available free-of-charge: there was no association (summary odds ratio: 1.02 (95%CI: 0.97-1.06) of seasonal influenza vaccine uptake with education level, while the summary odds of pneumococcal vaccine uptake were 32% lower amongst those with the highest education level.

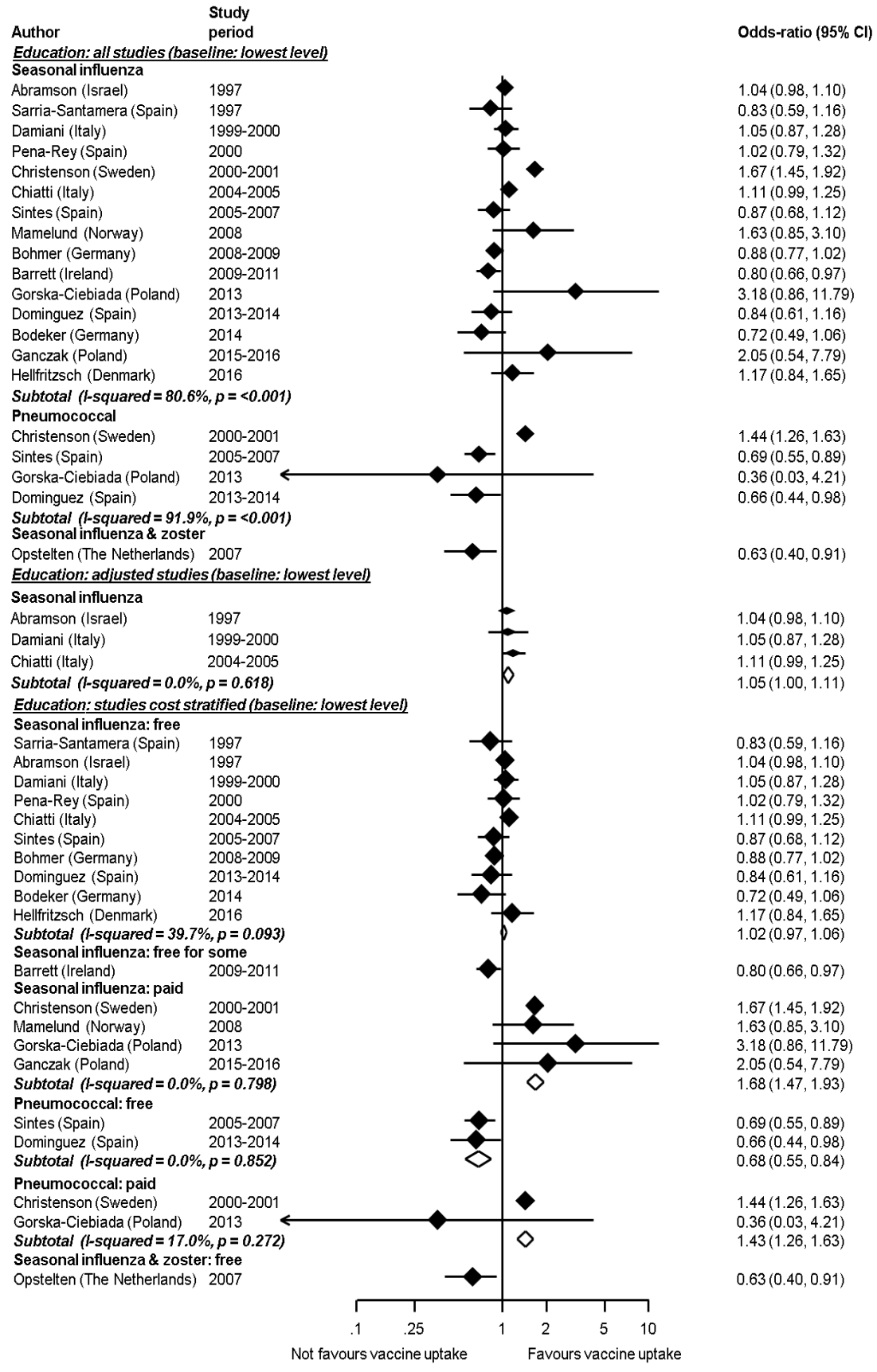


Figure 2-3 Association of education level with vaccine uptake: including studies identified on updating the review

D) Household/individual income

As described previously, meta-analysis was repeated after including the four additional studies identified in the 2017-updated search which reported the association of income with vaccine uptake,[92, 97-99] (Figure 2-4). Again, the inclusion of these additional studies did not change the findings from the published review; there was no consistent effect from the studies reporting odds ratios for the association of income with seasonal influenza vaccine uptake. Similar to the findings from the published review, there was no evidence for an overall association (summary risk ratio- 0.99 (95%CI: 0.95-1.04) of income with seasonal influenza vaccine uptake after adding a third study to the two studies that reported effect estimates as risk ratios (Figure 2-4). The higher summary odds for seasonal influenza vaccine uptake amongst those with higher income when the analysis was restricted to the adequately adjusted studies and where vaccine was available free-of charge, of 26% and 13% respectively (Figure 2-4), remained unchanged from the findings of the published review paper. In countries where the seasonal influenza vaccine was paid for, the inclusion of two[97, 98] additional studies to the previously identified single study, showed no consistent effect of income on seasonal influenza vaccine uptake.

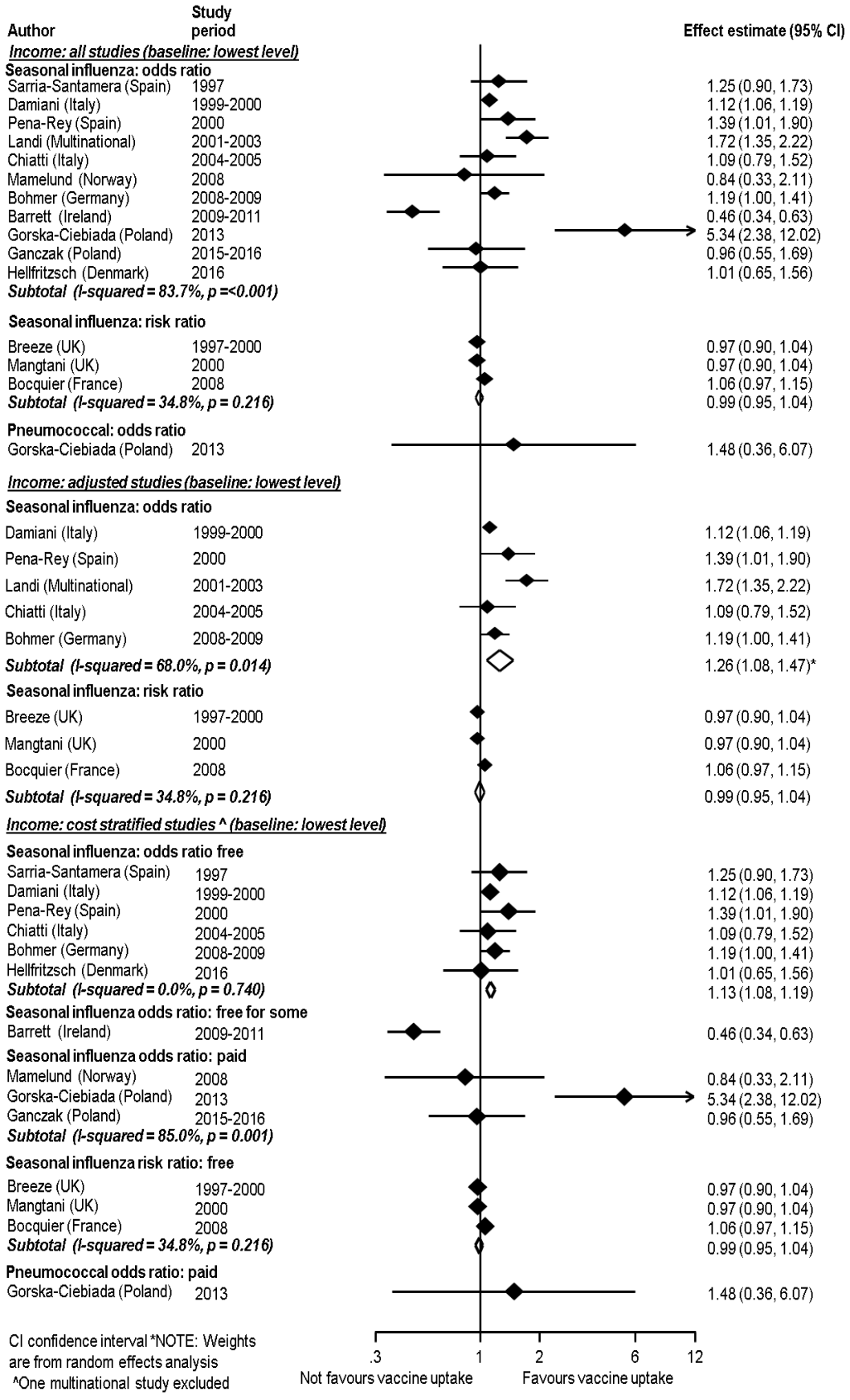


Figure 2-4 Association of income on vaccine uptake: including studies identified on updating the review

E) Urban or rural area of residence

The results of meta-analysis for the effect of area of residence on vaccine uptake, after including the four additional studies identified in the 2017-updated search, [92, 97-99] are shown in Figure 2-5. As found previously, no consistent effect was observed for the studies reporting odds ratio for the association of an individual's residence with seasonal influenza vaccine uptake after including three additional studies.[97-99] Amongst the three studies reporting a risk ratio (including one recent study from France [92] and the two previously described UK studies[100, 101]) for the association of individual's residence with seasonal influenza vaccine uptake, no consistent effect of residence on vaccine uptake was observed (Figure 2-5). This latter finding was in contrast from that of the published review where the summary estimate from the two UK studies:[100, 101] showed 11% higher uptake amongst urban residents (summary risk ratio 1.11, 95%CI: 1.02-1.20). The higher (15%) summary odds for pneumococcal vaccine uptake amongst individuals residing in urban area after including one additional study,[98] as described in the published review, remained unchanged. Similarly no change was observed after the 2017update when analyses were restricted to the adequately adjusted studies and to the countries where vaccines were available free-of-charge. (Figure 2-5). The 2017-updated review provided additional information from two Polish studies where vaccinations were not free; [97, 98] the odds of uptake of both seasonal influenza and pneumococcal vaccines were higher (more than twice) amongst urban residents in these studies.

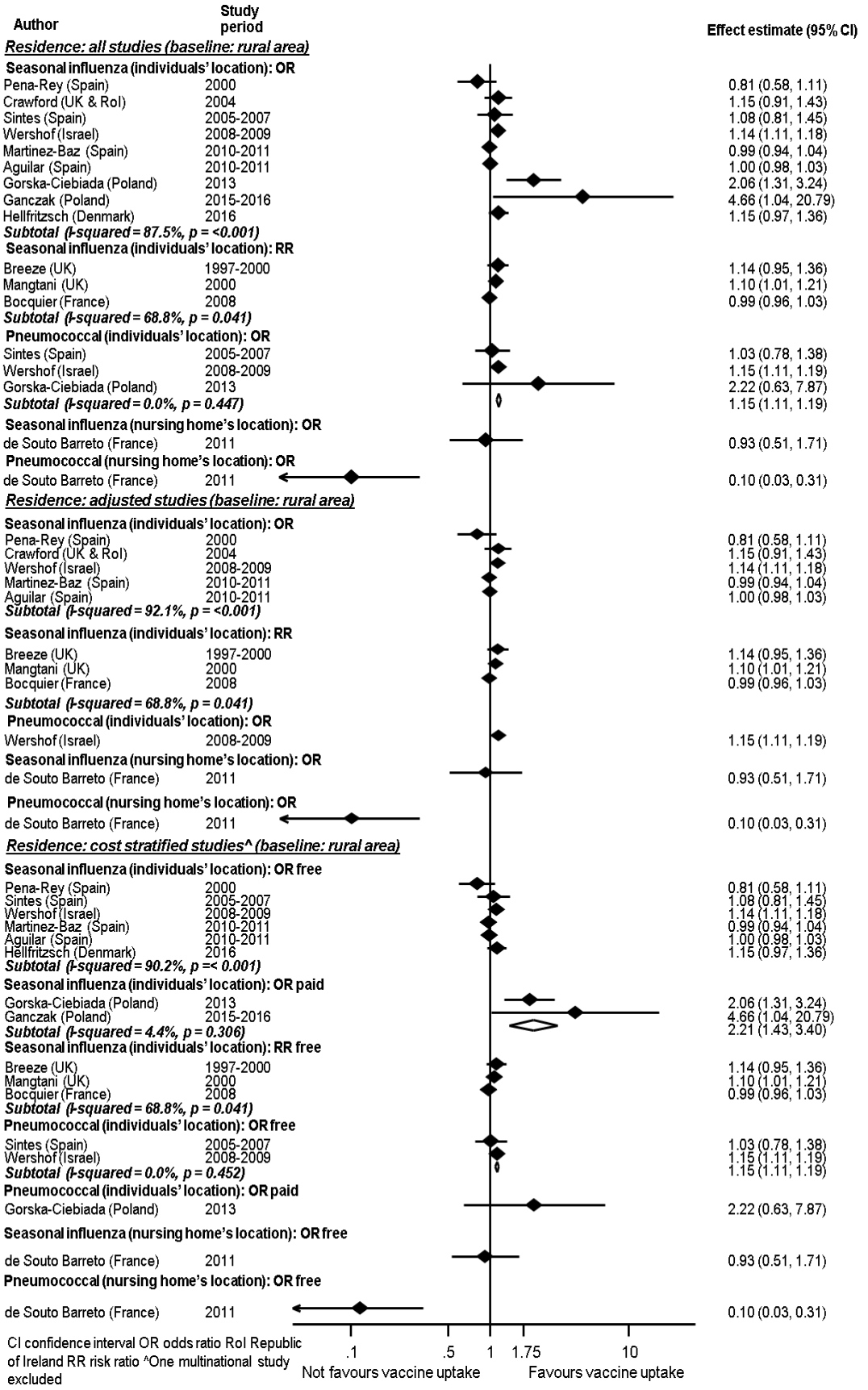
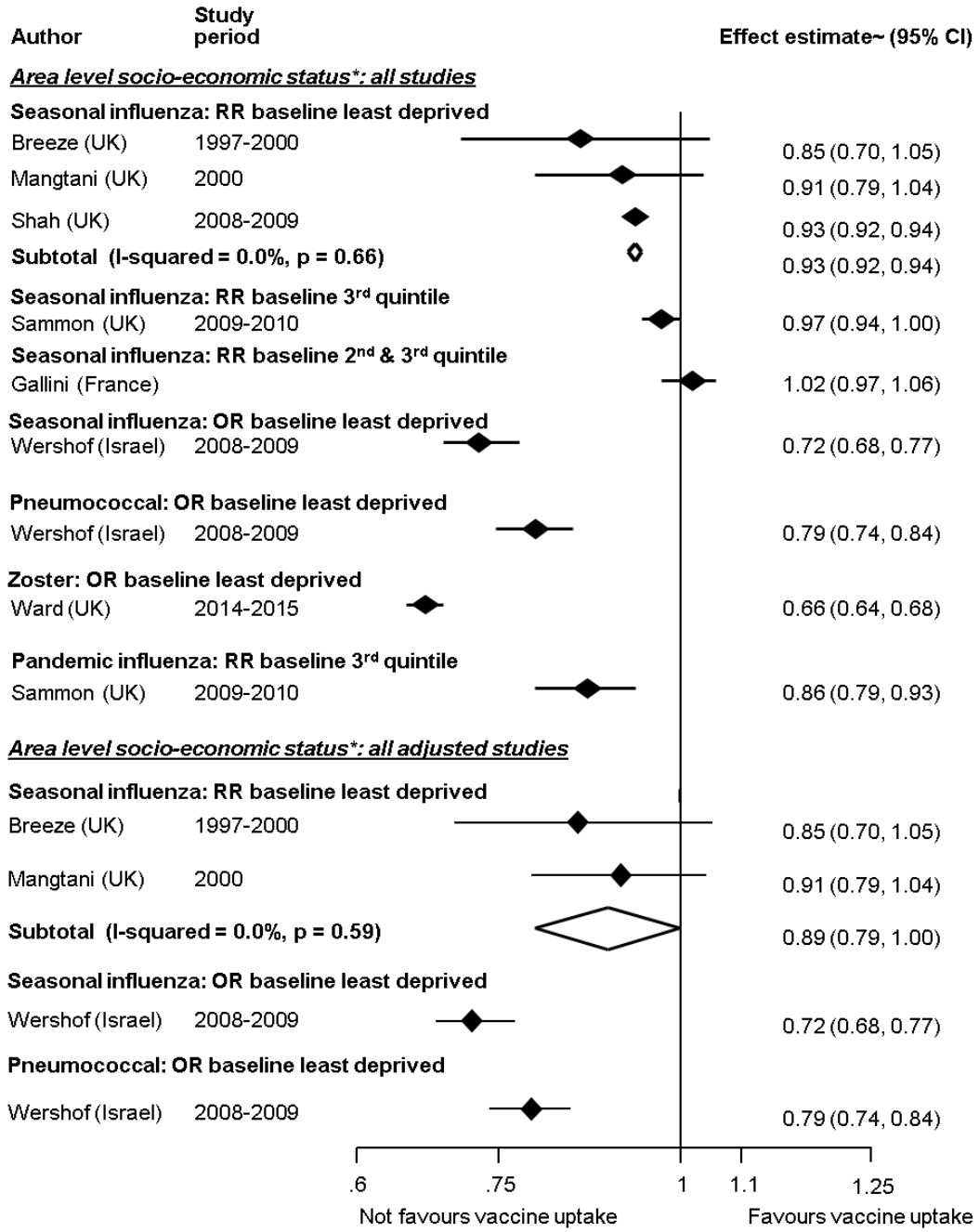


Figure 2-5 Association of residence with vaccine uptake: including studies identified on updating the review

F) Area-level socio-economic status

Two studies identified from the 2017-updated search reported the association of area-level socio-economic status with the uptake of seasonal influenza[96] and zoster vaccine.[82] The findings of the meta-analysis from the published review remained unchanged following the inclusion of these two additional studies (Figure 2-6); the risk of seasonal influenza uptake remained modestly lower (7-11%) amongst individuals from most deprived areas. Additional information was available for the association of area-level socio-economic status with zoster vaccine uptake from the 2017-updated review, the odds for zoster vaccine were lower (0.66 (95%CI: 0.64-0.68)) amongst individuals from the most deprived areas as compared to the baseline group of least deprived areas,[82] keeping with the finding for other vaccine types from the published review. The reference group for the study reporting the uptake of seasonal influenza vaccine identified in the 2017-updated review, was the second and third quartile of deprivation; the reported adjusted risk ratio amongst those from the lowest quartile of deprivation was 1.00 (0.96-1.04) and amongst those from the highest quartile of deprivation was 1.02 (0.97- 1.06), respectively.[96]



~All effect estimates are odds ratio unless specified otherwise *Cost stratified studies not presented as all study countries provided free-of-charge vaccine CI confidence interval RR risk ratio OR odds ratio

Figure 2-6 Association of area-level socio-economic status with vaccine uptake: including studies identified on updating the review

G) Country of birth

As described previously for other social factors, the meta-analysis was repeated after including one additional study identified in the 2017-updated review (Figure 2-7).[95] The findings from the published review remained unchanged, the summary odds of uptake were 40% and 33% lower amongst immigrants for both seasonal influenza and pneumococcal vaccines, respectively (Figure 2-7). Similar to the published review there was a strong evidence of between-study heterogeneity.

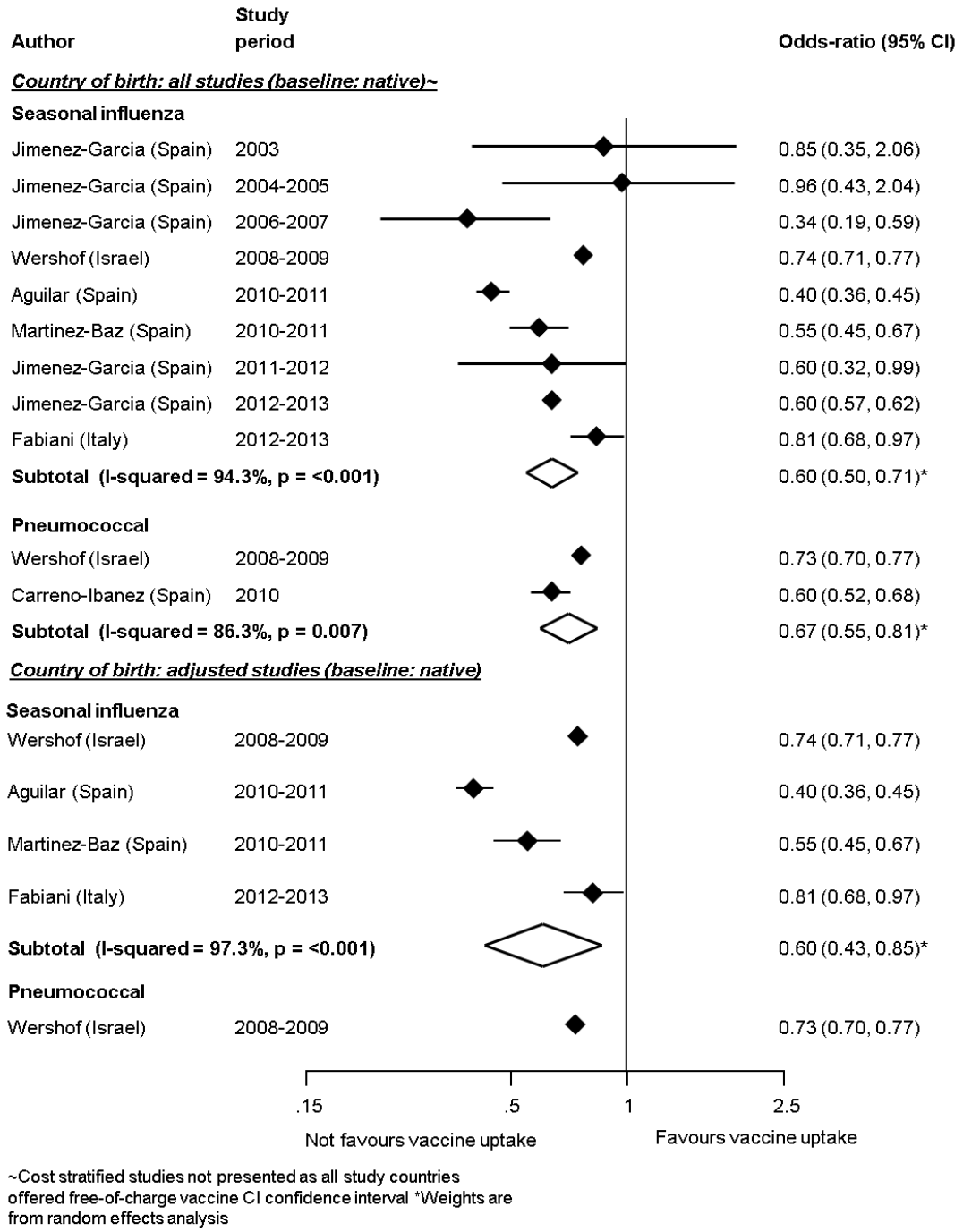


Figure 2-7 Association of country of birth with vaccine uptake: including studies identified on updating the review

2.5 Chapter summary

A systematic review and meta-analysis of the socio-demographic factors associated with vaccine uptake amongst older individuals was conducted to meet the first objective of this thesis. The factors associated with lower vaccine uptake included living alone, being not married, being an immigrant, individuals with lower-level of education, lower income,

residence in rural areas and area with higher level of deprivation. The findings were presented as a published paper. The review was updated in November 2017 and nine additional studies that identified were included with the studies from the published review paper and the meta-analyses were repeated, which corroborated the findings of the published review paper. One difference was the inclusion of a single extra study from France, that unlike the two UK studies from the published review (which showed slightly higher uptake in urban areas), reported no difference in uptake between urban and rural areas.

In the next chapter (**Chapter 3**), the details of the electronic health data utilised in this thesis are provided and in **Chapter 4** I will describe how the socio-demographic factors identified in this review were determined in the electronic data.

Methods section

The methods section for this thesis has three chapters:

Chapter 3 describes the different electronic datasets used for the analyses in this thesis. It also presents the methods used to select the study populations from these data for the three observational studies conducted to meet **objectives 2-4** of this thesis.

Chapter 4 describes the methods used to identify the social factors of interest in the electronic data that were identified from the findings of the systematic review (**Chapter 2)**.

Chapter 5 presents the methods used to ascertain the outcome variables in these data, namely herpes zoster and zoster vaccine uptake, as well as all other covariates used in analyses.

Chapter 3. Data sources: Electronic Health Records

3.1 Introduction

Health care provided by the National Health Service (NHS) in the UK is delivered free at point-of-care.[102] The general practice forms the main component of primary care delivered by the NHS, and offer diagnostic, preventative and therapeutic services to the UK population. More than 98% of individuals in England are registered with a general practitioner (GP) and nearly 80% of patient contact in the NHS occurs via general practice; the GP consultation rate during 2013-2014 was ~5 per person-year.[103-105]

General practice, considered to be the most digitalised part of the NHS, began using computers for patients' records in the 1980s and by the middle of the 2000 decade nearly all practices were using EHR at point-of-care.[106, 107] In 2004, a pay-for-performance scheme (the Quality and Outcomes Framework (QOF)) was introduced for general practices in England.[108] Under this scheme, GPs are financially incentivised based on their performances against a set of QOF parameters, which are defined annually. General practice EHR are also indispensable when claiming for QOF payments.[106]

Data from NHS hospitals in England are also available in form of a data warehouse: the Hospital Episode Statistics (HES), managed by NHS Digital.[109] These data are recorded by healthcare providers for patient care and payment purposes.[109] There are different types of data in HES and these include all admitted patient care data, data for attendances in outpatient departments and accident and emergency (A&E) attendances data.[109] The HES data are discussed further in **Section 3.3**.

Routinely collected electronic medical data such as those described above provide an invaluable data resource for research. Compared to research based on data collected specifically for research purposes, EHR-based research typically offers a quicker, more efficient and less expensive alternative.[110] It generally allows larger sample sizes, longer follow-up and assessment for numerous outcomes including rare conditions.[110] In England where all residents have access to primary and hospital-based health care that is

computerised, the results of EHR-based research are more likely to be generalizable than specific research population. It is also feasible to link primary care EHR with other data sources such as hospitalisation data, disease registries and death registration data, which makes these an attractive research option.[111, 112] It is therefore not surprising that in this era of financial constraints, EHR are increasingly utilised for health research and many research groups now specialise in conducting research using EHR.[110]

However, there are caveats to using EHR data for research. The primary purpose of these data is patient care and not research. Therefore, researchers should consider the completeness and validity of the EHR data. This also includes changes in EHR data over time, for example with changes in clinical, diagnostic and QOF criteria.[111] In the following sections, the main electronic health datasets used in this thesis are described, including primary care data, hospitalisation data and deprivation data.

3.2 Primary care EHR: The Clinical Practice Research Datalink

The primary care electronic health data utilised in this thesis were the anonymised longitudinal UK primary care data provided by the Clinical Practice Research Datalink (CPRD), known as CPRD GOLD.[113] The CPRD was initiated in 1987, and provides one of the world's largest repository of primary care data for research, which has been used in more than 1000 peer-reviewed publications.[113, 114] CPRD GOLD (herein referred to as CPRD data) covers ~7% of the UK population and is representative of the UK population in terms of gender, age and ethnicity.[114] The CPRD software system extracts de-identified patient information (Figure 3-1) from consenting general practices monthly. Patient-identifiable data such as the patient's name, full date of birth, address, and NHS number are not extracted and to maintain patient confidentiality, CPRD provides only the year of birth for adult patients.[114, 115] As outlined in **Section 3.2.3**, CPRD primary care data are also linked to other data such as hospital or deprivation data. These anonymised data are subsequently made available to researchers.[115]

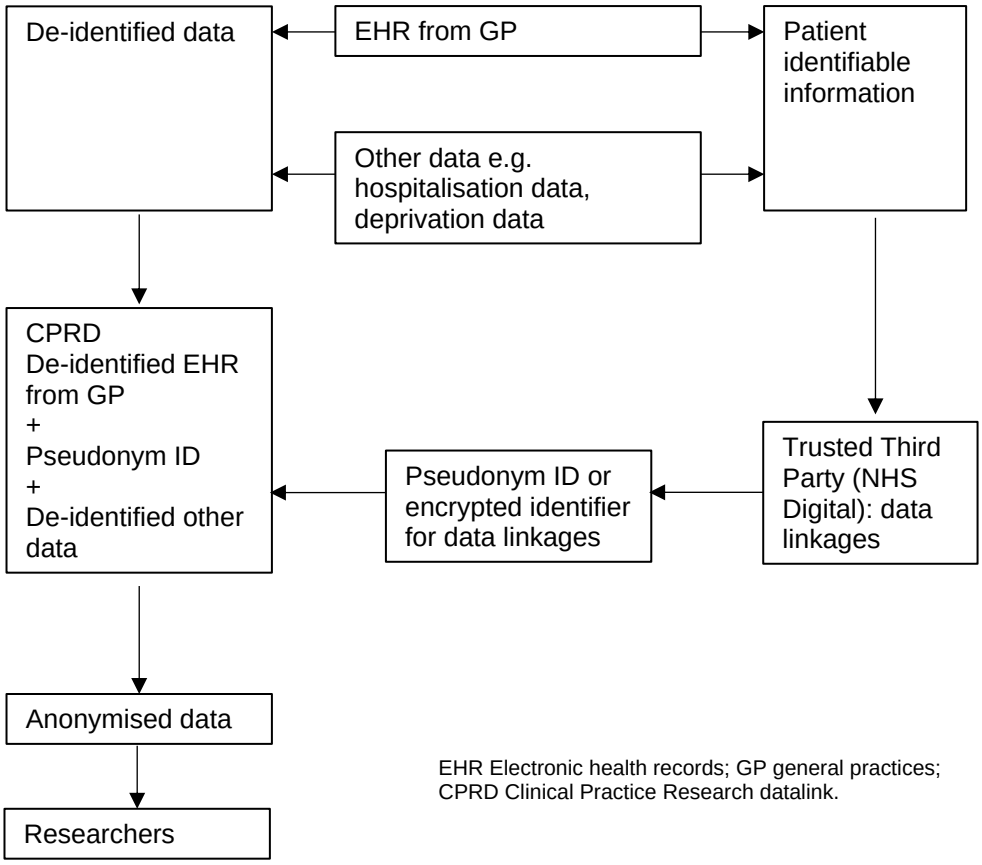


Figure 3-1 Data extraction and linkages by Clinical Practice Research Datalink*

***adapted from[115]**

3.2.1 CPRD data collection and format

As mentioned in **Section 3.2**, the data available in CPRD are collected in general practices, as a part of routine clinical care and therefore the frequency of these records is dependent on a patient's medical circumstances.[114] Much of the information in EHR is captured using structured and coded data; free-text being used if required.[107] Previously, selected anonymised free text data could be purchased by researchers, however changes in the information governance of CPRD means that these data were no longer available after March 2016 [Personal communications via email with the CPRD Knowledge Centre]. The majority of the information (e.g. clinical, administrative and lifestyle data) is recorded using Read codes (Read Version 2) and other specialist codes (described below), while therapies are recorded using Gemscript codes.[107, 114, 116] The aim of coded data entry is to help ensure that recordings are largely consistent, speedy, and retrievable for audit or payment purposes.[107] The information received by practices from a range of referral services,

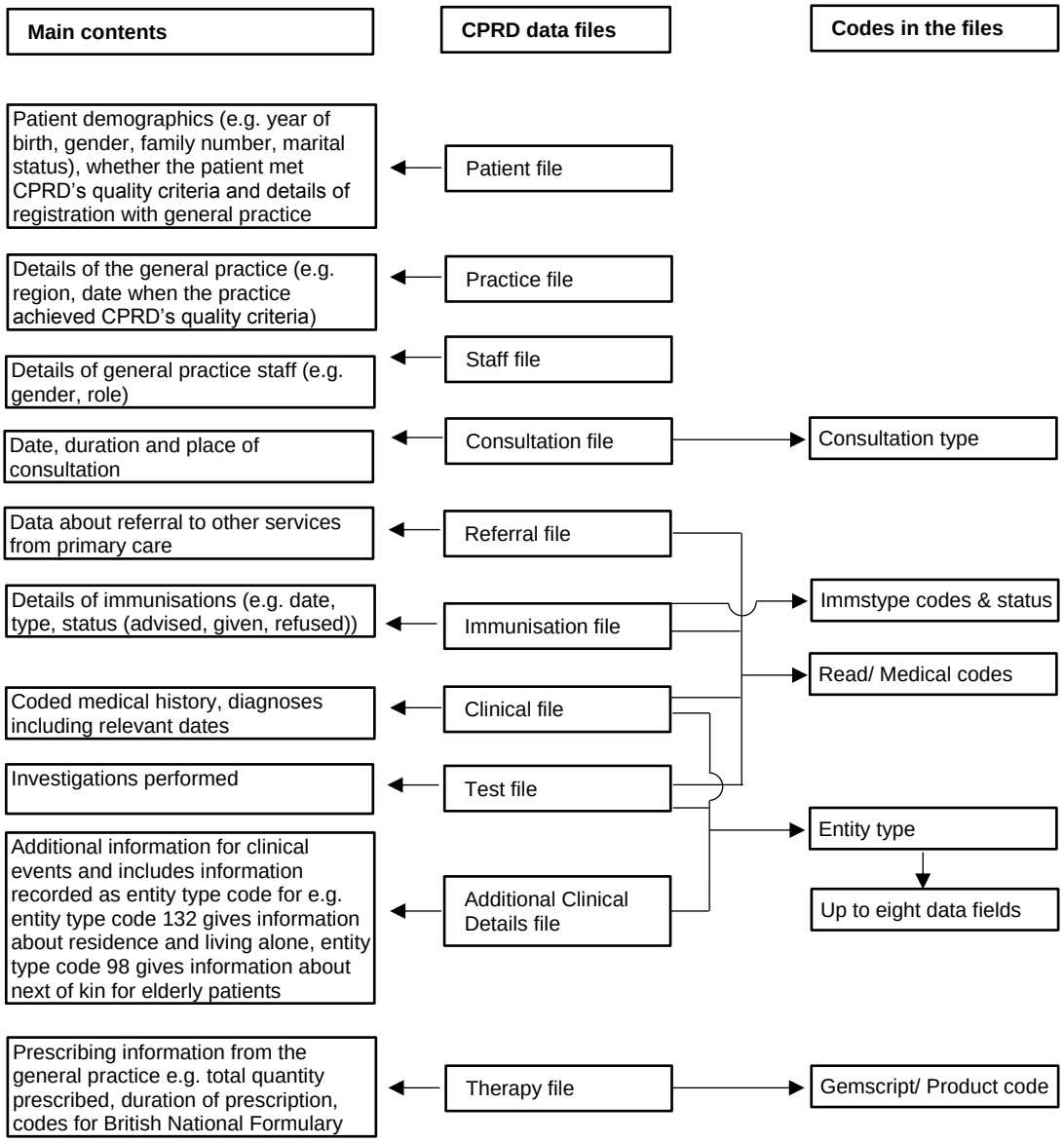


Figure 3-2 Clinical Practice Research Datalink: data structure and contents

including patient-related correspondence, may be also recorded using coded data.[114] CPRD also generates unique codes for the Read and the Gemscript codes called medical codes and product codes respectively, that are available to the researchers.

The information captured in the CPRD is formatted in ten different data files (Figure 3-2). These files provide information about the patient, the general practice and its staff, medical and preventative care provided to the patient, investigations, details of referral and correspondence with specialist care and also include the treatments provided.

A patient's demographic details, an overall indicator of whether their data are of acceptable quality (further described in **Section 3.2.2**, below), and their registration details with the practice such as their current registration date and the date they left the practice, are available in the Patient file (Figure 3-2). It also includes information (the family number) to identify other individuals registered with the practice sharing the same address as the patient. The Practice file includes unique practice identifiers for all practices in the database and provides details about the region where the general practice is located, the date when the data were last collected from the practice (the last collection date) and the up to standard date (UTS date: discussed in **Section 3.2.2**).

The Read codes and corresponding medical codes are present in the Clinical, Referral, Test and Immunisation files while the Gemscript/product codes are available in the Therapy files. In addition to the medical codes, the immunisation files also provide information about of the type of vaccine administered (e.g. seasonal influenza, zoster) and the status of immunisation i.e. whether the vaccination was advised, refused or given. Additional clinical information and test results (for e.g., a patient's weight or blood pressure results) are also available in the form of entity type codes, which capture additional structured coded data i.e. data recorded in a format that can be identified by the GP computer systems. This entity type field is available in the Clinical, Additional Clinical Details and Test files. Each entity type field may additionally have up to eight data fields (Figure 3-2) depending upon the type of data file, that gives additional information regarding that entity.

With the exception of the Patient, Practice, Staff and Additional Clinical Details files, all CPRD data files provide two date fields associated with 'events' (for example- recording of

symptoms and signs, diagnoses, tests, prescriptions): (i) the event date, which is the date the event occurred as recorded by the GP and (ii) the system date, the date when the event was recorded on the GP computer system.

The details of all medical and product codes are provided by CPRD in the form of medical and product dictionaries, which can be searched using the supplied Browser Tool function (the Medical Browser tool for medical codes and the Product Browser tool for medications or product codes) to create various code lists for research studies. Similarly, CPRD also provides detailed information for all entity type codes present in the data.

3.2.2 CPRD data quality

The validity and reliability of the results of an EHR-based research depend upon the quality of data in terms of both completeness and validity. The introduction of QOF in 2004, which remunerated the GPs for their performance against pre-specified targets, played an important part in improving the quality of some aspects of primary care health records.[107]

Secondly, CPRD also provides data quality checks at both the patient and the general practice level.[114, 117] Patients meeting CPRD's quality criteria are identified in the Patient file by an 'acceptable' flag, which gives an indication about the continuity of their follow-up and the quality of their captured data.[114, 117] Some of the criteria for labelling patients as 'unacceptable' include invalid recording of: gender, year of birth, current or first registration date, transfer out date; age >115 years, and temporary registration.[114, 117] It is recommended that patients who do not meet the CPRD's acceptability criteria should not be included in research projects.

At the practice level, the date when a practice meets the CPRD quality assurance criteria is indicated by the UTS date in the Practice file. The quality of the data from the practice is judged on (1) data continuity and (2) any unexpected gaps in the death rate for the practice.[114] As with the patient acceptability flag, it is recommended to include the practice data for research purposes only after the UTS date.

The validity of the diagnoses recorded in CPRD has been examined in numerous studies.[114, 117] A 2010 systematic review summarised the findings and the quality of validation studies

for 183 diagnoses recorded in CPRD and reported a high positive predictive value (median value of 89% (range 24-100%)) for the diagnoses in these data.[118] However, this review also found that most validation studies did not report the negative predictive value, specificity and sensitivity for the diagnoses.[118] Although overall there is a good comparability of disease rates for a range of diseases estimated using the CPRD with rates from external sources, an overestimation of incidence rates have been observed within these data during the immediate post-registration period for patients.[118, 119] This overestimation in rates soon after patient registration may result from either a patient with new onset of symptoms seeking to register with a new GP, or during these earlier visits to the GP a patient's past medical conditions are recorded with the date of the visit, thus being misclassified as ongoing or present conditions.[119] Excluding the period immediately following a patient's registration for six months (for acute conditions) to one year (for chronic conditions) has been shown to minimise this misclassification.[119]

3.2.3 CPRD: data linkages

General practices in England, subject to their consent, can have their data linked with other datasets at an individual-level. All patients registered with the consenting practices are included for the linkages, unless they opt out. [114] By 2015, linked data were available for up to 75% of the English practices (~57% of all UK practices).[114, 120] Some of the other datasets available for linkages include deprivation data, hospitalisation data, disease registries and death registration data.[120] The linkages with these data, which require access to patient identifiable information, are conducted by a trusted third party (NHS Digital).[115] The trusted third party provides CPRD with an encrypted linker key, which is common to both primary care records and the linkage data (Figure 3-1).[120] For this thesis, CPRD data linked to admitted patient HES data and deprivation (IMD data) were utilised. These two linked data sources are described in the next two sections: **Sections 3.3** and **3.4**.

3.3 Hospital Episode Statistics

As introduced in **Section 3.1**, HES includes different types of data such as admitted patient care data, A&E attendances and outpatient appointments data.[109] In this thesis, the Admitted Patient Care data, which includes administrative and clinical details for all patients admitted

in the NHS hospitals in England, were utilised. Unlike other data in HES, the Admitted Patient Care data records full diagnostic information. CPRD provides linkages with Admitted Patient Care HES data from 1997 onwards as the NHS number, a patient identifier required for data linkages, was introduced in 1997.[120] Depending upon the linkage period covered, CPRD provides different sets/ versions of HES data linked to CPRD patients. For example, in this thesis HES version 10 (covering the Admitted Patient Care data for the period: 01/04/1997-31/03/2014) and version 13 (covering the Admitted Patient Care for the period: 01/04/1997-29/02/2016) were utilised. Primarily, HES data are used for clinical care and also allow the healthcare providers to be paid for their activities.[109] Additionally, these data have non-clinical or secondary uses; they are utilised for the commissioning of health services, planning for future healthcare and research by numerous bodies such as the Department of Health, NHS, local commissioning groups, commercial and national organisations.[109]

3.3.1 Data collection and format

The hospital data are collated by a single data repository, the Secondary Uses Service (SUS) maintained by NHS digital, which extracts this information as a database (HES) and also supplies information to the healthcare commissioners for payment purposes.[109] The SUS takes extracts from the data submitted by the healthcare providers at predetermined intervals and sends it to HES. The HES extracts are available every month, which are cumulative. For example at the start of the financial year the April extract will include data for only one month, but in month 4 the extract will include cumulative data from April-July.[109]

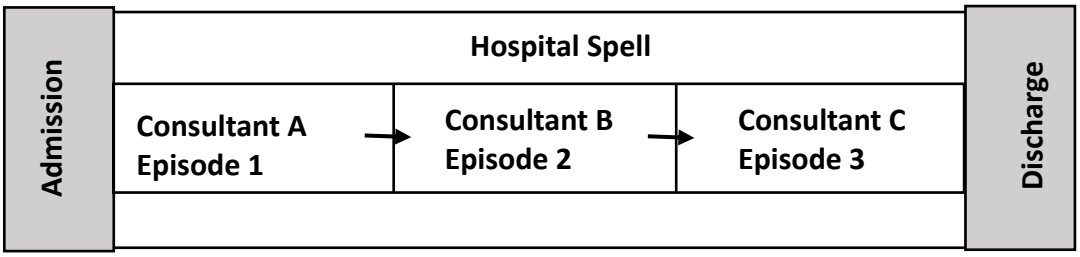
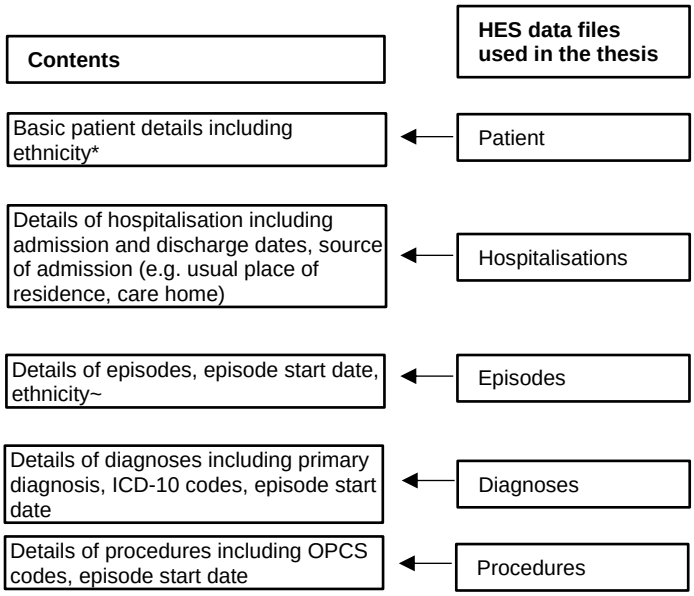


Figure 3-3 Hospital Episode Statistics: data structure

In HES, the period of hospitalisation between admission and discharge is known as a 'spell'. Each hospital spell in turn comprises of one or several consultant episodes (Figure 3-3), each episode being defined as a period of continuous care from one consultant at a single hospital.[109] As mentioned earlier in **Section 3.3**, HES Admitted Patient Care data consists of individual-level data about clinical diagnoses and hospital procedures during hospitalisation.[109] It also includes basic demographic details for the patient (age group, sex, ethnicity, geographical location) and a HES generated patient identifier. Each HES episode has an episode start date, one primary diagnosis and may have up to 19 secondary diagnosis and up to 24 procedures recorded.[121] The primary diagnosis for the first episode typically indicates the reason for hospital admission.[121] The codes used for recording the clinical diagnoses and procedures are the World Health Organization's 10th revision of International Classification of Diseases and Related Health Problems (ICD-10) and the 4th revision of the Office of Population Censuses and Surveys: Classification of Interventions and Procedures (OPCS-4), respectively.[122]

CPRD supplies the HES data as text tab delimited files with different types of data content. The HES data files used in this thesis are shown in Figure 3-4; these included the Patient, Hospitalisation, Episodes, Diagnoses and Procedures files.



*HES version 10
~HES version 13
ICD International Classification of Diseases
OPCS Office of Population Censuses and Surveys

Figure 3-4 Hospital Episode Statistics: data format and contents

3.3.2 HES data quality

The data captured from the NHS hospitals by the SUS is audited against set standards for validity and completeness.[123] Before these data can be made available in the HES data warehouse, NHS Digital removes patient-related sensitive data, carries out data cleaning including removal of duplicate records, performing routine and ad hoc quality checks, and publishing data quality reports.[123] The accuracy of diagnoses and procedures coding in data submitted for payment were audited in 2012-2013 and a mean error rate of 11%-16% was found .[124] The majority of the errors were reported for secondary diagnoses coding due to poor capture of co-morbidities data.[124] However, since the introduction Payment by Results (2004) whereby the hospitals are remunerated based on the coding data, the accuracy of the coding information continues to improve in more recent data.[125, 126]

3.4 Deprivation data

Patients' and/or general practices' postcodes in CPRD databases can be linked by a trusted third party (NHS Digital) with a small area-based measure of relative deprivation called the English Index of Multiple Deprivation (IMD), a proxy marker for socio-economic status.[127] The IMD is defined at a Lower Layer Super Output Area (LSOA): an area with an average population of 1500 people.[128] This index is a composite score of 38 indicators derived from seven domains, which measure different aspects of deprivation including income, employment, education and skills, health and disability, crime, housing and living environment.[129] The actual IMD scores are not provided to researchers using CPRD to avoid the risk of identification of LSOA and patients' area of residence. Instead, all LSOA in England are ranked based on their area-level IMD score and are divided into equal groups or quantiles (generally quintiles), which are available to the researchers. Quintile one represents the least deprived and quintile five represents the most deprived quintile.[129] There are four English IMD datasets (2004, 2007, 2010 and 2015) available for linkage.[120] To mitigate the risk of deductive disclosure of an individual's area of residence, CPRD provides linkage with only one these datasets for any one study.[120]

3.5 Identifying the study populations

In **Chapters 6, 7** and **8**, the three observational studies conducted to ascertain the recording of social factors amongst older individuals in linked electronic health data and then the application of these methods to examine the socio-demographic determinants of zoster burden and uptake of zoster vaccine are described, respectively. In this section an overview of how the study populations for these three studies were selected from the linked electronic data is provided.

3.5.1 Identifying the study population for the cross-sectional study to ascertain socio-demographic factors and assess their recording in the electronic health record data (objective 2)

The CPRD data used for this study was from the January 2015 release, linked to version 10 of the HES data and the 2010 English IMD data. To assess both completeness and

timeliness of recording of the social factor data, an index date of 01/01/2013 (the start of the year in which zoster vaccination was introduced in England) was chosen.[68] The study population was required to be aged ≥65 years on 01/01/2013. As only year of birth was available in these data (**Section 3.2**), the common convention of using the mid-year (1st July) to assign study participants' day and month of birth was followed. To ensure data quality, both the individuals and the practices included in the study were required to meet the quality requisites set by the CPRD i.e. individuals were required to be acceptable for research (**Section 3.2.2**). Participants were required to be active (alive and registered with a CPRD practice that was UTS) on the index date (01/01/2013). Active registration on the index date was determined by ensuring patients' start dates (the later of their current registration date with the practice or the UTS date for the practice) fell before the index date and their end dates (the earliest of their transfer out date, date of death or practice's last collection date) were after the index date. This led to the inclusion of 591,037 patients from 389 general practices.

3.5.2 Identifying the study population for the cohort study to describe the socio-demographic factors associated with zoster disease incidence in England (objective 3)

This cohort study spanned a period of ten years (01/09/2003-31/08/2013) prior to the introduction of zoster vaccine in England on 01/09/2013.[68] The CPRD data utilised for this study was from the January 2016 release, linked to HES data version 10 and 2007 English IMD data (the latter approximately at the midpoint of the study period). The participants were required to have no prior history of zoster, and to be alive and currently registered with a CPRD practice in England. As described previously (**Section 3.2.2**), to ensure data quality, only participants categorised as 'acceptable' by the CPRD, were included in the study. Follow-up for each individual started on the latest of: their 65th birthday, one year after their current registration date, the UTS date for the practice or the study start date (01/09/2003) (Figure 3-5). As discussed in **Section 3.2.2**, a period of one year was added to the current registration date to avoid overestimation of zoster incidence in the immediate post-registration period as a patient's past zoster history might be misreported as an ongoing or a

presenting complaint.[119] The end of follow-up was defined as the earliest of: the patient's transfer out date from the practice, their death date, the date of zoster, the last collection date from the practice or the end of the study (31/08/2013) (Figure 3-5). Patients were required to have a minimum follow-up of one day.

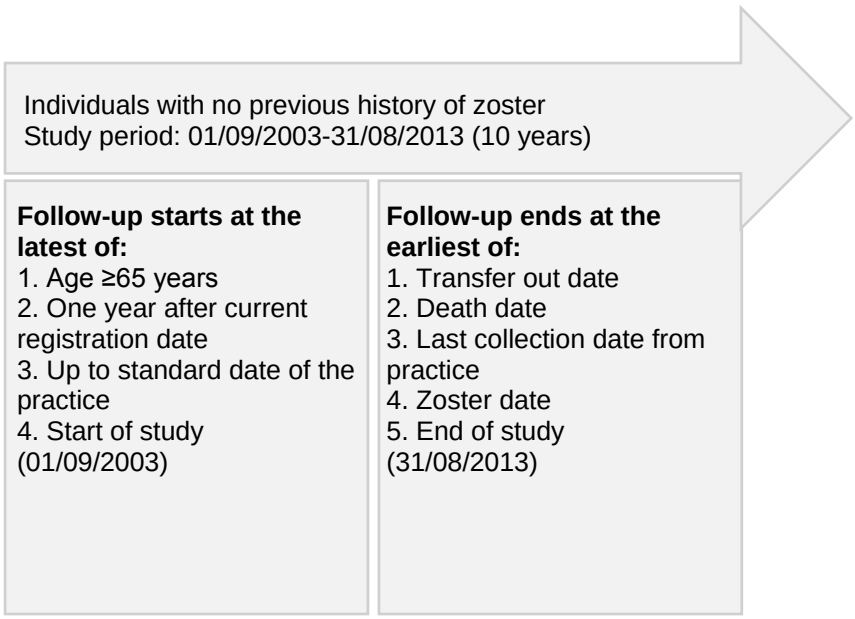
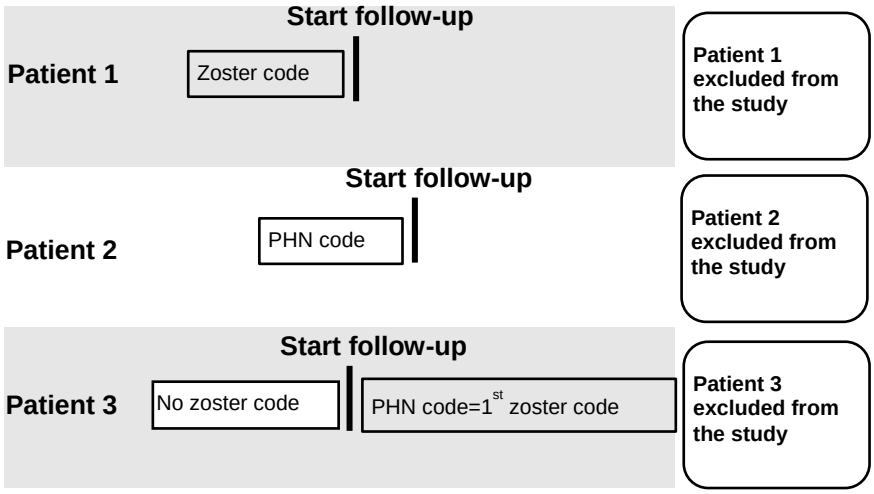


Figure 3-5 Cohort study ascertaining the socio-demographic factors associated with zoster disease incidence: study follow-up period

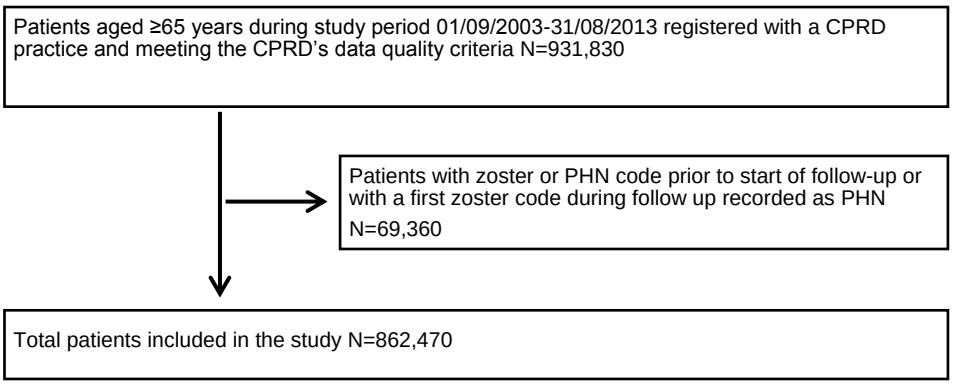
Two approaches were used to identify and exclude individuals with previous zoster history using CPRD data linked to HES: (1) Patients with a code for zoster or PHN (Appendix 3) prior to the start of follow-up were excluded (2) Individuals for whom the first zoster code was that for PHN during the follow-up period were also excluded (Figure 3-6). Both medical codes and ICD-10 codes[130] were utilised to identify individuals with zoster and PHN (Appendix 3).



PHN Post-herpetic neuralgia

Figure 3-6 Identifying individuals' previous history of zoster or post-herpetic neuralgia

The number of patients meeting the above defined eligibility criteria was 931,830 from 385 practices in England. Of these participants, 69,360 (7.4%) individuals were excluded due to a prior history of zoster (Figure 3-7).



CPRD Clinical Practice Research Datalink
PHN post-herpetic neuralgia

Figure 3-7 Cohort study ascertaining the socio-demographic factors associated with zoster disease incidence: study participant flow chart

3.5.3 Identifying the study population for the cohort study to describe the socio-demographic factors associated with zoster vaccine uptake in England (objective 4)

The CPRD data utilised for this study was from the January 2017 release, linked to HES data version 13 and the 2015 English IMD data. This cohort study spanned the first two years following the introduction of zoster vaccine in England, from 01/09/2013 until 31/08/2015.[68] Follow-up started on 01/09/2013 (start of national programme) and all participants were required to be "acceptable" (**Section 3.2.2**), alive and currently registered with a UTS CPRD practice in England on this date. Follow-up ended at the earliest of: the patient's transfer out date, death date, the date data were last collected from the practice or the end of the study (31/08/2015) (Figure 3-8). To allow sufficient time for the individuals to be invited for vaccination and the possibility of co-administration of zoster vaccine with seasonal influenza vaccine amongst the older population, the study participants were required to have a minimum follow-up of 5 months (September 1st until the end of January 2013), which coincided with the main part of the seasonal influenza vaccination campaign.[131] As zoster vaccine was available to a limited extent (privately at first followed by availability on the NHS based on GP's discretion) prior to the introduction of the national programme, any individuals with a zoster vaccine code prior to 01/09/2013 were also excluded from the study.[132, 133]

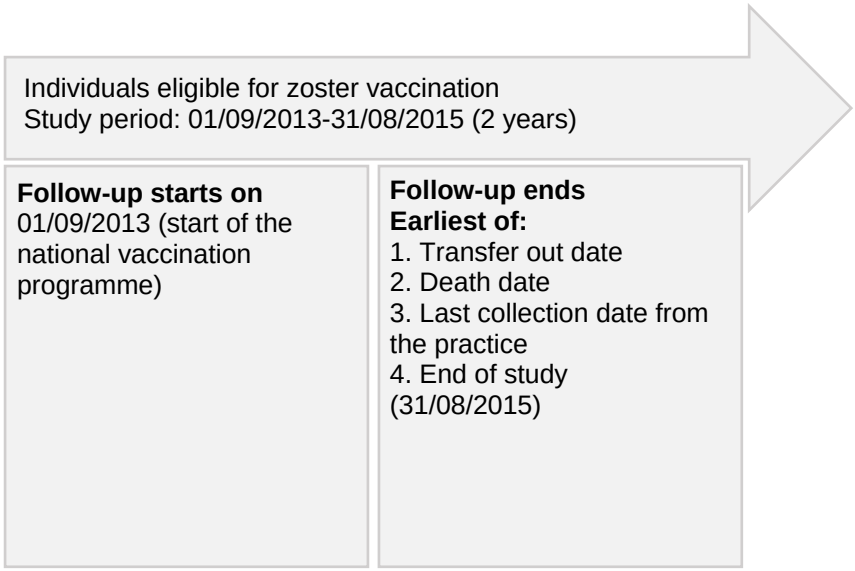


Figure 3-8 Cohort study ascertaining the socio-demographic factors associated with zoster vaccine uptake: study follow-up period

3.5.3.1 Identifying individuals eligible for zoster vaccination

In England zoster vaccine is offered routinely to individuals aged 70 years on 1st of September of the corresponding vaccination year, with a catch-up amongst older individuals as detailed in **Section 1.2.5** and Table 1-1. For this study, which spanned a two-year period (2013-2015), the routine cohort eligible for vaccination comprised of individuals born between 02/9/1942-1/9/1943 for the first vaccination year (2013-2014) and those born 02/9/1943-1/9/1944 for the second vaccination year (2014-2015) (Table 1-1). As discussed previously, to maintain patient confidentiality, only year of birth is available for adults in CPRD data. This posed a problem in how to identify an individual's age-based eligibility for zoster vaccine during the study period. The common convention of assigning individuals with a nominal birth of 1st July would misclassify some individuals' eligibility. For example, during the 2013-2014 vaccination year, individuals born between 02/09/1942-01/09/1943 and aged 70 years on 01/09/2013 were eligible for vaccination as a part of the routine cohort. The assigned date of birth for those born between 02/09/1942-31/12/1942 would be 01/07/1942, therefore misclassifying all these individuals as ineligible as their CPRD age on 01/09/2013 would be 71 years (Figure 3-9). On the other hand, individuals born between 01/01/1943-01/09/1943, with an assigned date of birth as 01/07/1943 and aged 70 years on 01/09/2013

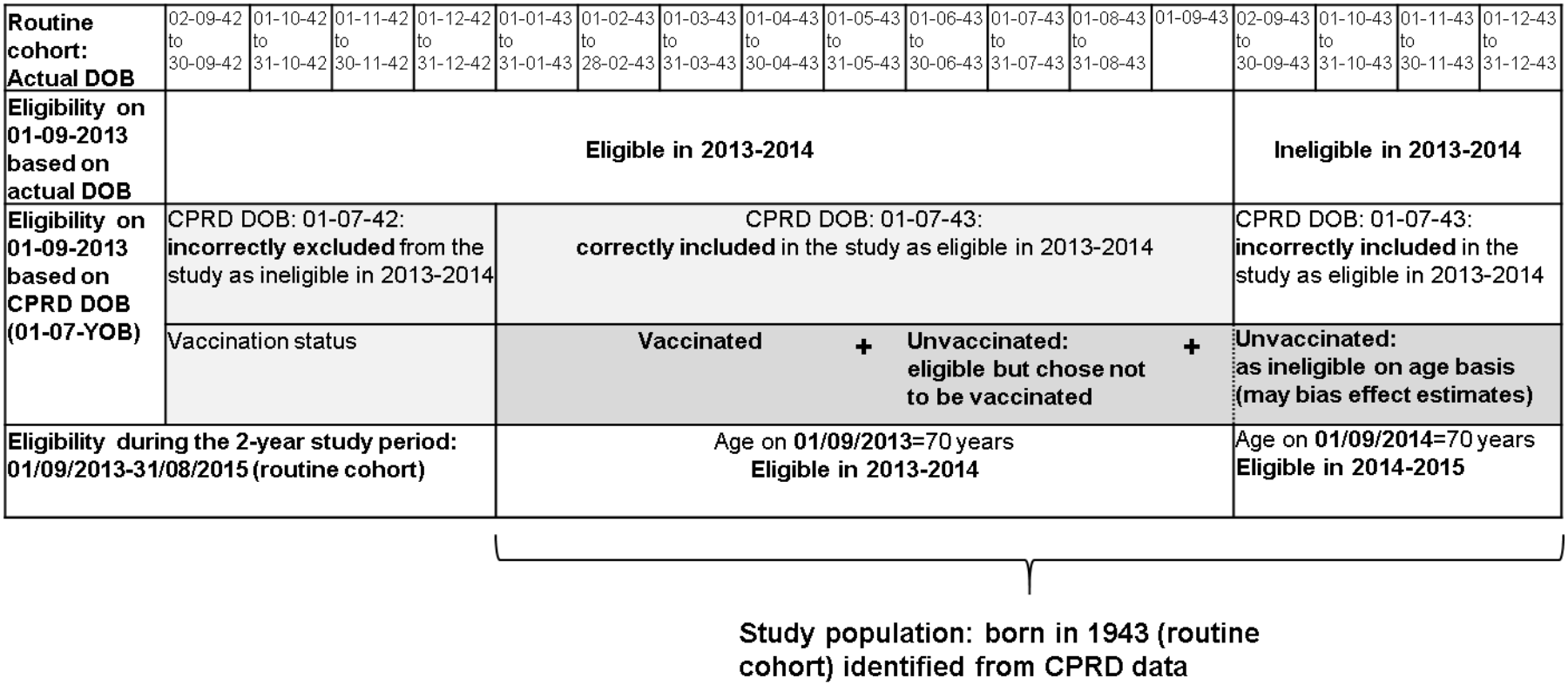
would be correctly identified as eligible. The remaining group of individuals, those born between 02/09/1943-31/12/1943 with an assigned date of birth of 01/07/1943 would be incorrectly identified as eligible (Figure 3-9). Importantly, the inclusion of this latter group could bias the effect estimates for vaccine uptake for the socio-demographic factors of interest because the unvaccinated group would comprise a mixture of individuals with possibly differing socio-demographic factors: a) those eligible for vaccination who chose not to be vaccinated and b) those ineligible on the grounds of age (Figure 3-9).

To address this, all individuals born in 1943 (or 1934 for the catch-up cohort), who would have been eligible for the vaccine in 2013/14 (if born between January-August) or in 2014/15 (if born between September-December) were selected to investigate vaccine uptake for the 2-year study period (Figures 3-9 and 3-10). The study population therefore comprised individuals born in 1943 (the routine cohort, Figure 3-9) and in 1934 (the catch-up cohort, Figure 3-10).

3.5.3.2 Excluding patients with immunosuppressive conditions and treatments

As zoster vaccine contains the live attenuated virus, the UK Green book provides guidance about contraindications to its administration amongst individuals with certain immunosuppressive conditions and treatment (**Section 1.2.5**).[60] To ascertain eligibility for zoster vaccination, individuals with the following conditions and treatments were identified and excluded at the start of follow-up. These conditions included: leukaemia, lymphoma, myeloma, other plasma cell dyscrasias, stem cell transplant, bone marrow transplant, solid organ transplants, Human Immunodeficiency Virus infection and cellular immune deficiency.[60] The immunosuppressive treatments (**Section 1.2.5**) comprised: biological therapies, other immunosuppressive agents such as tacrolimus, disease modifying anti-rheumatic drugs such as ciclosporin, specific doses for some of these: azathioprine, methotrexate, 6-mercaptopurine, steroids; cancer chemotherapy and radiotherapy.[60]

The details of how these immunosuppressive conditions and treatment were identified in the linked CPRD data are provided in **Chapter 5** (**Section 5.5**).



DOB date of birth
CPRD Clinical Practice Research Datalink
YOB year of birth

Figure 3-9 Individuals included in the zoster vaccine uptake cohort study during 2013-2015 based on year of birth in Clinical Practice Research Datalink: routine cohort

<table>
<tr><td>Catch-up cohort: Actual DOB</td><td>02-09-33 to 30-09-33</td><td>01-10-33 to 31-10-33</td><td>01-11-33 to 30-11-33</td><td>01-12-33 to 31-12-33</td><td>01-01-34 to 31-01-34</td><td>01-02-34 to 28-02-34</td><td>01-03-34 to 31-03-34</td><td>01-04-34 to 30-04-34</td><td>01-05-34 to 31-05-34</td><td>01-06-34 to 30-06-34</td><td>01-07-34 to 31-07-34</td><td>01-08-34 to 31-08-34</td><td>01-09-34</td><td>02-09-34 to 30-09-34</td><td>01-10-34 to 31-10-34</td><td>01-11-34 to 30-11-34</td><td>01-12-34 to 31-12-34</td></tr>
<tr><td>Eligibility on 01-09-2013 based on actual DOB</td><td colspan="13">Eligible in 2013-2014</td><td colspan="4">Ineligible in 2013-2014</td></tr>
<tr><td rowspan="2">Eligibility on 01-09-2013 based on CPRD DOB (01-07-YOB)</td><td colspan="4">CPRD DOB: 01-07-33:
incorrectly excluded from the study as ineligible in 2013-2014</td><td colspan="13">CPRD DOB: 01-07-34:
correctly included in the study as eligible in 2013-2014</td><td colspan="4">CPRD DOB: 01-07-34:
incorrectly included in the study as eligible in 2013-2014</td></tr>
<tr><td colspan="4">Vaccination status</td><td colspan="13">Vaccinated + Unvaccinated: eligible but chose not to be vaccinated +</td><td colspan="4">Unvaccinated: as ineligible on age basis (may bias effect estimates)</td></tr>
<tr><td colspan="4">Eligibility during the 2-year study period: 01/09/2013-31/08/2015 (catch-up cohort)</td><td colspan="13">Age on 01/09/2013=79 years
Eligible in 2013-2014</td><td colspan="4">Age on 01/09/2014=79 years
Eligible in 2014-2015</td></tr>
</table>

Study population: born in 1934 (catch-up cohort) identified from CPRD data

DOB date of birth
CPRD Clinical Practice Research Datalink
YOB year of birth

Figure 3-10 Individuals included in the zoster vaccine uptake cohort study during 2013-2015 based on year of birth in Clinical Practice Research Datalink: catch-up cohort

3.6 Data management

Data were analysed using Stata®14 software (StataCorp, College Station, TX, USA).

In **Chapters 4** and **5** details of how I identified the exposure and outcome variables in these data including the other covariates used in the analyses, are provided.

I first generated the patient denominator files for the different studies from the Patient and Practice files in CPRD data to identify eligible individuals for each study. The patient list thus created was used to identify their records in all the remaining CPRD data files.

Information for the variables of interest was extracted using code lists, which were generated using both text terms and hierarchical searches of the relevant Read codes applied to the CPRD's Medical Browser tool. Similarly, for drugs and therapeutic agents, a list of product codes was generated using the CPRD's Product Browser tool (**Section 3.2.1**). In addition to code lists, information was also captured from the Patient file, Consultation file (using consultation type codes) and the structured coded data in these records (entity type codes). Information as to when data were recorded was extracted using event dates and system dates (**Section 3.2.1**). As discussed in **Section 3.2.1**, the Additional Clinical Details files does not have dates showing when any entity type code was recorded. However, it is feasible to link the Clinical details file with the Additional Clinical Details file using the specific identifier present in both files. This allows an event date which is present in the Clinical file to be associated with an entity type code recorded in the Additional Clinical Details file (**Section 3.2.1**). I brought together the information from these different sources using specific algorithms where necessary (as described in the relevant sections of **Chapter 4** for socio-demographic factors of interest, and of **Chapter 5** for the outcome of interest and other variables used in analyses).

In HES, code lists were generated to identify ICD-10 codes for the conditions of interest. Similarly, OPCS code lists were created to identify procedures (for example, bone marrow transplants) performed in hospital. The list of patients eligible for inclusion in the study was merged with the Patient, Hospitalisation, Episodes and Diagnoses files in the HES data. The resultant file comprising eligible patients' hospitalisation records was subsequently used to

identify the ICD-10 codes of interest from the ICD-10 code lists generated. The Procedures file was used to select the OPCS codes of interest from the OPCS code lists.

3.7 Ethics

All data were anonymised prior to receipt by the candidate.

Objective 2: Approval for this study was obtained from the Independent Scientific Advisory Committee of the Medicines and Healthcare products Regulatory Agency Database Research (Ref: 15_253). The study was also approved by the Observational Research Ethics Committee of the London School of Hygiene and Tropical Medicine (reference: 10524).

Objectives 3 and 4: The protocol for this research was approved by the Independent Scientific Advisory Committee of the Medicines and Healthcare products Regulatory Agency Database Research (protocol number 16_168). The study was also approved by the Observational Research Ethics Committee of the London School of Hygiene and Tropical Medicine (Reference: 11910).

3.8 Chapter summary

This thesis utilised CPRD data, one of the world's largest repository of routinely collected primary care electronic health data, linked to hospitalisation data (HES) and deprivation data (IMD) from England. These quality-assured primary care data are generally representative and cover ~7% of the UK population.

In this chapter I described the nature of the data sources and how I selected the study population for the three different observational studies from the linked CPRD data, conducted to meet **objectives 2, 3** and **4** of this thesis.

In the next chapter (**Chapter 4**), I describe the methods I used to identify the socio-demographic factors of interest (exposure variables), including age, gender, ethnicity and the relevant socio-demographic factors identified from the systematic review (**Chapter 2**) in these linked data.

Chapter 4. Defining social factors in electronic health records

In this chapter (the second of the three methods chapters in this thesis), I describe the following- (1) the rationale for selecting the socio-demographic factors considered for further investigation, (2) the electronic data sources used to identify these factors, (3) identification of socio-demographic factors in linked electronic data and (4) how data algorithms were developed and categorisation for each factor was carried out. The results of analyses to assess the completeness, timeliness and representativeness of recording for these socio-demographic variables in the electronic health data are described under the Results section (**Chapter 6**).

4.1 Rationale for selecting the socio-demographic factors

The factors examined were chosen if they were considered relevant at an individual level, informed by my systematic review (**Chapter 2**) that was based on the WHO CSDH's conceptual framework (**Section 1.1.1**) (Figure 1-1), and if they were potentially available in the linked CPRD data.[4]

Apart from age and gender, the seven socio-demographic factors of interest included: ethnicity, immigration status, religion, living arrangements (including two closely-related variables: living alone and cohabitation (living as a couple)),[134] marital (relationship) status, residence and deprivation (the latter available as linked data). Of these factors, immigration status, living arrangements, residence, marital status and area-level deprivation were identified as important determinants of vaccine uptake from the findings of my systematic review (**Chapter 2**). The review also highlighted the lack of availability of studies examining the association of religion with vaccine uptake. Also, as discussed earlier (**Section 1.3.3**), the zoster vaccine used in the UK includes porcine components which may compromise its acceptability amongst some religious groups. Therefore religion was included as one of the factors examined in this thesis. Place of residence, which was examined as a binary variable

in the systematic review (as urban versus rural area of residence), was examined in greater detail, as described later (**Section 4.4**). Ethnicity was included because of its association with both zoster disease burden and zoster vaccine uptake, as previously described (**Sections 1.3.2** and **1.3.3**) and to allow comparisons of this thesis' findings with the analyses of zoster vaccine uptake that had been carried out using the national data, which included ethnicity (**Section 1.3.3**).[82] The additional rationale for including specific socio-demographic factors in the analyses conducted to meet **Objectives 2-4** are described in **Chapters 6-8**.

4.2 Electronic health data for ascertainment of socio-demographic factors

As discussed in **Chapter 3**, the electronic health data utilised for analyses comprised CPRD, HES and IMD data. Information for socio-demographic factors was extracted from all three sources, as described below.

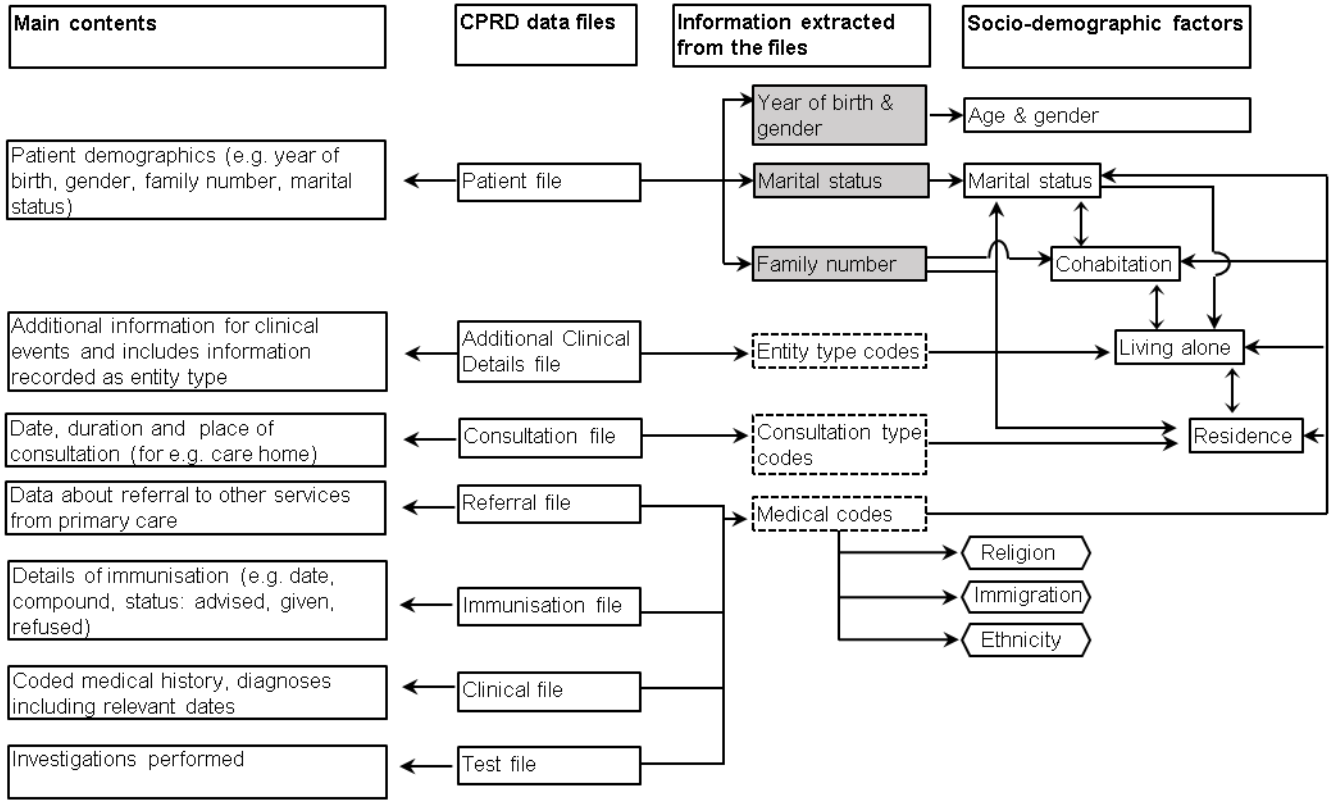
4.2.1 CPRD data

The data structure of CPRD was detailed in **Section 3.2**. Information about the socio-demographic factors of interest was gathered from different data files (**Section 3.2.1**) available in this primary care database. Information was obtained from (1) coded data available in different data files and (2) using more targeted information in specific data fields within these files (Figure 4-1). To extract information recorded as coded data, specific code lists (**Section 4.3**) were generated for each factor, while information from the specific data fields in the Patient files was extracted using specific criteria (**Section 4.4**).

Code lists comprised medical, entity type and consultation type codes. Medical codes were utilised to gather information for specific socio-demographic factors from the Clinical, Immunisation, Referral and Test files (Figure 4-1). Entity type codes available in the Additional Clinical Details files and the place where the consultation with the GP took place (consultation type codes) was taken from the Consultation files.

Targeted information from specific data fields available in the Patient file (Figure 4-1) included gender, year of birth, marital status and family number. Family number, as

described previously in **Section 3.2.1**, is a practice-specific data field based on a patient's address.[135] This number may help to identify individuals registered with the same practice who may be sharing a household. Apart from the same households, family number may also represent patients with the same address from institutions such as long-term hospital care (e.g. neuro-disability), sheltered accommodation, prisons or even under some circumstances a block of flats.[136] This field is generated by the general practice software when a patient registers with a GP or moves address but it is unclear as to how often the family number field is updated with changes in address [Personal communications via email CPRD Knowledge Centre]. Family number was used to provide information for the following social factors: residence, living arrangements (cohabitation and living alone) and marital status (Figure 4-1), further details are provided in **Section 4.3**.



Key: Information for social factors was obtained from the data fields in the Patient file (grey boxes) and using coded data (boxes with dotted lines) from the rest of the data files

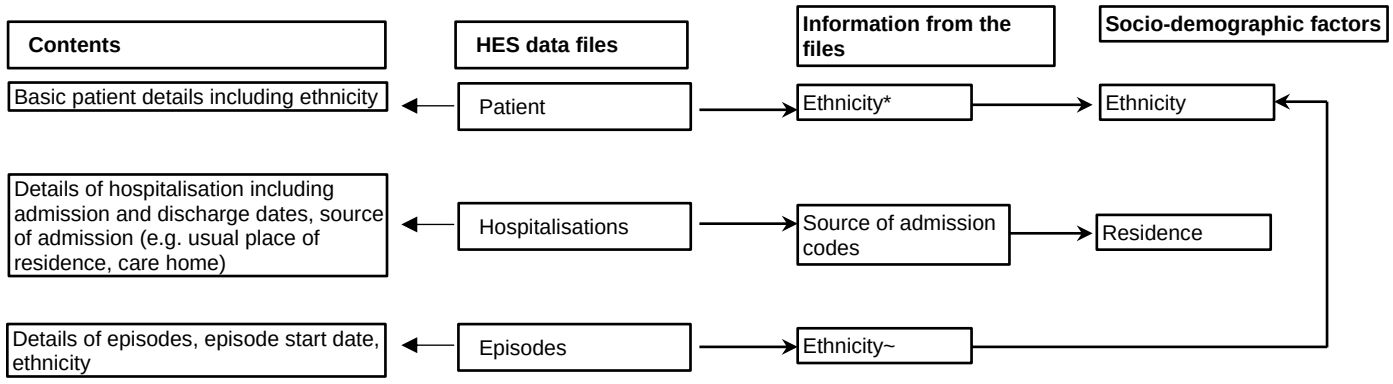
Figure 4-1 Information for socio-demographic factors from Clinical Practice Research Datalink data

4.2.2 HES data

The data structure of HES was described in **Section 3.3**. The data for socio-demographic factors were gathered from the Patient, Hospitalisation and Episodes files of HES (Figure 4-2). The basic demographic (ethnicity) information about individuals was obtained from the Patient and Episodes file (**Section 4.3.3**). Information was also accrued from the source of admission codes in the Hospitalisation file. (Figure 4-2).

4.2.3 IMD data

As described in **Section 3.4**, CPRD provides information on patient- and general practice-level deprivation data as linked datasets. Further details on how the IMD data were categorised for use in the analyses are provided in **Section 4.5**.



*HES version 10
~HES version 13

Figure 4-2. Information on socio-demographic factors from Hospital Episode Statistics data

4.3 Identification of socio-demographic factors in linked electronic data

Code lists were generated and applied to the different data files of the linked CPRD data to identify socio-demographic factors of interest (Figures 4-1 and 4-2; details are given in the following sections). Further information was also obtained from data held within the Patient file of CPRD.

The code lists of CPRD medical codes for socio-demographic factors except ethnicity were developed by Prof. Sara Thomas. I went through these medical codes to assess if I concurred with these codes and any differences were resolved by discussion. Ethnicity codes for both CPRD and HES data were those used previously by Mathur *et al.* and recommended for use under QOF.[137] I identified other types of codes (entity type codes and consultation type codes) for social factors of interest from the Additional Clinical Details file and the Consultation files of CPRD (Figure 4-1). I also identified relevant socio-demographic factor codes available in the Patient file of HES data (Figure 4-2). The code lists generated for use in the different data sources were then combined to generate final code lists for each factor after discussions amongst Prof. Sara Thomas, Dr AJ van Hoek and myself. The details of the development of code lists for specific socio-demographic factors is described in the following sections.

As mentioned in **Section 4.2.1**, four data fields: year of birth, gender, marital status and family number, available in the Patient file of CPRD data (Figure 4-1) were also utilised to gather information for socio-demographic factors. Information from the family number field was obtained as described below.

Information from family number available in the Patient file of CPRD

As mentioned briefly in **Section 4.2.1**, family number is a general practice-specific data field based on a patient's address.[135] As family number is not a unique entity across all general practices in CPRD, I created a unique identifier by combining both the practice identification number and the family number. This unique number was subsequently used to identify individuals sharing the same family number (i.e. likely to be from the same household) within

the same practice. This allowed identification of study participants who shared the same family number (and with other individuals in the general practice who were not part of the study population) (Figure 4-3).

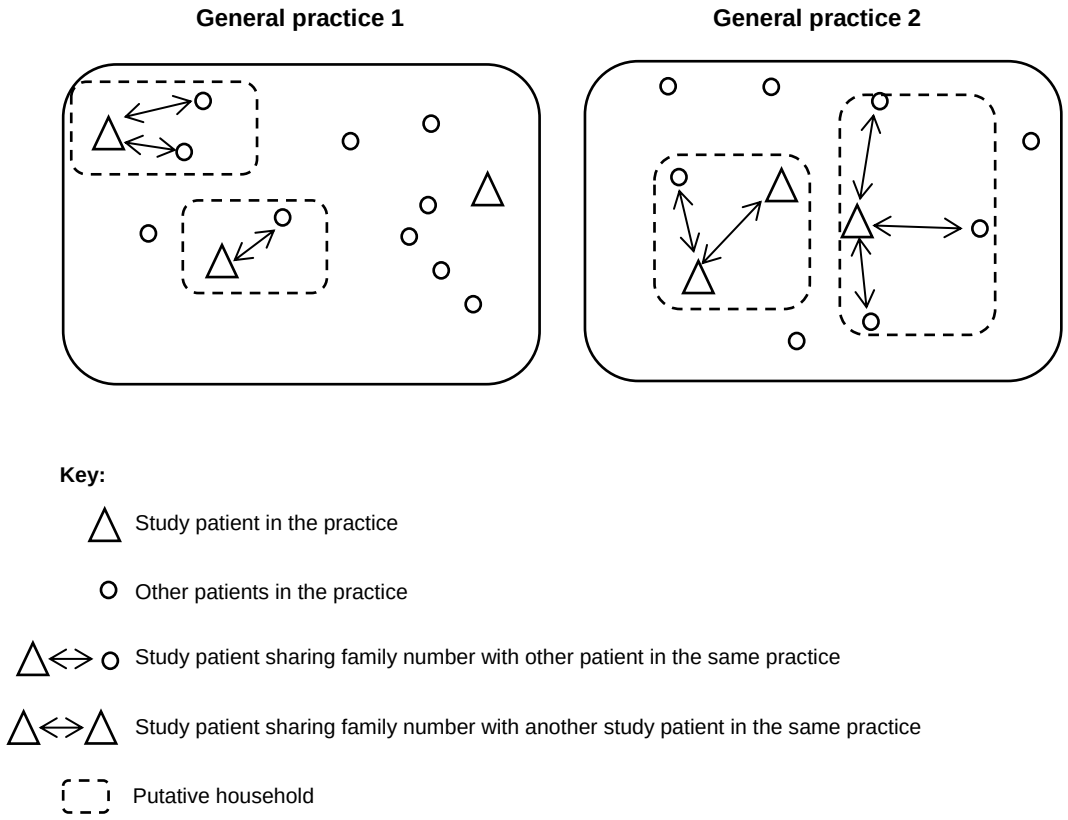


Figure 4-3 Identifying individuals sharing a family number in general practices

Family number was utilised to provide information for residence, living arrangements (cohabitation and living alone) and marital status for the cross-sectional study (**objective 2**) and the two cohort studies (**objectives 3 and 4**). For the cross-sectional study, individuals sharing same household as the study patients were required to be actively registered on the index date of interest (01/01/2013) and their age was also ascertained on this date. For the two cohort studies, individuals sharing the same household had to be actively registered with the practice at the start of follow-up of the study participant and their age (which was required for the development of algorithms to extract relevant information and is discussed for each specific factor below) was also determined on this date.

I will now describe how the code lists for specific socio-demographic factors were developed and how the information from the Patient file including family number was utilised to identify specific factors in the linked data.

4.3.1 Age

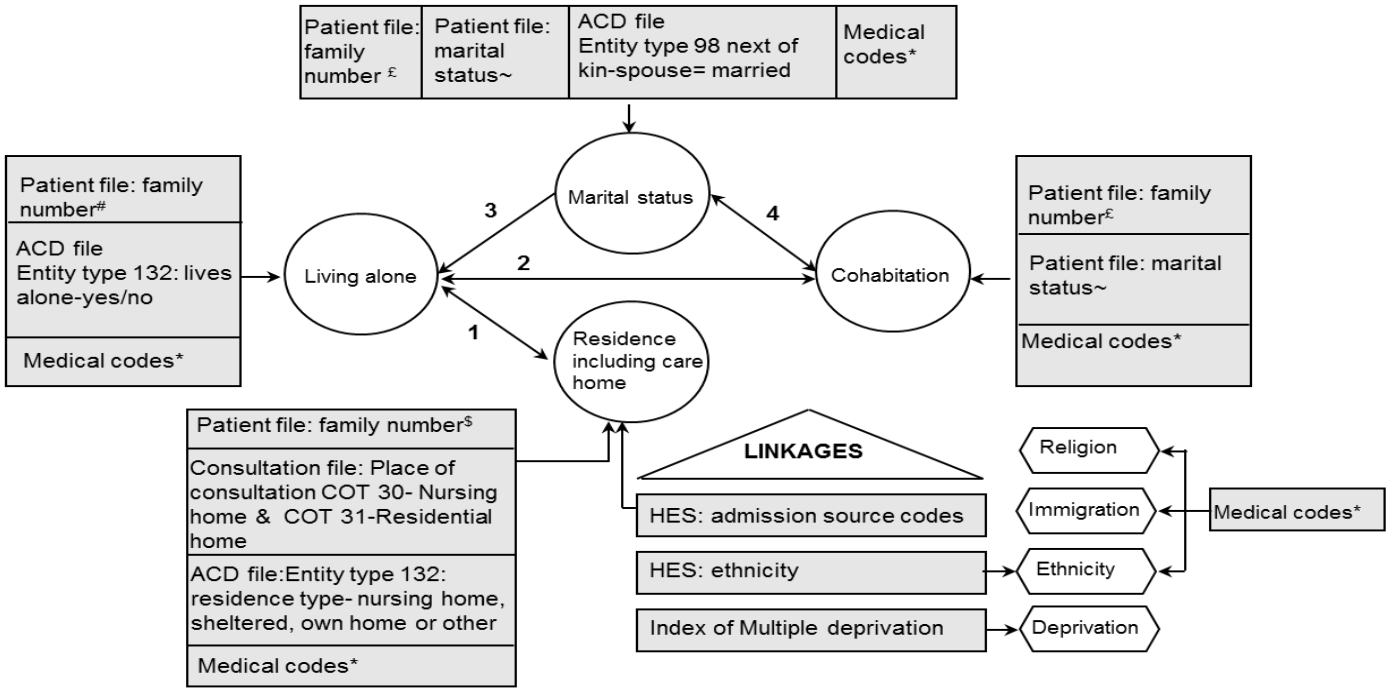
Age was estimated from year of birth available in the Patient file (Figure 4-1) by the common convention of using the 1st of July (mid-year) to assign study participants' day and month of birth.

4.3.2 Gender

The categorisation of gender available in the Patient file is discussed in **Section 4.4**.

4.3.3 Ethnicity

As mentioned in **Section 4.3** above, the codes used for identifying ethnicity from the linked CPRD data (Figures 4-1 and 4-2) were those used by Mathur *et al*.[137] The code list is provided in Appendix 4 and consisted of 183 codes. The medical codes were sought in the Clinical, Referral, Test and Immunisation files of the CPRD dataset (Figure 4-4). In the HES data, information on ethnicity was captured from the Patient file (HES version 10) or the Episodes file (HES version 13). The site for ethnicity codes in the HES data changed over time and I found that it was available in the Episodes file of HES version 13 unlike the HES version 10 where this information was available in the Patient file. The implications of this finding for extracting ethnicity information from HES are described further in **Section 4.4**.



Key: source of information for each variable from electronic health data are shown in grey boxes, time-varying factors are shown in circles; * from: Clinical files, Immunisation files, Referral files and Test files ~include categories: single, married, remarried, civil partnership, co-habiting, engaged, widowed, divorced & separated ACD Additional Clinical Details file COT consultation type code HES Hospital Episode Statistics
Assumptions made: 1- Those living in care home, hospice or prison were categorised as not living alone, those living alone were categorised as not in a care home; 2- Those living alone were categorised as not cohabiting and those cohabiting were categorised as not living alone 3- Those married were categorised as not living alone (exceptions described in text), 4- Individuals married/ in stable partnerships were assumed to be cohabiting **Family number assumptions:** #Individuals with households size of ≥2 were assumed to be not living alone £ Two adults with age difference of ≤15 years and the age difference between the couple and the other occupant was >15 years were categorised as cohabiting and marital status as partner uncategorised $ 2 criteria were used: Criterion 1: household with >3 individuals aged ≥65 years was defined as a care home if their total count was more than individuals aged <65 years and criterion 2: households with >3 individuals aged ≥65 years and ≤3 individual aged ≤50 years was defined as a care home

Figure 4-4 Ascertainment of socio-demographic factors in linked Clinical Practice Research Datalink

4.3.4 Immigration status

I identified immigration status using both country of birth codes and specific immigration codes. Unlike ethnicity, information for immigration status was available only from the CPRD data and not from the HES data (Figure 4-4). Initially 240 medical codes were identified for country of birth and immigration status; records with these codes were accrued from the Clinical, Referral, Test and Immunisation files of the dataset. However, when the initial analysis indicated that these codes did not capture the full extent of immigration status (as outlined in **Chapter 6**), the code list was expanded to additionally include language codes to identify individuals born in non-English speaking countries. This broader definition was used to maximise the use of available data because from 2008-2011 GPs were incentivised to record the first language spoken for all registered patients.[138, 139] This decision led to inclusion of an additional 225 medical codes. So, in total 465 codes were used for the broader definition of immigration status (including country of birth, immigration status and language codes) (Appendix 5).

4.3.5 Religion

As with immigration status, information on patients' religion was also only available in the CPRD data (Figure 4-4). A code list consisting of 110 medical codes for religion (Appendix 6) was used to extract relevant information from the Clinical, Referral, Test and Immunisation files of the dataset (Figure 4-4).

4.3.6 Residence

CPRD does not provide information on whether practices or patients are situated in urban or rural areas. However, information was sought on the type of residence for the older study populations, such as whether they lived independently, in sheltered housing, or resided in care homes. Care homes included both (i) nursing homes that provide nursing care and (ii) residential homes providing only personal care to their residents.[140] Homelessness was also a potential variable of interest. Codelists were drawn up to identify all these factors as detailed below.

Information from CPRD data

(a) Information from medical, entity type and consultation type codes in CPRD

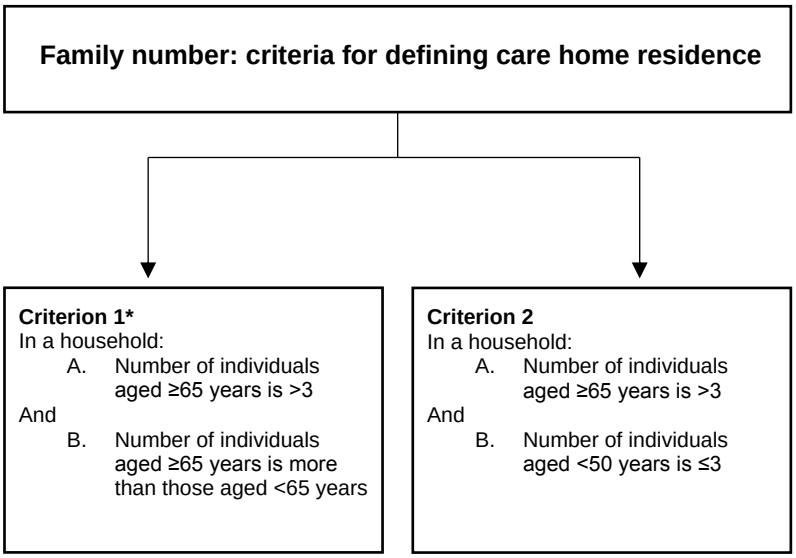
Information from the Clinical, Immunisation, Referral and Test files was extracted using 204 medical codes (Figure 4-4) for place of residence and homelessness (Appendix 7). The code list comprised of codes such as- 'seen in own home', 'residential care', 'sheltered housing' and 'homeless'. Additional information on place of residence was obtained from the Consultation file and the Additional Clinical Details file. Two consultation type codes in the Consultation file were used: consultation type code 30 (nursing home visit) and 31 (residential home visit) (Figure 4-4). The entity type code 132 from the Additional Clinical details files provided information on care home residence, residence in the patient's own home, sheltered accommodation and other places of residence.

(b) Information from the family number (Patient file of CPRD)

Family number was utilised by Shah *et al.* as one of the criteria used to define care home residence, using data from the Health Improvement Network (THIN) (another UK primary care database comprising of some general practices contributing data to both CPRD and THIN).[141] This study included individuals aged ≥65 years from 326 general practices from England and Wales; all these practices had to provide data at least up to March 2008.[141] Care home residence was defined by the presence of a Read code for living in a care home, or at least two of the following three criteria: (i) ≥4 individuals aged ≥65 years residing in one household, identified using family number, but excluding households where the majority of individuals were aged <65 years; (ii) a specially commissioned postcode linkage to an area with a care home; (iii) a record of a consultation in care home.[141] Although no explanations were provided as to why these criteria were utilised, the age and gender distribution of care home residents identified by this methodology were comparable to the distributions from a national survey and from census data.[141]

In the UK, ~94% of care home residents are aged ≥65 years.[142] The average nursing home size (~47 beds) is larger than the average residential home size (~18 places), and ~40% of residential homes provide <10 beds.[140] I used this information on the size of care home (ranging from <10- 47 beds), the age of care home residents (majority being ≥65 years of

age) , and the methodology of Shah *et al.*,[141] to develop two independent criteria to define care home residence. Criterion 1 was based on the family number definition used by Shah *et al.* and was as follows:[141] a household with >3 individuals aged ≥65 years was defined as a care home if the total count of these older individual was greater than the number of individuals aged <65 years in the same household. For Criterion 2, to further allow capture of information if the care homes included individuals aged 51-64 years, households with >3 individuals aged ≥65 years and ≤3 individuals aged ≤50 years were defined as care homes (Figure 4-5).



*Based on[141]

Figure 4-5 Criteria for defining care home residence using family number

Information from HES data

The codes for source of admission in the Hospitalisations file of the HES data, which provide information about patient's location immediately prior to hospital admission, were also used to derive information about an individual's place of residence. The code list utilised is shown in Table 4-1 and comprised codes for place of residence such as prison, care home and hospice.

Table 4-1 Source of Admission codes in the Hospital Episodes Statistics data used to derive place of residence information

Code*	Description	Information extracted for residence[#]
30	Repatriation from high security psychiatric hospital (1999-00 to 2006-07)	Residence: other
39	Penal establishment (court and police station excluded from 1999-2000)	Residence: other
48	High security psychiatric hospital, Scotland (1999-00 to 2006-07)	Residence: other
49	NHS other hospital provider: high security psychiatric accommodation in an NHS hospital provider (NHS trust)	Residence: other
50	NHS other hospital provider: medium secure unit (1999-00 to 2006-07)	Residence: other
54	NHS run nursing home, residential care home or group home	Care home residence
65	Local authority Part 3 residential accommodation: where care is provided (from 1996-97)	Sheltered accommodation
66	Local authority foster care, but not in Part 3 residential accommodation: where care is provided (from 1996-97)	Residence: other
69	Local authority home or care (1989-90 to 1995-96)	Care home residence
85	Non-NHS (other than Local Authority) run residential care home (from 1996-97)	Care home residence
86	Non-NHS (other than Local Authority) run nursing home (from 1996-97 to 2006-07)	Care home residence
88	Non-NHS (other than Local Authority) run hospice	Residence: other

* Source of admission codes [#] Categorisation are outlined in Section 4.4.4

Information from place of residence such as such as living in a household, care home residence or sheltered accommodation was also extended to rule out that a patient was homeless.

The categorisation of the residence variable after information from all sources was combined is described in **Section 4.4.4**.

4.3.7 Living arrangements: cohabitation

Information from CPRD data

(a) *Information from medical codes in CPRD*

The medical code list for cohabitation comprised 86 codes and included codes such as ‘cohabiting’ and ‘spouse unwell’ (Appendix 8). The list was used to identify information recorded in the Clinical, Immunisation, Referral and Test files (Figure 4-4).

(b) *Information from the family number (Patient file of CPRD)*

Further information on cohabitation was accrued from the family number field of the Patient file. The criteria used to identify cohabitation status from the family number were based on two previous studies conducted using the THIN database.[143, 144] In the older study, conducted between 2005-2008 amongst individuals aged ≥60 years, the criteria for identifying cohabitation were based on an analysis of national survey data.[144] In this study, individuals aged ≥60 years residing with a member of the opposite sex with an age gap of ≤10 years, and with an age gap between the couple and any other younger member of the household of >15 years, were identified as a cohabiting couple.[144] In the second study, conducted between 2003-2013, cohabitees were identified as a two adult household (to avoid counting care homes or a block of flats), irrespective of gender, with age gap of ≤15 years.[143] These authors excluded household with two adults where the age difference was >15 years to avoid counting individuals residing with their children or individuals who had parents living with them.[143]

For this thesis, the criteria from the two studies described above,[143, 144] were adapted to identify cohabitation status from the family number as follows. Two adults (at least one aged ≥65 years) living in a household size of two or three, irrespective of gender, were considered as a cohabiting couple if their age difference was ≤15 years (to avoid counting offspring); if there was another occupant, the age difference between the couple and the third occupant was required to be >15 years to capture either living with children or an elderly parent.

Further information for cohabitation was also obtained from the other two closely related social factors: living alone and marital status (described further in **Section 4.4**).

4.3.8 Marital status

Information from CPRD data

(a) *Information from medical and entity type codes in CPRD*

The medical code list for marital status consisted of 152 codes (Appendix 9). Entity type code 98 from the Additional Clinical Details files (Figure 4-4), which provided information on 'next of kin- spouse' was also used to extract information.

(b) *Information from the Patient file of CPRD*

Further information for marital status was also gathered from the two data fields present in the Patient files of the CPRD data (Figure 4-1): marital status and family number. The information obtained from the marital status data field in the Patient file (Figure 4-1) was used to supplement data obtained from the marital status code list. The categorisation of this variable in the Patient file is supplied by CPRD and provides information about whether an individual was single, engaged, married or in civil partnership, separated, widowed or divorced (Table 4-2). The 'stable relationship' field was not utilised to extract marital status data as this field was deemed too non-specific to provide further information about the relationship status of an individual.

Table 4-2 Extraction of marital status information from the Patient file of Clinical Practice Research Datalink

Marital status field in Patient files	**Information extracted for marital status variable**
Single	Single
Married	Married/ civil partnership
Remarried	Married/ civil partnership
Civil partnership	Married/ civil partnership
Co-habiting	Partner uncategorised
Stable relationship	Not used as does not provide information on marital status
Engaged	Single
Widowed	Widowed
Divorced	Divorced
Separated	Separated

Individuals who were cohabiting (**Section 4.3.7**) were also assigned the marital status of- 'Partner uncategorised' (categorisation of marital status is discussed in **Section 4.4.4**) due to limited information about marital status available from cohabitation status.

4.3.9 Living arrangements: living alone

Information from CPRD data

(a) *Information from medical and entity type codes in CPRD*

The code lists for living alone status (as a binary yes/no variable) comprised both medical codes and entity type codes. The medical code list comprised 91 codes (Appendix 10) and included codes such as 'lives alone' and 'lives with relatives' (the latter providing evidence for not living alone). Entity type code 132, available from the Additional Clinical Details file (**Section 4.2.1**) was also used to provide information on living alone (Figure 4-4).

(b) *Information from the family number (Patient file of CPRD)*

Further information on not living alone was also accrued from the family number field of the Patient file. Study participants were described as not living alone if their family number was shared by one or more individuals (household size ≥2).

Additionally, indirect information on not living alone was also obtained from other social factors: place of residence, cohabitation and marital status (Figure 4-4) as described in **Section 4.4.3**.

4.4 Data algorithms and categorisation of socio-demographic factors

In this section, I describe:

- variation of some socio-demographic factors over time
- how the information about socio-demographic factors, depending upon their variability over time, was assimilated from different data sources (as described in **Section 4.3**) using data algorithms and how indirect information was obtained from other social factors ;
- categorisation of factors; and
- how variables that varied with time were managed for specific studies conducted as a part of this thesis.

4.4.1 Effect of time on socio-demographic factors

Certain socio-demographic factors such as ethnicity and immigration status which do not change with time, and factors such as religion which are unlikely to change over time, were assumed as time-invariant variables. For example, if a person had their ethnicity recorded 20 years ago, it was assumed to hold true for the present time. On the other hand, a recording made 20 years ago about individuals' marital status might not necessarily reflect their current marital status. Therefore, marital status, place of residence and living arrangements, which were more likely to change with the passage of time, were classified as time-varying factors in this thesis.

4.4.2 Determining the date of recording of socio-demographic factors

For the time-varying social factors- residence, living arrangements and marital status, it was important to determine the date when the factor was recorded in the health data.

Determining dates of recording of time-varying factors in CPRD data

As described previously in **Sections 3.2.1** and **3.6**, all CPRD data files (with a few exceptions- namely the Patient, Practice and Additional Clinical Details files) provide two different date fields associated with any recordings made. These include an event date (the date the event occurred, as recorded by the GP) and a system date (the date when the event was recorded on the GP computer system). The event date was used to determine when a socio-demographic factor was captured in these data. If the event date was unavailable, the system date was utilised. For information extracted from the Patient files (as described in **Section 4.3**), both the event date and system date were unavailable to indicate when the data for the given factor was recorded. For such records, patients' current registration date (the date when a patient's current registration began with the general practice, **Section 3.2.1**), which is available in the Patient file, was used as a conservative estimate of the date of recording the socio-demographic factor. The dates for recording of entity codes in the Additional Clinical Details file, as described in **Section 3.6**, were ascertained after linking this file to the Clinical file and using the event date field present in the Clinical file.

Determining dates of recordings in HES data

For information extracted from the Hospitalisation file in HES data, the hospital admission date was utilised as the date of recording of the factor; for data extracted from the remaining HES files, the episode start date (as described in **Section 3.3.1**) was used.

The issue of when factors were recorded in these data (timeliness of recording) is further discussed in **Chapter 6** where timeliness of recording of time-varying factors was considered as a quality criterion in terms of ascertaining these factors from EHR.

4.4.3 Developing data algorithms

An individual may have single or multiple records of a socio-demographic factor of interest in their EHR. Multiple records can be made on either the same event date or on different event dates. When an individual had multiple records for a factor with the same event date, if the information was discordant or contradictory, those records were excluded. For example, if an individual had two records on a single event date, with one record coding this individual as an immigrant and another record coding this same individual as a non-immigrant, both these records for the patient for that event date were excluded from any further analysis.

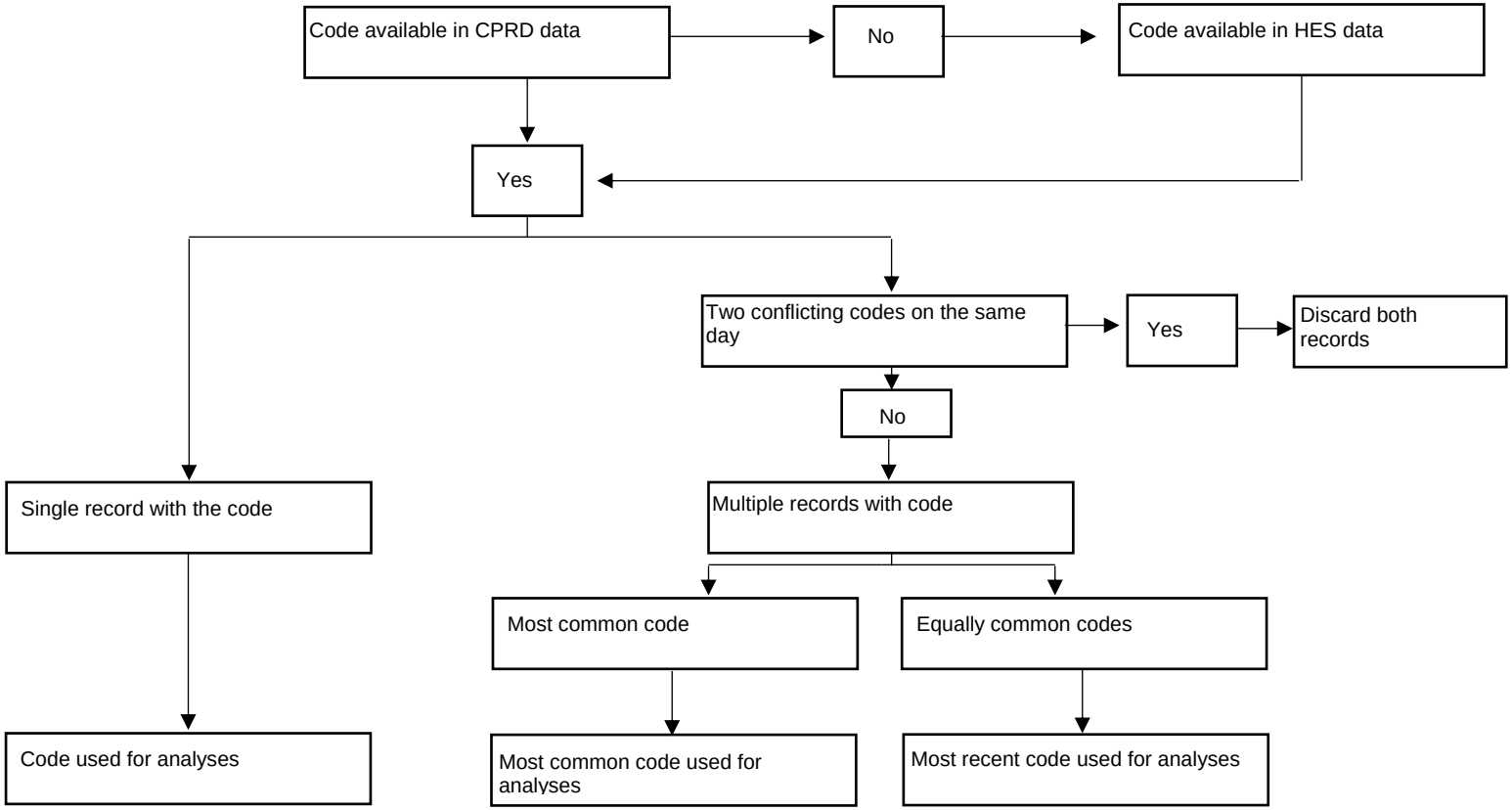
In the following sections, I describe how information for both time-invariant and time-varying factors for a given patient were further processed.

(I) Data algorithm for assimilation of information for time-invariant factors

As discussed in **Section 4.3.1**, information on ethnicity was assimilated from both CPRD and HES data (Figure 4-4). If a patient had no ethnicity information from CPRD data but had this information available in their HES data (if version 10), no algorithms were required to extract ethnicity information as the information from the HES Patient file was supplied as a single record. Information from individuals with multiple records of ethnicity in CPRD data which did not have discordant information on same event date, was extracted using an algorithm developed by Mathur *et al*. [91] According to this algorithm, when an individual had multiple ethnicity coded records in CPRD data, the code which was most common was utilised to assign ethnicity. If all ethnicity codes were equally common then the most recent code was used to assign ethnicity. However, for HES version 13, I found that ethnicity

information was recorded in the Episodes file and not (as in HES version 10) in the Patient file (Figure 4-2). As a result, there could be more than one ethnicity-coded record for a patient in the HES version 13 data. I adapted the above described algorithm (Figure 4-6) to extract ethnicity information, using the same principle of first utilising the most common code followed by most recent code if all codes were equally common.

Unlike ethnicity, information for religion and immigration status was only available from CPRD data (Figure 4-4). The algorithm described above for determining ethnicity from multiple records per patient, using the most common code or most recent code if codes were equally common (Figure 4-6), was also utilised to gather information for these two factors.



CPRD Clinical Practice Research Datalink HES Hospital Episode Statistics

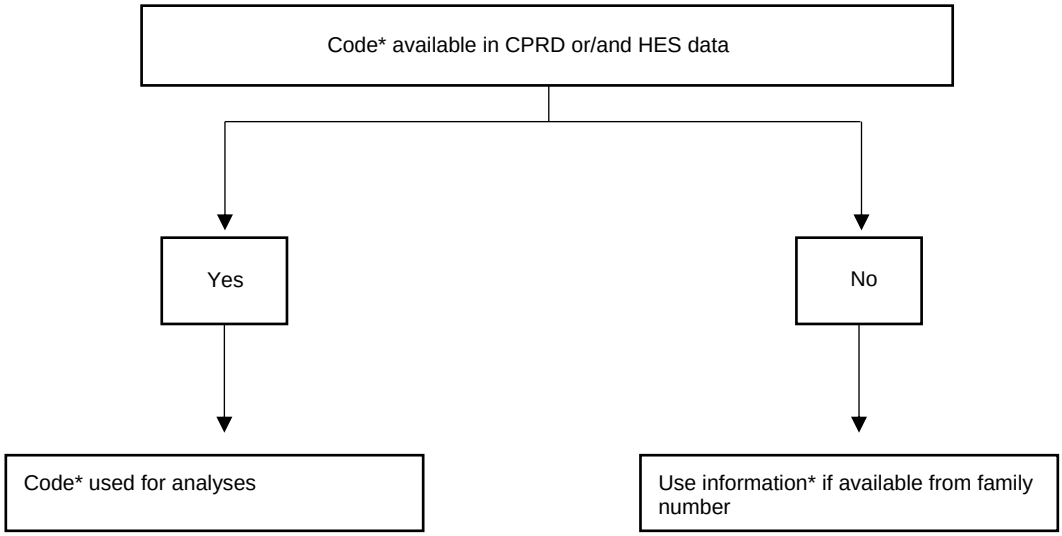
Figure 4-6 Algorithm for ascertainment of time-invariant social factors (ethnicity, immigration status and religion) in linked Clinical Practice Research Datalink data*

* Based on[91]

(II) Data algorithm for assimilation of information for time-varying factors

II a) Information from family number

Information for time-varying factors, namely marital status, place of residence and living arrangements (as described in previous **Section 4.3**), was gathered from different sources using CPRD and HES data (Figure 4-4). Information for these variables was also accrued from the family number in the Patient files (**Section 4.3)**. However, as it was unclear as to how often the family number field is updated (**Section 4.2.1**) with changes in patient's address [Personal communications via email with the CPRD Knowledge Centre]; information for marital status, residence and living arrangements extracted from this field was used only when data for these factors for a given patient were unavailable from other data sources in CPRD or HES (Figure 4-7).



* for marital status, residence or living arrangements
CPRD Clinical Practice Research Datalink
HES Hospital Episode Statistics

Figure 4-7 Using information for marital status, living arrangements and residence extracted from family number in linked Clinical Practice Research Datalink data

II b) Indirect information about a social factor from other closely related social factors

Indirect information was also obtained for a time-varying social factor from information for another social factors (Figure 4-4) in the following manner. Ascertainment of marital status

also provided indirect information for cohabitation, as shown in the Table 4-3 and Figure 4-4. Individuals with codes for being married, in a civil partnership or in a stable relationship were assumed to be cohabiting, and individuals who were cohabiting were assumed to be not living alone. Individuals with a residence code for living in a care home or residential home, in a hospice, psychiatric unit or prison were also assumed to be not living alone (Table 4-4 and Figure 4-4). Similarly individuals with codes for residing in households, care homes, sheltered accommodation or other places of residence were assumed not to be homeless.

Table 4-3 Extracting information from closely related time-varying social factors: marital status, cohabitation and living alone

Marital status code	Information for cohabitation	Information for living alone variable
Married	Cohabiting	Not living alone
Remarried	Cohabiting	Not living alone
Civil partnership	Cohabiting	Not living alone
Co-habiting	Cohabiting	Not living alone
Stable relationship	Cohabiting	Not living alone

Table 4-4 Extracting information from closely related time-varying social factors: residence and living alone

Residence code	Information for Living alone variable
Residence in care home, residential home or hospice	Not living alone
Residence in prison	Not living alone
Residence in high security psychiatric hospital or medium secure units	Not living alone

4.4.4 Categorisation of social factors

The categorisation of both time-invariant and time-varying factors was guided by the categorisation used for these variables in the 2011 English Census data and the availability of data in EHR.[134, 145-151] The categorisation used in the Census was utilised in this thesis to enable assessment of the representativeness of the recorded socio-demographic factors in the linked EHR by comparing these recordings with the 2011 English Census; this comparison is described further in **Chapter 6**. In the following section I describe how these factors were categorised.

Age

Age in years was categorised into age-groups (described further in **Chapters 6-8**).

Gender

Gender was a binary (male/female) variable.

Ethnicity

The ethnicity data were categorised into five categories: White, South Asian, Black, Others and Mixed.

Immigration status

In the 2011 English Census data, country of birth had four main categories: (a) Europe including the United Kingdom, (b) Africa, Middle East and Asia, (c) The Americas and the Caribbean and (d) Antarctica, Oceania and other.[152] I anticipated that the data from the EHR would provide less detailed information about immigration status and therefore categorised this factor as a binary variable: immigrant and not an immigrant. It was still feasible to compare the recording of immigration status with the 2011 English Census data, which could also be categorised as a binary variable.[152]

Religion

Religion was categorised into eight categories: Buddhists, Christians, Hindus, Jews, Muslims, Sikhs, Others and no religion (atheists).

Residence

Place of residence was grouped into four categories: household, care home including residential homes, sheltered accommodation and `other places of residence'. The latter consisted of places of residence not included in the first three residence categories: for example- prisons and hospices. Information obtained about care home residence was also considered as a binary variable in its own right as it was assumed that a GP was more likely to record care home residence than other places of residence such as household, perhaps due to differences in healthcare requirements – this is further discussed in **Chapter 6**. Homelessness was also categorised as a binary variable.

Living arrangements: cohabitation and living alone

Cohabitation and living alone were both categorised as binary (yes/no) variables.

Marital status

Marital status had seven categories: single (including engaged), married/in a civil partnership, widow/er, divorced, separated, partner-other, and partner-uncategorised. The partner-other category included the following three groups: common-law husband, common-law wife and common-law partnership. The partner-uncategorised category included non-specific codes such as ‘relationship problem’s, ‘cohabitation’, ‘partner unemployed’ and ‘partner stops working’ (the entire list of codes included in the partner uncategorised category are presented in Appendix 11). I considered that some of these non-specific codes could be used by GPs for individuals who were previously categorised with a more specific code such as married, common-law husband or engaged. A decision tree was generated for individuals categorised as partner-uncategorised to gather more specific information from earlier codes, if available. If an individual had an earlier code for being married, engaged or a partner-other category, their marital status was categorised as per their earlier code (Figure 4-8). However if individuals’ previous marital status was widowed, divorced or separated, I decided to keep the marital status as partner-uncategorised, as these individuals might have a different current relationship status (Figure 4-8). No changes were made if the individual’s previous marital category was also partner-uncategorised (Figure 4-8).

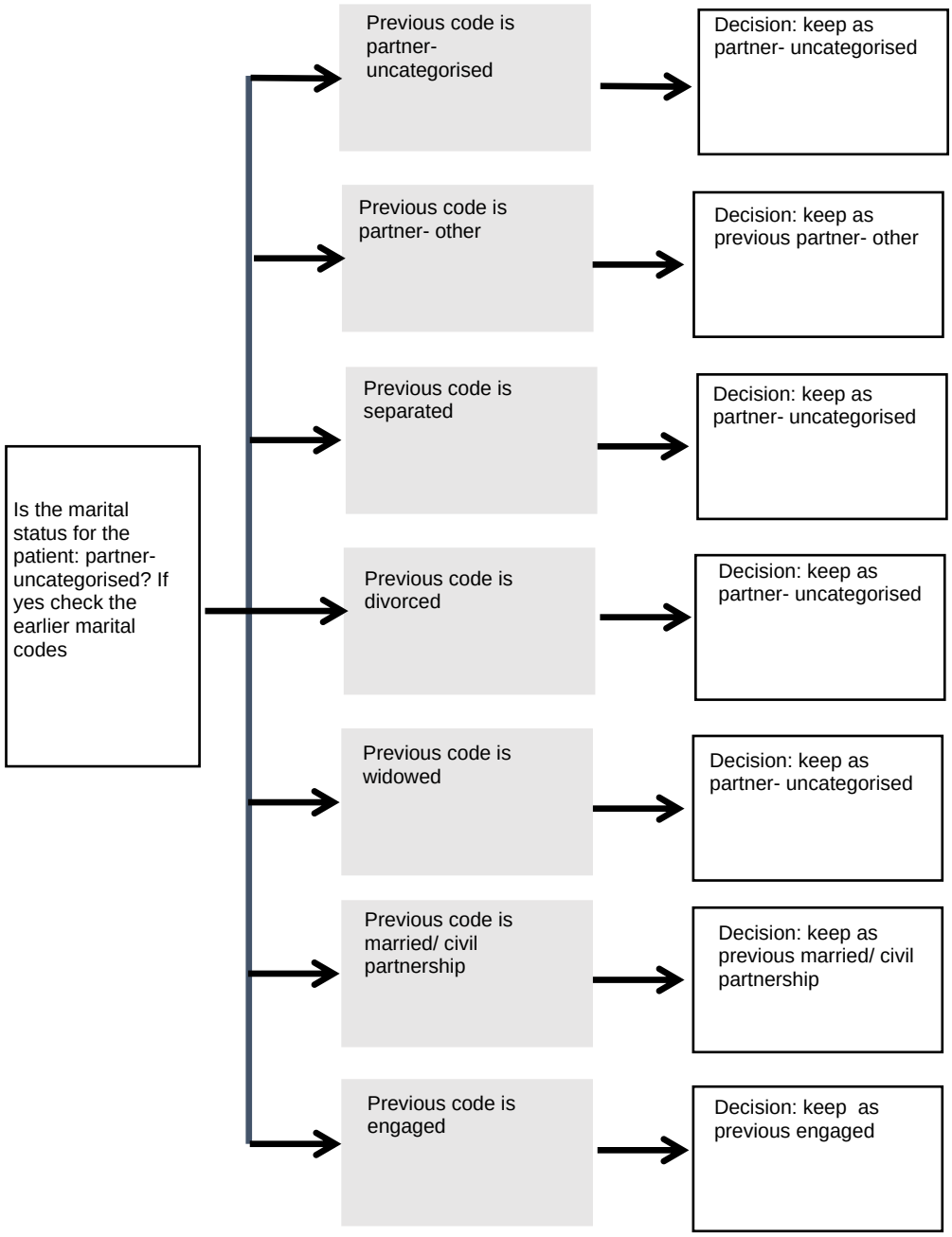


Figure 4-8 Decision tree for categorisation of marital status: partner uncategorised

4.4.5 Ascertainment of socio-demographic factors for the cross-sectional and cohort studies

This section outlines how date of recording was used to ascertain socio-demographic factors for the cross-sectional study carried out for **objective 2** (the investigation of completeness, timeliness and representativeness of recording of socio-demographic factors in the linked

EHR) and for two cohort studies carried out for **objectives 3** and **4** (to assess inequalities in the burden of zoster and uptake of zoster vaccine amongst older individuals).

Time-invariant factors: ethnicity, religion and immigration status

Codes for factors considered as time-invariant (**Section 4.4.1**) were considered for analyses irrespective of the date of recording.

Time-varying factors: marital status, living arrangements and place of residence

For the cross-sectional study (**Section 3.5.1**, **objective 2**), the latest code of a time-varying social factor in the period immediately before or on the index date of interest (01/01/2013) was used for the analysis.

For the two cohort studies (**Sections 3.5.2 and 3.5.3**, **objectives 3** and **4**), information for time-varying social factors, with the exception of care home residence (explanation to follow), for a given patient was carried forwards or backwards depending upon the availability of the code in relation to the study period. This is illustrated in the Figures 4-9, 4-10 and 4-11. If a single code for a given factor was available before the start of follow-up, the information from the code was carried forward for the duration of the study (Figure 4-9). Similarly, if a code was available only after the end of follow-up of the study, the information was carried backwards for the study period (Figure 4-10). If multiple codes were available (Figure 4-11), the information from a code was carried forwards up until the appearance of another code.

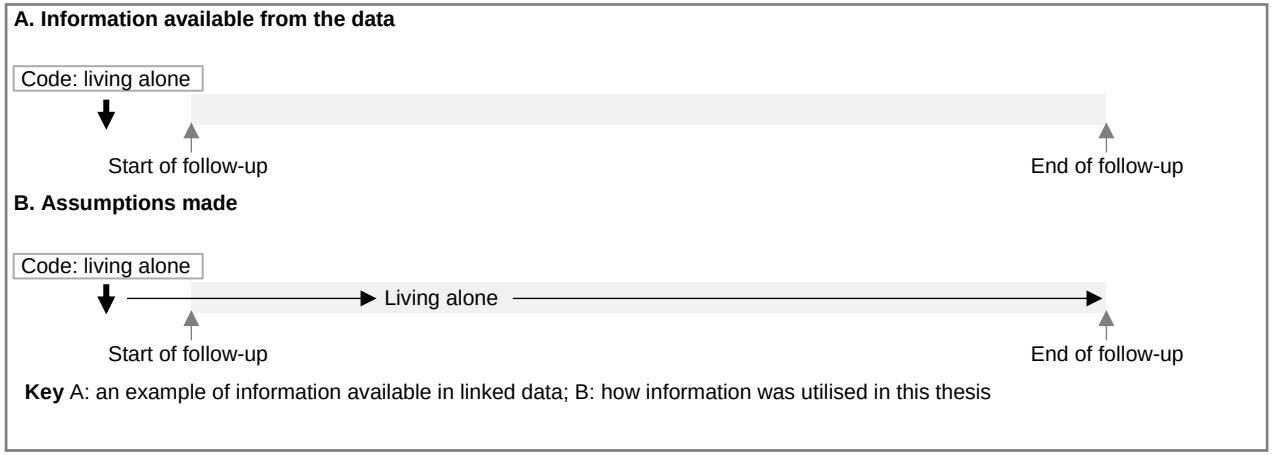


Figure 4-9 Utilising information for time-varying factors (except care home residence) available only before the start of follow-up of cohort study

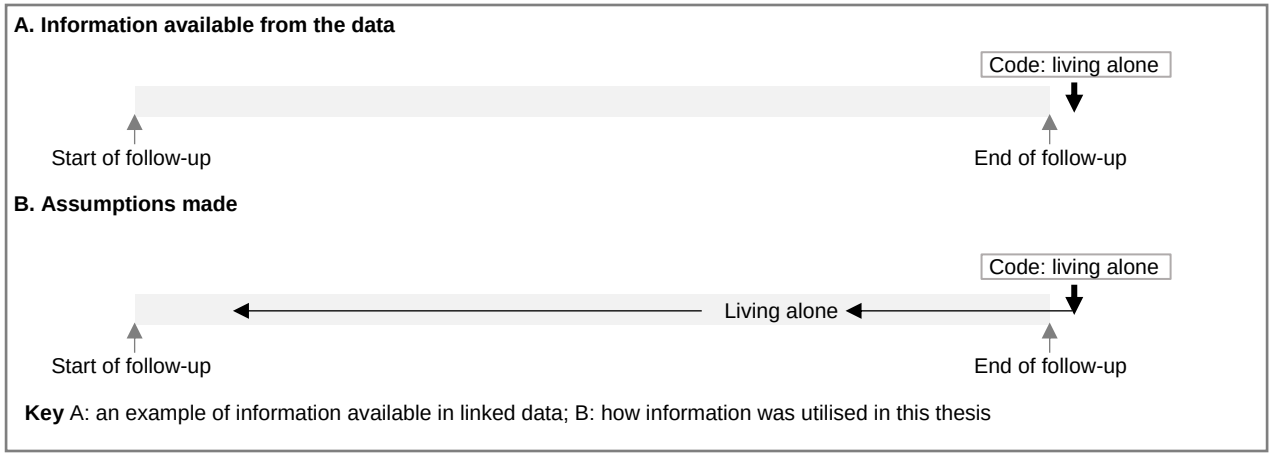


Figure 4-10 Utilising information for time-varying factors (except care home residence) available only after the end of follow-up of cohort study

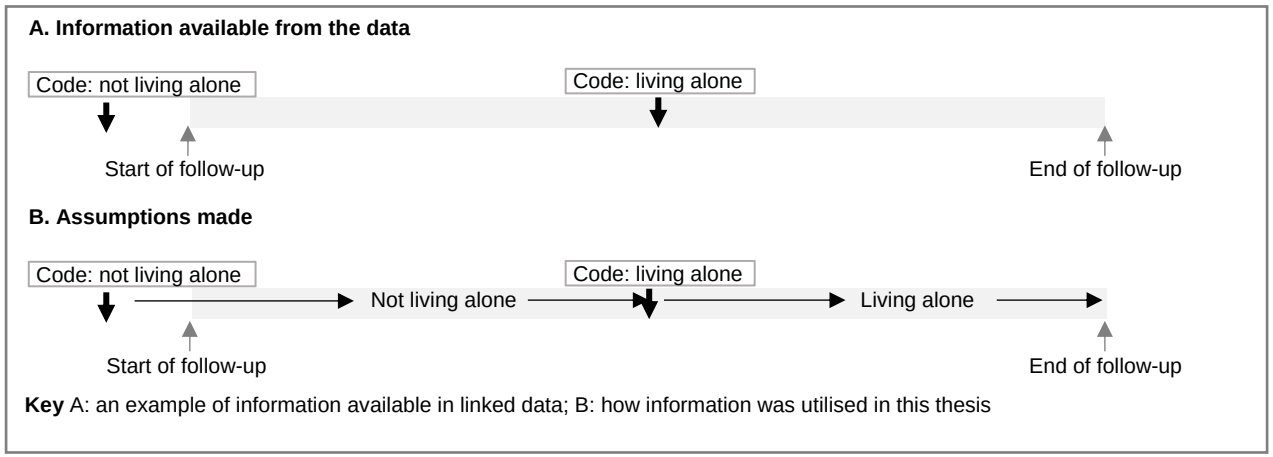


Figure 4-11 Utilising information for time-varying factors (except care home residence) available before and during follow-up of cohort study

For individuals residing in care homes, I assumed that a GP was more likely to record their place of residence compared to the residence of other older individuals, due to differing health needs of this social group. Therefore carrying a care home code information backwards i.e. assuming that a patient was residing in a care home in the period preceding the care home code, as was conducted for other time-varying factors, could have an increased risk of misclassification. So in the period preceding the appearance of a care home code, individuals were considered as not residing in a care home (Figure 4-12) and in the period after the code, they were assumed to be living in a care home until the appearance of another code indicating different residential circumstances.

Further details about ascertainment of these factors in the specific cohort studies are presented in **Chapters 7** and **8**.

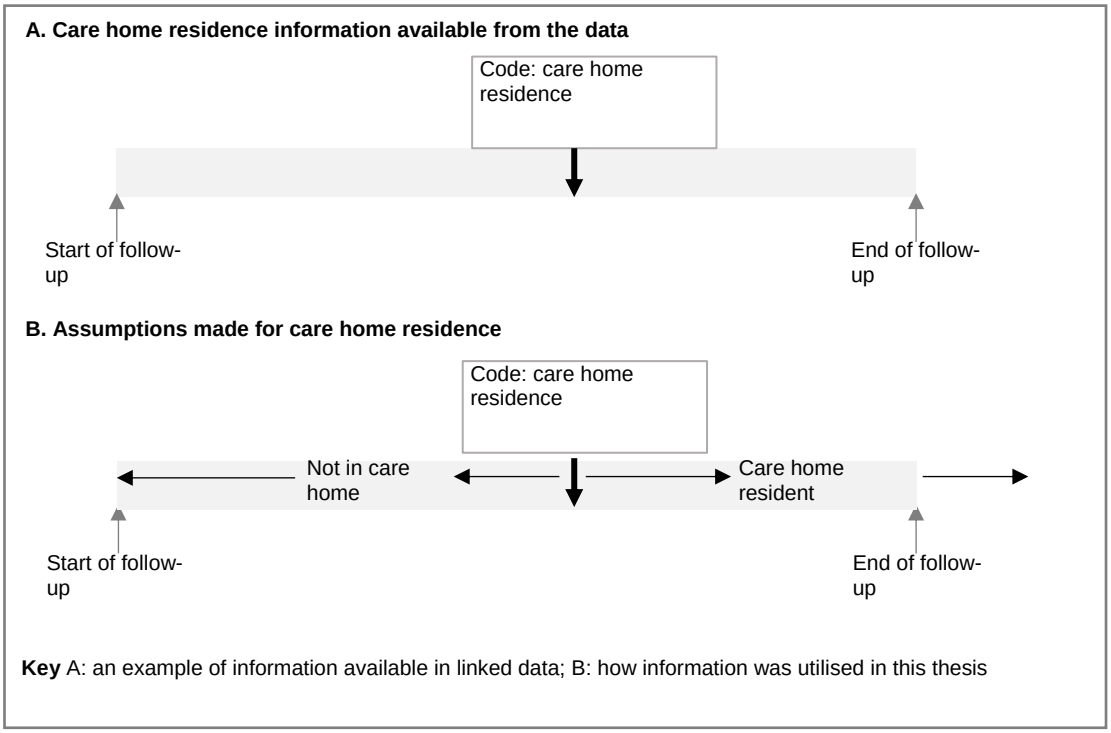


Figure 4-12 Utilising information for care home residence from linked data for cohort study.

4.5 Index of Multiple Deprivation: Patient- and practice-level

As detailed in **Section 3.4**, the IMD quintiles used in analyses were available at a LSOA level for both the location of the general practice and for the patient's residence. Quintile 1

represented the least deprived area and quintile 5 indicated the most deprived area.[129] Practice-level IMD quintiles were used if patient-level data were unavailable. The details about the proportion of patients with missing IMD status for whom the practice-level IMD data were used are provided in **Chapters 7** and **8**. As CPRD provides linkage with only one of the IMD datasets for any one study to maintain patient confidentiality,[120] the 2010 IMD data were used for the cross-sectional study (**objective 2**) while the 2007 and 2015 IMD data were used for the zoster burden and zoster vaccine uptake cohort studies (**objectives 3 and 4**), respectively.

4.6 Chapter summary

In this chapter, I have described the methods used to ascertain and categorise the socio-demographic factors of interest in the linked EHR. In the next chapter, I continue to discuss the methodology employed in this thesis, and describe how the outcome variables and other covariates used in the analyses of zoster burden and zoster vaccine uptake were ascertained in the electronic data.

Chapter 5. Defining outcomes and other variables of interest in electronic health records

5.1 Introduction

This is the third and the final chapter for the Methods section of this thesis. In this chapter, I describe the ascertainment of the outcomes of interest in the linked data for **objectives 3** and **4**, namely incident zoster and receipt of zoster vaccination, as well as other covariates used in the analyses.

5.2 Outcome variables

As mentioned earlier (**Section 1.5**), two observational studies were conducted to meet **objectives 3** and **4**: to examine the socio-demographic determinants of the burden of incident zoster and of zoster vaccine uptake amongst older UK individuals, respectively.

5.2.1 Defining zoster incidence in the linked data

To meet the third objective, a 10-year cohort study (2003-2013), covering the period prior to zoster vaccine introduction in the UK, was conducted to ascertain the association of socio-demographic factors with a first episode of zoster. The identification of the study population in these linked data was described previously (**Section 3.5.2**). It consisted of individuals aged ≥ 65 years who were alive and currently registered with a CPRD practice in England. As the objective of this study was to determine the incidence of a first zoster episode during follow-up (i.e. a first code for a zoster diagnosis during the study period) it was not necessary to generate multiple zoster episodes during the follow-up period and individuals with a history of zoster prior to the start of follow-up had to be excluded. The generation of the zoster code list and the method of excluding individuals with past zoster was detailed in **Section 3.5.2** when describing the study population, and a brief overview is presented here. Both CPRD and HES data (Admitted Patient Care data, **Section 3.3**) were examined to identify a diagnosis of zoster as patients with zoster can present in general practice or directly to a hospital. This entailed using medical codes (CPRD data) and ICD-10 codes

(HES data) for zoster and PHN (the code list is available in Appendix 3). In CPRD data, the Clinical and Referral data files (described in **Section 3.2.1)** were utilised to identify these individuals. In HES data, the diagnosis of zoster or PHN was identified using relevant ICD-10 codes recorded in either the primary or secondary diagnosis fields (**Section 3.3.1**) of the Diagnoses data file (Figure 3-4) from any hospitalisation episode.

After identifying patients with relevant zoster codes, I ascertained the date of recording of the zoster diagnosis using the event date field in CPRD (described in **Section 3.2.1**) and the episode start date in HES data (described in **Section 3.3.1**). Individuals with missing dates for zoster diagnoses were excluded from the zoster incidence study as it was impossible to ascertain whether zoster occurred prior to or during the study period. Zoster-coded records of study participants from CPRD and/or HES were appended together. To identify and exclude patients with a prior history of zoster (as detailed in the **Section 3.5.2**), individuals who had a code for zoster or PHN recorded prior to the start of follow-up were excluded (Figure 3-6). Similarly, individuals who had their first code for zoster as PHN (a sequela of zoster) during the follow-up period (Figure 3-6) were also excluded. For the remaining participants, the earliest date of a zoster code recorded during the study period in the appended CPRD and HES dataset was used to identify the first zoster code and this was used as a date of the outcome (incident zoster).

The incidence of first episode of zoster during follow-up was ascertained using a Poisson regression model and was determined by dividing the number of individuals with a first zoster code (the numerator) by the person-time at risk of developing zoster (the denominator). The details of the statistical analysis, and the results of this analysis: ascertaining the socio-demographic determinants of zoster incidence in this study population, are presented in **Chapter 7** in form of a published paper.

5.2.2 Defining zoster vaccine uptake in CPRD

For the fourth objective of this thesis a cohort study, spanning a two-year period (2013-2015) following the introduction of zoster vaccine in the UK, was conducted to examine the association of socio-demographic factors with zoster vaccine uptake. The study population (identified as described in **Section 3.5.3**) comprised individuals currently registered with a

CPRD practice in England and eligible for zoster vaccination during the study period (01/09/2013-31/08/2015). Below, a description of how I identified zoster vaccine uptake during the study period is provided.

The CPRD data were examined to determine zoster vaccination for the participants during the study period as the NHS zoster vaccination programme is delivered through general practice and not via hospitals. Zoster vaccination was determined from five different data files in CPRD data. These included using product codes in the Therapy files, immstype vaccine codes in the Immunisation file and medical codes in the Clinical, Referral and Test files (codes provided by Prof. Sara Thomas, Appendix 12). In the Immunisation file an additional 'status' field exists (as described in **Section 3.2.1,** Figure 3-2) which also provides information on the status of vaccination: i.e. whether the vaccine was advised, refused or given. Similarly, medical codes for declining, not consenting or not attending for zoster vaccination were also identified (Appendix 12). The records for individuals with relevant zoster vaccination codes from these five different data files were first appended. I then excluded from the study individuals with conflicting information on zoster vaccine uptake on same date; i.e. participants with the simultaneous recoding of a zoster vaccination code and a refusal/declining/not attending/not consenting code on a given date.

An individual might have multiple records for zoster vaccination recorded on the same day or on different days in the same and/or different data files. For a participant with multiple vaccination records on different dates but in the same data file, I used the earliest record. In order to integrate information from individuals with multiple vaccination codes recorded on different event dates in different data files, I developed an algorithm (Figure 5-1) to determine when these individuals were vaccinated during the study period. In this algorithm, the Therapy files were given the highest priority as the presence of a product code in this file indicated that a prescription was actually issued by the GP.[113] The second priority was given to the Immunisation files that provided information about both the vaccine type (zoster) and additional information on whether the vaccine was advised, refused or given (the 'status' field). Finally, medical codes from the Clinical, Referral or Test files were used. After excluding individuals with conflicting vaccination information on a given date (Figure 5-1), receipt of zoster vaccination during the study period was first ascertained by the presence of

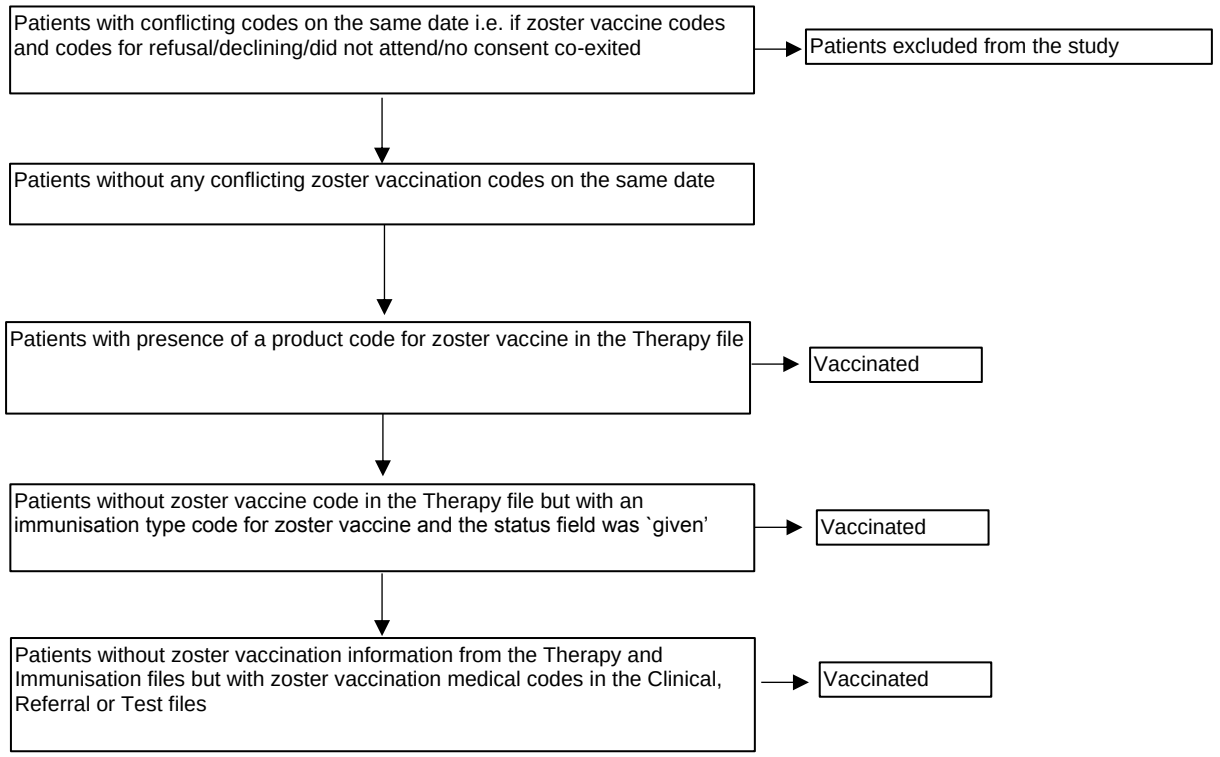


Figure 5-1 Algorithm for determining zoster vaccination status in Clinical Practice Research Datalink

a relevant code in the Therapy file, as described in the algorithm. For patients without vaccination information from the Therapy file, the Immunisation file was then examined for the relevant immunisation type codes with the immunisation status field recorded as `given' to assign vaccination status. Finally, the Clinical, Referral or Test file records of the remaining participants were examined for the presence of specific zoster vaccine medical codes (Figure 5-1) to categorise individuals as vaccinated.

The association of socio-demographic factors with zoster vaccine uptake was assessed using a logistic regression model. The reasons why a logistic regression model was used for these analyses and the results are discussed in **Chapter 8** in form of a research paper (submitted for publication).

5.3 Other covariates

In the two analyses for **objectives 3** and **4**, conducted to ascertain the association between socio-demographic factors and outcome of interest (zoster disease burden and zoster vaccine uptake respectively), the reasons why other covariates needed to be considered, follow. Firstly, in the zoster disease burden analyses, certain chronic conditions and immunosuppressive conditions/therapies that are risk factors for zoster were considered as *a priori* potential mediators of the relationship between socio-demographic factors and zoster disease incidence. Secondly, in the zoster vaccine uptake analyses, the study population consisted of individuals eligible to receive this live vaccine (**Section 3.5.3**). In order to identify eligible participants, individuals with certain immunosuppressive conditions or taking immunosuppressive therapies, which are contraindications for zoster vaccine administration had to be identified and excluded from the study. Additional covariates for the vaccine uptake analysis comprised a past history of zoster and administration of seasonal influenza vaccine. In **Chapters 7** and **8**, the rationale for using these covariates in these two analyses is further discussed. In this section, I provide the details of how these variables were determined in the linked electronic health data.

The immunosuppressive conditions and therapies which are contraindications to zoster vaccine administration were identified based on the UK Green Book guidance.[60] Chronic conditions that increase the risk of zoster were identified from a previous UK study.[46] The

covariates were identified using medical codes in CPRD (**Section 3.2**), and using ICD-10 codes in HES Admitted Patient care data (**Section 3.3**). For some hospital-based procedures (described in the relevant sections below), OPCS codes (**Section 3.3.1**) were also utilised to identify certain immunosuppressive conditions in HES data. The code lists were provided by Prof. Sara Thomas. I examined the entire records of the patients for the presence of these codes at any point prior to the end of follow-up. The only exceptions to this were the two covariates utilised in the zoster vaccine uptake analyses: (a) for past history of zoster, I looked for the relevant code present at any point before the start of follow-up, and (b) for seasonal influenza vaccine uptake- I ascertained relevant codes during the zoster vaccine uptake study period (2013-2015). Individuals with chronic conditions (described in **Section 5.3.1** below) were considered to have the condition from the date of the first recording of the code in either the CPRD or HES dataset; if codes for chronic conditions were identified in both CPRD and HES data, the earliest date of recording was used. For immunosuppressive conditions and therapies, I devised algorithms and criteria to ascertain periods of immunosuppression during the study period (details to follow in **Sections 5.3.2** and **5.3.3**). Following the common convention when routinely collected health data are utilised for research, individuals without a relevant code were assumed not to have that condition or treatment. Further details for these covariates are provided below in **Sections 5.3.1**-**5.3.5**.

5.3.1 Chronic conditions

The chronic conditions that increase the risk of zoster were identified from a previous study and included: rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, chronic obstructive pulmonary disease, asthma, chronic kidney disease and diabetes.[46] Both CPRD (Clinical, Referral and Test files) and HES data were used to identify these conditions using medical codes and ICD-10 codes, respectively (Appendix 13).

5.3.2 Immunosuppressive conditions

Based on the UK Green Book guidance, the following immunosuppressive conditions, in which zoster vaccination is contraindicated, were identified: haematopoietic and lymphoid tissue malignancies, human Immunodeficiency virus (HIV) infection, other cellular immune

deficiency and solid organ transplant.[60] The details of how these conditions were identified in CPRD (Clinical, Referral and Test files) and hospitalisation data, and the criteria used for determining the duration of immunosuppression are provided below.

A) Haematopoietic and lymphoid tissue malignancies including haematopoietic stem cell transplant

This included leukaemia, lymphoma, myeloma, other plasma cell dyscrasias and haematopoietic stem cell transplant.[60] Individuals with these conditions were identified using both medical codes and ICD-10 codes (Appendix 14) in CPRD and HES data. OPCS codes (to identify procedures carried out during hospitalisation, **Section 3.3.1**) were also used to identify haematopoietic stem cell transplant in the Procedures file of HES data. The list of OPCS codes used is provided in the Appendix 14. Following each diagnostic or procedure record, individuals with any of these conditions were considered to be immunosuppressed for a period of 24 months.[46, 60]

B) HIV, other cellular immune deficiency and solid organ transplant

Individuals with these conditions were identified in both the CPRD and HES data, using medical and ICD-10 code lists (Appendix 15), respectively. The OPCS code list was also used to identify individuals with solid organ transplants (Appendix 15). Individuals with cellular immune deficiency (e.g. Di George syndrome, Wiskott - Aldrich syndrome), with HIV infection or with a solid organ transplant were considered to be immunosuppressed from the date of the first appearance of the code, as these are life-long conditions.

5.3.3 Immunosuppressive medications

As described for the immunosuppressive conditions, the UK Green Book also provides criteria for certain immunosuppressive treatments during which the administration of zoster vaccine is contraindicated.[60] These immunosuppressive treatments (Table 5-1) included chemotherapy, radiotherapy, specific high doses of oral or injectable corticosteroids and other immunosuppressive agents (thiopurine medications, Disease Modifying Anti-rheumatic Drugs (DMARDs), non-biological immune modulating agents and biological therapies). The

details of how I identified these medications in the linked CPRD data and criteria used for defining the duration of immunosuppression are provided below.

A) Immunosuppressive chemotherapy and radiotherapy

As for other conditions described in previous sections, individuals undergoing immunosuppressive chemotherapy and/or radiotherapy were identified in the Clinical, Referral and Test files of CPRD using medical codes (Appendix 16); and using ICD-10 codes and OPCS codes (Appendix 16) in HES data. Study participants with these codes were considered to be immunosuppressed for a period of three months before the first documented prescription in the general practice, as these therapies are initiated in hospital. Individuals on these medications were also categorised as immunosuppressed for one year after each record instead of the recommended duration 6 months in the UK Green Book to account for potential recording delays in GP data for any hospital-based treatments .[60]

Table 5-1 Immunosuppressive medications: defining dose criteria and period of immunosuppression

Immunosuppressive medications	Immunosuppressive dose	Duration of immunosuppression prior to first documented script*	Duration of immunosuppression after every script
Corticosteroids	>40 mg/daily for >7 days or >20mg/ daily for >14 days	3 months	3 months
Methotrexate	>3.57 mg/day or >25mg per week	3 months	3 months
Azathioprine	≥50mg/daily[#]	3 months	3 months
6-mercaptopurine	≥45mg/daily[#]	3 months	3 months
Other immunosuppressants such as tacrolimus, sirolimus	Any dose	3 months	3 months
Other DMARDs such as ciclosporin, mycophenolate, leflunomide	Any dose	3 months	3 months
Biological therapy, chemotherapy and radiotherapy	Any dose	3 months	12 months

* these treatments might be initiated in hospital prior to the first documented record in primary care [#] UK Green Book and British Society of Gastroenterology guidance (as described in the text) DMARD disease modifying anti-rheumatic drugs

B) High dose corticosteroids and other immunosuppressive therapies

Individuals on immunosuppressive treatment were identified using code lists (product codes) from the Therapy files of CPRD (Appendix 17). I classified the product codes in these code lists into specific therapeutic categories to apply the specific immunosuppressive dose criteria (Table 5-1). The immunosuppressive dose of corticosteroids was defined as >40mg of prednisolone/day for >7 days or >20mg of prednisolone/day for >14 days; for methotrexate, doses of >25mg/week were considered immunosuppressive (Table 5-1).[60] The immunosuppressive doses for azathioprine and 6-mercaptopurine were defined as ≥50mg/day and 45mg/day respectively, based on the recommendations from the UK Green Book and the British Society of Gastroenterology. [60, 153] Other immune-modulating drugs such as tacrolimus, ciclosporin, etc. were considered to be immunosuppressive irrespective of the doses used. As with chemotherapy and radiotherapy, patients on these therapies were considered to be immunosuppressed for a period 3 months prior to the first documented script in primary care based on assumption that the therapy was typically initiated in a hospital setting (Table 5-1). Patients on any dose of biological therapy (e.g. anti-tumour necrosis factor agents such as alemtuzumab, ofatumumab and rituximab) were considered to be immunosuppressed for one year after each prescription.[60] For the remaining medications, patients were considered to be immunosuppressed for a period of 3 months following each prescription (Table 5-1).[60]

5.3.3.1 Data management to obtain information for immunosuppressive medications from the therapy files in CPRD

Apart from the product codes and generic drug codes, the Therapy file in CPRD data also includes data fields which provide additional information about a given prescription. These data field can be used to estimate the dose and duration for each prescription which are unavailable in CPRD data.[46] These data fields include:

(i) Product name: provides the name of the product including the dose (for example prednisolone tablets 5 mg)

(ii) Text identifier: This field provides information from the free text associated with the record in form of numeric values, which are interpreted by CPRD. A value of

0 indicates there is no free text available for that record. This field consists of actual prescribing information i.e. how many tablets are to be taken by the patient, for example, “take one daily”. This data provides information on numeric daily dose, as described below under (iii).

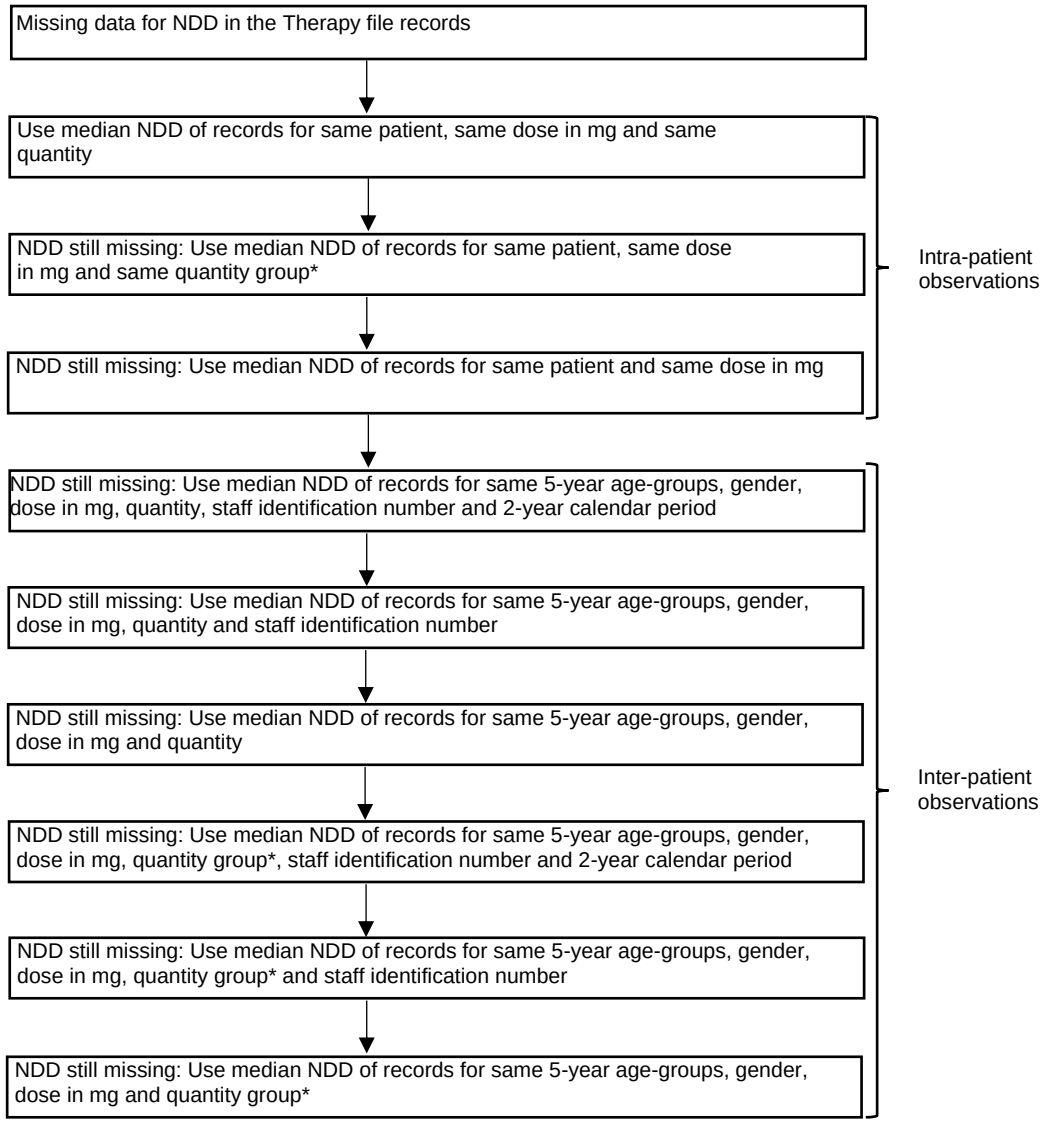
(iii) Numeric daily dose: This data field provides information about the numeric daily dose of each drug, which describes the total number of doses of the prescribed product to be taken by a patient per day. CPRD uses an algorithm based on information obtained from text identifier (described in (ii), above) to provide information in this field. To illustrate this with an example, if the free text associated with a record was “one tablet twice a day”, the numeric daily dose provided for that record will be 2.

(iv) Total quantity: the total quantity of the prescribed product for that prescription as entered by the GP.

(v) Other fields: these include the number of treatment days and the number of product packs prescribed for a particular prescription.

The information on the number of treatment days and the numeric daily dose was required to apply the dose and duration criteria for defining the immunosuppressive phase of specific therapies. However, the data for numeric daily dose and number of treatment days were missing for ~>30% of the prescriptions for oral corticosteroids and other immunosuppressive medications (Appendix 18). I modified a technique called `hot decking’ which was developed by Forbes *et al* for cleaning the prescription data for immunosuppressive agents and imputing the missing values for numeric daily dose.[46] In this technique, the missing values for the numeric daily dose are replaced by the median numeric daily dose of the chosen group of records. These groups of records could be from the same patient (intra-patient) or from different patients (inter-patients) sharing common characteristics such as the same age group, gender, and drug dosage. These records are selected based on an algorithm in which missing values for the numeric daily dose are first replaced by the median values from intra-patient observations; if these were unavailable the median values from records of patients sharing common characteristics are utilised (inter-patient values) (Figure 5-2).[46] I adapted this algorithm

in two ways. Firstly, changes in the information governance policies of CPRD [personal communication via email CPRD Knowledge Team] led to unavailability of the data for free text (described in (ii) above) when the numeric value of the text identifier was ≥100,000 . This had implications for the data management. Secondly, to reflect temporal changes in prescribing and to capture prescribing practices of practice staff members, I used two additional criteria (in addition to age-groups, gender and dosage) to define groups of patients sharing the same characterises and use their median values for numeric daily doses from these inter-patient observations. These additional criteria included observations with prescriptions issued within two years of each other (a 2-year calendar period) and prescriptions issued by same member of staff (using the staff identifier available in the Therapy file) (Figure 5-2). Applying this adapted algorithm, the missing numeric daily doses were sequentially replaced by the median numeric daily dose value from the chosen stratum, as detailed in Figure 5-2.



NDD numeric daily dose: number of tablets/day *binary variable (low/high): cut off was the median quantity (56 tablets for oral corticosteroids and 28 tablets for other immunosuppressant drugs)

Figure 5-2 Algorithm[#] for imputing missing values of numeric daily dose

[#] Modified from[46]

5.3.4 Seasonal influenza vaccine uptake

For the zoster vaccine uptake study (**objective 4**), I also examined the co-administration of zoster vaccine with seasonal influenza vaccine, as GPs were encouraged to administer zoster vaccine at the same as time as seasonal influenza vaccine (**Section 1.2.6**),[72] although zoster vaccine could continue to be administered outside the seasonal influenza season. Seasonal influenza vaccine uptake was identified during the influenza vaccination campaign season (September-March)[73] of the corresponding years of the zoster vaccine uptake study (2013/14 and 2014/15). Similar to zoster vaccine, the uptake of seasonal influenza vaccine was identified in the CPRD data by utilising specific product codes in the Therapy file, immunisation type codes in the Immunisation file and medical codes in the Clinical, Referral and Test files (Appendix 19). The information for seasonal influenza vaccine code was first extracted using the Therapy file (as described for zoster vaccine uptake in **Section 5.2.2**). The Immunisation file, for individuals with no vaccination information from the Therapy file, was examined for the presence of specific immunisation type codes and the status field had to be `given' (**Section 3.2.1)** to categorise these individuals as vaccinated for seasonal influenza. Amongst individuals without seasonal influenza immunisation information in either the Therapy or Immunisation files, the vaccination status was determined based on information obtained from the presence of specific medical codes from the Clinical, Referral and Test files.

5.3.5 Past history of zoster

To examine whether the association of zoster vaccine uptake with social factors varied with prior history of zoster (as a potential partial mediator for some social factors such as ethnicity, as discussed in **Chapter 8**), [154, 155] individuals with a prior zoster history were identified as described in **Section 3.5.2**.

5.4 Chapter summary

This final chapter of the Methods section has detailed the data algorithms that I developed and/or adapted and applied to the linked electronic health data to ascertain the two outcome variables of interest for **objectives 3** and **4** of the thesis, namely incident zoster and zoster vaccine uptake, respectively. The definitions and data algorithms to identify the key

covariates in the analyses for **objectives 3** and **4**, comprising selected chronic conditions and immunosuppressive conditions/therapies, have also been outlined.

The next chapter (**Chapter 6**) is the first of the three chapters comprising the Results section of the thesis and presents the findings of the cross-sectional study conducted to meet the second objective (**Section 1.5.2**): to develop methodology for the ascertainment of socio-demographic factors in linked electronic health records, and to assess their availability in these data.

Results section

The Results section of this thesis has three chapters: **Chapters 6-8**, which present the findings of the three observational studies to meet **objectives 2-4** of this thesis (**1.5.2**).

Chapter 6 presents the finding of the cross-sectional study (the first observational study) conducted to investigate the completeness, timeliness and representativeness of recording of socio-demographic factors of interest in the linked CPRD data (**objective 2**).

Chapter 7 presents the findings from the cohort study (the second observational study), which describe the association of socio-demographic factors with zoster disease incidence in England using the methodology developed and presented in **Chapter 6**.

Chapter 8 presents the findings of the third observational study: a cohort study that investigated zoster vaccination inequalities amongst older individuals in England by determining the socio-demographic factors associated with zoster vaccine uptake.

All these three chapters are presented in a journal article format with brief abstract, background, methods, results, discussion and overall conclusion sections. Any additional results or discussions follow the journal article in the relevant chapter.

Chapter 6. Quality and completeness of recording of social factors in linked electronic health records: a cross-sectional study

6.1 Introduction

This chapter forms the first of the three chapters included in the Results section of this thesis. It reports the findings of the cross-sectional study conducted to meet the second objective of this thesis: to assess the methodology for ascertainment of socio-demographic factors (including those identified from the systematic review (**chapter 2**)) and assess their availability in the linked electronic health records. The details of this work, published in the journal PLOS ONE, are presented in the next section.

The detailed methodology for determining the socio-demographic factors of interest was presented previously (**Chapter 4**). The paper presented in this current chapter reports the results of the analyses to assess among 59,1037 older individuals the completeness of recording of socio-demographic factors, including: the extent to which linked data improved completeness; timeliness of recording for factors that might change with time (such as marital status, living arrangements or residence); and the representativeness of the results compared with data from the English 2011 Census. The paper is followed by supplementary material for the published paper (**Section 6.3**); further discussion on how immigration status was determined in these data and the implications of this (**Section 6.4**), and how data from the family number variable were utilised (**Section 6.5**).

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SECTION A – Student Details

Student	Anu Jain
Principal Supervisor	Prof. Sara Thomas
Thesis Title	Use of electronic health records to investigate vaccination inequalities in older individuals in England

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	PLOS ONE		
When was the work published?	2017		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	N/A		
Have you retained the copyright for the work?*	**Yes**	Was the work subject to academic peer review?	**Yes**

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	
Please list the paper's authors in the intended authorship order:	
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	The study was conceptualised by S Thomas and AJ van Hoek. I developed the study methodology with supervision from S Thomas and AJ van Hoek and advice from the other co-authors. The medical codes for the social factors except ethnicity were provided by S Thomas and were reviewed by me. I used medical codes for ethnicity

	developed by R Mathur. I identified further codes for social factors from other data files and developed the data algorithms. I also adapted the technique developed by R Mathur for the assessment of ethnicity in these data. I conducted data management and all analyses under supervision of S Thomas and J Walker; I wrote the initial draft of the manuscript which was revised based on comments by the co-authors. The manuscript was peer-reviewed and I also incorporated the reviewers' comments in the final manuscript.

Student Signature: [redacted] **Date:** 01/02/2018

Supervisor Signature: [redacted] **Date:** 01/02/2018

6.2 Paper 2: Identifying social factors amongst older individuals in linked electronic health records: An assessment in a population based study

PLOS ONE

RESEARCH ARTICLE

Identifying social factors amongst older individuals in linked electronic health records: An assessment in a population based study

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Data Availability Statement: The third-party data for this study were obtained from the Clinical Practice Research Datalink (CPRD). CPRD is a research service that provides primary care and linked data for public health research. CPRD data governance and our own license to use CPRD data do not allow us to distribute or make available patient data directly to other parties. Researchers can apply for data access at www.cprd.com, and must have their study protocol approved by the Independent Scientific Advisory Committee for

Abstract

Identification and quantification of health inequities amongst specific social groups is a pre-requisite for designing targeted healthcare interventions. This study investigated the recording of social factors in linked electronic health records (EHR) of individuals aged ≥65 years, to assess the potential of these data to identify the social determinants of disease burden and uptake of healthcare interventions. Methodology was developed for ascertaining social factors recorded on or before a pre-specified index date (01/01/2013) using primary care data from Clinical Practice Research Datalink (CPRD) linked to hospitalisation and deprivation data in a cross-sectional study. Social factors included: religion, ethnicity, immigration status, small area-level deprivation, place of residence (including communal establishments such as care homes), marital status and living arrangements (e.g. living alone, cohabitation). Each social factor was examined for: completeness of recording including improvements in completeness by using other linked EHR, timeliness of recording for factors that might change over time and their representativeness (compared with English 2011 Census data when available). Data for 591,037 individuals from 389 practices from England were analysed. The completeness of recording varied from 1.6% for immigration status to ~80% for ethnicity. Linkages provided the deprivation data (available for 82% individuals) and improved completeness of ethnicity recording from 55% to 79% (when hospitalisation data were added). Data for ethnicity, deprivation, living arrangements and care home residence were comparable to the Census data. For time-varying variables such as residence and living alone, ~60% and ~35% respectively of those with available data, had this information recorded within the last 5 years of the index date. This work provides methods to identify social factors in EHR relevant to older individuals and shows that factors such as ethnicity, deprivation, not living alone, cohabitation and care home residence can be ascertained using these data. Applying these methodologies to routinely collected data could improve surveillance programmes and allow assessment of health equity in specific healthcare studies.

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Introduction

Health inequity is defined as unjust differences in health status amongst different social groups, and may be explained by the distribution of social determinants of health.[1] Health inequities not only exist between countries, but are apparent within a country.[2] In the UK, reducing health inequities is a statutory requirement and is a common theme in the area of health improvement in the Public Health Outcome Framework.[3–6] In order to attain health equity, it is vital that the disadvantaged individuals are identified to quantify the problem and formulate targeted public health interventions. Increase in life expectancy has led to an aging population, and globally the proportion of individuals aged ≥60 years is projected to nearly double by 2050 from ~12% in 2013.[7, 8]The higher prevalence of chronic diseases in this age group is associated with greater disability and requirement for long-term care, necessitating changes in health and social care delivery.[9, 10] The effect of ageing on future health expenditure will depend on health expectancy: a measure that takes both life expectancy and disability into account.[11, 12] A 2015 systematic review reported associations of social factors such as gender, ethnicity, and socioeconomic position (including education) with inequalities in healthy life expectancy amongst older individuals.[13] Similarly, amongst individuals aged 50–65 years, social class, education, wealth and income were found to be associated with all three indicators of health expectancies: disability-free, illness-free and healthy life expectancy.[9] Living alone is also known to be associated with higher morbidity and mortality.[14] Uptake of preventative measures such as vaccination amongst older individuals has been shown to be lower amongst immigrants, individuals of certain ethnicities, and those living alone.[15, 16]

One of the recommendations by the World Health Organisation's (WHO) Commission on Social Determinants of Health (CSDH) in 2008 was setting of global and national equity surveillance systems to monitor health inequities routinely.[17] Surveillance programmes in the UK lack detailed information about social factors.[18] However, these factors potentially could be ascertained using routinely collected electronic health records (EHR). This provides an opportunity to utilise routinely collected data to improve surveillance programmes and to assess health inequities in specific studies.

The Clinical Practice Research Datalink (CPRD) is the world's largest primary care database, comprising anonymised patient information from ~7% of the UK population and including >79 million person-years of follow-up cumulatively.[19, 20] These EHR comprise not only data relating to primary care consultations, but also records of referrals to and feedback from secondary care.[21] Data in CPRD are representative of the UK population and are quality assured at both patient and general practice level.[20, 21] In England, linkage of the CPRD data at the individual level (from ~75% of English practices that consent to linkages) is available for hospitalisation data (Hospital Episode Statistics, HES)[22] and deprivation data (e.g. quintiles of Index of Multiple deprivation (IMD) score).[21, 23] For deprivation data, the linkage is made at the lower layer super output areas (LSOA) level, which covers a population of 1000–3000.[23] The completeness and quality of recording of one social factor in the CPRD, namely ethnicity, have been assessed by Mathur *et al* using data up to 2012 and focusing chiefly on the time during which GPs were financially incentivised to record the ethnicity of newly registered patients.[24] This study showed that in linked CPRD-HES data, completeness of recording reached 90% in newly registered patients. However, this analysis did not include assessment of recording specifically for older patients in CPRD, and was not extended to examine completeness after incentivisation was withdrawn in 2011.[25] In the UK, EHR have also been utilised to study cohabitation and care home residence,[26–28] but these studies did not provide information on timeliness or representativeness of recording of these factors and did not utilise linked hospitalisation data. To our knowledge, simultaneous investigation of the

quality and completeness of recording in CPRD of the social determinants of disease burden or healthcare usage in older populations have not yet been undertaken.

This study aimed to investigate the utility of the CPRD and linked databases in ascertaining social factors that are potential determinants of disease burden and inequitable healthcare interventions targeted towards older individuals, to discuss challenges associated with using routinely collected data and to supplement and enhance existing surveillance methods with the overarching goal of informing interventions to reduce health inequities.

Methods

Data source and study date

This was a cross-sectional study using CPRD data linked to HES data and deprivation data (IMD 2010) in England. It investigated the historical recording of social factors among individuals aged ≥65 years, actively registered with a CPRD practice on a randomly chosen index date (1st January 2013), to allow assessment of both completeness and timeliness of recording of social factor data. Active registration on 01/01/2013 was determined by ensuring that patients' start dates (the later of their registration date with the practice or the date the practice reached CPRD-defined quality criteria[21]) fell before the index date and their end dates (the earliest of their transfer out date, date of death or practice last collection date) were after the index date.

CPRD data are supplied in ten different files,[19] of which eight (patient, practice, clinical, consultation, additional clinical details, immunisation, referral and test files) were used for this study (S1 Table). These files include information about patients' demography, lifestyle factors, clinical details, feedback from secondary care, therapy and laboratory results, stored in form of medical, therapy and other codes used by the GP practice staff.[21]

Social factors examined

In this study, social factors relevant at an individual level and informed by the conceptual framework of the WHO's CSDH,[1] were examined in CPRD and included: religion, ethnicity, immigration status, deprivation based on LSOA of each individual's residence,[23] living arrangements (living alone and cohabitation), residence (place of residence and homelessness) and marital status.

Lists of medical codes (S2 Table) for each factor were compiled by searching the CPRD's Read code dictionary [21] for specific and broader text terms (using wild card searches) encompassing all social factors of interest. This was an iterative process that subsequently included a hierarchical search of the Read codes identified. The number of codes identified for these factors ranged from 86–465 (S2 Table). Further information (S1 Table) was accrued from other sources within the dataset as follows: the consultation files provided codes ('consultation type') on where the consultation took place and thus patients' residence (for example in a care home), while the patient files provided information regarding patients' marital status and their family number.[29] The latter variable can identify individuals sharing the same household and therefore can be used to get information for living arrangements (living alone, cohabitation), marital status and care home status. Similarly, the additional clinical details files provided coded information ('entity type') about residence, living alone and marital status. The linked hospitalisation data from HES provided additional information for ethnicity and residence, whilst the deprivation data provided deprivation scores for individuals' LSOA as IMD quintile. The multiple code lists thus generated were discussed amongst the three of the authors (AJ, SLT and AJvH). These code lists were then utilised to systematically search for the Read codes in the clinical, immunisation, referral and test files. Additional information was

sought from consultation type and entity types in the consultation and additional clinical details files respectively and also from the patient file and from linked HES and deprivation data. Some factors also provided information about another social factors: for example an individual coded as living alone was deemed not to be cohabiting, whereas an individual residing in a care home was considered not to be living alone.

The following example illustrates how information for social factors was assimilated. Type of residence (whether a patient lived in their own home, in sheltered accommodation, or in a care home) can be recorded in numerous way in both CPRD and HES. In CPRD, this information can be determined using the medical codes within multiple files as described above, using the entity type 132 for residence in the additional clinical details file, from the consultation file (e.g. "nursing-home visit") and from the family number (as described below); residence data are also potentially available in HES by using information about individual's location prior to hospital admission.

Exposure variables definition and categorisation

The code lists for the social factors of interest (religion, ethnicity, living arrangements (including living alone and cohabitation), immigration status, deprivation, residence (including place of residence and homelessness) and marital status) are presented in S2 Table. Ethnicity codes were those recommended for use by the Quality and Outcomes Framework, as used by Mathur *et al.*[24] Family number was used to derive additional information by modifying approaches used in previous studies,[27, 28, 30] as follows. Two adults, living in a household size of two or three, were identified as cohabiting (adults living in a couple) if the age difference between the couple was $\leq$15 years and age difference between the other household occupants and those living in a couple was >15 years. Couples identified as cohabiting were also allocated 'partner-uncategorised' category for marital status. Individuals from household size of two or more were identified as not living alone. Based on previous studies [26, 31, 32] care home was defined as a household with >3 individuals aged $\geq$65 years and if their total count was more than individuals aged <65 years. In sensitivity analyses households with >3 individuals aged $\geq$65 years and $\leq$3 individual aged $\leq$50 years were defined as a care home.

Religion was categorised into eight categories (Buddhists, Christians, Hindus, Jews, Muslims, Sikhs, Others and no religion (atheists)) to ensure comparability with Census data.[33] We hypothesised that certain minority religions might be more likely to be coded by GPs, and explored this by categorising one religion (Muslim) as a binary (yes/no) variable. Ethnicity was categorised in five groups: White, South Asian, Black, Others and Mixed as per the UK 2011 Census.[34]

Living alone and cohabitation were coded as binary variables (yes/no). Immigration status, a binary variable (immigrant/ not immigrant) was defined using: i) country of birth information and (to increase completeness of ascertainment) ii) codes for the first language spoken (S2 Table).

Place of residence had four categories: living in a care home, sheltered accommodation, other places of residence (e.g. prison, hospice, hostel, welfare home) and living in a household. Care home status was also considered as a binary (yes/no) variable, on the assumption that being in a care home might be more completely recorded by GPs than other places of residence (e.g living in a household). Homelessness was also a binary variable.

Relationship status was characterised by using following seven categories: single, married/ civil partnership, widow/er, divorced, separated, partner-other (e.g. common-law husband/ wife) and partner (uncategorised). As the last category was non-specific, an algorithm was developed to obtain more specific marital status information. If the 'partner uncategorised'

status was preceded by any of the following three categories: 1) Single/engaged 2) Married/ civil partnership and 3) Partner-other category, the 'partner uncategorised' category was updated to that of the earlier observation.

Deprivation status is a composite score of 38 indicators for seven domains of deprivation (income, health and disability, employment, education and training, housing, living environment and crime).[23] These indices are available at the small area level (LSOA) as quintiles: quintile one representing the least deprived to quintile five representing the most deprived.[23]

Analysis

For the purposes of recording, the social factors that were likely to change with time (e.g. marital status, living alone status) were treated as time-varying exposure variables whereas ethnicity, religion and immigration status were deemed to be time-invariant.

In CPRD the event date (the date the event occurred as recorded by the GP) was used to ascertain when the factor was recorded in relation to the index date. If the event date was missing then the system date (the date when the event was recorded on the GP system) was used for these observations.[19] For information extracted from the patient files (such as marital status, family number), which does not include event dates, a conservative estimate of the date of recording was taken, using the date the patient registered with the practice[19], and the hospital admission date was utilised for HES data.[22]

All mentions of each factor of interest were identified within a patient's linked records. Observations providing discordant information for a factor on the same date for a patient were excluded and the social factor recorded nearest the index date was used.

As family number provided information for social factors indirectly, and the date of recording this variable was unclear, information from family number was used only when data for a particular social factor were unavailable from other sources in CPRD or HES for that patient.

For each social factor, the following information was analysed:

(a) Completeness of recording and contribution from linkages. Completeness was described as the percentage of total patients who had data available: i) within CPRD and ii) within CPRD linked to HES, to investigate the extent to which use of the linked data increased completeness. For time-varying variables, completeness was determined in the period before or on the index date (taking the value nearest the index date). However, for time-invariant variables such as country of birth, ethnicity and religion, completeness of recording included both the period before and after the index date. For ethnicity, we further investigated completeness of recording by GPs over time by plotting completeness against year of registration with the general practice. We also assessed the contribution of family number by looking at completeness with and without family number data.

(b) Representativeness. The representativeness of the recorded data was investigated by comparing the distribution of each social factor amongst those with non-missing data with the distribution recorded in the 2011 Census (data from England for individuals aged $\geq$65 years). When applicable, we also considered the binary version of multi-category variables (i.e. care home status instead of the four-category variable for residence, and Muslim religion). For all binary variables, (immigration status, care home status, Muslim religion, homelessness, living alone, and cohabitation status) we assessed representativeness assuming that those without a code did not have the attribute, and thus compared the distribution of each factor among the entire study population to the Census data.

(c) Timeliness. For the time-varying factors, the duration between index date and the record nearest to the index date was calculated. Factors recorded more than five years before the index date were not considered timely.

Ethics approval

All data were anonymised prior to receipt by the authors. Approval for this study was obtained from the Independent Scientific Advisory Committee of the Medicines and Healthcare products Regulatory Agency (Ref: 15_253) and the Research Ethics Committee of the London School of Hygiene and Tropical Medicine (reference:10524). The original Independent Scientific Advisory Committee protocol was made available to the reviewers of this paper.

Data were analysed using Stata-14 software (StataCorp, College Station, TX, USA).

Results

The study population comprised 591,037 patients from 389 GP practices in England. More than half of the study participants (55%) were females, and 53% were aged between 65–74 years at the index date, with ~14% aged ≥85 years. The median age for women was 75.5 years (interquartile range (IQR): 69.5–82.5 years) whilst for men it was 73.5 years (IQR: 68.5–79.5 years). Information for one or more time-invariant social factors was available for~92% (n = 541,197) of the study population, while 75% (n = 444,827) had data for one or more time-varying social factors. Overall, ~98% (n = 578,410) had information for one or more social factors. Further details of the overall pattern of completeness is given in S3 Table; only 45 patients (<0.01%) had data for all seven social factors included in this study while ~21% (n = 123,450) had information for three social factors: ethnicity, IMD and living alone. The system date was used to replace missing event date for only 0.4% (n = 2,219) of the study population (S4 Table). The maximum number (n = 456; <0.1%) of patients were excluded due to discordant information recorded on the same date (S4 Table) were for the factor: living alone.

Completeness of recording for individual social factors, and contribution from linkages

Completeness of recording for all social factors was better for females and amongst the oldest individuals (aged ≥85 years) for all factors except for religion, immigration status and IMD score (Table 1). Of the seven social factors ascertained, recording for deprivation data and ethnicity were the most complete, at ~82% (n = 486,426) and ~80% (n = 469,557) respectively (Table 1). The recording of ethnicity over time showed an increase in completeness in the year 2006 (when incentivisation was introduced) with a slight downward trend in 2011 and 2012 (Fig 1).

The most incompletely recorded social factor was immigration status which available for only 4,187 (0.7%, data not shown) of the study population when country of birth codes were used alone. However, the additional use of 'first language' codes with country of birth codes more than doubled the information, to 1.6% (n = 9,713) of the study population (Table 1).

Religion was the second most poorly recorded factor, available for only 2.6% (n = 15,449) of study individuals (Table 1). Data on place of residence was recorded for 10.3% of the population, whereas living alone (yes/no) and marital status were recorded for nearly a third of the study population (29.2% and 27.2%, respectively).

The contribution of data from linked datasets to completeness of recording was particularly important for ethnicity, which showed a ~45% improvement (increasing from ~55% to ~80%, Table 1) after including linked hospitalisation data, and for IMD data (which was only available as linked data). For other social factors, there was hardly any evidence of improvement in completeness of recording from the linked data compared to using CPRD alone (Table 1).

The utilisation of family number in providing information for individuals who had no data for living alone, cohabitation, care home residence and marital status in either CPRD or HES

Table 1. Proportion of individuals with information on social factors available in Clinical Practice Research Datalink and Hospital Episodes Statistics: Age, sex and database distribution (N = 591037).

Study population stratified (N)	Codes available for social factors in CPRD and linked data: proportion* (95% confidence interval)								
	Marital status codes	Living arrangements		Residence		Religion codes	Ethnicity codes	IMD	Immigration status codes
		Cohabitation (yes/no) codes	Living alone (yes/no) codes	Place of residence codes	Homeless (yes/no) codes				
Age groups in years (N)									
65–69 (183382)	26.10%	21.50%	26.60%	4.60%	4.60%	2.40%	76.90%	82.50%	1.60%
	(25.9–26.3)	(21.4–21.7)	(26.4–26.8)	(4.5–4.6)	(4.5–4.7)	(2.3–2.5)	(76.7–77.1)	(82.3–82.7)	(1.5–1.7)
70–74 (131552)	25.90%	21%	26.60%	5.70%	5.70%	2.70%	80%	82.60%	1.80%
	(25.7–26.2)	(20.8–21.2)	(26.4–26.9)	(5.6–5.9)	(5.6–5.9)	(2.6–2.8)	(79.8–80.2)	(82.4–82.8)	(1.8–1.9)
75–79 (109628)	27.10%	21.40%	27.80%	8.20%	8.20%	2.90%	80.10%	82.30%	1.80%
	(26.8–27.3)	(21.1–21.6)	(27.5–28)	(8.1–8.4)	(8.1–8.4)	(2.8–3)	(79.8–80.3)	(82–82.5)	(1.7–1.9)
80–84 (84473)	28.70%	21.80%	30.30%	13.10%	13.20%	2.70%	81.10%	82%	1.60%
	(28.4–29)	(21.5–22)	(30–30.6)	(12.9–13.4)	(12.9–13.4)	(2.5–2.8)	(80.9–81.4)	(81.8–82.3)	(1.5–1.7)
85–89 (51278)	30.80%	24.30%	37.70%	25.20%	25.30%	2.60%	82.40%	82%	1.40%
	(30.4–31.2)	(23.9–24.6)	(37.3–38.1)	(24.8–25.6)	(24.9–25.7)	(2.5–2.8)	(82.1–82.7)	(81.6–82.3)	(1.3–1.5)
≥90 (30724)	29.50%	23.40%	43.90%	38.20%	38.30%	2.50%	80.70%	81.60%	0.97%
	(29–30)	(22.9–23.9)	(43.3–44.4)	(37.7–38.7)	(37.8–38.9)	(2.3–2.7)	(80.2–81.1)	(81.1–82)	(0.9–1.1)
Gender (N)#									
Males (264752)	22.80%	19.60%	24.40%	8.20%	8.30%	2.50%	79.30%	82.30%	1.50%
	(22.6–23)	(19.5–19.8)	(24.3–24.6)	(8.1–8.3)	(8.2–8.4)	(2.5–2.6)	(79.2–79.5)	(82.2–82.5)	(1.5–1.6)
Females (326283)	30.80%	23.50%	33.10%	11.90%	11.90%	2.70%	79.60%	82.30%	1.70%
	(30.6–31)	(23.4–23.6)	(32.9–33.2)	(11.8–12)	(11.8–12.1)	(2.6–2.7)	(79.4–79.7)	(82.2–82.4)	(1.7–1.8)
Database (N)									
CPRD database only (591037)	27.20%	21.80%	29%	10%	10.10%	2.60%	55.40%		1.6%
	(27.1–27.3)	(21.6–21.9)	(28.9–29.2)	(10.0–10.1)	(10.0–10.1)	(2.6–2.7)	(55.3–55.5)		(1.6–1.7)
CPRD & Linked data (591037)			29.20%	10.30%	10.30%		79.40%	82.30%	
			(29.1–29.3)	(10.2–10.3)	(10.2–10.4)		(79.3–79.5)	(82.2–82.4)	

* row percentages IMD index of multiple deprivation CPRD Clinical Practice Research Datalink

2 individuals had indeterminate gender

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showed that there was much higher completeness of recoding for living alone (70% versus 29%), cohabitation (60% versus 22%) and marital status (60% versus 27%) when information from family number was included (S3 Table, S4 Table and S5 Table). In contrast, family number contributed little to the completeness of recording of care home residence (11% versus 10%), irrespective of definitions used (S4 Table).

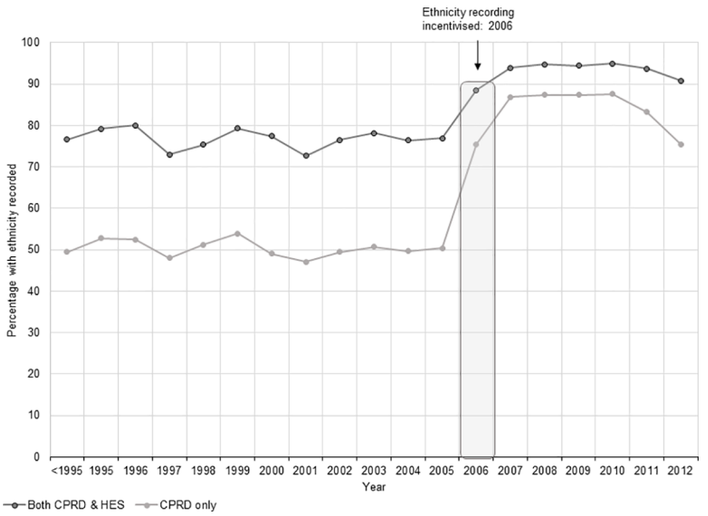

Fig 1. Patients with ethnicity records in Clinical Practice Research Datalink and Hospital Episode Statistics over time. Abbreviations: CPRD Clinical Practice Research Datalink HES Hospital Episode Statistics.

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Representativeness

Amongst those with ethnicity data available, (Table 2), White ethnicity was recorded for the majority (~95%) and the ethnic composition of the study population was comparable to the English Census data[34] (Fig 2). In contrast, amongst the small number of individuals with available data on religion, 85% (n = 13,074) were recorded as Christians (Table 2), with an over-representation of the minority religion categories in CPRD (Table 2) compared to Census data[33], for example Muslim (3.1% in CPRD versus 1.3% in the Census), Hindu (2.5% versus 0.8%), Jewish (1.6% versus 0.7%) and Sikh (1.1% versus 0.4%). When Muslim religion was considered as a binary variable, using the entire study population as the denominator and assuming those without a code were non-Muslim, there was appreciable under-recording of Muslim status (n = 481, 0.1%) compared to English Census (1.3%).[33]

Similarly, among those with data on immigrant status, there was marked over-representation of immigrants (n = 7,866, ~81% of the total) among those with recorded data (Table 2), but under-representation when immigrant status was considered as a binary variable (1.3% of the total study population (Fig 3) compared to 9.9% non-UK born individuals in the English Census).[35]

For living arrangements, amongst those with available data, the proportion of individuals recorded as living in a household (~50%, Table 2) was under-reported in CPRD compared to English Census data (in which ~96% of people aged ≥65 years were recorded as living in household) and living in a care home was over-reported (~48%) compared to Census (3.2%). [36, 37] However, once care home residence was categorised as a binary yes/no variable, representativeness improved markedly; in the total study population, 4.9% of individuals were categorised care home residents compared to 3.2% in the English Census data (Fig 3).[37]

The data from EHR for marital status amongst those with non-missing data were also not comparable to the Census data, [38–40] with 68% being recorded as married or in a civil partnership, compared to 55.9% in the Census data. Data were comparable for the sub-categories of: 'single' (4.5% versus 5.5% in the Census) and 'separated' (1.3% versus 1.2%), but there were

Table 2. Social factors in Clinical Practice Research Datalink: Recording and categorisation.

Social factors recorded* and their categorisation (N = Total number with information available)		CPRD only N (%)*	CPRD & linked data N (%)*
Marital status (N = 160812)	Single	7291 (4.5%)	No further information from linked data
	Married/Civil	108921 (67.7%)	
	Widow/er	30459 (18.9%)	
	Divorced	7446 (4.6%)	
	Separated	2100 (1.3%)	
	Partner uncategorised/ other[#]	4595 (2.9%)	
Living arrangements: Cohabitation (N = 128573)	No	14666 (11.4%)	No further information from linked data
	Yes	113907 (88.6%)	
Living arrangements: living alone CPRD (N = 171625); CPRD & linked data (N = 172590)	No	165914 (96.7%)	166896 (96.7%)
	Yes	5711 (3.3%)	5694 (3.3%)
Residence: place CPRD (N = 59263); CPRD & linked data (N = 60638)	Care home	28318 (47.8%)	28876 (47.6%)
	Sheltered	1001 (1.7%)	1272 (2.1%)
	Household	29371 (49.5%)	29296 (48.3%)
	Others	573 (1%)	1194 (2%)
Residence: homelessness CPRD (N = 59435); CPRD & linked data (N = 60809)	No	59342 (99.8%)	60717 (99.8%)
	Yes	93 (0.2%)	92 (0.2%)
Religion (N = 15449)	Christian	13074 (84.6%)	No further information from linked data
	Buddhist	40 (0.3%)	
	Hindu	389 (2.5%)	
	Jewish	249 (1.6%)	
	Muslim	481 (3.1%)	
	Sikh	169 (1.1%)	
	Other	31 (0.2%)	
	No religion	1016 (6.6%)	
Ethnicity CPRD (N = 327420); CPRD & linked data (N = 469557)	White	311466 (95.1%)	449668 (95.7%)
	South Asian	7688 (2.4%)	9316 (2%)
	Black	4686 (1.4%)	5483 (1.2%)
	Other	2727 (0.8%)	4045 (0.9%)
	Mixed	853 (0.3%)	1045 (0.2%)
Index of Multiple Deprivation (N = 486426)	Least deprived	No information from CPRD	119826 (24.6%)
	2		126957 (26.1%)
	3		101068 (20.8%)
	4		81978 (16.9%)
	Most deprived		56597 (11.6%)
Immigration status (N = 9713)	Not immigrant	1847 (19%)	No further information from linked data
	Immigrant	7866 (81%)	

* Total study population = 591037 CPRD Clinical Practice Research Datalink IMD

[#] Due to very small numbers in 'Partner: other' category the data are combined with 'Partner: uncategorised'

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small number of individuals in both these sub-categories, making it difficult to draw any conclusions.

The number of individuals with a code indicating that they were homeless was also very small, representing just 0.02% (n = 92) of total study population. There were no corresponding data in the 2011 Census, but data for statutory homelessness and homelessness prevention and

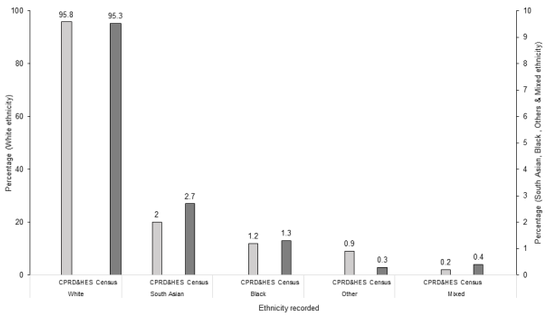

Fig 2. Comparing ethnicity recording (denominator: Those with available data) in electronic health records with English Census 2011. Abbreviations: CPRD Clinical Practice Research Datalink HES Hospital Episode Statistics.

https://doi.org/10.1371/journal.pone.0189038.g002

relief data (2013) from local authorities in England for individuals aged ≥65 years showed that the proportion of homeless individuals accepted for assistance was 0.01%,[41] providing a minimum estimate of the true proportion of homeless individuals (as not all would have been accepted for assistance).

Amongst those with available data, individuals categorised as those not living alone and as cohabiting were both over-represented in the data (96.7% and 88.6% respectively, Table 2). When considered as a binary variable using the entire study population as denominator, these factors were under-represented (28% and 19% respectively) compared to the Census data (68.5% and 58.6%, respectively).[39, 40] However, when information from family number was added, the percentage of those not living alone (68.9%) or cohabiting (52.2%) were fairly comparable (68.5% and 58.6% respectively) to the Census data (Fig 3).[39, 40]

For deprivation (Table 2), the data showed a slightly lower proportion of study population from the two most deprived quintiles of IMD status, suggesting that older patients in the practices consenting for linkage with deprivation data tended to be from more affluent areas. This is in contrast to a previous study which suggested that overall, including patients of all ages, those in linked CPRD IMD data are comparable to the UK population.[42]

Timeliness

The recording of time-varying social factors in relation to the index date varied considerably (Fig 4). Amongst those who had information available, 34.7% of individuals had data on whether they lived alone recorded within 5 years of the index date if data from family number

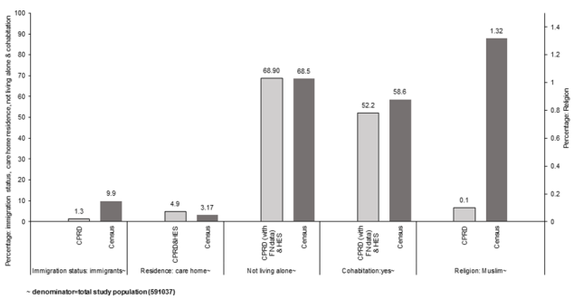

Fig 3. Comparing recording of immigration status, care home residence, not living alone, cohabitation and religion in electronic health records and English Census 2011. Abbreviations CPRD Clinical Practice Research Datalink HES Hospital Episode Statistics FN family number.

https://doi.org/10.1371/journal.pone.0189038.g003

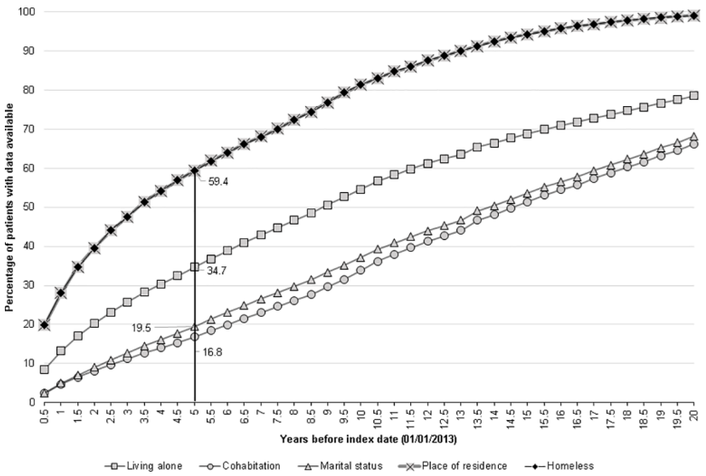

Fig 4. Timeliness of recording of living alone, cohabitation, marital status and place of residence. *data from family number analysis excluded

https://doi.org/10.1371/journal.pone.0189038.g004

was not included, but this decreased to about 20% if family number data were also considered (Fig 4 and S1 Fig). The equivalent percentages for marital status, without and with family number data were 19.5% and 13.5%, respectively. (Fig 4 and S2 Fig). Little difference (58.8% versus 59.5%) was observed for recording of residence within this defined period for analyses including and excluding family number (Fig 4 and S1 Fig).

The equivalent figures for timeliness when the entire study population (n = 591037) was considered, varied from 3.7% for cohabitation status to 14.2% for living alone data (including use of family number, S3 Fig).

Discussion and conclusions

This study presents the methodology for ascertaining social factors utilising one of the largest collections of primary care EHR in the world. This involved drawing up detailed code lists, utilising multiple files within CPRD and in the linked hospitalisation data to maximise ascertainment, and devising algorithms to time-update variables and to deal with discordant recording. Wide variation in the completeness of recording of social factors was noted, ranging from 1.6% for immigration status to ~82% for deprivation. Overall, the completeness for recording was better amongst females and older individuals, perhaps reflecting a higher consultation rates amongst this demographic group.[43]

The influence of GP incentivisation on completeness of recording of social factors was evident in the recording of ethnicity, an important factor for describing disease burden and for ascertaining health inequities. In 2006 GPs were incentivised to record ethnicity for all newly registered patients[44] and in year 2008 this was extended for all registered patients including the recording of first language spoken.[45] However, this incentivisation was withdrawn on 31 March 2011[25] and we found signs of a downward trend in ethnicity recording from 2011 onwards. The ethnicity data from the present study were available for 79% of the study population and when compared to Census data, were found to be representative of the English population. These results are comparable to an earlier study that reported ethnicity recording in CPRD and linked data for all age groups combined, which found completeness of recoding to be ~78% and ethnicity composition comparable to UK Census.[24]

Immigration status and religion were poorly recorded in these data, and living arrangements were also sub-optimally recorded. Among those with data, a higher than expected proportion were of minority religion, immigrant status or living in a care home, suggesting that GPs are more likely to record these specific social characteristics. When these factors were considered as binary variables (present or absent) in the entire study population, comparison with Census data suggested that care home status may indeed be well recorded. This is perhaps not surprising, as these individuals may be fragile and have higher healthcare needs, necessitating more attendances and interventions. In contrast, being of Muslim religion or an immigrant appeared to be under-recorded. However, our use of "first language" codes may have preferentially captured immigrants from specific countries, whilst under-ascertaining English-speaking individuals born in countries such as the Republic of Ireland, North America, Australasia and the Caribbean, who comprised of ~34% of non-UK born individuals in the 2011 Census.[35] This under-ascertainment may be exacerbated for individuals who moved to the UK many decades previously. Thus, CPRD data may be better for capturing recent arrivals to the UK who are not native English speakers. Homelessness was also under-recorded in these datasets, representing just 0.02% (n = 92) of total study population. Although the proportion of homeless individuals registered with GP has increased (63% in 2002 to 90% in 2014), the poor recording of homelessness status in these data is likely to reflect difficulties encountered by homeless individuals in accessing GP services.[46, 47]

Our findings show that completeness of recording was enhanced by use of multiple sources within datasets, as well as use of linked data. Living in a care home was recorded by GPs in the clinical, referral and test files, consultation data, additional clinical details and could be inferred from the family number, with additional information provided in the hospital data. Similarly, living arrangements such as cohabitation and living alone, the latter an important indicator of morbidity and mortality,[14, 48] were well captured for the study population (~60% and 70%, respectively) when Read code and family number data from CPRD and HES data were combined. Other studies have utilised family number to identify care home residence[26] and cohabitation status.[27, 28, 49] We found that addition of data from family number improved completeness and representativeness of recording of whether a patient lived alone or cohabited, but at the potential expense of timeliness of recording and misclassification. The family number variable is generated by the general practice software when a patient registers with a GP or moves address, assigning the same number to individuals with the same address (Personal communications via email CPRD Knowledge Centre). As the date of updating family number is not captured directly, we took the patient's registration date as a conservative estimate of when these data were recorded. Patients can move in or out of households and this information may not be captured by the practice, and patients sharing households may be registered at different practices, so that cohabitation status and living alone may be wrongly assigned. For this reason, we used family number to supplement information only when it was unavailable from other sources.

Other social characteristics of patients may have been misclassified in these routinely collected medical records–either due to mis-recording or because patients' status changed over time and this was not updated. Even factors considered time-invariant in this study may not necessarily have been so; for example, individuals may change their religion. A further point is that the codes used for determining social factors in general practice have not been validated except for ethnicity.[50] We could not examine other social factors that may be associated with uptake of healthcare interventions and health inequities but that were not recorded in these data, such as education, income, housing, social class, social relationships and cultural beliefs.[1, 51]

The significance of determining social factors in assessing the quality of healthcare and value-based payments to healthcare providers have been recognised, for example in a 2017

report published in the United States.[51, 52] A rise in multi-morbidity and frailty amongst older individuals due to population ageing will also increase the need for assessing social factors for delivering equitable healthcare. The CPRD database is used internationally for a wide range of public health studies, and HES includes nation-wide data used extensively for National Health Service (NHS) based research in the UK. Our methods will be thus of interest to researchers using these data. The underlying methods of this study could also be adapted for use in other UK primary care databases. The broader methodological approach utilised in this study such as to investigate the timeliness and the representativeness of these factors in electronic health data by comparing to a national standard such as Census data should be generalizable to other countries with EHR. Our study shows that linked general practice data can be used to ascertain individuals' ethnicity, deprivation status, care home residence, and whether they live alone. However, other factors such as religion and immigration status are incompletely captured and as mentioned earlier some relevant social characteristics are not recorded in these data. Improvement in completeness and quality of recording of these factors could be achieved by GP incentivisation and use of unambiguous codes. The effect of GP incentivisation was evident in the recording of ethnicity in CPRD which increased from ~30% in the period prior to incentivisation to >80% during the period of incentivisation.[24] A similar approach could be used for other social factors that are currently poorly captured in these data. Increasing health care providers' awareness about the role of social factors in disease burden and uptake of interventions should also help to improve recording of these factors. Linkages of general practice records with other population based data such as the Census could also greatly enhance the availability of information on social factors.

Supporting information

S1 Table. Sources of information for social factors in linked Clinical Practice Research Datalink.
(DOCX)

S2 Table. Code lists for social factors.
(DOCX)

S3 Table. Pattern of completeness for social factors recording (N = 591037(100%)).
(DOCX)

S4 Table. Time varying social factors and data source: Discordant information on same date and missing event dates (total study population 591037(100%)).
(DOCX)

S5 Table. Additional information obtained from using family number.
(DOCX)

S1 Fig. Timeliness of recording of living alone and residence: Comparing data from Clinical Practice Research Datalink (CPRD) and Hospital Episodes Statistics (HES) with data obtained from CPRD, HES and family number.
(DOCX)

S2 Fig. Timeliness of recording of cohabitation and marital status: Comparing data from Clinical Practice Research Datalink (CPRD) and Hospital Episodes Statistics (HES) with data obtained from CPRD, HES and family number.
(DOCX)

S3 Fig. Proportion of total study population (n = 591037) with recording of time varying social factors within 5 years of index date (01/01/2013).
(DOCX)

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Writing – review & editing: Anu Jain, Albert J. van Hoek, Jemma L. Walker, Rohini Mathur, Liam Smeeth, Sara L. Thomas.

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6.3 Supplementary material to the published paper 2

S1 Table- Sources of information for social factors in linked Clinical Practice Research Datalink

Social factors	CPRD data files								HES	Deprivation data
	Patient file	Patient file (family number)	Consultation file	Clinical file	Additional clinical details	Immunisation file	Referral file	Test file		
Religion	-	-	-	Medcodes	-	Medcodes	Medcodes	Medcodes	-	-
Ethnicity	-	-	-	Medcodes	-	Medcodes	Medcodes	Medcodes	Ethnos variable	-
Immigration status	-	-	-	Medcodes	-	Medcodes	Medcodes	Medcodes	-	-
IMD	-	-	-	-	-	-	-	-	-	Yes
Type of residence including homelessness	-	Yes	Consultation Type:30 & 31	Medcodes	Entity Type: 132	Medcodes	Medcodes	Medcodes	Admisorc variable	-
Living alone/ cohabitation	Derived from marital status	Yes	Consultation Type:30 & 31	Medcodes	Entity Type: 132	Medcodes	Medcodes	Medcodes	Admisorc variable	-
Marital status	Marital status	Yes	-	Medcodes	Entity Type: 98	Medcodes	Medcodes	Medcodes	-	-

CPRD Clinical Practice Research Datalink HES Hospital Episodes Statistics IMD index of multiple deprivation

S2 Table- Code lists for social factors

Codelists are available in this thesis as Appendices 4-10.

S3 Table- Pattern of completeness for social factor recording (N=591,037(100%)).

Social factors	**Source: CPRD & HES** Number of patients with complete information N (%)	**Source: CPRD and HES (including family number)** Number of patients with complete information N (%)
All eight social factors Living arrangements: living alone (yes/no) Living arrangements: cohabitation (yes/no) Marital status Residence: place Ethnicity IMD Immigration status Religion	45 (0.01%)	53 (0.01%)
Six social factors (excluding religion and immigration status) Living arrangements: living alone (yes/no) Living arrangements: cohabitation (yes/no) Marital status Residence: place Ethnicity IMD	13042 (2.2%)	22477 (3.8%)
Five social factors (additionally excluding residence) Living arrangements: living alone (yes/no) Living arrangements: cohabitation (yes/no) Marital status Ethnicity IMD	81583 (13.8%)	222600 (37.7%)
Four social factors (additionally excluding marital status) Living arrangements: living alone (yes/no) Living arrangements: cohabitation (yes/no) Ethnicity IMD	84974 (14.4%)	246609 (41.7%)
Three social factors (additionally excluding cohabitation) Living arrangements: living alone (yes/no) Ethnicity IMD	123450 (20.9%)	290912 (49.2%)

CPRD Clinical Practice Research Datalink HES Hospital Episodes Statistics IMD index of multiple deprivation

S4 Table- Time varying social factors and data source: discordant information on the same date and missing event dates (total study population 591,037(100%)).

Social factors and source of their information		Number of patients (%) with information on social factor prior to dropping discordant information recorded on same date	Number of patients (%) excluded due to discordant information recorded on same date	Number of patients (%) with information on social factor after dropping discordant information recorded on same date	Missing event date replaced with system date# Number of patients (%)
Living arrangements	Living alone (yes/no) (CPRD & HES)	173046 (29.3%)	456 (0.1%)	172590 (29.2%)	1812 (0.3%)
	Living alone (yes/no) (CPRD only)	172085 (29.1%)	460 (0.1%)	171625 (29%)	1812 (0.3%)
	Living alone (yes/no) (CPRD, HES & FN)	413694 (70%)	456 (0.1%)	413238 (69.9%)	1812 (0.3%)
	Cohabitation (yes/no) (CPRD & HES)	128641 (21.8%)	68 (0.01%)	128573 (21.8%)	1916 (0.3%)
	Cohabitation (yes/no) (CPRD only)	128641 (21.8%)	68 (0.01%)	128573 (21.8%)	1916 (0.3%)
	Cohabitation (yes/no) (CPRD, HES & FN)	356870 (60.4%)	68 (0.01%)	356802 (60.4%)	1916 (0.3%)
Marital status	Marital status (CPRD only)	160963 (27.2%)	151 (0.03%)	160812 (27.2%)	2061 (0.3%)
	Marital status (CPRD, HES & FN)	351432 (59.5%)	151 (0.03%)	351281 (59.4%)	2061 (0.3%)
Residence	Residence: place (CPRD & HES)	60811 (10.3%)	173 (0.03%)	60638 (10.3%)	61 (0.01%)
	Residence: place (CPRD only)	59437 (10.1%)	174 (0.03%)	59263 (10%)	61 (0.01%)
	Residence: place (CPRD, HES & FN)~	65140 (11%)	173 (0.03%)	64967 (11%)	61 (0.01%)
	Residence: place (CPRD, HES & FN)*	64876 (11%)	173 (0.03%)	64703 (10.9%)	61 (0.01%)
	Residence: homelessness (CPRD & HES)	60813 (10.3%)	4 (<0.001%)	60809 (10.3%)	64 (0.01%)
	Residence: homelessness (CPRD)	59439 (10.1%)	4 (<0.001%)	59435 (10.1%)	64 (0.01%)

CPRD Clinical Practice Research Datalink HES Hospital Episodes Statistics FN Family number

Overall, event date was missing for 2219 (0.4%) patients

~ 1st criteria for care home residence using family number: households with ≥3 individuals aged ≥65 years who were in the majority compared to those aged <65 years

*2nd criteria for care home residence using family number: households with ≥3 individuals aged ≥65 years, ≤3 individuals aged ≤50 years and those aged ≥65 years were in the majority

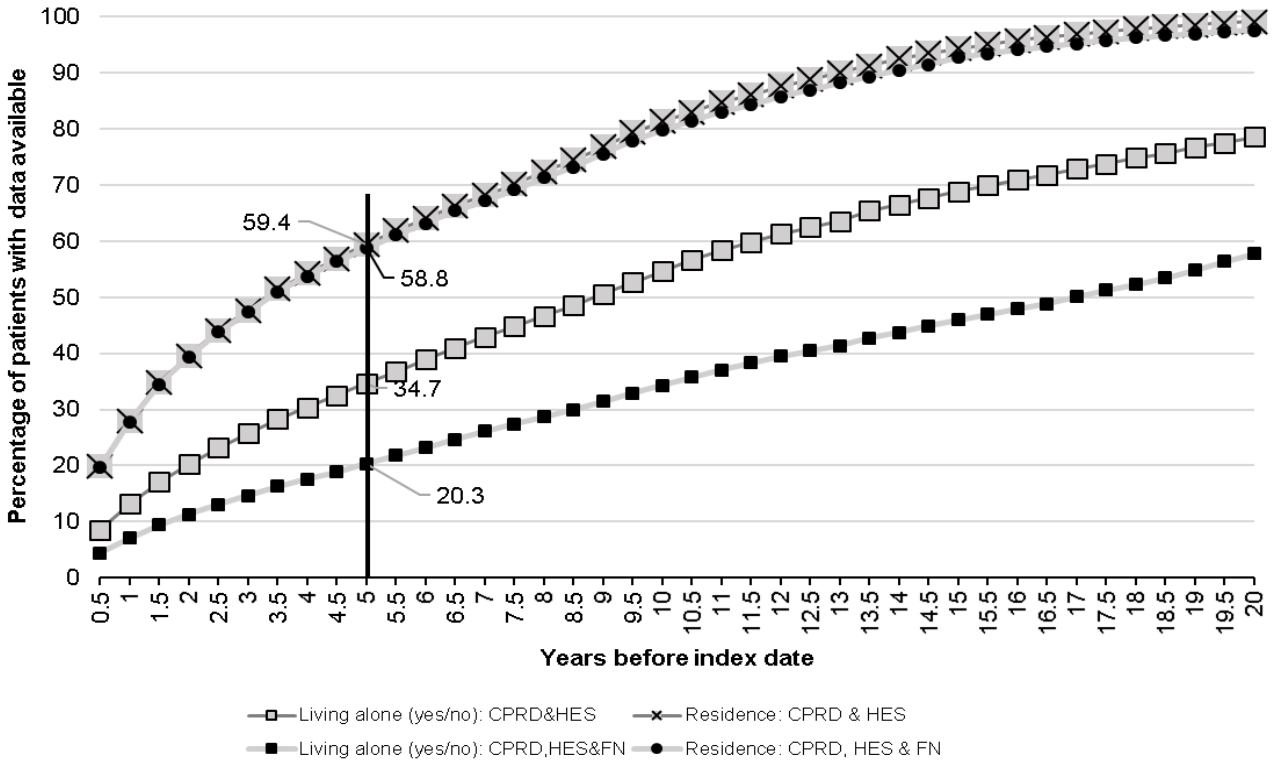
S5 Table- Additional information obtained from using family number

Social factors		Information from CPRD (including family number) &, HES (number of patients with data available) Total study population 591,037 (100%)		Information from CPRD (excluding family number)& HES Total study population 591,037(100%)	
		Frequency (%)	Missing data	Frequency (%)	Missing data
Living alone	No	407544 (69%)	177799 (30.1%)	166896 (28.2%)	418447 (70.8%)
	Yes	5694 (1%)		5694 (1%)	
Cohabitation	No	48445 (8.2%)	234235 (39.6%)	14666 (2.5%)	462464 (78.2%)
	Yes	308357 (52.2%)		113907 (19.3%)	
Residence: place	Care home	33205 (5.6%)	526070 (89%)	28876 (4.9%)	530399 (89.7%)
	Sheltered	1272 (0.2%)		1272 (0.2%)	
	Household	29296 (5%)		29296 (5%)	
	Others	1194 (0.2%)		1194 (0.2%)	
Marital status	Single	7291 (1.2%)	239756 (40.6%)	7291 (1.2%)	430225 (72.8%)
	Married/Civil	108921 (18.4%)		108921 (18.4%)	
	Widow/er	30459 (5.2%)		30459 (5.1%)	
	Divorced	7446 (1.3%)		7446 (1.3%)	
	Separated	2100 (0.3%)		2100 (0.4%)	
	Partner uncategorised/other[#]	195064 (33%)		4595 (0.8%)	

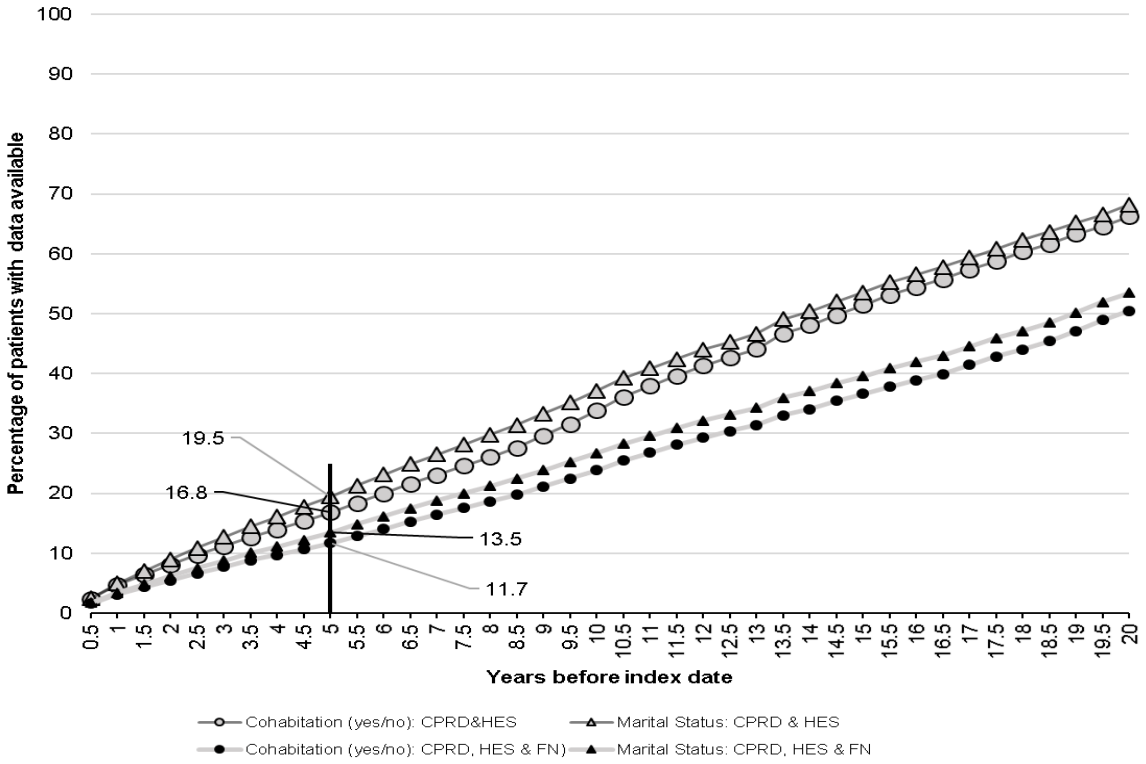
[#]Due to very small numbers in `Partner: other' category the data are presented combined with `Partner: uncategorised'

CPRD Clinical Practice Research Datalink HES Hospital Episodes Statistics

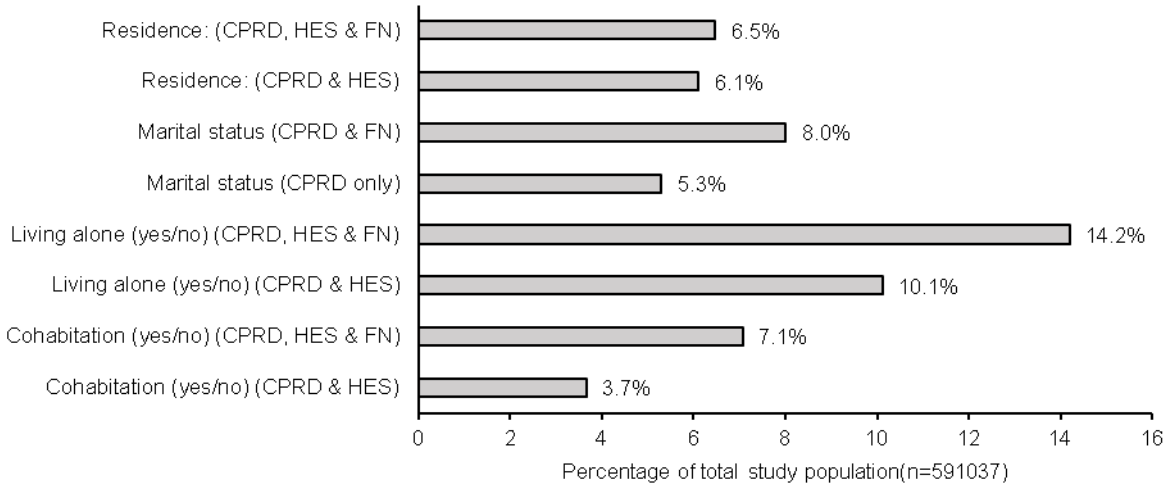
S1 Fig- Timeliness of recording of living alone and residence: comparing data from Clinical Practice Research Datalink (CPRD) and Hospital Episodes Statistics (HES) with data obtained from CPRD, HES and family number



S2 Fig- Timeliness of recording of cohabitation and marital status: comparing data from Clinical Practice Research Datalink (CPRD) and Hospital Episodes Statistics (HES) with data obtained from CPRD, HES and family number



S3 Fig- Proportion of total study population (n=591,037) with recording of time-varying social factors within 5 years of index date (01/01/2013)



CPRD Clinical Practice Research Datalink HES Hospital Episodes Statistics FN family number

6.4 Determining immigration status in CPRD data

As outlined previously in **Chapter 4** (**Section 4.3.4**), I initially assessed immigration status based on medical codes for country of birth. To increase the assessment of immigration status, I expanded the code list to include “first language” codes to identify individuals born in countries where English was not the first language. This was done because the GPs were incentivised to record first language for all registered patients between 2008-2011.[138, 139] When immigration status was determined based only on country of birth medical codes, information was available for only 0.7% (n= 4187) of the study population (Table 6-1). The completeness of recording of immigration status increased to 1.6% (n= 9713) with the additional use of first language codes with country of birth codes (Table 6-1). As shown in Table 6-1, among the 9713 individuals with information on immigration status (using the wider definition comprising both country of birth and language codes), 7866 (81%) had a code for being an immigrant, while 19% (n=1847) had a code for being a non-immigrant. I considered that a GP was more likely to record that a patient was an immigrant than record that a patient was non-immigrant. Based on this assumption, as described in the published paper (**Section 6.2**), immigration status was considered as a binary variable for the entire study population: individuals with a country of birth code as immigrants or with first language code for languages other than English were categorised as immigrants while the rest of the study population was categorised as non-immigrants. Based on this binary categorisation and using the entire study population as denominator, of the total study population of 591037 individuals: 7866 (1.3%) individuals were categorised as immigrants and the remaining 583171 (98.7%) individuals were categorised as non-immigrants.

Table 6-1 Ascertainment of immigration status in CPRD GOLD data based on country of birth and language codes

Age group (study participants)	Total number of individuals	Immigration status information based on only country of birth codes N (row %)	Immigration status information based on country of birth and language codes N (row %)
65-70 years	183382	1333 (0.7)	2938 (1.6)
70-75 years	131552	1001 (0.8)	2422 (1.8)
75-80 years	109628	815 (0.7)	1982 (1.8)
80-85 years	84473	562 (0.7)	1349 (1.6)
85-90 years	51278	325 (0.6)	723 (1.4)
>90 years	30724	151 (0.5)	299 (1)
Total	**591037**	**4187 (0.7)#**	**9713* (1.6)**

As described in text: # Of these 4187 individuals with available information: 2336 (55.8%) and 1851 (44.2%) were coded as immigrants and non-immigrants, respectively *Of these 9713 individuals with available information 7866 individuals (81%) and 1847 (19%) were coded as immigrants and non-immigrants respectively

As mentioned in the published paper (**Section 6.2**), the proportion of individuals identified as immigrants (1.3%) in the study was lower compared to the 2011 English Census data in which 9.9% individuals aged ≥65 years were recorded as non-UK born.[152] The use of language codes could have preferentially captured data from immigrants who moved to the UK from non-English speaking countries but captured fewer individuals who migrated to the UK in early childhood if these individuals considered English as their first language. The language codes could have also under-ascertained individuals born in countries other than UK where English is the first language such as the Republic of Ireland, United States of America, Canada or Australia, and those who registered with their GPs after 2011 when incentivisation for first language recording was withdrawn. The effect of under ascertainment of immigration status on its association with zoster disease burden and zoster vaccine uptake are further discussed in **Chapters 7** and **8**.

6.5 Family number

The use of family number (discussed in detail in **Chapter 4**: **Section 4.3**) contributed to the availability of data for living alone, cohabitation and marital status. This is illustrated in the supplementary material to the published paper (S4 Table): in comparison to data available from CPRD (excluding family number) and/or HES, the additional use of family number increased the completeness of recording for living alone (29% versus 70%), cohabitation

(22% versus 60%) and marital status (27% versus 59%). However, data obtained from using family number was less timely compared to the information obtained from using CPRD GOLD and HES data without family number. This is because it is unclear how often the family number is updated with changes in patient's address as discussed previously in **Section 4.4.3**. After including information from family number for determining whether individuals were living alone, their cohabitation status and marital status, 20.3%, 11.7% and 13.5% respectively of individuals with available data had this information recorded within 5 years of the index date (S1 and S2 Fig. supplementary material to the published paper). These proportions were lower compared to those obtained from using only CPRD GOLD (without family number) and HES data: 34.7%, 16.8% and 19.5% of individuals with available data for living alone, cohabitation status and marital status respectively had information recorded within 5 years of the index date.

The assessment of care home residence after including information from the family number resulted in ~5.6% of the total study population (n=591037) being defined as care home residents (S5 table supplementary material to the published paper). This proportion was higher compared to the proportion (4.9%) residing in care home, obtained from utilising only CPRD GOLD and HES data (i.e. not using information from family number). The latter data (4.9%) were more comparable (Figure 3 published paper **Section 6.2**) to the 2011 English census data, which reported 3.2% individuals aged ≥65 years residing in care home.[147] Therefore, ascertainment of care home residence was based on information obtained from using only CPRD and HES data.

6.6 Chapter summary

This chapter presented the application of methodology for ascertainment of socio-demographic factors in linked EHR, developed as a part of this thesis and detailed in **Chapter 4**. This included an assessment of completeness of recording of socio-demographic factors, their representativeness, timeliness of recordings and additional information gained from linkages, which was the second objective of this thesis (**Section 1.5.2**). In the next two chapters: **Chapters 7** and **8**, I describe the results of applying these

methods to assess the association of socio-demographic factors with zoster incidence and zoster vaccine uptake, respectively.

Chapter 7. A cohort study to investigate the role of social determinants related to the burden of herpes zoster: a vaccine preventable disease

7.1 Introduction

This chapter forms the second of the three chapters included in the Results section of this thesis. The methodology for determining the recording of socio-demographic factors in the linked electronic data (**Chapter 4**) was applied in a cohort study conducted to assess inequalities in zoster disease burden amongst older individuals in England, which is the third objective of this thesis. The details of this work, published in the British Journal of Dermatology are presented in the next section. The paper is followed by the supplementary material (**Section 7.3**) to the published paper and results of further investigation into the possible impact of missing data on the findings of the paper (**Section 7.4**).

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RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

SECTION A – Student Details

Student	Anu Jain
Principal Supervisor	Prof. Sara Thomas
Thesis Title	Use of electronic health records to investigate vaccination inequalities in older individuals in England

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?	British Journal of Dermatology		
When was the work published?	2018		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion	N/A		
Have you retained the copyright for the work?*	**Yes**	Was the work subject to academic peer review?	**Yes**

**If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.*

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	
Please list the paper's authors in the intended authorship order:	
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	The study was conceptualised by S Thomas and AJ van Hoek. I developed the study methodology with supervision from S Thomas and AJ van Hoek and advice from the other co-authors. The methodology for assessment of socio-demographic factors was as described in Chapter 6. The medical codes for zoster and other covariates used in

	analyses were provided by S Thomas and reviewed by me. I devised the algorithms and criteria to define periods of immunosuppression in these data. I adapted a technique developed by H Forbes for imputing missing doses for immunosuppressive drugs. J Walker and H Forbes helped me to write statistical programmes for time-updating the variables of interest. I conducted the data management, formal analyses and I wrote the initial draft of the manuscript which was revised based on comments by the co-authors. The manuscript was peer-reviewed, and I also incorporated the reviewer's comments in the final manuscript.

Student Signature: _____ **Date:** 01/02/2018

Supervisor Signature: _____ **Date:** 01/02/2018

7.2 Paper 3: Inequalities in zoster disease burden: a population-based cohort study to identify social determinants using linked data from the UK Clinical Practice Research Datalink

BJD
British Journal of Dermatology

Inequalities in zoster disease burden: a population-based cohort study to identify social determinants using linked data from the U.K. Clinical Practice Research Datalink

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Summary

Background Zoster vaccination was introduced in England in 2013, where tackling health inequalities is a statutory requirement. However, specific population groups with higher zoster burden remain largely unidentified.
Objectives To evaluate health inequalities in zoster disease burden prior to zoster vaccine introduction in England.
Methods This population-based cohort study used anonymized U.K. primary care data linked to hospitalization and deprivation data. Individuals aged ≥ 65 years without prior zoster history (N = 862 470) were followed from 1 September 2003 to 31 August 2013. Poisson regression was used to obtain adjusted rate ratios (ARRs) for the association of sociodemographic factors (ethnicity, immigration status, individuals' area-level deprivation, care home residence, living arrangements) with first zoster episode. Possible mediation by comorbidities and immunosuppressive medications was also assessed.
Results There were 37 014 first zoster episodes, with an incidence of 8·79 [95% confidence interval (CI) 8·70–8·88] per 1000 person-years at risk. In multivariable analyses, factors associated with higher zoster rates included care home residence (10% higher vs. those not in care homes), being a woman (16% higher vs. men), nonimmigrants (~30% higher than immigrants) and white ethnicity (for example, twice the rate compared with those of black ethnicity). Zoster incidence decreased slightly with increasing deprivation (ARR most vs. least deprived 0·96 (95% CI 0·92–0·99) and among those living alone (ARR 0·96, 95% CI 0·94–0·98). Mediating variables made little difference to the ARR of social factors but were themselves associated with increased zoster burden (ARR varied from 1·11 to 3·84).
Conclusions The burden of zoster was higher in specific sociodemographic groups. Further study is needed to ascertain whether these individuals are attending for zoster vaccination.

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Conflicts of interest
A.J.'s PhD studentship was funded by the National Institute for Health Research (HPRU-2012-10096). A.J.v.H. and J.L.W. have received grant support from the National Institute for Health Research (HPRU-2012-10096). S.M.L. reports grants from the National Institute for Health Research and a Wellcome Trust senior clinical fellowship in science (205039/Z/16/Z). L.S. reports grants from the Wellcome Trust (098504/Z/12/Z), grants from the Medical Research Council, grants from NIHR, grants and personal fees from GSK, personal fees from AstraZeneca, grants from the European Union and is a trustee of the British Heart Foundation. S.L.T. reports grants from the National Institute for Health Research (HPRU-2012-10096).

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What's already known about this topic?

- Monitoring and reducing health inequalities is a statutory requirement in the U.K.
- Incidence of herpes zoster is known to be higher among individuals with certain comorbidities and those taking immunosuppressive treatment.
- In contrast, little is known about the social determinants of zoster, which may contribute to the inequality of zoster disease burden in England.

What does this study add?

- Older individuals at higher risk of zoster included women, those in care homes, those of white ethnicity and nonimmigrants.

- Individuals with certain comorbidities and taking immunosuppressive therapies were at appreciable increased risk of zoster, but this explained little of the increased risk in the specific demographic and social groups.
- The findings should inform possible future use of the inactivated zoster vaccine among those at higher risk, including care home residents.

Herpes zoster is associated with appreciable morbidity, and postherpetic neuralgia (PHN, its commonest complication) can be an incapacitating condition.[1,2] Zoster can be precipitated by immunosenescence or suppression of cell-mediated immunity, and incidence increases with age, with rates varying from 6–8 per 1000 person-years to 8–12 per 1000 person-years among those aged 60 and 80 years, respectively.[1–5] Antiviral medications may limit zoster symptoms but their effect on PHN remains uncertain.[6] A single-dose vaccine that is effective in preventing zoster and PHN was introduced in the U.K. in 2013, targeting individuals aged 70–79 years.[7–10]

The effect of sociodemographic factors on zoster incidence has not been extensively investigated. Older individuals and those of white ethnicity have been shown to be at higher risk of zoster.[4,11,12] The association with other sociodemographic factors such as sex, country of birth, marital status and socioeconomic status has been inconclusive.[3–5,12–14] The unequal distribution of zoster between social groups could potentially be exacerbated by differential uptake of zoster vaccination, resulting in even higher disease burden among some older individuals. Identifying social groups at higher zoster risk is therefore essential for planning preventative interventions to mitigate inequalities of zoster burden and promote healthy ageing across the population.

In England, zoster incidence trends are monitored using general practice data to assess the impact of the vaccination programme, but apart from sex no other social factors are being evaluated.[15] We have shown that some of these factors can be ascertained using routinely collected electronic health records such as the Clinical Practice Research Datalink (CPRD),[16] one of the world's largest anonymized primary care data sources.[17]

The aim of this cohort study was to determine the association of sociodemographic factors with zoster incidence in England using linked CPRD data in the period immediately before zoster vaccine introduction, to inform suitable targeted vaccination strategies.

Patients and methods

Data sources

This study used anonymized CPRD data linked to hospitalization and deprivation data. CPRD provides quality-assured clinical, lifestyle, demographic and administrative data, for a representative sample of ~7% of the U.K. population.[17–19] The validity of recorded diagnoses within the database is generally high.[18] In England, CPRD provides linkages at an individual level with other data, including hospitalization [Hospital Episode Statistics (HES)] and deprivation data, for ~75% of practices.[17,18] The deprivation data were based on a patient's area of residence and/or practice location [Index of Multiple Deprivation (IMD): a composite small area-level score].[17,18]

Study population and follow-up

This cohort study spanned the 10-year period (1 September 2003 to 31 August 2013) prior to zoster vaccine introduction. The study population comprised patients aged ≥ 65 years who were registered with a CPRD practice in England during the study period and eligible for linkage. Patients with zoster or PHN codes prior to start of follow-up, or whose first zoster code during follow-up was PHN, were identified in CPRD and HES [using Read codes for CPRD and International Classification of Disease (ICD) 10th revision codes for HES, Appendix S1] and excluded.

Follow-up started on the latest of the following: study start date (1 September 2003); 1 year after current registration date (to avoid retrospective recording of past zoster in first few months of new registration);[20] the date the practice met CPRD's quality criteria;[18] or individuals' 65th birthday. Follow-up ended on the earliest of the following: study end date (31 August 2013); zoster date; transfer-out date; last collection date from the practice; or date of death.

Outcome

Incident zoster cases were defined as the first diagnostic code for zoster during follow-up, using both CPRD and HES data (Appendix S1; see Supporting Information). In the HES data, patients with zoster codes in either the primary or the secondary diagnosis fields were included, and the hospital episode start date was used as the date of zoster.

Exposures

A conceptual framework (Appendix S2), based on the World Health Organization's Commission on Social Determinants of Health framework, was hypothesized for the association of individual-level sociodemographic factors with zoster incidence.[21] These factors included immigration status, religion, ethnicity, deprivation, care home residence, marital status, cohabitation (individuals living as a couple) and living alone. The latter three factors provided overlapping information

about an individual's living arrangements. The code lists and details of how these factors were identified in linked CPRD data are provided in Appendices S3 and S4. The following factors were categorized as binary variables: being an immigrant to the U.K., care home residence, cohabitation and living alone. Marital status had six categories: single, married, widowed, divorced, separated, and uncategorized/other partner. Religion and ethnicity had eight (Christian, Buddhist, Hindu, Jewish, Muslim, Sikh, other and no religion) and five (white, south Asian, black, other and mixed) categories, respectively. Social factors that changed with time such as marital status, cohabitation, living alone and care home residence were time-updated over the study period.

IMD data were available at both individual- and practice-small area-level as quintiles [1 (least deprived) to 5 (most deprived)]; individuals with missing IMD data were assigned their practice's IMD quintile.

Other variables

Based on previous data[22] and the U.K. Green Book[10] guidance for immunosuppressive conditions considered to be a contraindication to live zoster vaccination, certain predisposing conditions and immunosuppressive medications were postulated as mediators between sociodemographic factors and zoster incidence (Appendix S2). Conditions identified in either CPRD or HES (Appendix S3) that were considered immunosuppressive from the time of recorded diagnosis included rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease, asthma, human immunodeficiency virus infection, other cellular immune deficiency and solid organ transplant. Individuals with haematopoietic stem cell transplant, leukaemia, lymphoma, myeloma and other plasma cell dyscrasias were considered to be immunosuppressed for 24 months following each record.[22] Information on immunosuppressive medications was extracted using previously described methodology.[22] Details for identifying immunosuppressive conditions and treatments in these data are provided in Appendices S4–5. All putative mediating variables were categorized as binary variables. Age was categorized in 5-yearly bands from 65 to 84 years, with a final category of $\geq$ 85 years. The study period was divided into five approximately equal categories to observe any temporal changes in zoster incidence.

Analyses

For all sociodemographic factors, the person-time at risk, number of first zoster cases and missing values were tabulated. Zoster incidence rates for each factor were obtained by dividing the number of zoster cases by the person-time at risk. The demographic characteristics of individuals with a past history of zoster excluded from the study were compared with individuals included in the study.

Poisson regression was used to estimate incidence of the first zoster episode and 95% confidence intervals (CI). Hypothesis testing was conducted using likelihood ratio tests unless otherwise stated. Age, sex and calendar period were considered as a priori confounders; age and sex were also considered as risk factors in their own right. The effect estimates for all explanatory and hypothesized mediating variables were first examined after adjusting for the three a priori confounders in a minimally adjusted model. A hierarchical approach to causal modelling, based on the hypothesized causal framework between the factors of interest, was then adopted for multivariable analyses (Appendix S6).[23] The first multivariable model included the a priori confounders, ethnicity and immigration status (model 1); patient-level IMD was then added (model 2), followed by care home residence and living alone status (model 3). The potential mediating effects of comorbidities and therapeutic agents were examined in models 4 and 5, respectively. Collinearity between closely related factors (for example living arrangements) was assessed by comparing measures of effect and log standard errors of the coefficient in minimally adjusted and multivariable models. For multivariable models, individuals with complete covariate data were analysed. Data were analysed using the Stata 14 software package (StataCorp, College Station, TX, U.S.A.).

Ethics

The protocol for this research was approved by the Independent Scientific Advisory Committee (ISAC) for Medicines and Healthcare products Regulatory Agency Database Research (protocol number 16_168) and made available to the journal and reviewers during peer review. The study was also approved by the Observational/Interventions Research Ethics Committee of the London School of Hygiene and Tropical Medicine (Reference: 11910).

Results

The cohort initially included 931 830 individuals (Fig. 1) from 385 practices across England, of which 69 360 were excluded because of a prior history of zoster. The demographic characteristics of patients with and without a prior zoster history (excluded and included, respectively, in the study) are presented in Appendix S7. Those with a previous history of zoster were likely to be older at the start of the study (1 September 2003), women, nonimmigrants and individuals of white ethnicity, but were similar to included individuals with respect to IMD quintiles.

The median follow-up time for the eligible study cohort (N = 862 470) was 4·33 [interquartile range (IQR)1·82–8·07] years. More than half of the eligible study population were women and were aged 65–69 years at the start of follow-up (Table S1; see Supporting Information). Data were missing for four variables: religion (98% missing), marital status (47% missing), ethnicity (17·5% missing) and sex (< 0·01% missing) (Table S1). For < 0·1% of the study population (n = 849), the missing values of patient-level IMD were replaced by practice-level IMD (Table S1).

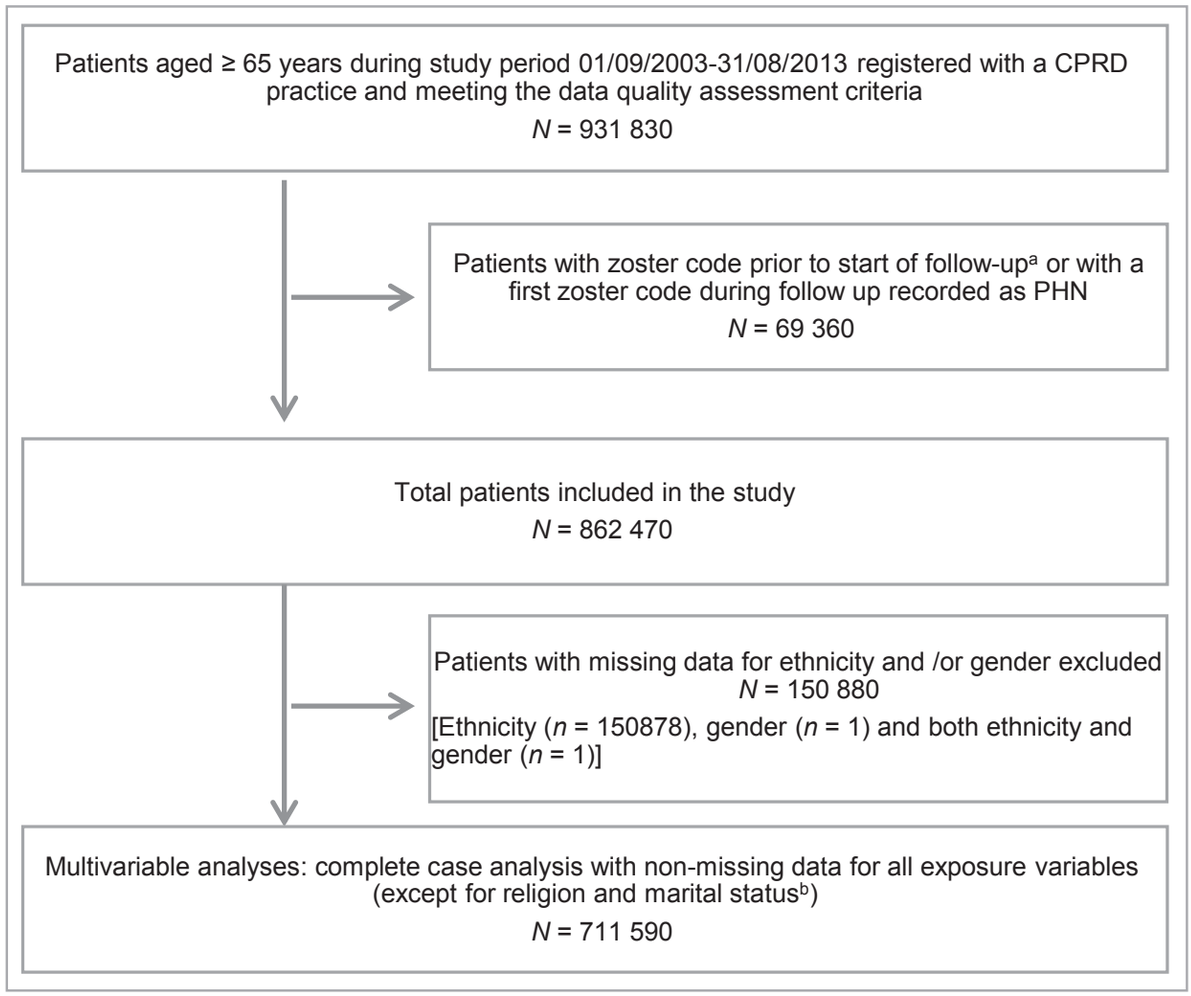

Fig 1. Study participants flow chart. [a]Follow-up started on the latest of the following: study start date (1 September 2003); 1 year after current registration date; the date the practice met CPRD's quality criteria; or individuals' 65th birthday. Follow-up ended on the earliest of the following: study end date (31 August 2013); zoster date; transfer-out date; last collection date from the practice; or date of death. [b]Both these variables were excluded from the analyses. CPRD, Clinical Practice Research Datalink; PHN, post-herpetic neuralgia.

In total, 37 014 individuals experienced a first zoster episode during follow-up, the median age at zoster was 75·7 years (IQR 70·2–81·8 years) and the incidence was 8·79 (95% CI 8·70–8·88) per 1000 person-years at risk (Table S1). The unadjusted zoster rates for all sociodemographic factors and mediating variables are presented in Table S1.

A decision was made to drop the two variables with appreciable missing data (religion and marital status) from further analyses. Ethnicity and sex were retained in the analysis but individuals with missing data were dropped. The complete case analysis included 711 590 patients, after dropping participants with missing data on ethnicity (n = 150 878) and/or sex (n = 2) (Fig. 1). Demographic characteristics of individuals with and without missing ethnicity data are provided in Appendix S8. Those without ethnicity data were similar to those included in the analysis with only slightly lower zoster incidence and marginally fewer comorbidities (Appendix S8).

In the minimally adjusted model (adjusted for age, sex and calendar period, Table S2), zoster rates increased linearly with age, the adjusted rate ratios (ARRs) in the oldest age groups (aged ≥ 85 years) being 40% higher than for those aged 65–-69 years. There was little evidence of changing incidence over the study period. For the sociodemographic factors of interest, men, those who were of non-white ethnicity, immigrants, those living in more deprived areas (at the practice or patient-level) and those living alone had lower rates of zoster, with reduced rates of between 5% (for moderate deprivation at the patient-level) to 53% (for black ethnicity) (all P-values < 0·001). Care home residents had higher zoster incidence (ARR 1·12, 95% CI 1·06–1·18) than non-care home residents. As expected, most of the comorbidities and all immunosuppressive treatments were associated with higher zoster incidence (Table S2).

After adjusting for immigration status in addition to the a priori confounders (model 1), the effect of ethnicity was

almost unchanged, with each non-white ethnic group remaining at lower risk of zoster [ranging from a 15% reduced rate (other ethnicity) to a 51% reduced rate (black ethnicity), Table S2]. In contrast, the effect estimate for immigration status was slightly attenuated after additionally adjusting for ethnicity, although immigrants remained at 23% lower risk of zoster.

Practice- and patient-level deprivation were closely correlated, as were living alone and cohabitation status; thus, only patient-level IMD was added to model 2 and living alone to model 3. There were no appreciable changes in the effect estimates for each factor with successive adjustment (Table S2). Those living in a care home had about a 10% higher rate of zoster, and those living alone a reduced rate of 4% (model 3, Table S2). None of the factors appeared to be mediated by comorbidities or immunosuppressive therapies (models 4 and 5, Table S2).

When analyses were repeated for those with missing ethnicity data, effect estimates in the minimally adjusted analysis were all in the same direction of the main analysis (Appendix S9). In further sensitivity analyses, restriction to those of white ethnicity also showed no differences to the main analysis (Appendix S10). Substitution of practice- for patient-level IMD (Appendix S11) and cohabitation instead of living alone (Appendix S12) also did not change the findings.

Discussion

In this large population-based cohort study, sociodemographic factors independently associated with higher zoster risk included age, female sex, white ethnicity and care home residence. There was little evidence of increased incidence among minority ethnic groups, those living alone or living in deprived areas. As in previous studies, increasing age, specific comorbidities and immunosuppressive treatments were associated with higher zoster incidence.

This study used one of the world's largest quality-assured primary care databases, linked to hospitalization and social deprivation data, and provided data for a wide range of social factors, including potential mediating variables for zoster risk. These results could be potentially generalizable to older individuals without prior history of zoster from countries with universal access to health care as in the U.K. Ascertainment of social factors using routinely collected electronic health records was achieved by using detailed coding algorithms and rigorous methodology. Causal modelling based on a predefined conceptual framework ensured quantification of robust effect estimates.

The limitations associated with use of routinely collected data included potential misclassification of both exposure and outcome. Time-varying exposures such as living alone may be misclassified in these data if not updated in a timely manner in general practitioner records. Similarly, for binary variables, the assumption that absence of a code implies absence of the characteristic may not be true. However, the methods used in this study are based on our previously developed methodology for ascertainment of social factors among older individuals using linked CPRD data, which found prevalence of factors such as ethnicity, living alone, cohabitation and care home residence comparable with the 2011 English Census, whereas being an immigrant was under-represented in these data.[16] In the U.K., zoster is mainly diagnosed clinically;[22] however, a clinical diagnosis of zoster in primary care is reported to have a high (91%) positive predictive value among older individuals.[24] Any misclassification of exposure or outcome is likely to be nondifferential, tending to bias effect estimates towards the null. Thus, the actual effect estimates may be even larger than observed here.

Differential zoster ascertainment in different social groups is a consideration. For example, it is possible that those living alone or in more deprived areas may not seek care for zoster. Those seeking ongoing care for their comorbidities may have a higher opportunity of zoster diagnosis, although we found no mediating effect of comorbidities for any of the social factors examined. A previous U.S. study reported that 95% of older individuals were likely to consult for zoster, irrespective of sociodemographic characteristics such as income or marital status.[25] Unavailability of factors such as education, income and social class, and poor recording of religion (2%) and marital status (~50%) in these data precluded the assessment of their association with zoster in this study. Finally, excluding individuals with missing ethnicity data could have biased our results, but further multivariable and sensitivity analyses showed no evidence for this.

The rates in this study are comparable with previously reported zoster rates of 6–8 per 1000 person-years and 8–12 per 1000 person-years among individuals aged 60 and 80 years, respectively.[2] However, the overall incidence of first zoster episodes in this study of individuals aged ≥ 65 years was slightly higher than a U.K.-based study of only immunocompetent individuals that reported zoster rates of 5·96 (aged 65–69 years) to 6·22 (aged ≥ 85 years) per 1000 person-years.[26]

Increasing age and female sex are both known to be associated with higher zoster incidence owing to age- and sex-related immune differences and possible differences in health-seeking behaviour.[2–4] The finding of lower zoster disease burden among individuals of non-white ethnicity seen in this study has been previously reported.[4,11–14] This effect of lower zoster incidence among individuals of non-white ethnicity could be explained by persisting immunity to zoster in later years because of late-onset varicella in individuals born in the Caribbean or tropical countries,[3,14,27,28] although immigrants represent a heterogeneous group in terms of their country of origin and age of arrival in the U.K. There was little evidence of collinearity between ethnicity and immigration status, and the finding of lower zoster incidence among those of non-white ethnicity, independent of immigration status, could perhaps be explained by social mixing patterns in extended families leading to varicella contacts and boosting of zoster immunity among older individuals.[29] It is also possible that zoster might be underdiagnosed if individuals of non-white ethnicity who developed zoster were less likely to consult or less likely to be diagnosed, but it seems implausible in view of the large effect seen. The association of care home residence with

higher zoster incidence was noted independent of age and comorbidities. The effect of malnutrition on immune function could also play an important role; previous research has suggested that nearly one in three care home residents could be at risk of malnutrition.[30–32] The association of higher zoster incidence with certain comorbidities and taking immunosuppressive treatment has been previously reported.[2,3,5,22,33] Similarly, as reported previously, we also did not find any evidence of an association of diabetes with zoster disease burden.[22] The association of social support, cohabitation or being married with zoster incidence is conflicting: some studies have reported no association with being married,[5,12,14] individuals with a confidant having lower[12] or no effect[14] on zoster incidence, whereas another study reported higher zoster risk among individuals not cohabiting.[4] The unexpected finding of an independent association of living alone and lower patient-level IMD with lower incidence of first zoster episode could perhaps be because of a higher occurrence of zoster among these social groups before the age of 65 years and thus their exclusion from the current study. However, there was no evidence for any appreciable differences in patient-level IMD scores when the characteristics of individuals with/without prior zoster history were compared.

In conclusion, this large population-based cohort study has identified social factors associated with zoster incidence among an older population in the U.K. Typically, older patients with higher level of deprivation, those of non-white ethnicity, immigrants and those living alone are at greater risk of infectious diseases; interestingly, our study found these groups were at lower risk of zoster. However, care home residence was associated with higher zoster burden and it may be worth considering targeted vaccination of this group. Further research on the risk of PHN in these social groups would also help inform vaccination policy. It will be interesting to determine in future studies whether these social groups with higher zoster incidence come forward for zoster vaccination.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Table S1 Baseline characteristics of the study cohort (N = 862 470, outcome n = 37 014).

Table S2 Multivariable analysis: social factors associated with zoster disease incidence (complete case analysis; individuals with missing data for ethnicity and sex excluded) (N = 711 590, outcome n = 32 459).

Appendix S1 Code list: zoster.

Appendix S2 Conceptual hierarchical framework for the association of social factors with zoster disease burden.

Appendix S3 Code lists: social factors, comorbidities and medications.

Appendix S4 Identification of exposures, comorbidities and medications in Clinical Practice Research Datalink and Hospital Episode Statistics.

Appendix S5 Immunosuppressive medications and conditions: defining periods of immunosuppression.

Appendix S6 Inclusion of explanatory variables in causal modelling based on a hierarchical framework.

Appendix S7 Comparison of patients excluded due to prior history of zoster and patients included in the study.

Appendix S8 Baseline characteristics of patients excluded from analysis due to missing data for ethnicity and included in complete case analysis.

Appendix S9 Multivariable analysis: social factors associated with zoster disease incidence among patients excluded from analysis due to missing data for ethnicity.

Appendix S10 Multivariable analysis: social factors associated with zoster disease incidence restricted to patients of white ethnicity (complete case analysis).

Appendix S11 Sensitivity analysis: multivariable analysis including practice-level Index of Multiple Deprivation.

Appendix S12. Sensitivity analysis: multivariable analysis including cohabitation.

7.3 Supplementary material to the published paper 3

Table S1 Baseline characteristics of the study cohort (*N* = 862 470 outcome *n* =37 014)

Characteristics		Total N (column %*)	Outcome N (row %*)	Person-years (1000)	Zoster incidence per 1,000 person-years at risk (95% CI)
Overall		862,470	37,014 (4.3%)	4210.5	8.79 (8.70–8.88)
Time-constant exposure variables					
Age at start of follow-up (years)	65-69	442499 (51.3%)	15979 (3.6%)	2051	7.79 (7.67-7.91)
	70-74	136151 (15.8%)	7842 (5.8%)	856.6	9.15 (8.95-9.36)
	75-79	112302 (13%)	6358 (5.7%)	632.9	10.05 (9.80-10.30)
	80-84	89827 (10.4%)	4292 (4.8%)	420.7	10.20 (9.90-10.51)
	85 & above	81691 (9.5%)	2543 (3.1%)	249.3	10.20 (9.81-10.60)
Sex	Male	389,264 (45.1%)	14771 (3.8%)	1873.7	7.88 (7.76-8.01)
	Female	473,204 (54.9%)	22243 (4.7%)	2336.8	9.52 (9.39-9.64)
	Missing	2 (0.0002%)	0	-	-
Ethnicity	White	684870 (79.4%)	31789 (4.6%)	3454.5	9.20 (9.10-9.30)
	South Asian	12273 (1.4%)	322 (2.6%)	52.1	6.18 (5.54-6.90)
	Black	7176 (0.8%)	128 (1.8%)	30.5	4.19 (3.53-4.99)
	Other	5850 (0.7%)	178 (3%)	24.1	7.39 (6.38-8.56)
	Mixed	1422 (0.2%)	42 (3%)	6.2	6.75 (4.99-9.14)
	Missing	150879 (17.5%)	4555 (3%)	-	-
Religion	Christian	14705 (1.7%)	660 (4.5%)	68.7	9.60 (8.90-10.36)
	Buddhist	47 (0%)	1 (2.1%)	0.2	5.96 (0.84-42.30)
	Hindu	428 (0.1%)	16 (3.7%)	2.1	7.69 (4.71-12.55)
	Jewish	344 (0%)	8 (2.3%)	1.7	4.79 (2.40-9.59)
	Muslim	681 (0.1%)	9 (1.3%)	2.9	3.16 (1.64-6.07)
	Sikh	136 (0%)	2 (1.5%)	0.5	4.06 (1.01-16.23)
	Other	27 (0%)	0 (0%)	0.1	-
	No religion	1085 (0.1%)	51 (4.7%)	4.4	11.59 (8.81-15.24)
	Missing	845017 (98%)	36267 (4.3%)	-	-
Immigration status	Not immigrant	853123 (98.9%)	36785 (4.3%)	4170.6	8.82 (8.73-8.91)
	Immigrant	9347 (1.1%)	229 (2.4%)	39.9	5.74 (5.04-6.53)
Patient-level IMD~	1 (least deprived)	201684 (23.4%)	9141 (4.5%)	1011.5	9.04 (8.85-9.22)
	2	220924 (25.6%)	9790 (4.4%)	1095.6	8.94 (8.76-9.11)
	3	181648 (21.1%)	7671 (4.2%)	881	8.71 (8.51-8.90)
	4	158865 (18.4%)	6485 (4.1%)	758.8	8.55 (8.34-8.76)
	5 (most deprived)	99349 (11.5%)	3927 (4%)	463.7	8.47 (8.21-8.74)
Practice-level IMD	1 (least deprived)	129174 (15%)	6101 (4.7%)	649.7	9.39 (9.16-9.63)
	2	197749 (22.9%)	8420 (4.3%)	972	8.66 (8.48-8.85)
	3	195727 (22.7%)	8491 (4.3%)	935.5	9.08 (8.89-9.27)
	4	185751 (21.5%)	7649 (4.1%)	896.2	8.53 (8.35-8.73)
	5 (most deprived)	154069 (17.9%)	6353 (4.1%)	757.2	8.39 (8.19-8.60)
Time-varying exposure variables					
Age acquired during the study (years)	65-69	-	8907	1227.4	7.26 (7.11-7.41)
	70-74	-	8488	1006.6	8.43 (8.25-8.61)
	75-79	-	7934	827.5	9.59 (9.38-9.80)
	80-84	-	6147	613.5	10.02 (9.77-10.27)
	85 & above	-	5538	535.5	10.34 (10.07-10.62)
Living alone	No	-	24865	2767.5	8.98 (8.87-9.1)
	Yes	-	12149	1443.1	8.42 (8.27-8.57)

Contd.

Characteristics		Total N (column %*)	Outcome N (row %*)	Person-years (1000)	Zoster incidence per 1,000 person-years at risk (95% CI)
Marital status	Single	-	402	46.2	8.69 (7.88-9.59)
	Married/Civil	-	7126	768.4	9.27 (9.06-9.49)
	Widow/er	-	2730	265.1	10.30 (9.92-10.69)
	Divorced	-	332	39.5	8.41 (7.55-9.37)
	Separated	-	111	11.2	9.87 (8.20-11.89)
	Partner uncategorized/ other	-	10471	1169.1	8.96 (8.79-9.13)
	Missing	407609 (47.3%)	15842 (3.9%)	-	-
Cohabiting	No	-	18855	2215.9	8.51 (8.39-8.63)
	Yes	-	18159	1994.6	9.1 (8.97-9.24)
Care home	No	-	35494	4071.7	8.72 (8.63-8.81)
	Yes	-	1520	138.8	10.95 (10.41-11.51)
Calendar period	2003-2005	-	8357	958.9	8.72 (8.53-8.90)
	2006-2007	-	7611	849	8.96 (8.77-9.17)
	2008-2009	-	7752	872.6	8.88 (8.69-9.08)
	2010-2011	-	7528	853.2	8.82 (8.63-9.02)
	2012-2013	-	5766	676.9	8.52 (8.30-8.74)
Comorbidities and medications					
Rheumatoid arthritis	No	-	35724	4114.6	8.68 (8.59-8.77)
	Yes	-	1290	95.9	13.45 (12.74-14.2)
Systemic lupus Erythematosus	No	-	36923	4204.5	8.78 (8.69-8.87)
	Yes	-	91	6.1	15.05 (12.26-18.49)
Inflammatory bowel disease	No	-	36417	4158.6	8.76 (8.67-8.85)
	Yes	-	597	52	11.49 (10.6-12.45)
Diabetes mellitus	No	-	31335	3584.9	8.74 (8.64-8.84)
	Yes	-	5679	625.7	9.08 (8.84-9.32)
Chronic kidney disease	No	-	30563	3590.2	8.51 (8.42-8.61)
	Yes	-	6451	620.3	10.4 (10.15-10.66)
COPD/ asthma	No	-	29365	3504.1	8.38 (8.28-8.48)
	Yes	-	7649	706.4	10.83 (10.59-11.07)
Human Immunodeficiency virus infection	No	-	37008	4210	8.79 (8.7-8.88)
	Yes	-	6	0.5	12.26 (5.51-27.29)
Cellular immune deficiency	No	-	36932	4204.2	8.78 (8.7-8.87)
	Yes	-	82	6.3	12.97 (10.44-16.1)
Solid organ transplant	No	-	36949	4206.4	8.78 (8.69-8.87)
	Yes	-	65	4.2	15.66 (12.28-19.97)
Bone marrow/ stem cell transplant	No	-	36997	4210.3	8.79 (8.7-8.88)
	Yes	-	17	0.2	79.01 (49.12-127.1)
Lymphoma, myeloma, other plasma cell dyscrasias and leukaemia	No	-	36535	4191.4	8.72 (8.63-8.81)
	Yes	-	479	19.1	25.03 (22.88-27.37)
Cancer chemotherapeutic agents/ cancer radiotherapy	No	-	36256	4164.3	8.71 (8.62-8.8)
	Yes	-	758	46.2	16.41 (15.28-17.62)
Oral corticosteroids	No	-	36655	4192.6	8.74 (8.65-8.83)
	Yes	-	359	17.9	20.02 (18.05-22.2)
Other immunosuppressant drugs[#]	No	-	36673	4191.8	8.75 (8.66-8.84)
	Yes	-	341	18.7	18.2 (16.36-20.23)

*percentage presented for time-constant variables ~849 (0.1%) missing values for patient-level IMD replaced by practice IMD;
[#]includes azathioprine, biological therapy, methotrexate, 6-mercaptopurine, other immunosuppressants such as tacrolimus, sirolimus, and other disease-modifying antirheumatic drugs: ciclosporin, mycophenolate, leflunomide.

Table S2 Multivariable analysis: social factors associated with zoster disease incidence (complete case analysis; individuals with missing data for ethnicity and sex excluded) (*N* = 711 590, outcome *n* =32 459)

Exposures		Minimally adjusted for age, sex and calendar period RR (95% CI)	P-value* (PT)	Model 1: additionally adjusted for immigration status & ethnicity RR (95% CI)	P-value* (PT)	Model 2: additionally adjusted for patient-level IMD RR (95% CI)	P-value* (PT)	Model 3: additionally adjusted for care home residence & living alone RR (95% CI)	P-value* (PT)	Model 4: additionally adjusted for comorbidities RR (95% CI)	P-value* (PT)	Model 5: additionally adjusted for immuno-suppressive therapies RR (95% CI)	P-value* (PT)
Age acquired during the study(years)	65-69	1		1		1		1		1		1	<0.0001
	70-74	1.16 (1.12-1.20)	<0.0001	1.16 (1.12-1.20)	<0.0001	1.16 (1.12-1.20)	<0.0001	1.16 (1.12-1.20)	<0.0001	1.15 (1.11-1.18)	<0.0001	1.15 (1.11-1.18)	
	75-79	1.29 (1.25-1.34)	(<0.0001)	1.29 (1.25-1.33)	(<0.0001)	1.29 (1.25-1.33)	(<0.0001)	1.29 (1.25-1.33)	(<0.0001)	1.26 (1.22-1.31)	(<0.0001)	1.27 (1.22-1.31)	(<0.0001)
	80-84	1.36 (1.31-1.41)		1.35 (1.31-1.40)		1.35 (1.31-1.40)		1.35 (1.30-1.40)		1.32 (1.27-1.36)		1.32 (1.28-1.37)	
	85 & above	1.40 (1.35-1.45)		1.38 (1.34-1.44)		1.39 (1.34-1.44)		1.38 (1.33-1.43)		1.35 (1.30-1.40)		1.36 (1.31-1.41)	
Sex	Male	0.85 (0.84-0.87)	<0.0001	0.85 (0.84-0.87)	<0.0001	0.85 (0.84-0.87)	<0.0001	0.86 (0.84-0.87)	<0.0001	0.86 (0.84-0.88)	<0.0001	0.86 (0.84-0.88)	<0.0001
	Female	1		1		1		1		1		1	
Ethnicity	White	1		1		1		1		1		1	
	South Asian	0.70 (0.63-0.79)	<0.0001	0.76 (0.67-0.85)	<0.0001	0.76 (0.68-0.85)	<0.0001	0.76 (0.68-0.85)	<0.0001	0.75 (0.67-0.84)	<0.0001	0.75 (0.67-0.84)	<0.0001
	Black	0.47 (0.40-0.56)		0.49 (0.41-0.58)		0.49 (0.41-0.59)		0.49 (0.41-0.59)		0.49 (0.42-0.59)		0.50 (0.42-0.59)	
	Other	0.83 (0.71-0.96)		0.85 (0.74-0.99)		0.86 (0.74-0.99)		0.85 (0.74-0.99)		0.86 (0.75-1.00)		0.87 (0.75-1.00)	
	Mixed	0.77 (0.57-1.04)		0.78 (0.58-1.06)		0.78 (0.58-1.06)		0.78 (0.58-1.06)		0.78 (0.58-1.06)		0.79 (0.58-1.06)	
Immigration status	Not immigrant	1		1		1		1		1		1	
	Immigrant	0.65 (0.57-0.74)	<0.0001	0.77 (0.67-0.88)	0.0001	0.77 (0.67-0.88)	0.0001	0.77 (0.67-0.88)	0.0001	0.77 (0.67-0.89)	0.0002	0.77 (0.67-0.89)	0.0002
Patient-level IMD~	1 (least deprived)	1		Not in model	-	1		1		1		1	
	2	0.98 (0.95-1.01)	0.0006			0.98 (0.95-1.01)	0.01	0.98 (0.95-1.01)	0.02	0.98 (0.95-1.01)	0.0003	0.98 (0.95-1.01)	0.0005
	3	0.95 (0.92-0.98)				0.95 (0.92-0.99)		0.95 (0.92-0.99)		0.95 (0.92-0.98)		0.95 (0.92-0.98)	
	4	0.94 (0.91-0.98)				0.95 (0.92-0.99)		0.96 (0.92-0.99)		0.94 (0.91-0.98)		0.94 (0.91-0.98)	
	5 (most deprived)	0.93 (0.90-0.97)				0.95 (0.92-0.99)		0.96 (0.92-0.99)		0.93 (0.89-0.97)		0.93 (0.89-0.97)	
Practice-level IMD	1 (least deprived)	1		Not in model	-	Not in model	-	Not in model	-	Not in model	-	Not in model	-
	2	0.92 (0.88-0.95)	<0.0001										
	3	0.96 (0.93-1.00)											
	4	0.91 (0.88-0.94)											
	5 (most deprived)	0.90 (0.86-0.93)											
Calendar period	2003-2005	1		1		1		1		1		1	
	2006-2007	1.03 (0.99-1.06)	0.14	1.03 (0.99-1.06)	0.18	1.03 (0.99-1.06)	0.19	1.03 (0.99-1.06)	0.18	1.01 (0.98-1.04)	0.007	1.01 (0.98-1.04)	0.001
	2008-2009	1.02 (0.99-1.06)		1.03 (0.99-1.06)		1.03 (0.99-1.06)		1.02 (0.99-1.06)		0.99 (0.96-1.03)		0.99 (0.96-1.03)	
	2010-2011	1.01 (0.98-1.05)		1.02 (0.99-1.05)		1.02 (0.98-1.05)		1.01 (0.98-1.05)		0.98 (0.94-1.01)		0.97 (0.94-1.01)	
	2012-2013	0.99 (0.95-1.02)		0.99 (0.96-1.03)		0.99 (0.96-1.03)		0.99 (0.95-1.02)		0.95 (0.91-0.98)		0.94 (0.91-0.97)	
Care home residence	No	1		Not in model	-	Not in model	-	1		1		1	
	Yes	1.12 (1.06-1.18)	0.0001					1.10 (1.04-1.17)	0.0007	1.09 (1.03-1.15)	0.004	1.09 (1.03-1.15)	0.004
	No	1		Not in model	-	Not in model	-	1		1		1	
Living alone	Yes	0.95 (0.93-0.97)	<0.0001					0.96 (0.94-0.98)	0.0006	0.96 (0.94-0.98)	0.001	0.96 (0.94-0.99)	0.002
Cohabitation	No	1		Not in model	-	Not in model	-	Not in model	-	Not in model	-	Not in model	-
	Yes	1.07 (1.05-1.09)	<0.0001										
Rheumatoid arthritis	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.45 (1.37-1.54)	<0.0001							1.40 (1.32-1.49)	<0.0001	1.34 (1.26-1.42)	<0.0001
Systemic lupus Erythematosus	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.67 (1.35-2.07)	<0.0001							1.53 (1.24-1.89)	0.0003	1.45 (1.17-1.80)	0.001

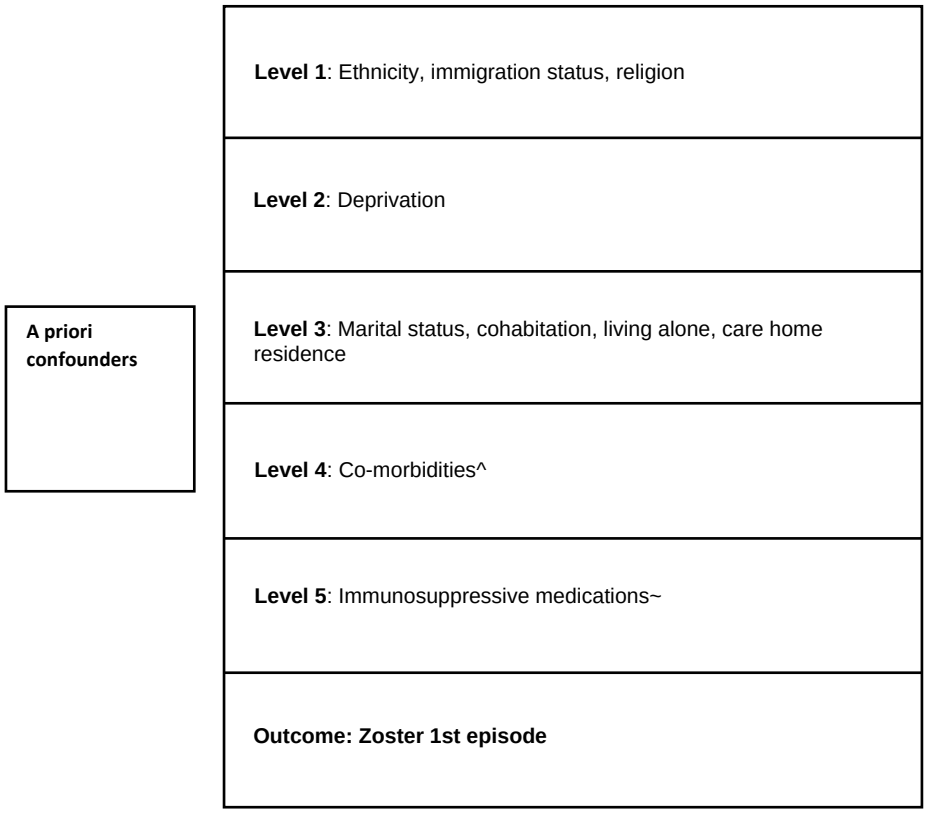
Exposures		Minimally adjusted for age, sex and calendar period RR (95% CI)	P-value* (PT)	Model 1: additionally adjusted for immigration status & ethnicity RR (95% CI)	P-value* (PT)	Model 2: additionally adjusted for patient-level IMD RR (95% CI)	P-value* (PT)	Model 3: additionally adjusted for care home residence & living alone RR (95% CI)	P-value* (PT)	Model 4: additionally adjusted for comorbidities RR (95% CI)	P-value* (PT)	Model 5: additionally adjusted for immuno-suppressive therapies RR (95% CI)	P-value* (PT)
Inflammatory bowel disease	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.29 (1.18-1.40)	<0.0001							1.25 (1.15-1.36)	<0.0001	1.19 (1.10-1.30)	0.0001
Diabetes mellitus	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.02 (0.99-1.05)	0.21							1.01 (0.98-1.04)	0.48	1.01 (0.98-1.04)	0.52
Chronic kidney disease	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.13 (1.10-1.17)	<0.0001							1.11 (1.08-1.15)	<0.0001	1.11 (1.07-1.14)	<0.0001
COPD/ asthma	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.26 (1.23-1.30)	<0.0001							1.25 (1.22-1.29)	<0.0001	1.24 (1.21-1.27)	<0.0001
HIV	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.80 (0.81-4.01)	0.19							1.93 (0.87-4.29)	0.15	1.94 (0.87-4.31)	0.14
Cellular immune deficiency	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.41 (1.13-1.77)	0.004							1.15 (0.91-1.43)	0.25	1.04 (0.83-1.31)	0.71
Solid organ transplant	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	1.95 (1.53-2.48)	<0.0001							1.81 (1.42-2.31)	<0.0001	1.43 (1.12-1.84)	0.008
Bone marrow/ stem cell transplant	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	10.31 (6.41-16.59)	<0.0001							4.53 (2.80-7.35)	<0.0001	3.84 (2.37-6.24)	<0.0001
Lymphoma, myeloma, other plasma cell dyscrasias & leukaemia	No	1		Not in model	-	Not in model	-	Not in model	-	1		1	
	Yes	2.83 (2.58-3.10)	<0.0001							2.68 (2.44-2.94)	<0.0001	2.36 (2.14-2.60)	<0.0001
Cancer chemotherapeutic agents/ radiotherapy	No	1		Not in model	-	Not in model	-	Not in model	-	Not in model	-	1	
	Yes	1.86 (1.73-2.00)	<0.0001									1.55 (1.43-1.67)	<0.0001
Oral corticosteroids	No	1		Not in model	-	Not in model	-	Not in model	-	Not in model	-	1	
	Yes	2.32 (2.09-2.58)	<0.0001									2.00 (1.80-2.23)	<0.0001
Other immuno-suppressant drugs[#] excluding oral corticosteroids	No	1		Not in model	-	Not in model	-	Not in model	-	Not in model	-	1	
	Yes	2.09 (1.87-2.33)	<0.0001									1.63 (1.45-1.83)	<0.0001

RR, rate ratios; CI, confidence interval; PT, P-value for trend; IMD, index of multiple deprivation. ~ 668 (0.09%) missing values replaced by practice IMD; COPD, chronic obstructive pulmonary disease; HIV, Human Immunodeficiency virus infection; *likelihood ratio test [#]azathioprine, biological therapy, methotrexate, 6-mercaptopurine, other immunosuppressants such as tacrolimus, sirolimus, other disease-modifying antirheumatic drugs e.g.: ciclosporin, mycophenolate, leflunomide.

Appendix S1 Codelist: zoster

Codelist is available in this thesis as Appendix 3.

Appendix S2 Conceptual hierarchical framework for the association of social factors with zoster disease burden



^included rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease or asthma, HIV infection, other cellular immune deficiency, leukemia, lymphoma, myeloma, other plasma cell dyscrasias, haematopoietic stem cell transplant & solid organ transplant ~included immune-suppressive doses of oral/injectable corticosteroids, other immune-suppressants drugs (e.g. azathioprine, biological therapy, methotrexate) and

Appendix S3 Code lists: social factors, comorbidities and medications

Codelists are available in this thesis as Appendices 4-10 and13-17.

Appendix S4 Identification of exposures, comorbidities and medications in Clinical Practice Research Datalink and Hospital Episode Statistics

These are described in thesis **Chapters 4** and **5**.

Appendix S5 Immunosuppressive medications and conditions: defining periods of immunosuppression

These are described in thesis **Chapter 5**.

Appendix 6 Inclusion of explanatory variables in causal modelling based on hierarchical framework
(Based on[1])

Model	Explanatory variable	Interpretation
Adjusted for *a priori* confounders	All variables adjusted for *a priori* confounders: age, sex and calendar period	Effect estimate of each variable adjusted for *a priori* confounders
Model-1*	Ethnicity and immigration status with *a priori* confounders	Effects of ethnicity and immigration status adjusted for *a priori* confounders and each other
Model-2*	Model-1+IMD	Effects of ethnicity and immigration status not mediated via IMD & adjusted for *a priori* confounders and each other Effects of IMD adjusted for other variables in the model and *a priori* confounders*
Model-3*	Model-2 + living alone+ care home residence	Effects of ethnicity and immigration status not mediated via living alone and care home residence, adjusted for other variables in the model and *a priori* confounders* Effect of IMD not mediated via living alone and care home residence, adjusted for other variables in the model and *a priori* confounders* Effect of living alone+ and care home residence adjusted for other variables in the model and *a priori* confounders*
Model-4*	Model-3 + co-morbidities~	Effect of ethnicity and immigration status, IMD, living alone and care home residence not mediated via co-morbidities* Effect of co-morbidities adjusted for other variables in the model and *a priori* confounders*
Model-5*	Model-4 + medications[#]	Effect of ethnicity and immigration status, IMD, living alone, care home residence and co-morbidities not mediated via medications* Effect of medication adjusted for other variables in the model and *a priori* confounders*

*all variables in the model adjusted for each other and *a priori* confounders: age, sex and calendar period
IMD index of multiple deprivation ~co-morbidities included systemic lupus erythematosus, rheumatoid arthritis, inflammatory bowel disease, chronic obstructive pulmonary disease, asthma, chronic kidney disease, diabetes, HIV, cellular immune deficiency, acute and chronic leukemia, lymphoma, myeloma and other haematological malignancies including plasma cell dyscrasias, solid organ transplant and bone marrow transplant # steroids (oral or injectable), radiotherapy and chemotherapy, biological therapy, disease modifying anti-rheumatic drugs (DMARDs): azathioprine, methotrexate, and other DMARDs), other immunosuppressive drugs such as tacrolimus

Reference: 1. Victora CG, Huttly SR, Fuchs SC, Olinto MT. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. Int J Epidemiol. 1997 Feb;26(1):224-7

Appendix S7 Comparison of patients excluded due to prior history of zoster and patients included in the study

Characteristics		Excluded individuals from study due to prior history of zoster N=69360	Included in study N=862470
Median age in years at start of the study date (01/09/2003) (interquartile range)		70.2 (61.2-79.2)	68.2 (61.2-76.2)
Sex	Male	27,296 (39.4%)	389,264 (45.1%)
	Female	42,064 (60.6)	473,204 (54.9%)
	Missing	-	2 (0.0002%)
Patient-level IMD[~+]	1 (least deprived)	16542 (23.9%)	201684 (23.4%)
	2	17933 (25.8%)	220924 (25.6%)
	3	14705 (21.2%)	181648 (21.1%)
	4	12200 (17.6%)	158865 (18.4%)
	5 (most deprived)	7980 (11.5%)	99349 (11.5%)
Immigration status	Not immigrant	68916 (99.4%)	853123 (98.9%)
	Immigrant	444 (0.6%)	9347 (1.1%)
Ethnicity	White	58022 (83.6%)	684870 (79.4%)
	South Asian	597 (0.9%)	12273 (1.4%)
	Black	213 (0.3%)	7176 (0.8%)
	Other	385 (0.6%)	5850 (0.7%)
	Mixed	72 (0.1%)	1422 (0.2%)
	Missing	10071 (14.5%)	150879 (17.5%)

IMD index of multiple deprivation [~] for excluded group 42 (0.06%) missing values replaced by practice IMD [+] for included group 849 (0.1%) missing values replaced by practice IMD

Appendix S8 Baseline characteristics of patients excluded from analysis due to missing data for ethnicity and included in complete case analysis

		Patients excluded from complete case analysis* N=150,878 outcome=4555 (3%) Incidence per 1,000 pyr (95%CI) 7.08 (6.88-7.29) Median age (years) at start of follow-up (IQR) 68.2 (65-77.2) Median age (years) at current registration date (IQR) 54.5 (40.7-65.2)			**Patients included in complete case analysis** N=711,590, outcome=32,459 (4.6%) Incidence per 1,000 pyr (95%CI)= 9.09 (9.0-9.20) Median age (years)at start of follow-up (IQR) 69.6 (65-77.8) Median age (years) at current registration date (IQR) 57.8 (43.6-67.7)		
		Total (column %)	***No outcome (row %)***	***With outcome (row %)***	***Total (column %)***	***No outcome (row %)***	***With outcome (row %)***
Age at start of follow-up (years)	65-69	83822 (55.6%)	81529 (97.3%)	2293 (2.7%)	358677 (50.4%)	344991 (96.2%)	13686 (3.8%)
	70-74	20483 (13.6%)	19610 (95.7%)	873 (4.3%)	115668 (16.3%)	108699 (94%)	6969 (6%)
	75-79	15803 (10.5%)	15173 (96%)	630 (4%)	96499 (13.6%)	90771 (94.1%)	5728 (5.9%)
	80-84	13997 (9.3%)	13568 (96.9%)	429 (3.1%)	75828 (10.7%)	71965 (94.9%)	3863 (5.1%)
	85 & above	16773 (11.1%)	16443 (98%)	330 (2%)	64918 (9.1%)	62705 (96.6%)	2213 (3.4%)
Sex	Male	69563 (46.1%)	67808 (97.5%)	1755 (2.5%)	319701 (44.9%)	306685 (95.9%)	13016 (4.1%)
	Female	81315 (53.9%)	78515 (96.6%)	2800 (3.4%)	391889 (55.1%)	372446 (95%)	19443 (5%)
Ethnicity	White	Missing	-	-	684869 (96.2%)	653080 (95.4%)	31789 (4.6%)
	South Asian	Missing	-	-	12273 (1.7%)	11951 (97.4%)	322 (2.6%)
	Black	Missing	-	-	7176 (1%)	7048 (98.2%)	128 (1.8%)
	Other	Missing	-	-	5850 (0.8%)	5672 (97%)	178 (3%)
	Mixed	Missing	-	-	1422 (0.2%)	1380 (97%)	42 (3%)
Immigration status	Not immigrant	150493 (99.7%)	145943 (97%)	4550 (3%)	702628 (98.7%)	670393 (95.4%)	32235 (4.6%)
	Immigrant	385 (0.3%)	380 (98.7%)	5 (1.3%)	8962 (1.3%)	8738 (97.5%)	224 (2.5%)
Patient-level IMD^{-+}	1 (least deprived)	43002 (28.5%)	41528 (96.6%)	1474 (3.4%)	158682 (22.3%)	151015 (95.2%)	7667 (4.8%)
	2	38525 (25.5%)	37304 (96.8%)	1221 (3.2%)	182399 (25.6%)	173830 (95.3%)	8569 (4.7%)
	3	30681 (20.3%)	29743 (96.9%)	938 (3.1%)	150966 (21.2%)	144233 (95.5%)	6733 (4.5%)
	4	24951 (16.5%)	24334 (97.5%)	617 (2.5%)	133913 (18.8%)	128045 (95.6%)	5868 (4.4%)
	5 (most deprived)	13719 (9.1%)	13414 (97.8%)	305 (2.2%)	85630 (12%)	82008 (95.8%)	3622 (4.2%)
Practice-level IMD	1 (least deprived)	27600 (18.3%)	26611 (96.4%)	989 (3.6%)	101574 (14.3%)	96462 (95%)	5112 (5%)
	2	34219 (22.7%)	33174 (96.9%)	1045 (3.1%)	163530 (23%)	156155 (95.5%)	7375 (4.5%)
	3	36234 (24%)	35084 (96.8%)	1150 (3.2%)	159492 (22.4%)	152151 (95.4%)	7341 (4.6%)
	4	30206 (20%)	29429 (97.4%)	777 (2.6%)	155544 (21.9%)	148672 (95.6%)	6872 (4.4%)
	5 (most deprived)	22619 (15%)	22025 (97.4%)	594 (2.6%)	131450 (18.5%)	125691 (95.6%)	5759 (4.4%)
Lived alone^	No	94153 (62.4%)	91134 (96.8%)	3019 (3.2%)	469693 (66%)	447925 (95.4%)	21768 (4.6%)
	Yes	56725 (37.6%)	55189 (97.3%)	1536 (2.7%)	241897 (34%)	231206 (95.6%)	10691 (4.4%)
Cohabiting^	No	86967 (57.6%)	84630 (97.3%)	2337 (2.7%)	384524 (54%)	368040 (95.7%)	16484 (4.3%)
	Yes	63911 (42.4%)	61693 (96.5%)	2218 (3.5%)	327066 (46%)	311091 (95.1%)	15975 (4.9%)
Care home^	No	142765 (94.6%)	138370 (96.9%)	4395 (3.1%)	653967 (91.9%)	622930 (95.3%)	31037 (4.7%)
	Yes	8113 (5.4%)	7953 (98%)	160 (2%)	57623 (8.1%)	56201 (97.5%)	1422 (2.5%)
Rheumatoid arthritis^	No	148501 (98.4%)	144047 (97%)	4454 (3%)	689035 (96.8%)	657765 (95.5%)	31270 (4.5%)
	Yes	2377 (1.6%)	2276 (95.8%)	101 (4.2%)	22555 (3.2%)	21366 (94.7%)	1189 (5.3%)
Systemic Lupus Erythematosus^	No	150712 (99.9%)	146163 (97%)	4549 (3%)	710274 (99.8%)	677900 (95.4%)	32374 (4.6%)
	Yes	166 (0.1%)	160 (96.4%)	6 (3.6%)	1316 (0.2%)	1231 (93.5%)	85 (6.5%)
Inflammatory bowel disease^	No	149776 (99.3%)	145268 (97%)	4508 (3%)	700505 (98.4%)	668596 (95.4%)	31909 (4.6%)
	Yes	1102 (0.7%)	1055 (95.7%)	47 (4.3%)	11085 (1.6%)	10535 (95%)	550 (5%)
Diabetes mellitus^	No	133054 (88.2%)	129003 (97%)	4051 (3%)	578619 (81.3%)	551335 (95.3%)	27284 (4.7%)
	Yes	17824 (11.8%)	17320 (97.2%)	504 (2.8%)	132971 (18.7%)	127796 (96.1%)	5175 (3.9%)
Chronic kidney disease^	No	131782 (87.3%)	127735 (96.9%)	4047 (3.1%)	542165 (76.2%)	515649 (95.1%)	26516 (4.9%)
	Yes	19096 (12.7%)	18588 (97.3%)	508 (2.7%)	169425 (23.8%)	163482 (96.5%)	5943 (3.5%)
COPD/ asthma^	No	131132 (86.9%)	127240 (97%)	3892 (3%)	557917 (78.4%)	532444 (95.4%)	25473 (4.6%)
	Yes	19746 (13.1%)	19083 (96.6%)	663 (3.4%)	153673 (21.6%)	146687 (95.5%)	6986 (4.5%)
HIV infection^	No	150860 (100%)	146305 (97%)	4555 (3%)	711457 (100%)	679004 (95.4%)	32453 (4.6%)
	Yes	18 (0%)	18 (100%)	0 (0%)	133 (0%)	127 (95.5%)	6 (4.5%)
Cellular immune deficiency^	No	150631 (99.8%)	146081 (97%)	4550 (3%)	708715 (99.6%)	676333 (95.4%)	32382 (4.6%)
	Yes	247 (0.2%)	242 (98%)	5 (2%)	2875 (0.4%)	2798 (97.3%)	77 (2.7%)
Solid organ transplant^	No	150795 (99.9%)	146240 (97%)	4555 (3%)	710593 (99.9%)	678199 (95.4%)	32394 (4.6%)
	Yes	83 (0.1%)	83 (100%)	0 (0%)	997 (0.1%)	932 (93.5%)	65 (6.5%)
Bone marrow/ stem cell transplant^	No	150871 (100%)	146317 (97%)	4554 (3%)	711397 (100%)	678960 (95.4%)	32437 (4.6%)
	Yes	7 (0%)	6 (85.7%)	1 (14.3%)	193 (0%)	171 (88.6%)	22 (11.4%)
Leukemia and other disorders$^{\$\wedge}$	No	149762 (99.3%)	145246 (97%)	4516 (3%)	701044 (98.5%)	669161 (95.5%)	31883 (4.5%)
	Yes	1116 (0.7%)	1077 (96.5%)	39 (3.5%)	10546 (1.5%)	9970 (94.5%)	576 (5.5%)
Cancer CT/ RT^	No	147571 (97.8%)	143105 (97%)	4466 (3%)	667658 (93.8%)	636619 (95.4%)	31039 (4.6%)
	Yes	3307 (2.2%)	3218 (97.3%)	89 (2.7%)	43932 (6.2%)	42512 (96.8%)	1420 (3.2%)
Oral corticosteroids^	No	149154 (98.9%)	144665 (97%)	4489 (3%)	694275 (97.6%)	662784 (95.5%)	31491 (4.5%)
	Yes	1724 (1.1%)	1658 (96.2%)	66 (3.8%)	17315 (2.4%)	16347 (94.4%)	968 (5.6%)
Other immuno-suppressant drugs$^{\wedge\#}$	No	150274 (99.6%)	145745 (97%)	4529 (3%)	704364 (99%)	672362 (95.5%)	32002 (4.5%)
	Yes	604 (0.4%)	578 (95.7%)	26 (4.3%)	7226 (1%)	6769 (93.7%)	457 (6.3%)

pyr person-years at risk CI confidence interval *one patients with missing gender information excluded from analysis IQR interquartile range IMD index of multiple deprivation $^{-}$for excluded group 181 (0.1%) missing values replaced by practice IMD $^{+}$for included group 668 (0.09%) missing values replaced by practice IMD ^ Ever had, $ includes lymphoma, myeloma, other plasma cell dyscrasias CT chemotherapy RT radiotherapy # includes azathioprine, biological therapy, methotrexate, 6-mercaptopurine, other immunosuppressant such as tacrolimus, sirolimus, and other disease-modifying antirheumatic drugs: ciclosporin, mycophenolate, leflunomide

Appendix S9 Multivariable analysis: Social factors associated with zoster disease incidence amongst patients excluded from analysis due to missing data for ethnicity (N= 150878, outcome= 4555)[$]

Exposures		Minimally adjusted for age, gender and calendar period RR (95% CI)	P value*	Model additionally adjusted for immigration status & patient-level IMD	P value*	Model additionally adjusted for care home residence & living alone RR (95% CI)	P value*	Model additionally adjusted for co-morbidities ^ RR (95% CI)	P value*	Model additionally adjusted for immuno-suppressive therapies[+] RR (95% CI)	P value*
Age acquired during the study(years)	65-69	1		1		1		1		1	
	70-74	1.10 (1.02-1.19)	<0.0001	1.10 (1.02-1.19)	<0.0001	1.10 (1.02-1.19)	<0.0001	1.09 (1.00-1.18)	<0.0001	1.08 (1.00-1.18)	<0.0001
	75-79	1.33 (1.23-1.45)		1.34 (1.23-1.45)		1.33 (1.23-1.45)		1.29 (1.19-1.41)		1.29 (1.19-1.41)	
	80-84	1.23 (1.11-1.35)		1.24 (1.12-1.36)		1.23 (1.12-1.36)		1.18 (1.07-1.30)		1.18 (1.07-1.30)	
	85 & above	1.19 (1.08-1.31)		1.20 (1.09-1.33)		1.19 (1.08-1.31)		1.15 (1.04-1.27)		1.15 (1.04-1.27)	
Gender	Male	0.80 (0.75-0.85)	<0.0001	0.80 (0.75-0.85)	<0.0001	0.81 (0.76-0.86)	<0.0001	0.81 (0.76-0.86)	<0.0001	0.81 (0.76-0.86)	<0.0001
	Female	1		1		1		1		1	
Immigration status	Not immigrant	1		1		1		1		1	
	Immigrant	0.52 (0.22-1.26)	0.11	0.54 (0.23-1.31)	0.13	0.54 (0.22-1.30)	0.13	0.53 (0.22-1.29)	0.12	0.54 (0.22-1.29)	0.12
Patient-level IMD~	1 (least deprived)	1		1		1		1		1	
	2	0.96 (0.89-1.04)	<0.0001	0.96 (0.89-1.04)	<0.0001	0.97 (0.90-1.04)	<0.0001	0.97 (0.90-1.04)	<0.0001	0.97 (0.90-1.04)	<0.0001
	3	0.95 (0.88-1.03)		0.95 (0.88-1.03)		0.96 (0.88-1.04)		0.95 (0.88-1.03)		0.95 (0.88-1.03)	
	4	0.79 (0.72-0.86)		0.79 (0.72-0.86)		0.80 (0.73-0.88)		0.79 (0.72-0.87)		0.79 (0.72-0.87)	
	5 (most deprived)	0.74 (0.66-0.84)		0.75 (0.66-0.84)		0.76 (0.67-0.86)		0.75 (0.66-0.85)		0.75 (0.66-0.85)	
Practice-level IMD	1 (least deprived)	1		Not in model	-	Not in model	-	Not in model	-	Not in model	-
	2	0.91 (0.83-0.99)	<0.0001								
	3	0.92 (0.85-1.01)									
	4	0.81 (0.73-0.89)									
	5 (most deprived)	0.78 (0.70-0.86)									
Calendar period	2003-2005	1		1		1		1		1	
	2006-2007	1.01 (0.92-1.10)	0.63	1.00 (0.92-1.09)	0.53	1.00 (0.91-1.08)	0.49	0.98 (0.90-1.07)	0.19	0.99 (0.91-1.07)	0.22
	2008-2009	0.95 (0.87-1.04)		0.94 (0.86-1.03)		0.94 (0.86-1.02)		0.92 (0.84-1.00)		0.92 (0.84-1.01)	
	2010-2011	0.99 (0.91-1.08)		0.98 (0.90-1.07)		0.98 (0.90-1.07)		0.95 (0.87-1.04)		0.96 (0.88-1.05)	
	2012-2013	0.95 (0.87-1.05)		0.94 (0.86-1.04)		0.94 (0.85-1.03)		0.91 (0.83-1.00)		0.91 (0.83-1.01)	
Care home residence	No	1		Not in model	-	1		1		1	
	Yes	1.31 (1.11-1.54)	0.002			1.24 (1.05-1.46)	0.02	1.20 (1.02-1.42)	0.03	1.20 (1.02-1.42)	0.03
Living alone	No	1		Not in model	-	1		1		1	
	Yes	0.85 (0.80-0.90)	<0.0001			0.87 (0.82-0.93)	<0.0001	0.88 (0.82-0.93)	<0.0001	0.88 (0.83-0.94)	<0.0001
Cohabitation	No	1		Not in model	-	Not in model#	-	Not in model#	-	Not in model#	-
	Yes	1.18 (1.12-1.25)	<0.0001								

[$]one patients with missing gender information excluded from analysis RR rate ratios CI confidence interval IMD index of multiple deprivation ~for excluded group 181 (0.1%) missing values replaced by practice IMD *likelihood ratio test # multicollinearity issue ^included rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease or asthma, HIV infection, other cellular immune deficiency, leukemia, lymphoma, myeloma, other plasma cell dyscrasias, haematopoietic stem cell transplant & solid organ transplant [+]included immunosuppressive doses of oral/injectable corticosteroids, other immunosuppressants drugs (e.g. azathioprine, biological therapy, methotrexate) and cancer chemo/radiotherapy

Appendix S10 Multivariable analysis: Social factors associated with zoster disease incidence restricted to patients of White ethnicity (N= 684869 outcome= 31789)

Exposures		Minimally adjusted for age, gender & calendar period RR (95% CI)	P value* (PT)	Model adjusted for age, gender, calendar period, immigration & IMD RR (95% CI)	P value* (PT)	Model additionally adjusted for care home residence & living alone RR (95% CI)	P value* (PT)	Model additionally adjusted for co-morbidites^ RR (95% CI)	P value* (PT)	Model 4 additionally adjusted for IS therapies~ RR (95% CI)	P value* (PT)
Age acquired during the study(years)	65-69	1	<0.0001 (<0.0001)	1	<0.0001 (<0.0001)	1	<0.0001 (<0.0001)	1	<0.0001 (<0.0001)	1	<0.0001 (<0.0001)
	70-74	1.16 (1.12-1.20)		1.16 (1.12-1.20)		1.16 (1.12-1.20)		1.15 (1.11-1.18)		1.15 (1.11-1.18)	
	75-79	1.29 (1.25-1.34)		1.29 (1.25-1.34)		1.29 (1.25-1.34)		1.27 (1.23-1.31)		1.27 (1.23-1.31)	
	80-84	1.35 (1.30-1.40)		1.35 (1.30-1.40)		1.35 (1.30-1.40)		1.32 (1.27-1.36)		1.32 (1.27-1.37)	
	85 & above	1.38 (1.34-1.44)		1.39 (1.34-1.44)		1.38 (1.33-1.43)		1.35 (1.30-1.40)		1.36 (1.31-1.41)	
Gender	Male	0.85 (0.83-0.87)	<0.0001	0.85 (0.83-0.87)	<0.0001	0.85 (0.83-0.87)	<0.0001	0.85 (0.84-0.87)	<0.0001	0.85 (0.83-0.87)	<0.0001
	Female	1		1		1		1		1	
Immigration status	Not immigrant	1	0.002	1	0.002	1	0.002	1	0.002	1	0.002
	Immigrant	0.74 (0.61-0.90)		0.75 (0.62-0.91)		0.75 (0.62-0.90)		0.75 (0.62-0.91)		0.75 (0.62-0.91)	
Patient level IMD~	1 (least deprived)	1	0.02	1	0.02	1	0.04	1	0.0006	1	0.0009
	2	0.98 (0.95-1.01)		0.98 (0.95-1.01)		0.98 (0.95-1.01)		0.98 (0.95-1.01)		0.98 (0.95-1.01)	
	3	0.96 (0.92-0.99)		0.96 (0.92-0.99)		0.96 (0.93-0.99)		0.95 (0.92-0.98)		0.95 (0.92-0.98)	
	4	0.95 (0.92-0.99)		0.95 (0.92-0.99)		0.96 (0.92-0.99)		0.94 (0.91-0.98)		0.94 (0.91-0.98)	
	5 (most deprived)	0.95 (0.92-0.99)		0.96 (0.92-0.99)		0.96 (0.92-1.00)		0.93 (0.90-0.97)		0.93 (0.90-0.97)	
Practice-level IMD	1 (least deprived)	1	<0.0001	Not in model	-	Not in model	-	Not in model	-	Not in model	-
	2	0.92 (0.88-0.95)									
	3	0.97 (0.93-1.00)									
	4	0.92 (0.89-0.95)									
	5 (most deprived)	0.90 (0.87-0.94)									
Calendar period	2003-2005	1	0.13	1	0.13	1	0.13	1	0.005	1	0.0008
	2006-2007	1.03 (1.00-1.07)		1.03 (1.00-1.07)		1.03 (1.00-1.06)		1.01 (0.98-1.05)		1.01 (0.98-1.05)	
	2008-2009	1.03 (1.00-1.06)		1.03 (1.00-1.06)		1.03 (0.99-1.06)		1.00 (0.96-1.03)		0.99 (0.96-1.03)	
	2010-2011	1.02 (0.98-1.05)		1.02 (0.98-1.05)		1.01 (0.98-1.05)		0.98 (0.94-1.01)		0.97 (0.94-1.01)	
	2012-2013	0.99 (0.96-1.03)		0.99 (0.96-1.03)		0.99 (0.95-1.02)		0.95 (0.91-0.98)		0.94 (0.91-0.98)	
Care home residence	No	1	0.0002	Not in model	-	1	0.001	1	0.007	1	0.006
	Yes	1.11 (1.05-1.18)				1.10 (1.04-1.16)		1.08 (1.02-1.15)		1.08 (1.02-1.15)	
Living alone	No	1	0.0001	Not in model	-	1	0.001	1	0.002	1	0.002
	Yes	0.95 (0.93-0.98)				0.96 (0.94-0.98)		0.96 (0.94-0.99)		0.96 (0.94-0.99)	
Cohabitation	No	1	<0.0001	Not in model	-	Not in model #	-	Not in model #	-	Not in model #	-
	Yes	1.06 (1.03-1.08)									

RR rate ratios CI confidence interval PT P value for trend IMD index of multiple deprivation ~ 648 patients (0.09%) missing values replaced by practice IMD *likelihood ratio test IS immunosuppressive # multicollinearity issue ^included rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease or asthma, HIV infection, other cellular immune deficiency, leukemia, lymphoma, myeloma, other plasma cell dyscrasias, haematopoietic stem cell transplant & solid organ transplant ~included immunosuppressive doses of oral/injectable corticosteroids, other immunosuppressants drugs (e.g. azathioprine, biological therapy, methotrexate) and cancer chemo/radiotherapy

Appendix S11 Sensitivity analysis: Multivariable analysis including practice-level IMD

Exposures		Model adjusted for age, gender, calendar period, immigration status, ethnicity and practice-level IMD RR(95%CI)	P value*	Model 2 additionally adjusted for care home residence & living alone RR (95% CI)	P value*	Model 3 additionally adjusted for co-morbidities^ RR (95% CI)	P value*	Model 4 additionally adjusted for IS therapies~ RR (95% CI)	P value*
Age acquired during the study(years)	65-69	1	<0.0001	1	<0.0001	1	<0.0001	1	<0.0001
	70-74	1.16 (1.12-1.20)		1.16 (1.12-1.20)		1.15 (1.11-1.18)		1.15 (1.11-1.18)	
	75-79	1.29 (1.25-1.33)		1.29 (1.25-1.33)		1.26 (1.22-1.31)		1.26 (1.22-1.31)	
	80-84	1.35 (1.30-1.40)		1.35 (1.30-1.39)		1.32 (1.27-1.36)		1.32 (1.27-1.37)	
	85 & above	1.38 (1.33-1.43)		1.37 (1.32-1.42)		1.35 (1.30-1.40)		1.36 (1.31-1.41)	
Gender	Male	0.85 (0.84-0.87)	<0.0001	0.86 (0.84-0.87)	<0.0001	0.86 (0.84-0.88)	<0.0001	0.86 (0.84-0.88)	<0.0001
	Female	1		1		1		1	
Ethnicity	White	1	<0.0001	1	<0.0001	1	<0.0001	1	<0.0001
	South Asian	0.76 (0.68-0.85)		0.76 (0.67-0.85)		0.75 (0.67-0.84)		0.75 (0.67-0.84)	
	Black	0.49 (0.41-0.59)		0.49 (0.41-0.59)		0.49 (0.41-0.59)		0.49 (0.42-0.59)	
	Other	0.85 (0.74-0.99)		0.85 (0.73-0.99)		0.86 (0.74-1.00)		0.86 (0.74-1.00)	
	Mixed	0.78 (0.58-1.06)		0.78 (0.58-1.06)		0.78 (0.58-1.06)		0.78 (0.58-1.06)	
Immigration	Not immigrant	1	0.0002	1	0.0002	1	0.0002	1	0.0002
	Immigrant	0.77 (0.67-0.89)		0.77 (0.67-0.89)		0.77 (0.67-0.89)		0.77 (0.67-0.89)	
Patient level IMD~	1 (least deprived)	Not in model		Not in model	-	Not in model	-	Not in model	-
	2								
	3								
	4								
	5 (most deprived)								
Practice-level IMD	1 (least deprived)	1	<0.0001	1	<0.0001	1	<0.0001	1	<0.0001
	2	0.92 (0.88-0.95)		0.92 (0.89-0.95)		0.92 (0.89-0.95)		0.92 (0.89-0.95)	
	3	0.97 (0.93-1.00)		0.97 (0.93-1.00)		0.97 (0.93-1.00)		0.97 (0.93-1.00)	
	4	0.92 (0.88-0.95)		0.92 (0.89-0.95)		0.91 (0.88-0.95)		0.92 (0.88-0.95)	
	5 (most deprived)	0.90 (0.87-0.94)		0.91 (0.87-0.94)		0.90 (0.86-0.93)		0.90 (0.86-0.93)	
Calendar period	2003-2005	1	0.18	1	0.17	1	0.007	1	0.0013
	2006-2007	1.03 (0.99-1.06)		1.03 (0.99-1.06)		1.01 (0.98-1.04)		1.01 (0.98-1.04)	
	2008-2009	1.03 (0.99-1.06)		1.02 (0.99-1.06)		0.99 (0.96-1.03)		0.99 (0.96-1.03)	
	2010-2011	1.02 (0.98-1.05)		1.01 (0.98-1.05)		0.98 (0.94-1.01)		0.97 (0.94-1.01)	
	2012-2013	0.99 (0.96-1.03)		0.99 (0.95-1.02)		0.95 (0.91-0.98)		0.94 (0.91-0.97)	
Care home	No	Not in model	-	1	0.0008	1	0.005	1	0.005
	Yes			1.10 (1.04-1.16)		1.08 (1.02-1.15)		1.08 (1.03-1.15)	
Living alone	No	Not in model	-	1	0.0007	1	0.001	1	0.001
	Yes			0.96 (0.94-0.98)		0.96 (0.94-0.98)		0.96 (0.94-0.99)	
Cohabitation	No	Not in model	-	Not in model #	-	Not in model #	-	Not in model #	-
	Yes								

RR rate ratios CI confidence interval IMD index of multiple deprivation ~ 668 patients (0.09%) missing values replaced by practice IMD *likelihood ratio test IS immunosuppressive # multicollinearity issue ^included rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease or asthma, HIV infection, other cellular immune deficiency, leukemia, lymphoma, myeloma, other plasma cell dyscrasias, haematopoietic stem cell transplant & solid organ transplant ~included immunosuppressive doses of oral/injectable corticosteroids, other immunosuppressant drugs (e.g. azathioprine, biological therapy, methotrexate) and cancer chemo/radiotherapy

Appendix S12 Sensitivity analysis: Multivariable analysis including cohabitation

Exposures		Model adjusted for age, gender, ethnicity, immigration, deprivation, care home residence & cohabitation RR (95% CI)	P value*	Model additionally adjusted for co-morbidities^ RR (95% CI)	P value*	Model additionally adjusted for immuno-suppressive therapy~ RR (95% CI)	P value*
Age acquired during the study(years)	65-69	1		1		1	
	70-74	1.16 (1.12-1.19)	<0.0001	1.15 (1.11-1.18)	<0.0001	1.15 (1.11-1.18)	<0.0001
	75-79	1.29 (1.24-1.33)		1.26 (1.22-1.30)		1.26 (1.22-1.30)	
	80-84	1.35 (1.30-1.39)		1.32 (1.27-1.36)		1.32 (1.28-1.37)	
	85 & above	1.38 (1.33-1.43)		1.36 (1.31-1.41)		1.37 (1.32-1.42)	
Gender	Male	0.85 (0.83-0.87)	<0.0001	0.86 (0.84-0.87)	<0.0001	0.85 (0.84-0.87)	<0.0001
	Female	1		1		1	
Ethnicity	White	1		1		1	
	South Asian	0.77 (0.68-0.86)	<0.0001	0.76 (0.68-0.85)	<0.0001	0.76 (0.68-0.85)	<0.0001
	Black	0.50 (0.42-0.59)		0.50 (0.42-0.59)		0.50 (0.42-0.60)	
	Other	0.86 (0.74-1.00)		0.87 (0.75-1.01)		0.87 (0.75-1.01)	
	Mixed	0.79 (0.58-1.07)		0.79 (0.58-1.07)		0.79 (0.59-1.07)	
Immigration status	Not immigrant	1		1		1	
	Immigrant	0.77 (0.67-0.89)	0.0001	0.77 (0.67-0.89)	0.0002	0.78 (0.67-0.89)	0.0002
Patient level IMD~	1 (least deprived)	1		1		1	
	2	0.98 (0.95-1.01)	0.04	0.98 (0.95-1.01)	0.0009	0.98 (0.95-1.01)	0.001
	3	0.96 (0.93-0.99)		0.95 (0.92-0.98)		0.95 (0.92-0.98)	
	4	0.96 (0.93-0.99)		0.95 (0.91-0.98)		0.95 (0.91-0.98)	
	5 (most deprived)	0.96 (0.92-1.00)		0.93 (0.90-0.97)		0.94 (0.90-0.97)	
Practice-level IMD	1 (least deprived)	Not in model	-	Not in model	-	Not in model	-
	2						
	3						
	4						
	5 (most deprived)						
Calendar period	2003-2005	1		1		1	
	2006-2007	1.03 (0.99-1.06)	0.18	1.01 (0.98-1.04)	0.006	1.01 (0.98-1.04)	0.001
	2008-2009	1.02 (0.99-1.06)		0.99 (0.96-1.03)		0.99 (0.96-1.02)	
	2010-2011	1.01 (0.98-1.05)		0.98 (0.94-1.01)		0.97 (0.94-1.01)	
	2012-2013	0.99 (0.95-1.02)		0.95 (0.91-0.98)		0.94 (0.90-0.97)	
Care home residence	No	1		1		1	
	Yes	1.13 (1.07-1.19)	<0.0001	1.11 (1.05-1.17)	0.0002	1.11 (1.05-1.17)	0.0002
Living alone	No	Not in model #	-	Not in model #	-	Not in model #	-
	Yes						
Cohabitation	No	1		1		1	
	Yes	1.06 (1.04-1.08)	<0.0001	1.06 (1.04-1.08)	<0.0001	1.06 (1.04-1.08)	<0.0001

RR rate ratios CI confidence interval IMD index of multiple deprivation ~ 668 patients (0.09%) missing values replaced by practice IMD *likelihood ratio test # multicollinearity issue ^included rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease or asthma, HIV infection, other cellular immune deficiency, leukemia, lymphoma, myeloma, other plasma cell dyscrasias, haematopoietic stem cell transplant & solid organ transplant ~included immunosuppressive doses of oral/injectable corticosteroids, other immunosuppressant drugs (e.g. azathioprine, biological therapy, methotrexate) and cancer chemo/radiotherapy

7.4 Further investigation of the likely impact of missing data

The use of a complete case analysis (**Section 7.2**) after excluding 17.5% (N=150880) of the study participants who had missing ethnicity (n=150878), missing gender (n=1) or missing both ethnicity and gender data (n=1) (study flow chart: Figure 1 submitted paper), could have biased the effect estimates. To assess the impact of missing data, I conducted some additional analyses, described in next section.

7.4.1 Additional analyses to assess the impact of missing data

Additional analyses include those that were presented in the Appendices of the paper (**Sections 7.2** and **7.3**) and those conducted subsequently. Together, these extended analyses comprised:

(1) A comparison of the baseline characteristics of patients included and excluded (owing to missing ethnicity data) from the complete case analysis was conducted. The reasons for start and end follow-up between the two groups were also compared.

(2) As the group excluded from the main analyses had missing data for ethnicity, fully adjusted multivariable models (adjusted for other socio-demographic factors including ethnicity) could not be compared between the excluded group and the individuals included in the primary analyses. However, it was feasible to compare the association of socio-demographic factors except ethnicity with zoster disease incidence in minimally adjusted analyses (adjusted for age, gender and calendar period) between the two groups.

(3) Minimally adjusted analyses for the entire study population (N=862468), excluding only the two patients with missing gender data, and comparing the results to the minimally adjusted analysis for the individuals who were included in the complete case analysis.

7.4.2 Results of additional analyses

Results of the three additional analyses conducted are summarised below.

(1) Individuals excluded from the complete case analysis because of missing ethnicity data (n=150878) had a slightly lower rate of zoster (7.08 (95%CI: 6.88-7.29) per 1000 person-years) compared to the participants included in the main analysis with zoster incidence rate of 9.09 (95%CI 9.0-9.20) per 1000 person-years (Table 7-1).

Table 7-1 Comparison of zoster incidence between total study population, individuals included and excluded from the complete case analysis

	Zoster incidence per 1000 person-years at risk (95% confidence interval)
Total study population N=862470 Outcome=37014	8.79 (8.70-8.88)
Patients included in complete case analysis N=711590 Outcome=32459	9.09 (9.0-9.20)
Patients excluded from complete case analysis N=150878 Outcome=4555	7.08 (6.88-7.29)

The baseline characteristics of patients included in the complete case analyses and excluded from these analyses owing to missing ethnicity data are also provided in Appendix 8 (**Section 7.3**). Patients included in the analysis were slightly older at their current registration date with their GP: median age 57.8 years (IQR: 43.6-67.7 years) compared to 54.5 Years (IQR: 40.7-65.2 years) for excluded patients. Participants excluded from the analysis were also more likely to be from the two extreme age groups at the start of follow-up (65-69 years: 56% versus 50%; ≥85 years: 11% versus 9%), from the least deprived patient-level IMD (~29% versus 22%) and slightly more likely to be living alone (~38% versus 34%). Excluded patients were less likely to have co-morbidities such as diabetes, chronic kidney disease, and COPD/asthma. In the excluded group, individuals were also less likely to be recorded as an immigrant (0.3% versus 1.3%) or to be residing in care home (~5% versus 8%). When, in further analyses, the criteria used for start and end of follow-up were compared for the two groups (Table 7-2), individuals included in the analysis were more likely to have joined the practice recently compared to the excluded group (entering the study one year after they registered with the practice),

perhaps explaining the better capture of ethnicity data in the included group. Individuals with missing ethnicity data were more likely to end follow-up because they had transferred out of the practice (22% compared to 15% of those with non-missing ethnicity data).

Table 7-2 Criteria for start and end of follow-up for patients excluded from complete case analysis due to missing data for ethnicity and for patients included in complete case analyses

	Criterion	Patients excluded from complete case analysis due to missing ethnicity data N=150,878[$]	Patients included in complete case analysis N=711590
Start of follow up	Study start date	74929 (49.7%)	332016 (46.7%)
	Age=65 years	56719 (37.6%)	223064 (31.4%)
	CRD+1 year	13168 (8.7%)	124071 (17.4%)
	UTS date	6062 (4%)	32434 (4.6%)
	CRD+1 year & UTS date	-	4 (0*%)
	CRD+1 year & study start date	-	1 (0*%)
End of follow-up	End of study	59526 (39.5%)	327202 (46%)
	Transfer out date	33723 (22.4%)	105846 (14.9%)
	Death	26312 (17.4%)	121909 (17.1%)
	Last collection date from practice	20439 (13.6%)	100628 (14.1%)
	Death and transfer out date	6323 (4.2%)	23519 (3.3%)
	Outcome date	4555 (3%)	32456 (4.6%)
	Death and end of study date	-	26 (0*%)
	Outcome date and end of study date	-	2 (0*%)
	Transfer out date and end of study date	-	1 (0*%)
	Last collection date from practice and outcome date	-	1 (0*%)

[$]one patient with missing both gender & ethnicity information excluded from analysis CRD current registration date UTS up to standard date * rounded to one decimal point

(2) Complete case analyses for the association of socio-demographic factors with zoster disease incidence amongst patients with missing ethnicity data are presented in Appendix 9 of the published paper and a comparison of minimally adjusted analyses restricted to individuals with missing ethnicity data and those included in the complete case analyses are reproduced in Table 7-3. Overall, the effect estimates were in the same direction as those from the main analysis. Amongst the excluded group, the effect estimate for care home residence was greater than that in

the complete case analysis (RR: 1.31 versus 1.12), although the 95% CI overlapped. In contrast, there was evidence from the non-overlapping confidence intervals that the effect of living alone was stronger in the excluded group (RR: 0.85 versus 0.95). Some other differences included: there was no evidence of linear trend of increasing zoster incidence with age, and there was no evidence for the association of immigration status on zoster incidence (RR: 0.52 (95%CI: 0.22-1.26) in the excluded group compared to the main analysis (RR: 0.65 (95%CI: 0.57-0.74)). Amongst the excluded individuals there was a strong inverse gradient of decreasing zoster risk with increasing deprivation, with the most deprived individuals in the excluded groups having a lower zoster risk than those in the complete case analysis (RR: 0.74 versus 0.93).

(3) The comparison of the minimally adjusted analysis for the entire study population with the minimally adjusted model of the complete case analysis is also presented in Table 7-3 (final two columns). There were no appreciable differences in the effect estimates between these two groups for any of the factors examined.

Table 7-3 Socio-demographic factors associated with zoster burden in the minimally adjusted model: comparison of individuals excluded due to missing ethnicity data, those included in complete case analysis and total study population

Exposures		Individuals excluded due to missing ethnicity data N=150878[$] Outcome=4555		Patient included in complete case analysis N=711,590 Outcome=32,459		Total study population N=862,468[#] Outcome=37,014	
		Minimally adjusted for age, gender and calendar period RR (95% CI)	P value*	Minimally adjusted for age, gender and calendar period RR (95% CI)	P value* (PT)	Minimally adjusted for age, gender and calendar period RR (95% CI)	P value* (PT))
Age acquired during the study(years)	65-69	1	<0.0001	1	<0.0001 (<0.0001)	1	<0.0001 (<0.0001)
	70-74	1.10 (1.02-1.19)		1.16 (1.12-1.20)		1.16 (1.12-1.19)	
	75-79	1.33 (1.23-1.45)		1.29 (1.25-1.34)		1.31 (1.27-1.35)	
	80-84	1.23 (1.11-1.35)		1.36 (1.31-1.41)		1.36 (1.32-1.41)	
	85 & above	1.19 (1.08-1.31)		1.40 (1.35-1.45)		1.38 (1.34-1.43)	
Gender	Male	0.80 (0.75-0.85)	<0.0001	0.85 (0.84-0.87)	<0.0001	0.85 (0.83-0.87)	<0.0001
	Female	1		1		1	
Calendar period	2003-2005	1	0.63	1	0.14	1	0.11
	2006-2007	1.01 (0.92-1.10)		1.03 (0.99-1.06)		1.03 (1.00-1.06)	
	2008-2009	0.95 (0.87-1.04)		1.02 (0.99-1.06)		1.02 (0.99-1.05)	
	2010-2011	0.99 (0.91-1.08)		1.01 (0.98-1.05)		1.02 (0.99-1.05)	
	2012-2013	0.95 (0.87-1.05)		0.99 (0.95-1.02)		0.99 (0.96-1.02)	
Immigration status	Not immigrant	1	0.11	1	<0.0001	1	<0.0001
	Immigrant	0.52 (0.22-1.26)		0.65 (0.57-0.74)		0.66 (0.58-0.75)	
Patient-level IMD	1 (least deprived)	1	<0.0001	1	0.0006	1	<0.0001
	2	0.96 (0.89-1.04)		0.98 (0.95-1.01)		0.98 (0.96-1.01)	
	3	0.95 (0.88-1.03)		0.95 (0.92-0.98)		0.96 (0.93-0.99)	
	4	0.79 (0.72-0.86)		0.94 (0.91-0.98)		0.94 (0.91-0.97)	
	5 (most deprived)	0.74 (0.66-0.84)		0.93 (0.90-0.97)		0.93 (0.89-0.96)	
Practice-level IMD	1 (least deprived)	1	<0.0001	1	<0.0001	1	<0.0001
	2	0.91 (0.83-0.99)		0.92 (0.88-0.95)		0.92 (0.89-0.95)	
	3	0.92 (0.85-1.01)		0.96 (0.93-1.00)		0.96 (0.93-0.99)	
	4	0.81 (0.73-0.89)		0.91 (0.88-0.94)		0.91 (0.88-0.94)	
	5 (most deprived)	0.78 (0.70-0.86)		0.90 (0.86-0.93)		0.89 (0.86-0.93)	
Care home residence	No	1	0.002	1	0.0001	1	<0.0001
	Yes	1.31 (1.11-1.54)		1.12 (1.06-1.18)		1.14 (1.08-1.20)	
Living alone	No	1	<0.0001	1	<0.0001	1	<0.0001
	Yes	0.85 (0.80-0.90)		0.95 (0.93-0.97)		0.93 (0.91-0.95)	
Cohabitation	No	1	<0.0001	1	<0.0001	1	<0.0001
	Yes	1.18 (1.12-1.25)		1.07 (1.05-1.09)		1.09 (1.06-1.11)	

[$]one patient with missing both gender & ethnicity information excluded from analysis # 2 patients with missing gender data excluded RR rate ratios CI confidence interval *likelihood ratio test PT P value for trend IMD index of multiple deprivation

7.4.3 Conclusions from additional analyses to assess the impact of missing data

The socio-demographic characteristics of the individuals excluded (due to missing ethnicity data) and included in the complete case analysis were described. The minimally adjusted effect estimates for zoster incidence from the main analysis were also compared to (1) a minimally adjusted model restricted to individuals with missing ethnicity data and (2) a minimally adjusted model for the entire study population. Although it was not possible to compare the results of the fully adjusted RRs in those included and excluded from analyses (due to missing ethnicity data for those excluded), the results of minimally adjusted analyses suggested that the effect estimates for excluded individuals were generally in the same direction to that of main analysis. The lack of evidence for the effect of immigration status in the excluded group could be due to lack of power to detect an effect - the number of individuals identified as immigrants in excluded group who experienced a zoster episode during the follow-up period was relatively small (n=5; supplementary material to the published paper: Appendix 8). It is also feasible that excluded patients with missing ethnicity data might also have lower capture of immigration status recording. There was also no strong evidence of a difference in the effect of care home in the excluded and included groups on zoster incidence. However the effect of living alone in the excluded and included group, although in same direction of lower risk, had non-overlapping 95% confidence intervals indicating a difference between the two groups with regards to this factor. In contrast, the comparison of effect estimates from minimally adjusted analysis between those included in the complete case analysis and those in the total study population were all very similar, including the estimate for living alone.

Those excluded had a lower prevalence of co-morbidities, and therefore the lack of recording of ethnicity in the excluded group may have been due to less GP visits. Given that those with co-morbidities are higher risk for zoster,[46] this might explain the higher zoster incidence recorded amongst the individuals included in the main analysis (Table 7-1).

As stated earlier it was not possible to compare fully adjusted models amongst those included and excluded from the analyses owing to missing ethnicity data in the excluded group. However, the effect estimates from the multivariable model (Model 3 in Table 2 of the published paper - adjusted for age, gender, ethnicity, immigration status, patient-level deprivation, care home residence and living alone) in the main analysis were largely similar to those of the minimally adjusted model. Therefore, based on the comparison of the minimally adjusted models, if those with missing ethnicity data could have been included in the main analyses, the effect of social factors such as care home residence are likely to have been similar to the main analysis; and there was no obvious evidence that missing data had biased the effect estimate for care home residence. For the effect of living alone and those residing in most deprived areas, it is possible that the complete case analyses might have underestimated the lower zoster risk in these social groups.

7.5 Chapter summary

This chapter described the application of the methodology developed (thesis **objective 2**) for ascertaining socio-demographic factors in linked electronic health data by assessing the socio-demographic determinants of zoster disease burden in England. In the next chapter (**Chapter 8**), a further application of this methodology for the assessment of zoster vaccination inequalities in England is described to assess whether specific socio-demographic groups with higher zoster burden are coming forward for zoster vaccination.

Chapter 8. A cohort study to investigate the role of social determinants and uptake of zoster vaccine

8.1 Introduction

This chapter is the last of the three chapters comprising the Results section of this thesis. Similar to the previous two Results chapters (**Chapter 6** and **7**), this chapter is presented in journal paper format and details the work conducted to meet the fourth and the final objective of this thesis: to determine the association of socio-demographic factors with zoster vaccine uptake in England.

The paper is followed by supplementary material (**Section 8.3**) to the submitted paper. The results of further investigation into the possible impact of missing data on the findings of the paper, the details of inadvertent zoster vaccination amongst immunosuppressed individuals (a secondary objective in the published paper) and potential misclassification of individuals eligible for zoster vaccination due to the lack of availability of month of birth in CPRD (**Section 3.5.3**) are described in **Sections 8.4**, **8.5** and **8.6**, respectively. Finally, as introduced previously in **Section 1.3.4**, I identify different socio-demographic groups with potential double inequalities in **Section 8.7**.

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SECTION A – Student Details

Student	Anu Jain
Principal Supervisor	Prof. Sara Thomas
Thesis Title	Use of electronic health records to investigate vaccination inequalities in older individuals in England

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
When was the work published?			
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	Choose an item.	Was the work subject to academic peer review?	Choose an item.

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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	PLOS ONE
Please list the paper's authors in the intended authorship order:	Anu Jain, Jemma L Walker, Rohini Mathur, Harriet J Forbes, Sinéad M Langan, Liam Smeeth, Albert Jan van Hoek and Sara L Thomas
Stage of publication	**Submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	The study was conceptualised by S Thomas and AJ van Hoek. I developed the study methodology with supervision from S Thomas and AJ van Hoek and advice from the other co-authors. The medical codes for the social factors, zoster vaccination and other covariates used in analyses were

	provided by S Thomas and were reviewed by me. I adapted the technique developed by R Mathur for ascertainment of ethnicity in these data. Socio-demographic factors were ascertained using the methodology developed and described in Chapter 6. As described in Chapter 7, I adapted the technique developed by H Forbes for imputing the missing doses for immunosuppressive drugs. I conducted all data management and formal analyses, and I wrote the initial draft of the manuscript which was revised based on comments by the co-authors.

Student Signature: Anufaw **Date:** 01/02/2018

Supervisor Signature: Sam Thomas **Date:** 01/02/2018

8.2 Submitted paper: Zoster vaccination inequalities: a population based cohort study to identify the association of socio-demographic factors with uptake using linked data from the UK Clinical Practice Research Datalink

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Abstract

Objective

To quantify inequalities in zoster vaccine uptake by determining its association with socio-demographic factors: age, gender, ethnicity, immigration status, deprivation, care home residence and living arrangements.

Method

This population-based cohort study utilised anonymised primary care electronic health records (Clinical Practice Research Datalink) linked to deprivation and hospitalisation data. Data from 35,333 individuals from 277 general practices in England and eligible for zoster vaccination during the two-year period (2013-2015) after vaccine introduction were analysed. Logistic regression was to obtain adjusted odds ratios (aOR) for the association of socio-demographic factors with zoster vaccine uptake for adults aged 70 years (main target group) and adults aged 79 years (catch-up group).

Results

Amongst those eligible for vaccination, 52.4% (n=18,499) received the vaccine. Socio-demographic factors independently associated with lower zoster vaccine uptake in multivariable analyses were: being older (catch-up group: aged 79 years) aOR=0.89 (95% confidence interval (CI):0.85-0.93), care home residence (aOR=0.64 (95%CI: 0.57-0.73)) and living alone (aOR=0.85 (95%CI: 0.81-0.90)). Uptake decreased with increasing levels of deprivation (p-value for trend<0.0001; aOR most deprived versus least deprived areas=0.69 (95%CI: 0.64-0.75)). Uptake was also lower amongst those of non-White ethnicities (for example, Black versus White ethnicity: aOR=0.61 (95%CI: 0.49-0.75)) but was not lower among immigrants after adjusting for ethnicity. Lower uptake was also seen amongst females in the catch-up group.

Conclusions

Inequalities in zoster vaccine uptake exist in England; with lower uptake among those of non-White ethnicities, and among those living alone, in a care home and in more deprived areas. Tailored interventions to increase uptake in these social groups should assist in realising the aim of mitigating vaccination inequalities. As care home residents are also at higher risk of zoster, improving the uptake of zoster vaccination in this group will also mitigate inequalities in zoster burden.

Introduction

Zoster is caused by reactivation of latent varicella-zoster virus infection and mainly affects older individuals. It is characterised by a painful dermatomal rash which may be followed by persisting pain called post-herpetic neuralgia (PHN).[1] Amongst individuals aged ≥70 years in England and Wales, an estimated ~53,000 cases of zoster occur annually of which ~27% develop post-herpetic neuralgia.[2] To reduce zoster disease burden, the UK introduced a national zoster vaccination programme (using a live vaccine) in 2013, targeting individuals aged 70 years, with a catch-up programme targeting older age groups.[3-5] The programme comprises vaccine administration to individuals aged 70 years on 1 September of the corresponding year (the routine cohort). For the catch-up programme, the vaccine was gradually rolled out in 2013/14 to individuals aged 79 years on 1 September 2013, and in 2014/15 to those aged 78 and 79 years on 1 September 2014.[6, 7] Additionally, eligible individuals who missed the vaccine in previous years were given the opportunity to get vaccinated in subsequent years. At introduction, uptake of the programme was around ~62% in the routine cohort but has decreased to ~55% in 2015-2016.[8] The reasons cited for this decline include difficulties experienced by general practice personnel who were busy with seasonal influenza vaccination, challenges in identifying individuals eligible for vaccination, insufficient follow-up of unvaccinated individuals and a potential decline in vaccine knowledge amongst the eligible cohort.[6-8]

Monitoring and reducing inequalities in healthcare services or interventions is a statutory requirement in the UK.[9] Inequalities in vaccine uptake, resulting in higher disease burden

in specific population groups, are well described.[10-13] Our 2017 systematic review and meta-analysis investigated vaccine uptake amongst individuals aged ≥65 years in Europe and reported lower seasonal influenza vaccine uptake amongst individuals living alone, those residing in more deprived areas and amongst immigrants.[12] Currently the national zoster post-vaccination surveillance in England comprises collection of aggregated general practice level data with information only on gender and limited ethnicity data.[8] The national zoster vaccine uptake for England was found generally to be higher amongst males, particularly in the catch-up cohort.[8] The aggregated national zoster uptake data were also utilised in a 2017 study, which reported lower zoster vaccine uptake in deprived areas and amongst most non-White ethnic groups.[14] However in this study, deprivation was assessed as an ecological factor and individuals were assigned ethnicity and vaccination status derived from the proportions reported only at an aggregated general practice level.[14]

Ascertainment of the socio-demographic determinants of zoster vaccine uptake can provide important information to public health professionals to address vaccination-related inequalities and reduce zoster disease burden. We have recently shown that routinely collected clinical and administrative information in the form of anonymised linked electronic health records are a useful resource to examine some of these socio-demographic factors, and these data can be used to supplement the routine surveillance data.[15]

The primary objective of this study was therefore to identify the socio-demographic determinants, relevant at an individual level, of zoster vaccine uptake in England, using one of the world's largest databases of general practice electronic health records: the Clinical Practice Research Datalink (CPRD),[16] with an overarching aim of mitigating vaccination inequalities amongst older individuals. The nine socio-demographic factors of interest included: age, gender, ethnicity, immigration status, deprivation (patient- and practice-level), marital status, cohabitation, living alone and care home residence. As a secondary objective, we also ascertained inadvertent zoster vaccination of individuals whilst they were immunosuppressed, to quantify possible violations of the inclusion criteria.

Methods

Data source

The CPRD provides quality-assured anonymised primary care patients' clinical, administrative and lifestyle data representative of and covering ~7% of the UK population.[16, 17] Additionally, CPRD data from ~75% general practices in England can be linked at an individual level to hospitalisation (Hospital Episode Statistics, HES) data,[18] which provides information on all admissions to NHS hospitals, and at lower layer super output area (LSOA) level (which covers a population of 1000-3000)[19] to deprivation data (Index of Multiple deprivation (IMD) score).[19, 20] The validity of various diagnoses recorded in CPRD was reported as high in a systematic review spanning a 21-year study period.[21]

Study population

This 2-year cohort study from England spanned the period from 01/09/2013 to 31/08/2015, the first two years after the zoster vaccine was introduced. To maintain patient anonymity, CPRD data provide only year of birth for adult patients. This posed a problem in how to identify individuals who were eligible for zoster vaccination, which is determined by their age on a specific date. The common convention of using the mid-year (1st July) to assign study participants' day and month of birth would wrongly classify some individuals as eligible for zoster vaccination. Importantly, the resulting unvaccinated group would comprise a mixture of individuals with possibly differing social factors: a) those eligible for vaccination who chose not to be vaccinated and b) those ineligible on the grounds of age, thus potentially resulting in biased effect estimates. To address this, we selected all individuals born in 1943 (or 1934 for catch-up cohort), who would have been eligible for vaccination at some point during the 2-year follow-up period as follows: those born in January-August 1943 would be eligible for the vaccine in 2013/14 or in 2014/15 if born September-December 1943; and determined vaccine uptake for the 2-year study period. The study population therefore comprised individuals born in 1943 (the routine cohort) and in 1934 (the catch-up cohort), who were alive and registered on 01/09/2013 (the start of the national programme) with a

CPRD general practice that had agreed to linkage to HES and IMD data and that met CPRD's quality assurance criteria.[20] Start of follow up was on 01/09/2013 and a minimum of five months of follow-up was required from then (i.e. from September until the end of January, coinciding with the main part of the seasonal influenza vaccination season),[22] to ensure that individuals had sufficient opportunity to receive zoster vaccination. Individuals who had any immunosuppressive conditions or therapies at the start of follow up, that were contraindications to receiving the live zoster vaccine,[4] were excluded from analyses of the socio-demographic determinants of vaccine uptake but included in descriptive analyses of inadvertent zoster vaccinations amongst immunosuppressed individuals. All individuals with zoster vaccine codes prior to the start of national programme and start of the study (01/09/2013) were also excluded.[23, 24] End of follow-up was defined as the earliest of: (a) the end of the study (31/08/2015), (b) individuals' transfer out date from the practice, (c) individuals' date of death, or (d) the date data were last collected from the practice.[20]

Defining the outcome

Zoster vaccination was determined in five different data files in CPRD: using product codes in patients' therapy files, immunisation codes in their immunisation files and Read codes (S1 Table) in their clinical, referral and test files.[20] Additional immunisation and Read codes provided further information on whether the vaccine was advised, refused or administered. When vaccination data appeared in more than one file, we used an algorithm to assign vaccination date for each individual and handle conflicting information; details are provided in the S1 Text and S1 Fig.

Exposure variables

The socio-demographic factors of interest were identified based on our previously developed methodology of using CPRD linked to HES and IMD data.[15] The factors of interest, in addition to age and gender, included ethnicity, immigration status, care home residence, marital status, cohabitation (defined as two individuals living as a couple) and living alone; code lists are provided in S2 Table. The latter three social factors provided complementary information about an individual's living arrangements. Religion was not examined as our previous work has shown it to be poorly recorded in CPRD data (<3% of older

individuals).[15] For binary socio-demographic variables, individuals without relevant codes were considered not to have that characteristic. Ethnicity (five categories: White, South Asian, Black, Others and Mixed) and immigration status (binary) were defined as factors that did not vary with time. Time-varying factors included marital status (six categories: single, widow, married, divorced, separated, partner uncategorised/other), cohabitation, living alone and care home residence (binary variables). All the time-varying factors were determined at the start of follow up, with any changes by the end of the 2-year follow-up period quantified and described. Deprivation data (IMD quintile at LSOA level: 2015) for patient- and practice-level were both available. Practice-level IMD quintiles were used if individual-level data were unavailable.

Other variables

At the initiation of the zoster vaccination programme, GPs were encouraged to co-administer zoster with seasonal influenza vaccine (SIV).[25] We therefore investigated the concurrent administration of zoster vaccine with SIV. This was achieved by identifying specific product codes, immunisation type codes and Read codes in CPRD (S3 Table) during the SIV campaign season (September-March)[26] of 2013/14 and 2014/15. Individuals who received SIV or/and zoster vaccine were quantified.

We also identified, throughout the study period, individuals who had immunosuppressive conditions or treatments that were contraindications to receipt of zoster vaccine. This was done to identify those who were eligible to receive the live zoster vaccine for the main analysis, and to describe the extent of inadvertent administration of zoster vaccine to those with contraindications. The immunosuppressive conditions and drugs included were those listed in the UK Green Book; code lists (S2 Table) and algorithms used to identify these are described in the S4 Table.[4]

A past history of zoster was also ascertained using zoster or PHN codes from both CPRD and HES (S5 Table) occurring before the start of follow-up (01/09/2013), or a first zoster code of PHN occurring during follow-up.

Analyses

A complete case analysis using multivariable logistic regression was used to determine the association of socio-demographic factors with zoster vaccine uptake, using adjusted odds ratios (aOR) with 95% confidence intervals (CI). Logistic regression models were chosen to address the problem of potential misclassification of individuals for vaccine eligibility based on their date of birth and therefore the lack of information on person-time at risk for vaccination. The exposure and outcome characteristics of individuals excluded from complete case primary analysis because of missing data were described.

Gender and being a part of the routine or catch-up cohort (born in 1943 and 1934, respectively) were considered to be *a priori* confounders of the socio-demographic factors of interest, as well as potential determinants of zoster vaccine uptake. An existing conceptual framework [27] was adapted to postulate the hierarchical inter-relationships between distal and proximate social factors with the outcome (S6 Table).[28] Using this framework, socio-demographic factors were added sequentially, as long as data sparsity or multicollinearity were not encountered. Standard errors of the coefficients were compared in successive analyses to assess multicollinearity between socio-demographic factors. Likelihood ratio tests were conducted for hypothesis testing unless otherwise indicated. Linear trends, if appropriate, were also examined for ordered categorical variables such as patient- and practice-level IMD. Differences in the effects of social factors in the two age groups (routine and catch-up) were investigated by adding interaction terms to the models.

In sensitivity analyses, we repeated multivariable analyses: 1) restricted to individuals who were followed up for the entire study period of two years; 2) adding the social factors that had been excluded due to multicollinearity issues; 3) replacing the status of the time-varying factors to that ascertained at the end of follow-up instead of at the start of follow-up, and 4) including past history of zoster in the final multivariable model as a potential mediator of some of the socio-demographic factors.

Additionally, inadvertent zoster vaccination amongst individuals with immunosuppressive conditions or therapies was also described.

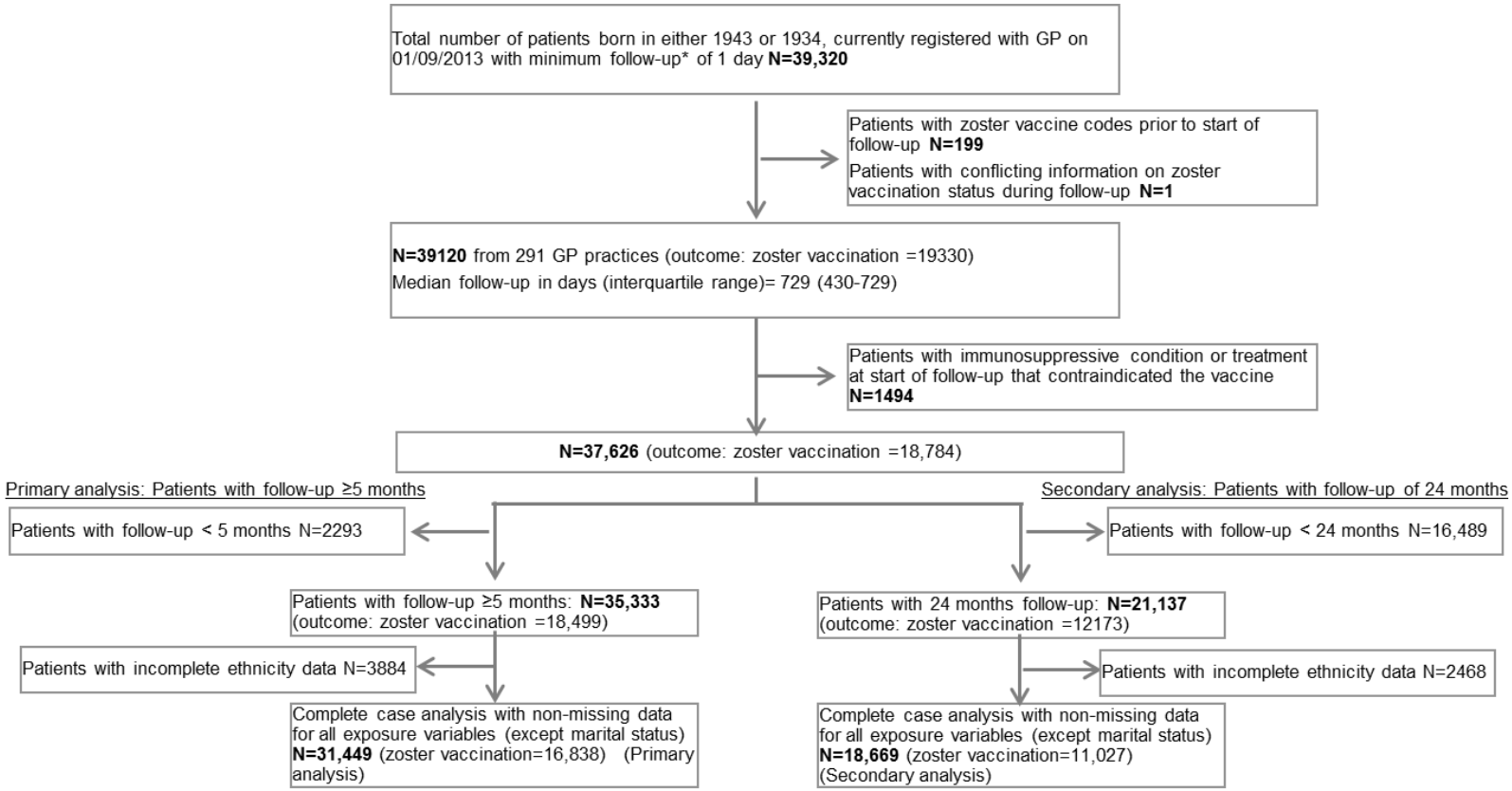
Data were analysed using Stata 14 (StataCorp, College Station, TX, USA).

Ethics

Approval was sought and obtained from the Observational/Interventions Research Ethics Committee of the London School of Hygiene and Tropical Medicine (Reference: 11910) and from the Independent Scientific Advisory Committee (ISAC) of the Medicines and Healthcare products Regulatory Agency (reference:16_168). The ISAC protocol was made available to the reviewers of this paper.

Results

A total of 39,120 individuals born in 1943 or 1934 and with no evidence of prior zoster vaccination were registered with a CPRD practice, which had consented to linkages, on 01/09/2013 (Fig1). After excluding those who had contraindications to zoster vaccine at the start of follow-up or less than 5 months follow-up, 35,333 individuals from 277 practices were considered for the primary analysis (Fig 1).



*Start of follow-up: 01/09/2013 and end of follow-up: earliest of end of study date (31/08/2015), individuals' transfer out date from the practice, individuals' date of death or date the data were last collected from the practice

Fig.1 Zoster vaccine uptake study flow chart

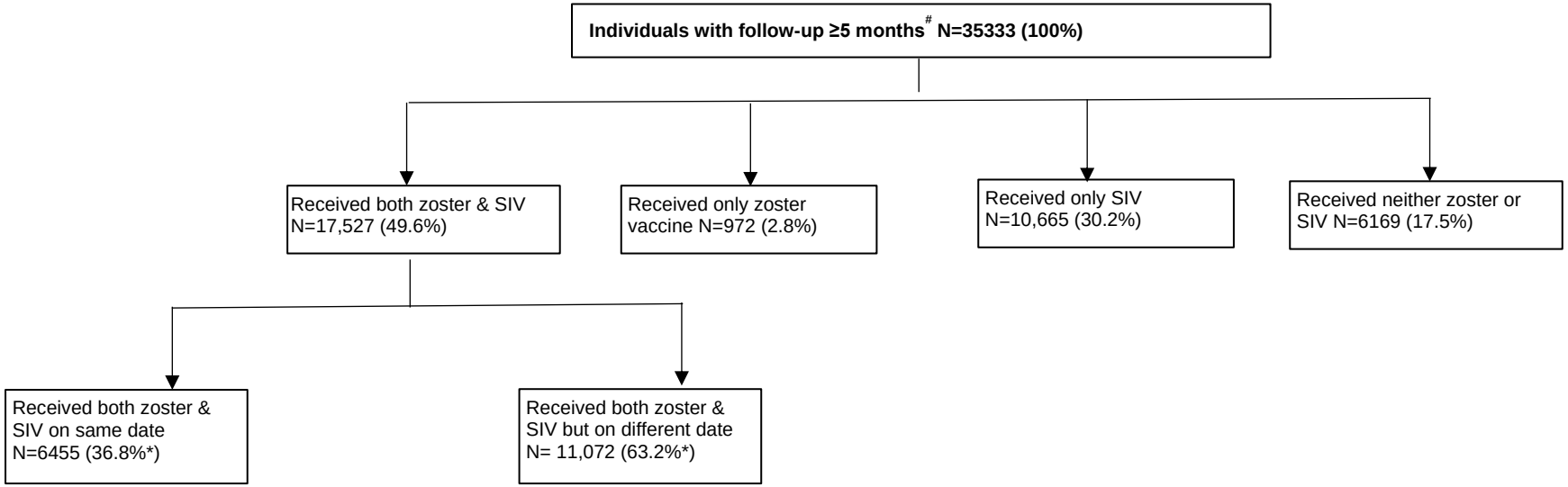
Primary analysis

A slight majority of the participants in the primary analysis (Table 1) were female. A higher proportion was born in the year 1943 (the main target group), were from a White ethnic background, and were cohabiting (living as a couple) and/or not living alone. Data for marital status were missing for ~37% participants (Table 1) and practice-level IMD was used to replace the missing patient-level IMD for 0.07% (n=26) participants. A past history of zoster was present for ~11% of participants (Table 1).

Table 1.Baseline characteristics of the study population: comparison of individuals with minimum follow-up of 5 months and 24 months

Variables		Primary analysis[a] N= 35333 from 277 practices, vaccine uptake=18499 (52.4%)		Sensitivity analysis[b] N= 21137 from 178 practices, vaccine uptake=12173 (57.6%)	
		Total (column %)	Received zoster vaccine (row %)	Total (column %)	Received zoster vaccine (row %)
Gender	Male	16633 (47.1%)	8859 (53.3%)	9829 (46.5%)	5763 (58.6%)
	Female	18700 (52.9%)	9640 (51.6%)	11308 (53.5%)	6410 (56.7%)
Year of birth	1943	21458 (60.7%)	11452 (53.4%)	13011 (61.6%)	7580 (58.3%)
	1934	13875 (39.3%)	7047 (50.8%)	8126 (38.4%)	4593 (56.5%)
Immigration status	Not immigrant	34821 (98.6%)	18270 (52.5%)	20891 (98.8%)	12052 (57.7%)
	Immigrant	512 (1.4%)	229 (44.7%)	246 (1.2%)	121 (49.2%)
Ethnicity	White	30052 (85.1%)	16244 (54.1%)	18044 (85.4%)	10709 (59.3%)
	South Asian	669 (1.9%)	304 (45.4%)	269 (1.3%)	136 (50.6%)
	Black	380 (1.1%)	147 (38.7%)	172 (0.8%)	89 (51.7%)
	Other	262 (0.7%)	107 (40.8%)	138 (0.7%)	68 (49.3%)
	Mixed	86 (0.2%)	36 (41.9%)	46 (0.2%)	25 (54.3%)
	Missing	3884 (11%)	1661 (42.8%)	2468 (11.7%)	1146 (46.4%)
Patient-level IMD[~#]	Least deprived	9313 (26.4%)	5230 (56.2%)	5521 (26.1%)	3429 (62.1%)
	2	8692 (24.6%)	4670 (53.7%)	5096 (24.1%)	2959 (58.1%)
	3	7520 (21.3%)	3884 (51.6%)	4644 (22%)	2645 (57%)
	4	5828 (16.5%)	2890 (49.6%)	3595 (17%)	1950 (54.2%)
	Most deprived	3980 (11.3%)	1825 (45.9%)	2281 (10.8%)	1190 (52.2%)
Practice-level IMD	Least deprived	6184 (17.5%)	3479 (56.3%)	3190 (15.1%)	1922 (60.3%)
	2	7979 (22.6%)	3952 (49.5%)	4994 (23.6%)	2711 (54.3%)
	3	7407 (21%)	3849 (52%)	4157 (19.7%)	2464 (59.3%)
	4	6455 (18.3%)	3488 (54%)	4040 (19.1%)	2321 (57.5%)
	Most deprived	7308 (20.7%)	3731 (51.1%)	4756 (22.5%)	2755 (57.9%)
Care home*	No	34133 (96.6%)	17976 (52.7%)	20509 (97%)	11851 (57.8%)
	Yes	1200 (3.4%)	523 (43.6%)	628 (3%)	322 (51.3%)
Living alone*	No	25525 (72.2%)	13738 (53.8%)	15419 (72.9%)	9122 (59.2%)
	Yes	9808 (27.8%)	4761 (48.5%)	5718 (27.1%)	3051 (53.4%)
Cohabiting*	No	15352 (43.4%)	7316 (47.7%)	8899 (42.1%)	4691 (52.7%)
	Yes	19981 (56.6%)	11183 (56%)	12238 (57.9%)	7482 (61.1%)
Marital status*	Single	497 (1.4%)	232 (46.7%)	295 (1.4%)	148 (50.2%)
	Married/Civil	6495 (18.4%)	3502 (53.9%)	3959 (18.7%)	2372 (59.9%)
	Widow/er	1537 (4.4%)	800 (52%)	872 (4.1%)	508 (58.3%)
	Divorced	516 (1.5%)	246 (47.7%)	304 (1.4%)	163 (53.6%)
	Separated	143 (0.4%)	64 (44.8%)	93 (0.4%)	50 (53.8%)
	Partner other/ uncategorised	13091 (37.1%)	7465 (57%)	8028 (38%)	4969 (61.9%)
	Missing	13054 (36.9%)	6190 (47.4%)	7586 (35.9%)	3963 (52.2%)
History of zoster*	No	31319 (88.6%)	16286 (52%)	18732 (88.6%)	10721 (57.2%)
	Yes	4014 (11.4%)	2213 (55.1%)	2405 (11.4%)	1452 (60.4%)

[a]Those with immunosuppressing condition at start of follow-up excluded with minimum follow-up >=5 months IMD index of multiple deprivation ~ 26 and [#]2 patients with missing patient-level IMD were replaced with practice-level IMD for primary and secondary analyses respectively [b]Those with immunosuppressing condition at start of follow-up excluded with minimum follow-up >=24 months *at start of follow-up



#Individuals with immunosuppressing condition at start of follow-up excluded and had minimum follow-up of ≥5 months
SIV seasonal influenza vaccine
*denominator=17,527

Fig.2 Zoster and seasonal influenza vaccine uptake amongst study participants

Of the total participants considered for the primary analysis, zoster vaccine was administered to 18,499 (52.4%) individuals. Uptake amongst the main target group (those born in 1943) was ~53% compared to ~51% amongst the catch-up cohort (individuals born in 1934). Nearly half (n=17,527) of the participants received both zoster vaccine and SIV (Fig 2); of these, only ~37% (n=6455) got both vaccines on same date (Fig 2), however the majority (~87%, n=16,066) received zoster vaccination during the influenza campaign period (September-March)[26] of 2013/2014 and 2014/2015. Amongst ~80% (n=28,192) of the participants who received SIV, ~73% (n=20,685) received SIV in both the 2013/2014 and 2014/2015 campaign periods while 22.4% (N=6,323) received SIV only in 2013/2014, and 4.2% (N=1,184) only in 2014/2015 season (data not shown).

A decision was made to drop marital status from the multivariable analyses, due to a large proportion of individuals with missing data for this variable. Thus, in the subsequent complete case analysis, only patients with missing ethnicity data were excluded. This resulted in a final study population of 31,449 individuals, amongst whom the zoster vaccine uptake was 53.5% (Fig 1). Comparison of individuals included (n=31,449) and excluded (n=3884) from the complete case analysis due to missing ethnicity data is available in S7 Table. Briefly, excluded individuals were more likely to be in the main target cohort, and to be from less deprived patient- and practice-level areas, and were less likely to be care home residents, to have evidence that they were an immigrant or to have past history of zoster. The excluded group was also less likely to be vaccinated for zoster.

Time-varying exposures at the start and end of follow-up remained largely unchanged for ~99% individuals included in the complete case analysis (S8 Table).

a) **Minimally adjusted model**

In the analysis adjusted for *a priori* confounders (gender and year of birth), there was strong evidence of an association between higher zoster vaccine uptake and male gender, with uptake 10% higher compared to females (Table 2). There was also evidence of lower vaccine uptake amongst the catch-up cohort, immigrants, those of non-White ethnicity, care home residents, those living alone and those not cohabiting, with reduced odds of between 12% (being in the catch-up cohort) to 46% (Black ethnicity) (all p values <0.001, Table 2)).

There was also strong evidence for a linear trend (p for trend <0.0001) for decreasing vaccine uptake with increasing patient-level deprivation (IMD) score, the most deprived group having 34% lower odds of uptake compared to the least deprived group. Non-linear decreases in uptake were seen for practices in more deprived areas (Table 2).

Table 2.Multivariable analyses- social factors associated with zoster vaccine uptake complete case analysis: Individuals with minimum follow-up of 5 months[a]

		Minimally adjusted for year of birth & gender OR (95% CI)	P value~ (PT)	Model 1 additionally adjusted for immigration status & ethnicity OR (95% CI)	P value~	Model 2 additionally adjusted for patient-level IMD OR (95% CI)	P value~ (PT)	Model 3 adjusted for all variables unless indicated OR (95% CI)	P value~ (PT)
Gender	Male	1.10 (1.05-1.15)	0.0001	1.09 (1.05-1.14)	0.0001	1.09 (1.04-1.14)	0.0001	1.08 (1.04-1.13)	0.0005
	Female	1		1		1		1	
Year of birth	1943 (main target group)	1		1		1		1	
	1934 (catch-up cohort)	0.88 (0.84-0.92)	<0.0001	0.88 (0.84-0.92)	<0.0001	0.87 (0.84-0.91)	<0.0001	0.89 (0.85-0.93)	<0.0001
Immigration status	Not immigrant	1		1		1		1	
	Immigrant	0.71 (0.59-0.85)	0.0002	0.91 (0.75-1.11)	0.36	0.94 (0.77-1.15)	0.55	0.94 (0.77-1.14)	0.52
Ethnicity	White	1		1		1		1	
	South Asian	0.70 (0.60-0.82)	<0.0001	0.73 (0.61-0.86)	<0.0001	0.73 (0.62-0.86)	<0.0001	0.72 (0.61-0.85)	<0.0001
	Black	0.54 (0.44-0.67)		0.55 (0.44-0.67)		0.61 (0.49-0.75)		0.61 (0.49-0.75)	
	Other	0.58 (0.45-0.75)		0.59 (0.46-0.76)		0.60 (0.47-0.77)		0.61 (0.47-0.78)	
	Mixed	0.61 (0.40-0.94)		0.61 (0.40-0.94)		0.63 (0.41-0.96)		0.62 (0.40-0.96)	
Patient-level IMD[#]	Least deprived	1		Not in model		1		1	
	2	0.92 (0.86-0.98)	<0.0001			0.92 (0.86-0.98)	<0.0001	0.92 (0.87-0.98)	<0.0001
	3	0.85 (0.79-0.90)	(<0.0001)			0.85 (0.80-0.91)	(<0.0001)	0.86 (0.81-0.92)	(<0.0001)
	4	0.77 (0.72-0.83)				0.78 (0.73-0.84)		0.80 (0.74-0.86)	
	Most deprived	0.66 (0.61-0.71)				0.67 (0.62-0.73)		0.69 (0.64-0.75)	
Practice-level IMD	Least deprived	1		Not in model		Not in model#		Not in model#	
	2	0.76 (0.71-0.82)	<0.0001						
	3	0.86 (0.80-0.93)							
	4	0.94 (0.87-1.01)							
	Most deprived	0.81 (0.75-0.87)							
Care home*	No	1		Not in model		Not in model		1	
	Yes	0.66 (0.58-0.74)	<0.0001					0.64 (0.57-0.73)	<0.0001
Living alone*	Not living alone	1		Not in model		Not in model		1	
	Yes living alone	0.85 (0.81-0.89)	<0.0001					0.85 (0.81-0.90)	<0.0001
Cohabiting*	No	0.73 (0.70-0.77)	<0.0001	Not in model		Not in model		Not in model#	
	Yes	1							

[a]Those with immunosuppressing condition at start of follow-up excluded (Number of patients=31449 vaccine uptake= 16,838 (53.5%)) OR odds ratio CI confidence interval ~ likelihood ratio test PT P value for trend IMD index of multiple deprivation [#] 19 patients with missing patient-level IMD were replaced with practice-level IMD *at start of follow-up # excluded due to multicollinearity issues

b) Multivariable analyses

After additionally adjusting the minimally adjusted model for immigration status and ethnicity (Multivariable Model 1, Table 2), no appreciable changes in effect estimates were observed, except lower uptake amongst immigrants was no longer apparent after adjustment for ethnicity, with no evidence of collinearity between the two variables. As patient- and practice-level IMD were considered to be correlated, and as social factors relevant at an individual level were more of interest, only patient-level IMD was added to Model 2. No noticeable changes in effect estimates between Model 1 and Model 2 were observed, and the strong evidence of linear trend of lower uptake with increasing deprivation score seen in minimally adjusted analysis was still evident ($p<0.001$) in this model. Similarly, living alone status and cohabitation were closely correlated, and so living alone was added to the final multivariable model (Model 3), along with care home residence. Again, the previously observed associations of lower uptake with living alone and residing in care home persisted in this model; individuals living alone and those residing in care home had 15% and 36% decreased odds of uptake, respectively (Table 2). The effect estimates for other variables were unchanged.

There was evidence that the effect of male gender, patient-level IMD and care home residence varied with age (Table 3). Analyses showed that the increase in vaccine uptake among males was restricted to the catch-up cohort, and that the effects of care home status and (to a lesser extent) increasing deprivation on lower vaccine uptake were more marked in the catch-up cohort compared to the routine cohort.

Table 3 Interaction between age and social factors

	Gender	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted[#] OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	Males	9059 (48.4%)	4977 (54.9%)	1.00 (0.95-1.06)	<0.0001
	Females	9677 (51.6%)	5303 (54.8%)	1	
Catch-up cohort	Males	5786 (45.5%)	3156 (54.5%)	1.22 (1.13-1.31)	
	Females	6927 (54.5%)	3402 (49.1%)	1	
	Immigration status	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted[#] OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	Not immigrant	18432 (98.4%)	10139 (55%)	1	0.93
	Immigrant	304 (1.6%)	141 (46.4%)	0.93 (0.73-1.19)	
Catch-up cohort	Not immigrant	12527 (98.5%)	6478 (51.7%)	1	
	Immigrant	186 (1.5%)	80 (43%)	0.95 (0.70-1.29)	
	Ethnicity	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted[#] OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	White	17878 (95.4%)	9907 (55.4%)	1	0.73
	South Asian	423 (2.3%)	202 (47.8%)	0.75 (0.61-0.91)	
	Black	211 (1.1%)	79 (37.4%)	0.55 (0.41-0.72)	
	Other	170 (0.9%)	69 (40.6%)	0.57 (0.42-0.78)	
	Mixed	54 (0.3%)	23 (42.6%)	0.61 (0.35-1.05)	
Catch-up cohort	White	12174 (95.8%)	6337 (52.1%)	1	
	South Asian	246 (1.9%)	102 (41.5%)	0.68 (0.52-0.89)	
	Black	169 (1.3%)	68 (40.2%)	0.70 (0.51-0.96)	
	Other	92 (0.7%)	38 (41.3%)	0.67 (0.44-1.03)	
	Mixed	32 (0.3%)	13 (40.6%)	0.64 (0.32-1.31)	
	Patient-level IMD	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted[#] OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	Least deprived	4781 (25.5%)	2766 (57.9%)	1	0.07
	2	4514 (24.1%)	2520 (55.8%)	0.93 (0.85-1.00)	
	3	4033 (21.5%)	2226 (55.2%)	0.91 (0.83-0.99)	
	4	3160 (16.9%)	1658 (52.5%)	0.83 (0.76-0.91)	
	Most deprived	2248 (12%)	1110 (49.4%)	0.75 (0.68-0.83)	
Catch-up cohort	Least deprived	3261 (25.7%)	1837 (56.3%)	1	
	2	3208 (25.2%)	1732 (54%)	0.92 (0.83-1.01)	
	3	2677 (21.1%)	1342 (50.1%)	0.80 (0.72-0.88)	
	4	2119 (16.7%)	1024 (48.3%)	0.76 (0.68-0.84)	
	Most deprived	1448 (11.4%)	623 (43%)	0.62 (0.55-0.70)	
	Care home residence	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted[#] OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	No	18217 (97.2%)	10021 (55%)	1	0.0008
	Yes	519 (2.8%)	259 (49.9%)	0.80 (0.67-0.95)	
Catch-up cohort	No	12097 (95.2%)	6328 (52.3%)	1	
	Yes	616 (4.8%)	230 (37.3%)	0.53 (0.45-0.63)	
	Living alone	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted[#] OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	Not living alone	14005 (74.7%)	7860 (56.1%)	1	0.22
	Yes living	4731 (25.3%)	2420 (51.2%)	0.83 (0.78-0.89)	
Catch-up cohort	Not living alone	8791 (69.1%)	4618 (52.5%)	1	
	Yes living	3922 (30.9%)	1940 (49.5%)	0.89 (0.82-0.96)	

Final Model 3 from Table 2 (Number of patients=31449 vaccine uptake= 16,838 (53.5%)) OR odds ratio CI confidence interval *likelihood ratio test

Sensitivity analyses

There were no appreciable differences between the baseline characteristics of individuals with follow-up for the entire 2-year study period and those included in primary analysis (follow-up period of ≥5 months) (Table 1). The results of multivariable analyses for those with longer follow up were similar to those from primary analysis except there was some attenuation in the association of ethnicity with vaccine uptake; individuals of Other ethnicities had 31% reduced odds (versus 39% in primary analysis) of uptake compared to those of White ethnicity in this model (Table 4).

Table 4 Sensitivity analyses: Social factors associated with zoster vaccine uptake complete case analysis (Model 3)

Variables		Primary analysis N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[a] N=18,669 vaccine uptake: n=11027		Sensitivity analysis[b] N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[c] N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[d] N=31,130 vaccine uptake: n=16,707		Sensitivity analysis[e] N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[f] N=31,449 vaccine uptake: n=16,838	
		OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)
Gender	Male	1.08 (1.04-1.13)	0.0005	1.10 (1.03-1.16)	0.003	1.07 (1.02-1.12)	0.003	1.08 (1.04-1.13)	0.0005	1.09 (1.04-1.14)	0.0003	1.08 (1.04-1.13)	0.0005	1.09 (1.04-1.14)	0.0003
	Female	1		1		1		1		1		1		1	
Year of birth	1943	1		1		1		1		1		1		1	
	1934	0.89 (0.85-0.93)	<0.0001	0.92 (0.86-0.98)	0.006	0.89 (0.85-0.93)	<0.0001	0.89 (0.85-0.93)	<0.0001	0.89 (0.85-0.93)	<0.0001	0.89 (0.85-0.94)	<0.0001	0.89 (0.85-0.93)	<0.0001
Immigrant	No	1		1		1		1		1		1		1	
	Yes	0.94 (0.77-1.14)	0.52	0.82 (0.62-1.08)	0.16	0.94 (0.77-1.15)	0.56	0.92 (0.75-1.12)	0.4	0.96 (0.79-1.18)	0.72	0.93 (0.77-1.14)	0.51	0.94 (0.77-1.15)	0.54
Ethnicity	White	1		1		1		1		1		1		1	
	South Asian	0.72 (0.61-0.85)	<0.0001	0.73 (0.57-0.94)	0.03	0.76 (0.64-0.89)	<0.0001	0.71 (0.60-0.84)	<0.0001	0.73 (0.62-0.86)	<0.0001	0.72 (0.61-0.85)	<0.0001	0.72 (0.61-0.86)	<0.0001
	Black	0.61 (0.49-0.75)		0.85 (0.62-1.15)		0.64 (0.52-0.79)		0.55 (0.45-0.68)		0.59 (0.48-0.74)		0.61 (0.49-0.75)		0.62 (0.50-0.76)	
	Other	0.61 (0.47-0.78)		0.69 (0.49-0.97)		0.62 (0.48-0.79)		0.60 (0.47-0.78)		0.62 (0.48-0.80)		0.60 (0.47-0.78)		0.61 (0.47-0.78)	
	Mixed	0.62 (0.40-0.96)		0.84 (0.47-1.50)		0.63 (0.41-0.98)		0.61 (0.40-0.93)		0.58 (0.38-0.91)		0.62 (0.40-0.96)		0.63 (0.41-0.96)	
Patient-level IMD	Least deprived	1		1		1		Not in model#		1		1		1	
	2	0.92 (0.87-0.98)	<0.0001	0.84 (0.77-0.92)	<0.0001	0.93 (0.87-0.99)	<0.0001			0.94 (0.88-1.00)	<0.0001	0.92 (0.87-0.98)	<0.0001	0.92 (0.87-0.98)	<0.0001
	3	0.86 (0.81-0.92)	(<0.0001)	0.81 (0.74-0.88)	(<0.0001)	0.87 (0.81-0.92)	(<0.0001)			0.86 (0.81-0.92)	(<0.0001)	0.86 (0.81-0.92)	(<0.0001)	0.86 (0.81-0.92)	(<0.0001)
	4	0.80 (0.74-0.86)		0.74 (0.67-0.81)		0.81 (0.76-0.87)				0.80 (0.75-0.86)		0.80 (0.75-0.86)		0.80 (0.74-0.86)	
	Most deprived	0.69 (0.64-0.75)		0.67 (0.60-0.75)		0.72 (0.66-0.78)				0.69 (0.64-0.75)		0.70 (0.65-0.76)		0.69 (0.64-0.75)	

Contd.

Variables		Primary analysis N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[a] N=18,669 vaccine uptake: n=11027		Sensitivity analysis[b] N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[c] N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[d] N=31,130 vaccine uptake: n=16,707		Sensitivity analysis[e] N=31,449 vaccine uptake: n=16,838		Sensitivity analysis[f] N=31,449 vaccine uptake: n=16,838	
		OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)	OR (95% CI)	P value~ (PT)
Practice-level IMD	Least deprived	Not in model#		Not in model#		Not in model#		1		Not in model#		Not in model#		Not in model#	
	2							0.77 (0.72-0.83)	<0.0001						
	3							0.87 (0.81-0.94)							
	4							0.97 (0.90-1.04)							
	Most deprived							0.83 (0.77-0.90)							
Care home*	No	1		1		1		1		1		1		1	
	Yes	0.64 (0.57-0.73)	<0.0001	0.68 (0.58-0.80)	<0.0001	0.69 (0.61-0.78)	<0.0001	0.63 (0.56-0.71)	<0.0001	0.64 (0.57-0.73)	<0.0001	0.63 (0.57-0.70)	<0.0001	0.64 (0.57-0.72)	<0.0001
Living alone*	Not living alone	1		1		Not in model#		1		1		1		1	
	Yes living alone	0.85 (0.81-0.90)	<0.0001	0.84 (0.79-0.90)	<0.0001			0.83 (0.79-0.88)	<0.0001	0.86 (0.82-0.91)	<0.0001	0.85 (0.81-0.89)	<0.0001	0.86 (0.81-0.90)	<0.0001
Cohabiting*	No	Not in model#		Not in model#		1		Not in model#		Not in model#		Not in model#		Not in model#	
	Yes					1.30 (1.25-1.36)	<0.0001								
History of zoster*	No	Not in model		Not in model		Not in model		Not in model		Not in model		Not in model		1	
	Yes													1.12 (1.04-1.20)	0.002

OR odds ratio CI confidence interval PT P value for trend ~ likelihood ratio test [a] restricted to individuals with follow-up of 24 months [b] Including cohabitation instead of living alone in multivariable analysis [c] Including practice level IMD instead of patient level IMD [d] Excluding patients with immunosuppressing condition at end of follow-up (n=1835) instead of at start of follow-up and excluding those with follow-up <5months [e] Care home status at end of follow-up [f] includes history of zoster in the model *determined at start of follow-up IMD index of multiple deprivation # excluded due to multicollinearity issues

Substitution of cohabitation status instead of living alone, practice-level IMD instead of patient-level IMD, excluding individuals with immunosuppressive conditions at the end as opposed to start of follow-up (S9 Table) and determining care home status at the end instead of start of follow-up (Table 4: sensitivity analyses) did not change the findings. Individuals with a past history of zoster had 12% higher odds of uptake (Table 4), but inclusion of past zoster in the multivariable model made little difference to the other effect estimates.

To assess the impact of excluding individuals from the complete case analysis, a further exploratory analysis was conducted, by re-running the minimally adjusted analysis for the entire study population (N=35,333) with follow-up ≥5 months including those with missing data on ethnicity (S10 Table). Comparing the minimally adjusted model with that of primary analysis revealed no noticeable differences in effect estimates.

Inadvertent zoster vaccinations

Of the 19,330 in the total study population who received vaccination (Fig 1), 3% (n=596) received zoster vaccine whilst immunosuppressed.[4] Of these 596 patients, 28 (4.7%) patients had more than one immunosuppressive condition at the time of vaccination. The maximum number of immunosuppressive conditions at time of vaccination was three. The most common immunosuppressive condition (n=445) during which the patients received zoster vaccine was cancer chemotherapy or radiotherapy, followed by patients taking other immunosuppressive medications (n=69), patients with leukemia, lymphoma, myeloma, other plasma cell dyscrasias (n=49), treatment with immunosuppressive dose of oral corticosteroid (n=28), cellular immune deficiency (n=25), solid organ transplant (n=9) and HIV (n=1). None of the patients received zoster vaccination during the immunosuppressive phase of a stem cell or bone marrow transplant.

Discussion

To the best of our knowledge, this is the first study to quantify the inequalities in the uptake of zoster vaccine, administered in a national vaccination programme, using anonymised electronic health records. This large 2-year population based study from England revealed

that lower zoster vaccine uptake was independently associated with being a part of the catch-up cohort, non-White ethnicity, residing in a care home, living alone, and not cohabiting (living as a couple). A graded inverse association of patient-level deprivation with vaccine uptake was also observed. Lower uptake was also seen amongst females in the catch-up cohort, and the effects of care home residence and deprivation were more marked among the older catch-up group.

Strengths and limitations

Strengths of the study include the large sample size, and linkages to hospitalisation data which provided additional information about socio-demographic factors as well as zoster vaccine contraindications. Multivariable analysis, using a hierarchical causal modelling approach, enabled appropriate interpretation of effect estimates. The NHS zoster vaccination programme is administered via general practice only and thus capture of vaccination is likely to be good. Additionally, our previous methodological study investigating ascertainment of socio-demographic factors in linked CPRD data showed that the distribution of factors such as ethnicity, not living alone, cohabitation and care home residence for individuals aged ≥65 years was comparable to the distribution in the 2011 English Census.[15]

The study limitations include potential misclassification of both socio-demographic factors and the zoster vaccination recording, despite our previous study showing good capture of socio-demographic factors in CPRD data.[15] If this misclassification was non-differential, this may have underestimated the effect estimates in this study. An additional issue is that some individuals may have changed exposure status over time. Ideally, person-time at risk to estimate vaccination rates would have been preferable but unavailability of complete dates of birth in CPRD precluded this ascertainment. However, factors ascertained at start of follow-up remained unchanged for ~99% individuals at the end of follow-up and sensitivity analyses to assess the impact of the time-varying factors reassuringly revealed similar results to the primary analysis. There was also potential for bias resulting from the complete case analysis (owing to missing ethnicity information) which led to exclusion of data from 11% of the study population. Further assessment of this revealed that effect estimates from

the minimally adjusted models for individuals for the entire study population (after dropping ethnicity) had no appreciable differences to those obtained from the complete case analysis. Lack of recording of marital status prevented investigation of its association with zoster vaccine uptake, but other closely related variables for living arrangements such as cohabitation and living alone were available.

Comparison with other studies

Our finding of higher uptake in the main target group compared to the catch-up cohort reflects the findings from the national annual zoster vaccine coverage data for England over the same time period, and vaccine coverage among the individuals in our study who were followed up for the entire study duration (and thus had fuller capture of uptake of vaccination) is comparable to the coverage estimates in the national data.[6, 7] Higher uptake amongst males in the catch-up cohort observed in this study also was shown in the national data for 2013-2015 for reasons that are currently unexplained.[6, 7] This is in contrast to findings from North America that have reported a higher zoster vaccine uptake amongst females.[29-31] The majority of zoster vaccinations (87%) in this study occurred during the influenza season, suggesting that opportunistic targeting of the eligible population for zoster vaccine during SIV programme might have played a role. The national annual zoster vaccination data also supports this finding.[6, 7] Our finding of a linear relationship between increasing level of deprivation and lower zoster vaccine uptake also confirms the earlier analyses of the national data, which found a similar trend but was restricted to examining deprivation at the general practice-level;[14] studies from the US and Canada have also reported the lower zoster vaccine amongst individuals with lower income.[30-32] Higher zoster vaccine uptake amongst individuals of White ethnicity, as seen here, has been reported from other zoster vaccine studies from high income countries.[14, 30, 32-35]

Several of our findings are novel with respect to zoster vaccine uptake. These include lower uptake among individuals who were living alone or not cohabiting; this echoes studies showing lower uptake of seasonal influenza vaccine among those living alone in older European populations.[12] Our finding that immigration status was not independently associated with zoster vaccine uptake after adjusting for ethnicity is in contrast with previous

findings of lower uptake among immigrant populations for seasonal influenza and pneumococcal vaccine in Spain and Israel, although none of these studies adjusted additionally for ethnicity.[36-43] The lower uptake of zoster vaccine among care home residents adds to a number of studies investigating uptake of other vaccines such as influenza and pneumococcal vaccines which have reported higher and lower uptake respectively, amongst care home residents.[44-48]

Interpretation of findings and implications

This study demonstrates that in a public funded healthcare system, vaccination inequalities exist during a crucial period of programme initiation, and identifies socio-demographic groups that could be targeted with tailored interventions to increase zoster vaccine uptake. Of particular interest is the finding of lower uptake among care home residents; we have shown recently that individuals in care homes are at higher risk of developing zoster,[49] and so are a group with possible double health inequity (of both zoster burden and zoster vaccine uptake). Lower vaccine uptake among these residents could be due to lack of awareness amongst care home staff about the newly introduced programme and issues around getting consent. The reasons cited for differential (higher or lower) uptake of other vaccines among care home residents have included presence of vaccination polices in care homes, staff awareness, vaccination consent from the residents, location and care home ownership (public versus private).[44, 47, 48] The potential double health inequity amongst care home residents highlights a need for more rigorous targeting of these individuals to mitigate health inequality.

Similarly, targeting of older individuals who live alone may be needed to encourage zoster vaccination. Individuals cohabiting or living with their relatives may be more motivated by their social networks to get vaccinated. Secondly, higher disease awareness amongst these individuals, by witnessing the debilitating effect of zoster in their relatives, may also increase uptake. This was examined in a US study that reported higher zoster vaccine uptake amongst individuals in the three months after occurrence of zoster in their partners, reflecting a short term effect of disease awareness.[49] However, our finding that adjustment for a past personal history of zoster made little difference to effect estimates of

social factors suggests that social networks may have a longer-lasting effect on encouraging vaccine uptake in older individuals, or that the occurrence of zoster in partners versus self may have a different effect on uptake. The lower uptake of vaccine among those of non-White ethnicity, but the attenuation of this association after restricting to individuals with longer follow up, suggests that there might be delay in uptake amongst some ethnic groups. There may be a lack of zoster disease awareness among some ethnic groups because of lower lifetime risk of zoster, which may be due to genetic causes, social mixing patterns that limit contacts with varicella and thus boosting of varicella-zoster virus immunity, and late onset of varicella among those born overseas.[33, 49, 50] Alternatively, the lower uptake may reflect existing healthcare inequalities. The lack of association of immigration status with zoster vaccine uptake after adjusting for ethnicity could be due to confounding by ethnicity, or simply to lack of power to detect an effect - the number of individuals identified as immigrants in the study population was relatively small (1.4%; n=512) of which zoster vaccine uptake was observed amongst only 229 individuals. It is also feasible that in England, where national zoster vaccination programme is available free-of-charge, vaccination inequalities were not observed for older immigrant populations.

Conclusions

This population-based cohort study provides evidence of inequalities in zoster vaccine uptake in the period immediately after the introduction of a national vaccination programme, identifying a wide range of socio-demographic determinants of uptake of zoster vaccine. This work should encourage effective planning and implementation of specific interventions to target these socio-demographic groups to mitigate vaccination inequalities amongst older individuals. Factors that are currently poorly recorded in routinely collected data, such as religion, education and income, should inform policy drivers such as the sustainability and transformation partnerships to incentivise better recording of these factors and/or facilitate other data linkages for comprehensive knowledge and future interventions to improve overall health and wellbeing of older populations. As care home residents are both less likely to receive zoster vaccine and are at higher risk of zoster, improving the uptake of zoster vaccination in this group will also mitigate inequalities in zoster burden.

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Supporting Information

S1 Table Code list: zoster vaccine

S2 Table Code list social factors and immunosuppressive conditions

S3 Table Code list seasonal influenza vaccine

S4 Table Dose and duration criteria for immunosuppressive conditions/therapies

S5 Table Zoster and post-herpetic neuralgia codes

S6 Table Hierarchical conceptual framework and interpretation of effect estimates

S7 Table Baseline characteristics of patients excluded from primary complete case analysis due to missing ethnicity and those included in analysis with complete covariate data

S8 Table Changes in time varying factors at start and end follow-up

S9 Table Changes in immunosuppressive therapy/ condition during follow-up

S10 Table Social factors associated with zoster vaccine uptake: primary complete case analysis excluding ethnicity

S1 Text Details of determining zoster vaccination status

S1 Fig Decision flow chart for ascertaining zoster vaccine status

8.3 Supplementary material to the submitted paper

S1 Table Code list: zoster vaccine

Codelist is available in this thesis as Appendix 12

S2 Table Code list social factors and immunosuppressive conditions

Codelists are available in this thesis as Appendices 4-10 and 14-17

S3 Table Code list seasonal influenza vaccine

Codelist is available in this thesis as Appendix 19

S4 Table Dose and duration criteria for immunosuppressive conditions/therapies

These are described in **Chapter 5** of this thesis

S5 Table Zoster and post-herpetic neuralgia codes

Codelist is available in this thesis as Appendix 3

S6 Table Hierarchical conceptual framework and interpretation of effect estimates

(based on [1])

Hierarchical models	Explanatory variables	Interpretation of effect estimates
`Minimally' adjusted model	Each explanatory variable adjusted in-turn for *a priori* confounders: year of birth and gender	Effect estimate of each variable adjusted for *a priori* confounders.
Model-1*^	Ethnicity +immigration status^ with *a priori* confounders	Effects of ethnicity and immigration status adjusted for each other and *a priori* confounders
Model-2*	Model-1+ patient-level deprivation#	(i) Effects of ethnicity and immigration status not mediated via deprivation and adjusted for each other and *a priori* confounders (ii) Effect of patient-level deprivation adjusted for *a priori* confounders, ethnicity and immigration status
Model-3*	Model-2 + rest of the explanatory variables~	(i) Effect of ethnicity and immigration status not mediated via deprivation and other explanatory variables~ * (ii) Effect of deprivation not mediated via other explanatory variables~* (iii) Effect of other explanatory variables~ *

*all variables in the model adjusted for each other and *a priori* confounders: year of birth and sex ^ethnicity and immigration status examined for multicollinearity # patient-level and practice-level deprivation were considered to be correlated therefore only patient-level deprivation used ~ care home residence, living alone status and cohabitation status (living alone and cohabitation examined for multicollinearity)

1. Victora CG, Huttly SR, Fuchs SC, Olinto MT. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. Int J Epidemiol. 1997;26(1):224-7. PubMed PMID: 9126524.

S7 Table Baseline characteristics of patients excluded from primary complete case analysis due to missing ethnicity and those included in analysis with complete covariate data

Variables		Excluded from complete case analysis[1] due to missing data on ethnicity N=3884, vaccine uptake=1661 (42.8%) Age (years) at current registration date: median (IQR) 48.9 (36.4-58.2), mean (range) 46.3 (0-79)			Included in complete case analysis[1] N=31449, vaccine uptake=16,838 (53.5%) Age (years) at current registration date: median (IQR) 52.9 (40.4-62.8), mean (range) 50 (0-79)		
		Total (column %)	Not received zoster vaccine (row %)	Received zoster vaccine (row %)	Total (column %)	Not received zoster vaccine (row %)	Received zoster vaccine (row %)
Gender	Male	1788 (46%)	1062 (59.4%)	726 (40.6%)	14845 (47.2%)	6712 (45.2%)	8133 (54.8%)
	Female	2096 (54%)	1161 (55.4%)	935 (44.6%)	16604 (52.8%)	7899 (47.6%)	8705 (52.4%)
Year of birth	1943 (main target group)	2722 (70.1%)	1550 (56.9%)	1172 (43.1%)	18736 (59.6%)	8456 (45.1%)	10280 (54.9%)
	1934 (catch-up cohort)	1162 (29.9%)	673 (57.9%)	489 (42.1%)	12713 (40.4%)	6155 (48.4%)	6558 (51.6%)
Immigration status	Not immigrant	3862 (99.4%)	2209 (57.2%)	1653 (42.8%)	30959 (98.4%)	14342 (46.3%)	16617 (53.7%)
	Immigrant	22 (0.6%)	14 (63.6%)	8 (36.4%)	490 (1.6%)	269 (54.9%)	221 (45.1%)
Patient level IMD	Least deprived	1271 (32.7%)	644 (50.7%)	627 (49.3%)	8042 (25.6%)	3439 (42.8%)	4603 (57.2%)
	2	970 (25%)	552 (56.9%)	418 (43.1%)	7722 (24.6%)	3470 (44.9%)	4252 (55.1%)
	3	810 (20.9%)	494 (61%)	316 (39%)	6710 (21.3%)	3142 (46.8%)	3568 (53.2%)
	4	549 (14.1%)	341 (62.1%)	208 (37.9%)	5279 (16.8%)	2597 (49.2%)	2682 (50.8%)
	Most deprived	284 (7.3%)	192 (67.6%)	92 (32.4%)	3696 (11.8%)	1963 (53.1%)	1733 (46.9%)
Practice level IMD	Least deprived	976 (25.1%)	476 (48.8%)	500 (51.2%)	5208 (16.6%)	2229 (42.8%)	2979 (57.2%)
	2	868 (22.3%)	514 (59.2%)	354 (40.8%)	7111 (22.6%)	3513 (49.4%)	3598 (50.6%)
	3	844 (21.7%)	510 (60.4%)	334 (39.6%)	6563 (20.9%)	3048 (46.4%)	3515 (53.6%)
	4	559 (14.4%)	350 (62.6%)	209 (37.4%)	5896 (18.7%)	2617 (44.4%)	3279 (55.6%)
	Most deprived	637 (16.4%)	373 (58.6%)	264 (41.4%)	6671 (21.2%)	3204 (48%)	3467 (52%)
Care home*	No	3819 (98.3%)	2192 (57.4%)	1627 (42.6%)	30314 (96.4%)	13965 (46.1%)	16349 (53.9%)
	Yes	65 (1.7%)	31 (47.7%)	34 (52.3%)	1135 (3.6%)	646 (56.9%)	489 (43.1%)
Living alone*	Not living alone	2729 (70.3%)	1469 (53.8%)	1260 (46.2%)	22796 (72.5%)	10318 (45.3%)	12478 (54.7%)
	Yes living alone	1155 (29.7%)	754 (65.3%)	401 (34.7%)	8653 (27.5%)	4293 (49.6%)	4360 (50.4%)
Cohabiting*	No	1754 (45.2%)	1103 (62.9%)	651 (37.1%)	13598 (43.2%)	6933 (51%)	6665 (49%)
	Yes	2130 (54.8%)	1120 (52.6%)	1010 (47.4%)	17851 (56.8%)	7678 (43%)	10173 (57%)
History of zoster*	No	3524 (90.7%)	2037 (57.8%)	1487 (42.2%)	27795 (88.4%)	12996 (46.8%)	14799 (53.2%)
	Yes	360 (9.3%)	186 (51.7%)	174 (48.3%)	3654 (11.6%)	1615 (44.2%)	2039 (55.8%)

[1] Those with immune-suppressing condition at start of follow-up excluded with minimum follow-up >=5 months IQR interquartile range IMD index of multiple deprivation * at start of follow-up

S8 Table Changes in time varying factors at start and end follow-up

Variables	Patients with information available N (%)	Patients with same information at start and end of follow-up N (%)	Patients with different exposure information at start and end of follow-up N (%)
Living alone	31449 (100%)	31427 (99.9%)	22 (0.1%)
Cohabiting	31449 (100%)	31439 (99.97%)	10 (0.03%)
Care home	31449 (100%)	31080 (98.8%)	369 (1.2%)
Marital status	19930 (63.3%)	19895 (99.8%)	35 (0.2%)

S9 Table Changes in immunosuppressive therapy/ condition during follow-up

Out of the total study population N=39120, 2818 individuals had record(s) of immunosuppressive condition/therapy during follow-up. An individual might have >1 condition at a given time; similarly one individual may be immunosuppressed at different time points during the follow-up. Number of individuals with immunosuppressive condition/ therapy record at start of follow-up was N=1494, at end of follow-up was N=1835. Individuals with a code(s) during the middle of the follow-up and not at the start or end of the follow-up was 377.

Immunosuppressive therapy or condition	**Total number* of patients with one or more immunosuppressive condition(s) or taking immunosuppressive therapy (therapies) at any time during follow-up: N=2818 (Total study population=39120)**				
	Total number of individuals with the condition*	**Patients with condition at start of follow-up & not at end-follow-up N (row%)**	**Patients with condition at end of follow-up & not at start of follow-up N (row%)**	**Patients with condition at both start & end of follow-up N (row%)**	**Patients with condition only during middle of follow-up not at start or end of follow-up N (row%)**
Oral corticosteroids	194	46 (23.7%)	45 (23.2%)	26 (13.4%)	77 (39.7%)
Other immune- suppressive drugs~	317	48 (15.1%)	51 (16.1%)	195 (61.5%)	23 (7.3%)
Lymphoma, myeloma, other plasma cell	399	75 (18.8%)	166 (41.6%)	158 (39.6%)	0 (0%)
Stem cell transplant, bone marrow transplant	12	5 (41.7%)	5 (41.7%)	2 (16.7%)	0 (0%)
Cancer radio/chemotherapy	2082	525 (25.2%)	788 (37.8%)	446 (21.4%)	323 (15.5%)
Solid organ transplant	60	0 (0%)	6 (10%)	54 (90%)	0 (0%)
Cellular immune deficiency	132	0 (0%)	57 (43.2%)	75 (56.8%)	0 (0%)
HIV	15	0 (0%)	0 (0%)	15 (100%)	0 (0%)

*an individual may have >1 condition/therapy at a given time ~includes azathioprine, biological therapy, methotrexate, 6-mercaptopurine, other immunosuppressant such as tacrolimus, sirolimus, and other disease-modifying antirheumatic drugs: ciclosporin, mycophenolate, leflunomide

S10 Table Social factors associated with zoster vaccine uptake: primary complete case analysis excluding ethnicity

Number of patients=35,333 vaccine uptake=18,499

Variables		Minimally adjusted for year of birth & gender OR (95% CI)	P value~ (PT)
Gender	Male	1.07 (1.02-1.11)	0.002
	Female	1	
Year of birth	1943 (main target group)	1	
	1934 (catch-up cohort)	0.90 (0.87-0.94)	<0.0001
Immigration status	Not immigrant	1	
	Immigrant	0.73 (0.62-0.88)	0.0005
Patient-level IMD$	Least deprived	1	
	2	0.91 (0.86-0.96)	<0.0001
	3	0.83 (0.78-0.89)	(<0.0001)
	4	0.77 (0.72-0.82)	
	Most deprived	0.66 (0.61-0.71)	
Practice-level IMD	Least deprived	1	
	2	0.76 (0.71-0.82)	<0.0001
	3	0.84 (0.79-0.90)	
	4	0.92 (0.85-0.98)	
	Most deprived	0.81 (0.76-0.87)	
Care home*	No	1	
	Yes	0.71 (0.63-0.79)	<0.0001
Living alone*	Not living alone	1	
	Yes living alone	0.82 (0.78-0.86)	<0.0001
Cohabiting*	No	0.72 (0.69-0.75)	<0.0001
	Yes	1	

OR odds ratio CI confidence interval PT P value for trend ~ likelihood ratio test IMD index of multiple deprivation $26 patients with missing patient-level IMD were replaced with practice-level IMD *at start of follow-up

S1 Text Details of determining zoster vaccination status

This is described in **Section 5.2.2.**

S1 Fig Decision flow chart for ascertaining zoster vaccine status

Please see Figure 5-1 of this thesis.

8.4 Further investigation of the likely impact of missing data

Individuals with complete covariate data were included in multivariable analysis, and this led to the exclusion of 3884 (11%) study participants with missing ethnicity data (study flow chart: Figure 1 submitted paper **Section 8.2**). As with the analyses of zoster burden presented in **Chapter 7**, the complete case analyses of the socio-demographic determinants of zoster vaccine uptake could have resulted in biased effect estimates. To assess the impact of missing data, I utilised the same approach as for the zoster disease burden analyses and conducted three additional analyses, which are described in the next section.

8.4.1 Additional analyses to assess the impact of missing data

Although the analyses were briefly discussed in the submitted paper, they are reported in detail here. These three analyses included:

(1) The baseline characteristics of patients included and excluded from complete case analysis were compared. The start of follow-up for all study participants was on the same date (01/09/2013; the start of the national zoster vaccination programme), but the reasons for end of follow-up in the two groups were also compared.

(2) Comparison of minimally adjusted analyses (adjusted for age and gender) between those included and excluded from the complete case analyses.

(3) As described above (2), minimally adjusted analyses for the association of all socio-demographic factors except ethnicity (the variable with missing data) with zoster vaccine uptake for the entire study population were also compared with the minimally adjusted estimates from the primary analysis.

8.4.2 Results of additional analyses

A comparison of the baseline characteristics of the individuals excluded and included in complete case analysis is shown in **Section 8.3** (Supplementary material: S7 Table of the submitted paper). Individuals excluded from analyses were less likely to be vaccinated (43% versus ~54% in the included group); they were also more likely (70% versus 60%) to be from the main target group (those aged 70 years) and were slightly younger at the time of registration with their GP (median age 48.9 years versus 52.9 years for the included group).

Excluded individuals were also more likely to be from less-deprived practice- and patient-level IMD, less likely to be care home residents (1.7% versus 3.6%) or to be recorded as an immigrant (0.6% versus 1.6%). The reasons for individuals' end of follow-up are shown in Table 8-1. The main differences between the two groups was that the individuals excluded from the study were less likely to die during the follow-up (0.6% versus 2.9% in the included group).They were also more likely to end follow-up at the study end date of 31/08/2015 (64% versus 59% of those included in the main analysis).

Table 8-1 Reasons for end of follow-up for patients excluded (due to missing ethnicity data) and included in complete case analysis

	Reason	Patients excluded from complete case analysis due to missing data on ethnicity N=3884	Patients included in complete case analysis N=31449
End of follow-up*	End of study	2468 (63.5%)	18667 (59.4%)
	Last collection date from practice	1229 (31.6%)	10588 (33.7%)
	Transfer out date	160 (4.1%)	1132 (3.6%)
	Death date	22 (0.6%)	897 (2.9%)
	Transfer out date and death date	5 (0.1%)	163 (0.5%)
	End of study and death date	-	2 (0%)

* All study participants started follow-up at the start of national zoster vaccination programme: 01/09/2013

A comparison of the minimally adjusted models for the association of socio-demographic factors with zoster vaccine uptake for both analyses (2) and (3) is provided in Table 8-2. The minimally adjusted effect estimates for deprivation, living alone and cohabitation from the excluded and included groups were in same direction (Table 8-2). There was some evidence that the lower uptake amongst those living alone (OR:0.62 (95%CI: 0.54-0.71)) in the excluded group was more marked compared to those included in the analysis (OR:0.85 (95%CI: 0.81-0.89)).The main differences between the excluded and the included groups were for male gender, care home residence and immigration status. The odds of uptake were lower (OR: 0.85 (95%CI: 0.74-0.96)) amongst males in the excluded group versus the slightly higher uptake (OR: 1.10 (95%CI: 1.05-1.15)) amongst males in included group (Table 8-2). There was no evidence for the association of care home residence with zoster vaccination (OR: 1.46 (95%CI: 0.89-2.39)) in the excluded group compared to lower odds of

vaccine uptake in the included group (OR: 0.66 (95%CI: 0.58-0.74)); however, the former analysis was based on only 65 individuals residing in a care home. Although the point estimates were very similar, there was also no evidence for an association of immigration status (OR: 0.76 (95%CI: 0.32-1.83) in the excluded compared to those included in analyses (OR: 0.71 (95%CI: 0.59-0.85)); as with care home residence, this latter analysis was based on only 22 individuals coded as being an immigrant.

In contrast, the minimally adjusted effect estimates for the entire study population were largely similar for all socio-demographic factors of interest to those from complete case analyses (Table 8-2).

Table 8-2 Socio-demographic factors associated with zoster vaccine uptake in minimally adjusted model: comparison of individuals excluded due to missing ethnicity data, those included in complete case analysis and total study population

Exposures		Individuals excluded due to missing ethnicity data N=3884, uptake=1661 (42.8%)		Individuals included in primary complete case analysis N=31449 uptake=16, 838 (53.5%)		Total study population N=35,333 uptake=18,499 (52.4%)	
		Minimally adjusted for age & gender OR (95% CI)	P value~ (PT)	Minimally adjusted for age & gender OR (95% CI)	P value~ (PT)	Minimally adjusted for age & gender OR (95% CI)	P value~ (PT)
Gender	Male	0.85 (0.74-0.96)	0.01	1.10 (1.05-1.15)	0.0001	1.07 (1.02-1.11)	0.002
	Female	1		1		1	
Year of birth	1943 (main target group)	1		1		1	
	1934 (catch-up cohort)	0.95 (0.83-1.09)	0.48	0.88 (0.84-0.92)	<0.0001	0.90 (0.87-0.94)	<0.0001
Immigration	Not immigrant	1		1		1	
	Immigrant	0.76 (0.32-1.83)	0.5	0.71 (0.59-0.85)	0.0002	0.73 (0.62-0.88)	0.0005
Patient-level IMD	Least deprived	1		1		1	
	2	0.78 (0.66-0.92)	<0.0001 (<0.0001)	0.92 (0.86-0.98)	<0.0001 (<0.0001)	0.91 (0.86-0.96)	<0.0001 (<0.0001)
	3	0.65 (0.55-0.78)		0.85 (0.79-0.90)		0.83 (0.78-0.89)	
	4	0.62 (0.51-0.77)		0.77 (0.72-0.83)		0.77 (0.72-0.82)	
	Most deprived	0.49 (0.37-0.64)		0.66 (0.61-0.71)		0.66 (0.61-0.71)	
Practice-level IMD	Least deprived	1		1		1	
	2	0.65 (0.54-0.78)	<0.0001	0.76 (0.71-0.82)	<0.0001	0.76 (0.71-0.82)	<0.0001
	3	0.62 (0.51-0.74)		0.86 (0.80-0.93)		0.84 (0.79-0.90)	
	4	0.56 (0.45-0.69)		0.94 (0.87-1.01)		0.92 (0.85-0.98)	
	Most deprived	0.67 (0.55-0.82)		0.81 (0.75-0.87)		0.81 (0.76-0.87)	
Care home*	No	1		1		1	
	Yes	1.46 (0.89-2.39)	0.13	0.66 (0.58-0.74)	<0.0001	0.71 (0.63-0.79)	<0.0001
Living alone*	Not living alone	1		1		1	
	Yes living alone	0.62 (0.54-0.71)	<0.0001	0.85 (0.81-0.89)	<0.0001	0.82 (0.78-0.86)	<0.0001
Cohabiting*	No	0.65 (0.57-0.74)	<0.0001	0.73 (0.70-0.77)	<0.0001	0.72 (0.69-0.75)	<0.0001
	Yes	1		1		1	

OR odds ratio CI confidence interval PT P value for trend ~ likelihood ratio test IMD index of multiple deprivation *at start of follow-up

8.4.3 Conclusions from additional analyses to assess the impact of missing data

As mentioned in **Section 8.4.1**, owing to missing ethnicity data it was only possible to compare effect estimates adjusted for gender and age between the total study population and the groups excluded and included in the complete case analyses. Within the complete case analyses (Table 2 of the submitted paper, **Section 8.2**), the estimates for all socio-demographic factors (except for immigration status) remained largely unchanged from minimally adjusted estimates to those from the multivariable model (Model 3: adjusted for age, gender, ethnicity, immigration, deprivation, care home residence and living alone). Further adjustment for other socio-demographic factors in the analyses for the excluded individuals, has this been possible, would not have altered appreciably the effect estimates reported in the minimally adjusted model for these individuals (other than immigration status). The minimally adjusted model including all (excluded and included) individuals provides effect estimates that are likely to be similar to those that could have been obtained in a fully adjusted model (data permitting).

In the excluded group, there was no evidence for the effect of immigration status, unlike the included group, though the point estimates were very similar. However, this could have been due to lack of power and perhaps due to poorer capture of immigration status amongst these individuals who were missing ethnicity data. It was also not feasible to adjust the effect of immigration on uptake for ethnicity, which in the main analysis suggested that the effect of being an immigrant was confounded by ethnicity. Similarly, the differences in the minimally adjusted estimates for care home residence amongst the two groups could be explained due of lack of power in the excluded group. For the total study population, on the other hand, there were no appreciable changes in the minimally adjusted effect estimates for these factors compared to those observed in the complete case analyses.

The effect of gender (with lower odds of uptake amongst men) on vaccine uptake in the minimally adjusted analysis for the excluded group is interesting. As described in the submitted paper (**Section 8.2**) the effect of gender on vaccination in the routine and catch-up cohort was examined by adding an interaction term to the main analyses (Table 4 of the

submitted paper, **Section 8.2**), the results of which are reproduced below as Table 8-3 for comparative purposes. In the main analysis, there was strong evidence that the effect of gender was different in the two age groups, with higher vaccine uptake amongst males being restricted to the catch-up cohort.

Table 8-3 Interaction between age and gender: complete case primary analysis

	Gender	Total N (column %)	Zoster vaccinations N (row %)	Stratum-specific adjusted# OR for zoster vaccination (95%CI)	P-value for interaction*
Main target group	Males	9059 (48.4%)	4977 (54.9%)	1.00 (0.95-1.06)	<0.0001
	Females	9677 (51.6%)	5303 (54.8%)	1	
Catch-up cohort	Males	5786 (45.5%)	3156 (54.5%)	1.22 (1.13-1.31)	
	Females	6927 (54.5%)	3402 (49.1%)	1	

Final Model 3 from Table 2 of the paper (Section 8.2) OR odds ratio CI confidence interval *likelihood ratio test

As mentioned in **Section 8.4.2**, the excluded group contained a higher proportion of individuals belonging to the routine cohort (70% versus 59.6% in the included group). When further stratified by gender, the majority of excluded males were also from the routine cohort (1305/1788, 73%). Similar to the main analysis, I examined the effect of gender in the excluded cohort stratified by age by adding an interaction term to the minimally adjusted analysis (Table 8-4).

Table 8-4 Interaction between age and gender amongst individuals excluded from analysis

		Total N (column %)	Zoster vaccination N (row %)	Stratum-specific OR for vaccine uptake	P value of interaction
Main target group	Males	1305 (33.6)	530 (40.6)	0.83 (0.71-0.96)	0.56
	Females	1417 (36.5)	642 (45.3)	1	
Catch-up cohort	Males	483 (12.4)	196 (40.6)	0.90 (0.71-1.14)	
	Females	679 (17.5)	293 (43.2)	1	
Total		**3884 (100)**	**1661 (42.8)**		

As shown in Table 8-3, in the main analysis, there was no evidence for an effect of gender on uptake in the routine cohort. However, amongst the excluded individuals, the stratified analysis (Table 8-4) revealed a lower uptake amongst men compared to women in the

younger (routine) group with little evidence of an effect of gender in the catch-up cohort, although assessment of the latter was limited by small numbers. As the excluded individuals included a higher proportion (73%) of males from the routine cohort (Table 8-4), this may have explained why, overall, there was no increased odds of vaccination among males in the excluded group, if the effect of increased uptake in older males was being diluted by a higher proportion of younger males. It is also possible that males excluded from the analyses because of missing ethnicity data could comprise those with low health-seeking behaviour, who were possibly less likely to come forward for vaccination. However, for the total study population, in keeping with the findings for other socio-demographic factors, there was no appreciable difference for the effect of gender in the minimally adjusted analysis to that observed in the complete case analyses. Moreover, the national surveillance data for 2013-2015, which captured coverage data from almost all practices in England, also found increased uptake amongst men in the catch-up cohort but very similar uptake among males versus females in the routine cohort.[68, 69] This is in keeping with the findings of my primary complete case analysis.

8.5 Inadvertent zoster vaccination amongst immunosuppressed individuals

As discussed in previously in **Section 1.2.6**, currently only live zoster vaccine is available in the UK, which is contraindicated for those with immunosuppressive conditions or taking immunosuppressive therapies. A secondary objective of this cohort study (**Section 8.2**) was to assess inadvertent zoster vaccination amongst immunosuppressed individuals to quantify the magnitude of possible violations of the UK zoster vaccination guidelines.[60]

The methods to identify individuals who had an immunosuppressive condition/therapy that is a contraindication for the live zoster vaccine were described in **Chapter 5** (**Sections 5.3.2** and **5.3.3**). Inadvertent zoster vaccination was discussed briefly in the submitted journal paper (**Section 8.2**). Details about the number and the type of immunosuppressive conditions/therapy at the time zoster vaccination are provided here. The rationale for this further characterisation was that this information could be useful in increasing awareness of primary care healthcare providers about contraindications to zoster vaccination.

Of the 19,330 individuals in the total study population who received vaccination, 3% (n=596) received zoster vaccine whilst they were immunosuppressed. Of these 596 individuals, the majority (95%; n=568) had only one immunosuppressive condition and/or therapy at the time of vaccination (Table 8-5). Amongst individuals with single immunosuppressive condition/ therapy, the commonest condition was a recent receipt of cancer radiotherapy or chemotherapy (n=425; 75% of the total) followed by use of other non-steroid immunosuppressive drugs (n=56; 10%).

Table 8-5 Individuals with one immunosuppressive condition at the time zoster vaccination

Immunosuppressive condition/ therapy	Number of individuals with zoster vaccinations
Cancer radio/chemotherapy	425 (74.8%)
Other immunosuppressive drugs	56 (9.9%)
Haematological malignancies	37 (6.5%)
Oral steroid (immunosuppressive doses)	25 (4.4%)
Cellular immune deficiency	20 (3.5%)
Solid organ transplant	4 (0.7%)
HIV	1 (0.2%)
Total	**568 (100%)**

A further 26 individuals (4% of the total 596) had two immunosuppressive conditions and/or therapy at the time of vaccination, most of these individuals (n=18; 69% of the total) were also those who had recently received cancer chemotherapy or radiotherapy (Table 8-6).

Table 8-6 Individuals with two immunosuppressive conditions at the time zoster vaccination

Immunosuppressive condition/ therapy	Number of individuals with zoster vaccinations
Cancer radio/chemotherapy & haematological malignancies	9 (34.6%)
Cancer radio/chemotherapy & other immunosuppressive drugs	5 (19.2%)
Cancer radio/chemotherapy & oral steroids	3 (11.5%)
Cellular immune deficiency & other immunosuppressive drugs	3 (11.5%)
Solid organ transplant & other immunosuppressive drugs	3 (11.5%)
Cellular immune deficiency & haematological malignancies	2 (7.7%)
Cancer radio/chemotherapy & solid organ transplant	1 (3.8%)
Total	**26 (100%)**

Only two individuals (0.3% of the total 596) had three immunosuppressive conditions (Table 8-7). This indicates that the presence of more than one immunosuppressive conditions at the time zoster vaccination was less likely to lead to the breach of vaccination guidelines.

The possibility of misclassification of immunosuppressive status resulting in overestimation of violations of vaccine policy is discussed in **Chapter 9**.

Table 8-7 Individuals with three immunosuppressive conditions at the time zoster vaccination

Immunosuppressive condition/ therapy	Number of individuals with zoster vaccinations
Cancer radio/chemotherapy & other immunosuppressive drugs & solid organ transplant	1 (50%)
Cancer radio/chemotherapy & other immunosuppressive drugs & haematological malignancies	1 (50%)
Total	**2 (100%)**

8.6 Potential misclassification of individuals eligible for zoster vaccination

As the month of birth for adults was unavailable in CPRD (**Section 3.5.3**), individuals born in 1943 (or 1934 for the catch-up cohort), who would have been eligible for the vaccine in 2013/14 (if born between January-August) or in 2014/15 (if born between September-December) were selected (Figures 3-9 and 3-10). For the primary analysis individuals included in the study were required to have a minimum follow-up of 5 months, while individuals who completed the follow-up for the entire study period i.e. 24 months were included in the secondary analysis (Figure 1 of the submitted paper, **Section 8.2**). It is possible that some individuals born between September- December (Figures 3-9 and 3-10) were only followed up for the first 5 months of the study period (September 2013- January 2014). These individuals would not have been eligible for zoster vaccination during the period (2013/14) that they contributed data for primary analysis. Inclusion of these ineligible individuals would have biased the ORs towards null. I examined this in a secondary analysis of individuals who were followed-up for the entire study period i.e. 24 months (Table 4 of the submitted paper, **Section 8.2**). The results of multivariable analyses were similar to those of

the primary analysis except the lower odds of uptake amongst non-White ethnicities were attenuated. This may indicate that the effect estimates from the primary analysis perhaps better capture early adopters of vaccination and that specific socio-demographic groups may come forward later. It is therefore important to repeat the analysis of vaccine uptake as the campaign continues to observe temporal changes in the inequalities of vaccine uptake identified in the first two years of the vaccination programme.

8.7 Double inequalities

Having completed investigations of socio-demographic determinants of both zoster disease burden and zoster vaccine uptake, it was possible to identify individuals from specific socio-demographic groups who were "doubly disadvantaged" (**Section 1.3.4**) i.e. at increased risk of developing zoster and also having lower zoster vaccine uptake. The two such groups identified (Table 8-8) included individuals residing in care homes and older females (Table 8-3). These individuals could be specifically targeted with more personalised interventions to reduce vaccination inequalities. This is discussed further in **Section 9.4**.

Table 8-8 Strength of association of social determinants with zoster disease burden and vaccine uptake

Social determinants	First zoster episode 2003-2013 aIRR (95% CI)	Zoster vaccine uptake 2013-2015 aOR (95% CI)	Evidence for double inequality~
Gender: Females versus males	1.17 (1.14-1.20)	0.92 (0.88-0.97)	Yes
Care home residence: Care home residence versus non-residence	1.10 (1.04-1.17)	0.64 (0.57- 0.73)	Yes
Ethnicity: Black ethnicity versus White	0.49 (0.41-0.59)	0.61 (0.49-0.75)	No
Immigration: Immigrant versus non-immigrant:	0.77 (0.67-0.88)	0.94 (0.77-1.14)	No
Deprivation: Most deprived versus least deprived	0.96 (0.92-0.99)	0.69 (0.64-0.75)	No
Living alone: Living alone versus not living alone	0.96 (0.94-0.98)	0.85 (0.81-0.90)	No

aIRR adjusted incidence risk ratio aOR adjusted odds ratio CI confidence interval ~ higher disease burden and lower vaccine uptake

8.8 Chapter summary

This chapter comprises a report of the social determinants of zoster vaccine uptake amongst older individuals in England and formed the last chapter of the Results section. In the last chapter of this thesis, **Chapter 9,** I discuss the overall findings from studies carried out in this thesis, and give an overview of the strengths and limitations of this work. The implication for future research and public health are also described.

Chapter 9. Overall discussion & conclusions

The first section of this chapter briefly recapitulates the overall aims and objectives of the thesis, provides a synopsis of the main results and discussion points from the more detailed description presented under the Results section and also describes the overall strengths and limitations of this work. The second section of this chapter explores the implications of this work for public health and future research.

9.1 Recapitulation of the aims and objectives of the thesis

The overall aim of this thesis was to assess inequalities in vaccine-preventable disease burden and vaccine uptake in older individuals using routinely collected EHR and to contribute towards achieving the goal of health equality. The objectives of this thesis (Table 1-2) were: to identify from the existing literature which socio-demographic factors were associated with vaccine uptake amongst older individuals (**objective 1**); to develop methodology for the ascertainment of socio-demographic factors and to assess their recording in the linked UK EHR of older individuals (**objective 2**), and then using the linked EHR to describe socio-demographic factors associated with zoster disease incidence (**objective 3**) and zoster vaccine uptake in England (**objective 4**).

9.2 Summary of main findings

9.2.1 Which socio-demographic factors are associated with uptake of routinely administered vaccines amongst older individuals in Europe?

What was previously known?

A previous review described associations of social factors such as socio-economic level, education, marital status, urban or rural area of residence and ethnicity with uptake of a single vaccine: seasonal influenza vaccine.[156] No overall effect estimates for the associations with vaccine uptake, or assessment of between-study heterogeneity, were provided.

What does this thesis add?

The comprehensive systematic review (published paper: **Chapter 2**) conducted to meet the first objective of this thesis, examined the association of uptake of all routinely administered vaccines amongst older individuals with a wide range of socio-demographic factors: living alone, religion, immigration status, residence (rural/ urban), marital status, education, income, vaccination costs, social class and area-level deprivation. This was also the first review to quantify the association of these factors with vaccine uptake, using meta-analysis. Furthermore, a detailed quality assessment of the published literature and exploration of the reasons for between-study heterogeneity using meta-regression were conducted. The review identified 35 eligible studies, which quantified the association of socio-demographic factors with seasonal influenza, pneumococcal, zoster and pandemic influenza vaccination. One key factor identified in this review to be associated with seasonal influenza vaccine uptake was living alone, which is emerging as a broader determinant of healthy ageing.[15, 157] Higher seasonal influenza vaccine uptake was observed amongst individuals not living alone while lower uptake of this vaccine was observed amongst individuals from more deprived areas and immigrants. The studies included in the review had low risk of bias due to exposure or outcome misclassification, but had a higher risk of confounding bias. However, multivariable meta-regression analysis undertaken to investigate between-study heterogeneity for the effect of education (a social factor with sufficient studies to conduct meta-regression) with seasonal influenza vaccine uptake indicated that heterogeneity in study findings was partly explained by vaccination costs and by confounding bias.

9.2.2 To develop methodology for ascertainment of socio-demographic factors and to assess their availability in EHR amongst older individuals

What was previously known?

Methodologies to improve ascertainment of social determinants of health in EHR are required to allow utilisation of these databases for researching health inequalities on an

ongoing basis and to also provide insights into improving data quality. The quality and completeness of recording for one social factor, ethnicity, had been assessed in linked CPRD data.[137] However, data for the completeness of recording of ethnicity specifically for older individuals were unavailable and this previous evaluation was conducted mainly during the period when general practitioners were incentivised to record ethnicity. Some other studies have utilised EHR in the UK to assess time-varying factors such as residence in a care home and cohabitation.[136, 141, 143, 144] However, these studies did not did not report the timeliness or representativeness of recording of these factors and did not utilise primary care data linked to hospitalisation data.

What does this thesis add?

Methodology was developed for assessing the recording of socio-demographic factors, which could potentially be determinants of health inequality, including disease burden and health care interventions. In addition to ethnicity and small area-level deprivation, six other socio-demographic factors were assessed: religion, immigration status, marital status, place of residence, living alone and cohabitation (living as a couple). The quality of recording of these factors was evaluated using four pre-set standards: completeness, representativeness, timeliness (when appropriate) and the contribution made by linkages to EHR in addition to primary care data. The completeness of recording for these factors varied considerably from 2.6% (for religion) to 79.4% for ethnicity. The recording of ethnicity, care home residence, and living arrangements (living alone and cohabitation) was comparable to the 2011 English Census data. Despite using country of birth and “first language” codes, the number of individuals coded as immigrants was under-ascertained in these data compared to the 2011 English Census (as detailed in **Chapter 6**). Timeliness (recording within the last five years of date of interest) for time-varying factors ranged from ~35% to ~60%. Linkages to other datasets improved the availability of ethnicity data from ~55% in CPRD to ~79% using both CPRD and HES; while deprivation data were only available as linkage.

This thesis demonstrated that linked CPRD data can be successfully utilised for ascertainment of socio-demographic factors. Based on the analyses reported in **Chapter 6**, ethnicity, care home residence, living arrangements (living alone and cohabitation) and

deprivation can be assessed in these data as potential socio-demographic determinants of inequalities amongst older individuals. Some factors, such as religion and marital status, were found to be poorly captured in these data. GP incentivisation plays an important role in completeness of these records as was exemplified by the recording of ethnicity. Incentivisation of GPs for recording of other socio-demographic factors and linkages with other data sources may help to improve the completeness of these data.

9.2.3 Health inequalities and social determinants of zoster disease burden

What is already known on this topic?

The zoster vaccination programme was introduced in September 2013 in the UK. To make a comprehensive assessment of the impact of zoster vaccination on zoster disease burden, studies to identify any disparities in zoster burden in the pre-vaccination period are required. Although certain co-morbidities and immunosuppressive therapies are known to be associated with high risk of zoster, the social determinants for zoster disease burden in England, which may contribute to inequalities, are not well known.

What this study adds

Inequalities in zoster disease burden were seen amongst individuals aged ≥65 years in England during the ten-year period prior to vaccine introduction (2003-2013). In multivariable analyses, older individuals identified at a higher risk of zoster burden included females (16% higher rate compared to males), non-immigrants (~30% higher rate than immigrants) and White ethnicity (for example, twice the rate compared to those of Black ethnicity). Individuals residing in a care home were also at a 10% higher risk of zoster. Individuals living in the most deprived areas compared to least deprived were at a slightly (4%) lower zoster risk, as were the older individuals living alone versus those not living alone. Adjusting for certain co-morbidities, immunosuppressive conditions and therapeutic agents (potential mediators of the effect of socio-demographic factors on zoster risk) made little difference to the effect estimates for any of the socio-demographic factors but were themselves associated with appreciable increased risk of zoster. Identification of the social determinants of zoster disease burden in the pre-zoster vaccination era amongst older individuals revealed an interesting picture. As anticipated, older age, female gender and care home residence were associated with a higher zoster disease burden. However, individuals with a higher level of

deprivation, non-White ethnicity, immigrants and individuals living alone were at a lower risk of a first zoster episode, although these social groups are usually considered to be at higher risk for infectious diseases. The associations of older age, female gender, care home residence, White ethnicity, and being a non-immigrant with higher zoster incidence are biologically plausible, as discussed in **Chapter 7**, and the appreciably increased risks of zoster among individuals with immunosuppressive conditions or therapies have been shown in previous research. The slight decreased risk of zoster associated with both living alone and living in the most deprived areas was a surprising finding and one which is difficult to explain. It is feasible that these individuals might have had zoster episodes before the age of 65 years that were poorly captured in the historical GP data when these individuals registered with a new GP.

9.2.4 Health inequalities and social determinants of zoster vaccine uptake

What is already known on this topic?

The national zoster immunisation programme was introduced in England on 1 September 2013, which targeted individuals aged 70 years (routine cohort) with a catch-up cohort of older individuals aged ≤79 years. Vaccine uptake during first year of introduction (2013-2014) was ~61% and gradually reduced to ~55% (2015-2016). The national data provide coverage information using aggregated GP data for gender with limited ethnicity data and coverage by deprivation at the general practice level (as an ecological factor). Uptake was reported to be lower amongst females for the period 2013-2015, and for individuals of most non-White ethnicities and those registered with general practices in more deprived areas (2014-2015).

What this study adds

In multivariable analyses, 36% lower zoster vaccine uptake was observed amongst individuals residing in care homes, 15% lower uptake amongst individuals living alone and 11% lower uptake amongst those in the catch-up cohort. In contrast to the national data, which utilised aggregated GP data, this study reported the association of social factors such as ethnicity and deprivation at an individual level. Lower vaccine uptake was observed amongst individuals of non-White ethnicity (for example, individuals of Black ethnicity had 39% lower uptake compared to individuals of White ethnicity)- confirming the findings of the previous analysis of national data. Conversely, immigration status was not associated with zoster vaccine uptake

after adjusting for ethnicity. Unlike the analysis of the national surveillance data that provided information on deprivation at the general practice level, this study found decreasing vaccine uptake with increasing patient-level deprivation (p value for trend <0.0001) with 31% lower uptake amongst the most deprived patient-level IMD versus the least deprived IMD. Higher uptake (22%) was also observed for males in the catch-up cohort. Using the results of zoster burden analysis, it was possible to identify individuals with double inequalities (lower uptake and higher disease burden); two such groups identified included individuals residing in care homes and older females.

Inadvertent zoster vaccination amongst individuals whilst they were immunosuppressed was observed for ~3% of the study population. This finding should be useful for increasing awareness amongst health care professionals about contraindications to the administration of this live vaccine.

9.3 Strengths and limitations

The strengths and weaknesses of the systematic review and of the three studies conducted to meet the other objectives of this thesis were comprehensively discussed in the specific chapters: **Chapter 2** and **Chapters 6-8**, respectively. Here an overview of the strengths and limitations of this thesis are presented.

9.3.1 Strengths

9.3.1.1 Large primary care database linked to other data sources

All three studies conducted to meet the study objectives utilised a primary care database: CPRD, which is one the world's largest quality-assured databases and is broadly representative of the UK population. The large sample sizes of these studies were feasible owing to this large database, allowing reduction of random error with more accurate estimation of effect estimates. The use of CPRD also allowed for a good capture of zoster vaccination data, as the NHS zoster vaccination programme is delivered via primary care. There was sufficient power to study the association of multiple exposures with the outcome of interest and to include hypothesized mediating variables in the statistical models.

Using primary care data linked to hospitalisation data facilitated and improved assessment of socio-demographic factors, incident zoster (the outcome in the zoster burden analysis), co-morbidities and other covariates of interest. Similarly, linkage to deprivation data provided small area-level deprivation status for the study participants. The availability of long-term data for participants also allowed the exposure and co-morbidities to be time-updated.

9.3.1.2 Conceptual frameworks and ascertainment of socio-demographic factors

Pre-defined conceptual frameworks were used in all three observational studies and the systematic review, which facilitated the study of the inter-relationships between the main exposures, hypothesized mediating variables and the outcomes of interest. These frameworks were an adaptation of the conceptual framework proposed by the WHO's Commission on Social Determinants of Health, which assesses the complex association of social determinants of health with health inequalities.[4] Use of these pre-specified frameworks allowed hierarchical causal modelling, adjustment for confounding variables and appropriate interpretation of effect estimates.

The details of the methodology developed to identify socio-demographic factors amongst older individuals in EHR were provided in **Chapter 6**. This methodology provides a resource for the research community for the assessment of inequalities amongst older individuals for different conditions and interventions. The development of code lists for socio-demographic factors utilised in this thesis was an iterative process that also utilised the hospitalisation data. This involved extensive use of codes across data sources including innovative use of "first language" codes to help identify immigration status. Time updating these factors, when appropriate, to minimise exposure misclassification and the comparison of recording of the socio-demographic factors in EHR with the standard national data (Census data) provided reassurance about the representativeness of some of these data.

9.3.1.3 Study designs and analyses

Suitable study designs, feasible in routinely collected data, were chosen to address the study objectives appropriately. To identify the social determinants of zoster disease burden and zoster vaccine uptake (**objectives 3** and **4**, respectively) cohort studies were used. Use of a cohort study design for identifying inequalities in zoster disease burden permitted the

assessment of incidence rates and incidence rate ratios. Similarly, a cross-sectional study design, which is an efficient way to assess the prevalence of social factors' recording in the EHR (**objective 2**), was also utilised.

The use of meta-analyses in the systematic review (**Chapter 2**) made it feasible to quantify the association of socio-demographic factors with vaccine uptake amongst older individuals and provided summary effect estimates (**objective 1**). For the zoster burden and vaccine uptake analyses, exposures of interest were mutually adjusted in multivariable analyses, for example inclusion of both ethnicity and immigration status in the models estimated the association of these two factors with the outcome of interest independent of each other. However, for other closely related socio-demographic factors, for example living alone and cohabitation (living as a couple), where collinearity issues precluded the simultaneous inclusion of these factors, sensitivity analyses with these individual factors allowed the ascertainment of their association with the outcome. It was also possible to study numerous hypothesized mediating variables (co-morbidities and immunosuppressive conditions/therapies in the burden study) and other covariates of interest (seasonal influenza vaccine uptake and past history of zoster) in the uptake study. Although unavailability of complete date of birth in the EHR (discussed in **Chapter 3**) precluded the estimation of person-time at risk for the vaccine uptake analyses, sensitivity analyses allowed for the ascertainment of time varying factors at both the start and end of the follow-up of the study.

9.3.2 Limitations

9.3.2.1 Information bias and misclassification

The possibility of both non-differential and differential misclassification of the socio-demographic factors and of the zoster episode or vaccination, and the implications of any misclassification, were discussed in detail in **Chapters 6**-**8**. Misclassification of exposures, outcomes and other covariates may occur in a number of ways in routinely collected EHR. This may occur due to coding errors, incomplete capture of some factors by healthcare personnel or may also be due to misdiagnoses of zoster or co-morbidities. It is also possible to misclassify time-varying factors if they are not updated in a timely way in these data.

Misclassification of the binary variables may also occur if the assumption that absence of codes indicate absence of those characteristics is incorrect.

If the misclassification of these factors was non-differential with respect to vaccine uptake or zoster incidence, this may have underestimated the effect estimates in this study. Although not investigated specifically for zoster, in general the validity of diagnostic codes in CPRD is reported to have a high positive predictive value;[118] also as mentioned in the Introduction (**Section 1.2.4**) the positive predictive for the clinical diagnosis of zoster is reported to be high (91%-100%).[50, 51] The use of these primary care data also maximises the ascertainment of zoster vaccination which is delivered through primary care.

I will now highlight specific issues, previously discussed in **Chapters 6-8**, which are pertinent to the analyses conducted in this thesis.

In the zoster burden analysis, ascertainment bias was feasible if zoster episodes were differentially assessed amongst individuals who might not come forward for clinical care, such as individuals from areas that are more deprived or those living alone. This differential misclassification could have led to underestimation of the zoster disease effect estimates in this thesis. It is also feasible that some milder cases of zoster are not captured in these data and the association reported in this thesis are applicable to zoster cases severe enough to warrant a GP consultation. However, a previous US study has shown that older individuals with zoster are likely to seek medical advice irrespective of their social circumstances, minimising the possibility of differential misclassification.[85] For both the zoster burden and vaccine uptake study, it was possible that individuals coming forward with zoster symptoms or for vaccination might be more likely to have their socio-demographic factors recorded, biasing the effect estimates for a factor for which an absence of code was treated as the absence of the characteristics (immigration status) or resulting in missing data and exclusion of the individual from multivariable analyses. Although in this thesis the recording of factors such as ethnicity, care home residence and living arrangements in the linked CPRD data were comparable to the prevalence recorded in the 2011 English Census data, factors such as immigration status, religion and marital status appeared to be under-ascertained. The effect of marital status could not be assessed for both burden and uptake analyses due to

missing data but results were available for other two closely related factors: living alone and cohabitation.

The association of immigration with burden of zoster (aRR 0.77 (0.67-0.88) versus non-immigrants) could be biased due to under-ascertainment of immigration status in these data. However, if such misclassification was non-differential with respect to zoster risk, this would not explain the protective effect. I also tried to capture immigration status using the "first language" codes (as described in **Section 6.4**), which were included as GPs were incentivised to record first language spoken for all registered patients between 2008-2011.[138, 139] This could have led to preferential capture of immigrants who moved from non-English speaking countries, a heterogeneous group, with varying age of acquiring primary infection and zoster risk. For the zoster vaccine uptake study, the lower odds of vaccine uptake in the minimally adjusted model amongst immigrants was attenuated after adjusting for other variables including ethnicity. As with the burden analyses, the lower uptake amongst immigrants observed in the minimally adjusted model could not be explained if the misclassification of immigration status was non-differential with respect to uptake. The attenuation after adjusting for ethnicity may have been due to confounding of the effect of immigration status by ethnicity, although the inability to detect an effect due to lack of power is also a possibility as there were only 1.4% (n=514) individuals were coded as immigrants for the primary analysis (Table 1 submitted paper **Section 8.2**).

For defining the immunosuppressive period, I included a period of three months prior to the appearance of first code for immunosuppressive therapies in CPRD to account for coding delays based on the assumptions that these therapies were initiated in hospitals. This assumption may be incorrect for some individuals prescribed high doses of oral corticosteroids for conditions such as chronic obstructive pulmonary disease, which may be initiated by GPs. I could have therefore overestimated the proportion of individuals who were vaccinated during a period of immunosuppression. For the burden analyses, for which immunosuppressive agents were considered as potential mediators between socio-demographic factors and zoster incidence, this misclassification could have resulted in attenuation of any mediating effect of immunosuppression on zoster incidence. Conversely,

for other immunosuppressive therapies given entirely in secondary care such as cancer radiotherapy, I might have underestimated periods of immunosuppression.

Another limitation of using these data was the potential misclassification of individuals eligible for zoster vaccination due to unavailability of month of birth for adults. As detailed earlier in **Section 8.6**, it was possible that effect estimates in the primary analyses were underestimated due to the potential inclusion of some individuals born in the later part of 2013-2014 and only followed-up for the first 5 months of the study period (September 2013-January 2014) who would not have been eligible for vaccination in 2013-2014. However, the secondary analysis of individuals who were followed-up for the entire study period (24 months) revealed similar results to the primary analysis except that the lower uptake amongst non-White ethnicities was attenuated. Similarly, the person-time at risk for vaccination could not be ascertained due to the lack of availability of date of birth. As person-time at risk for vaccination could not be determined, to determine study participants eligible to receive the live zoster vaccine and to ascertain the status of other time-varying factors of interest, I chose the option of using immunosuppressive status and time-varying social factors at the start of follow-up. I chose this option based on the assumption that in this older group of individuals the changes in their sociodemographic and immune status was likely to small during the two-year study period. This assumption might not have been correct for some factors such as living alone or cohabitation or some individuals might have initiated immunosuppressive treatment during follow-up. Therefore, to assess the impact of misclassification resulting from these variables not being time updated during the 2-year study period, I reassessed effect estimates in sensitivity analyses based on the status of these factors at the end of follow-up (Table 3, submitted paper **Section 8.2**) . These sensitivity analyses did not reveal any appreciable differences from the main analysis.

For defining individuals eligible for zoster vaccination, the other option that I could have used to reduce misclassification of immunosuppressive status was to exclude all individuals with immunosuppressive conditions/therapies code at any time during the follow-up to determine the number of people eligible for vaccination. As shown in S9 Table (supplementary material to the published paper, **Section 8.3**) out of the total study population (N=39120), 2818 (7.2%) individuals had one or more code(s) for immunosuppressive condition(s) at some

time point during the follow-up. Of these 2818 participants, 1494 and 1835 individuals had one or more of these codes at start or end of follow-up, respectively. The number of individuals who had code(s) for these conditions only during the middle of follow-up was very small (n= 377).

9.3.2.2 Selection bias and missing data

The study population selected for all the studies conducted to meet this thesis's objectives were derived from the CPRD, which is largely representative of the UK population.[114] Although all individuals meeting the eligibility criteria were included in the cohort studies (inequalities in zoster incidence and zoster vaccine uptake) conducted in this thesis, selection bias could have resulted by excluding individuals with missing data. Complete case analyses were used for the two cohort studies after excluding participants with missing data for ethnicity. This led to inclusion of ~83% (n=711,590) and ~89% (n=31,449) of study population in the primary analysis for the zoster burden study (**objective 3**, **Chapter 7**) and the zoster vaccine uptake study (**objective 4**, **Chapter 8**), respectively. The additional analyses conducted to assess the impact of missing data and the conclusions from these analyses were detailed for both burden and uptake cohort studies in **Sections 7.4** and **8.4**, respectively. Here I discuss some salient features of these analyses.

For the burden analyses, it is feasible that complete case analyses might have under-estimated the effect of living alone on zoster disease burden. Amongst the excluded group with missing ethnicity data, the minimally adjusted model (adjusted for age, gender and time) (**Section 7.4.2**) for the effect of living alone on zoster incidence revealed a slightly larger protective effect (aRR 0.85 (95%CI: 0.80-0.90) compared to the similar model from the complete case analyses (aRR 0.95 (95%CI: 0.93-0.97) and that from the total study population (aRR 0.93 (95%CI: 0.91-0.95).

Similarly, in the zoster vaccine uptake study (as detailed in **Section 8.4**), there was evidence for lower uptake amongst men in the minimally adjusted model (adjusted for age) (Table 8-2, **Section 8.4.2**) in the group excluded from analyses due to missing ethnicity data. The effect of gender between the routine and catch-up cohort was assessed by adding an interaction term to the primary analysis (Table 8-3) which revealed that the higher uptake was confined

to men from the catch-up cohort with no effect in the routine cohort. The excluded group largely consisted of younger individuals from the routine cohort (70% versus 60% in the included group). The excluded group also had higher proportion (73%) of men from the routine cohort, who had lower uptake compared to women (Table 8-4). However, the finding of higher zoster vaccine uptake amongst older men (catch-up cohort) in the main analysis in this thesis also echoes the findings of the national surveillance data, which did not suffer from missing data as discussed previously in **Section 8.4.3**.

Apart from the complete case analyses for dealing with missing data, I could have utilised multiple imputation. Imputing missing values is appropriate if the data are missing at random. However, I did not use this technique as the assumption of missing at random might not have been valid in these analyses, for example, lack of ethnicity recording could possibly be due to less health seeking behaviour with less contact with health services and thus less opportunity for vaccination. As an alternative to multiple imputation, I conducted series of sensitivity analyses to examine the effect of missing data on effect estimates.

Finally, the association of factors such as religion and marital status with zoster incidence and vaccine uptake could not be examined owing to missing data. As mentioned before, it was feasible to look at the association of other factors closely related to marital status: cohabitation and living alone in both these analyses.

9.3.2.3 Other factors

The association of vaccine uptake with other social factors relevant at an individual level, identified in the WHO's CSDH conceptual framework (**Section 1.1.1**), that were examined in the systematic review (**Chapter 2**) included education, income and social class. These social factors could not be assessed in the zoster vaccine uptake and burden analyses due to their unavailability in the linked CPRD data.

Similarly, I could not examine the association of mediating behavioural factors (cultural factors, knowledge, beliefs and attitudes) with vaccination inequalities, as they were unavailable in these data. These factors are likely to play a role in vaccine uptake in older populations, as has been shown for influenza vaccination.[156, 158] Identification of these factors would have provided a more comprehensive picture about the social determinants of

vaccination inequalities and would allow better implementation of specific interventions. This would have also provided a better understanding of lower uptake amongst certain socio-demographic groups such as care home residence or individuals living alone. For care homes, mediating factors at both individual- and care-home level need exploration. Co-morbidities could also be potential mediators of the association between social characteristics and vaccine uptake or burden of disease. I examined certain co-morbidities, identified as risk factors for zoster in a previous study, as possible mediators for the association between socio-demographic factors with zoster burden, but they did not appear to explain the associations that were seen. Unlike influenza vaccine, there are currently no recommended clinical risk groups for targeting with the live zoster vaccine that would prompt GPs to offer the vaccine to individuals with specific co-morbidities. It is possible that, as individuals with co-morbidities are more likely to have repeated contacts with their GPs, this may have provided a window of opportunity for vaccinations. However, this seems unlikely to explain some of the associations seen, such as the higher uptake in males compared to females in the catch-up cohort.

9.3.2.4 Confounding

Adjusted effect estimates could have residual confounding from misclassification of social factors that were acting as confounders of other factors- for example, as observed for the zoster vaccine uptake analyses, the association of immigration status (lower odds of uptake amongst immigrants) with zoster vaccine uptake observed in the minimally adjusted analysis (adjusted for age and gender, **Section 8.2**, Table 2) was attenuated after adjusting for ethnicity. It is therefore feasible that association observed between immigration and uptake could potentially have residual confounding if ethnicity was misclassified. Residual confounding could have also occurred from unmeasured social factors such as religion, education, or an individual's income.

9.3.2.5 Reverse causality

In the zoster disease burden study, it is possible that some exposures might have resulted from the outcome, for example if individuals develop PHN, this may affect their social life, ability to work and eventually determine their socio-economic status. However, in this thesis

first zoster episode was defined as the outcome of interest and individuals with a past history of zoster were excluded from the analyses. Secondly, this may also be less likely in view of the study population consisting of older individuals, many of whom would have already retired from work.

9.3.2.6 External validity

The demographic group of interest for the aims and objectives of this thesis was the older UK population and therefore all studies conducted in this thesis incorporated older age as an eligibility criterion. In this thesis, the social determinants of the burden of a first zoster episode and zoster vaccine uptake were ascertained for individuals from England. The results are potentially generalizable to older individuals from countries with universal healthcare access and a national zoster vaccination programme as seen in the UK. The generalisability of equity-related outcomes is more likely if there is a biological basis for the association, as seen here for the burden analyses. For vaccine uptake, although knowledge and behavioural factors play a role, the findings from the vaccine uptake study are in keeping with the results from the systematic review (**Chapter 2**) which presented summary estimates for the association of socio-demographic factors with vaccine uptake in Europe. Therefore, the results of the uptake study are likely to be generalizable to other high income countries offering a national zoster vaccination programme via primary care with vaccination provided free-of-charge.

9.4 Implications for public health and policy makers

The rationale for using the socio-demographic factors identified from the systematic review of factors associated with vaccine uptake was to establish the role of double inequalities (**9.4.1**) i.e. are the factors associated with lower vaccine uptake also associated with higher disease burden? It could be argued that another systematic review examining socio-demographic factors associated with vaccine-preventable disease burden could also have been undertaken. However, this thesis utilised the WHO's comprehensive conceptual framework for the social determinants of health,[4] and gathered all social factors information available in the CPRD data relevant for older individuals for the burden analyses.

The vaccination inequalities found to be present in England within the first two years of the introduction of the zoster immunisation programme should help public health professionals to target specific groups amongst older individuals to mitigate vaccination inequality, promote healthy ageing and ultimately contribute towards a higher and an equitable healthy life expectancy (**1.1.2**).

Some social factors were poorly captured in the EHR and their association with zoster burden and vaccination could not be assessed in this thesis. Incentivisation of health care professional for recoding these factors play a role in completeness of recordings as was shown for ethnicity recording this thesis and a prior study.[137] This could guide policy makers such as the sustainability and transformation partnerships to incentivise primary care providers for better recording of these factors and to also facilitate other data linkages for improving the health of older individuals by monitoring and striving towards health equality.

9.4.1 The role of double inequalities

As described in **Section 8.7**, the findings from this thesis should also help healthcare providers in identifying specific social groups with double inequalities (Table 8-8) i.e. individuals residing in care homes and older females. Specific interventions directed towards these groups can be implemented to reduce vaccination inequalities.

9.5 Implications for future research

9.5.1 Using electronic health records and future linkages

This thesis provided the association of socio-demographic factors with first zoster episodes. Understanding about the social determinants of zoster could be further improved by also ascertaining the social determinants of PHN, an important sequela of zoster. This study question would be also helpful in informing the national zoster vaccination policy.

Another important contribution of this thesis is the development of methodology for ascertainment of socio-demographic factors using EHR. The methodology could be also adapted for use in other countries using EHR and could be potentially extrapolated for use in younger age groups, pregnant women and other individuals in clinical risk groups. Identifying the social determinants of vaccine uptake amongst these population groups will also

enhance the understanding and provide a broad overview of health inequalities in the UK for appropriate interventions. The statistical methods developed as a part of thesis will be available to other researchers using CPRD and HES data and studying other conditions amongst older individuals. These methods offer a significant opportunity in developing automated surveillance processes for generating ongoing cycle of inequality assessment i.e. identifying socio-demographic factors for vaccine preventable diseases, other chronic conditions and interventions. This should contribute towards achieving health equalities.

The feasibility of future data linkages between primary care data, social care data and census data could be explored with appropriate data permissions. Such linkages will not only enhance the availability of biological factors but other social, behavioural and psychological factors that could not be examined in this thesis. The establishment of a national health and bioinformatics institute by the Medical Research council, Health Data Research UK to harness different data and research expertise available in the UK is a positive step in this direction.[159]

9.5.2 Other research questions

The association of social factors such as education, social class and income with zoster disease burden and vaccine uptake could be also examined in future research using primary data collection. The reasons for lower uptake amongst certain socio-demographic groups such as care home residents need further exploration for factors relevant at an individual level (for example, knowledge and attitudes towards vaccination) and at the care home-level (for example, attitudes of staff, vaccination policy implementation). Additionally, as discussed in **Section 8.6**, the social determinants of zoster vaccine uptake should be re-assessed as the vaccination programme continues to observe whether vaccination inequalities seen in the first two years of programme change.

9.6 Personal development

Conducting different studies as a part of this thesis has been an eventful journey. I found the systematic review and meta-analysis to be one of the most challenging task of this thesis. The diversity of study designs and finding an effective and meaningful way to summarise the

evidence so they made sense to the readers was an iterative process. This has helped me to develop necessary skills of project management, to conduct meta-analyses and quality assessments. Using routinely collected data for conducting three different observational studies not only improved my understanding of these data but has made me aware of some of the challenges in study design specific to these data sources.

My data management skills, ability to use Stata® software, applying the principles of epidemiology that I learned during my MSc course to conduct well-designed studies and dealing with uncertainty have definitely improved during the course of this thesis. Presenting the findings of this research in various conferences and writing peer-reviewed papers have also improved my communication skills. Another difficult but an important lesson that I learned during this doctorate was from my two doctorate supervisors: “how to see the wood for the trees”, an expression used on numerous occasions in our meetings.

These skills will undoubtedly help in my future career in Public Health and Medical Microbiology.

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Appendices

Appendix 1 2017-updated review: summary of the studies identified

First Author	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
Cross-sectional studies					
Bocquier[92]	Income	SIV	Income (individual level based on education class and income) (6)		
	Living arrangements		lowest level (0-1)	1 (adjusted risk ratio)	Gender, age, living with a partner, type of residence area, and for whether the respondent answered him/herself or not. (Note effect estimates from model 1 which was not adjusted for chronic diseases)
	Area of residence		2	1.01 (0.96-1.06)	
			3	1.05 (1.00-1.11)	
			4	1.08 (1.01-1.15)	
			5	1.05 (0.97-1.14)	
			highest level 6	1.06 (0.97-1.15)	
			Living arrangements (2)		
			Living with partner No	1 (adjusted risk ratio)	
			Living with partner Yes	1.10 (1.06-1.14)	
			Area of residence (2)		
			Rural	1 (adjusted risk ratio)	
			Urban	0.99 (0.96-1.03)	
Dominguez[93]	Education	SIV	Education (2)		Unadjusted
	Relationship status		No/primary education	1	
	Living arrangements		Secondary or higher	0.84 (0.61–1.16) (cOR)	
			Relationship status (4)		
			Married/Cohabiting	1 (aOR)	Gender marital status living alone, number of GP visits, alcohol intake, influenza vaccine in last 3 seasons, past pneumococcal vaccine uptake, level of dependence
			Single	0.55 (0.31–0.98)	
			Widowed	1.10 (0.77–1.58)	
			Separated/Divorced	0.87 (0.36–2.11)	
			Living arrangements (2)		
			Lives alone	1 (aOR)	

First Author	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			Lives with cohabitant	1.35 (0.88–2.07)	
Dominguez[94]	Education Relationship status Living arrangements	PV	Education (3)		Unadjusted
			No education	1 (cOR)	
			Primary education	0.86 (0.60- 1.22)	
			Secondary or higher	0.66 (0.44-0.98)	
			Relationship status (4)		
			Married/Cohabiting	1(cOR)	
			Single	0.83 (0.46-1.51)	
			Widowed	0.97 (0.70-1.35)	
			Separated/Divorced	1.98 (0.47-8.26)	
			Living arrangements (2)		
			Lives alone	1(cOR)	
			Lives with cohabitant	1.16 (0.79-1.70)	
Fabiani[95]	COB	SIV	COB (2)		Sex, age, area of residence, educational level, occupational status, household composition, economic resources, and health services utilization index
			Native	1 (aOR)	
			Immigrants	0.81 (0.68-0.97)	
Ganczak[97]	Area of residence Education Income Living arrangements	SIV	Area of residence (2)		Age, residence, co-morbidity, influenza vaccine information, family member vaccinated and willingness for vaccination
			Rural	1 (aOR)	
			Urban	7.69 (1.18-100)	
			Education (2)		Unadjusted
			primary & secondary	1 (cOR)	
			vocational & university	1.21 (0.70-2.09)	
			Income (self-assessed) (2)		
			high	0.96 (0.55-1.69)	
			low	1 (cOR)	

First Author	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			Living arrangements (2)		
			Not living alone	0.58 (0.33-1.02)	
			Living alone	1 (cOR)	
Gorska-Ciebiada[98]	Area of residence Income Relationship status Education	SIV	Area of residence (2)		
			Rural	1 (cOR)	Unadjusted
			Urban	2.06 (1.31-3.24)	
			Income (3)		
			High ((>2000 pln/person)	5.34 (2.38- 12.02)	Income, comorbidity, health professional recommendation, anti-hyperglycemic medications
			Medium	Not reported	
			Low (<1000 pln/person)	1	
			Relationship status (2)		
			Single	0.99 (0.52-1.86)	
			Married	1 (cOR)	Unadjusted
			Education (4)		
			Primary	1 (cOR)	
			Secondary	1.54 (0.48-4.93)	
			Technical	1.43 (0.41-4.94)	
			University	3.18 (0.86-11.79)	
		PV	Area of residence (2)		
			Rural	1 (cOR)	Unadjusted as estimated from raw data
			Urban	2.22 (0.63-7.87)	
			Income (3)		
			High (>2000 pln/person)	1.48 (0.36-6.07)	
			Medium (1000-2000 pln/person)	1.25 (0.33-4.80)	
			Low (<1000 pln/person)	1 (cOR)	

First Author	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			Relationship status (2)		
			Single	1.28 (0.50-3.29)	
			Married	1 (cOR)	
			Education (4)		
			Primary	1 (cOR)	
			Secondary	1.11 (0.23-5.40)	
			Technical	1.15 (0.21-6.20)	
			University	0.36 (0.03-4.21)	
Hellfritzsch[99]	Relationship status Education Area of residence Income	SIV	Relationship status (2)		Adjusted prevalence ratio of being married amongst vaccinated vs being married amongst unvaccinated=1.07(1.03–1.11); Adjusted prevalence ratio of being Alone/divorced/widowed amongst vaccinated vs being married amongst
			Married/living with partner	1 (cOR) from raw data	
			Alone/divorced/widowed	0.87 (0.75-1.01)	
			Education level beyond primary school (7)		No difference reported in adjusted (age and gender) prevalence ratios for education, residence and income
			None	1 (cOR) from raw data	
			Skilled worker	1.19 (0.86-1.65)	
			Very short (courses)	0.98 (0.83-1.15)	
			Short (< 3 years)	0.82 (0.63-1.06)	
			Medium (3-4 years)	0.91 (0.72-1.14)	
			Long (>4 years)	1.17 (0.84-1.65)	
			Other	0.97 (0.73-1.28)	
			Area of residence (4)		
			Urban	1.15 (0.97-1.36)	
			Small town	1.06 (0.86-1.31)	
			Rural	1 (cOR) from raw data	
			Other	0.25 (0.06-1.10)	
			Annual household income (6)		

First Author	SD examined	vaccine	Definitions and categorisation of SD (Numbers in brackets indicate the number of categories used for the SD)	Effect estimates of vaccine uptake (estimates are odds ratios (95% confidence interval) unless specified	Effect estimates adjusted for the following confounders
			<99,000 Danish Kroner/annum	1 (cOR) from raw data	
			100,000–149,000 Danish Kroner /annum	0.89 (0.64-1.25)	
			150,000–249,000 Danish Kroner /annum	1.07 (0.79-1.46)	
			250,000–374,000 Danish Kroner /annum	0.88 (0.63-1.22)	
			375,000–524,000 Danish Kroner /annum	0.72 (0.49-1.05)	
			>525,000 Danish Kroner /annum	1.01 (0.65-1.56)	
Ward[82]	Area-level SES	HZ	Area-level SES for GP practice (5)		
			Quintile 1 - least deprived	1 (cOR) from raw data	
			Quintile 2	0.90 (0.87-0.93)	Unadjusted
			Quintile 3	0.87 (0.84-0.90)	
			Quintile 4	0.73 (0.71-0.76)	
			Quintile 5- most deprived	0.66 (0.64-0.68)	
Cohort study					
Gallini[96]	Area-level SES	SIV	Area-level SES of individual's municipality (3)		
			Lowest quartile	1.00 (0.96-1.04) adjusted risk	Age, gender, deprivation, co-morbidities and
			2nd and 3rd quartile	1	health resource use
			Highest quartile	1.02 (0.97- 1.06)	

SD social determinants SIV seasonal influenza vaccine COB country of birth PV pneumococcal vaccine HZ herpes zoster SES socio-economic status CI confidence interval aOR adjusted odds ratio cOR unadjusted odds ratio pln Polish złoty

Appendix 2 Quality assessment details: 2017-updated review

First author	Selection bias	Outcome misclassification	SD number Examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
Bocquier[92]	Low risk response rate 76.6%	Low risk : Self-reported SIV vaccine in last 12 months	3	Income/ wealth Living arrangements Residence	Based on 3 variables education, income and occupation (interview self-reported): Low risk	All 3 SD: Low risk as adjusted for year, gender, living with partner, area of residence	Low risk: 0.5% missing data	Low risk: as model without chronic disease provided
Dominguez[93]	Unclear risk : response rate not available	Low risk : from recent records SIV vaccinations	3	Education	Self-reported and records: low risk	Education: High risk as unadjusted	Low risk	Low risk: as model without chronic disease provided
				Marital status		Living arrangements and marital status adjusted for each other and unadjusted for any other level 1 variable (adjusted for gender marital status living alone, number of GP visits, alcohol intake, influenza vaccine in last 3 seasons, past pneumococcal vaccine uptake, level of dependence)	Unclear risk as not reported	
				Living arrangements				
Dominguez[94]	Unclear risk : response rate not available	Low risk : from PV vaccination records	3	Education	Self-reported and records: low risk	High risk as unadjusted	Low risk 0.5% missing	Low risk: as unadjusted
				Marital status			Low risk 0.6% missing	
				Living arrangements			Low risk 0.3% missing	
Fabiani[95]	Low risk: 82.5% overall response rate age specific response rate not available but as overall response rate is high so low risk	Low risk : Self-reported SIV vaccine in preceding season	1	Country of birth	(self-reported): Low risk	Low risk adjusted for sex, age, area of residence, educational level, occupational status, household composition, economic resources, and health services utilization index	Low risk none missing	Low risk
Ganczak[97]	Low risk: 92% response rate	Low risk : Self-reported SIV vaccine in preceding season	4	Place of residence	(self-reported): Low risk	Residence: High risk as unadjusted for gender or another level 1 variable	Low risk none missing	High risk as adjusted for co-morbidity

First author	Selection bias	Outcome misclassification	SD number Examined	Which SD	Exposure bias	Confounding bias	Missing data bias	Overadjustment
				Education		Education: High risk as unadjusted		Low risk as unadjusted
				Income		Income: High risk as unadjusted		
				Living arrangement		Living arrangements: High risk as unadjusted		
Gorska-Ciebiada[98]	Unclear risk: response rate not reported	Low risk : Self-reported SIV vaccine in preceding season & ever had PV vaccine	4	Place of residence	(self-reported): Low risk for both SIV & PV	SIV place of residence, education and marital status: High risk as unadjusted SIV income high risk as unadjusted for any other level 1 variable PV all 4 SD high risk as unadjusted	Low risk none missing	Low risk for both SIV & PV
				Education				Low risk for both SIV & PV
				Income				High risk as adjusted for co-morbidity for SIV but low risk for PV
				Marital status				Low risk for both SIV & PV
Hellfritzsch[99]	Unclear risk: age specific response rate not reported (overall response rate=69%)	Low risk : SIV vaccine from records within 6 months of answering questionnaire	4	Place of residence	(self-reported): Low risk	High risk as unadjusted	Low risk	Low risk as unadjusted
				Education				
				Marital status				
				Income			High risk a missing for 35%	
Ward[82]	Low risk	Low risk : zoster vaccine from records	1	Area-level SES	Low risk records	High risk as unadjusted	Low risk	Low risk as not adjusted for co-morbidity
Gallini[96]	Low risk >70% were followed-up	Low risk: recent records SIV vaccination	1	Area-level SES	Area SES (from records date not reported): Unclear risk	Area SES: High risk as unadjusted for any level 1 variable (adjusted for age and gender, deprivation co-morbidities, health resource use)	Low risk: SD data available for all individuals	High risk

SD social determinants SIV seasonal influenza vaccine PV pneumococcal vaccine HZ herpes zoster SES socio-economic status

Appendix 3 Appendix Codelists: zoster and post herpetic neuralgia

1. Zoster

CPRD

Medical code	Read term
390	Herpes zoster
516	Shingles
7331	Ramsey Hunt Syndrome
8936	Ophthalmic herpes zoster infection
14718	Herpes zoster with ophthalmic complication
14793	Herpes zoster otitis externa
18918	Herpes zoster ophthalmicus
21069	Herpes zoster with unspecified complication
21471	Herpes zoster NOS
25320	Herpes zoster with dermatitis of eyelid
27403	Geniculate herpes zoster
27546	Herpes zoster with keratoconjunctivitis
31681	Herpes zoster - otitis externa
33810	Herpes zoster with other ophthalmic complication
38531	Herpes zoster with other specified complication NOS
39692	Polyneuropathy in herpes zoster
43235	Herpes zoster with other specified complication
44944	Herpes zoster with meningitis
47375	Zoster encephalitis
50537	Herpes zoster with other CNS complications
51692	Encephalitis due to herpes zoster
52126	Herpes zoster with other central nervous system complication
52319	Disseminated zoster
55940	Herpes zoster iridocyclitis
57895	Herpes zoster meningitis
62558	Infective otitis externa due to herpes zoster
63739	Herpes zoster with other CNS complication NOS
69405	Herpes zoster encephalitis
70197	[X]Zoster without complications
71464	Meningitis due to herpes zoster virus
105157	Hutchinson's sign - herpes zoster involving nose tip

HES

ICD code	ICD description
B02	Herpes zoster
B02.0	Zoster encephalitis
B02.1	Zoster meningitus
B02.3	Zoster ocular disease
B02.7	Disseminated zoster
B02.8	Zoster with other complications
B02.9	Zoster without complications

2. History of zoster codes (Post herpetic neuralgia)

CPRD

Medical code	Read term
1598	Post-herpetic neuralgia
7584	Post-herpetic trigeminal neuralgia
10223	Postherpetic neuralgia
17180	Postzoster neuralgia
31709	Postherpetic polyneuropathy
11498	Postherpetic trigeminal neuralgia

HES

ICD code	ICD description
G53.0	Postherpectic neuralgia
B02.2	Zoster with other nervous system involvement

Appendix 4 Codelist: ethnicity

Medcode	Readcode	Readterm
10196	9S...00	Ethnic groups (1991 census)
22467	9S1..00	White
12446	9S10.00	White British
24837	9S11.00	White Irish
12444	9S12.00	Other white ethnic group
26467	9S13.00	White Scottish
26310	9S14.00	Other white British ethnic group
12632	9S2..00	Black Caribbean
12778	9S3..00	Black African
24339	9S4..00	Black, other, non-mixed origin
12452	9S41.00	Black British
57435	9S42.00	Black Caribbean/W.I./Guyana
47950	9S42.11	Black Caribbean
47997	9S42.12	Black West Indian
32100	9S42.13	Black Guyana
41329	9S43.00	Black N African/Arab/Iranian
46812	9S43.11	Black North African
57752	9S43.12	Black Arab
50286	9S43.13	Black Iranian
35412	9S44.00	Black - other African country
47965	9S45.00	Black E Afric Asia/Indo-Caribb
57753	9S45.11	Black East African Asian
57763	9S45.12	Black Indo-Caribbean
48005	9S46.00	Black Indian sub-continent
35350	9S47.00	Black - other Asian
26312	9S48.00	Black Black - other
25676	9S5..00	Black - other, mixed
25623	9S51.00	Other Black - Black/White orig
32165	9S52.00	Other Black - Black/Asian orig
12482	9S6..00	Indian
24690	9S7..00	Pakistani
24740	9S8..00	Bangladeshi
24272	9S9..00	Chinese
30280	9SA..00	Other ethnic non-mixed (NMO)
32110	9SA1.00	Brit. ethnic minor. spec.(NMO)
57764	9SA2.00	Brit. ethnic minor. unsp (NMO)
54593	9SA3.00	Caribbean I./W.I./Guyana (NMO)
57094	9SA3.11	Caribbean Island (NMO)
57075	9SA3.12	West Indian (NMO)
93144	9SA3.13	Guyana (NMO)
24962	9SA4.00	N African Arab/Iranian (NMO)
47285	9SA4.11	North African Arab (NMO)
25082	9SA4.12	Iranian (NMO)
47969	9SA5.00	Other African countries (NMO)
38097	9SA6.00	E Afric Asian/Indo-Carib (NMO)
46818	9SA6.11	East African Asian (NMO)
99316	9SA6.12	Indo-Caribbean (NMO)
39696	9SA7.00	Indian sub-continent (NMO)
26379	9SA8.00	Other Asian (NMO)
24270	9SA9.00	Irish (NMO)
45947	9SAA.00	Greek/Greek Cypriot (NMO)
45955	9SAA.11	Greek (NMO)
47949	9SAA.12	Greek Cypriot (NMO)
32066	9SAB.00	Turkish/Turkish Cypriot (NMO)
32126	9SAB.11	Turkish (NMO)
32069	9SAB.12	Turkish Cypriot (NMO)
12633	9SAC.00	Other European (NMO)
41214	9SAD.00	Other ethnic NEC (NMO)
12696	9SB..00	Other ethnic, mixed origin
47401	9SB1.00	Other ethnic, Black/White orig
32401	9SB2.00	Other ethnic, Asian/White orig
35459	9SB3.00	Other ethnic, mixed white orig
32420	9SB4.00	Other ethnic, other mixed orig
32425	9SB5.00	Black Caribbean and White
32443	9SB6.00	Black African and White
25411	9SC..00	Vietnamese
12429	9SD..00	Ethnic group not given - patient refused
24340	9SE..00	Ethnic group not recorded
32136	9SG..00	Other black ethnic group
12668	9SH..00	Other Asian ethnic group

Medcode	Readcode	Readterm
47601	9SI..00	Irish traveller
12757	9SJ..00	Other ethnic group
45199	9SZ..00	Ethnic groups (census) NOS
23955	9T...00	Ethnicity and other related nationality data
45008	9T1..00	New Zealand ethnic groups
57286	9T11.00	New Zealand European
85509	9T11.11	Pakeha
85505	9T12.00	Other European in New Zealand
32479	9T13.00	New Zealand Maori
64610	9T14.00	Samoan
89910	9T15.00	Cook Island Maori
60837	9T16.00	Tongan
55584	9T17.00	Niuean
25434	9T18.00	Tokelauan
64609	9T19.00	Fijian
46752	9T1A.00	Other Pacific ethnic group
46649	9T1B.00	South East Asian
12718	9T1C.00	Chinese
25920	9T1D.00	Indian
32396	9T1E.00	Other Asian
96789	9T1Y.00	Other New Zealand ethnic group
71425	9T1Z.00	New Zealand ethnic group NOS
32781	9T2..00	Traveller - gypsy
94487	9T3..00	Yemeni
12435	9i...00	Ethnic category - 2001 census
12351	9i0..00	British or mixed British - ethnic category 2001 census
98111	9i00.00	White British - ethnic category 2001 census
12532	9i1..00	Irish - ethnic category 2001 census
98213	9i10.00	White Irish - ethnic category 2001 census
12421	9i2..00	Other White background - ethnic category 2001 census
12352	9i20.00	English - ethnic category 2001 census
12436	9i21.00	Scottish - ethnic category 2001 census
12681	9i22.00	Welsh - ethnic category 2001 census
28887	9i23.00	Cornish - ethnic category 2001 census
42294	9i24.00	Northern Irish - ethnic category 2001 census
40102	9i25.00	Ulster Scots - ethnic category 2001 census
32778	9i26.00	Cypriot (part not stated) - ethnic category 2001 census
12355	9i27.00	Greek - ethnic category 2001 census
12769	9i28.00	Greek Cypriot - ethnic category 2001 census
12746	9i29.00	Turkish - ethnic category 2001 census
32413	9i2A.00	Turkish Cypriot - ethnic category 2001 census
12412	9i2B.00	Italian - ethnic category 2001 census
55223	9i2C.00	Irish Traveller - ethnic category 2001 census
55113	9i2D.00	Traveller - ethnic category 2001 census
42290	9i2E.00	Gypsy/Romany - ethnic category 2001 census
12467	9i2F.00	Polish - ethnic category 2001 census
12433	9i2G.00	Baltic Estonian/Latvian/Lithuanian - ethn categ 2001 census
28973	9i2H.00	Commonwealth (Russian) Indep States - ethn categ 2001 census
26341	9i2J.00	Kosovan - ethnic category 2001 census
25422	9i2K.00	Albanian - ethnic category 2001 census
46956	9i2L.00	Bosnian - ethnic category 2001 census
28866	9i2M.00	Croatian - ethnic category 2001 census
47074	9i2N.00	Serbian - ethnic category 2001 census
28936	9i2P.00	Other republics former Yugoslavia - ethnic categ 2001 census
26391	9i2Q.00	Mixed Irish and other White - ethnic category 2001 census
12402	9i2R.00	Oth White European/European unsp/Mixed European 2001 census
28900	9i2S.00	Other mixed White - ethnic category 2001 census
12591	9i2T.00	Other White or White unspecified ethnic category 2001 census
12742	9i3..00	White and Black Caribbean - ethnic category 2001 census
12437	9i4..00	White and Black African - ethnic category 2001 census
12638	9i5..00	White and Asian - ethnic category 2001 census
12873	9i6..00	Other Mixed background - ethnic category 2001 census
12795	9i60.00	Black and Asian - ethnic category 2001 census
49940	9i61.00	Black and Chinese - ethnic category 2001 census
40110	9i62.00	Black and White - ethnic category 2001 census
12706	9i63.00	Chinese and White - ethnic category 2001 census
47005	9i64.00	Asian and Chinese - ethnic category 2001 census
32408	9i65.00	Other Mixed or Mixed unspecified ethnic category 2001 census
12414	9i7..00	Indian or British Indian - ethnic category 2001 census
12460	9i8..00	Pakistani or British Pakistani - ethnic category 2001 census
28888	9i9..00	Bangladeshi or British Bangladeshi - ethn categ 2001 census
12513	9iA..00	Other Asian background - ethnic category 2001 census
26392	9iA1.00	Punjabi - ethnic category 2001 census
64133	9iA2.00	Kashmiri - ethnic category 2001 census
47077	9iA3.00	East African Asian - ethnic category 2001 census

Medcode	Readcode	Readterm
12608	9iA4.00	Sri Lankan - ethnic category 2001 census
12760	9iA5.00	Tamil - ethnic category 2001 census
12887	9iA6.00	Sinhalese - ethnic category 2001 census
32399	9iA7.00	Caribbean Asian - ethnic category 2001 census
12653	9iA8.00	British Asian - ethnic category 2001 census
46056	9iA9.00	Mixed Asian - ethnic category 2001 census
28935	9iAA.00	Other Asian or Asian unspecified ethnic category 2001 census
12432	9iB..00	Caribbean - ethnic category 2001 census
12350	9iC..00	African - ethnic category 2001 census
32389	9iD..00	Other Black background - ethnic category 2001 census
12443	9iD0.00	Somali - ethnic category 2001 census
32886	9iD1.00	Nigerian - ethnic category 2001 census
40097	9iD2.00	Black British - ethnic category 2001 census
40096	9iD3.00	Mixed Black - ethnic category 2001 census
46047	9iD4.00	Other Black or Black unspecified ethnic category 2001 census
12468	9iE..00	Chinese - ethnic category 2001 census
12434	9iF..00	Other - ethnic category 2001 census
12719	9iF0.00	Vietnamese - ethnic category 2001 census
12473	9iF1.00	Japanese - ethnic category 2001 census
12420	9iF2.00	Filipino - ethnic category 2001 census
12730	9iF3.00	Malaysian - ethnic category 2001 census
63872	9iF4.00	Buddhist - ethnic category 2001 census
56127	9iF5.00	Hindu - ethnic category 2001 census
46063	9iF6.00	Jewish - ethnic category 2001 census
47091	9iF7.00	Muslim - ethnic category 2001 census
49658	9iF8.00	Sikh - ethnic category 2001 census
46059	9iF9.00	Arab - ethnic category 2001 census
47028	9iFA.00	North African - ethnic category 2001 census
28909	9iFB.00	Mid East (excl Israeli, Iranian & Arab) - eth cat 2001 cens
46964	9iFC.00	Israeli - ethnic category 2001 census
25937	9iFD.00	Iranian - ethnic category 2001 census
45964	9iFE.00	Kurdish - ethnic category 2001 census
25451	9iFF.00	Moroccan - ethnic category 2001 census
26246	9iFG.00	Latin American - ethnic category 2001 census
12756	9iFH.00	South and Central American - ethnic category 2001 census
32382	9iFJ.00	Mauritian/Seychellois/Maldivian/St Helena eth cat 2001census
26455	9iFK.00	Any other group - ethnic category 2001 census
12459	9iG..00	Ethnic category not stated - 2001 census

Appendix 5 Codelist: country of birth, immigration status and language codes

Medcode	Readcode	Readterm
4114	13ZC.00	Immigrant
8929	ZV70314	[V]Immigration medical
9144	13Z6800	Speaks English poorly
9292	133L.00	Immigrant
9627	13ZN.00	Asylum seeker
11552	13e..00	Country of birth (Asian)
12458	13gf.00	Born in South Africa
12713	13eG.00	Born in Iraq
22294	13lZ.00	Main spoken language Turkish
23523	13Z6000	English as a second language
24295	13Z6500	Language Punjabi
24296	13Z6300	Language Hindi
24403	13ZB.00	Refugee
24691	13Z6600	Language Urdu
24712	13Z6200	Language Gujurati
24741	13Z6100	Language Bengali
24881	13lC.00	Main spoken language Polish
25007	13eH.00	Born in Israel
25008	13go.00	Born in Zimbabwe
25092	13eY.00	Born in Philippines
25133	13gi.00	Born in Tanzania
25256	13dl.00	Born in Yugoslavia
25410	13b0.00	Vietnamese language
25423	13lS.00	Main spoken language Albanian
25472	13l2.00	Main spoken language Cantonese
25609	13lx.00	Main spoken language Thai
25616	13lp.00	Main spoken language Malayalam
25632	ZV70516	[V]Refugee health examination
25664	13gC.00	Born in Congo
25665	13l5.00	Main spoken language French
25730	13dM.00	Born in Kosovo
25752	13dC.00	Born in England
25802	13l1.00	Main spoken language Bengali
25829	13lE.00	Main spoken language Punjabi
25995	13eW.00	Born in Pakistan
26078	13lP.00	Main spoken language Shona
26196	13Z6400	Language Pashtu
26247	13lH.00	Main spoken language Spanish
26334	13eo.00	Born in Vietnam
26335	13lb.00	Main spoken language Vietnamese
26337	13l0.00	Main spoken language Arabic
26361	13lL.00	Main spoken language Urdu
26426	13eF.00	Born in Iran
26463	13dA.00	Born in Czech Republic
26464	13l3.00	Main spoken language Czech
28301	13dP.00	Born in Lithuania
28529	13eg.00	Born in Syria
30224	13gY.00	Born in Niger
30606	13f5.00	Born in Canada
30800	13d..00	Country of birth (European)
32053	13f..00	Country of birth (American)
32055	13d0.00	Born in Albania
32058	13e8.00	Born in China
32060	13e0.00	Born in Afghanistan
32061	13h0.00	Born in Australia
32062	13jC.00	Born in Trinidad and Tobago
32065	13db.00	Born in Scotland
32067	13gJ.00	Born in Ghana
32068	13gl.00	Born in Uganda
32070	13el.00	Born in Japan
32072	13fL.00	Born in USA
32074	13h1.00	Born in New Zealand
32075	13f3.00	Born in Brazil
32076	13j6.00	Born in Jamaica
32079	13g0.00	Born in Algeria
32080	13dH.00	Born in Greece
32081	13dF.00	Born in France
32082	13eD.00	Born in India
32085	13dG.00	Born in Germany
32089	13j2.00	Born in Barbados
32090	13fN.00	Born in Venezuela
32094	13dW.00	Born in Poland
32097	13de.00	Born in Spain

Medcode	Readcode	Readterm
32098	13df.00	Born in Sweden
32099	13gM.00	Born in Ivory Coast
32102	13g..00	Country of birth (African)
32103	13di.00	Born in Ukraine
32105	13dk.00	Born in Wales
32108	13gV.00	Born in Morocco
32111	13gZ.00	Born in Nigeria
32112	13gN.00	Born in Kenya
32113	13dK.00	Born in Ireland
32114	13ek.00	Born in Turkey
32115	13gS.00	Born in Malawi
32116	13dL.00	Born in Italy
32117	13dU.00	Born in Northern Ireland
32119	13dc.00	Born in Slovakia
32120	13fB.00	Born in Grenada
32125	13e3.00	Born in Bangladesh
32127	13eb.00	Born in Russia
32128	13eM.00	Born in Kyrgyzstan
32131	13j9.00	Born in St. Lucia
32135	13ej.00	Born in Thailand
32139	13dD.00	Born in Estonia
32140	13gU.00	Born in Mauritius
32144	13ec.00	Born in Saudi Arabia
32150	13dh.00	Born in The Netherlands
32157	13ed.00	Born in Singapore
32158	13gG.00	Born in Ethiopia
32160	13dX.00	Born in Portugal
32162	13gW.00	Born in Mozambique
32166	13fJ.00	Born in Peru
32167	13g5.00	Born in Burundi
32168	13gn.00	Born in Zambia
32169	13d7.00	Born in Bulgaria
32171	13eP.00	Born in Malaysia
32173	13dE.00	Born in Finland
32186	13dB.00	Born in Denmark
32189	13ge.00	Born in Somalia
32190	13d9.00	Born in Cyprus
32197	13gd.00	Born in Sierra Leone
32201	13fF.00	Born in Mexico
32202	13e7.00	Born in Chechnya
32207	13gI.00	Born in Gambia
32217	13eT.00	Born in Nepal
32220	13eC.00	Born in Hong Kong
32233	13gX.00	Born in Namibia
32237	13gP.00	Born in Liberia
32242	13dN.00	Born in Latvia
32245	13ef.00	Born in Sri Lanka
32254	13e6.00	Born in Burma
32255	13g7.00	Born in Cameroon
32260	13g1.00	Born in Angola
32273	13e2.00	Born in Bahrain
32293	13k4.00	Born in Seychelles
32301	13j0.00	Born in Antigua and Barbuda
32303	13f7.00	Born in Columbia
32304	13jB.00	Born in Togo
32309	13gc.00	Born in Senegal
32311	13f9.00	Born in Ecuador
32313	13d2.00	Born in Austria
32325	13f0.00	Born in Argentina
32331	13ga.00	Born in Rwanda
32333	13gE.00	Born in Egypt
32342	13f4.00	Born in British Guyana
32345	13dZ.00	Born in Romania
32347	13gL.00	Born in Guinea Republic
32352	13d4.00	Born in Belgium
32361	13e1.00	Born in Armenia
32369	13j4.00	Born in Dominican Republic
32390	13eh.00	Born in Taiwan
32397	13d6.00	Born in Bosnia - Herzegovnia
32417	13k..00	Country of birth (Pacific)
32427	13lF.00	Main spoken language Russian
32456	13lG.00	Main spoken language Somali
32688	13dI.00	Born in Hungary
32728	13lD.00	Main spoken language Portuguese
32741	13gk.00	Born in Tunisia

Medcode	Readcode	Readterm
32776	13lB.00	Main spoken language Mandarin
32807	13dg.00	Born in Switzerland
36794	13gg.00	Born in Sudan
36852	13lW.00	Main spoken language Japanese
36862	13lt.00	Main spoken language Serbian
36980	13lQ.00	Main spoken language Italian
37197	13gR.00	Born in Madagascar
38075	13fD.00	Born in Guyana
38117	13gA.00	Born in Chad
39974	13dS.00	Born in Moldavia
41209	13gm.00	Born in Zaire
41210	13d8.00	Born in Croatia
41211	13eO.00	Born in Lebanon
41213	13dV.00	Born in Norway
41217	13eL.00	Born in Kuwait
41228	13ee.00	Born in South Korea
41230	13f2.00	Born in Bolivia
41233	13d5.00	Born in Belorussia
41280	13fE.00	Born in Honduras
41289	13eE.00	Born in Indonesia
41290	13j3.00	Born in Cuba
41291	13f6.00	Born in Chile
41292	13eK.00	Born in Kazakhstan
41297	13eX.00	Born in Palestine
41302	13el.00	Born in Turkmenistan
41304	13dd.00	Born in Slovenia
41311	13eJ.00	Born in Jordan
41312	13dJ.00	Born in Iceland
41316	13g3.00	Born in Botswana
41318	13g2.00	Born in Benin
41327	13h..00	Country of birth (Australasian)
41337	13d3.00	Born in Azerbaijan
41341	13gQ.00	Born in Libya
41344	13ep.00	Born in Yemen
41350	13gh.00	Born in Swaziland
41351	13eS.00	Born in Mongolia
41354	13e9.00	Born in Democratic People's Republic of Korea
41356	13ea.00	Born in Republic of Korea
41357	13dY.00	Born in Republic of Ireland
41364	13dR.00	Born in Malta
41365	13gK.00	Born in Guinea Bissau
41367	13fM.00	Born in Uruguay
41372	13em.00	Born in United Arab Emirates
41399	13fI.00	Born in Paraguay
41402	13en.00	Born in Uzbekistan
42635	13k0.00	Born in Fiji
42639	13eZ.00	Born in Qatar
46014	13lN.00	Main spoken language Kurdish
46029	13l8.00	Main spoken language Hindi
46325	13lY.00	Main spoken language Lithuanian
46861	13lK.00	Main spoken language Tamil
46973	13ln.00	Main spoken language Lingala
46974	13lV.00	Main spoken language Greek
47007	13li.00	Main spoken language French Creole
47029	13lO.00	Main spoken language Farsi
47073	133Q.00	Family reunion immigrant
47399	13n2.00	Reads Punjabi
47400	13n9.00	Reads Cantonese
47402	13n0.00	Reads Arabic
47404	13n7.00	Reads Urdu
47559	13k6.00	Born in Tonga
47627	13lJ.00	Main spoken language Sylheti
47628	13ld.00	Main spoken language Amharic
47630	13lR.00	Main spoken language German
47631	13lw.00	Main spoken language Tagalog
47641	13lI.00	Main spoken language Swahili
47643	13lu.00	Main spoken language Sinhala
47644	13ly.00	Main spoken language Tigrinya
47646	13lm.00	Main spoken language Igbo
48002	13l6.00	Main spoken language Gujerati
48029	6951.00	Immigration examination
48297	13k5.00	Born in Solomon Islands
49402	13eB.00	Born in Georgia
49907	13j..00	Country of birth (Atlantic)
51778	13eV.00	Born in Oman

Medcode	Readcode	Readterm
52200	13b4.00	Mirpuri language
52204	13nD.00	Reads Hindi
52209	13n8.00	Reads Bengali
54409	13lM.00	Main spoken language Yoruba
54410	13lT.00	Main spoken language Croatian
54413	13lc.00	Main spoken language Akan
54414	13lf.00	Main spoken language Dutch
54415	13lX.00	Main spoken language Korean
54416	13l9.00	Main spoken language Iba
54417	13lv.00	Main spoken language Swedish
56879	13lh.00	Main spoken language Flemish
57186	13eA.00	Born in East Timor
57189	13k7.00	Born in Tuvalu
57341	13nE.00	Reads Chinese
57343	13n5.00	Reads Spanish
57345	13n1.00	Reads Portuguese
57462	13b3.00	Creole language
57755	13ll.00	Main spoken language Hebrew
57758	13lq.00	Main spoken language Norwegian
58192	13j5.00	Born in Haiti
58193	13l7.00	Main spoken language Hausa
58525	13nC.00	Reads French
58527	13g4.00	Born in Burkina Faso
58528	13n3.00	Reads Russian
58531	13n4.00	Reads Somali
58533	13j1.00	Born in Bahamas
58537	13nF.00	Reads Polish
58552	13nA.00	Reads Czech
58643	13lr.00	Main spoken language Pashto
59657	13gH.00	Born in Gabon
62298	13e5.00	Born in Brunei
63923	13fH.00	Born in Panama
63927	13gj.00	Born in The Gambia
63932	13sA.00	English as a second language
63943	13fA.00	Born in El Salvador
64120	13k3.00	Born in Papua New Guinea
64391	13lj.00	Main spoken language Gaelic
64948	13ls.00	Main spoken language Patois
64949	13gp.00	Born in Eritrea
64984	13f8.00	Born in Costa Rica
65310	13eR.00	Born in Mali
65503	69D8.00	Exam. of refugee
66551	13jA.00	Born in St. Vincent
66553	13j8.00	Born in St. Kitts and Nevis
66560	13eU.00	Born in North Korea
66564	13nW.00	Reads Greek
66565	13nR.00	Reads Italian
66685	13la.00	Main spoken language Ukrainian
66826	13n6.00	Reads Tamil
68778	13nS.00	Reads German
68866	13gD.00	Born in Djibouti
69131	13dQ.00	Born in Luxembourg
69135	13j7.00	Born in Puerto Rico
69139	13lg.00	Main spoken language Ethiopian
69143	13gT.00	Born in Mauritania
69153	13lo.00	Main spoken language Luganda
69426	13fK.00	Born in Suriname
69431	13eN.00	Born in Laos
69560	13g8.00	Born in Cape Verde Islands
69806	13fC.00	Born in Guatemala
71190	13dT.00	Born in Monaco
72379	13lA.00	Main spoken language Kutchi
74892	13fG.00	Born in Nicaragua
90860	13nH.00	Reads Farsi
90868	13nG.00	Reads Lithuanian
91328	13eQ.00	Born in Maldives
91419	13nY.00	Reads Turkish
91420	13nQ.00	Reads Kurdish
91422	13lk.00	Main spoken language Hakka
91423	13nJ.00	Reads Chinese - Traditional
93443	13nc.00	Reads Pashto
93444	13nf.00	Reads Tigrinya
93462	13nK.00	Reads Gujarati
93569	13nX.00	Reads Japanese
93697	13gO.00	Born in Lesotho

Medcode	Readcode	Readterm
93893	13nh.00	Reads Burmese
93923	13gF.00	Born in Equatorial Guinea
93935	13d1.00	Born in Andorra
94050	13f1.00	Born in Belize
94072	13ng.00	Reads Bulgarian
94906	13Zd.00	Failed asylum seeker
95590	13nM.00	Reads Chinese - Simplified
95593	13nV.00	Reads Croatian
95708	13dO.00	Born in Liechtenstein
95775	13nZ.00	Reads Vietnamese
95897	13u0.00	Main spoken language Bulgarian
95940	13ur.00	Main spoken language Latvian
95968	13lT.11	Main spoken language Serbo-Croatian
95969	13lt.11	Main spoken language Serbo-Croatian
95970	13lO.11	Main spoken language Persian
95974	13lu.11	Main spoken language Sinhalese
95978	13w1.00	Main spoken language Nepali
95985	13nm.00	Reads Malay
96041	13ua.00	Main spoken language Hungarian
96146	13uh.00	Main spoken language Irish
96147	13lE.11	Main spoken language Panjabi
96148	13u5.00	Main spoken language Afrikaans
96152	13u1.00	Main spoken language Romanian
96163	13wL.00	Main spoken language Telugu
96223	13wR.00	Main spoken language Twi
96230	13wG.00	Main spoken language Slovenian
96240	13wD.00	Main spoken language Sindhi
96267	13ux.00	Main spoken language Marathi
96268	13uj.00	Main spoken language Kannada
96289	13uN.00	Main spoken language Danish
96290	13u6.00	Main spoken language Armenian
96295	13t..00	Born in British overseas territory
96296	13na.00	Reads Amharic
96317	13w5.00	Main spoken language Quechua
96370	13uv.00	Main spoken language Maltese
96376	13uu.00	Main spoken language Malay
96485	13le.00	Main spoken language Brawa
96558	13wM.00	Main spoken language Tibetan
96559	13uG.00	Main spoken language Burmese
96560	13uT.00	Main spoken language Finnish
96611	13us.00	Main spoken language Macedonian
96634	13wN.00	Main spoken language Tongan
96636	13g6.00	Born in Cambodia
96784	13wT.00	Main spoken language Uzbek
96805	13nj.00	Reads Indonesian
96824	13dm.00	Born in former Yugoslav Republic of Macedonia
96857	13u2.00	Main spoken language Oromo
96858	13w2.00	Main spoken language Occitan
96868	13u4.00	Main spoken language Afar
96873	13wa.00	Main spoken language Zulu
96877	13w..00	Supplemental main language spoken
96928	13uQ.00	Main spoken language Estonian
97015	13uk.00	Main spoken language Kashmiri
97038	13uz.00	Main spoken language Mongolian
97039	13wW.00	Main spoken language Wolof
97041	13wQ.00	Main spoken language Turkmen
97083	13u9.00	Main spoken language Azerbaijani
97131	13wH.00	Main spoken language Sundanese
97136	13no.00	Reads Ndebele
97212	13uX.00	Main spoken language Georgian
97273	13wX.00	Main spoken language Xhosa
97274	13uc.00	Main spoken language Indonesian
97297	13w3.00	Main spoken language Oriya
97298	9NUC.11	Persian language interpreter needed
97390	13e4.00	Born in Bhutan
97439	13wB.00	Main spoken language Southern Sotho
97440	13w6.00	Main spoken language Romansh
97574	13uB.00	Main spoken language Basque
97595	13ul.00	Main spoken language Kazakh
97612	13v..00	Born French overseas region department collectivity territor
97644	9NUz.00	Bulgarian language interpreter needed
97685	13wP.00	Main spoken language Tsonga
97789	13uP.00	Main spoken language Esperanto
97997	13uK.00	Main spoken language Catalan
98038	13t1.00	Born in Bermuda

Medcode	Readcode	Readterm
98062	9Nmm.00	Burmese language interpreter needed
98070	13uZ.00	Main spoken language Guarani
98132	13up.00	Main spoken language Lao
98194	13um.00	Main spoken language Kinyarwanda
98215	13uy.00	Main spoken language Moldavian
98228	13nN.00	Reads Swahili
98229	13nn.00	Reads Mongolian
98255	13uw.00	Main spoken language Maori
98285	13w4.00	Main spoken language Filipino
98369	13nP.00	Reads Yoruba
98510	13uY.00	Main spoken language Kalaallisut
98530	13da.00	Born in San Marino
98604	13ub.00	Main spoken language Icelandic
98762	13u8.00	Main spoken language Aymara
98809	9NmQ.00	Hungarian language interpreter needed
98841	9NUy.00	Romanian language interpreter needed
98942	13nb.00	Reads Lingala
99119	13dj.00	Born in Vatican City
99258	13g9.00	Born in Central African Republic
99431	13jD.00	Born in Dominica
99712	13wS.00	Main spoken language Uighur
99740	13nd.00	Reads Serbian
99794	9Nn1.00	Tsonga language interpreter needed
100007	13ei.00	Born in Tajikistan
100010	13nT.00	Reads Albanian
100011	13ui.00	Main spoken language Javanese
100013	13uL.00	Main spoken language Slovak
100438	9NmA.00	Macedonian language interpreter needed
100517	13dn.00	Born in Serbia
100707	13uR.00	Main spoken language Faeroese
100714	13uS.00	Main spoken language Fijian
100716	13ug.00	Main spoken language Inuktitut
100743	13uW.00	Main spoken language Galician
100759	9Nn7.00	Slovenian language interpreter needed
100813	9NmM.00	Interlingue language interpreter needed
100828	13uH.00	Main spoken language Belarusian
100949	13uD.00	Main spoken language Bihari
101038	13wb.00	Main spoken language Konkani
101158	13gB.00	Born in Comoros Islands
101189	13uJ.00	Main spoken language Central Khmer
101220	13wA.00	Main spoken language Dari
101284	9NnK.00	Nepali language interpreter needed
101591	13gb.00	Born in Sao Tome and Principe
101614	9Nn4.00	Telugu language interpreter needed
101620	13ut.00	Main spoken language Malagasy
101659	13ud.00	Main spoken language Interlingua
101761	13l9.11	Main spoken language Iban
101788	13uM.00	Main spoken language Corsican
101814	9NUc.11	Punjabi language interpreter needed
102007	13uY.11	Main spoken language Greenlandic
102127	13uC.00	Main spoken language Dzongkha
102128	13uF.00	Main spoken language Breton
102129	13ue.00	Main spoken language Interlingue
102184	13u3.00	Main spoken language Abkhazian
102218	13u7.00	Main spoken language Assamese
102259	13uA.00	Main spoken language Bashkir
102877	13wC.00	Main spoken language Tswana
103200	13uV.00	Main spoken language Frisian
103219	13w7.00	Main spoken language Samoan
103364	13v0.00	Born in Martinique
103965	13k9.00	Born in Western Samoa
104071	13uq.00	Main spoken language Bamun
104123	13Zw.00	Has United Kingdom student visa
104284	13ni.00	Reads Chechen
104635	9NmC.00	Latvian language interpreter needed
104678	9Nmx.00	Oromo language interpreter needed
104886	13wE.00	Main spoken language Ndebele
104901	9Nm6.00	Brawa language interpreter needed
104983	13t2.00	Born in Anguilla
105079	9Nmd.00	Catalan language interpreter needed
105153	133A000	International student
105523	13wV.00	Main spoken language Tetum
105529	13wc.00	Main spoken language Aragonese
105608	13nk.00	Reads Kinyarwanda
105923	13t0.00	Born in Montserrat

Medcode	Readcode	Readterm
105960	13wJ.00	Main spoken language Tajik
107687	133A011	Overseas student
108184	9Nn6.00	Turkmen language interpreter needed
108271	13jE.00	Born in Aruba
108936	13v7.00	Born in Guadeloupe
109092	13ds.00	Born in Jersey
109093	13dr.00	Born in Guernsey
109226	13eq.00	Born in Christmas Island
109260	13dq.00	Born in Republic of Moldova
109276	13t5.00	Born in St Helena, Ascension and Tristan da Cunha
109457	13do.00	Born in Montenegro
109458	13jG.00	Born in Saint Vincent and the Grenadines
109489	9NmE.00	Kinyarwanda language interpreter needed
109727	13t3.00	Born in British Virgin Islands
109791	13kB.00	Born in American Samoa
109898	13dp.00	Born in Belarus
109992	13gq.00	Born in Democratic Republic of Congo

Appendix 6 Codelist: religion

Medcode	Readcode	Readterm
2053	1357	Jehovah's Witness
12477	1355	Jewish
12622	135Y.00	Spiritualist
12685	1358	Hindu
19559	135D.00	Religion, none
24263	1351	Church of England
24268	1352	Roman Catholic
24273	135S.00	Buddhist
24297	135B.00	Sikh
24341	1359	Islam
24669	135A.00	Christian
25594	135F.00	Baptist
25996	1359.11	Muslim
29954	1356	Christian Scientist
31044	135J.00	Church of Scotland
31585	135N.00	Plymouth Brethren
39701	135M.00	Society of Friends
39751	135G.00	Methodist
39839	1354	Atheist
46063	9iF6.00	Jewish - ethnic category 2001 Census
47091	9iF7.00	Muslim - ethnic category 2001 Census
47329	135W.00	Salvation Army
47959	135K.00	Pentecostal
47961	135L.00	Evangelical
47962	135C.00	Mixed religion
47968	135P.00	Agnostic
47971	1351.11	Anglican
47972	135I.00	Presbyterian
47998	135d.00	Orthodox Christian
47999	135V.00	Jainism
48000	135H.00	United Reform Church
49658	9iF8.00	Sikh - ethnic category 2001 Census
50229	135T.00	Rastafarian
52201	135O.00	Christadelphian
56127	9iF5.00	Hindu - ethnic category 2001 Census
57757	1353	Nonconformist
58665	1359100	Sunni muslim
63872	9iF4.00	Buddhist - ethnic category 2001 Census
64041	1359000	Shiite muslim
64056	135b.00	Pagan
64057	135c.00	Mormon
64058	135a.00	Moravian religion
92227	135X.00	Eastern Catholic
99738	13zA.00	Protestant
100125	13zp.00	Church of England, follower of religion
100433	13z2.00	Armenian Orthodox
100435	13yH.00	Follower of Goddess tradition
100497	13yX.00	Mennonite
100522	13zJ.00	Church of Scotland, follower of religion
100526	13yc.00	Seventh Day Adventist
100536	13z6.00	Scottish Episcopalian
100713	13yQ.00	Pure Land Buddhist
100794	13zC.00	French Protestant
100867	135l.00	African religion, follower of religion
100951	135m.00	Yoruba, follower of religion
101115	13zG.00	Lutheran
101118	13yB.00	Ancestral worship
101144	135z.00	New age practitioner
101384	13zi.00	Orthodox Jew
101650	135i.00	Baha'i
101828	13z5.00	Ukrainian Catholic
101837	13yP.00	Zen Buddhist
101856	13z3.00	Greek Orthodox
101905	13y8.00	Black magic
102123	135x.00	Native American religion, follower of religion
102124	13z9.00	Catholic: non Roman Catholic
102238	13yi.00	Judaic Christian
102253	135v.00	Radha Soami
102459	13zE.00	Follower of United Reformed Church
102498	13yD.00	Wiccan
102646	135e.00	Shinto
102697	13yy.00	Romanian Orthodox
102902	13zF.00	Quaker

Medcode	Readcode	Readterm
102956	13za.00	Sanatana Dharma
102991	13zd.00	Shakti Hindu
103060	135j.00	Druze
103225	135t.00	Satanist
103376	13y5.00	Chondogyo
103692	13ys.00	Russian Orthodox
103742	13yH.11	Goddess
103845	13y3.00	Humanist
103929	13zD.00	Free Church of Scotland
104111	13z1.00	Bulgarian Orthodox
104329	135v.11	Sant Mat
104723	13zH.00	Congregationalist
104737	13zl.00	Ashkenazi Jew
104893	13yl.00	Christian Existentialist
104965	13ze.00	Smarta Hindu
105120	135w.00	Pantheist
105407	13y4.00	Deist
105517	13yF.00	Occultist
105548	13y1.00	Kabbalist
105874	135q.00	Taoist
106119	135p.00	Unitarian Universalist
106797	13yt.00	Ethiopian Orthodox Tewahedo
107174	135Z.11	Rastafarian
107288	13yh.00	Messianic Jew
107636	13zP.00	Reformed Christian
107810	13yv.00	Ukrainian Orthodox
107871	13yG.00	Heathen
107962	13zh.00	Reform Jew
108011	135k.00	Ahmadi
108014	13ym.00	Celtic Christian
108015	13yj.00	Christian Spiritualist
108066	13yZ.00	Free Church
108225	13yC.00	Zoroastrian
108497	13zg.00	Arya Samaj Hindu
108571	13yn.00	Celtic Orthodox Christian
109080	13yN.00	Mahayana Buddhist
109590	13z8.00	Church in Wales

Appendix 7 Codelist: residence

Medcode	Readcode	Readterm
1123	13HQ.00	In prison
2562	13D..11	Homeless
6855	9491.00	Patient died at home
6859	9N1F.00	Seen in warden sup home
6991	9493.00	Patient died in nursing home
7101	9N1F.12	Seen in old people's home
7653	9N1G.00	Seen in nursing home
10120	9N1C.00	Seen in own home
10993	ZLG4.00	Discharge to nursing home
11419	13F7200	Lives in an old peoples home
11504	ZU33200	Lives with daughter
11949	13F4.00	Warden attended
12798	ZU33600	Lives with father
12807	ZU33100	Lives with children
13355	13F1.00	Independant housing, not alone
13357	13F3.00	Lives alone -no help available
13358	13FH.00	Lives with relatives
13359	13F6100	Lives in a nursing home
13360	13F6.00	Nursing/other home
13361	13F4.11	Lives in warden controlled accommodation
13562	ZV70317	[V]Old age home admission medical
15691	13F3100	Lives alone needs housekeeper
15700	13JS.00	Works away from home
15840	13F7100	Lives in a welfare home
17279	13FH000	Elderly relative lives with family
18291	13EC.00	House in poor repair
19610	13FJ.00	Independent housing, lives alone
21280	13F5200	Resident in part III accomodation
22503	ZU33300	Lives with son
24494	ZV60600	[V]Institution resident
24756	13KD.00	Owner-occupier
24815	13K8.00	House rented from council
24816	Z177C00	Residential care
24828	Z177F00	Nursing home care
24910	13KA.00	House rented-private landlord
24956	13FK.00	Lives in a residential home
25143	13K6.00	Houseowner - no mortgage
25452	13D2.00	Homeless single person
26177	8He0.00	Referral to intermediate care - hospital at home
26720	13FB.00	Living in lodgings
26812	9494.00	Patient died in resid.inst.NOS
27360	13F5100	Part III accomodation arranged
27425	13F5.00	Part III accommodation
27936	8HE6.00	Delayed discharge to nursing home
27968	13F7.00	Residential institution
28448	ZU33500	Lives with mother
28773	ZV60700	[V]Sheltered housing
30200	ZV60611	[V]Boarding school resident
30807	13F4000	Resident in sheltered accommodation
31385	13F8100	Long stay hospital inpatient
31678	13EF.00	Divorced couple sharing house
31951	13F9.00	Living in hostel
32448	13EH100	Harrassment by landlord
32753	13D3.11	Tramp
32774	13D1.00	Homeless family
33006	1311.11	Homemaker
33153	1312.00	House husband
33994	ZW63200	Staying with carer
34506	13FL.00	Living rough
34794	13F9.11	Living in sheltered accomodatn
35040	ZLG5.00	Discharge to sheltered housing
35172	9N1E.00	Seen in warden sup flat
35187	9N1D.00	Seen in warden sup house
35279	9N1H.00	Seen in Elderly Mentaly Infirm home
35716	13FA.00	Living in B&B accommodation
36096	13F5.11	Part 3 accomodation
36730	Z37C.00	Provision of special residential school
36809	ZU33.00	Lives with family
36905	ZLG5100	Discharge to warden controlled accommodation
36968	ZU33400	Lives with parents
37829	U195100	[X]Victim of volcanic eruption occurrn in resident instit'n
39311	9492.00	Patient died in part 3 accom.
39685	13K7.00	Houseowner with mortgage

Medcode	Readcode	Readterm
40822	ZU33700	Lives with grandparents
41188	13FC.11	Lives in a bedsit
41388	13D5.00	Vagrant
41986	699Z.00	Exam. for institution NOS
42191	ZLG3.00	Discharge to residential home
42533	ZU26100	Number of dependants in household
42654	ZU35.00	Lives with companion
43057	13FG.00	Squatter
43393	ZU33800	Lives with grandfather
43709	ZV70H00	[V]Examination for admission to residential institutions
43911	ZU33900	Lives with grandmother
43915	ZLG4100	Discharge to private nursing home
44053	699..00	Examination for institution
45650	T704.00	Place of occurrence of accident/poisoning, residential house
46222	T774.00	Place of occurrence of accident/poisoning, old people's home
46303	U10z100	[X]Unspecified fall, occurrence in residential institution
46588	13K9.00	House rented from housing ass.
46642	9b79.00	Other residential care homes managed by local authority
47577	ZW63100	Living with carer
47591	13FS.00	Long stay hospital inpatient
47609	T77..00	Place of accident or poisoning, residential institution
47685	ZV6y200	[V]Other boarder in health-care facility
48549	ZLG3100	Discharge to private residential home
48733	U198100	[X]Victim of flood, occurrence in residential institution
48805	U120100	[X]Hit struck kick twist bit/scratch anoth pers resid instit
48932	U125100	[X]Bitten/struck by oth mammal occurrn in resident instit'n
49138	ZV63212	[V]Delayed discharge - nursing home vacancy awaited
49210	U101100	[X]Fall same level from slip trip + stumb occ resid instit
49681	13FX.00	Lives in care home
50206	8O0A.00	Provision of special residential school
50792	9N1F.11	Seen in Part 3 accomodation
51193	ZU32.00	Lives with friends
51495	13FC.00	Living in bedsitter
51851	U104100	[X]Fall whle carried/supported oth persons occ resid instit
52249	13FQ.00	Lives on council site
52466	U10A100	[X]Fall on + from stair + step occurrnce resident instit'n
52682	6992.00	Prison medical examination
52881	U291.00	[X]Intent self harm by sharp object occ resident instit'n
53140	Z177D00	Local authority residential care
53600	U12A100	[X]Contct wth plant thorn+spine+sharp leave occ resid instit
54260	U3F1.00	[X]Assault by blunt object occurrn in resident institution
54735	13EC.11	Slum housing
54948	ZLG5200	Discharge to part III accommodation
55276	ZU37.00	Lives in a community
56326	U3K1.00	[X]Assault by bodily force occurrn in residential institut'n
56969	T77z.00	Accident/poisoning occurred in residential institution NOS
57438	ZU32100	Lives with friend
59330	T776.00	Place of occurrence of accident or poisoning, prison
59523	13D3.12	Vagabond
59548	13FT.00	Lives in an old peoples home
59653	6991.00	Geriatric home admission exam.
60404	U221.00	[X]Intent self harm by drowning/submersn occ resid instit'n
60684	U2A1.00	[X]Intent self harm by blunt object occ resident instit'n
61385	9b1C.00	Hospice - independent
62522	U3z1.00	[X]Assault by unspecified means occurrn resident institut'n
64410	U211.00	[X]Intent self harm by hangng strangult/suffoct resid instit
65445	13FP.00	Lives on private site
66122	13F5111	Part 3 accomodation arranged
66599	U152100	[X]Exposure to unspecif electric current occ resid instit'n
66656	U128100	[X]Bitten/struck by crocodil/alligatr occ in resid instit'n
66922	U108100	[X]Fall involv other furniture occurrn resident institut'n
67112	9k6..00	Homeless - enhanced services administration
67187	13FM.00	Sleeping in night shelter
67586	U241.00	[X]Int self harm rifl s'gun/lrg frarm disch occ resid instit
67903	U105100	[X]Fall involvng wheelchair occurrence residential instit'n
67930	13FG.11	Illegal tennant
68005	13FV.00	Lives in a welfare home
69028	ZLG3200	Discharge to part III residential home
69762	U106100	[X]Fall involving bed occurrence in residential institution
70021	ZU36.00	Lives as companion
70848	13FW.00	Living in temporary housing
71663	ZU37200	Lives in boarding school
72474	U10J100	[X]Other fall on same level, occurrnce in resident instit'n
72716	U143100	[X]Inhalation of gastric contents occurrn resident instit'n

Medcode	Readcode	Readterm
72838	13FR.00	Lives on unofficial site
73083	9b0Y.00	Nursing home visit note
73101	U3L1.00	[X]Sexual assault by bodily force occurrn resident instit'n
73177	ZLG6100	Discharge to long stay hospital
73321	9b1P.00	Nursing home
87882	U2y1.00	[X]Intent self harm by oth specif means occ resid instit'n
90547	ZU34.00	Lives with lodger
91941	U11Q100	[X]Foreign body enter into/thr eye/natrl orif, resid instit
92265	U197100	[X]Victim of cataclysmic storm occurrn in resident instit'n
92315	U3y1.00	[X]Assault by oth specif means occurrn resident institution
93837	U2C1.00	[X]Int self harm jump/lying befr mov obje occ resid instit'n
93865	U11H100	[X]Explosn+ruptur of pressr tyre pipe/hose occ resid instit
93998	9b0i.00	Residential home visit note
94070	8O24.00	Provision of continuing care in nursing home
95555	ZU37300	Lives in a commune
95661	U116100	[X]Contact wth knife sword/dagger occurrn in resid instit'n
95880	13It.00	Lives with grandmother
96605	9k60.00	Homeless - enhanced service completed
96663	U112100	[X]Strikng against/struck by other object occ in resid inst
97138	13Is.00	Lives with grandfather
97757	13D7.00	Sofa surfer - person of no fixed abode
99091	U122100	[X]Crush push/step on by crowd/humn stampede occ resid inst
99110	U10F100	[X]Fall from cliff, occurrence in residential institution
99120	U193100	[X]Victim of lightning, occurrn in residential institution
99148	9b7A.00	Other residential care home man voluntary/private agents
99453	U156100	[X]Expos unspecif type of radiatn occurrn resident instit'n
99598	U114100	[X]Contact with lifting+transmissn dev NEC occ resid instit
99907	ZV60011	[V]Hobo
100246	ZVu5700	[X]Other boarder in health care facility
100389	U321.00	[X]Assault by pesticides occurrn in residential institution
100710	U10D100	[X]Fall from out of/thro buildng/struct occ resid instit'n
101003	9NFR.00	Home visit request by residential institution
101078	949D.00	Patient died in care home
101400	13Zr.00	Lives with immunocompromised person
102230	M270100	Nursing home acquired pressure ulcer
102493	8Ht..00	Admission to nursing home
103138	U3E1.00	[X]Assault by sharp object occurrn in resident institution
103285	9b70.00	Client's or patient's home
103461	133c.00	Hospital at home patient
103510	ZV60014	[V]Tramp
103553	ZU37100	Lives in a school community
104962	13D8.00	Length of time homeless
105063	U127100	[X]Bittn/stung by nven insct+oth nven arthrop occ resid inst
106027	13KD.11	Lives in own home
106285	U126100	[X]Contact wth marine animal occurrn in resident institut'n
106972	13IZ000	Lives with adoptive parents
107072	U144100	[X]Inhal+ingest food caus obst resp tract occ resid instit'n
107393	9Ngr.00	Under care of homeless advocacy service
107733	13IZ200	Lives with biological parents
107757	9NFW.00	Care home visit
107809	918F200	Lives with carer
107927	U1B4100	[X]Lack of water, occurrence in residential institution
108702	13D6.00	Lives in squat
109437	TD17200	Accident due to fall from burning convalescent home
109673	13IZ100	Lives with biological parent and step parent

Appendix 8 Codelist: cohabitation

Medcode	Readcode	Readterm
333	13H4200	Marital conflict
723	13H4.12	Marital stress
954	13H4100	Marital breakdown
1349	13H4.00	Marital problems
1540	13H4212	Marital disharmony
1580	1332.11	Remarried
3321	SN56300	Battered wife
3394	13W9.00	Single parent family
3483	13HD.00	Violent spouse
3551	13H4211	Marital discord
3719	13L6.00	Spouse unwell
3988	1332.00	Married
4565	6741.00	Marital counselling
4925	1333.13	Wife left home
5055	1333.12	Husband left home
7419	1332.12	Newly wed
7869	13H1.00	Marriage
8470	13IL100	Wife pregnant
9551	ZV61100	[V]Marital problems
9612	1311.00	Housewife
10330	13L3.11	Alcoholic spouse
11103	1331.11	Single - unmarried
13001	6123.00	No partner at present
15115	13HH.15	Looks after chronically sick spouse
15313	13H4300	Maladjustment to married life
15404	13L3.13	Husband alcoholic
15777	13HV311	Spouse committed infidelity
15824	13L1.11	Disabled spouse
15950	13H5.12	Spouse returned home
16262	13H6.11	Unmarried parent
16315	133G.00	Common-law husband
16344	8C81.12	Artificial insemin by husband
16552	13HH.13	Looks after chronically sick husband
17538	13IL300	Wife alive
20079	13H6.00	Single parent
20149	13HH.16	Looks after chronically sick wife
21346	8C92.00	Spouse reassured
21433	13HV313	Husband committed adultery
21860	13IL.00	Health of spouse
21925	13HV400	Seven year itch - marital
23385	13FD100	Spouse cannot care for patient
23508	SN56400	Battered husband
23514	13HT114	Wife unable to cope
23974	13IL200	Wife well
24769	13I7100	Husband in prison
25149	13W9011	Single parent family - mother
25452	13D2.00	Homeless single person
25503	1336.00	Cohabiting
27385	1333.11	Separated from cohabitee
29543	13H5.00	Marital reconciliation
29544	13H4.11	Marital trouble
30597	ZV26500	[V]Artificial insemination from husband
30950	13H4213	Row with wife
31678	13EF.00	Divorced couple sharing house
32984	1F81.00	Spouse cooks food
33001	131..11	Occupation of husband
33153	1312.00	House husband
34771	13HV.00	Extra-marital problems
36077	131..00	Occupation of spouse
36333	ZLB4.00	Seen by marriage guidance counsellor
37113	U3M0.00	[X]Neglect and abandonment, by spouse or partner
37265	1331.00	Single
37551	13HVZ00	Extra-marital problems NOS
38325	13H5.11	Cohabitee returned
39292	131..12	Occupation of wife
39474	9NA8.00	Cohabitee made appointment
39651	13HV300	Spouse committed adultery
39879	13HV314	Oil rig wives syndrome
41203	13L1200	Spouse is handicapped
42321	13H4311	Spouse unsympathetic
42386	133H.00	Common-law wife

Medcode	Readcode	Readterm
42398	13I7200	Spouse arrested
42400	13HV312	Wife committed adultery
42402	13WE.00	Spouse works away from home
42428	1333.14	Cohabitee left home
50149	13W7000	Crime against spouse
54096	131Z.00	Occupation of spouse NOS
54816	13H4312	Spouse inattentive
59817	9d31.00	Husband
59829	9d32.00	Wife
60723	918j.00	Partner is informal carer
63118	1276.11	Spouse haemophiliac
88373	133S.00	Married/civil partner
95101	9d30.00	Spouse
98130	9d33.00	Cohabitee
104879	133e.00	Common law partnership

Appendix 9 Codelist: marital status

Medcode	Readcode	Readterm
207	13M1.00	Death of spouse
333	13H4200	Marital conflict
723	13H4.12	Marital stress
838	13H3000	Divorce proceedings
954	13H4100	Marital breakdown
1328	6124.00	Partner had vasectomy
1349	13H4.00	Marital problems
1522	1334.00	Divorced
1540	13H4212	Marital disharmony
1580	1332.11	Remarried
2093	13H2.00	Separation
2159	13H3100	Divorce proceedings pending
3111	13HP100	Girlfriend relationship problem
3321	SN56300	Battered wife
3394	13W9.00	Single parent family
3483	13HD.00	Violent spouse
3551	13H4211	Marital discord
3719	13L6.00	Spouse unwell
3988	1332.00	Married
4204	1333.00	Separated
4312	1335.00	Widowed
4531	13HP000	Boyfriend relationship problem
4565	6741.00	Marital counselling
4925	1333.13	Wife left home
5055	1333.12	Husband left home
6056	13H3.00	Divorce
6104	13HP.00	Relationship problems
7419	1332.12	Newly wed
7869	13H1.00	Marriage
8470	13IL100	Wife pregnant
9112	13HX.00	New relationship
9551	ZV61100	[V]Marital problems
9612	1311.00	Housewife
9910	13H3.11	Divorce problems
10330	13L3.11	Alcoholic spouse
11103	1331.11	Single - unmarried
11251	13MG.00	Death of wife
12076	ZU14111	Husband died
12325	ZU14100	Death of husband
13001	6123.00	No partner at present
15020	13HG.11	Spouse left home
15115	13HH.15	Looks after chronically sick spouse
15313	13H4300	Maladjustment to married life
15404	13L3.13	Husband alcoholic
15527	133C.00	Widower
15777	13HV311	Spouse committed infidelity
15824	13L1.11	Disabled spouse
15950	13H5.12	Spouse returned home
16262	13H6.11	Unmarried parent
16315	133G.00	Common-law husband
16344	8C81.12	Artificial insemin by husband
16552	13HH.13	Looks after chronically sick husband
17538	13IL300	Wife alive
17802	13MH.00	Husband died
20079	13H6.00	Single parent
20149	13HH.16	Looks after chronically sick wife
20217	13HM.11	Legal problem with separation
20313	13HM.12	Legal problem with divorce
20536	13HV100	Affair ended
21346	8C92.00	Spouse reassured
21433	13HV313	Husband committed adultery
21860	13IL.00	Health of spouse
21925	13HV400	Seven year itch - marital
22336	13L6.11	Has infirm partner
22909	13JK.13	Partnership problems
22934	6124.11	Partner sterilised
23385	13FD100	Spouse cannot care for patient
23409	13HV000	Affair started
23445	13HV200	Affair unsatisfactory
23508	SN56400	Battered husband
23514	13HT114	Wife unable to cope
23858	ZV61011	[V]Divorce
23974	13IL200	Wife well

Medcode	Readcode	Readterm
24055	13HG.00	Broken with partner
24769	13I7100	Husband in prison
25097	13MI.00	Death of husband
25149	13W9011	Single parent family - mother
25452	13D2.00	Homeless single person
25503	1336.00	Cohabiting
27385	1333.11	Separated from cohabitee
27434	13HV011	Lover taken
27572	13HE.00	Engaged
28440	13MF.00	Death of partner
28484	U3N0.00	[X]Other maltreatment syndromes, by spouse or partner
29543	13H5.00	Marital reconciliation
29544	13H4.11	Marital trouble
30597	ZV26500	[V]Artificial insemination from husband
30950	13H4213	Row with wife
31495	8H7I.00	Refer to partner
31678	13EF.00	Divorced couple sharing house
32451	67M..00	Informing partner
32984	1F81.00	Spouse cooks food
33000	13Q..12	Widows pensions
33001	131..11	Occupation of husband
33153	1312.00	House husband
33188	13ID.00	Partner unemployed
34771	13HV.00	Extra-marital problems
36077	131..00	Occupation of spouse
36333	ZLB4.00	Seen by marriage guidance counsellor
36947	13L7.00	Partner dying
37113	U3M0.00	[X]Neglect and abandonment, by spouse or partner
37265	1331.00	Single
37551	13HVZ00	Extra-marital problems NOS
38325	13H5.11	Cohabitee returned
39292	131..12	Occupation of wife
39474	9NA8.00	Cohabitee made appointment
39651	13HV300	Spouse committed adultery
39879	13HV314	Oil rig wives syndrome
40493	13HF.00	Broken engagement
40866	13Q..00	Widows benefits
41203	13L1200	Spouse is handicapped
42321	13H4311	Spouse unsympathetic
42386	133H.00	Common-law wife
42390	13I7300	Boyfriend arrested
42398	13I7200	Spouse arrested
42400	13HV312	Wife committed adultery
42402	13WE.00	Spouse works away from home
42428	1333.14	Cohabitee left home
45005	1AZ5.00	Fertility problems in partner
45010	13Q3.00	Widows pension
47411	13I2.00	Partner stops work
49666	1AZ4.00	Low sperm count in partner
50149	13W7000	Crime against spouse
50485	13HY.00	First relationship
54096	131Z.00	Occupation of spouse NOS
54816	13H4312	Spouse inattentive
56178	13HV012	Mistress taken
59817	9d31.00	Husband
59829	9d32.00	Wife
60723	918j.00	Partner is informal carer
60821	13QZ.00	Widows benefits NOS
61291	1A85.00	Breast lump detected by partner
61509	13Q..11	Widows allowances
63118	1276.11	Spouse haemophiliac
68095	13I7400	Girlfriend arrested
88373	133S.00	Married/civil partner
91652	7E0A300	Intrauterine insemination superovulation partner sperm
94044	133V.00	Widowed/surviving civil partner
94917	13Ir.00	Partner pregnant
95101	9d30.00	Spouse
96856	133T.00	Divorced/person whose civil partnership has been dissolved
97076	6127.00	Partner had tubal ligation
98130	9d33.00	Cohabitee
98610	13Q5.00	War widows pension
98818	13Q1.00	Widows allowance
99328	13I1.00	Partner begins work
100785	68b9.00	Anten screen, partner tested and no genetic risk identified
101900	13I4.00	Partner works after retirement

Medcode	Readcode	Readterm
102413	133b.00	Partner in relationship
104879	133e.00	Common law partnership
104936	U3P0.00	[X]Maltreatment, by spouse or partner
109323	13I3.00	Partner retires

Appendix 10 Codelist: living alone

Medcode	Readcode	Readterm
464	13HT115	Domestic problems
1123	13HQ.00	In prison
1650	13HT100	Stress at home
2562	13D..11	Homeless
2955	1B1K.12	Lives alone
11504	ZU33200	Lives with daughter
12798	ZU33600	Lives with father
12807	ZU33100	Lives with children
13355	13F1.00	Independant housing, not alone
13356	13F2.00	Lives alone - help available
13357	13F3.00	Lives alone -no help available
13358	13FH.00	Lives with relatives
15416	13F7300	Lives in a childrens home
15691	13F3100	Lives alone needs housekeeper
15700	13JS.00	Works away from home
15840	13F7100	Lives in a welfare home
17279	13FH000	Elderly relative lives with family
19610	13FJ.00	Independent housing, lives alone
20155	13HT113	Home unsettled
21405	13F7400	Admitted to a children's home
22249	ZU3..11	Lives with
22336	13L6.11	Has infirm partner
22503	ZU33300	Lives with son
23575	13FD.00	No carers, though not alone
25167	ZU31.00	Lives alone
25452	13D2.00	Homeless single person
25715	8He1.00	Referral to intermediate care - community rehabilitation
26177	8He0.00	Referral to intermediate care - hospital at home
28448	ZU33500	Lives with mother
30200	ZV60611	[V]Boarding school resident
30965	13E6.00	Overcrowded in house
31385	13F8100	Long stay hospital inpatient
31678	13EF.00	Divorced couple sharing house
32753	13D3.11	Tramp
32774	13D1.00	Homeless family
32882	8He..00	Referral to intermediate care
33006	1311.11	Homemaker
33994	ZW63200	Staying with carer
34506	13FL.00	Living rough
36418	ZV60300	[V]Person living alone
36730	Z37C.00	Provision of special residential school
36809	ZU33.00	Lives with family
36947	13L7.00	Partner dying
36968	ZU33400	Lives with parents
40822	ZU33700	Lives with grandparents
41388	13D5.00	Vagrant
42533	ZU26100	Number of dependants in household
42654	ZU35.00	Lives with companion
43393	ZU33800	Lives with grandfather
43911	ZU33900	Lives with grandmother
47577	ZW63100	Living with carer
47591	13FS.00	Long stay hospital inpatient
49138	ZV63212	[V]Delayed discharge - nursing home vacancy awaited
50111	13HH.11	Cares for mentally handicapped dependent
50206	8O0A.00	Provision of special residential school
50994	13HH.18	Looks after physically handicapped dependent
51193	ZU32.00	Lives with friends
52682	6992.00	Prison medical examination
53343	ZU3..12	LW - Lives with
55276	ZU37.00	Lives in a community
57438	ZU32100	Lives with friend
59330	T776.00	Place of occurrence of accident or poisoning, prison
59523	13D3.12	Vagabond
61385	9b1C.00	Hospice - independent
66549	13EA.00	Multiple occupancy
67112	9k6..00	Homeless - enhanced services administration
67187	13FM.00	Sleeping in night shelter
68005	13FV.00	Lives in a welfare home
70021	ZU36.00	Lives as companion
71339	0A82.00	Companion
71663	ZU37200	Lives in boarding school
73177	ZLG6100	Discharge to long stay hospital
86390	13FY.00	Lives in a children's unit

Medcode	Readcode	Readterm
90547	ZU34.00	Lives with lodger
94886	13Il.00	Subject to interim supervision order under Children Act 1989
95555	ZU37300	Lives in a commune
95880	13It.00	Lives with grandmother
96605	9k60.00	Homeless - enhanced service completed
97138	13Is.00	Lives with grandfather
99907	ZV60011	[V]Hobo
101400	13Zr.00	Lives with immunocompromised person
101582	9b0t.00	Children's home visit note
103510	ZV60014	[V]Tramp
103553	ZU37100	Lives in a school community
104962	13D8.00	Length of time homeless
106972	13IZ000	Lives with adoptive parents
107393	9Ngr.00	Under care of homeless advocacy service
107733	13IZ200	Lives with biological parents
107809	918F200	Lives with carer
109673	13IZ100	Lives with biological parent and step parent

Appendix 11 Codelist: partner uncategorised

Medcode	Read code	Read term
1328	6124.00	Partner had vasectomy
6104	13HP.00	Relationship problems
9112	13HX.00	New relationship
20536	13HV100	Affair ended
22336	13L6.11	Has infirm partner
22909	13JK.13	Partnership problems
22934	6124.11	Partner sterilised
23409	13HV000	Affair started
23445	13HV200	Affair unsatisfactory
25503	1336.00	Cohabiting
27434	13HV011	Lover taken
28484	U3N0.00	[X]Other maltreatment syndromes, by spouse or partner
31495	8H7I.00	Refer to partner
32451	67M..00	Informing partner
33188	13ID.00	Partner unemployed
36947	13L7.00	Partner dying
37113	U3M0.00	[X]Neglect and abandonment, by spouse or partner
38325	13H5.11	Cohabitee returned
39474	9NA8.00	Cohabitee made appointment
45005	1AZ5.00	Fertility problems in partner
47411	13I2.00	Partner stops work
49666	1AZ4.00	Low sperm count in partner
50485	13HY.00	First relationship
56178	13HV012	Mistress taken
60723	918j.00	Partner is informal carer
61291	1A85.00	Breast lump detected by partner
91652	7E0A300	Intrauterine insemination superovulation partner sperm
94917	13Ir.00	Partner pregnant
97076	6127.00	Partner had tubal ligation
98130	9d33.00	Cohabitee
99328	13I1.00	Partner begins work
100785	68b9.00	Anten screen, partner tested and no genetic risk identified
101900	13I4.00	Partner works after retirement
102413	133b.00	Partner in relationship
104936	U3P0.00	[X]Maltreatment, by spouse or partner
109323	13I3.00	Partner retires

Appendix 12 Codelist: zoster vaccine

Medcode	Read code	Read term
106904	65FY.00	Herpes zoster vaccination
106593	65FY.11	Shingles vaccination
107067	65FY000	Herpes zoster vaccination given by other health care provide
106948	68Nv.00	No consent for herpes zoster vaccination
106946	8I2r.00	Herpes zoster vaccination contraindicated
106947	8IEl.00	Herpes zoster vaccination declined
107061	9Nig.00	Did not attend herpes zoster vaccination
108895	U60K600	[X]Herpes zoster vacc caus adverse effects therapeutic use

prodcode	Productname
47327	Zostavax vaccine powder and solvent for suspension for injection 0.65ml pre-filled syringes (sanofi pasteur MSD Ltd)
48314	Shingles (Herpes Zoster) vaccine (live) powder and solvent for suspension for injection 0.65ml pre-filled syringes

immtype	Description
88	Shingles
91	Shingles OHP

Appendix 13 Codelist: chronic conditions

1. **Systemic lupus erythematosus**

A) CPRD

medcode	readcode	readterm
4125	M154.00	Lupus erythematosus
7522	M154z00	Lupus erythematosus NOS
7871	N000.00	Systemic lupus erythematosus
11920	N000400	Systemic lupus erythematosus with pericarditis
20007	N000000	Disseminated lupus erythematosus
22205	K01x411	Lupus nephritis
29519	N000300	Systemic lupus erythematosus with organ or sys involv
31564	H57y400	Lung disease with systemic lupus erythematosus
33449	M154000	Lupus erythematosus chronicus
36942	N000200	Drug-induced systemic lupus erythematosus
40797	M154200	Lupus erythematosus migrans
42719	N000z00	Systemic lupus erythematosus NOS
44095	F371000	Polyneuropathy in disseminated lupus erythematosus
45726	ZRq9.00	Systemic lupus erythematosus disease activity index
47047	ZR2l.11	BILAG - British isles lupus assessment group score
47672	K01x400	Nephrotic syndrome in systemic lupus erythematosus
51798	ZRq8.00	Systemic lupus activity measure
57675	N000100	Libman-Sacks disease
58706	Nyu4300	[X]Other forms of systemic lupus erythematosus
63283	ZRq9.11	SLEDAI-Sys lup ery dis act ind
63955	M154600	Lupus erythematosus unguium mutilans
65391	M154300	Lupus erythematosus nodularis
101433	N000600	Cerebral lupus
106086	ZRq8.11	SLAM - Systemic lupus activity measure
108072	F396100	Myopathy due to disseminated lupus erythematosus

B) Hospital Episodes Statistics

ICD 10	DESCRIPTION
M32	Systemic lupus erythematosus
M32.0	Drug-induced systemic lupus erythematosus
M32.1	Systemic lupus erythematosus with organ or system involvement
M32.8	Other forms of systemic lupus erythematosus
M32.9	Systemic lupus erythematosus, unspecified

2. **Rheumatoid arthritis**

A) CPRD

medcode	readcode	readterm
844	N040.00	Rheumatoid arthritis
4186	N043.00	Juvenile rheumatoid arthritis - Still's disease
5723	N042200	Rheumatoid nodule
6916	N040P00	Seronegative rheumatoid arthritis
8350	N040T00	Flare of rheumatoid arthritis
9707	N047.00	Seropositive errosive rheumatoid arthritis
9954	H570.00	Rheumatoid lung
12019	N04X.00	Seropositive rheumatoid arthritis, unspecified
17412	66H..13	Rheumatoid arthrit. monitoring
18155	N040Q00	Rheumatoid bursitis
21358	N040200	Rheumatoid arthritis of shoulder
21533	N043200	Pauciarticular juvenile rheumatoid arthritis
23552	N041.00	Felty's syndrome
23834	N005.00	Adult Still's Disease
27557	N043z00	Juvenile rheumatoid arthritis NOS
28853	N04y012	Fibrosing alveolitis associated with rheumatoid arthritis
30548	N040N00	Rheumatoid vasculitis
31054	N040S00	Rheumatoid arthritis - multiple joint
31209	F396400	Myopathy due to rheumatoid arthritis
31360	N045500	Juvenile rheumatoid arthritis
31724	N04y000	Rheumatoid lung
32001	N04y200	Adult-onset Still's disease
33264	2G27.00	O/E-hands-rheumatoid spindling
36276	N043300	Monarticular juvenile rheumatoid arthritis
37431	N042z00	Rheumatoid arthropathy + visceral/systemic involvement NOS
41941	N040900	Rheumatoid arthritis of PIP joint of finger

medcode	readcode	readterm
42299	N040800	Rheumatoid arthritis of MCP joint
42719	N000z00	Systemic lupus erythematosus NOS
43816	G5yA.00	Rheumatoid carditis
44203	N040100	Other rheumatoid arthritis of spine
44743	N040000	Rheumatoid arthritis of cervical spine
46436	N042100	Rheumatoid lung disease
47831	N043100	Acute polyarticular juvenile rheumatoid arthritis
48832	N040700	Rheumatoid arthritis of wrist
49067	N040B00	Rheumatoid arthritis of hip
49227	N042.00	Other rheumatoid arthropathy + visceral/systemic involvement
49787	G5y8.00	Rheumatoid myocarditis
50644	N043000	Juvenile rheumatoid arthropathy unspecified
50863	N040D00	Rheumatoid arthritis of knee
51238	N040K00	Rheumatoid arthritis of 1st MTP joint
51239	N040F00	Rheumatoid arthritis of ankle
53621	N040R00	Rheumatoid nodule
56202	Nyu1G00	[X]Seropositive rheumatoid arthritis, unspecified
56838	N04y011	Caplan's syndrome
59738	N040500	Rheumatoid arthritis of elbow
62401	F371200	Polyneuropathy in rheumatoid arthritis
63198	N040A00	Rheumatoid arthritis of DIP joint of finger
63365	N040600	Rheumatoid arthritis of distal radio-ulnar joint
70221	Nyu1200	[X]Other specified rheumatoid arthritis
70658	N040H00	Rheumatoid arthritis of talonavicular joint
71784	N040J00	Rheumatoid arthritis of other tarsal joint
73619	N040G00	Rheumatoid arthritis of subtalar joint
93715	Nyu1100	[X]Other seropositive rheumatoid arthritis
99414	N040L00	Rheumatoid arthritis of lesser MTP joint
100776	N040C00	Rheumatoid arthritis of sacro-iliac joint
100914	N040400	Rheumatoid arthritis of acromioclavicular joint
102088	7P20300	Delivery of rehabilitation for rheumatoid arthritis
103829	38DZ000	Disease activity score 28 joint in rheumatoid arthritis
105507	66HB000	Rheumatoid arthritis annual review
106092	9hR1.00	Except rheumatoid arthritis qual indicator: informed dissent
106093	9hR..00	Exception reporting: rheumatoid arthritis quality indicators
106118	9hR0.00	Except rheumatoid arthritis quality indicator: pt unsuitable
106440	Nyu1000	[X]Rheumatoid arthritis+involvement/other organs or systems
107112	N040M00	Rheumatoid arthritis of IP joint of toe
107340	9mM..00	Rheumatoid arthritis monitoring invitation
107435	9mM0.00	Rheumatoid arthritis monitoring invitation first letter
107575	9mM1.00	Rheumatoid arthritis monitoring invitation second letter
107606	9mM3.00	Rheumatoid arthritis monitoring verbal invitation
107676	9mM2.00	Rheumatoid arthritis monitoring invitation third letter
107791	N040E00	Rheumatoid arthritis of tibio-fibular joint
107797	9mM4.00	Rheumatoid arthritis monitoring telephone invitation
107963	N040300	Rheumatoid arthritis of sternoclavicular joint

B) Hospital Episodes Statistics

ICD 10	DESCRIPTION
J99.0	Rheumatoid lung disease
M05	Seropositive rheumatoid arthritis
M05.0	Felty's syndrome
M05.00	Felty's syndrome
M05.01	Felty's syndrome
M05.02	Felty's syndrome
M05.03	Felty's syndrome
M05.04	Felty's syndrome
M05.05	Felty's syndrome
M05.06	Felty's syndrome
M05.07	Felty's syndrome
M05.08	Felty's syndrome
M05.09	Felty's syndrome
M05.1	Rheumatoid lung disease
M05.10	Rheumatoid lung disease
M05.11	Rheumatoid lung disease
M05.12	Rheumatoid lung disease
M05.13	Rheumatoid lung disease
M05.14	Rheumatoid lung disease
M05.15	Rheumatoid lung disease
M05.16	Rheumatoid lung disease
M05.17	Rheumatoid lung disease
M05.18	Rheumatoid lung disease
M05.19	Rheumatoid lung disease

ICD 10	DESCRIPTION
M05.2	Rheumatoid vasculitis
M05.20	Rheumatoid vasculitis
M05.21	Rheumatoid vasculitis
M05.22	Rheumatoid vasculitis
M05.23	Rheumatoid vasculitis
M05.24	Rheumatoid vasculitis
M05.25	Rheumatoid vasculitis
M05.26	Rheumatoid vasculitis
M05.27	Rheumatoid vasculitis
M05.28	Rheumatoid vasculitis
M05.29	Rheumatoid vasculitis
M05.3	Rheumatoid arthritis with involvement of other organs and systems
M05.30	Rheumatoid arthritis with involvement of other organs and systems
M05.31	Rheumatoid arthritis with involvement of other organs and systems
M05.32	Rheumatoid arthritis with involvement of other organs and systems
M05.33	Rheumatoid arthritis with involvement of other organs and systems
M05.34	Rheumatoid arthritis with involvement of other organs and systems
M05.35	Rheumatoid arthritis with involvement of other organs and systems
M05.36	Rheumatoid arthritis with involvement of other organs and systems
M05.37	Rheumatoid arthritis with involvement of other organs and systems
M05.38	Rheumatoid arthritis with involvement of other organs and systems
M05.39	Rheumatoid arthritis with involvement of other organs and systems
M05.8	Other seropositive rheumatoid arthritis
M05.80	Other seropositive rheumatoid arthritis
M05.81	Other seropositive rheumatoid arthritis
M05.82	Other seropositive rheumatoid arthritis
M05.83	Other seropositive rheumatoid arthritis
M05.84	Other seropositive rheumatoid arthritis
M05.85	Other seropositive rheumatoid arthritis
M05.86	Other seropositive rheumatoid arthritis
M05.87	Other seropositive rheumatoid arthritis
M05.88	Other seropositive rheumatoid arthritis
M05.89	Other seropositive rheumatoid arthritis
M05.9	Seropositive rheumatoid arthritis, unspecified
M05.90	Seropositive rheumatoid arthritis, unspecified
M05.91	Seropositive rheumatoid arthritis, unspecified
M05.92	Seropositive rheumatoid arthritis, unspecified
M05.93	Seropositive rheumatoid arthritis, unspecified
M05.94	Seropositive rheumatoid arthritis, unspecified
M05.95	Seropositive rheumatoid arthritis, unspecified
M05.96	Seropositive rheumatoid arthritis, unspecified
M05.97	Seropositive rheumatoid arthritis, unspecified
M05.98	Seropositive rheumatoid arthritis, unspecified
M05.99	Seropositive rheumatoid arthritis, unspecified
M06	Other rheumatoid arthritis
M06.0	Seronegative rheumatoid arthritis
M06.00	Seronegative rheumatoid arthritis
M06.01	Seronegative rheumatoid arthritis
M06.02	Seronegative rheumatoid arthritis
M06.03	Seronegative rheumatoid arthritis
M06.04	Seronegative rheumatoid arthritis
M06.05	Seronegative rheumatoid arthritis
M06.06	Seronegative rheumatoid arthritis
M06.07	Seronegative rheumatoid arthritis
M06.08	Seronegative rheumatoid arthritis
M06.09	Seronegative rheumatoid arthritis
M06.1	Adult-onset Still's disease
M06.10	Adult-onset Still's disease
M06.11	Adult-onset Still's disease
M06.12	Adult-onset Still's disease
M06.13	Adult-onset Still's disease
M06.14	Adult-onset Still's disease
M06.15	Adult-onset Still's disease
M06.16	Adult-onset Still's disease
M06.17	Adult-onset Still's disease
M06.18	Adult-onset Still's disease
M06.19	Adult-onset Still's disease
M06.2	Rheumatoid bursitis
M06.20	Rheumatoid bursitis
M06.21	Rheumatoid bursitis
M06.22	Rheumatoid bursitis
M06.23	Rheumatoid bursitis
M06.24	Rheumatoid bursitis
M06.25	Rheumatoid bursitis
M06.26	Rheumatoid bursitis

ICD 10	DESCRIPTION
M06.27	Rheumatoid bursitis
M06.28	Rheumatoid bursitis
M06.29	Rheumatoid bursitis
M06.3	Rheumatoid nodule
M06.30	Rheumatoid nodule
M06.31	Rheumatoid nodule
M06.32	Rheumatoid nodule
M06.33	Rheumatoid nodule
M06.34	Rheumatoid nodule
M06.35	Rheumatoid nodule
M06.36	Rheumatoid nodule
M06.37	Rheumatoid nodule
M06.38	Rheumatoid nodule
M06.39	Rheumatoid nodule
M06.8	Other specified rheumatoid arthritis
M06.80	Other specified rheumatoid arthritis
M06.81	Other specified rheumatoid arthritis
M06.82	Other specified rheumatoid arthritis
M06.83	Other specified rheumatoid arthritis
M06.84	Other specified rheumatoid arthritis
M06.85	Other specified rheumatoid arthritis
M06.86	Other specified rheumatoid arthritis
M06.87	Other specified rheumatoid arthritis
M06.88	Other specified rheumatoid arthritis
M06.89	Other specified rheumatoid arthritis
M06.9	Rheumatoid arthritis, unspecified
M06.90	Rheumatoid arthritis, unspecified
M06.91	Rheumatoid arthritis, unspecified
M06.92	Rheumatoid arthritis, unspecified
M06.93	Rheumatoid arthritis, unspecified
M06.94	Rheumatoid arthritis, unspecified
M06.95	Rheumatoid arthritis, unspecified
M06.96	Rheumatoid arthritis, unspecified
M06.97	Rheumatoid arthritis, unspecified
M06.98	Rheumatoid arthritis, unspecified
M06.99	Rheumatoid arthritis, unspecified
M08.0	Juvenile rheumatoid arthritis
M08.00	Juvenile rheumatoid arthritis
M08.01	Juvenile rheumatoid arthritis
M08.02	Juvenile rheumatoid arthritis
M08.03	Juvenile rheumatoid arthritis
M08.04	Juvenile rheumatoid arthritis
M08.05	Juvenile rheumatoid arthritis
M08.06	Juvenile rheumatoid arthritis
M08.07	Juvenile rheumatoid arthritis
M08.08	Juvenile rheumatoid arthritis
M08.09	Juvenile rheumatoid arthritis

3. **Inflammatory bowel disease**

A) CPRD

medcode	readcode	readterm
593	J40..11	Crohn's disease
704	J410100	Ulcerative colitis
1784	J41..12	Ulcerative colitis and/or proctitis
1796	J4...12	Inflammatory bowel disease
5133	J41..00	Idiopathic proctocolitis
5749	14C4.11	H/O: ulcerative colitis
6538	J401z11	Crohn's colitis
6650	J410.00	Ulcerative proctocolitis
8347	J410300	Ulcerative proctitis
9359	J400z00	Crohn's disease of the small bowel NOS
11119	ZR3S.11	CDAI - Crohn's disease activity index
11286	J40..00	Regional enteritis - Crohn's disease
11337	ZR3S.00	Crohn's disease activity index
12575	N045300	Juvenile arthritis in Crohn's disease
15207	J41z.00	Idiopathic proctocolitis NOS
15773	J402.00	Regional ileocolitis
17641	N031000	Arthropathy in ulcerative colitis
20480	N031100	Arthropathy in Crohn's disease
20688	J401z00	Crohn's disease of the large bowel NOS
22516	J410400	Exacerbation of ulcerative colitis
24550	J41y.00	Other idiopathic proctocolitis
24858	J410200	Ulcerative rectosigmoiditis

medcode	readcode	readterm
28476	J400200	Crohn's disease of the terminal ileum
29616	J08z900	Orofacial Crohn's disease
30433	J411.00	Ulcerative (chronic) enterocolitis
33456	J410z00	Ulcerative proctocolitis NOS
36913	J400500	Exacerbation of Crohn's disease of small intestine
39037	J401200	Exacerbation of Crohn's disease of large intestine
39278	J400400	Crohn's disease of the ileum NOS
42822	J412.00	Ulcerative (chronic) ileocolitis
43090	J41yz00	Other idiopathic proctocolitis NOS
44426	J401.00	Regional enteritis of the large bowel
48732	J410000	Ulcerative ileocolitis
51576	J400.00	Regional enteritis of the small bowel
51578	J40..12	Granulomatous enteritis
52449	J40z.00	Regional enteritis NOS
53743	Jyu4100	[X]Other ulcerative colitis
59994	J40z.11	Crohn's disease NOS
62628	J401000	Regional enteritis of the colon
63036	J400100	Regional enteritis of the jejunum
64773	J401100	Regional enteritis of the rectum
66238	J400300	Crohn's disease of the ileum unspecified
69959	Jyu4000	[X]Other Crohn's disease
71083	N045400	Juvenile arthritis in ulcerative colitis
71945	J400000	Regional enteritis of the duodenum
104259	J413.00	Ulcerative pancolitis
107313	8Cc5.00	Management of inflammatory bowel disease
110283	8Cc5.11	Management of IBD (inflammatory bowel disease)

B) Hospital Episodes Statistics

ICD 10	DESCRIPTION
K50	Crohn's disease [regional enteritis]
K50.0	Crohn's disease of small intestine
K50.1	Crohn's disease of large intestine
K50.8	Other Crohn's disease
K50.9	Crohn's disease, unspecified
K51	Ulcerative colitis
K51.0	Ulcerative (chronic) pancolitis
K51.2	Ulcerative (chronic) proctitis
K51.3	Ulcerative (chronic) rectosigmoiditis
K51.4	Inflammatory polyps
K51.5	Left sided colitis
K51.8	Other ulcerative colitis
K51.9	Ulcerative colitis, unspecified
M07.4	Arthropathy in Crohn's disease [regional enteritis]
M07.40	Arthropathy in Crohn's disease [regional enteritis]
M07.41	Arthropathy in Crohn's disease [regional enteritis]
M07.42	Arthropathy in Crohn's disease [regional enteritis]
M07.43	Arthropathy in Crohn's disease [regional enteritis]
M07.44	Arthropathy in Crohn's disease [regional enteritis]
M07.45	Arthropathy in Crohn's disease [regional enteritis]
M07.46	Arthropathy in Crohn's disease [regional enteritis]
M07.47	Arthropathy in Crohn's disease [regional enteritis]
M07.48	Arthropathy in Crohn's disease [regional enteritis]
M07.49	Arthropathy in Crohn's disease [regional enteritis]
M07.5	Arthropathy in ulcerative colitis
M07.50	Arthropathy in ulcerative colitis
M07.51	Arthropathy in ulcerative colitis
M07.52	Arthropathy in ulcerative colitis
M07.53	Arthropathy in ulcerative colitis
M07.54	Arthropathy in ulcerative colitis
M07.55	Arthropathy in ulcerative colitis
M07.56	Arthropathy in ulcerative colitis
M07.57	Arthropathy in ulcerative colitis
M07.58	Arthropathy in ulcerative colitis
M07.59	Arthropathy in ulcerative colitis
M09.1	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.10	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.11	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.12	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.13	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.14	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.15	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.16	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.17	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.18	Juvenile arthritis in Crohn's disease [regional enteritis]

ICD 10	DESCRIPTION
M09.19	Juvenile arthritis in Crohn's disease [regional enteritis]
M09.2	Juvenile arthritis in ulcerative colitis
M09.20	Juvenile arthritis in ulcerative colitis
M09.21	Juvenile arthritis in ulcerative colitis
M09.22	Juvenile arthritis in ulcerative colitis
M09.23	Juvenile arthritis in ulcerative colitis
M09.24	Juvenile arthritis in ulcerative colitis
M09.25	Juvenile arthritis in ulcerative colitis
M09.26	Juvenile arthritis in ulcerative colitis
M09.27	Juvenile arthritis in ulcerative colitis
M09.28	Juvenile arthritis in ulcerative colitis
M09.29	Juvenile arthritis in ulcerative colitis

4. **Chronic obstructive pulmonary disease and asthma**

A) CPRD

medcode	readcode	readterm
78	H33..00	Asthma
81	663..11	Asthma monitoring
185	H333.00	Acute exacerbation of asthma
232	H33z100	Asthma attack
233	H33z011	Severe asthma attack
719	14B4.00	H/O: asthma
794	H32..00	Emphysema
998	H3...11	Chronic obstructive airways disease
1001	H3...00	Chronic obstructive pulmonary disease
1208	H330.12	Childhood asthma
1446	H312200	Acute exacerbation of chronic obstructive airways disease
1555	H33..11	Bronchial asthma
2290	H330.11	Allergic asthma
3018	663V100	Mild asthma
3243	H31..00	Chronic bronchitis
3366	663V300	Severe asthma
3458	663V000	Occasional asthma
3665	H331.11	Late onset asthma
4084	663K.00	Airways obstructn irreversible
4442	H33z.00	Asthma unspecified
4606	H33zz11	Exercise induced asthma
4892	H33z000	Status asthmaticus NOS
5267	H331.00	Intrinsic asthma
5627	H330011	Hay fever with asthma
5710	H3z..00	Chronic obstructive airways disease NOS
5798	H312000	Chronic asthmatic bronchitis
5909	H312011	Chronic wheezy bronchitis
6707	H330111	Extrinsic asthma with asthma attack
7058	8H2P.00	Emergency admission, asthma
7146	H330.00	Extrinsic (atopic) asthma
7191	663P.00	Asthma limiting activities
7229	663W.00	Asthma prophylactic medication used
7378	663U.00	Asthma management plan given
7416	663N.00	Asthma disturbing sleep
7731	H330.14	Pollen asthma
7884	H3y1.00	Chron obstruct pulmonary dis wth acute exacerbation, unspec
8335	H33z111	Asthma attack NOS
8355	9OJA.11	Asthma monitored
9018	663y.00	Number of asthma exacerbations in past year
9520	66YB.00	Chronic obstructive pulmonary disease monitoring
9552	66Y5.00	Change in asthma management plan
9663	66Y9.00	Step up change in asthma management plan
9876	H38..00	Severe chronic obstructive pulmonary disease
10043	66YJ.00	Asthma annual review
10274	8B3j.00	Asthma medication review
10487	663j.00	Asthma - currently active
10802	H37..00	Moderate chronic obstructive pulmonary disease
10863	H36..00	Mild chronic obstructive pulmonary disease
10980	H322.00	Centrilobular emphysema
10996	2126200	Asthma resolved
11019	8H2R.00	Admit COPD emergency
11022	178..00	Asthma trigger
11150	H311.00	Mucopurulent chronic bronchitis
11287	66YM.00	Chronic obstructive pulmonary disease annual review
11370	1O2..00	Asthma confirmed
11839	212G.00	Asthma resolved
12166	H3y..00	Other specified chronic obstructive airways disease

medcode	readcode	readterm
12987	H33z200	Late-onset asthma
13064	663V.00	Asthma severity
13065	663V200	Moderate asthma
13066	663h.00	Asthma - currently dormant
13173	663O.00	Asthma not disturbing sleep
13174	663Q.00	Asthma not limiting activities
13175	663N200	Asthma disturbs sleep frequently
14777	H330000	Extrinsic asthma without status asthmaticus
14798	H312100	Emphysematous bronchitis
15157	H31z.00	Chronic bronchitis NOS
15248	H330.13	Hay fever with asthma
15626	H310000	Chronic catarrhal bronchitis
16070	H33zz00	Asthma NOS
16410	H32yz00	Other emphysema NOS
16667	8795	Asthma control step 2
16785	8794	Asthma control step 1
18141	66YE.00	Asthma monitoring due
18223	66YA.00	Step down change in asthma management plan
18224	8796	Asthma control step 3
18323	H331111	Intrinsic asthma with asthma attack
18476	66YL.11	COPD follow-up
18501	66YI.00	COPD self-management plan given
18621	66YL.00	Chronic obstructive pulmonary disease follow-up
18792	9Oi..00	Chronic obstructive pulmonary disease monitoring admin
19003	66Ye.00	Emergency COPD admission since last appointment
19106	66Yd.00	COPD accident and emergency attendance since last visit
19167	66YQ.00	Asthma monitoring by nurse
19519	663p.00	Asthma treatment compliance unsatisfactory
19520	663n.00	Asthma treatment compliance satisfactory
19539	9OJA.00	Asthma monitoring check done
20860	8798	Asthma control step 5
20886	8797	Asthma control step 4
21061	H3y0.00	Chronic obstruct pulmonary dis with acute lower resp infectn
21232	H33zz12	Allergic asthma NEC
22752	173c.00	Occupational asthma
22905	H581.00	Interstitial emphysema
23492	H320z00	Chronic bullous emphysema NOS
24248	H313.00	Mixed simple and mucopurulent chronic bronchitis
24479	663d.00	Emergency asthma admission since last appointment
24506	8791	Further asthma - drug prevent.
24884	663u.00	Asthma causes daytime symptoms 1 to 2 times per week
25181	663e.00	Asthma restricts exercise
25603	H310.00	Simple chronic bronchitis
25791	8CR0.00	Asthma clinical management plan
25796	H332.00	Mixed asthma
26018	66YS.00	Chronic obstructive pulmonary disease monitoring by nurse
26306	H320.00	Chronic bullous emphysema
26501	663s.00	Asthma never causes daytime symptoms
26503	663v.00	Asthma causes daytime symptoms most days
26504	663f.00	Asthma never restricts exercise
26506	6.63E+102	Asthma severely restricts exercise
26861	663	Asthma sometimes restricts exercise
27819	H312.00	Obstructive chronic bronchitis
27926	H330100	Extrinsic asthma with status asthmaticus
28743	66Yf.00	Number of COPD exacerbations in past year
28755	9Oi0.00	Chronic obstructive pulmonary disease monitoring 1st letter
29325	H331000	Intrinsic asthma without status asthmaticus
29645	8793	Asthma control step 0
30458	66YR.00	Asthma monitoring by doctor
30815	663N000	Asthma causing night waking
31167	66YP.00	Asthma night-time symptoms
31225	663t.00	Asthma causes daytime symptoms 1 to 2 times per month
32727	H33z.11	Hyperreactive airways disease
33450	H32z.00	Emphysema NOS
34202	9Oi1.00	Chronic obstructive pulmonary disease monitoring 2nd letter
34215	9Oi2.00	Chronic obstructive pulmonary disease monitoring 3rd letter
37247	H3z..11	Chronic obstructive pulmonary disease NOS
37371	66YD.00	Chronic obstructive pulmonary disease monitoring due
37959	H311100	Fetid chronic bronchitis
38074	9Oi4.00	Chronic obstructive pulmonary disease monitor phone invite
38143	663O000	Asthma never disturbs sleep
38144	663w.00	Asthma limits walking up hills or stairs
38145	663x.00	Asthma limits walking on the flat
38146	663N100	Asthma disturbs sleep weekly
39570	663r.00	Asthma causes night symptoms 1 to 2 times per month

medcode	readcode	readterm
40159	H311000	Purulent chronic bronchitis
40788	H32y.00	Other emphysema
40823	H334.00	Brittle asthma
40864	U60F615	[X] Adverse reaction to theophylline - asthma
41017	1780	Aspirin induced asthma
41020	66YC.00	Absent from work or school due to asthma
42258	9Oi3.00	Chronic obstructive pulmonary disease monitoring verb invite
42313	679V.00	Health education - chronic obstructive pulmonary disease
42824	663q.00	Asthma daytime symptoms
44525	H312z00	Obstructive chronic bronchitis NOS
45073	H331z00	Intrinsic asthma NOS
45089	H31y100	Chronic tracheobronchitis
45770	66Yg.00	Chronic obstructive pulmonary disease disturbs sleep
45771	66Yh.00	Chronic obstructive pulmonary disease does not disturb sleep
45777	8CR1.00	Chronic obstructive pulmonary disease clini management plan
45782	H330z00	Extrinsic asthma NOS
45998	66YT.00	Chronic obstructive pulmonary disease monitoring by doctor
46036	66Yi.00	Multiple COPD emergency hospital admissions
46529	9OJ1.00	Attends asthma monitoring
46578	H321.00	Panlobular emphysema
47337	663m.00	Asthma accident and emergency attendance since last visit
47684	H47y000	Detergent asthma
47993	66YZ.00	Does not have asthma management plan
48591	TJF7300	Adverse reaction to theophylline (asthma)
54893	H582.00	Compensatory emphysema
56860	H320000	Segmental bullous emphysema
58196	H331100	Intrinsic asthma with status asthmaticus
59263	H32y111	Acute interstitial emphysema
60188	H320200	Giant bullous emphysema
61118	H310z00	Simple chronic bronchitis NOS
61513	H311z00	Mucopurulent chronic bronchitis NOS
63479	H32y200	MacLeod's unilateral emphysema
64721	H464000	Chronic emphysema due to chemical fumes
65733	Hyu3100	[X]Other specified chronic obstructive pulmonary disease
66043	H31y.00	Other chronic bronchitis
66058	Hyu3000	[X]Other emphysema
67040	H3y..11	Other specified chronic obstructive pulmonary disease
68066	H31yz00	Other chronic bronchitis NOS
68662	H320100	Zonal bullous emphysema
70787	H32y100	Atrophic (senile) emphysema
73522	173d.00	Work aggravated asthma
92955	H32y000	Acute vesicular emphysema
93568	H39..00	Very severe chronic obstructive pulmonary disease
96931	14OX.00	At risk of chronic obstructive pulmonary diseas exacerbation
98283	9kf2.00	COPD structured smoking assessment declined - enh serv admin
98284	9kf1.00	Refer COPD structured smoking assessment - enhanc serv admin
99536	H320300	Bullous emphysema with collapse
99793	8CMA000	Patient has a written asthma personal action plan
99948	9kf0.00	COPD patient unsuitable for pulmonary rehab - enh serv admin
100509	9NNX.00	Under care of asthma specialist nurse
101042	8BMW.00	Issue of chronic obstructive pulmonary disease rescue pack
102170	66Yp.00	Asthma review using Roy Colleg of Physicians three questions
102209	38DV.00	Mini asthma quality of life questionnaire
102301	1787	Asthma trigger - seasonal
102341	1781	Asthma trigger - pollen
102395	66Yr.00	Asthma causes symptoms most nights
102400	66Yq.00	Asthma causes night time symptoms 1 to 2 times per week
102449	1789	Asthma trigger - respiratory infection
102685	66YB000	Chronic obstructive pulmonary disease 3 monthly review
102713	663P000	Asthma limits activities 1 to 2 times per month
102888	663P100	Asthma limits activities 1 to 2 times per week
102952	1783	Asthma trigger - warm air
103007	66YB100	Chronic obstructive pulmonary disease 6 monthly review
103321	1786	Asthma trigger - animals
103400	9kf1.11	Referred for COPD structured smoking assessment
103494	14B3.12	History of chronic obstructive pulmonary disease
103558	8CeD.00	Preferred place of care for next exacerbation of COPD
103612	66Ys.00	Asthma never causes night symptoms
103678	8BMa000	Chronic obstructiv pulmonary disease medication optimisation
103758	8Hkw.00	Referral to COPD community nursing team
103760	9kf2.11	COPD structured smoking assessment declined
103813	1788.00	Asthma trigger - cold air
103864	9kf0.11	COPD patient unsuitable for pulmonary rehabilitation
103944	178A.00	Asthma trigger - airborne dust
103945	1785.00	Asthma trigger - damp

medcode	readcode	readterm
103952	1784.00	Asthma trigger - emotion
103955	1782.00	Asthma trigger - tobacco smoke
103998	663P200	Asthma limits activities most days
104117	661M300	COPD self-management plan agreed
104169	661N300	COPD self-management plan review
104265	9e03.00	GP OOH service notified of COPD care plan
104481	8CMV.00	Has chronic obstructive pulmonary disease care plan
104608	H3A..00	End stage chronic obstructive airways disease
104710	9NgP.11	On COPD (chr obstruc pulmonary disease) supportv cre pathway
104985	9NgP.00	On chronic obstructive pulmonary disease supprtv cre pathway
104998	8I61000	Chronic obstructve pulmonry disease rescue pack not indicatd
105420	661N100	Asthma self-management plan review
105457	8CMW500	Chronic obstructive pulmonary disease care pathway
105674	661M100	Asthma self-management plan agreed
106637	9Nk7000	Seen in chronic obstructive pulmonary disease clinic
106805	H335.00	Chronic asthma with fixed airflow obstruction
106945	8IEZ.00	Chronic obstructive pulmonary disease rescue pack declined
107167	66Yu.00	Number days absent from school due to asthma in past 6 month
107877	8IEy.00	Chronic obstructive pulmon dis wr self managem plan declined
108475	66Yz000	Asthma management plan declined
108586	66Yz100	Chronic obstruct pulmonary disease management plan declined
108599	38QM.00	Childhood Asthma Control Test
108912	9OJB.00	Asthma monitorng invit SMS (short message servce) txt messge
109468	9OJC.00	Asthma monitoring invitation email
109683	2126F00	Chronic obstructive pulmonary disease resolved
109774	66YB200	Telehealth chronic obstructive pulmonary disease monitoring
109958	H3B..00	Asthma-chronic obstructive pulmonary disease overlap syndrom
109996	66Yz500	Telehealth asthma monitoring
110339	9OJB000	Asthma monitoring SMS text message 1st invitation
110345	38B8.00	Severe asthma exacerbation risk assessment
110406	14Ok000	At risk of severe asthma exacerbation
110533	9OJB100	Asthma monitoring SMS text message 2nd invitation

B) Hospital Episodes Statistics

ICD10	**DESCRIPTION**
J41	Simple and mucopurulent chronic bronchitis
J41.0	Simple chronic bronchitis
J41.1	Mucopurulent chronic bronchitis
J41.8	Mixed simple and mucopurulent chronic bronchitis
J42	Unspecified chronic bronchitis
J43	Emphysema
J43.0	MacLeod syndrome
J43.1	Panlobular emphysema
J43.2	Centrilobular emphysema
J43.8	Other emphysema
J43.9	Emphysema, unspecified
J44	Other chronic obstructive pulmonary disease
J44.0	Chronic obstructive pulmonary disease with acute lower respiratory infection
J44.1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified
J44.8	Other specified chronic obstructive pulmonary disease
J44.9	Chronic obstructive pulmonary disease, unspecified
J45	Asthma
J45.0	Predominantly allergic asthma
J45.1	Nonallergic asthma
J45.8	Mixed asthma
J45.9	Asthma, unspecified
J46	Status asthmaticus

5. **Diabetes**

A) CPRD

medcode	readcode	readterm
506	C100112	Non-insulin dependent diabetes mellitus
711	C10..00	Diabetes mellitus
758	C10F.00	Type 2 diabetes mellitus
1038	C100011	Insulin dependent diabetes mellitus
1323	F420.00	Diabetic retinopathy
1407	C10FJ00	Insulin treated Type 2 diabetes mellitus
1549	C10E.00	Type 1 diabetes mellitus
1647	C108.00	Insulin dependent diabetes mellitus
1682	C101.00	Diabetes mellitus with ketoacidosis
1684	66A4.00	Diabetic on oral treatment
2340	F381311	Diabetic amyotrophy

medcode	readcode	readterm
2342	F372.12	Diabetic neuropathy
2378	66AJ.00	Diabetic - poor control
2471	K01x100	Nephrotic syndrome in diabetes mellitus
2475	C104.11	Diabetic nephropathy
2478	66AJ100	Brittle diabetes
2986	F420200	Preproliferative diabetic retinopathy
3286	F420100	Proliferative diabetic retinopathy
3837	F420400	Diabetic maculopathy
4513	C109.00	Non-insulin dependent diabetes mellitus
5002	F372.11	Diabetic polyneuropathy
5884	C109.11	NIDDM - Non-insulin dependent diabetes mellitus
6125	66AS.00	Diabetic annual review
6430	9NM0.00	Attending diabetes clinic
6509	C108700	Insulin dependent diabetes mellitus with retinopathy
6791	C108800	Insulin dependant diabetes mellitus - poor control
7045	14F4.00	H/O: Admission in last year for diabetes foot problem
7059	8H2J.00	Admit diabetic emergency
7069	F420000	Background diabetic retinopathy
7328	M037200	Cellulitis in diabetic foot
7563	66A3.00	Diabetic on diet only
7795	C106.12	Diabetes mellitus with neuropathy
8403	C109700	Non-insulin dependant diabetes mellitus - poor control
8836	66AR.00	Diabetes management plan given
8842	66A5.00	Diabetic on insulin
9013	66AJ.11	Unstable diabetes
9835	2BBL.00	O/E - diabetic maculopathy present both eyes
9881	M271200	Mixed diabetic ulcer - foot
9958	42W..00	Hb. A1C - diabetic control
9974	9N1v.00	Seen in diabetic eye clinic
10098	C10yy00	Other specified diabetes mellitus with other spec comps
10099	F420300	Advanced diabetic maculopathy
10418	C10ED00	Type 1 diabetes mellitus with nephropathy
10642	ZC2C800	Dietary advice for diabetes mellitus
10659	F464000	Diabetic cataract
10692	C10EM00	Type 1 diabetes mellitus with ketoacidosis
10755	F420600	Non proliferative diabetic retinopathy
10824	9N1i.00	Seen in diabetic foot clinic
10977	66Ac.00	Diabetic peripheral neuropathy screening
11018	8HBG.00	Diabetic retinopathy 12 month review
11047	66AH000	Conversion to insulin
11094	9NND.00	Under care of diabetic foot screener
11129	2BBQ.00	O/E - left eye background diabetic retinopathy
11433	2BBP.00	O/E - right eye background diabetic retinopathy
11471	8B3l.00	Diabetes medication review
11599	7276	Pan retinal photocoagulation for diabetes
11626	F420z00	Diabetic retinopathy NOS
11663	M271100	Neuropathic diabetic ulcer - foot
11677	8H7r.00	Refer to diabetic foot screener
12213	8BL2.00	Patient on maximal tolerated therapy for diabetes
12247	8I6G.00	Diabetic foot examination not indicated
12262	8I3X.00	Diabetic retinopathy screening refused
12307	66AU.00	Diabetes care by hospital only
12455	C10E.11	Type I diabetes mellitus
12506	66AP.00	Diabetes: practice programme
12640	C10FC00	Type 2 diabetes mellitus with nephropathy
12675	66AQ.00	Diabetes: shared care programme
12736	C10F500	Type 2 diabetes mellitus with gangrene
13071	66AI.00	Diabetic - good control
13078	13AC.00	Diabetic weight reducing diet
13097	2BBT.00	O/E - right eye proliferative diabetic retinopathy
13099	2BBR.00	O/E - right eye preproliferative diabetic retinopathy
13101	2BBV.00	O/E - left eye proliferative diabetic retinopathy
13102	2BBW.00	O/E - right eye diabetic maculopathy
13103	2BBS.00	O/E - left eye preproliferative diabetic retinopathy
13108	2BBX.00	O/E - left eye diabetic maculopathy
13279	C104y00	Other specified diabetes mellitus with renal complications
14049	42WZ.00	Hb. A1C - diabetic control NOS
14050	42c..00	HbA1 - diabetic control
14803	C100100	Diabetes mellitus, adult onset, no mention of complication
14889	C100111	Maturity onset diabetes
15690	C103.00	Diabetes mellitus with ketoacidotic coma
16230	C106.00	Diabetes mellitus with neurological manifestation
16490	66AH.00	Diabetic treatment changed
16491	C106.13	Diabetes mellitus with polyneuropathy
16502	C104.00	Diabetes mellitus with renal manifestation

medcode	readcode	readterm
16881	ZV65312	[V]Dietary counselling in diabetes mellitus
17067	F171100	Autonomic neuropathy due to diabetes
17095	2G5A.00	O/E - Right diabetic foot at risk
17236	14P3.00	H/O: insulin therapy
17247	F35z000	Diabetic mononeuritis NOS
17262	C109600	Non-insulin-dependent diabetes mellitus with retinopathy
17313	F440700	Diabetic iritis
17545	C108F11	Type I diabetes mellitus with diabetic cataract
17817	7L19800	Subcutaneous injection of insulin
17858	C108.12	Type 1 diabetes mellitus
17859	C109.12	Type 2 diabetes mellitus
17869	66AL.00	Diabetic-uncooperative patient
17886	66AM.00	Diabetic - follow-up default
18056	2G5C.00	Foot abnormality - diabetes related
18142	N030000	Diabetic cheiroarthropathy
18143	C109G11	Type II diabetes mellitus with arthropathy
18167	66AT.00	Annual diabetic blood test
18209	C109012	Type 2 diabetes mellitus with renal complications
18219	C109.13	Type II diabetes mellitus
18230	C108J12	Type 1 diabetes mellitus with neuropathic arthropathy
18264	C109J12	Insulin treated Type II diabetes mellitus
18278	C109J00	Insulin treated Type 2 diabetes mellitus
18311	68A7.00	Diabetic retinopathy screening
18387	C10E700	Type 1 diabetes mellitus with retinopathy
18390	C10FM00	Type 2 diabetes mellitus with persistent microalbuminuria
18425	C10FB00	Type 2 diabetes mellitus with polyneuropathy
18496	C10F600	Type 2 diabetes mellitus with retinopathy
18505	C108.11	IDDM-Insulin dependent diabetes mellitus
18642	C10EH00	Type 1 diabetes mellitus with arthropathy
18662	8HBH.00	Diabetic retinopathy 6 month review
18683	C10E500	Type 1 diabetes mellitus with ulcer
18747	8I6F.00	Diabetic retinopathy screening not indicated
18777	C10F000	Type 2 diabetes mellitus with renal complications
18824	8I3W.00	Diabetic foot examination declined
19381	8HTk.00	Referral to diabetic eye clinic
19739	68A9.00	Diabetic retinopathy screening offered
20696	66AA.11	Injection sites - diabetic
21482	C102.00	Diabetes mellitus with hyperosmolar coma
21983	C108012	Type 1 diabetes mellitus with renal complications
22023	66AJz00	Diabetic - poor control NOS
22573	C106z00	Diabetes mellitus NOS with neurological manifestation
22823	66Ab.00	Diabetic foot examination
22871	C10EP00	Type 1 diabetes mellitus with exudative maculopathy
22884	C10F.11	Type II diabetes mellitus
22967	2BBF.00	Retinal abnormality - diabetes related
23479	C350011	Bronzed diabetes
24327	M271000	Ischaemic ulcer diabetic foot
24363	8A13.00	Diabetic stabilisation
24423	C108.13	Type I diabetes mellitus
24458	C109711	Type II diabetes mellitus - poor control
24490	C100000	Diabetes mellitus, juvenile type, no mention of complication
24571	F372200	Asymptomatic diabetic neuropathy
24693	C109G00	Non-insulin dependent diabetes mellitus with arthropathy
24694	C108B00	Insulin dependent diabetes mellitus with mononeuropathy
24836	C109C12	Type 2 diabetes mellitus with nephropathy
25041	ZC2CA00	Dietary advice for type II diabetes
25591	C10FQ00	Type 2 diabetes mellitus with exudative maculopathy
25627	C10F700	Type 2 diabetes mellitus - poor control
26054	C10FL00	Type 2 diabetes mellitus with persistent proteinuria
26664	2G5B.00	O/E - Left diabetic foot at risk
26666	2G5E.00	O/E - Right diabetic foot at low risk
26667	2G5I.00	O/E - Left diabetic foot at low risk
26855	C108400	Unstable insulin dependant diabetes mellitus
27891	N030100	Diabetic Charcot arthropathy
27921	2G51000	Foot abnormality - diabetes related
28769	66AV.00	Diabetic on insulin and oral treatment
28856	8CP2.00	Transition of diabetes care options discussed
28873	66Ai.00	Diabetic 6 month review
29041	66AN.00	Date diabetic treatment start
29979	C109900	Non-insulin-dependent diabetes mellitus without complication
30247	TJ23000	Adverse reaction to insulins
30294	C10EL00	Type 1 diabetes mellitus with persistent microalbuminuria
30323	C10EK00	Type 1 diabetes mellitus with persistent proteinuria
30477	F420700	High risk proliferative diabetic retinopathy
30648	9N4p.00	Did not attend diabetic retinopathy clinic

medcode	readcode	readterm
31053	R054300	[D]Widespread diabetic foot gangrene
31156	2G5J.00	O/E - Left diabetic foot at moderate risk
31157	2G5F.00	O/E - Right diabetic foot at moderate risk
31171	2G5G.00	O/E - Right diabetic foot at high risk
31172	2G5K.00	O/E - Left diabetic foot at high risk
31310	C108900	Insulin dependant diabetes maturity onset
31790	F372.00	Polyneuropathy in diabetes
32359	ZRbH.00	Perceived control of insulin-dependent diabetes
32403	C107.11	Diabetes mellitus with gangrene
32556	C107.12	Diabetes with gangrene
32627	C10FN00	Type 2 diabetes mellitus with ketoacidosis
33254	C105.00	Diabetes mellitus with ophthalmic manifestation
33343	C10y.00	Diabetes mellitus with other specified manifestation
33807	C107200	Diabetes mellitus, adult with gangrene
34152	G73y000	Diabetic peripheral angiopathy
34268	C10F200	Type 2 diabetes mellitus with neurological complications
34283	C105z00	Diabetes mellitus NOS with ophthalmic manifestation
34450	C10FK00	Hyperosmolar non-ketotic state in type 2 diabetes mellitus
34528	3882	Diabetes well being questionnaire
34912	C109400	Non-insulin dependent diabetes mellitus with ulcer
35105	C104100	Diabetes mellitus, adult onset, with renal manifestation
35107	C104z00	Diabetes mellitis with nephropathy NOS
35116	2G5L.00	O/E - Left diabetic foot - ulcerated
35288	C10E800	Type 1 diabetes mellitus - poor control
35316	2G5H.00	O/E - Right diabetic foot - ulcerated
35321	8H3O.00	Non-urgent diabetic admission
35383	9OLD.00	Diabetic patient unsuitable for digital retinal photography
35385	C10FH00	Type 2 diabetes mellitus with neuropathic arthropathy
35399	C107.00	Diabetes mellitus with peripheral circulatory disorder
35785	F372100	Chronic painful diabetic neuropathy
36633	C109K00	Hyperosmolar non-ketotic state in type 2 diabetes mellitus
36695	C10D.00	Diabetes mellitus autosomal dominant type 2
36798	7L10000	Continuous subcutaneous infusion of insulin
37315	F3y0.00	Diabetic mononeuropathy
37648	C109J11	Insulin treated non-insulin dependent diabetes mellitus
37806	C10FF00	Type 2 diabetes mellitus with peripheral angiopathy
38076	M21yC00	Insulin lipohypertrophy
38130	ZRB6.00	Diabetes wellbeing questionnaire
38161	C108711	Type I diabetes mellitus with retinopathy
38617	C101y00	Other specified diabetes mellitus with ketoacidosis
38986	C100.00	Diabetes mellitus with no mention of complication
39070	C10EE00	Type 1 diabetes mellitus with hypoglycaemic coma
39317	C106100	Diabetes mellitus, adult onset, + neurological manifestation
39420	F381300	Myasthenic syndrome due to diabetic amyotrophy
39809	C108J00	Insulin dependent diab mell with neuropathic arthropathy
40023	C102000	Diabetes mellitus, juvenile type, with hyperosmolar coma
40401	C109500	Non-insulin dependent diabetes mellitus with gangrene
40682	C10E900	Type 1 diabetes mellitus maturity onset
40837	C10EN00	Type 1 diabetes mellitus with ketoacidotic coma
40962	C109H00	Non-insulin dependent d m with neuropathic arthropathy
41049	C108712	Type 1 diabetes mellitus with retinopathy
41389	C105100	Diabetes mellitus, adult onset, + ophthalmic manifestation
41686	Cyu2000	[X]Other specified diabetes mellitus
41716	C108C00	Insulin dependent diabetes mellitus with polyneuropathy
42505	C101z00	Diabetes mellitus NOS with ketoacidosis
42567	C103000	Diabetes mellitus, juvenile type, with ketoacidotic coma
42729	C108E11	Type I diabetes mellitus with hypoglycaemic coma
42762	C109612	Type 2 diabetes mellitus with retinopathy
42831	C10E200	Type 1 diabetes mellitus with neurological complications
43139	C102100	Diabetes mellitus, adult onset, with hyperosmolar coma
43227	C10F311	Type II diabetes mellitus with multiple complications
43453	C10C.00	Diabetes mellitus autosomal dominant
43493	M21yC11	Insulin site lipohypertrophy
43785	C109D00	Non-insulin dependent diabetes mellitus with hypoglyca coma
43857	C10M.00	Lipoatrophic diabetes mellitus
43921	C10E400	Unstable type 1 diabetes mellitus
43951	66AK.00	Diabetic - cooperative patient
44033	F345000	Diabetic mononeuritis multiplex
44260	C108F00	Insulin dependent diabetes mellitus with diabetic cataract
44312	9M10.00	Informed dissent for diabetes national audit
44440	C108E00	Insulin dependent diabetes mellitus with hypoglycaemic coma
44443	C108500	Insulin dependent diabetes mellitus with ulcer
44779	C109E12	Type 2 diabetes mellitus with diabetic cataract
44982	C10FE00	Type 2 diabetes mellitus with diabetic cataract
45276	C10E312	Insulin dependent diabetes mellitus with multiple complicat

medcode	readcode	readterm
45467	C109B00	Non-insulin dependent diabetes mellitus with polyneuropathy
45491	C10z.00	Diabetes mellitus with unspecified complication
45499	K01x111	Kimmelstiel - Wilson disease
45913	C109712	Type 2 diabetes mellitus - poor control
45914	C108812	Type 1 diabetes mellitus - poor control
45919	C109212	Type 2 diabetes mellitus with neurological complications
46150	C109512	Type 2 diabetes mellitus with gangrene
46290	C108y00	Other specified diabetes mellitus with multiple comps
46301	C10EC00	Type 1 diabetes mellitus with polyneuropathy
46624	C10C.11	Maturity onset diabetes in youth
46850	C108811	Type I diabetes mellitus - poor control
46917	C10FD00	Type 2 diabetes mellitus with hypoglycaemic coma
46963	C108000	Insulin-dependent diabetes mellitus with renal complications
47032	8CS0.00	Diabetes care plan agreed
47058	8Hg4.00	Discharged from care of diabetes specialist nurse
47315	C10F711	Type II diabetes mellitus - poor control
47321	C10F100	Type 2 diabetes mellitus with ophthalmic complications
47328	2BBk.00	O/E - right eye stable treated prolif diabetic retinopathy
47341	8A12.00	Diabetic crisis monitoring
47370	8HLE.00	Diabetology D.V. done
47377	C105y00	Other specified diabetes mellitus with ophthalmic complicatn
47409	C109B11	Type II diabetes mellitus with polyneuropathy
47582	C10E000	Type 1 diabetes mellitus with renal complications
47584	F420500	Advanced diabetic retinal disease
47649	C10E100	Type 1 diabetes mellitus with ophthalmic complications
47650	C10E300	Type 1 diabetes mellitus with multiple complications
47816	C109H11	Type II diabetes mellitus with neuropathic arthropathy
47954	C10F900	Type 2 diabetes mellitus without complication
48078	F372000	Acute painful diabetic neuropathy
48192	C109E11	Type II diabetes mellitus with diabetic cataract
48310	ZV6DA00	[V]Admitted for commencement of insulin
49074	C10F400	Type 2 diabetes mellitus with ulcer
49146	C108211	Type I diabetes mellitus with neurological complications
49276	C108100	Insulin-dependent diabetes mellitus with ophthalmic comps
49554	C10EF00	Type 1 diabetes mellitus with diabetic cataract
49640	2G5W.00	O/E - left chronic diabetic foot ulcer
49655	C10F611	Type II diabetes mellitus with retinopathy
49869	C109G12	Type 2 diabetes mellitus with arthropathy
49884	6761	Diabetic pre-pregnancy counselling
49949	C10E411	Unstable type I diabetes mellitus
50175	66AW.00	Diabetic foot risk assessment
50225	C109011	Type II diabetes mellitus with renal complications
50429	C109100	Non-insulin-dependent diabetes mellitus with ophthalm comps
50527	C10FB11	Type II diabetes mellitus with polyneuropathy
50609	L180600	Pre-existing diabetes mellitus, non-insulin-dependent
50813	C109A11	Type II diabetes mellitus with mononeuropathy
50960	L180500	Pre-existing diabetes mellitus, insulin-dependent
50972	C100z00	Diabetes mellitus NOS with no mention of complication
51261	C10E.12	Insulin dependent diabetes mellitus
51697	C10G.00	Secondary pancreatic diabetes mellitus
51756	C10FP00	Type 2 diabetes mellitus with ketoacidotic coma
51939	ZV6DB00	[V]Admitted for conversion to insulin
51957	C108511	Type I diabetes mellitus with ulcer
52041	2BBl.00	O/E - left eye stable treated prolif diabetic retinopathy
52104	C108300	Insulin dependent diabetes mellitus with multiple complicatn
52212	Cyu2.00	[X]Diabetes mellitus
52237	9360	Patient held diabetic record issued
52283	C108200	Insulin-dependent diabetes mellitus with neurological comps
52303	C109000	Non-insulin-dependent diabetes mellitus with renal comps
52630	2BBo.00	O/E - sight threatening diabetic retinopathy
53200	C101000	Diabetes mellitus, juvenile type, with ketoacidosis
53238	66AG.00	Diabetic drug side effects
53392	C10F911	Type II diabetes mellitus without complication
53630	C110.11	Insulin coma
53634	R054200	[D]Gangrene of toe in diabetic
54008	C10EJ00	Type 1 diabetes mellitus with neuropathic arthropathy
54212	C109F00	Non-insulin-dependent d m with peripheral angiopath
54600	C10E412	Unstable insulin dependent diabetes mellitus
54601	9NN8.00	Under care of diabetologist
54856	C101100	Diabetes mellitus, adult onset, with ketoacidosis
54899	C109F11	Type II diabetes mellitus with peripheral angiopathy
55075	C109411	Type II diabetes mellitus with ulcer
55239	C10EQ00	Type 1 diabetes mellitus with gastroparesis
55431	L180X00	Pre-existing diabetes mellitus, unspecified
55842	C109200	Non-insulin-dependent diabetes mellitus with neuro comps

medcode	readcode	readterm
56268	C109D11	Type II diabetes mellitus with hypoglycaemic coma
56448	C108A00	Insulin-dependent diabetes without complication
57278	C10F011	Type II diabetes mellitus with renal complications
57333	N030011	Diabetic cheiropathy
57389	93C4.00	Patient consent given for addition to diabetic register
57621	C108D00	Insulin dependent diabetes mellitus with nephropathy
57723	8HHy.00	Referral to diabetic register
58133	ZLD7500	Discharge by diabetic liaison nurse
58159	8I3k.00	Insulin therapy declined
58604	C109611	Type II diabetes mellitus with retinopathy
59253	C10FG00	Type 2 diabetes mellitus with arthropathy
59288	C103y00	Other specified diabetes mellitus with coma
59365	C109C00	Non-insulin dependent diabetes mellitus with nephropathy
59725	C109111	Type II diabetes mellitus with ophthalmic complications
59903	C106.11	Diabetic amyotrophy
59991	C10D.11	Maturity onset diabetes in youth type 2
60107	C108411	Unstable type I diabetes mellitus
60208	C108J11	Type I diabetes mellitus with neuropathic arthropathy
60499	C108600	Insulin dependent diabetes mellitus with gangrene
60699	C109F12	Type 2 diabetes mellitus with peripheral angiopathy
60796	C10FL11	Type II diabetes mellitus with persistent proteinuria
61021	68AB.00	Diabetic digital retinopathy screening offered
61071	C109D12	Type 2 diabetes mellitus with hypoglycaemic coma
61210	TJ23z00	Adverse reaction to insulins and antidiabetic agents NOS
61344	C108011	Type I diabetes mellitus with renal complications
61461	9M00.00	Informed consent for diabetes national audit
61520	C110000	Iatrogenic hyperinsulinism
61523	C106y00	Other specified diabetes mellitus with neurological comps
61557	8HKE.00	Diabetology D.V. requested
61670	889A.00	Diab mellit insulin-glucose infus acute myocardial infarct
61829	C108212	Type 1 diabetes mellitus with neurological complications
62107	C109511	Type II diabetes mellitus with gangrene
62146	C109300	Non-insulin-dependent diabetes mellitus with multiple comps
62209	C10EM11	Type I diabetes mellitus with ketoacidosis
62352	C108H11	Type I diabetes mellitus with arthropathy
62384	2G5V.00	O/E - right chronic diabetic foot ulcer
62613	C10EA11	Type I diabetes mellitus without complication
62674	C10FA00	Type 2 diabetes mellitus with mononeuropathy
63017	C108911	Type I diabetes mellitus maturity onset
63357	C107100	Diabetes mellitus, adult, + peripheral circulatory disorder
63364	U602312	[X] Adverse reaction to insulins
63371	C10y100	Diabetes mellitus, adult, + other specified manifestation
63412	8CR2.00	Diabetes clinical management plan
63690	C10FR00	Type 2 diabetes mellitus with gastroparesis
63762	C10z100	Diabetes mellitus, adult onset, + unspecified complication
64142	8HI1.00	Referral for diabetic retinopathy screening
64283	C10zy00	Other specified diabetes mellitus with unspecified comps
64357	C10zz00	Diabetes mellitus NOS with unspecified complication
64446	C108G00	Insulin dependent diab mell with peripheral angiopathy
64449	C108z00	Unspecified diabetes mellitus with multiple complications
64571	C109C11	Type II diabetes mellitus with nephropathy
64668	C10FJ11	Insulin treated Type II diabetes mellitus
65025	C107z00	Diabetes mellitus NOS with peripheral circulatory disorder
65062	C103z00	Diabetes mellitus NOS with ketoacidotic coma
65267	C10F300	Type 2 diabetes mellitus with multiple complications
65463	F420800	High risk non proliferative diabetic retinopathy
65616	C108H00	Insulin dependent diabetes mellitus with arthropathy
65684	U602311	[X] Adverse reaction to insulins and antidiabetic agents
65704	C109412	Type 2 diabetes mellitus with ulcer
66145	C10EN11	Type I diabetes mellitus with ketoacidotic coma
66274	66Ah.00	Insulin needles changed for each injection
66872	C108D11	Type I diabetes mellitus with nephropathy
66965	C109H12	Type 2 diabetes mellitus with neuropathic arthropathy
67853	C106000	Diabetes mellitus, juvenile, + neurological manifestation
67905	C109211	Type II diabetes mellitus with neurological complications
68105	C10EB00	Type 1 diabetes mellitus with mononeuropathy
68390	C108512	Type 1 diabetes mellitus with ulcer
68546	ZRB4.00	Diabetes clinic satisfaction questionnaire
68792	C10z000	Diabetes mellitus, juvenile type, + unspecified complication
68818	ZRB5.11	DTSQ - Diabetes treatment satisfaction questionnaire
68843	C103100	Diabetes mellitus, adult onset, with ketoacidotic coma
68928	TJ23.00	Adverse reaction to insulins and antidiabetic agents
69043	ZC2C900	Dietary advice for type I diabetes
69152	66Aj.00	Insulin needles changed less than once a day
69278	C109E00	Non-insulin depend diabetes mellitus with diabetic cataract

medcode	readcode	readterm
69676	C10EA00	Type 1 diabetes mellitus without complication
69748	C105000	Diabetes mellitus, juvenile type, + ophthalmic manifestation
69993	C10E600	Type 1 diabetes mellitus with gangrene
70316	C109112	Type 2 diabetes mellitus with ophthalmic complications
70448	C107000	Diabetes mellitus, juvenile +peripheral circulatory disorder
70766	C108E12	Type 1 diabetes mellitus with hypoglycaemic coma
70821	C10yz00	Diabetes mellitus NOS with other specified manifestation
72320	C109A00	Non-insulin dependent diabetes mellitus with mononeuropathy
72333	8HME.00	Listed for Diabetology admissn
72345	C102z00	Diabetes mellitus NOS with hyperosmolar coma
72702	C10E812	Insulin dependent diabetes mellitus - poor control
83485	66Am.00	Insulin dose changed
83532	66Ao.00	Diabetes type 2 review
85660	66An.00	Diabetes type 1 review
85991	C10FM11	Type II diabetes mellitus with persistent microalbuminuria
90301	66Ag.00	Insulin needles changed daily
91164	ZRB4.11	CSQ - Diabetes clinic satisfaction questionnaire
91646	C10F411	Type II diabetes mellitus with ulcer
91942	C10E311	Type I diabetes mellitus with multiple complications
91943	C10EC11	Type I diabetes mellitus with polyneuropathy
93380	C10N100	Cystic fibrosis related diabetes mellitus
93390	9OLH.00	Attended DAFNE diabetes structured education programme
93468	C10EG00	Type 1 diabetes mellitus with peripheral angiopathy
93491	9OLJ.00	DAFNE diabetes structured education programme completed
93631	9OLL.00	XPERT diabetes structured education programme completed
93704	8Hj3.00	Referral to DAFNE diabetes structured education programme
93727	C10FE11	Type II diabetes mellitus with diabetic cataract
93870	8Hj5.00	Referral to XPERT diabetes structured education programme
93875	C10E712	Insulin dependent diabetes mellitus with retinopathy
93878	C10E511	Type I diabetes mellitus with ulcer
93922	C104000	Diabetes mellitus, juvenile type, with renal manifestation
94011	9OLG.00	Attended XPERT diabetes structured education programme
94699	ZRB5.00	Diabetes treatment satisfaction questionnaire
94955	9NiE.00	Did not attend XPERT diabetes structured education programme
94956	8I84.00	Did not complete XPERT diabetes structured education program
95343	C10E711	Type I diabetes mellitus with retinopathy
95351	C10FA11	Type II diabetes mellitus with mononeuropathy
95636	C10ER00	Latent autoimmune diabetes mellitus in adult
95992	C108A11	Type I diabetes mellitus without complication
95994	66Aq.00	Diabetic foot screen
96010	66Ap.00	Insulin treatment initiated
96143	9kL..00	Insulin initiation - enhanced services administration
96235	C10E911	Type I diabetes mellitus maturity onset
96506	C10G000	Secondary pancreatic diabetes mellitus without complication
97446	C108912	Type 1 diabetes mellitus maturity onset
97474	C108412	Unstable type 1 diabetes mellitus
97809	8I82.00	Did not complete DAFNE diabetes structured education program
97824	ZRB6.11	DWBQ - Diabetes wellbeing questionnaire
97849	C10E912	Insulin dependent diabetes maturity onset
97894	C10EP11	Type I diabetes mellitus with exudative maculopathy
98071	C10E112	Insulin-dependent diabetes mellitus with ophthalmic comps
98392	C10C.12	Maturity onset diabetes in youth type 1
98616	C10F211	Type II diabetes mellitus with neurological complications
98704	C10E512	Insulin dependent diabetes mellitus with ulcer
98723	C10FD11	Type II diabetes mellitus with hypoglycaemic coma
98954	3883	Diabetes treatment satisfaction questionnaire
99231	C108B11	Type I diabetes mellitus with mononeuropathy
99277	9NiC.00	Did not attend DAFNE diabetes structured education programme
99311	C10E111	Type I diabetes mellitus with ophthalmic complications
99628	Kyu0300	[X]Glomerular disorders in diabetes mellitus
99716	C10EE12	Insulin dependent diabetes mellitus with hypoglycaemic coma
99719	C10EA12	Insulin-dependent diabetes without complication
100033	U60231E	[X] Adverse reaction to insulins and antidiabetic agents NOS
100292	Cyu2300	[X]Unspecified diabetes mellitus with renal complications
100770	C10EF12	Insulin dependent diabetes mellitus with diabetic cataract
100964	C10F111	Type II diabetes mellitus with ophthalmic complications
101311	C10EC12	Insulin dependent diabetes mellitus with polyneuropathy
101735	C10E212	Insulin-dependent diabetes mellitus with neurological comps
101881	2BBr.00	Impaired vision due to diabetic retinopathy
102112	C10E611	Type I diabetes mellitus with gangrene
102163	C10ED12	Insulin dependent diabetes mellitus with nephropathy
102201	C10FC11	Type II diabetes mellitus with nephropathy
102434	66Au.00	Diabetic erectile dysfunction review
102490	66Av.00	Diabetic assessment of erectile dysfunction
102611	66At111	Type 2 diabetic dietary review

medcode	readcode	readterm
102620	C10EL11	Type I diabetes mellitus with persistent microalbuminuria
102704	66At000	Type I diabetic dietary review
102740	C108112	Type 1 diabetes mellitus with ophthalmic complications
102768	9NiZ.00	Did not attend diabetes foot screening
102946	C10E012	Insulin-dependent diabetes mellitus with renal complications
103743	8IE2.00	Diabetes care plan declined
103902	C10FG11	Type II diabetes mellitus with arthropathy
103935	1IA..00	No evidence of diabetic nephropathy
104254	7L10011	Subcutaneous infusion with insulin pump
104287	8Hlc.00	Referral to community diabetes service
104323	C10F511	Type II diabetes mellitus with gangrene
104374	67D8.00	Provision of diabetes clinical summary
104453	66At011	Type 1 diabetic dietary review
104639	C10FF11	Type II diabetes mellitus with peripheral angiopathy
105207	8HTE100	Referral to community diabetes clinic
105302	K08yA00	Proteinuric diabetic nephropathy
105337	C10E811	Type I diabetes mellitus - poor control
105446	679c.00	Insulin administration education
105585	8CMW700	Diabetes clinical pathway
105740	2G5d.00	O/E - Left diabetic foot at increased risk
105741	2G5e.00	O/E - Right diabetic foot at increased risk
105784	C109912	Type 2 diabetes mellitus without complication
105937	8IEQ.00	Referral to community diabetes specialist nurse declined
106061	C10FP11	Type II diabetes mellitus with ketoacidotic coma
106218	9m0A.00	Declined diabetic retinopathy screening
106269	9m0..00	Diabetic retinopathy screening administrative status
106327	9m04.00	Excluded from diabetic retinopathy screening
106328	9m07.00	Excluded diabetc retinop screen as under care ophthalmolgist
106329	9m08.00	Excluded from diabetic retinopathy screening as blind
106332	9m00.00	Eligible for diabetic retinopathy screening
106350	9m05.00	Excluded from diabetic retinopathy screening as moved away
106351	9m09.00	Excluded from diabetic retinop screen as no longer diabetic
106352	9m06.00	Excluded from diabetic retinopathy screening as deceased
106360	K27y700	Erectile dysfunction due to diabetes mellitus
106441	9m01.00	Ineligible for diabetic retinopathy screening
106445	9m0E.00	Excluded from diabetic retinopathy screen physical disorder
106528	C10FN11	Type II diabetes mellitus with ketoacidosis
106679	8OA3.00	Provision of written information about diabetes and driving
106722	9Oy0300	Diabetic foot screening invitation second letter
106723	9Oy0200	Diabetic foot screening invitation first letter
106738	9Oy0000	Diabetic foot screening invitation
106778	9m0C.00	Excluded frm diabetic retinopathy screen as terminal illness
106953	8IEa.00	Referral to DAFNE diabetes structured educn prog declined
107331	66AH100	Conversion to insulin in secondary care
107361	679L200	Education about diabetes and driving
107414	8I94.00	Diabetes structured education programme not available
107423	661N400	Diabetes self-management plan review
107464	66AS000	Diabetes Year of Care annual review
107508	66AH200	Conversion to insulin by diabetes specialist nurse
107597	9m0D.00	Excluded from diabetic retinopthy screen as learn disability
107603	C10P.00	Diabetes mellitus in remission
107701	C10FK11	Hyperosmolar non-ketotic state in type II diabetes mellitus
107739	679L211	Advice about diabetes and driving
107793	9Oy0400	Diabetic foot screening invitation third letter
107824	C10P100	Type II diabetes mellitus in remission
107881	K08yA11	Clinical diabetic nephropathy
108005	C109312	Type 2 diabetes mellitus with multiple complications
108007	C108311	Type I diabetes mellitus with multiple complications
108360	C10P000	Type I diabetes mellitus in remission
108634	9NJy.00	In-house diabetic foot screening
108655	8BAp.00	Insulin passport not checked
108724	C10EQ11	Type I diabetes mellitus with gastroparesis
108890	679L300	Diabetic foot care education
108993	661M400	Diabetes self-management plan agreed
109051	C10E612	Insulin dependent diabetes mellitus with gangrene
109103	C109911	Type II diabetes mellitus without complication
109197	C10FH11	Type II diabetes mellitus with neuropathic arthropathy
109520	9m03.00	Eligibility permanently inactive for diabetic retinop screen
109521	9m02.00	Eligibility temporarily inactive for diabetic retinop screen
109628	C10P011	Type 1 diabetes mellitus in remission
109643	66o1.00	Enquiry about diabetic erectile dysfunction declined
109700	66AH300	Conversion to non-insulin injectable medication
109760	1M8..00	Diabetic peripheral neuropathic pain
109806	8Hgd.00	Discharge from secondary care diabetes service
109837	C10E011	Type I diabetes mellitus with renal complications

medcode	readcode	readterm
109865	C109B12	Type 2 diabetes mellitus with polyneuropathy
109878	ZC2C911	Diet advice for insulin-dependent diabetes
110344	66o2.00	Diabetic on non-insulin injectable medication
110379	66o5.00	Diabetic on oral treatment and glucagon-like peptide 1
110393	13B1000	Diabetic carbohydrate counting diet
110400	C108F12	Type 1 diabetes mellitus with diabetic cataract
110409	679l.00	Diabetic injection administration education
110611	C10P111	Type 2 diabetes mellitus in remission
110997	C10y000	Diabetes mellitus, juvenile, + other specified manifestation
111106	C108A12	Type 1 diabetes mellitus without complication

B) Hospital Episodes Statistics

ICD 10	**DESCRIPTION**
E10	Type 1 diabetes mellitus
E10.0	Type 1 diabetes mellitus
E10.1	Type 1 diabetes mellitus
E10.2	Type 1 diabetes mellitus
E10.3	Type 1 diabetes mellitus
E10.4	Type 1 diabetes mellitus
E10.5	Type 1 diabetes mellitus
E10.6	Type 1 diabetes mellitus
E10.7	Type 1 diabetes mellitus
E10.8	Type 1 diabetes mellitus
E10.9	Type 1 diabetes mellitus
E11	Type 2 diabetes mellitus
E11.0	Type 2 diabetes mellitus
E11.1	Type 2 diabetes mellitus
E11.2	Type 2 diabetes mellitus
E11.3	Type 2 diabetes mellitus
E11.4	Type 2 diabetes mellitus
E11.5	Type 2 diabetes mellitus
E11.6	Type 2 diabetes mellitus
E11.7	Type 2 diabetes mellitus
E11.8	Type 2 diabetes mellitus
E11.9	Type 2 diabetes mellitus
E13	Other specified diabetes mellitus
E13.0	Other specified diabetes mellitus
E13.1	Other specified diabetes mellitus
E13.2	Other specified diabetes mellitus
E13.3	Other specified diabetes mellitus
E13.4	Other specified diabetes mellitus
E13.5	Other specified diabetes mellitus
E13.6	Other specified diabetes mellitus
E13.7	Other specified diabetes mellitus
E13.8	Other specified diabetes mellitus
E13.9	Other specified diabetes mellitus
E14	Unspecified diabetes mellitus
E14.0	Unspecified diabetes mellitus
E14.1	Unspecified diabetes mellitus
E14.2	Unspecified diabetes mellitus
E14.3	Unspecified diabetes mellitus
E14.4	Unspecified diabetes mellitus
E14.5	Unspecified diabetes mellitus
E14.6	Unspecified diabetes mellitus
E14.7	Unspecified diabetes mellitus
E14.8	Unspecified diabetes mellitus
E14.9	Unspecified diabetes mellitus
G59.0	Diabetic mononeuropathy
G63.2	Diabetic polyneuropathy
H28.0	Diabetic cataract
H36.0	Diabetic retinopathy
M14.2	Diabetic arthropathy
N08.3	Glomerular disorders in diabetes mellitus
O24.0	Diabetes mellitus in pregnancy: Pre-existing type 1 diabetes mellitus
O24.1	Diabetes mellitus in pregnancy: Pre-existing type 2 diabetes mellitus
O24.3	Diabetes mellitus in pregnancy: Pre-existing diabetes mellitus, unspecified

6. **Chronic kidney disease**

A) CPRD

medcode	**readcode**	**readterm**
512	K05..00	Chronic renal failure
1803	K011.00	Nephrotic syndrome with membranous glomerulonephritis

medcode	readcode	readterm
2088	K00..00	Acute glomerulonephritis
2471	K01x100	Nephrotic syndrome in diabetes mellitus
2475	C104.11	Diabetic nephropathy
2773	K0...00	Nephritis nephrosis and nephrotic syndrome
2994	7L1A100	Peritoneal dialysis
2995	G760.00	Acquired arteriovenous fistula
2996	7L1A200	Haemodialysis NEC
2999	K01..00	Nephrotic syndrome
3205	7A60100	Creation of arteriovenous fistula NEC
4480	K07z.00	Renal sclerosis NOS
4668	G22..00	Hypertensive renal disease
4669	K02y200	Chronic focal glomerulonephritis
4850	K03..11	Nephritis and nephropathy unspecified
5182	K03z.00	Unspecified glomerulonephritis NOS
5291	K031.00	Membranous nephritis unspecified
5417	K00..11	Acute nephritis
6712	K050.00	End stage renal failure
7190	K072.00	Glomerulosclerosis
7804	K02..00	Chronic glomerulonephritis
8037	7L1B000	Insertion of ambulatory peritoneal dialysis catheter
8330	K0D..00	End-stage renal disease
8607	K0C0.00	Analgesic nephropathy
8668	K0A..00	Glomerular disease
8828	14D1.00	H/O: nephritis
8919	K08..00	Impaired renal function disorder
9379	K08y500	Acute interstitial nephritis
9765	7A61400	Ligation of acquired arteriovenous fistula
9840	K010.00	Nephrotic syndrome with proliferative glomerulonephritis
10081	K05..11	Chronic uraemia
10418	C10ED00	Type 1 diabetes mellitus with nephropathy
10636	J624.00	Hepatorenal syndrome
10647	K02..11	Nephritis - chronic
10809	K021.00	Chronic membranous glomerulonephritis
11553	SP08300	Kidney transplant failure and rejection
11773	7L1A.11	Dialysis for renal failure
11873	K03..12	Nephropathy unspecified
11875	K02..12	Nephropathy - chronic
12465	K032.00	Membranoproliferative nephritis unspecified
12479	1Z13.00	Chronic kidney disease stage 4
12566	1Z12.00	Chronic kidney disease stage 3
12585	1Z14.00	Chronic kidney disease stage 5
12586	1Z11.00	Chronic kidney disease stage 2
12640	C10FC00	Type 2 diabetes mellitus with nephropathy
12720	1Z1..00	Chronic renal impairment
13279	C104y00	Other specified diabetes mellitus with renal complications
15097	K02z.00	Chronic glomerulonephritis NOS
15106	G22z.00	Hypertensive renal disease NOS
15780	K0z..00	Nephritis nephrosis and nephrotic syndrome NOS
16008	K030.00	Proliferative nephritis unspecified
16465	K190X00	Persistent proteinuria
16502	C104.00	Diabetes mellitus with renal manifestation
16929	D215.00	Anaemia secondary to renal failure
17253	8L50.00	Renal transplant planned
17365	K01B.00	Nephrotic syndrome diffuse crescentic glomerulonephritis
17434	G22..11	Nephrosclerosis
18209	C109012	Type 2 diabetes mellitus with renal complications
18390	C10FM00	Type 2 diabetes mellitus with persistent microalbuminuria
18777	C10F000	Type 2 diabetes mellitus with renal complications
18779	7A61100	Repair of acquired arteriovenous fistula
19316	K016.00	Nephrotic syndrome diffuse membranous glomerulonephritis
20027	K00y000	Acute glomerulonephritis in diseases EC
20073	7L1A000	Renal dialysis
20074	K00..12	Bright's disease
20129	K00z.00	Acute glomerulonephritis NOS
20196	14V2.00	H/O: renal dialysis
20516	K13yz11	Salt-losing nephritis
21297	K0A3.00	Chronic nephritic syndrome
21423	K032600	Berger's IgA or IgG nephropathy
21687	C345.00	Gout due to impairment of renal function
21837	G232.00	Hypertensive heart&renal dis wth (congestive) heart failure
21947	K017.00	Nephrotic syn difus mesangial prolifertiv glomerulonephritis
21983	C108012	Type 1 diabetes mellitus with renal complications
21989	K019.00	Nephrotic syn diffuse mesangiocapillary glomerulonephritis
22205	K01x411	Lupus nephritis
22252	ZV45100	[V]Renal dialysis status

medcode	readcode	readterm
22852	K015.00	Nephrotic syndrome focal and segmental glomerular lesions
22897	D310100	Henoch-Schonlein nephritis
23773	7L1B100	Removal of ambulatory peritoneal dialysis catheter
23913	K014.00	Nephrotic syndrome minor glomerular abnormality
23990	K03T.00	Tubulo-interstit nephritis not specif as acute or chron
24151	7A60.00	Arteriovenous shunt
24384	K032400	Familial glomerulonephritis in Alport's syndrome
24736	K0C..00	Drug/heavy-metal-induced tubulo-interstitial and tub conditn
24836	C109C12	Type 2 diabetes mellitus with nephropathy
25394	D215000	Anaemia secondary to chronic renal failure
25521	7A60112	Creation of brachial-cephalic fistula
25980	K08z.00	Impaired renal function disorder NOS
26054	C10FL00	Type 2 diabetes mellitus with persistent proteinuria
26220	K07..00	Renal sclerosis unspecified
26862	7B06300	Exploration of renal transplant
27335	K03y000	Other nephritis and nephrosis in diseases EC
27427	K01z.00	Nephrotic syndrome NOS
28158	TB11.00	Kidney dialysis with complication without blame
28269	7A60111	Creation of radial-cephalic fistula
28684	G233.00	Hypertensive heart and renal disease with renal failure
29013	1Z10.00	Chronic kidney disease stage 1
29384	K000.00	Acute proliferative glomerulonephritis
29634	K013.00	Nephrotic syndrome with minimal change glomerulonephritis
29638	K080.00	Renal osteodystrophy
30294	C10EL00	Type 1 diabetes mellitus with persistent microalbuminuria
30301	K03X.00	Unsp nephrit synd diff mesang prolif glomerulonephritis
30323	C10EK00	Type 1 diabetes mellitus with persistent proteinuria
30709	7L1C000	Insertion of temporary peritoneal dialysis catheter
30756	7L1A500	Continuous ambulatory peritoneal dialysis
31478	7A60300	Removal of infected arteriovenous shunt
31549	7L1A.00	Compensation for renal failure
31581	K0A0.00	Acute nephritic syndrome
32423	G222.00	Hypertensive renal disease with renal failure
33580	K03..00	Nephritis and nephropathy unspecified
34637	K080z00	Renal osteodystrophy NOS
34648	K080100	Renal dwarfism
34669	K03y200	Other interstitial nephritis
34998	K020.00	Chronic proliferative glomerulonephritis
35065	K03y.00	Other nephritis and nephrosis unspecified
35105	C104100	Diabetes mellitus adult onset with renal manifestation
35107	C104z00	Diabetes mellitus with nephropathy NOS
35921	TA22.00	Failure of sterile precautions during perfusion
36125	K03U.00	Unspecif nephr synd diff concentric glomerulonephritis
36205	K0A5.00	Hereditary nephropathy not elsewhere classified
36342	K032y13	Mesangioproliferative glomerulonephritis NEC
36442	7L1B.11	Placement ambulatory dialysis apparatus - compens renal fail
38572	K104.00	Xanthogranulomatous pyelonephritis
39649	G220.00	Malignant hypertensive renal disease
39840	K08y.00	Other impaired renal function disorder
40349	K013.11	Lipoid nephrosis
40413	K0A3100	Chronic nephritic syndrm focal+segmental glomerular lesions
41013	K08y300	Renal function impairment with growth failure
41148	K0B4000	Renal tubulo-interstitial disorder in SLE
41159	K0C1.00	Nephropathy induced by other drugs meds and biologl substncs
41239	K0A5100	Hereditary nephropathy NEC focal+segmnt glomerular lesion
41285	K0A1200	Rapid progres neph syn diffuse membranous glomerulonephritis
41676	K034.00	Renal cortical necrosis unspecified
41881	K032y14	Mesangiocapillary glomerulonephritis NEC
42632	PD12.00	Medullary cystic disease
43611	K0A4.00	Isolated proteinuria with specified morphological lesion
43935	G221.00	Benign hypertensive renal disease
44055	K03yz00	Other nephritis and nephrosis NOS
44270	K0A5200	Hereditry nephropathy NEC difus membran glomerulnephritis
44422	14V2.11	H/O: kidney dialysis
44541	K0A2600	Recurrent and persistent haematuria dense deposit disease
44804	K0A4100	Isolatd proteinur/specifd morphlgcl les foc+seg glom lesn
45499	K01x111	Kimmelstiel - Wilson disease
45523	K0B..00	Renal tubulo-interstitial disorders in diseases EC
45867	K035.00	Renal medullary necrosis unspecified
45904	K0B2.00	Ren tub-interst disordr/blood dis+disordr inv immune mech
46145	ZV56011	[V]Aftercare involving renal dialysis NOS
46963	C108000	Insulin-dependent diabetes mellitus with renal complications
47135	PD12100	Medullary cystic disease adult type
47582	C10E000	Type 1 diabetes mellitus with renal complications
47672	K01x400	Nephrotic syndrome in systemic lupus erythematosus

medcode	readcode	readterm
47838	K00yz00	Other acute glomerulonephritis NOS
47922	K01x000	Nephrotic syndrome in amyloidosis
48022	7L1Ay00	Other specified compensation for renal failure
48057	K0B5.00	Renal tubulo-interstitial disordrs in transplant rejectn
48261	K00y200	Acute focal nephritis
48475	K08yz11	Renal acidaemia
49150	K0y..00	Other specified nephritis nephrosis or nephrotic syndrome
49642	K0A2300	Recur+persist haemuria df mesangial prolif glomerulnephritis
50200	K0A1600	Rapid progressive nephritic syndrome dense deposit disease
50225	C109011	Type II diabetes mellitus with renal complications
50305	K032y11	Hypocomplementaemic persistent glomerulonephritis NEC
50472	K018.00	Nephrotic syn difus endocapilary proliftv glomerulonephritis
50728	K080200	Renal infantilism
50804	K08yz00	Other impaired renal function disorder NOS
50893	K0C4.00	Toxic nephropathy not elsewhere classified
51039	7B01200	Bilateral nephrectomy
51113	K0A5000	Hereditary nephropathy NEC minor glomerular abnormality
52303	C109000	Non-insulin-dependent diabetes mellitus with renal comps
52969	C341.00	Gouty nephropathy
53852	K05..12	End stage renal failure
53940	Kyu2100	[X]Other chronic renal failure
54312	K0A0500	Acute neph syn diffuse mesangiocapillary glomerulonephritis
54844	U612200	[X]Failure sterile precautions dur kidney dialys/other perf
55100	K00y300	Acute diffuse nephritis
55389	K0A0300	Acut neph syn diffuse mesangial prolifrative glomnephritis
55548	K0A7.00	Glom disordr in blood diseas+disordr invlvg imun mechansm
56760	7L1B.00	Placement ambulatory apparatus compensation renal failure
56893	K0A3300	Chron neph syn difus mesangial prolifrtiv glomerulonephritis
56939	K08y000	Hypokalaemic nephropathy
56987	K01A.00	Nephrotic syndrome dense deposit disease
57072	K032500	Other familial glomerulonephritis
57168	K0A3200	Chron nephritic syndrom difuse membranous glomerulonephritis
57278	C10F011	Type II diabetes mellitus with renal complications
57621	C108D00	Insulin dependent diabetes mellitus with nephropathy
57784	K0C2.00	Nephropathy induced by unspec drug medicament or biol subs
57926	K013.12	Steroid sensitive nephrotic syndrome
57987	G234.00	Hyperten heart&renal dis+both(congestv)heart and renal fail
58060	K0A1300	Rpd prog neph syn df mesangial prolifratv glomerulonephritis
58164	K033.00	Rapidly progressive nephritis unspecified
58618	7A60z00	Arteriovenous shunt NOS
58671	K0A5300	Heredtry nephrpthy NEC difus mesangial prolif glomnephrit
58750	K01x300	Nephrotic syndrome in polyarteritis nodosa
59194	7L1By00	Placement ambulatory apparatus- compensate renal failure OS
59365	C109C00	Non-insulin dependent diabetes mellitus with nephropathy
59992	K0A4W00	Isolated proteinuria with unspecified morpholog changes
60128	K03V.00	Unspecified nephritic syndrome dense deposit disease
60198	K0A3600	Chronic nephritic syndrome dense deposit disease
60302	7A60600	Creation of graft fistula for dialysis
60484	K0A2500	Recur+persist hmuria df mesangiocapilary glomerulonephritis
60743	ZV56.00	[V]Aftercare involving intermittent dialysis
60796	C10FL11	Type II diabetes mellitus with persistent proteinuria
60856	K0A2700	Recur+persist haematuria difus crescentic glomerulonephritis
60857	K0A3700	Chronic nephritic syn diffuse crescentic glomerulonephritis
60960	K02y.00	Other chronic glomerulonephritis
61145	C341z00	Gouty nephropathy NOS
61317	K0A2200	Recur+persist haematuria difus membranous glomerulonephritis
61344	C108011	Type I diabetes mellitus with renal complications
61494	K022.00	Chronic membranoproliferative glomerulonephritis
61811	K0A4500	Isoltd prteinur+specfd morph les df mesangiocap glomnephr
61814	K0A0700	Acute nephrotic syndrm diffuse crescentic glomerulonephritis
62320	K0A1700	Rapid progres nephritic syn df crescentic glomerulonephritis
62520	K03W.00	Unsp nephrit synd diff endocap prolif glomerulonephritis
62868	K032300	Anaphylactoid glomerulonephritis
62980	K0A5X00	Hereditary nephropathy unspecif morphological changes
63000	G231.00	Benign hypertensive heart and renal disease
63063	7A60000	Insertion of arteriovenous prosthesis
63190	7A60200	Attention to arteriovenous shunt
63305	7A60500	Thrombectomy of arteriovenous fistula
63466	G23..00	Hypertensive heart and renal disease
63599	K00y.00	Other acute glomerulonephritis
63615	K02yz00	Other chronic glomerulonephritis NOS
63786	K01w.00	Congenital nephrotic syndrome
64030	Kyu5G00	[X]Persistent proteinuria unspecified
64571	C109C11	Type II diabetes mellitus with nephropathy
64636	7L1Az00	Compensation for renal failure NOS

medcode	readcode	readterm
64828	7L1A600	Peritoneal dialysis NEC
65064	K023.00	Chronic rapidly progressive glomerulonephritis
65089	7L1Cz00	Placement other apparatus- compensate for renal failure NOS
65398	7A60y00	Other specified arteriovenous shunt
65400	K02y300	Chronic diffuse glomerulonephritis
66062	K080300	Renal rickets
66136	K0A0100	Acute nephritic syndrome focal+segmental glomerular lesions
66503	K0A0200	Acute nephritic syn diffuse membranous glomerulonephritis
66505	K0A3000	Chronic nephritic syndrome minor glomerular abnormality
66613	K0A4300	Isoltd prteinur/spcfd morph lesn df mesngl prolf glomneph
66714	TB11.11	Renal dialysis with complication without blame
66872	C108D11	Type I diabetes mellitus with nephropathy
67193	K032y00	Nephritis unsp+OS membranoprolif glomerulonephritis lesion
67197	A786.00	Haemorrhagic nephrosonephritis
67232	G230.00	Malignant hypertensive heart and renal disease
67261	K0B4.00	Ren tub-interstitl disordr/systemc connectv tiss disorder
67460	K001.00	Acute nephritis with lesions of necrotising glomerulitis
67995	K032000	Focal membranoproliferative glomerulonephritis
68112	C373600	Nephropathic amyloidosis
68364	K0A2100	Recur+persist haematuria focal+segmental glomerular lesions
68659	G23z.00	Hypertensive heart and renal disease NOS
69266	TA22000	Failure of sterile precautions during kidney dialysis
69427	TA02z00	Accid cut puncture perf h'ge - perfusion NOS
69760	ZVu3G00	[X]Other dialysis
71124	7L1A300	Haemofiltration
71174	K0A1.00	Rapidly progressive nephritic syndrome
71709	Kyu0900	[X]Unsp nephrit synd diff mesang prolif glomerulonephritis
71964	K0A4200	Isolatd proteinur/specfd morphlgcl les df membrn glomneph
72303	K01w000	Finnish nephrosis syndrome
72478	Kyu1400	[X]Nephropathy induced by other drugs+biological substances
73026	K0A3500	Chronic neph syn difus mesangiocapillary glomerulonephritis
83513	7L1C.00	Placement other apparatus for compensation for renal failure
85659	K0A2800	IgA nephropathy
85991	C10FM11	Type II diabetes mellitus with persistent microalbuminuria
88597	7L1A400	Automated peritoneal dialysis
89332	9Ot5.00	Predicted stage chronic kidney disease
90952	7B0F100	Pre-transplantation of kidney work-up recipient
91738	K0A5600	Hereditary nephropathy NEC dense deposit disease
93922	C104000	Diabetes mellitus juvenile type with renal manifestation
94261	K00y100	Acute exudative nephritis
94350	K032z00	Nephritis unsp+membranoprolif glomerulonephritis lesion NOS
94373	K01y.00	Nephrotic syndrome with other pathological kidney lesions
94789	1Z17.00	Chronic kidney disease stage 1 with proteinuria
94793	1Z1B.00	Chronic kidney disease stage 3 with proteinuria
94842	Kyu1.00	[X]Renal tubulo-interstitial diseases
94965	1Z15.00	Chronic kidney disease stage 3A
95121	1Z1A.00	Chronic kidney disease stage 2 without proteinuria
95122	1Z1H.00	Chronic kidney disease stage 4 with proteinuria
95123	1Z1C.00	Chronic kidney disease stage 3 without proteinuria
95145	1Z1B.11	CKD stage 3 with proteinuria
95146	1Z19.00	Chronic kidney disease stage 2 with proteinuria
95175	1Z1E.00	Chronic kidney disease stage 3A without proteinuria
95176	1Z1E.11	CKD stage 3A without proteinuria
95177	1Z1G.00	Chronic kidney disease stage 3B without proteinuria
95178	1Z1F.00	Chronic kidney disease stage 3B with proteinuria
95179	1Z16.00	Chronic kidney disease stage 3B
95180	1Z1F.11	CKD stage 3B with proteinuria
95188	1Z1C.11	CKD stage 3 without proteinuria
95405	1Z1L.00	Chronic kidney disease stage 5 without proteinuria
95406	1Z1J.00	Chronic kidney disease stage 4 without proteinuria
95408	1Z1D.00	Chronic kidney disease stage 3A with proteinuria
95508	1Z1K.00	Chronic kidney disease stage 5 with proteinuria
95546	K0A2000	Recurrent+persistnt haematuria minor glomerular abnormality
95571	1Z1D.11	CKD stage 3A with proteinuria
95572	1Z18.00	Chronic kidney disease stage 1 without proteinuria
96131	7A60400	Banding of arteriovenous fistula
96184	TA02000	Accid cut puncture perf h'ge - kidney dialysis
96347	7A61900	Ligation of arteriovenous dialysis fistula
96819	Kyu4000	[X]Other disorders resulting/impaired renal tubular function
97388	K032y15	Mixed membranous and proliferative glomerulonephritis NEC
97587	1Z1J.11	CKD stage 4 without proteinuria
97683	1Z1L.11	CKD stage 5 without proteinuria
97734	K0A1100	Rapid progres nephritic syn focal+segmental glomerulr lesion
97758	K02y000	Chronic glomerulonephritis + diseases EC
97978	1Z1A.11	CKD stage 2 without proteinuria

medcode	readcode	readterm
97979	1Z19.11	CKD stage 2 with proteinuria
97980	1Z17.11	CKD stage 1 with proteinuria
99139	K0B6.00	Balkan nephropathy
99160	1Z1K.11	CKD stage 5 with proteinuria
99312	1Z1H.11	CKD stage 4 with proteinuria
99628	Kyu0300	[X]Glomerular disorders in diabetes mellitus
99644	K012.00	Nephrotic syndrome+membranoproliferative glomerulonephritis
99685	K0A0600	Acute nephritic syndrome dense deposit disease
100205	K0E..00	Acute-on-chronic renal failure
100235	7A61111	Ligation of acquired arteriovenous fistula
100292	Cyu2300	[X]Unspecified diabetes mellitus with renal complications
100558	K0A0000	Acute nephritic syndrome minor glomerular abnormality
100633	1Z1G.11	CKD stage 3B without proteinuria
100693	Kyu1C00	[X]Renal tubulo-interstitial disorders/transplant rejection
101358	K0A0400	Ac neph syn difus endocaplry prolifrative glomerulonephritis
101453	Kyu1000	[X]Other chronic tubulo-interstitial nephritis
101572	K0A4X00	Isolated proteinuria with oth specif morpholog changes
101756	7L1A011	Thomas intravascular shunt for dialysis
102163	C10ED12	Insulin dependent diabetes mellitus with nephropathy
102201	C10FC11	Type II diabetes mellitus with nephropathy
102620	C10EL11	Type I diabetes mellitus with persistent microalbuminuria
102946	C10E012	Insulin-dependent diabetes mellitus with renal complications
102947	K13yB00	Ischaemic nephropathy
103176	K13yA00	Dent's disease
103532	K0A5500	[X]Heredtry nephrpthy NEC difus mesangiocapilry glomneph
103757	Kyu1E00	[X]Tubulo-interstit nephritis, not specif as acute or chron
104201	SP08H00	Acute rejection of renal transplant
104586	7L1B200	Flushing of peritoneal dialysis catheter
104619	K053.00	Chronic kidney disease stage 3
104630	SP08G00	Acute rejection of renal transplant - grade III
104905	SP08D00	Acute-on-chronic rejection of renal transplant
104960	SP08E00	Acute rejection of renal transplant - grade I
104963	K054.00	Chronic kidney disease stage 4
104981	K05..13	Chronic kidney disease
105151	K055.00	Chronic kidney disease stage 5
105302	K08yA00	Proteinuric diabetic nephropathy
105383	K052.00	Chronic kidney disease stage 2
105392	K051.00	Chronic kidney disease stage 1
105436	SP0G.00	Anaphylactoid reaction due to haemodialysis
105680	K0C6.00	Chronic lithium nephrotoxicity
105723	K000100	Crescentic glomerulonephritis
105742	G72D200	Aneurysm of anastomotic site of dialysis AV fistula
105760	G72C.00	Ruptured aneurysm of dialysis vascular access
105794	PD12012	Autosomal recessive medullary cystic disease
105811	SP08R00	Renal transplant rejection
105859	K0A8.00	Rapidly progressive glomerulonephritis
105976	K0H..00	Acute scleroderma renal crisis
106058	C372400	Urate nephropathy
106213	C372411	Uric acid nephropathy
106620	SP08J00	Chronic rejection of renal transplant
106720	Gy21.00	Thrombosis of dialysis arteriovenous fistula
106975	Gy51.00	Haemorrhage of dialysis arteriovenous fistula
107000	SP08F00	Acute rejection of renal transplant - grade II
107027	K0G..00	Sickle cell nephropathy
107082	Gy31.00	Occlusion of dialysis arteriovenous fistula
107188	G72D.00	Aneurysm of dialysis arteriovenous fistula
107216	Kyu0F00	[X]Hereditary nephropathy, unspecif morphological changes
107220	G72D100	Aneurysm of needle site of dialysis arteriovenous fistula
107260	Gy41.00	Infection of dialysis arteriovenous fistula
107382	K0J0.00	Renal involvement in scleroderma
107719	7A61A00	Ligation of arteriovenous dialysis graft
107746	Gy1..00	Stenosis of dialysis vascular access
107771	K06..12	Kidney failure unspecified
107814	K032200	Focal glomerulon + focal recurr macroscop glomerulonephritis
107881	K08yA11	Clinical diabetic nephropathy
107900	SP0E.00	Disorders associated with peritoneal dialysis
108116	Gy3..00	Occlusion of dialysis vascular access
108213	Gy40.00	Infection of dialysis arteriovenous graft
108423	Gy60.00	Rupture of dialysis arteriovenous graft
108591	K01w100	Drash syndrome
108699	Gy10.00	Stenosis of dialysis arteriovenous graft
108711	K000111	CGN - Crescentic glomerulonephritis
108759	Gy5..00	Haemorrhage of dialysis vascular access
108766	661M200	Chronic kidney disease self-management plan agreed
108785	SP0F.00	Haemodialysis first use syndrome

medcode	readcode	readterm
108816	K01x.00	Nephrotic syndrome in diseases EC
108922	K01w112	Wilms' tumour + nephrotic syndrome + pseudohermaphroditism
109106	PD12200	Nephronophthisis - medullary cystic disease
109135	Gy30.00	Occlusion of dialysis arteriovenous graft
109657	1Z1Y.00	CKD with GFR category G3b & albuminuria category A2
109750	2126E00	Chronic kidney disease resolved
109804	1Z1T.00	CKD with GFR category G3a & albuminuria category A1
109805	1Z1V.00	CKD with GFR category G3a & albuminuria category A2
109809	Gy2..00	Thrombosis of dialysis vascular access
109837	C10E011	Type I diabetes mellitus with renal complications
109884	SP0H.00	Disorder associated with dialysis
109905	1Z1W.00	CKD with GFR category G3a & albuminuria category A3
109945	K0A1400	Rapid progres neph syn df endocapilary prolifv glomnephritis
109963	1Z1X.00	CKD with GFR category G3b & albuminuria category A1
109980	1Z1a.00	CKD with GFR category G4 & albuminuria category A1
109981	1Z1e.00	CKD with GFR category G5 & albuminuria category A2
109990	1Z1Z.00	CKD with GFR category G3b & albuminuria category A3
110003	1Z1N.00	CKD with GFR category G1 & albuminuria category A2
110033	1Z1M.00	CKD with GFR category G1 & albuminuria category A1
110051	Gy4..00	Infection of dialysis vascular access
110072	Z919200	Washing back through haemodialysis lines
110095	G72D000	Aneurysm of superficialised artery of dialysis AV fistula
110108	1Z1R.00	CKD with GFR category G2 & albuminuria category A2
110133	1Z1d.00	CKD with GFR category G5 & albuminuria category A1
110208	PD12211	Autosomal dominant medullary cystic disease
110251	1Z1S.00	CKD with GFR category G2 & albuminuria category A3
110269	1Z1Q.00	CKD with GFR category G2 & albuminuria category A1
110467	1Z1f.00	CKD with GFR category G5 & albuminuria category A3
110484	1Z1P.00	CKD with GFR category G1 & albuminuria category A3
110626	1Z1c.00	CKD with GFR category G4 & albuminuria category A3
110749	K01w200	Congenital nephrotic syndrome with focal glomerulosclerosis
111022	1Z18.11	CKD stage 1 without proteinuria
111029	K032y12	Lobular glomerulonephritis NEC
111103	SP0E100	Thrombus in peritoneal dialysis catheter

B) Hospital Episodes Statistics

ICD 10	DESCRIPTION	MODIFIER_4
E10.2	Type 1 diabetes mellitus	With renal complications
E11.2	Type 2 diabetes mellitus	With renal complications
E12.2	Malnutrition-related diabetes mellitus	With renal complications
E13.2	Other specified diabetes mellitus	With renal complications
E14.2	Unspecified diabetes mellitus	With renal complications
I12	Hypertensive renal disease	
I12.0	Hypertensive renal disease with renal failure	
I12.9	Hypertensive renal disease without renal failure	
I13	Hypertensive heart and renal disease	
I13.0	Hypertensive heart and renal disease with (congestive) heart failure	
I13.1	Hypertensive heart and renal disease with renal failure	
I13.2	Hypertensive heart and renal disease with both (congestive) heart failure and renal failure	
I13.9	Hypertensive heart and renal disease, unspecified	
N00	Acute nephritic syndrome	
N00.0	Acute nephritic syndrome	Minor glomerular abnormality
N00.1	Acute nephritic syndrome	Focal and segmental glomerular lesions
N00.2	Acute nephritic syndrome	Diffuse membranous glomerulonephritis
N00.3	Acute nephritic syndrome	Diffuse mesangial proliferative glomerulonephritis
N00.4	Acute nephritic syndrome	Diffuse endocapillary proliferative glomerulonephritis
N00.5	Acute nephritic syndrome	Diffuse mesangiocapillary glomerulonephritis
N00.6	Acute nephritic syndrome	Dense deposit disease
N00.7	Acute nephritic syndrome	Diffuse crescentic glomerulonephritis
N00.8	Acute nephritic syndrome	Other
N00.9	Acute nephritic syndrome	Unspecified
N01	Rapidly progressive nephritic syndrome	
N01.0	Rapidly progressive nephritic syndrome	Minor glomerular abnormality
N01.1	Rapidly progressive nephritic syndrome	Focal and segmental glomerular lesions
N01.2	Rapidly progressive nephritic syndrome	Diffuse membranous glomerulonephritis
N01.3	Rapidly progressive nephritic syndrome	Diffuse mesangial proliferative glomerulonephritis
N01.4	Rapidly progressive nephritic syndrome	Diffuse endocapillary proliferative glomerulonephritis
N01.5	Rapidly progressive nephritic syndrome	Diffuse mesangiocapillary glomerulonephritis
N01.6	Rapidly progressive nephritic syndrome	Dense deposit disease

ICD 10	DESCRIPTION	MODIFIER_4
N01.7	Rapidly progressive nephritic syndrome	Diffuse crescentic glomerulonephritis
N01.8	Rapidly progressive nephritic syndrome	Other
N01.9	Rapidly progressive nephritic syndrome	Unspecified
N02	Recurrent and persistent haematuria	
N02.0	Recurrent and persistent haematuria	Minor glomerular abnormality
N02.1	Recurrent and persistent haematuria	Focal and segmental glomerular lesions
N02.2	Recurrent and persistent haematuria	Diffuse membranous glomerulonephritis
N02.3	Recurrent and persistent haematuria	Diffuse mesangial proliferative glomerulonephritis
N02.4	Recurrent and persistent haematuria	Diffuse endocapillary proliferative glomerulonephritis
N02.5	Recurrent and persistent haematuria	Diffuse mesangiocapillary glomerulonephritis
N02.6	Recurrent and persistent haematuria	Dense deposit disease
N02.7	Recurrent and persistent haematuria	Diffuse crescentic glomerulonephritis
N02.8	Recurrent and persistent haematuria	Other
N02.9	Recurrent and persistent haematuria	Unspecified
N03	Chronic nephritic syndrome	
N03.0	Chronic nephritic syndrome	Minor glomerular abnormality
N03.1	Chronic nephritic syndrome	Focal and segmental glomerular lesions
N03.2	Chronic nephritic syndrome	Diffuse membranous glomerulonephritis
N03.3	Chronic nephritic syndrome	Diffuse mesangial proliferative glomerulonephritis
N03.4	Chronic nephritic syndrome	Diffuse endocapillary proliferative glomerulonephritis
N03.5	Chronic nephritic syndrome	Diffuse mesangiocapillary glomerulonephritis
N03.6	Chronic nephritic syndrome	Dense deposit disease
N03.7	Chronic nephritic syndrome	Diffuse crescentic glomerulonephritis
N03.8	Chronic nephritic syndrome	Other
N03.9	Chronic nephritic syndrome	Unspecified
N04	Nephrotic syndrome	
N04.0	Nephrotic syndrome	Minor glomerular abnormality
N04.1	Nephrotic syndrome	Focal and segmental glomerular lesions
N04.2	Nephrotic syndrome	Diffuse membranous glomerulonephritis
N04.3	Nephrotic syndrome	Diffuse mesangial proliferative glomerulonephritis
N04.4	Nephrotic syndrome	Diffuse endocapillary proliferative glomerulonephritis
N04.5	Nephrotic syndrome	Diffuse mesangiocapillary glomerulonephritis
N04.6	Nephrotic syndrome	Dense deposit disease
N04.7	Nephrotic syndrome	Diffuse crescentic glomerulonephritis
N04.8	Nephrotic syndrome	Other
N04.9	Nephrotic syndrome	Unspecified
N05	Unspecified nephritic syndrome	
N05.0	Unspecified nephritic syndrome	Minor glomerular abnormality
N05.1	Unspecified nephritic syndrome	Focal and segmental glomerular lesions
N05.2	Unspecified nephritic syndrome	Diffuse membranous glomerulonephritis
N05.3	Unspecified nephritic syndrome	Diffuse mesangial proliferative glomerulonephritis
N05.4	Unspecified nephritic syndrome	Diffuse endocapillary proliferative glomerulonephritis
N05.5	Unspecified nephritic syndrome	Diffuse mesangiocapillary glomerulonephritis
N05.6	Unspecified nephritic syndrome	Dense deposit disease
N05.7	Unspecified nephritic syndrome	Diffuse crescentic glomerulonephritis
N05.8	Unspecified nephritic syndrome	Other
N05.9	Unspecified nephritic syndrome	Unspecified
N06	Isolated proteinuria with specified morphological lesion	
N06.0	Isolated proteinuria with specified morphological lesion	Minor glomerular abnormality
N06.1	Isolated proteinuria with specified morphological lesion	Focal and segmental glomerular lesions
N06.2	Isolated proteinuria with specified morphological lesion	Diffuse membranous glomerulonephritis
N06.3	Isolated proteinuria with specified morphological lesion	Diffuse mesangial proliferative glomerulonephritis
N06.4	Isolated proteinuria with specified morphological lesion	Diffuse endocapillary proliferative glomerulonephritis
N06.5	Isolated proteinuria with specified morphological lesion	Diffuse mesangiocapillary glomerulonephritis
N06.6	Isolated proteinuria with specified morphological lesion	Dense deposit disease
N06.7	Isolated proteinuria with specified morphological lesion	Diffuse crescentic glomerulonephritis
N06.8	Isolated proteinuria with specified morphological lesion	Other
N06.9	Isolated proteinuria with specified morphological lesion	Unspecified
N07	Hereditary nephropathy, not elsewhere classified	
N07.0	Hereditary nephropathy, not elsewhere classified	Minor glomerular abnormality
N07.1	Hereditary nephropathy, not elsewhere classified	Focal and segmental glomerular lesions
N07.2	Hereditary nephropathy, not elsewhere classified	Diffuse membranous glomerulonephritis
N07.3	Hereditary nephropathy, not elsewhere classified	Diffuse mesangial proliferative glomerulonephritis
N07.4	Hereditary nephropathy, not elsewhere classified	Diffuse endocapillary proliferative glomerulonephritis
N07.5	Hereditary nephropathy, not elsewhere classified	Diffuse mesangiocapillary glomerulonephritis
N07.6	Hereditary nephropathy, not elsewhere classified	Dense deposit disease
N07.7	Hereditary nephropathy, not elsewhere classified	Diffuse crescentic glomerulonephritis
N07.8	Hereditary nephropathy, not elsewhere classified	Other

ICD 10	DESCRIPTION	MODIFIER_4
N07.9	Hereditary nephropathy, not elsewhere classified	Unspecified
N08	Glomerular disorders in diseases classified elsewhere	
N08.0	Glomerular disorders in infectious and parasitic diseases classified elsewhere	
N08.1	Glomerular disorders in neoplastic diseases	
N08.2	Glomerular disorders in blood diseases and disorders involving the immune mechanism	
N08.3	Glomerular disorders in diabetes mellitus	
N08.4	Glomerular disorders in other endocrine, nutritional and metabolic diseases	
N08.5	Glomerular disorders in systemic connective tissue disorders	
N08.8	Glomerular disorders in other diseases classified elsewhere	
N11	Chronic tubulo-interstitial nephritis	
N11.0	Nonobstructive reflux-associated chronic pyelonephritis	
N11.1	Chronic obstructive pyelonephritis	
N11.8	Other chronic tubulo-interstitial nephritis	
N11.9	Chronic tubulo-interstitial nephritis, unspecified	
N12	Tubulo-interstitial nephritis, not specified as acute or chronic	
N15.0	Balkan nephropathy	
N16.2	Renal tubulo-interstitial disorders in blood diseases and disorders involving the immune mechanism	
N16.3	Renal tubulo-interstitial disorders in metabolic diseases	
N16.4	Renal tubulo-interstitial disorders in systemic connective tissue disorders	
N16.5	Renal tubulo-interstitial disorders in transplant rejection	
N16.8	Renal tubulo-interstitial disorders in other diseases classified elsewhere	
N18	Chronic kidney disease	
N18.1	Chronic kidney disease, stage 1	
N18.2	Chronic kidney disease, stage 2	
N18.3	Chronic kidney disease, stage 3	
N18.4	Chronic kidney disease, stage 4	
N18.5	Chronic kidney disease, stage 5	
N18.9	Chronic kidney disease, unspecified	
N19	Unspecified kidney failure	
N25	Disorders resulting from impaired renal tubular function	
N25.0	Renal osteodystrophy	
N25.1	Nephrogenic diabetes insipidus	
N25.8	Other disorders resulting from impaired renal tubular function	
N25.9	Disorder resulting from impaired renal tubular function, unspecified	
T86.1	Kidney transplant failure and rejection	
Y84.1	Kidney dialysis	
Z49	Care involving dialysis	
Z49.0	Preparatory care for dialysis	
Z49.1	Extracorporeal dialysis	
Z49.2	Other dialysis	
Z99.2	Dependence on renal dialysis	

Appendix 14 Codelist: Haematopoietic and lymphoid tissue malignancies including haematopoietic stem cell transplant

1. Bone marrow/ stem cell transplant

A) CPRD

medcode	readcode	readterm
1392	7K1Q.11	Bone marrow transplant
15406	7K1Q100	Allograft of bone marrow NEC
18628	7K1Q200	Transfusion of stem cells
21021	7K1Q.00	Graft of bone marrow
22728	SP08700	Acute graft-versus-host disease
25695	SP08800	Chronic graft-versus-host disease
28232	7L14400	Peripheral blood stem cell graft
52943	SP08200	Bone-marrow transplant rejection
54420	7L14411	Second stage peripheral stem cell infusion
63236	7L17311	First stage peripheral stem cell infusion
70870	7K1Qz00	Graft of bone marrow NOS
72436	7K1Qy00	Other specified graft of bone marrow
85492	7K1Q300	Allograft of bone marrow from sibling donor
86063	7L14500	Autologous peripheral blood stem cell transplant
89920	7L14700	Allogeneic peripheral blood stem cell transplant
95840	7K1Q400	Allograft of bone marrow from matched unrelated donor
98608	7K1Q600	Allograft of bone marrow from unmatched unrelated donor
100912	7K1Q500	Allograft of bone marrow from haploidentical donor
110109	7L14600	Syngeneic peripheral blood stem cell transplant

B) Hospital Episodes Statistics

ICD10	DESCRIPTION
T86.0	Bone-marrow transplant rejection

C) Office of Population Censuses and Surveys (OPCS) version 4 codes

Opcs	Description_other	Description
W341	Graft of bone marrow	Autograft of bone marrow
W342	Graft of bone marrow	Allograft of bone marrow nec
W343	Graft of bone marrow	Allograft of bone marrow from sibling donor
W344	Graft of bone marrow	Allograft of bone marrow from matched unrelated donor
W345	Graft of bone marrow	Allograft of bone marrow from haploidentical donor
W346	Graft of bone marrow	Allograft of bone marrow from unmatched unrelated donor
W348	Graft of bone marrow	Other specified
W349	Graft of bone marrow	Unspecified
W991	Graft of cord blood stem cells to bone marrow	Allograft of cord blood stem cells to bone marrow
W998	Graft of cord blood stem cells to bone marrow	Other specified
W999	Graft of cord blood stem cells to bone marrow	Unspecified
X334	Other blood transfusion	Autologous peripheral blood stem cell transplant
X335	Other blood transfusion	Syngeneic peripheral blood stem cell transplant
X336	Other blood transfusion	Allogeneic peripheral blood stem cell transplant

2. Lymphoma, myeloma, other plasma cell dyscrasias & leukemia

A) CPRD

medcode	readcode	readterm
102688	ByuD400	[X]Other malignant immunoproliferative diseases
102688	ByuD400	[X]Other malignant immunoproliferative diseases
1481	B600.00	Reticulosarcoma
1483	BBg1.11	[M]Lymphoma NOS
2462	B61..00	Hodgkin's disease
3371	BBg2.11	[M]Non Hodgkins lymphoma
3604	B627.00	Non - Hodgkin's lymphoma
3672	BBn0.12	[M]MYELOMA NOS
3710	BBB1.00	[M]Adenolymphoma
4072	B680.00	Acute leukaemia NOS
4222	B64..11	Lymphatic leukaemia
4250	B68z.00	Leukaemia NOS
4251	B640.00	Acute lymphoid leukaemia
4413	B650.00	Acute myeloid leukaemia
4637	BBr..00	[M]Leukaemias
4870	B625.11	HISTIOCYTOSIS X (ACUTE, PROGRESSIVE)
4944	B630.00	MULTIPLE MYELOMA
5137	B624.11	Leukaemic reticuloendotheliosis

medcode	readcode	readterm
5179	B620.00	Nodular lymphoma (Brill - Symmers disease)
5915	BBrA400	[M]Hairy cell leukaemia
6316	BBr0100	[M]Acute leukaemia NOS
7176	B65..00	Myeloid leukaemia
7940	ByuDF11	[X]Non-Hodgkin's lymphoma NOS
8625	B641.00	Chronic lymphoid leukaemia
8649	ByuDF00	[X]Non-Hodgkin's lymphoma, unspecified type
9172	BBmK.00	[M]WALDENSTROM'S MACROGLOBULINAEMIA
9673	BBs5.00	[M]Chronic lymphoproliferative disease
10411	C333000	WALDENSTROM'S MACROGLOBULINAEMIA
10726	B651.00	Chronic myeloid leukaemia
12006	B621.00	Mycosis fungoides
12146	BBr2000	[M]Lymphoid leukaemia NOS
12323	B6...00	MALIGNANT NEOPLASM OF LYMPHATIC AND HAEMOPOIETIC TISSUE
12335	B62y.00	Malignant lymphoma NOS
12464	B62x200	Peripheral T-cell lymphoma
15027	B62yz00	Malignant lymphoma NOS
15036	B626.00	MALIGNANT MAST CELL TUMOURS
15211	B630.12	MYELOMATOSIS
15504	B62y800	Malignant lymphoma NOS of lymph nodes of multiple sites
16416	B681.00	Chronic leukaemia NOS
16460	BBg2.00	[M]Malignant lymphoma, non Hodgkin's type
16774	BBmD.00	[M] Cutaneous lymphoma
17177	1429	H/O: * leukaemia
17178	BBg..00	[M]Lymphomas, NOS or diffuse
17182	B627C11	Follicular lymphoma NOS
17460	B627700	Diffuse non-Hodgkin's lymphoblastic (diffuse) lymphoma
17887	B62x.00	Malignant lymphoma otherwise specified
18383	BBmH.00	[M] Large cell lymphoma
18744	BBn0.11	[M]MULTIPLE MYELOMA
19028	B630100	SOLITARY MYELOMA
19140	B614800	Hodgkin's nodular sclerosis of lymph nodes of multiple sites
19372	B64..00	Lymphoid leukaemia
19974	B660.00	Acute monocytic leukaemia
20437	BBk..00	[M]Lymphomas, nodular or follicular
20440	B69..00	Myelomonocytic leukaemia
20635	BBr2011	[M]Lymphatic leukaemia
20710	BBj..00	[M]Hodgkin's disease
21329	B630200	PLASMACYTOMA NOS
21402	B602.00	Burkitt's lymphoma
21463	BBgC.11	[M]Lymphocytic lymphoma NOS
21549	B627C00	Follicular non-Hodgkin's lymphoma
22050	B691.00	Chronic myelomonocytic leukaemia
22071	BBr0111	[M]Blast cell leukaemia
22158	B630000	Malignant plasma cell neoplasm, extramedullary plasmacytoma
23711	BBg1000	[M]Malignant lymphoma, diffuse NOS
25191	B68..00	Leukaemia of unspecified cell type
26135	BBm6.00	[M] ALPHA HEAVY CHAIN DISEASE
27330	B624.00	Leukaemic reticuloendotheliosis
27340	B670.11	Di Guglielmo's disease
27416	B601.00	Lymphosarcoma
27458	B661.00	Chronic monocytic leukaemia
27520	B651z00	Chronic myeloid leukaemia NOS
27664	B65y100	Acute promyelocytic leukaemia
27790	B641.11	Chronic lymphatic leukaemia
27965	BBv2.00	[M]AngiocentricT-cell lymphoma
28276	B675.00	ACUTE MYELOFIBROSIS
28639	B627000	Follicular non-Hodgkin's small cleaved cell lymphoma
29178	B614.00	Hodgkin's disease, nodular sclerosis
29335	BBr2700	[M]Adult T-cell leukaemia/lymphoma
29876	B613z00	Hodgkin's, lymphocytic-histiocytic predominance NOS
30632	B67z.00	Other specified leukaemia NOS
30646	B6y..00	MALIGNANT NEOPLASM LYMPHATIC OR HAEMATOPOIETIC TISSUE OS
31324	B626800	MAST CELL MALIGNANCY OF LYMPH NODES OF MULTIPLE SITES
31492	BBm9.00	[M] Monocytoid B-cell lymphoma
31537	BBj1100	[M]Hodgkin,s disease, lymphocytic predominance, nodular
31576	B627B00	Other types of follicular non-Hodgkin's lymphoma
31586	B64y100	Prolymphocytic leukaemia
31671	BBn0.00	[M]PLASMA CELL MYELOMA
31701	B651.11	Chronic granulocytic leukaemia
31726	BBgM.00	[M]Malignant lymphoma, small cleaved cell, diffuse
31741	BBj6200	[M]Hodgkin,s disease, nodular sclerosis, lymphocytic deplet
31749	BBv0.00	[M]Monocytoid B-cell lymphoma
31750	BBr0300	[M]Chronic leukaemia NOS
31794	B627W00	Unspecified B-cell non-Hodgkin's lymphoma

medcode	readcode	readterm
32240	4M22.00	Lymphoma stage III
33333	B62..00	OTHER MALIGNANT NEOPLASM OF LYMPHOID AND HISTIOCYTIC TISSUE
33344	B65z.00	Myeloid leukaemia NOS
33869	BBgR.00	[M]Malignant lymphoma, large cell, diffuse NOS
34089	B62y400	Malignant lymphoma NOS of lymph nodes of axilla and arm
34352	BBgG.12	[M]Lymphoblastic lymphoma NOS
34692	B68y.00	Other leukaemia of unspecified cell type
34926	B625.00	LETTERER-SIWE DISEASE
35014	B622.00	Sezary's disease
35697	BBr6.00	[M]Myeloid leukaemias
35875	B66..00	Monocytic leukaemia
36114	BBg1.00	[M]Malignant lymphoma NOS
36693	ZV10600	[V]Personal history of leukaemia
37112	B6...11	MALIGNANT NEOPLASM OF HISTIOCYTIC TISSUE
37182	B63..00	Multiple myeloma and immunoproliferative neoplasms
37272	B67..00	Other specified leukaemia
37410	BBr2100	[M]Acute lymphoid leukaemia
37461	B64y200	Adult T-cell leukaemia
37487	BBrA700	[M]Acute myelofibrosis
37723	BBr6011	[M]Granulocytic leukaemia NOS
38005	B621z00	Mycosis fungoides NOS
38321	B936.12	PLASMACYTOMA NOS
38331	B64yz00	Other lymphoid leukaemia NOS
38914	B64z.00	Lymphoid leukaemia NOS
38939	B613.00	Hodgkin's disease, lymphocytic-histiocytic predominance
39187	B631.00	Plasma cell leukaemia
39490	BBn0.14	[M]PLASMACYTIC MYELOMA
39798	B627X00	Diffuse non-Hodgkin's lymphoma, unspecified
39883	BBk5.00	[M]Malig lymp, follicular centre cell, cleaved, follicular
39906	BBgE.00	[M]Malignant lymphoma, centrocytic
40420	BBr0.00	[M]Leukaemias unspecified
40508	BBj6000	[M]Hodgkin,s disease, nodular sclerosis, lymphocytic predom
40513	BBkz.00	[M]Lymphoma, nodular or follicular NOS
40561	ZV10711	[V]Personal history of Hodgkin's disease
40740	ByuD.00	[X]Malignant neoplasms of lymphoid, haematopoietic and rela
40766	BBm5.00	[M] Peripheral T-cell lymphoma NOS
40991	4M2..00	Lymphoma staging system
41369	B60..00	Lymphosarcoma and reticulosarcoma
41500	BBr2300	[M]Chronic lymphoid leukaemia
41734	BBr0000	[M]Leukaemia NOS
41754	BBg7.00	[M]Malignant lymphoma, lymphoplasmacytoid type
41841	BBgB.00	[M]Malignant lymphoma, follicular centre cell NOS
42198	BBj6.00	[M]Hodgkin's disease, nodular sclerosis NOS
42297	BBrz.00	[M]Leukaemia NOS
42461	B61zz00	Hodgkin's disease NOS
42539	B670.00	Acute erythraemia and erythroleukaemia
42579	B62y300	Malignant lymphoma NOS of intra-abdominal lymph nodes
42769	BBjz.00	[M]Hodgkin's disease NOS
43312	B936.11	MYELOMA - SOLITARY
43415	ByuD000	[X]Other Hodgkin's disease
43450	B63z.00	Immunoproliferative neoplasm or myeloma NOS
43459	BBn..00	[M]Plasma cell tumours
43552	B630.11	KAHLER'S DISEASE
44196	B611.00	Hodgkin's granuloma
44267	B623.00	MALIGNANT HISTIOCYTOSIS
44318	B62xX00	Oth and unspecif peripheral & cutaneous T-cell lymphomas
44617	A789600	HIV disease resulting in Burkitt's lymphoma
45264	B620100	Nodular lymphoma of lymph nodes of head, face and neck
45768	BBm3.12	[M]ACUTE PROGRESSIVE HISTIOCYTOSIS X
46042	B630300	LAMBDA LIGHT CHAIN MYELOMA
46048	BBr2500	[M]Prolymphocytic leukaemia
46263	BBr6700	[M]Acute myelomonocytic leukaemia
46444	BBr4.00	[M]Erythroleukaemias
46877	BBgL.00	[M]Malignant lymphoma, small lymphocytic NOS
46931	BBg4.00	[M]Malignant lymphoma, stem cell type
46967	BBl..00	[M]Mycosis fungoides
47204	B625z00	LETTERER-SIWE DISEASE NOS
47330	BBm2.00	[M]HISTIOCYTIC MEDULLARY RETICULOSIS
48049	BBr6800	[M]Chronic myelomonocytic leukaemia
48155	BBr2.00	[M]Lymphoid leukaemias
48253	BBg8.00	[M]Malignant lymphoma, immunoblastic type
49131	BBg0.00	[M]Lymphomatous tumour, benign
49253	BBk0.13	[M]Giant follicular lymphoma
49262	B627200	Follicular non-Hodgkin's large cell lymphoma
49301	B6z..00	MALIGNANT NEOPLASM LYMPHATIC OR HAEMATOPOIETIC TISSUE NOS

medcode	readcode	readterm
49327	BBrA500	[M]Acute megakaryoblastic leukaemia
49530	BBmC.00	[M] T-gamma lymphoproliferative disease
49605	B615.00	Hodgkin's disease, mixed cellularity
49725	B64y.00	Other lymphoid leukaemia
49825	BBh0.11	[M]RETICULUM CELL SARCOMA NOS
50668	B627300	Diffuse non-Hodgkin's small cell (diffuse) lymphoma
50695	B627500	Diffuse non-Hodgkin mixed sml & lge cell (diffuse) lymphoma
50696	B62y100	Malignant lymphoma NOS of lymph nodes of head, face and neck
50858	B674.00	ACUTE PANMYELOSIS
50928	BBr2600	[M]Burkitt's cell leukaemia
51285	BBj2.00	[M]Hodgkin's disease, mixed cellularity
51680	BBgV.00	[M]Malignant lymphoma, small cell, noncleaved, diffuse
51852	BBgD.00	[M]Malig lymphoma, lymphocytic, intermediate different NOS
51895	BBgz.00	[M]Lymphoma, diffuse or NOS
52327	B653000	Chloroma
52591	BBgG.13	[M]Lymphoblastoma NOS
52593	BBmE.00	[M] GAMMA HEAVY CHAIN DISEASE
52942	BBr6300	[M]Chronic myeloid leukaemia
52946	4C53.00	BONE MARROW: MYELOMA CELLS
53397	B61z.00	Hodgkin's disease NOS
53477	ZV67811	[V]Follow-up examination after chemotherapy for leukaemia
53551	B627600	Diffuse non-Hodgkin's immunoblastic (diffuse) lymphoma
53647	BBn0.13	[M]MYELOMATOSIS
54083	B625800	LETTERER-SIWE DISEASE OF LYMPH NODES OF MULTIPLE SITES
54190	BBm8.00	[M] Angioimmunoblastic lymphadenopathy
54585	BBr6100	[M]Acute myeloid leukaemia
54793	B682.00	Subacute leukaemia NOS
55303	B614100	Hodgkin's nodular sclerosis of head, face and neck
56041	BBj1.00	[M]Hodgkin's disease, lymphocytic predominance
57225	B614000	Hodgkin's disease, nodular sclerosis of unspecified site
57316	BBr6600	[M]Acute promyelocytic leukaemia
57427	B62y000	Malignant lymphoma NOS of unspecified site
57544	BBm4.00	[M]True histiocytic lymphoma
57671	B672.00	Megakaryocytic leukaemia
57713	BBr8.00	[M]Eosinophilic leukaemias
57737	B62x100	Lymphoepithelioid lymphoma
58015	BBgQ.00	[M]Malignant lymphomatous polyposis
58082	B620800	Nodular lymphoma of lymph nodes of multiple sites
58684	B615200	Hodgkin's mixed cellularity of intrathoracic lymph nodes
58871	B623z00	MALIGNANT HISTIOCYTOSIS NOS
58953	BBk8.00	[M]Malig lymp,follicular centre cell,noncleaved,follicular
58962	B62x500	Malignant immunoproliferative small intestinal disease
59115	B602100	Burkitt's lymphoma of lymph nodes of head, face and neck
59593	BBm3.00	[M]LETTERER - SIWE DISEASE
59663	B936.00	Neoplasm of uncertain behaviour of plasma cells
59755	B61z200	Hodgkin's disease NOS of intrathoracic lymph nodes
59778	B61z100	Hodgkin's disease NOS of lymph nodes of head, face and neck
59929	BBr0z00	[M]Leukaemia unspecified, NOS
60092	B62y700	Malignant lymphoma NOS of spleen
60242	B600000	Reticulosarcoma of unspecified site
60275	BBgJ.00	[M]Malignant lymphoma, centroblastic type NOS
60433	N330900	OSTEOPOROSIS IN MULTIPLE MYELOMATOSIS
60504	BBgC.12	[M]Lymphocytic lymphosarcoma NOS
60918	4M20.00	Lymphoma stage I
61146	BBmF.00	[M] Angiocentric immunoproliferative lesion
61149	B614300	Hodgkin's nodular sclerosis of intra-abdominal lymph nodes
61251	BBgN.00	[M]Malign lymphoma,lymphocytic,intermediate differn, diffuse
61500	B690.00	Acute myelomonocytic leukaemia
61662	B61z000	Hodgkin's disease NOS, unspecified site
61693	ByuD600	[X]Other myeloid leukaemia
61997	BBj0.00	[M]Hodgkin's disease NOS
62330	BBr6z00	[M]Other myeloid leukaemia NOS
62380	B601200	Lymphosarcoma of intrathoracic lymph nodes
62437	B62x400	Malignant reticulosis
63054	B614z00	Hodgkin's disease, nodular sclerosis NOS
63105	B62y500	Malignant lymphoma NOS of lymph node inguinal region and leg
63239	BBm1.00	[M]MALIGNANT HISTIOCYTOSIS
63375	ByuDE00	[X]Unspecified B-cell non-Hodgkin's lymphoma
63475	B652.00	Subacute myeloid leukaemia
63570	BBr0113	[M]Stem cell leukaemia
63625	B616400	Hodgkin's lymphocytic depletion lymph nodes axilla and arm
63699	BBk0.00	[M]Malignant lymphoma, nodular NOS
63723	B601z00	Lymphosarcoma NOS
63864	BBn2.00	[M]PLASMACYTOMA NOS
63973	BBm0.00	[M]Microglioma

medcode	readcode	readterm
63994	BBgS.00	[M]Malignant lymphoma, large cell, cleaved, diffuse
64036	B612.00	Hodgkin's sarcoma
64068	BBnz.00	[M]Plasma cell tumour NOS
64336	ByuD300	[X]Other specified types of non-Hodgkin's lymphoma
64343	BBj6100	[M]Hodgkin,s disease, nodular sclerosis, mixed cellularity
64427	B62z100	UNSPEC MALIG NEOP LYMPHOID/HISTIOCYTIC LYMPH NODE HEAD/NECK
64515	ByuDC00	[X]Diffuse non-Hodgkin's lymphoma, unspecified
64567	B63y.00	Other immunoproliferative neoplasms
64618	BBr3.00	[M]Plasma cell leukaemias
64670	B601300	Lymphosarcoma of intra-abdominal lymph nodes
64947	BBk0.11	[M]Brill - Symmers' disease
64963	BBr0112	[M]Blastic leukaemia
65122	B624000	Leukaemic reticuloendotheliosis of unspecified sites
65123	B624300	Leukaemic reticuloend of intra-abdominal lymph nodes
65165	ByuD900	[X]Other leukaemia of unspecified cell type
65180	B627800	Diffuse non-Hodgkin's lymphoma undifferentiated (diffuse)
65434	B62z.00	MALIGNANT NEOPLASMS OF LYMPHOID AND HISTIOCYTIC TISSUE NOS
65483	B614400	Hodgkin's nodular sclerosis of lymph nodes of axilla and arm
65489	B610.00	Hodgkin's paragranuloma
65584	BBj1000	[M]Hodgkin,s disease, lymphocytic predominance, diffuse
65642	B623300	MALIGNANT HISTIOCYTOSIS OF INTRA-ABDOMINAL LYMPH NODES
65701	B620z00	Nodular lymphoma NOS
65721	B673.00	Mast cell leukaemia
65777	B672.11	Thrombocytic leukaemia
66089	B65yz00	Other myeloid leukaemia NOS
66327	B620000	Nodular lymphoma of unspecified site
66367	A789700	HIV dis resulting oth types of non-Hodgkin's lymphoma
66603	BBgK.00	[M]Malig lymphoma, follicular centre cell, non-cleaved NOS
66694	BBr6311	[M]Naegeli-type monocytic leukaemia
67029	ByuD500	[X]Other lymphoid leukaemia
67339	BBp2.00	[M]MALIGNANT MASTOCYTOSIS
67506	B614200	Hodgkin's nodular sclerosis of intrathoracic lymph nodes
67518	ByuD100	[X]Other types of follicular non-Hodgkin's lymphoma
67700	B66..12	Monoblastic leukaemia
67703	B616.00	Hodgkin's disease, lymphocytic depletion
68039	B612400	Hodgkin's sarcoma of lymph nodes of axilla and upper limb
68330	B613100	Hodgkin's, lymphocytic-histiocytic pred of head, face, neck
68353	BBmJ.00	[M] Angioendotheliomatosis
68964	BBgA.00	[M]Malignant lymphoma, centroblastic-centrocytic, diffuse
69299	BBrA111	[M]Thrombocytic leukaemia
69301	BBg5.00	[M]Malignant lymphoma, convoluted cell type NOS
69497	B623000	MALIGNANT HISTIOCYTOSIS OF UNSPECIFIED SITE
69767	AyuC600	[X]HIV disease resulting in other non-Hodgkin's lymphoma
69980	BBgC.00	[M]Malignant lymphoma, lymphocytic, well differentiated NOS
70374	B600300	Reticulosarcoma of intra-abdominal lymph nodes
70509	B627D00	Diffuse non-Hodgkin's centroblastic lymphoma
70716	B62zz11	Immunoproliferative neoplasm
70724	B653.00	Myeloid sarcoma
70740	BBm1.11	[M]Malignant reticulosis
70842	B627100	Follicular non-Hodg mixed sml cleavd & lge cell lymphoma
70935	BBr4000	[M]Erythroleukaemia
71031	B600100	Reticulosarcoma of lymph nodes of head, face and neck
71117	BBg3.00	[M]Malignant lymphoma, undifferentiated cell type NOS
71142	B613000	Hodgkin's, lymphocytic-histiocytic predominance unspec site
71238	B601100	Lymphosarcoma of lymph nodes of head, face and neck
71262	B62y600	Malignant lymphoma NOS of intrapelvic lymph nodes
71304	B602z00	Burkitt's lymphoma NOS
71377	BBr8000	[M]Eosinophilic leukaemia
71609	B62z500	UNSPEC MALIG NEOP LYMPHOID/HISTIOCYTIC NODES INGUINAL/LEG
71619	BBgT.00	[M]Malignant lymphoma, large cell, noncleaved, diffuse
71625	B601000	Lymphosarcoma of unspecified site
71652	BBgP.00	[M]Malignant lymphoma, mixed small and large cell, diffuse
71672	4M23.00	Lymphoma stage IV
71850	BBr6000	[M]Myeloid leukaemia NOS
72179	BBr0200	[M]Subacute leukaemia NOS
72196	BBgG.00	[M]Malignant lymphoma, lymphocytic, poorly different NOS
72197	B67y000	Lymphosarcoma cell leukaemia
72222	BBrA100	[M]Megakaryocytic leukaemia
72310	BBr0400	[M]Aleukaemic leukaemia NOS
72433	BBh0.00	[M]Reticulosarcoma NOS
72500	ByuDB00	[X]Mal neoplasm/lymphoid,haematopoietic+related tissu,unspcf
72714	B621500	Mycosis fungoides of lymph nodes of inguinal region and leg
72725	B62y200	Malignant lymphoma NOS of intrathoracic lymph nodes
72774	B642.00	Subacute lymphoid leukaemia

medcode	readcode	readterm
73066	BBrA.00	[M]Miscellaneous leukaemias
73088	BBr9000	[M]Monocytic leukaemia NOS
73135	BBn2.12	[M]SOLITARY MYELOMA
73532	B613300	Hodgkin's, lymphocytic-histiocytic pred intra-abdominal node
73777	B624z00	Leukaemic reticuloendotheliosis NOS
87335	B624.12	Hairy cell leukaemia
89230	BBj9.00	[M]Hodgkin's granuloma
89329	ByuD800	[X]Other specified leukaemias
89657	B626z00	MALIGNANT MAST CELL TUMOUR NOS
89762	ByuD700	[X]Other monocytic leukaemia
90201	B62x000	T-zone lymphoma
91674	B621300	Mycosis fungoides of intra-abdominal lymph nodes
91900	B61z400	Hodgkin's disease NOS of lymph nodes of axilla and arm
92068	B620300	Nodular lymphoma of intra-abdominal lymph nodes
92245	B613200	Hodgkin's, lymphocytic-histiocytic pred intrathoracic nodes
92380	B602500	Burkitt's lymphoma of lymph nodes of inguinal region and leg
93342	B66z.00	Monocytic leukaemia NOS
93384	B62z200	UNSPEC MALIG NEOP LYMPHOID/HISTIOCYTIC OF INTRATHORACIC NODE
93951	B613500	Hodgkin's, lymphocytic-histiocytic pred inguinal and leg
94005	B615z00	Hodgkin's disease, mixed cellularity NOS
94174	B67y.00	Other and unspecified leukaemia
94239	BBp1.00	[M]MAST CELL SARCOMA
94279	B61z700	Hodgkin's disease NOS of spleen
94407	B615100	Hodgkin's mixed cellularity of lymph nodes head, face, neck
94415	B623100	MALIGNANT HISTIOCYTOSIS OF LYMPH NODES HEAD, FACE AND NECK
94597	ZV10611	[V]Personal history of lymphoid leukaemia
94935	4M21.00	Lymphoma stage II
94995	B620500	Nodular lymphoma of lymph nodes of inguinal region and leg
95012	B621800	Mycosis fungoides of lymph nodes of multiple sites
95049	B616000	Hodgkin's lymphocytic depletion of unspecified site
95058	B600700	Reticulosarcoma of spleen
95338	B613600	Hodgkin's, lymphocytic-histiocytic pred intrapelvic nodes
95464	BBl0.00	[M]Mycosis fungoides
95545	B627911	Maltoma
95630	B62x600	True histiocytic lymphoma
95715	B627900	Mucosa-associated lymphoma
95792	B62zz00	LYMPHOID AND HISTIOCYTIC MALIGNANCY NOS
95949	B621000	Mycosis fungoides of unspecified site
96183	BBj4.00	[M]Hodgkin's disease,lymphocytic depletion,diffuse fibrosis
96379	B621400	Mycosis fungoides of lymph nodes of axilla and upper limb
96893	BBrA300	[M]Myeloid sarcoma
97577	B602300	Burkitt's lymphoma of intra-abdominal lymph nodes
97746	B61z800	Hodgkin's disease NOS of lymph nodes of multiple sites
97756	BBl1.00	[M]Sezary's disease
97852	BBk7.00	[M]Malignant lymphoma, centroblastic type, follicular
97863	B615000	Hodgkin's disease, mixed cellularity of unspecified site
98009	BBrA312	[M]Granulocytic sarcoma
98596	ByuD200	[X]Other types of diffuse non-Hodgkin's lymphoma
98840	B610300	Hodgkin's paragranuloma of intra-abdominal lymph nodes
98909	B611100	Hodgkin's granuloma of lymph nodes of head, face and neck
98961	BBk2.00	[M]Malignant lymphoma, centroblastic-centrocytic, follicular
99012	B61z500	Hodgkin's disease NOS of lymph nodes inguinal region and leg
99015	B66y.00	Other monocytic leukaemia
99067	C333200	GAMMA HEAVY CHAIN DISEASE
99200	BBj7.00	[M]Hodgkin's disease, nodular sclerosis, cellular phase
99240	B600z00	Reticulosarcoma NOS
99413	B67yz00	Other and unspecified leukaemia NOS
99655	BBg6.00	[M]Lymphosarcoma NOS
99695	BBlz.00	[M]Mycosis fungoides NOS
99702	BBn3.00	[M]Plasma cell tumour, malignant
99847	SP08A00	Post-transplant lymphoproliferative disorder
99887	B60y.00	Other specified reticulosarcoma or lymphosarcoma
99951	B60z.00	Reticulosarcoma or lymphosarcoma NOS
100006	B602200	Burkitt's lymphoma of intrathoracic lymph nodes
100352	B601500	Lymphosarcoma of lymph nodes of inguinal region and leg
100423	B610100	Hodgkin's paragranuloma of lymph nodes of head, face, neck
100532	B622z00	Sezary's disease NOS
100544	BBh2.00	[M]Reticulosarcoma, nodular
100615	B626500	Mast cell malignancy of lymph nodes inguinal region and leg
100786	B651000	Chronic eosinophilic leukaemia
100927	BBr4z00	[M]Erythroleukaemia NOS
101114	B627A00	Diffuse non-Hodgkin's large cell lymphoma
101271	BBs1.00	[M]Acute panmyelosis
101429	BBj0.11	[M]Lymphogranuloma, malignant

medcode	readcode	readterm
101465	B62z800	Unspec malig neop lymphoid/histiocytic of multiple sites
101530	B616z00	Hodgkin's disease, lymphocytic depletion NOS
101606	B662.00	Subacute monocytic leukaemia
101715	B616700	Hodgkin's disease, lymphocytic depletion of spleen
102158	B625200	Letterer-Siwe disease of intrathoracic lymph nodes
102164	BBn2.11	[M]Monostotic myeloma
102594	B627E00	Diffuse large B-cell lymphoma
102715	B625000	Letterer-Siwe disease of unspecified sites
102764	BBrA600	[M]Acute panmyelosis
102783	B651200	Chronic neutrophilic leukaemia
103245	B601700	Lymphosarcoma of spleen
103353	B62z300	Unspec malig neop lymphoid/histiocytic intra-abdominal nodes
103645	B66yz00	Other monocytic leukaemia NOS
103900	B626000	Mast cell malignancy of unspecified site
104152	B628.00	Follicular lymphoma
104291	B61..11	Hodgkin lymphoma
104325	B640000	B-cell acute lymphoblastic leukaemia
104328	B641000	B-cell chronic lymphocytic leukaemia
104386	B62F000	Small cell B-cell lymphoma
104391	B627.11	Non-Hodgkin lymphoma
104412	B62F200	Lymphoblastic (diffuse) lymphoma
104418	B630400	Solitary plasmacytoma
104475	B692.00	Subacute myelomonocytic leukaemia
104484	B61C.00	Other classical Hodgkin lymphoma
104620	B62F100	Mantle cell lymphoma
104743	B613800	Hodgkin's, lymphocytic-histiocytic pred of multiple sites
104788	B654.00	Acute myeloblastic leukaemia
104790	B601800	Lymphosarcoma of lymph nodes of multiple sites
104862	B62E300	Cutaneous T-cell lymphoma
104895	B617.00	Nodular lymphocyte predominant Hodgkin lymphoma
104934	B62Ew00	Other mature T/NK-cell lymphoma
104939	B64y500	Adult T-cell lymphoma/leukaemia (HTLV-1-associated)
105020	B628300	Follicular lymphoma grade 3a
105025	ByuDA00	[X]Oth spcf mal neoplsm/lymphoid,haematopoietic+rltd tissue
105038	B627G00	Mediastinal (thymic) large B-cell lymphoma
105069	B693.00	Juvenile myelomonocytic leukaemia
105083	B62D.00	Histiocytic sarcoma
105085	B62E.00	T/NK-cell lymphoma
105095	B628100	Follicular lymphoma grade 2
105203	B620200	Nodular lymphoma of intrathoracic lymph nodes
105286	B62EA00	Primary cutaneous CD30-positive T-cell proliferations
105335	B62A.00	Sarcoma of dendritic cells
105375	B62E800	Blastic NK-cell lymphoma
105472	B614700	Hodgkin's disease, nodular sclerosis of spleen
105559	B62E100	Anaplastic large cell lymphoma, ALK-positive
105636	B62E900	Angioimmunoblastic T-cell lymphoma
105709	B62E600	Enteropathy-associated T-cell lymphoma
105762	B62C.00	Unifocal Langerhans-cell histiocytosis
105792	B629.00	Multifocal multisystemic dissem Langerhans-cell histiocytosi
105841	B618.00	Nodular sclerosis classical Hodgkin lymphoma
105889	B628000	Follicular lymphoma grade 1
105925	B62E700	Subcutaneous panniculitic T-cell lymphoma
105955	B62E200	Anaplastic large cell lymphoma, ALK-negative
105957	B651100	Chronic myeloid leukaemia, BCR/ABL positive
105966	B627F00	Extranod marg zone B-cell lymphom mucosa-assoc lymphoid tiss
106063	B628700	Other types of follicular lymphoma
106137	BBh..00	[M]Reticulosarcomas
106197	BBr7000	[M]Basophilic leukaemia
106349	B61z.11	Hodgkin lymphoma NOS
106483	BBr6200	[M]Subacute myeloid leukaemia
106597	B61B.00	Lymphocyte-rich classical Hodgkin lymphoma
106867	B62F.11	Non-follicular lymphoma
106884	B62F.00	Nonfollicular lymphoma
106911	B613700	Hodgkin's, lymphocytic-histiocytic predominance of spleen
106924	B641200	Clinical stage B chronic lymphocytic leukaemia
106969	B628500	Diffuse follicle centre lymphoma
106970	BBk3.00	[M]Malig lymphoma, lymphocytic, well differentiated,nodular
107017	B641011	Chronic lymphocytic leukaemia of B-cell type
107032	B616800	Hodgkin's lymphocytic depletion lymph nodes multiple sites
107052	B641100	Clinical stage A chronic lymphocytic leukaemia
107163	B641300	Clinical stage C chronic lymphocytic leukaemia
107166	B628200	Follicular lymphoma grade 3
107236	B651300	Atypical chronic myeloid leukaemia, BCR/ABL negative
107638	B62z400	Unspec malig neop lymphoid/histiocytic lymph node axilla/arm
107643	B64y400	T-cell prolymphocytic leukaemia

medcode	readcode	readterm
107773	BBr8z00	[M]Eosinophilic leukaemia NOS
107804	B61z300	Hodgkin's disease NOS of intra-abdominal lymph nodes
107949	B62E500	Hepatosplenic T-cell lymphoma
107973	B628400	Follicular lymphoma grade 3b
108037	B62z000	Unspec malig neop lymphoid/histiocytic of unspecified site
108102	C333300	Heavy chain disease
108182	B627400	Diffuse non-Hodgkin's small cleaved cell (diffuse) lymphoma
108235	C333011	Waldenstrom macroglobulinaemia
108316	BBrAz00	[M]Miscellaneous leukaemia NOS
108424	B663.00	Acute monoblastic leukaemia
108656	B64y300	B-cell prolymphocytic leukaemia
108715	B66..11	Histiocytic leukaemia
108719	B628600	Cutaneous follicle centre lymphoma
108775	B619.00	Mixed cellularity classical Hodgkin lymphoma
108886	B615500	Hodgkin's mixed cellularity of lymph nodes inguinal and leg
108964	BBr6900	[M]Juvenile myelomonocytic leukaemia
109342	B62z600	Unspec malig neop lymphoid/histiocytic of intrapelvic nodes
109714	ByuDD00	[X]Oth and unspecif peripheral & cutaneous T-cell lymphomas
109780	B62E400	Extranodal NK/T-cell lymphoma, nasal type
110058	ZV10613	[V]Personal history of myeloid leukaemia
110191	B62B.00	Multifocal and unisystemic Langerhans-cell histiocytosis
110349	BBr3z00	[M]Plasma cell leukaemia NOS
110563	B616500	Hodgkin's lymphocytic depletion lymph nodes inguinal and leg
110838	B676.00	Acute erythroid leukaemia
110903	B623800	Malignant histiocytosis of lymph nodes of multiple sites
111040	D401.12	Lipochrome histiocytosis - familial
111113	BBj3.00	[M]Hodgkin's disease, lymphocytic depletion NOS

B) Hospital Episodes Statistics

ICD10	DESCRIPTION
B21.1	HIV disease resulting in Burkitt lymphoma
B21.2	HIV disease resulting in other types of non-Hodgkin lymphoma
B21.3	HIV disease resulting in other malignant neoplasms of lymphoid, haematopoietic and related tissue
C81	Hodgkin lymphoma
C81.0	Nodular lymphocyte predominant Hodgkin lymphoma
C81.1	Nodular sclerosis (classical) Hodgkin lymphoma
C81.2	Mixed cellularity (classical) Hodgkin lymphoma
C81.3	Lymphocyte depleted (classical) Hodgkin lymphoma
C81.4	Lymphocyte-rich (classical) Hodgkin lymphoma
C81.7	Other (classical) Hodgkin lymphoma
C81.9	Hodgkin lymphoma, unspecified
C82	Follicular lymphoma
C82.0	Follicular lymphoma grade I
C82.1	Follicular lymphoma grade II
C82.2	Follicular lymphoma grade III, unspecified
C82.3	Follicular lymphoma grade IIIa
C82.4	Follicular lymphoma grade IIIb
C82.5	Diffuse follicle centre lymphoma
C82.6	Cutaneous follicle centre lymphoma
C82.7	Other types of follicular lymphoma
C82.9	Follicular lymphoma, unspecified
C83	Non-follicular lymphoma
C83.0	Small cell B-cell lymphoma
C83.1	Mantle cell lymphoma
C83.2	Diffuse non-Hodgkin mixed sml & lge cell (diffuse) lymphoma
C83.3	Diffuse large B-cell lymphoma
C83.4	Diffuse non-Hodgkin's immunoblastic (diffuse) lymphoma
C83.5	Lymphoblastic (diffuse) lymphoma
C83.6	Diffuse non-Hodgkin's lymphoma undifferentiated (diffuse)
C83.7	Burkitt lymphoma
C83.8	Other non-follicular lymphoma
C83.9	Non-follicular (diffuse) lymphoma, unspecified
C84	Mature T/NK-cell lymphomas
C84.0	Mycosis fungoides
C84.1	S ├®zary disease
C84.2	Peripheral and cutaneous T-cell lymphomas, T-zone lymphoma
C84.3	Periph & cutan T-cell lymphomas, lymphoepithelioid lymphoma
C84.4	Peripheral T-cell lymphoma, not elsewhere classified
C84.5	Other mature T/NK-cell lymphomas
C84.6	Anaplastic large cell lymphoma, ALK-positive
C84.7	Anaplastic large cell lymphoma, ALK-negative
C84.8	Cutaneous T-cell lymphoma, unspecified

ICD10	DESCRIPTION
C84.9	Mature T/NK-cell lymphoma, unspecified
C85	Other and unspecified types of non-Hodgkin lymphoma
C85.0	Oth & unspec types of non-Hodgkin's lymphoma, lymphosarcoma
C85.1	B-cell lymphoma, unspecified
C85.2	Mediastinal (thymic) large B-cell lymphoma
C85.7	Other specified types of non-Hodgkin lymphoma
C85.9	Non-Hodgkin lymphoma, unspecified
C86	Other specified types of T/NK-cell lymphoma
C86.0	Extranodal NK/T-cell lymphoma, nasal type
C86.1	Hepatosplenic T-cell lymphoma
C86.2	Enteropathy-type (intestinal) T-cell lymphoma
C86.3	Subcutaneous panniculitis-like T-cell lymphoma
C86.4	Blastic NK-cell lymphoma
C86.5	Angioimmunoblastic T-cell lymphoma
C86.6	Primary cutaneous CD30-positive T-cell proliferations
C88	Malignant immunoproliferative diseases
C88.0	Waldenstr ├Âm macroglobulinaemia
C88.1	Alpha heavy chain disease
C88.2	Other heavy chain disease
C88.3	Immunoproliferative small intestinal disease
C88.4	Extranodal marginal zone B-cell lymphoma of mucosa-associated lymphoid tissue [MALT-lymphoma]
C88.7	Other malignant immunoproliferative diseases
C88.9	Malignant immunoproliferative disease, unspecified
C90	Multiple myeloma and malignant plasma cell neoplasms
C90.0	Multiple myeloma
C90.1	Plasma cell leukaemia
C90.2	Extramedullary plasmacytoma
C90.3	Solitary plasmacytoma
C91	Lymphoid leukaemia
C91.0	Acute lymphoblastic leukaemia [ALL]
C91.1	Chronic lymphocytic leukaemia of B-cell type
C91.2	Subacute lymphocytic leukaemia
C91.3	Prolymphocytic leukaemia of B-cell type
C91.4	Hairy-cell leukaemia
C91.5	Adult T-cell lymphoma/leukaemia [HTLV-1-associated]
C91.6	Prolymphocytic leukaemia of T-cell type
C91.7	Other lymphoid leukaemia
C91.8	Mature B-cell leukaemia Burkitt-type
C91.9	Lymphoid leukaemia, unspecified
C92	Myeloid leukaemia
C92.0	Acute myeloblastic leukaemia [AML]
C92.1	Chronic myeloid leukaemia [CML], BCR/ABL-positive
C92.2	Atypical chronic myeloid leukaemia, BCR/ABL-negative
C92.3	Myeloid sarcoma
C92.4	Acute promyelocytic leukaemia [PML]
C92.5	Acute myelomonocytic leukaemia
C92.6	Acute myeloid leukaemia with 11q23-abnormality
C92.7	Other myeloid leukaemia
C92.8	Acute myeloid leukaemia with multilineage dysplasia
C92.9	Myeloid leukaemia, unspecified
C93	Monocytic leukaemia
C93.0	Acute monoblastic/monocytic leukaemia
C93.1	Chronic myelomonocytic leukaemia
C93.2	Subacute monocytic leukaemia
C93.3	Juvenile myelomonocytic leukaemia
C93.7	Other monocytic leukaemia
C93.9	Monocytic leukaemia, unspecified
C94	Other leukaemias of specified cell type
C94.0	Acute erythroid leukaemia
C94.1	Chronic erythraemia
C94.2	Acute megakaryoblastic leukaemia
C94.3	Mast cell leukaemia
C94.4	Acute panmyelosis with myelofibrosis
C94.5	Acute myelofibrosis
C94.6	Myelodysplastic and myeloproliferative disease, not elsewhere classified
C94.7	Other specified leukaemias
C95	Leukaemia of unspecified cell type
C95.0	Acute leukaemia of unspecified cell type
C95.1	Chronic leukaemia of unspecified cell type
C95.2	Subacute leukaemia unsp cell type
C95.7	Other leukaemia of unspecified cell type
C95.9	Leukaemia, unspecified
C96	Other and unspecified malignant neoplasms of lymphoid, haematopoietic and related tissue

ICD10	DESCRIPTION
C96.0	Multifocal and multisystemic (disseminated) Langerhans-cell histiocytosis [Letterer-Siwe disease]
C96.1	Malignant histiocytosis
C96.2	Malignant mast cell tumour
C96.3	True histiocyt lymphoma
C96.4	Sarcoma of dendritic cells (accessory cells)
C96.5	Multifocal and unisystemic Langerhans-cell histiocytosis
C96.6	Unifocal Langerhans-cell histiocytosis
C96.7	Other specified malignant neoplasms of lymphoid, haematopoietic and related tissue
C96.8	Histiocytic sarcoma
C96.9	Malignant neoplasm of lymphoid, haematopoietic and related tissue, unspecified
Z85.6	Personal history of leukaemia
Z85.7	Personal history of other malignant neoplasms of lymphoid, haematopoietic and related tissues

Appendix 15 Codelist: HIV, other cellular immune deficiency and solid organ transplant

1. HIV

A) CPRD

medcode	readcode	readterm
2835	43C3.11	HIV positive
8281	A789A00	HIV disease resulting in wasting syndrome
9130	A788.11	Human immunodeficiency virus infection
23763	65QA.00	AIDS carrier
23770	A788.00	Acquired immune deficiency syndrome
23951	A789200	HIV disease resulting in candidiasis
24872	ZV01A00	[V]Asymptomatic human immunodeficency virus infection status
27053	4J34.00	HIV viral load
27641	A789300	HIV disease resulting in Pneumocystis carinii pneumonia
27853	A789500	HIV disease resulting in Kaposi's sarcoma
33943	65VE.00	Notification of AIDS
36294	A788z00	Acquired human immunodeficiency virus infection syndrome NOS
37006	A789000	HIV disease resulting in mycobacterial infection
41185	Eu02400	[X]Dementia in human immunodef virus [HIV] disease
43537	43j7.00	HIV 1 nucleic acid detection
44288	R109.00	[D]Laboratory evidence of human immunodeficiency virus [HIV]
44303	A789.00	Human immunodef virus resulting in other disease
44617	A789600	HIV disease resulting in Burkitt's lymphoma
47632	A788U00	HIV disease result/haematological+immunologic abnorms,NEC
50076	A789400	HIV disease resulting in multiple infections
51708	A789X00	HIV dis reslt/oth mal neopl/lymph,h'matopoetc+reltd tissu
53636	A788400	Human immunodeficiency virus with neurological disease
58857	A788000	Acute human immunodeficiency virus infection
58859	A788100	Asymptomatic human immunodeficiency virus infection
62854	AyuC.00	[X]Human immunodeficiency virus disease
62891	A788y00	Human immunodeficiency virus with other clinical findings
65117	A789900	HIV disease resulting in lymphoid interstitial pneumonitis
66367	A789700	HIV dis resulting oth types of non-Hodgkin's lymphoma
66368	A789100	HIV disease resulting in cytomegaloviral disease
67575	A788W00	HIV disease resulting in unspecified malignant neoplasm
69766	A788200	HIV infection with persistent generalised lymphadenopathy
69767	AyuC600	[X]HIV disease resulting in other non-Hodgkin's lymphoma
70528	A788500	Human immunodeficiency virus with secondary infection
70869	A788300	Human immunodeficiency virus with constitutional disease
71450	A788X00	HIV disease resulting/unspcf infectious+parasitic disease
93642	43w3.00	Human immunodeficiency virus RNA/DNA ratio
96751	AyuCB00	[X]HIV disease result/haematological+immunologic abnorms,NEC
96902	4J3F.00	Human immunodeficiency virus viral load by log rank
100769	AyuCD00	[X]Unspecified human immunodeficiency virus [HIV] disease
101191	66j0.00	Human immunodeficiency virus annual review
101836	A788600	Human immunodeficiency virus with secondary cancers
102117	AyuC300	[X]HIV disease resulting in multiple infections
102252	AyuCC00	[X]HIV disease resulting in other specified conditions
104134	AyuC400	[X]HIV disease resulting/other infectious+parasitic diseases
104466	L179.00	HIV disease complicating pregnancy childbirth puerperium
104717	A789311	HIV disease resulting in Pneumocystis jirovecii pneumonia
105040	9kl..00	HIV pos gen health check serv declind - enhanc service admin
105324	A789800	HIV disease resulting in multiple malignant neoplasms
107594	9Nt1000	Seen by community HIV (human immunodeficiency virus) nurse
107807	AyuC100	[X]HIV disease resulting in other viral infections
108054	A789511	HIV disease resulting in Kaposi sarcoma
108385	9mN..00	Human immunodeficiency virus infection monitoring invitation
108631	8Hle.00	Referral to community HIV nurse specialist
109327	9mN0.00	HIV infection monitoring telephone invitation
109513	4J3N.00	Human immunodeficiency virus drug resistance test
110374	4J3P.00	Human immunodeficiency virus type 1 subtype identification

B) Hospital Episodes Statistics

ICD 10	DESCRIPTION
B20	Human immunodeficiency virus [HIV] disease resulting in infectious and parasitic diseases
B20.0	HIV disease resulting in mycobacterial infection
B20.1	HIV disease resulting in other bacterial infections
B20.2	HIV disease resulting in cytomegaloviral disease
B20.3	HIV disease resulting in other viral infections
B20.4	HIV disease resulting in candidiasis
B20.5	HIV disease resulting in other mycoses

ICD 10	DESCRIPTION
B20.6	HIV disease resulting in Pneumocystis jirovecii pneumonia
B20.7	HIV disease resulting in multiple infections
B20.8	HIV disease resulting in other infectious and parasitic diseases
B20.9	HIV disease resulting in unspecified infectious or parasitic disease
B21	Human immunodeficiency virus [HIV] disease resulting in malignant neoplasms
B21.0	HIV disease resulting in Kaposi sarcoma
B21.1	HIV disease resulting in Burkitt lymphoma
B21.2	HIV disease resulting in other types of non-Hodgkin lymphoma
B21.3	HIV disease resulting in other malignant neoplasms of lymphoid, haematopoietic and related tissue
B21.7	HIV disease resulting in multiple malignant neoplasms
B21.8	HIV disease resulting in other malignant neoplasms
B21.9	HIV disease resulting in unspecified malignant neoplasm
B22	Human immunodeficiency virus [HIV] disease resulting in other specified diseases
B22.0	HIV disease resulting in encephalopathy
B22.1	HIV disease resulting in lymphoid interstitial pneumonitis
B22.2	HIV disease resulting in wasting syndrome
B22.7	HIV disease resulting in multiple diseases classified elsewhere
B23	Human immunodeficiency virus [HIV] disease resulting in other conditions
B23.0	Acute HIV infection syndrome
B23.1	HIV disease resulting in (persistent) generalized lymphadenopathy
B23.2	HIV disease resulting in haematological and immunological abnormalities, not elsewhere classified
B23.8	HIV disease resulting in other specified conditions
B24	Unspecified human immunodeficiency virus [HIV] disease
F02.4	Dementia in human immunodeficiency virus [HIV] disease
O98.7	Human immunodeficiency virus [HIV] disease complicating pregnancy, childbirth and the puerperium
R75	Laboratory evidence of human immunodeficiency virus [HIV]
Z21	Asymptomatic human immunodeficiency virus [HIV] infection status

2. Cellular immune deficiency

A) CPRD

medcode	readcode	readterm
938	D201600	Pancytopenia NOS
5823	D201500	Pancytopenia - acquired
10955	C391100	Di George syndrome
15422	D20..00	Aplastic anaemia
15658	D201.00	Acquired aplastic anaemia
16108	D201000	Aplastic anaemia due to chronic disease
16903	F14y011	Louis - Bar syndrome
21723	D201z00	Acquired aplastic anaemia NOS
31275	D201611	Pancytopenia with malformation
31322	C391200	Wiskott - Aldrich syndrome
31491	D200211	Pancytopenia-dysmelia
31541	C392300	Severe combined immunodefiency with reticular dysgenesis
37539	D2...00	Aplastic and other anaemias
41142	D204.00	Idiopathic aplastic anaemia
42394	D401.11	Job's syndrome
42439	C391211	Thrombocytopenic eczema with immunodeficiency
43166	D201100	Aplastic anaemia due to drugs
48035	C391011	T-lymphocyte deficiency
48293	C392100	Severe combined immunodeficiency
48307	C391.00	Deficiencies of cell-mediated immunity
48879	J637.00	Hepatic veno-occlusive disease
49530	BBmC.00	[M] T-gamma lymphoproliferative disease
49542	C392500	Severe combined immunodef with low or normal B-cell numbers
50526	C392800	Major histocompatibility complex class I deficiency
50665	C391000	Predominantly T-cell immuno-deficiency NOS
57552	C30yy11	Adenosine-deaminase deficiency
57859	D201200	Aplastic anaemia due to infection
60758	C391012	Cellular immunity syndrome
61326	D201612	Pancytopenia with pancreatitis
62236	C392.00	Combined immunity deficiency
62328	C392z00	Combined immunity deficiency NOS
66073	C392400	Severe combined immunodef with low T- and B-cell numbers
66239	D201400	Aplastic anaemia due to toxic cause
68087	D20z.00	Aplastic anaemia NOS
69027	D200.00	Constitutional aplastic anaemia
69061	D200011	Constitutional aplastic anaemia without malformation
69379	D200y00	Other specified constitutional aplastic anaemia
70128	D201311	Radiation aplastic anaemia

medcode	readcode	readterm
72804	C392600	Adenosine deaminase deficiency
73583	F14y000	Ataxia-telangiectasia
93936	C392700	Purine nucleoside phosphorylase deficiency
94120	C392111	Swiss type agammaglobulinaemia
102848	D200200	Constitutional aplastic anaemia with malformation
103977	C392900	Major histocompatibility complex class II deficiency

B) Hospital Episodes Statistics

ICD10	DESCRIPTION
D61	Other aplastic anaemias
D61.0	Constitutional aplastic anaemia
D61.1	Drug-induced aplastic anaemia
D61.2	Aplastic anaemia due to other external agents
D61.3	Idiopathic aplastic anaemia
D61.8	Other specified aplastic anaemias
D61.9	Aplastic anaemia, unspecified
D81	Combined immunodeficiencies
D81.0	Severe combined immunodeficiency [SCID] with reticular dysgenesis
D81.1	Severe combined immunodeficiency [SCID] with low T- and B-cell numbers
D81.2	Severe combined immunodeficiency [SCID] with low or normal B-cell numbers
D81.3	Adenosine deaminase [ADA] deficiency
D81.4	Nezelof syndrome
D81.5	Purine nucleoside phosphorylase [PNP] deficiency
D81.6	Major histocompatibility complex class I deficiency
D81.7	Major histocompatibility complex class II deficiency
D81.8	Other combined immunodeficiencies
D81.9	Combined immunodeficiency, unspecified
D82	Immunodeficiency associated with other major defects
D82.0	Wiskott-Aldrich syndrome
D82.1	Di George syndrome
D82.2	Immunodeficiency with short-limbed stature
D82.3	Immunodeficiency following hereditary defective response to Epstein-Barr virus
D82.4	Hyperimmunoglobulin E [IgE] syndrome
D82.8	Immunodeficiency associated with other specified major defects
D82.9	Immunodeficiency associated with major defect, unspecified
D83	Common variable immunodeficiency
D83.0	Common variable immunodeficiency with predominant abnormalities of B-cell numbers and function
D83.1	Common variable immunodeficiency with predominant immunoregulatory T-cell disorders
D83.2	Common variable immunodeficiency with autoantibodies to B- or T-cells
D83.8	Other common variable immunodeficiencies
D83.9	Common variable immunodeficiency, unspecified
D84.0	Lymphocyte function antigen-1 [LFA-1] defect
G11.3	Cerebellar ataxia with defective DNA repair
D47.1	Chronic myeloproliferative disease

3. Solid organ transplant

A) CPRD

medcode	readcode	readterm
242	7901000	Allotransplantation of heart NEC
250	7900.00	Transplantation of heart and lung
2124	8HBB.00	Transplant follow-up
2997	7B00.00	Transplantation of kidney
4405	7800.00	Transplantation of liver
4438	7901.00	Other transplantation of heart
5504	7B00z00	Transplantation of kidney NOS
5911	ZV42000	[V]Kidney transplanted
6692	SP08600	Liver transplant failure and rejection
9026	ZV42700	[V]Liver transplanted
9384	ZV42100	[V]Heart transplanted
10394	ZV42600	[V]Lung transplanted
10461	7450.00	Transplantation of lung
11113	SP08100	Transplanted organ rejection
11553	SP08300	Kidney transplant failure and rejection
11745	7B00100	Transplantation of kidney from live donor
18774	TB00111	Renal transplant with complication, without blame
22653	ZV42.00	[V]Transplanted organ or tissue
24361	7B00200	Transplantation of kidney from cadaver
25896	SP08z00	Transplanted organ complication NOS
26862	7B06300	Exploration of renal transplant

medcode	readcode	readterm
27319	7800z00	Transplantation of liver NOS
27679	SP08500	Heart-lung transplant failure and rejection
29831	SP08000	Transplanted organ failure
30052	SP...18	Transplant complications
31997	TB00200	Liver transplant with complication, without blame
32025	7800000	Orthotopic transplantation of liver
35368	7830.00	Transplantation of pancreas
37198	14S8.00	H/O: liver recipient
38011	7450z00	Transplantation of lung NOS
41495	7901z00	Other transplantation of heart NOS
44077	ZV42y12	[V]Pancreas transplanted
44893	SP08.00	Transplanted organ complication
47033	ZLEQJ00	Discharge from transplant surgery service
47484	SP08400	Heart transplant failure and rejection
47495	14SZ.00	H/O:tissue/organ recipient NOS
48057	K0B5.00	Renal tubulo-interstitial disordrs in transplant rejectn
48121	7B01500	Transplant nephrectomy
49028	14S2.00	H/O: kidney recipient
50226	SyuKK00	[X]Failure & rejection of other transplanted organ & tissue
53626	7900000	Allotransplantation of heart and lung
54990	TB00100	Kidney transplant with complication, without blame
55151	7B00000	Autotransplant of kidney
56993	7830100	Transplantation of whole pancreas
57403	14S..00	H/O: tissue/organ recipient
59394	14S3.00	H/O: heart recipient
59610	8C31.00	Transplant immunosuppression
60955	7830300	Transplantation of islets of Langerhans
61073	7900z00	Transplantation of heart and lung NOS
64438	TB00000	Heart transplant with complication, without blame
65772	14S9.00	H/O: lung recipient
66456	ZV42y00	[V]Other specified transplanted organ or tissue
66705	7B00111	Allotransplantation of kidney from live donor
67499	7830z00	Transplantation of pancreas NOS
69147	ZLD4K00	Discharge by transplant surgeon
69194	7800200	Replacement of previous liver transplant
69734	7901y00	Other specified other transplantation of heart
70712	SP08011	Det.ren.func.after ren.transpl
70874	7B00y00	Other specified transplantation of kidney
71422	7800100	Heterotopic transplantation of liver
72004	7B01511	Excision of rejected transplanted kidney
72092	ZV42z00	[V]Unspecified transplanted organ or tissue
72939	7901100	Xenotransplantation of heart
73743	7450y00	Other specified transplantation of lung
89445	7800111	Auxillary liver transplant
89924	7B00300	Allotransplantation of kidney from cadaver, heart-beating
90952	7B0F100	Pre-transplantation of kidney work-up, recipient
93366	7B0F.00	Interventions associated with transplantation of kidney
93713	7450100	Single lung transplant
93751	ZV42y11	[V]Intestine transplanted
93844	7901500	Revision of transplantation of heart NEC
94964	7B0F400	Post-transplantation of kidney examination, live donor
96095	7B0F200	Pre-transplantation of kidney work-up, live donor
96129	7831200	Excision of transplanted pancreas
96133	7B00400	Allotransplantation kidney from cadaver, heart non-beating
96423	ZV42.11	[V]Transplanted organ
96578	7450000	Double lung transplant
97157	7800500	Orthotopic transplantation of liver NEC
98364	7B00211	Allotransplantation of kidney from cadaver
99250	7800y00	Other specified transplantation of liver
99847	SP08A00	Post-transplant lymphoproliferative disorder
100073	7800112	Piggy back liver transplant
100621	764C.00	Transplantation of ileum
100693	Kyu1C00	[X]Renal tubulo-interstitial disorders/transplant rejection
101231	7830200	Transplantation of tail of pancreas
102998	7125.00	Transplantation of thymus gland
103429	7B0F300	Post-transplantation of kidney examination, recipient
103649	9b8K.00	Transplantation surgery
104049	7B0Fz00	Interventions associated with transplantation of kidney NOS
104050	7B0Fy00	OS interventions associated with transplantation of kidney
104201	SP08H00	Acute rejection of renal transplant
104630	SP08G00	Acute rejection of renal transplant - grade III
104905	SP08D00	Acute-on-chronic rejection of renal transplant
104960	SP08E00	Acute rejection of renal transplant - grade I
105328	7B00212	Cadaveric renal transplant
105506	7800400	Orthotopic transplantation of whole liver

medcode	readcode	readterm
105724	SP08N00	Unexplained episode of renal transplant dysfunction
105787	7B00600	Xenograft renal transplant
105811	SP08R00	Renal transplant rejection
106015	7842000	Transplantation of spleen
106301	SP08P00	Stenosis of vein of transplanted kidney
106620	SP08J00	Chronic rejection of renal transplant
106866	SP08W00	Vascular complication of renal transplant
107000	SP08F00	Acute rejection of renal transplant - grade II
107416	7901300	Piggyback transplantation of heart
107752	SP08T00	Urological complication of renal transplant
108330	SP08900	Complication of transplanted lung
108437	SP08V00	Very mild acute rejection of renal transplant
108705	SP08V11	Borderline changes of acute rejection
109304	9b8B200	Cardiothoracic transplantation
109455	7B00500	Allotransplantation of kidney from cadaver NEC
110789	761N.00	Transplantation of stomach

B) Hospital Episodes Statistics

ICD10	DESCRIPTION
T86.1	Kidney transplant failure and rejection
T86.2	Heart transplant failure and rejection
T86.3	Heart-lung transplant failure and rejection
T86.4	Liver transplant failure and rejection
Z94.0	Kidney transplant status
Z94.1	Heart transplant status
Z94.2	Lung transplant status
Z94.3	Heart and lungs transplant status
Z94.4	Liver transplant status

C) Office of Population Censuses and Surveys (OPCS) version 4 codes

Opcs	Description_other	Description
B171	Transplantation of thymus gland	Allotransplantation of thymus gland
B178	Transplantation of thymus gland	Other specified
B179	Transplantation of thymus gland	Unspecified
E531	Transplantation of lung	Double lung transplant
E532	Transplantation of lung	Single lung transplant
E533	Transplantation of lung	Single lobe lung transplant
E538	Transplantation of lung	Other specified
E539	Transplantation of lung	Unspecified
G681	Transplantation of ileum	Allotransplantation of ileum
G688	Transplantation of ileum	Other specified
G689	Transplantation of ileum	Unspecified
J011	Transplantation of liver	Orthotopic transplantation of liver nec
J012	Transplantation of liver	Heterotopic transplantation of liver
J013	Transplantation of liver	Replacement of previous liver transplant
J014	Transplantation of liver	Transplantation of liver cells
J015	Transplantation of liver	Orthotopic transplantation of whole liver
J018	Transplantation of liver	Other specified
J019	Transplantation of liver	Unspecified
J541	Transplantation of pancreas	Transplantation of pancreas and duodenum
J542	Transplantation of pancreas	Transplantation of whole pancreas
J543	Transplantation of pancreas	Transplantation of tail of pancreas
J544	Transplantation of pancreas	Transplantation of islet of langerhans
J545	Transplantation of pancreas	Renewal of transplanted pancreatic tissue
J548	Transplantation of pancreas	Other specified
J549	Transplantation of pancreas	Unspecified
J553	Total excision of pancreas	Excision of transplanted pancreas
J721	Other operations on spleen	Transplantation of spleen
K011	Transplantation of heart and lung	Allotransplantation of heart and lung
K012	Transplantation of heart and lung	Revision of transplantation of heart and lung
K018	Transplantation of heart and lung	Other specified
K019	Transplantation of heart and lung	Unspecified
K021	Other transplantation of heart	Allotransplantation of heart nec
K022	Other transplantation of heart	Xenotransplantation of heart
K023	Other transplantation of heart	Implantation of prosthetic heart
K024	Other transplantation of heart	Piggyback transplantation of heart
K025	Other transplantation of heart	Revision of implantation of prosthetic heart
K026	Other transplantation of heart	Revision of transplantation of heart nec
K028	Other transplantation of heart	Other specified

Opcs	Description_other	Description
K029	Other transplantation of heart	Unspecified
M011	Transplantation of kidney	Autotransplantation of kidney
M012	Transplantation of kidney	Allotransplantation of kidney from live donor
M013	Transplantation of kidney	Allotransplantation of kidney from cadaver nec
M014	Transplantation of kidney	Allotransplantation of kidney from cadaver heart
M015	Transplantation of kidney	Allotransplantation of kidney from cadaver heart non-
M018	Transplantation of kidney	Other specified
M019	Transplantation of kidney	Unspecified
M026	Total excision of kidney	Excision of rejected transplanted kidney
M084	Other open operations on kidney	Exploration of transplanted kidney
M174	Interventions associated with transplantation of	Post-transplantation of kidney examination - recipient
M178	Interventions associated with transplantation of	Other specified
M179	Interventions associated with transplantation of	Unspecified

Appendix 16 Codelist: Chemotherapy and radiotherapy

Radiotherapy and chemotherapy

A) CPRD

medcode	readcode	readterm
320	7M37100	Radiotherapy NEC
783	8BAD.00	CHEMOTHERAPY
1009	8HB6.00	Radiotherapy follow-up
1482	59...00	External radiotherapy
3622	5A11.00	Thyroid gland ablat - irradiat
5019	8BAD000	CANCER CHEMOTHERAPY
5404	7M0P.00	Introduction removable radioactive material into organ NOC
5527	ZV58000	[V]Radiotherapy session
9706	5154.00	Radiotherapy completed
10346	9N0D.00	Seen in radiotherapy clinic
10542	5A16.00	Radioactive drug therapy
10776	5A...11	Radiotherapy - internal
10932	8H67.00	Referred for radiotherapy
10950	ZL93100	Seen by radiotherapist
14887	8BA5.00	ORAL CHEMOTHERAPY
15362	7E0C000	Introduction of radioactive substance into uterine cavity
15386	7L16100	INTRAVENOUS CHEMOTHERAPY
16662	ZV66100	[V]Convalescence after radiotherapy
16771	59...11	X-ray therapy -external
16935	515..00	Progress of radiotherapy
18079	8HB7.00	CHEMOTHERAPY FOLLOW-UP
18675	8BAK.00	POST-OPERARTIVE CHEMOTHERAPY
18715	5AB..00	Stereotactic radiotherapy
18832	8BAa.00	DATE CHEMOTHERAPY COMPLETED
18904	ZV67100	[V]Radiotherapy follow-up
19467	8BAJ.00	PRE-OPERATIVE CHEMOTHERAPY
20282	7M0Py00	Introduction removable radioactive material to organ NOC OS
20336	7272200	Radiotherapy to lesion of retina
20381	ZV58100	[V]MAINTENANCE CHEMOTHERAPY
20443	ZV67200	[V]CHEMOTHERAPY FOLLOW-UP
21318	8BA5.11	Oral cytotoxic drug therapy
22472	59Z..00	External radiotherapy NOS
22490	8BAL.00	COMBINED PRE-OPERATIVE CHEMOTHERAPY AND RADIOTHERAPY
23589	7M0Pz00	Introduction removable radioactive material to organ NOC NOS
25479	ZV67800	[V]FOLLOW-UP EXAMIN AFTER CHEMOTHERAPY FOR MALIGN NEOPLASM
25490	ZLD2400	Discharge by radiotherapist
26149	8CV1.00	CHEMOTHERAPY STARTED
28071	7L10200	CONTINUOUS INFUSION OF CHEMOTHERAPY
28427	7D03400	Implantation of radioactive substance into vulva
28712	8J01.00	Iodine seed radiotherapy
28809	8BAM.00	COMBINED POST-OPERATIVE CHEMOTHERAPY AND RADIOTHERAPY
29285	5149.00	Radiotherapy-tumour palliation
29301	514Z.00	Radiotherapy purpose - NOS
29679	5146.00	Radiotherapy - post-op.control
30264	7L19300	SUBCUTANEOUS CHEMOTHERAPY
30547	ZV67700	[V]Follow-up exam after radiotherapy for malignant neoplasm
30942	9N1yC00	Seen in radiotherapy clinic
31489	ZV58800	[V]CHEMOTHERAPY SESSION FOR NEOPLASM
31527	514..00	Purpose of radiotherapy
31804	TB12100	Radiotherapy procedure with complication, without blame
32478	ZL13100	Under care of radiotherapist
35597	5147.00	Radiotherapy for analgesia
35609	ZV66200	[V]CONVALESCENCE AFTER CHEMOTHERAPY
36225	5A4..11	Radium needles
36489	7M0B200	Radiofrequency controlled thermal destruction of organ NOC
36810	5AC..00	Strontium 89 therapy
36981	5155.00	Awaiting radiotherapy
37123	7L18200	INTRAMUSCULAR CHEMOTHERAPY
38466	5151.00	Radiotherapy started
38662	7M0P000	Introduction of radioactive caesium into organ NOC
38773	5A...00	Other nuclear therapy
39951	5A9..00	Selectron therapy
40070	7101100	Implantation of radioactive substance into pituitary gland
40310	D400312	Neutropenia due to irradiation
40490	7046200	INTRATHECAL CHEMOTHERAPY
41044	8J...00	Radiotherapy treatment groups
42351	591..00	X-ray beam therapy

medcode	readcode	readterm
42671	5A8..00	Other radiotherapy misc.
43261	5144.00	Radiotherapy - pre-op. control
44148	5914.11	Deep X-ray therapy
44831	5153.00	Radiotherapy stopped
45087	8H3L.00	Non-urgent radiotherapy admisn
45099	515Z.00	Radiotherapy progress NOS
46028	8BAY.00	DATE CHEMOTHERAPY STOPPED
46824	8H2G.00	Admit radiotherapy emergency
48991	5136.00	X-ray metastasis control
49760	U603318	[X] Adverse reaction to mitomycin
50731	7H2C000	Introduction of radioactive substance into peritoneal cavity
51781	ZVu3L00	[X]OTHER CHEMOTHERAPY
51787	5975.00	EXT.BEAM + CHEMOTHERAPY
51959	8BAI.00	AMBULATORY CHEMOTHERAPY
52108	8F83.00	Convalescence after radiother.
53180	5A46.00	Radioth.: temp. pelvic implant
53477	ZV67811	[V]FOLLOW-UP EXAMINATION AFTER CHEMOTHERAPY FOR LEUKAEMIA
54828	7D15400	Implantation of radioactive substance into vagina
54919	5A8Z.00	Other radiotherapy NOS
55261	5152.00	Radiotherapy changed
55828	5145.00	Radiotherapy -intra-op.control
55832	5143.00	Radioth. for lymphat.irradiat.
55836	5148.00	Radiotherapy for inflammation
57591	591Z.00	X-ray beam therapy NOS
58036	7220100	Radiotherapy to lacrimal gland
59684	7M0c.00	Radiotherapy procedures
59796	5914.00	Deep X-ray therapy 150-400 Kv
59890	5913.00	Half deep therapy 60-150 Kv
60076	5141.00	Radioth.for immunosuppression
60091	5912.00	Superfic.X-ray therapy 10-60Kv
60674	7052200	Radiotherapy to lesion of peripheral nerve
60682	ZV6B100	[V]FOLLOW-UP EXAM AFTER CHEMOTHERAPY FOR OTHER CONDITIONS
61955	5AA..00	Iridium wire therapy
62202	8J00.00	High dose brachytherapy
62864	5A73.00	Radio-chemo.: oral route
62951	5A15.00	Bone tumour/metast.irradiat.
64143	597Z.00	Combined radiotherapy NOS
64801	5A3..00	Intern.radioth-permanent seeds
64997	7L1d.00	DELIVERY OF CHEMOTHERAPY FOR NEOPLASM
65739	5A53.00	Preload radioth.- nose
67248	5A12.00	Thyroid tumour/metast irradiat
68344	7244400	Radiotherapy to lesion of cornea
68423	7L1Z.00	Radiotherapy delivery
69165	594..00	Heavy particle therapy
69387	5974.00	EXT.BEAM-SURGERY+CHEMOTHERAPY
69877	5A3Z.00	Radioth.: permanent seeds NOS
69979	5AZ..00	Other nuclear therapy NOS
70128	D201311	Radiation aplastic anaemia
70246	5A1..00	Internal metabolic radiotherap
70290	5A7..00	RADIOMIMETIC CHEMOTHERAPY
70386	TA32.00	Overdose of radiation in therapy
70445	7M0cy00	Other specified radiotherapy procedures
70478	5A4..00	Radioth.: temporary implant
70549	5142.00	Radioth. for haemopo. irradiat
71008	7809400	Percutaneous radiofrequency ablation of lesion of liver
71098	592Z.00	High-energy beam therapy NOS
71598	5A45.00	Radioth.: temp. abdom. implant
71599	5A1Z.00	Internal metabolic radioth.NOS
71837	U603300	[X]OTHER ANTINEOPLAST DRUGS CAUS ADVERSE EFF IN THERAP USE
71926	5134.00	X-ray # reduction control
72850	5971.00	Extern.beam+intern.radiotherap
72978	597..00	Combined radiotherapy
73171	5A64.00	Afterload radioth.-fem.genital
73172	5A7Z.00	RADIO-CHEMOTHERAPY NOS
73173	5A13.00	Bone marrow suppres.-irradiat.
73300	5922.00	Betatron photon therapy
73462	5917.00	Intracavitary X-ray therapy
73692	5A4Z.00	Radioth.:temporary implant NOS
85984	5941.00	Proton therapy
86329	7L1Z400	Oral delivery of radiotherapy for thyroid ablation
87860	7M0P300	Intro radioactive substance org interstit brachytherapy NOC
88367	7B0A800	Percutaneous radiofrequency ablation of lesion of kidney
88762	5135.00	Radiological tumour control
88889	7M0Q300	Radioactive seed implantation NOC

medcode	readcode	readterm
89452	7L1b.00	PROCUREMENT DRUGS FOR CHEMOTHERAPY FOR NEOPLASM IN BANDS 1-5
90743	7L1e.00	DELIVERY OF ORAL CHEMOTHERAPY FOR NEOPLASM
91433	7B3CB00	Radioactive seed implantation into prostate
91694	7L1Z300	Delivery of a fraction of external beam radiotherapy NEC
91778	7L1d000	Del comp chemo neo inc prolong infusion treat first attend
91891	7L1Zz00	Radiotherapy delivery NOS
91918	7272700	External beam radiotherapy to lesion of retina
92174	7454400	Percutaneous radiofrequency ablation of lesion of lung
92956	7L1Z011	Delivery of a fraction of total body irradiation
92999	5A27.00	Radioth.: infuse organ cavity
93607	5A81.00	Give radiosensitising drug
93669	7L1Y.00	Radiotherapy preparation
94305	596..00	Short dis.+contact radiotherap
94306	593..00	Fast-electron therapy
94431	7L1ez00	DELIVERY OF ORAL CHEMOTHERAPY FOR NEOPLASM NOS
94478	5A42.00	Radioth:temp.head/neck implant
94479	5973.00	Ext.beam-surg.+post-op.radioth
94617	5A62.00	Afterload radioth.- upper GIT
94760	U603316	[X] Adverse reaction to chlorambucil
94764	7L1Y000	Preparation for total body irradiation
95009	7L1Z100	Delivery of a fraction of intracavitary radiotherapy
95066	5961.00	Radium contact therapy
95098	5A33.00	Radioth.: seeds into cavity
95126	7L1Zy00	Other specified radiotherapy delivery
95424	7L1dz00	DELIVERY OF CHEMOTHERAPY FOR NEOPLASM NOS
95693	7L1Xy00	Other specified radiotherapy volume definition
95851	U603311	[X] ADVERSE REACTION TO ANTINEOPLASTIC ANTIBIOTICS
95890	5962.00	Beta source contact therapy
96310	7L1dy00	OTHER SPECIFIED DELIVERY OF CHEMOTHERAPY FOR NEOPLASM
96446	U613200	[X]Overdose of radiation given during therapy
96458	7L1Z000	Delivery of a fraction of total body irradiation (TBI)
96467	5942.00	Deuteron therapy
96535	7B3BC00	Endoscopic radiofrequency ablation of lesion of prostate
97097	5131.00	Radiological pre-op. control
97106	5A28.00	Radioth.: infiltrate tissue
97154	5137.00	X-ray radiotherapy control
97253	7K1V700	Percutaneous radiofrequency ablation of lesion of bone
97412	7M0P400	Intro radioactive substance into organ for brachytherapy NOC
98358	7L1h000	Preparation for intensity modulated radiation therapy
98625	U603100	[X]ANTINEOPLAST ANTIMETABS CAUS ADVERSE EFF IN THERAP USE
98750	Z9KG500	Brachytherapy monitoring
98826	5A58.00	Preload radioth-female genital
98828	592..00	High-energy beam therapy
98829	5921.00	Linear-accelerator photon ther
98830	593Z.00	Fast-electron therapy NOS
98882	5A74.00	Radio-chemo.: I-V route
98902	7M0c500	Superficial or orthovoltage treatment for radiotherapy
98940	7L1i.00	Preparation for brachytherapy
99327	5963.00	Mould technique gamma/beta
99469	56B5.00	Image: field control:radiother
100382	5A21.00	Radioth.: infuse - skull/brain
100390	7M0P500	Intro non-remov radioact subst into organ for brachyther NOC
100396	7L1Z500	Delivery of a fraction of intraluminal brachytherapy
100724	5A2Z.00	Intern. unsealed radioth. NOS
100725	5A26.00	Radioth:infuse-urinary bladder
100758	5953.00	Comb.tele+int.dist.curietherap
100832	5133.00	Radiological post-op. control
100901	7M0c400	Megavoltage treatment for simple radiotherapy
100942	U60331B	[X] Adverse reaction to estramustine phosphate
101203	Z1Q1.11	Administering radionuclide
101391	7809300	Selective internal radiotherapy microspheres lesion of liver
101436	U603314	[X] Adverse reaction to bleomycin
101693	8CRC.00	Cancer chemotherapy management plan
102671	5A59.00	Preload radioth-urinary system
102672	5A14.00	Polycythaemia irradiation
102823	782M600	Percutaneous brachytherapy of lesion of bile duct
103302	U603200	[X]Antineoplast natural prod caus adverse eff in therap use
103372	5A2..00	Intern.radioth-unsealed source
103413	7L1i100	Preparation for intracavitary brachytherapy
103525	7L1Z200	Delivery of a fraction of interstitial radiotherapy
103600	U603118	[X] Adverse reaction to carboplatin
103872	7M0l.00	Support for preparation for radiotherapy
103957	7B3CA00	Transurethral radiofrequency needle ablation of prostate
104000	7L1h400	Prep for simple radioth with imaging and simple calculation

medcode	readcode	readterm
104099	7M0c300	Megavoltage treatment for complex radiotherapy
104142	8BAl.00	Neoadjuvant chemotherapy
105128	596Z.00	Short dist/contact radioth NOS
105129	5A57.00	Preload radioth.- resp.organs
105323	7M0c000	Delivery fraction complex radiotherapy megavoltage machine
105336	7L1d400	Electrochemotherapy
105610	7M0ly00	Other specified support for preparation for radiotherapy
105864	ZV1C300	[V]Personal history of chemotherapy for neoplastic disease
106149	5933.00	Positron therapy
106334	5A22.00	Radioth.: infuse - head/neck
107069	7L1Yz00	Radiotherapy preparation NOS
107130	5A77.00	Radio-chem.: into cavity
107133	595..00	Gamma-ray+int.dist.curietherap
107175	5A51.00	Preload radioth.- orbit
107418	5A17.00	Combined internal radiotherapy
107525	7L1iz00	Preparation for brachytherapy NOS
107734	7L1d200	Deliver simple parenteral chemother neoplas first attendance
107914	U60331D	[X] Adverse reaction to antineoplastic antibiotics NOS
108138	7L2..00	Radiotherapy
108140	7L1hz00	Preparation for external beam radiotherapy NOS
108202	7M0c200	Delivery fraction radiotherapy superficial orthovoltage mach
108561	7Q0J.00	Other chemotherapy drugs
109592	5932.00	Betatron electron therapy
110074	7M0p000	High dose rate brachytherapy
110894	SL07.00	Antineoplastic antibiotic poisoning

B) Hospital Episodes Statistics

ICD 10	DESCRIPTION
Z08.1	Follow-up examination after radiotherapy for malignant neoplasm
Z08.2	Follow-up examination after chemotherapy for malignant neoplasm
Z09.1	Follow-up examination after radiotherapy for other conditions
Z09.2	Follow-up examination after chemotherapy for other conditions
Z51.0	Radiotherapy session
Z51.1	Chemotherapy session for neoplasm
Z51.2	Other chemotherapy
Z54.1	Convalescence following radiotherapy
Z54.2	Convalescence following chemotherapy
Z29.2	Other prophylactic chemotherapy
Z92.6	Personal history of chemotherapy for neoplastic disease

C) Office of Population Censuses and Surveys (OPCS) version 4 codes

Opcs	Description_other	Description
B022	Destruction of pituitary gland	Implantation of radioactive substance into pituitary gland
C242	Operations on lacrimal gland	Radiotherapy to lacrimal gland
C823	Destruction of lesion of retina	External beam radiotherapy to lesion of retina
J123	Other therapeutic percutaneous operations on liver	Selective internal radiotherapy with microspheres to lesion
M706	Other operations on outlet of male bladder	Radioactive seed implantation into prostate
M712	Other operations on prostate	Implantation of radioactive substance into prostate
P064	Extirpation of lesion of vulva	Implantation of radioactive substance into vulva
P205	Extirpation of lesion of vagina	Implantation of radioactive substance into vagina
Q151	Introduction of other substance into uterine cavity	Introduction of radioactive substance into uterine cavity
T133	Introduction of substance into pleural cavity	Introduction of cytotoxic substance into pleural cavity
T481	Other operations on peritoneum	Introduction of radioactive substance into peritoneal cavity
T482	Other operations on peritoneum	Introduction of cytotoxic substance into peritoneal cavity
X352	Other intravenous injection	Intravenous chemotherapy
X373	Intramuscular injection	Intramuscular chemotherapy
X384	Subcutaneous injection	Subcutaneous chemotherapy
X651	Radiotherapy delivery	Delivery of a fraction of total body irradiation
X652	Radiotherapy delivery	Delivery of a fraction of intracavitary radiotherapy
X653	Radiotherapy delivery	Delivery of a fraction of interstitial radiotherapy
X654	Radiotherapy delivery	Delivery of a fraction of external beam radiotherapy nec
X655	Radiotherapy delivery	Oral delivery of radiotherapy for thyroid ablation
X656	Radiotherapy delivery	Delivery of a fraction of intraluminal brachytherapy
X658	Radiotherapy delivery	Other specified
X659	Radiotherapy delivery	Unspecified
X671	Preparation for external beam radiotherapy	Preparation for intensity modulated radiation therapy
X672	Preparation for external beam radiotherapy	Preparation for total body irradiation
X673	Preparation for external beam radiotherapy	Preparation for hemi body irradiation
X674	Preparation for external beam radiotherapy	Preparation for simple radiotherapy imaging and dosimetry
X675	Preparation for external beam radiotherapy	Preparation for simple radioth imaging simple calculation

Opcs	Description_other	Description
X676	Preparation for external beam radiotherapy	Preparation for superficial radiotherapy simple calculation
X677	Preparation for external beam radiotherapy	Preparation for complex conformal radiotherapy
X678	Preparation for external beam radiotherapy	Other specified
X679	Preparation for external beam radiotherapy	Unspecified
X721	Delivery of chemotherapy for neoplasm	Del. Of complex chemo./neoplasm/prolonged infusional treat.
X722	Delivery of chemotherapy for neoplasm	Del. Of complex parental chemo./neoplasm first attendance
X723	Delivery of chemotherapy for neoplasm	Del. Of simple parental chemo./neoplasm first attendance
X724	Delivery of chemotherapy for neoplasm	Del. Of subsequent element of cycle of chemo. For neoplasm
X728	Delivery of chemotherapy for neoplasm	Other specified
X729	Delivery of chemotherapy for neoplasm	Unspecified
X731	Delivery of oral chemotherapy for neoplasm	Delivery of exclusively oral chemotherapy for neoplasm
X738	Delivery of oral chemotherapy for neoplasm	Other specified
X739	Delivery of oral chemotherapy for neoplasm	Unspecified
Y351	Introduction of removable radioactive material into org	Introduction of radioactive caesium into organ noc
Y352	Introduction of removable radioactive material into org	Introduction of iridium wire into organ noc
Y353	Introduction of removable radioactive material into org	Introduction of radium into organ noc
Y354	Introduction of removable radioactive material into org	Introduction of radioactive substance organ brachytherap noc
Y358	Introduction of removable radioactive material into org	Other specified
Y359	Introduction of removable radioactive material into org	Unspecified
Y363	Introduction of non-removable material into organ noc	Radioactive seed implantation noc
Y364	Introduction of non-removable material into organ noc	Introduction non-rem radioact substance organ for brach noc
Y911	External beam radiotherapy	Megavoltage treatment for complex radiotherapy
Y912	External beam radiotherapy	Megavoltage treatment for simple radiotherapy
Y913	External beam radiotherapy	Superficial or orthovoltage treatment for radiotherapy
Y914	External beam radiotherapy	Megavoltage treatment for adaptive radiotherapy
Y918	External beam radiotherapy	Other specified
Y919	External beam radiotherapy	Unspecified
Y921	Support for preparation for radiotherapy	Technical support for preparation for radiotherapy
Y928	Support for preparation for radiotherapy	Other specified
Y929	Support for preparation for radiotherapy	Unspecified

Appendix 17 Codelist: steroids and other immunosuppressive drugs

1. Oral corticosteroids

Prodcode	Product name	Drug substance name	Substance strength	Formulation
44	prednisolone enteric coated tablets 5mg	prednisolone	5mg	enteric coated tablets
95	prednisolone tablets 5mg	prednisolone	5mg	tablets
186	dexamethasone elixir 0.5mg/5ml	dexamethasone	0.5mg/5ml	elixir
229	cortisone acetate tablets 25mg	cortisone acetate	25mg	tablets
557	prednisolone enteric coated tablets 2.5mg	prednisolone	2.5mg	enteric coated tablets
578	prednisolone tablets 1mg	prednisolone	1mg	tablets
955	prednisolone sodium phosphate soluble tablet 5mg	prednisolone sodium phosphate	5mg	soluble tablet
1063	PREDNESOL tablets 5mg [SOVEREIGN]	prednisolone sodium phosphate	5mg	tablets
1280	dexamethasone tablets 2mg	dexamethasone	2mg	tablets
1380	ENTOCORT CR modified release capsules 3mg [ASTRAZENEC]	budesonide	3mg	modified release capsules
1709	hydrocortisone pellets 2.5 mg loz			
1971	BETNESOL tablets 0.5mg [FOCUS]	betamethasone sodium phosphate	0.5mg	tablets
2044	prednisone 2.5 mg tab			
2130	methylprednisolone tablets 4mg	methylprednisolone	4mg	tablets
2368	prednisolone tablets 2.5mg	prednisolone	2.5mg	tablets
2390	prednisolone e/c 1 mg tab			
2704	prednisolone tablets 25mg	prednisolone	25mg	tablets
2799	prednisolone 10 mg tab			
2949	prednisone tablets 5mg	prednisone	5mg	tablets
3059	prednisolone 50 mg tab			
3345	SINTISONE tablets [PHARMACIA]	prednisolone steaglate		tablets
3418	hydrocortisone tablets 10mg	hydrocortisone	10mg	tablets
3557	prednisone tablets 1mg	prednisone	1mg	tablets
3898	budesonide modified release capsules 3mg	budesonide	3mg	modified release capsules
3969	dexamethasone 8 mg tab			
3992	deflazacort tablets 6mg	deflazacort	6mg	tablets
4535	hydrocortisone tablets 20mg	hydrocortisone	20mg	tablets
4779	dexamethasone tablets 0.5mg	dexamethasone	0.5mg	tablets
4943	dexamethasone sugar free oral solution 2mg/5ml	dexamethasone sodium phosphate	2mg/5ml	sugar free oral solution
5157	dexamethasone oral solution 2mg/5ml	dexamethasone	2mg/5ml	oral solution
5490	DELTACORTRIL ENTERIC tablets 5mg [ALLIANCE]	prednisolone	5mg	tablets
5913	DELTACORTRIL ENTERIC tablets 2.5mg [ALLIANCE]	prednisolone	2.5mg	tablets
6095	budesonide capsules 3mg	budesonide	3mg	capsules
6098	HYDROCORTONE tablets 10mg [M S D]	hydrocortisone	10mg	tablets
7286	betamethasone sodium phosphate soluble tablet 500micrograms	betamethasone sodium phosphate	500micrograms	soluble tablet
7548	cortisone acetate capsules 5mg	cortisone acetate	5mg	capsules
7584	prednisolone 4 mg tab			
7710	prednisolone 15 mg tab			
7934	prednisone 30 mg tab			
8261	MEDRONE tablets 16mg [PHARMACIA]	methylprednisolone	16mg	tablets
9375	deflazacort tablets 1mg	deflazacort	1mg	tablets
9727	prednisolone tablets 50mg	prednisolone	50mg	tablets
9994	DECADRON tablets 0.5mg [M S D]	dexamethasone	0.5mg	tablets
10552	methylprednisolone tablets 16mg	methylprednisolone	16mg	tablets
10574	cortisone acetate tablets 5mg	cortisone acetate	5mg	tablets
10683	MEDRONE tablets 2mg [PHARMACIA]	methylprednisolone	2mg	tablets
10684	methylprednisolone tablets 2mg	methylprednisolone	2mg	tablets
10754	HYDROCORTISTAB tablets 20mg [WAYMADE]	hydrocortisone	20mg	tablets
10864	betamethasone tablets 500micrograms	betamethasone	500micrograms	tablets
11149	BETNELAN tablets 0.5mg [FOCUS]	betamethasone	0.5mg	tablets
12398	CORTELAN tablets 25mg [GLAXO]	cortisone acetate	25mg	tablets
12400	CORTISYL tablets 25mg [AVENTIS]	cortisone acetate	25mg	tablets
13043	HYDROCORTONE tablets 20mg [M S D]	hydrocortisone	20mg	tablets
13522	prednisolone 2 mg tab			
13615	prednisone 10 mg tab			
14076	hydrocortisone sugar free oral suspension 5mg/5ml	hydrocortisone	5mg/5ml	sugar free oral suspension
14172	methylprednisolone tablets 100mg	methylprednisolone	100mg	tablets
15471	hydrocortisone 25 mg tab			

Prodcode	Product name	Drug substance name	Substance strength	Formulation
15555	MEDRONE tablets 4mg [PHARMACIA]	methylprednisolone	4mg	tablets
15617	LEDERCORT tablets 4mg [WYETH PHAR]	triamcinolone	4mg	tablets
16525	BUDENOFALK capsules 3mg [DR FALK]	budesonide	3mg	capsules
16724	prednisone 50 mg tab			
17101	dexamethasone 750 mcg tab			
17410	deflazacort tablets 30mg	deflazacort	30mg	tablets
18042	MEDRONE tablets 100mg [PHARMACIA]	methylprednisolone	100mg	tablets
18637	CORTISTAB tablets 25mg [WAYMADE]	cortisone acetate	25mg	tablets
18955	hydrocortisone 4.5 mg loz			
19141	PREDNISOLONE soluble tablet 5mg [SOVEREIGN]	prednisolone sodium phosphate	5mg	soluble tablet
19908	triamcinolone tablets 2mg	triamcinolone	2mg	tablets
20095	PRECORTISYL FORTE tablets 25mg [AVENTIS]	prednisolone	25mg	tablets
20577	CALCORT tablets 6mg [SHIRE]	deflazacort	6mg	tablets
20670	prednisolone e/c			
20731	hydrocortisone pellets			
21218	DEXSOL oral solution 2mg/5ml [ROSEMONT]	dexamethasone sodium phosphate	2mg/5ml	oral solution
21417	PREDNISOLONE tablets 5mg [HILLCROSS]	prednisolone	5mg	tablets
21465	betamethasone .1 mg tab			
21833	DECORTISYL tablets 5mg [ROUSSEL]	prednisone	5mg	tablets
21903	ORADEXON-ORGANON tablets 2mg [ORGANON]	dexamethasone	2mg	tablets
22555	CALCORT tablets 1mg [SHIRE]	deflazacort	1mg	tablets
22827	betamethasone .1 mg pel			
23111	triamcinolone tablets 4mg	triamcinolone	4mg	tablets
23210	CORTISTAB tablets 5mg [WAYMADE]	cortisone acetate	5mg	tablets
23512	PRECORTISYL tablets 5mg [HOECHSTMAR]	prednisolone	5mg	tablets
23788	cortisone acetate 2.5 mg tab			
24014	LEDERCORT tablets 2mg [WYETH PHAR]	triamcinolone	2mg	tablets
24716	prednisolone e/c			
25272	PRECORTISYL tablets 1mg [HOECHSTMAR]	prednisolone	1mg	tablets
27083	betamethasone valerate .1 mg tab			
27720	hydrocortisone			
27889	prednisolone			
27959	prednisolone			
27962	DELTASTAB tablets 1mg [WAYMADE]	prednisolone	1mg	tablets
28375	PREDNISOLONE enteric coated tablets 2.5mg [HILLCROSS]	prednisolone	2.5mg	enteric coated tablets
28376	PREDNISOLONE enteric coated tablets 2.5mg [BIOREX]	prednisolone	2.5mg	enteric coated tablets
28615	methylprednisolone l/a 4 mg cap			
28859	DELTASTAB tablets 5mg [WAYMADE]	prednisolone	5mg	tablets
29112	CALCORT tablets 30mg [SHIRE]	deflazacort	30mg	tablets
29322	betamethasone loz			
29333	PREDNISOLONE tablets 5mg [ACTAVIS]	prednisolone	5mg	tablets
30390	deltastab 2 mg tab			
30971	decortisyl 25 mg tab			
31327	prednisolone steaglate tablets 6.65mg	prednisolone steaglate	6.65mg	tablets
31532	PREDNISOLONE enteric coated tablets 5mg [HILLCROSS]	prednisolone	5mg	enteric coated tablets
32803	PREDNISOLONE enteric coated tablets 5mg [ACTAVIS]	prednisolone	5mg	enteric coated tablets
32835	PREDNISOLONE tablets 5mg [WOCKHARDT]	prednisolone	5mg	tablets
33639	cortisone acetate msd 25 mg tab			
33691	PREDNISOLONE enteric coated tablets 5mg [BIOREX]	prednisolone	5mg	enteric coated tablets
33988	PREDNISOLONE tablets 5mg [CO-PHARMA]	prednisolone	5mg	tablets
33990	PREDNISOLONE tablets 5mg [IVAX]	prednisolone	5mg	tablets
34109	prednisolone enteric coated tablets 5mg	prednisolone	5mg	enteric coated tablets
34393	PREDNISOLONE enteric coated tablets 5mg [TEVA]	prednisolone	5mg	enteric coated tablets
34404	PREDNISOLONE tablets 1mg [ACTAVIS]	prednisolone	1mg	tablets
34452	PREDNISOLONE tablets 1mg [HILLCROSS]	prednisolone	1mg	tablets
34461	PREDNISOLONE enteric coated tablets 2.5mg [ACTAVIS]	prednisolone	2.5mg	enteric coated tablets

Prodcode	Product name	Drug substance name	Substance strength	Formulation
34631	PREDNISOLONE tablets 1mg [CO-PHARMA]	prednisolone	1mg	tablets
34660	PREDNISOLONE tablets 1mg [KENT]	prednisolone	1mg	tablets
34748	PREDNISOLONE tablets 1mg [TEVA]	prednisolone	1mg	tablets
34781	PREDNISOLONE tablets 5mg [KENT]	prednisolone	5mg	tablets
34801	DEXAMETHASONE elixir 0.5mg/5ml [ROSEMONT]	dexamethasone	0.5mg/5ml	elixir
34880	DEXAMETHASONE tablets 2mg [ORGANON]	dexamethasone	2mg	tablets
34914	PREDNISOLONE tablets 1mg [CELLTECH]	prednisolone	1mg	tablets
34915	DEXAMETHASONE tablets 0.5mg [ORGANON]	dexamethasone	0.5mg	tablets
34978	PREDNISOLONE tablets 1mg [WOCKHARDT]	prednisolone	1mg	tablets
36055	DEXAMETHASONE tablets 2mg [HILLCROSS]	dexamethasone	2mg	tablets
36686	cortisone acetate msd 5 mg tab			
37203	beclometasone gastro-resistant modified release tablets 5mg	beclometasone dipropionate	5mg	gastro-resistant modified release tablets
38022	hydrocortisone oral suspension 10mg/5ml	hydrocortisone	10mg/5ml	oral suspension
38054	hydrocortisone tablets	hydrocortisone		tablets
38407	prednisolone (roi) tablets 20mg	prednisolone	20mg	tablets
39067	CLIPPER gastro-resistant modified release tablets 5mg [CHIESI]	beclometasone dipropionate	5mg	gastro-resistant modified release tablets
41335	CALCORT tablets 6mg [SANOFI/AVE]	deflazacort	6mg	tablets
41515	PREDNISOLONE tablets 5mg [TEVA]	prednisolone	5mg	tablets
41745	PREDNISOLONE tablets 25mg [WINTHROP]	prednisolone	25mg	tablets
43544	PREDNISONE tablets 5mg [KNOLL]	prednisone	5mg	tablets
44380	prednisone modified release tablet 1mg	prednisone	1mg	modified release tablet
44723	prednisone modified release tablet 5mg	prednisone	5mg	modified release tablet
44802	LODOTRA modified release tablet 5mg [NAPPPHARM]	prednisone	5mg	modified release tablet
44803	LODOTRA modified release tablet 2mg [NAPPPHARM]	prednisone	2mg	modified release tablet
45234	dexamethasone capsules	dexamethasone		capsules
45302	PREDNISOLONE tablets 5mg [BIOREX]	prednisolone	5mg	tablets
46711	prednisone modified release tablet 2mg	prednisone	2mg	modified release tablet
47142	Prednisolone 5mg Soluble tablet (Amdipharm Plc)	Prednisolone sodium phosphate	5mg	Soluble tablet
47225	Budesonide 9mg gastro-resistant granules sachets	Budesonide	9mg	Gastro-resistant granules
48088	Budenofalk 9mg gastro-resistant granules sachets (Dr. Falk Pharma UK Ltd)	Budesonide	9mg	Gastro-resistant granules
50225	Betnesol 500microgram soluble tablets (Waymade Healthcare Plc)	Betamethasone sodium phosphate	500microgram	Soluble tablet
51722	Hydrocortisone 5mg/5ml oral suspension	Hydrocortisone	1mg/1ml	Oral suspension
51753	Prednisolone 1mg tablets (Co-Pharma Ltd)	Prednisolone	1mg	Tablet
51824	Hydrocortisone 5mg/5ml oral suspension sugar free	Hydrocortisone	1mg/1ml	Oral suspension
51849	Hydrocortisone 1mg/5ml oral suspension			
51871	Hydrocortisone 2mg capsules			
51872	Hydrocortisone 2.5mg capsules	Hydrocortisone	2.5mg	Capsule
51997	Budesonide 9mg gastro-resistant granules sachets	Budesonide	9mg	Gastro-resistant granules
52053	Hydrocortisone 3mg/5ml oral suspension			
52396	Dexamethasone 1mg/5ml oral solution	Dexamethasone	200microgram/1ml	Oral solution
53143	Cortisone 25mg tablets (A A H Pharmaceuticals Ltd)	Cortisone acetate	25mg	Tablet
53207	Dexamethasone tablets	Dexamethasone		
53313	Prednisolone 20mg/5ml oral suspension	Prednisolone	4mg/1ml	Oral suspension
53336	Prednisolone 25mg tablets (A A H Pharmaceuticals Ltd)	Prednisolone	25mg	Tablet
53705	Cortisone acetate 5mg Capsule (Martindale Pharmaceuticals Ltd)	Cortisone acetate	5mg	Capsule
53953	Hydrocortisone 5mg modified-release tablets			
54118	Prednisolone 25mg/5ml oral suspension	Prednisolone	5mg/1ml	Oral suspension
54432	Lodotra 1mg modified-release tablets (Napp Pharmaceuticals Ltd)	Prednisone	1mg	Modified-release tablet
54434	Prednisolone 2.5mg/5ml oral suspension	Prednisolone	500microgram/1ml	Oral suspension
54793	Dexamethasone 2mg/5ml oral suspension	Dexamethasone	400microgram/1ml	Oral suspension
54794	Hydrocortisone 20mg modified-release tablets			

Prodcode	Product name	Drug substance name	Substance strength	Formulation
55024	Prednisolone 5mg/5ml oral solution	Prednisolone	1mg/1ml	Oral solution
55401	Dexamethasone 500microgram tablets (A A H Pharmaceuticals Ltd)	Dexamethasone	500microgram	Tablet
55480	Prednisolone 2.5mg gastro-resistant tablets (Alliance Pharmaceuticals Ltd)	Prednisolone	2.5mg	Gastro-resistant tablet
56144	Budenofalk 9mg gastro-resistant granules sachets (Dr. Falk Pharma UK Ltd)	Budesonide	9mg	Gastro-resistant granules
56319	Hydrocortisone 2.5mg muco-adhesive buccal tablets sugar free (A A H Pharmaceuticals Ltd)	Hydrocortisone sodium succinate	2.5mg	Muco-adhesive buccal tablet
56347	Dexamethasone 5mg/5ml oral solution	Dexamethasone	1mg/1ml	Oral solution
56443	Dexamethasone 10mg/5ml oral solution			
56891	Prednisolone 1mg tablets (Waymade Healthcare Plc)	Prednisolone	1mg	Tablet
57931	Hydrocortisone 20mg tablets (Teva UK Ltd)	Hydrocortisone	20mg	Tablet
58000	Prednisolone 5mg tablets (Almus Pharmaceuticals Ltd)	Prednisolone	5mg	Tablet
58061	Prednisone 50mg tablets	Prednisone	50mg	Tablet
58234	Prednisolone 10mg/5ml oral solution	Prednisolone	2mg/1ml	Oral solution
58369	Prednisolone 5mg tablets (Boston Healthcare Ltd)	Prednisolone	5mg	Tablet
58384	Prednisolone 1mg tablets (Almus Pharmaceuticals Ltd)	Prednisolone	1mg	Tablet
58474	Dexamethasone 2mg/5ml oral solution sugar free (A A H Pharmaceuticals Ltd)	Dexamethasone sodium phosphate	400microgram/1ml	Oral solution
58592	Plenadren 20mg modified-release tablets (Shire Pharmaceuticals Ltd)			
58987	Prednisolone 5mg gastro-resistant tablets (Phoenix Healthcare Distribution Ltd)	Prednisolone	5mg	Gastro-resistant tablet
59229	Dilacort 5mg gastro-resistant tablets (Auden McKenzie (Pharma Division) Ltd)	Prednisolone	5mg	Gastro-resistant tablet
59283	Dilacort 2.5mg gastro-resistant tablets (Auden McKenzie (Pharma Division) Ltd)	Prednisolone	2.5mg	Gastro-resistant tablet
59338	Prednisolone 1mg/5ml oral solution	Prednisolone	200microgram/1ml	Oral solution
59418	Plenadren 5mg modified-release tablets (Shire Pharmaceuticals Ltd)			
59912	Prednisolone 5mg gastro-resistant tablets (Waymade Healthcare Plc)	Prednisolone	5mg	Gastro-resistant tablet
60064	Dexamethasone 10mg/5ml oral solution sugar free			
60120	Dexamethasone 2mg tablets (Alliance Healthcare (Distribution) Ltd)	Dexamethasone	2mg	Tablet
60421	Prednisolone 5mg tablets (Co-Pharma Ltd)	Prednisolone	5mg	Tablet
60946	Entocort CR 3mg capsules (Waymade Healthcare Plc)	Budesonide	3mg	Modified-release capsule
61132	Prednisolone 1mg tablets (Boston Healthcare Ltd)	Prednisolone	1mg	Tablet
61162	Prednisolone 5mg tablets (Waymade Healthcare Plc)	Prednisolone	5mg	Tablet
61689	Prednisolone 5mg soluble tablets (A A H Pharmaceuticals Ltd)	Prednisolone sodium phosphate	5mg	Soluble tablet
61791	Hydrocortisone 2.5mg muco-adhesive buccal tablets sugar free (Waymade Healthcare Plc)	Hydrocortisone sodium succinate	2.5mg	Muco-adhesive buccal tablet
62656	Prednisone 5mg Tablet (Hillcross Pharmaceuticals Ltd)	Prednisone	5mg	Tablet
62909	Dexamethasone 2mg tablets (A A H Pharmaceuticals Ltd)	Dexamethasone	2mg	Tablet
63066	Prednisolone 2.5mg tablets	Prednisolone	2.5mg	Tablet
63082	Prednisolone 20mg tablets			
63138	Hydrocortisone 5mg/5ml oral solution			
63172	Prednisolone 10mg tablets			
63214	Prednisolone 5mg soluble tablets (Alliance Healthcare (Distribution) Ltd)	Prednisolone sodium phosphate	5mg	Soluble tablet
63549	Prednisolone 1mg/ml oral solution (Logixx Pharma Solutions Ltd)	Prednisolone	1mg/1ml	Oral solution
63791	Prednisolone 5mg/5ml oral solution unit dose			
63893	Budesonide 9mg modified-release tablets	Budesonide	9mg	Modified-release tablet
64007	Pevanti 10mg tablets (AMCo)	Prednisolone	10mg	Tablet
64008	Pevanti 2.5mg tablets (AMCo)	Prednisolone	2.5mg	Tablet
64009	Pevanti 20mg tablets (AMCo)			
64050	Martapan 2mg/5ml oral solution (Martindale Pharmaceuticals Ltd)	Dexamethasone sodium phosphate	400microgram/1ml	Oral solution
64059	Hydrocortisone 2.5mg/5ml oral suspension	Hydrocortisone	500microgram/1ml	Oral suspension
64128	Pevanti 5mg tablets (AMCo)	Prednisolone	5mg	Tablet

Prodcode	Product name	Drug substance name	Substance strength	Formulation
64221	Prednisolone 5mg/5ml oral suspension	Prednisolone	1mg/1ml	Oral suspension
64235	Betamethasone 500microgram soluble tablets sugar free (Alliance Healthcare (Distribution) Ltd)	Betamethasone sodium phosphate	500microgram	Soluble tablet
64416	Prednisolone 10mg/ml oral solution sugar free			
64557	Cortiment 9mg modified-release tablets (Ferring Pharmaceuticals Ltd)	Budesonide	9mg	Modified-release tablet
64747	Dexamethasone 2mg/5ml oral solution			
64766	Dexamethasone 20mg/5ml oral solution sugar free	Dexamethasone sodium phosphate	4mg/1ml	Oral solution
64787	Hydrocortisone 10mg tablets (Almus Pharmaceuticals Ltd)	Hydrocortisone	10mg	Tablet
65020	Prednisolone 25mg/5ml oral solution			
65626	Prednisolone 10mg/5ml oral suspension	Prednisolone	2mg/1ml	Oral suspension
65984	Hydrocortisone 10mg tablets (Actavis UK Ltd)	Hydrocortisone	10mg	Tablet
66015	Prednisolone Dompe 5mg/5ml oral solution unit dose (Logixx Pharma Solutions Ltd)			
66200	Dexamethasone 2mg soluble tablets sugar free			
66287	Dexamethasone 8mg soluble tablets sugar free			
66327	Hydrocortisone 20mg tablets (Actavis UK Ltd)	Hydrocortisone	20mg	Tablet
66524	Dexamethasone 4mg soluble tablets sugar free	Dexamethasone sodium phosphate	4mg	Soluble tablet
66550	Prednisolone 5mg gastro-resistant tablets (Alliance Healthcare (Distribution) Ltd)	Prednisolone	5mg	Gastro-resistant tablet
66556	Hydrocortisone 2.5mg muco-adhesive buccal tablets sugar free (Sigma Pharmaceuticals Plc)	Hydrocortisone sodium succinate	2.5mg	Muco-adhesive buccal tablet
66645	Prednisolone 5mg/5ml oral solution unit dose (Logixx Pharma Solutions Ltd)			
66666	Hydrocortisone 10mg tablets (Teva UK Ltd)	Hydrocortisone	10mg	Tablet
66724	Dexamethasone 10mg capsules			
66914	Prednisolone 1mg gastro-resistant tablets			

2. Other immunosuppressant drugs* excluding oral corticosteroids

Prodcode	Product name	Drug substance name	Substance strength	Formulation
12339	AZAMUNE tablets 50mg [PENN]	azathioprine	50mg	tablets
6882	adalimumab injection 40mg	adalimumab	40mg	injection
65339	Azapress 50mg tablets (Ennogen Pharma Ltd)	Azathioprine	50mg	Tablet
55773	Azathioprine 10mg/5ml oral suspension	Azathioprine	2mg/1ml	Oral suspension
53869	Azathioprine 20mg/5ml oral solution	Azathioprine	4mg/1ml	Oral solution
54982	Azathioprine 20mg/5ml oral suspension	Azathioprine	4mg/1ml	Oral suspension
63121	Azathioprine 25mg tablets (Alliance Healthcare (Distribution) Ltd)	Azathioprine	25mg	Tablet
59006	Azathioprine 25mg tablets (Kent Pharmaceuticals Ltd)	Azathioprine	25mg	Tablet
66003	Azathioprine 25mg tablets (Mawdsley-Brooks & Company Ltd)	Azathioprine	25mg	Tablet
53956	Azathioprine 50mg tablets (Almus Pharmaceuticals Ltd)	Azathioprine	50mg	Tablet
53797	Azathioprine 50mg tablets (Arrow Generics Ltd)	Azathioprine	50mg	Tablet
58654	Azathioprine 50mg tablets (Sandoz Ltd)	Azathioprine	50mg	Tablet
61160	Azathioprine 50mg tablets (Tillomed Laboratories Ltd)	Azathioprine	50mg	Tablet
23850	HUMIRA injection 40mg [ABBOTT]	adalimumab	40mg	injection
65735	Aflibercept 2mg/50microlitres solution for injection vials	Aflibercept	40mg/1ml	Solution for injection
60484	Eylea 2mg/50microlitres solution for injection vials (Bayer Plc)	Aflibercept	40mg/1ml	Solution for injection
51181	Azathioprine 60mg/5ml oral solution	Azathioprine	12mg/1ml	Oral solution
770	azathioprine capsules	azathioprine		capsules
42273	alemtuzumab concentrate for solution for infusion 30mg/1ml	alemtuzumab	30mg/1ml	concentrate for solution for infusion

Prodcode	Product name	Drug substance name	Substance strength	Formulation
55815	MabCampath 30mg/1ml concentrate for solution for infusion vials (Genzyme Therapeutics Ltd)	Alemtuzumab	30mg/1ml	Solution for infusion
39115	azathioprine capsules 10mg	azathioprine	10mg	capsules
270	azathioprine injection 50mg/vial	azathioprine	50mg/vial	injection
55858	Azathioprine oral solution	Azathioprine		
22982	azathioprine oral solution 50mg/5ml	azathioprine	50mg/5ml	oral solution
31598	MABCAMPATH concentrate for solution for infusion 10mg/ml [SCHERING]	alemtuzumab	10mg/ml	concentrate for solution for infusion
36792	azathioprine oral solution 50mg/ml	azathioprine	50mg/ml	oral solution
35518	azathioprine oral suspension 50mg/5ml	azathioprine	50mg/5ml	oral suspension
13320	azathioprine tablets 10mg	azathioprine	10mg	tablets
451	azathioprine tablets 25mg	azathioprine	25mg	tablets
34816	AZATHIOPRINE tablets 25mg [GEN (UK)]	azathioprine	25mg	tablets
32101	AZATHIOPRINE tablets 25mg [HILLCROSS]	azathioprine	25mg	tablets
571	azathioprine tablets 50mg	azathioprine	50mg	tablets
43562	AZATHIOPRINE tablets 50mg [ACTAVIS]	azathioprine	50mg	tablets
41670	AZATHIOPRINE tablets 50mg [CP PHARM]	azathioprine	50mg	tablets
34451	AZATHIOPRINE tablets 50mg [GEN (UK)]	azathioprine	50mg	tablets
34687	AZATHIOPRINE tablets 50mg [HILLCROSS]	azathioprine	50mg	tablets
29340	AZATHIOPRINE tablets 50mg [IVAX]	azathioprine	50mg	tablets
31215	AZATHIOPRINE tablets 50mg [KENT]	azathioprine	50mg	tablets
41620	AZATHIOPRINE tablets 50mg [TEVA]	azathioprine	50mg	tablets
26261	BERKAPRINE tablets 50mg [RORER]	azathioprine	50mg	tablets
21899	IMMUNOPRIN tablets 50mg [ASHBOURNE]	azathioprine	50mg	tablets
14395	IMURAN injection 50mg/vial [ASPEN EURO]	azathioprine	50mg/vial	injection
30495	IMURAN tablets 10mg [WELLCOME]	azathioprine	10mg	tablets
43077	IMURAN tablets 25mg [ASPEN EURO]	azathioprine	25mg	tablets
671	IMURAN tablets 25mg [WELLCOME]	azathioprine	25mg	tablets
42988	IMURAN tablets 50mg [ASPEN EURO]	azathioprine	50mg	tablets
1899	IMURAN tablets 50mg [WELLCOME]	azathioprine	50mg	tablets
19072	OPRISINE tablets 50mg [OPUS]	azathioprine	50mg	tablets
3874	busulfan tablets 2mg	busulfan	2mg	tablets
22204	busulfan tablets 500micrograms	busulfan	500micrograms	tablets
26301	MYLERAN tablets 2mg [WELLCOME]	busulfan	2mg	tablets
32412	MYLERAN tablets 500micrograms [WELLCOME]	busulfan	500micrograms	tablets
65607	Capecitabine 150mg tablets (A A H Pharmaceuticals Ltd)	Capecitabine	150mg	Tablet
7340	capecitabine tablets 150mg	capecitabine	150mg	tablets
7341	capecitabine tablets 500mg	capecitabine	500mg	tablets
33127	XELODA tablets 150mg [ROCHE]	capecitabine	150mg	tablets
18063	XELODA tablets 500mg [ROCHE]	capecitabine	500mg	tablets
61065	Carboplatin 450mg/45ml solution for infusion vials	Carboplatin	10mg/1ml	Solution for infusion
10328	carboplatin concentrate for solution for infusion 10mg/ml	carboplatin	10mg/ml	concentrate for solution for infusion
40781	carboplatin concentrate for solution for infusion 150mg/15ml	carboplatin	150mg/15ml	concentrate for solution for infusion
35855	carboplatin concentrate for solution for infusion 50mg/5ml	carboplatin	50mg/5ml	concentrate for solution for infusion
39450	carboplatin concentrate for solution for infusion 600mg/60ml	carboplatin	600mg/60ml	concentrate for solution for infusion
24096	carboplatin injection 150mg	carboplatin	150mg	injection
36726	anakinra injection 100mg/0.67ml	anakinra	100mg/0.67ml	injection
32418	KINERET injection 100mg/0.67ml [SWED ORPH]	anakinra	100mg/0.67ml	injection
42696	THYMOGLOBULINE powder for solution for infusion 25mg [GENZYME]	antithymocyte immunoglobulin (rabbit)	25mg	powder for solution for infusion
18236	carboplatin injection 50mg/vial	carboplatin	50mg/vial	injection
64626	Otezla 30mg tablets (Celgene Ltd)	Apremilast	30mg	Tablet
37915	basiliximab powder for solution for infusion 10mg	basiliximab	10mg	powder for solution for infusion
40632	basiliximab powder for solution for infusion 20mg	basiliximab	20mg	powder for solution for infusion
41963	PARAPLATIN concentrate for solution for infusion 10mg/ml [BRISTOL]	carboplatin	10mg/ml	concentrate for solution for infusion
37542	PARAPLATIN injection 150mg [BRISTOL]	carboplatin	150mg	injection
41281	carmustine implant 7.7mg	carmustine	7.7mg	implant
5600	chlorambucil tablets 2mg	chlorambucil	2mg	tablets
8665	chlorambucil tablets 5mg	chlorambucil	5mg	tablets
16838	LEUKERAN tablets 2mg [WELLCOME]	chlorambucil	2mg	tablets
61351	Simulect 10mg powder and solvent for solution for injection vials (Novartis Pharmaceuticals UK Ltd)	Basiliximab	10mg	Powder and solvent for solution for injection

Prodcode	Product name	Drug substance name	Substance strength	Formulation
26315	LEUKERAN tablets 5mg [WELLCOME]	chlorambucil	5mg	tablets
28709	chlormethine injection 10mg	chlormethine hydrochloride	10mg	injection
26119	CHLORMETHINE injection 10mg/ml [SOVEREIGN]	chlormethine hydrochloride	10mg/ml	injection
47102	Capimune 50mg capsules (Generics (UK) Ltd)	Ciclosporin	50mg	Capsule
46395	CAPIMUNE capsules 100mg [GEN (UK)]	ciclosporin	100mg	capsules
46637	CAPIMUNE capsules 25mg [GEN (UK)]	ciclosporin	25mg	capsules
63798	Ciclosporin 100mg capsules (A A H Pharmaceuticals Ltd)	Ciclosporin	100mg	Capsule
59250	Ciclosporin 100mg capsules (Colorama Pharmaceuticals Ltd)	Ciclosporin	100mg	Capsule
54975	Ciclosporin 100mg capsules (Cubic Pharmaceuticals Ltd)	Ciclosporin	100mg	Capsule
65639	Ciclosporin 100mg capsules (J M McGill Ltd)	Ciclosporin	100mg	Capsule
48556	Ciclosporin 100mg capsules (Phoenix Healthcare Distribution Ltd)	Ciclosporin	100mg	Capsule
54134	Ciclosporin 100mg capsules (Sigma Pharmaceuticals Plc)	Ciclosporin	100mg	Capsule
55116	Ciclosporin 25mg capsules (Cubic Pharmaceuticals Ltd)	Ciclosporin	25mg	Capsule
62051	Ciclosporin 25mg capsules (Niche Pharma Ltd)	Ciclosporin	25mg	Capsule
48763	Ciclosporin 25mg capsules (Phoenix Healthcare Distribution Ltd)	Ciclosporin	25mg	Capsule
52743	Ciclosporin 25mg capsules (Sigma Pharmaceuticals Plc)	Ciclosporin	25mg	Capsule
59249	Ciclosporin 50mg capsules (Colorama Pharmaceuticals Ltd)	Ciclosporin	50mg	Capsule
54974	Ciclosporin 50mg capsules (Cubic Pharmaceuticals Ltd)	Ciclosporin	50mg	Capsule
48798	Ciclosporin 50mg capsules (Phoenix Healthcare Distribution Ltd)	Ciclosporin	50mg	Capsule
54867	Ciclosporin 50mg capsules (Sigma Pharmaceuticals Plc)	Ciclosporin	50mg	Capsule
3896	ciclosporin capsules 100mg	ciclosporin	100mg	capsules
16035	ciclosporin capsules 10mg	ciclosporin	10mg	capsules
32614	SIMULECT powder for solution for infusion 20mg [NOVARTIS]	basiliximab	20mg	powder for solution for infusion
2838	ciclosporin capsules 25mg	ciclosporin	25mg	capsules
25740	AVASTIN concentrate for solution for infusion 100mg/4ml [ROCHE]	bevacizumab	100mg/4ml	concentrate for solution for infusion
2837	ciclosporin capsules 50mg	ciclosporin	50mg	capsules
42924	ciclosporin concentrate for solution for infusion 250mg/5ml	ciclosporin	250mg/5ml	concentrate for solution for infusion
38056	ciclosporin concentrate for solution for infusion 50mg/1ml	ciclosporin	50mg/1ml	concentrate for solution for infusion
19370	ciclosporin concentrate for solution for infusion 50mg/ml	ciclosporin	50mg/ml	concentrate for solution for infusion
1626	ciclosporin oral solution 100mg/ml	ciclosporin	100mg/ml	oral solution
42449	DEXIMUNE capsules 100mg [DEXCEL]	ciclosporin	100mg	capsules
42637	DEXIMUNE capsules 25mg [DEXCEL]	ciclosporin	25mg	capsules
42448	DEXIMUNE capsules 50mg [DEXCEL]	ciclosporin	50mg	capsules
52615	Neoral 100mg capsules (Sigma Pharmaceuticals Plc)	Ciclosporin	100mg	Capsule
49958	Neoral 25mg capsules (Doncaster Pharmaceuticals Ltd)	Ciclosporin	25mg	Capsule
53175	Neoral 25mg capsules (Mawdsley-Brooks & Company Ltd)	Ciclosporin	25mg	Capsule
53176	Neoral 50mg capsules (Doncaster Pharmaceuticals Ltd)	Ciclosporin	50mg	Capsule
973	NEORAL capsules 100mg [NOVARTIS]	ciclosporin	100mg	capsules
16137	NEORAL capsules 10mg [NOVARTIS]	ciclosporin	10mg	capsules
972	NEORAL capsules 25mg [NOVARTIS]	ciclosporin	25mg	capsules
4231	NEORAL capsules 50mg [NOVARTIS]	ciclosporin	50mg	capsules
1905	NEORAL oral solution 100mg/ml [NOVARTIS]	ciclosporin	100mg/ml	oral solution
13556	SANDIMMUN capsules 100mg [NOVARTIS]	ciclosporin	100mg	capsules
3920	SANDIMMUN capsules 25mg [NOVARTIS]	ciclosporin	25mg	capsules
15596	SANDIMMUN capsules 50mg [NOVARTIS]	ciclosporin	50mg	capsules
26790	SANDIMMUN concentrate for solution for infusion 50mg/ml [NOVARTIS]	ciclosporin	50mg/ml	concentrate for solution for infusion
13494	SANDIMMUN sugar free solution 100mg/ml [NOVARTIS]	ciclosporin	100mg/ml	sugar free solution
64857	Vanquoral 100mg capsules (Teva UK Ltd)	Ciclosporin	100mg	Capsule
66785	Vanquoral 10mg capsules (Teva UK Ltd)	Ciclosporin	10mg	Capsule
66473	Vanquoral 25mg capsules (Teva UK Ltd)	Ciclosporin	25mg	Capsule

Prodcode	Product name	Drug substance name	Substance strength	Formulation
64858	Vanquoral 50mg capsules (Teva UK Ltd)	Ciclosporin	50mg	Capsule
38145	bevacizumab concentrate for solution for infusion 100mg/4ml	bevacizumab	100mg/4ml	concentrate for solution for infusion
48068	Cisplatin 100mg/100ml solution for infusion vials	Cisplatin	1mg/1ml	Solution for infusion
38453	cisplatin concentrate for solution for infusion 10mg/10ml	cisplatin	10mg/10ml	concentrate for solution for infusion
32824	cisplatin concentrate for solution for infusion 1mg/ml	cisplatin	1mg/ml	concentrate for solution for infusion
44388	cisplatin concentrate for solution for infusion 50mg/50ml	cisplatin	50mg/50ml	concentrate for solution for infusion
28324	cisplatin powder 25mg/vial	cisplatin	25mg/vial	powder
38185	cisplatin powder for concentrate for solution for infusion 50mg	cisplatin	50mg	powder for concentrate for solution for infusion
40454	cladribine injection 10mg/5ml	cladribine	10mg/5ml	injection
38081	ERWINASE powder for solution for injection 10000 units/vial [OPI]	crisantaspase	10000 units/vial	powder for solution for injection
47752	Cyclophosphamide 25mg tablets	Cyclophosphamide	25mg	Tablet
26322	cyclophosphamide injection 100mg	cyclophosphamide	100mg	injection
26066	cyclophosphamide injection 200mg	cyclophosphamide	200mg	injection
29840	cyclophosphamide powder for solution for injection 1000mg	cyclophosphamide	1000mg	powder for solution for injection
16105	cyclophosphamide powder for solution for injection 500mg	cyclophosphamide	500mg	powder for solution for injection
3984	cyclophosphamide tablets 10mg	cyclophosphamide	10mg	tablets
3985	cyclophosphamide tablets 50mg	cyclophosphamide	50mg	tablets
34728	CYCLOPHOSPHAMIDE tablets 50mg [PHARMACIA]	cyclophosphamide	50mg	tablets
44309	ENDOXANA injection 1000mg [BAXTER ONC]	cyclophosphamide	1000mg	injection
44273	ENDOXANA injection 200mg [BAXTER ONC]	cyclophosphamide	200mg	injection
31193	ENDOXANA tablets 10mg [BAXTER ONC]	cyclophosphamide	10mg	tablets
10729	ENDOXANA tablets 50mg [BAXTER ONC]	cyclophosphamide	50mg	tablets
44740	bortezomib powder for solution for injection 3.5mg	bortezomib	3.5mg	powder for solution for injection
41266	cytarabine injection solution 1g/10ml	cytarabine	1g/10ml	injection solution
40732	VELCADE powder for solution for injection 3.5mg [ORTHO BIO]	bortezomib	3.5mg	powder for solution for injection
45647	canakinumab powder for solution for injection 150mg	canakinumab	150mg	powder for solution for injection
44100	certolizumab pegol injection solution 200mg/1ml	certolizumab pegol	200mg/1ml	injection solution
43703	CIMZIA injection solution 200mg/1ml [UCB]	certolizumab pegol	200mg/1ml	injection solution
19335	CYTOSAR injection 500mg [PHARMACIA]	cytarabine	500mg	injection
66380	DepoCyte 50mg/5ml suspension for injection vials (Napp Pharmaceuticals Ltd)	Cytarabine	10mg/1ml	Suspension for injection
18238	dacarbazine powder for solution for injection 100mg	dacarbazine citrate	100mg	powder for solution for injection
28682	dacarbazine powder for solution for injection 200mg	dacarbazine citrate	200mg	powder for solution for injection
32204	DTIC-DOME injection 100mg/vial [BAYER]	dacarbazine citrate	100mg/vial	injection
58496	Cosmegen Lyovac 500microgram powder for solution for injection vials (Orphan Europe (UK) Ltd)	Dactinomycin	500microgram	Powder for solution for injection
27071	dactinomycin powder for solution for injection 500micrograms	dactinomycin	500micrograms	powder for solution for injection
11003	CERUBIDIN powder for concentrate for solution for injection 20mg/vial [RHONE]	daunorubicin	20mg/vial	powder for concentrate for solution for injection
43805	daunorubicin powder for concentrate for solution for injection 20mg/vial	daunorubicin	20mg/vial	powder for concentrate for solution for injection
52396	Dexamethasone 1mg/5ml oral solution	Dexamethasone	200microgram/1ml	Oral solution
13952	DECADRON injection 4mg/ml [MSD MORSON]	dexamethasone sodium phosphate	4mg/ml	injection
26454	DECADRON injection 4mg/ml [MSD MORSON]	dexamethasone sodium phosphate	4mg/ml	injection
21668	DECADRON SHOCK PAK 20mg/ml [M S D]	dexamethasone sodium phosphate	20mg/ml	SHOCK PAK
31948	DEXAMETHASONE injection 4mg/ml [MAYNE]	dexamethasone sodium phosphate	4mg/ml	injection
34083	DEXAMETHASONE injection 5mg/ml [ORGANON]	dexamethasone sodium phosphate	5mg/ml	injection
19259	dexamethasone injection 8mg/2ml	dexamethasone sodium phosphate	8mg/2ml	injection

Prodcode	Product name	Drug substance name	Substance strength	Formulation
26300	dexamethasone shock treatment pack 20mg/ml	dexamethasone sodium phosphate	20mg/ml	shock treatment pack
28215	dexamethasone sodium phosphate injection 120mg/5ml	dexamethasone sodium phosphate	120mg/5ml	injection
4233	dexamethasone sodium phosphate injection 4mg/ml	dexamethasone sodium phosphate	4mg/ml	injection
13972	dexamethasone sodium phosphate injection 5mg/ml	dexamethasone sodium phosphate	5mg/ml	injection
11334	dexamethasone sodium phosphate IV injection 4mg/ml	dexamethasone sodium phosphate	4mg/ml	IV injection
47755	Docetaxel 160mg/16ml solution for infusion vials	Docetaxel	160mg/16ml	Concentrate For Solution For Infusion
36831	docetaxel concentrate for dilution for infusion solution 20mg/0.5ml	docetaxel	20mg/0.5ml	concentrate for dilution for infusion solution
38999	docetaxel concentrate for dilution for infusion solution 80mg/2ml	docetaxel	80mg/2ml	concentrate for dilution for infusion solution
33560	docetaxel concentrate for intravenous infusion 40mg/ml	docetaxel	40mg/ml	concentrate for intravenous infusion
44425	docetaxel concentrate for solution for infusion 20mg/1ml	docetaxel	20mg/1ml	concentrate for solution for infusion
23849	TAXOTERE concentrate for intravenous infusion 40mg/ml [AVENTIS]	docetaxel	40mg/ml	concentrate for intravenous infusion
36552	TAXOTERE concentrate for solution for infusion 20mg/0.5ml [AVENTIS]	docetaxel	20mg/0.5ml	concentrate for solution for infusion
44087	TAXOTERE concentrate for solution for infusion 20mg/1ml [AVENTIS]	docetaxel	20mg/1ml	concentrate for solution for infusion
26680	ADRIAMYCIN injection 10mg/vial [PHARMACIA]	doxorubicin hydrochloride	10mg/vial	injection
27469	ADRIAMYCIN injection 50mg/vial [PHARMACIA]	doxorubicin hydrochloride	50mg/vial	injection
42817	daclizumab concentrate for solution for infusion 25mg/5ml	daclizumab	25mg/5ml	concentrate for solution for infusion
42390	dasatinib tablets 100mg	dasatinib	100mg	tablets
37238	dasatinib tablets 20mg	dasatinib	20mg	tablets
36062	dasatinib tablets 50mg	dasatinib	50mg	tablets
36957	dasatinib tablets 70mg	dasatinib	70mg	tablets
66774	Benepali 50mg/1ml solution for injection pre-filled syringes (Biogen Idec Ltd)	Etanercept	50mg/1ml	Solution for injection
61373	Enbrel 50mg/1ml solution for injection pre-filled MyClic pen (Pfizer Ltd)	Etanercept	50mg/1ml	Solution for injection
37784	CAELYX concentrate for solution for infusion 20mg/10ml [JANSSEN]	doxorubicin hydrochloride	20mg/10ml	concentrate for solution for infusion
24997	CAELYX concentrate for solution for infusion 2mg/ml [SCHERING-P]	doxorubicin hydrochloride	2mg/ml	concentrate for solution for infusion
40250	CAELYX concentrate for solution for infusion 50mg/25ml [JANSSEN]	doxorubicin hydrochloride	50mg/25ml	concentrate for solution for infusion
37942	doxorubicin citrate liposomal complex powder for concentrate for solution for infusion 50mg	doxorubicin hydrochloride	50mg	powder for concentrate for solution for infusion
55271	Doxorubicin encapsulated in liposomes 2mg/ml concentrate solution for infusion	Doxorubicin Hydrochloride		
39307	doxorubicin injection 10mg/5ml	doxorubicin hydrochloride	10mg/5ml	injection
45026	doxorubicin injection 200mg/100ml	doxorubicin hydrochloride	200mg/100ml	injection
26947	doxorubicin injection 2mg/ml	doxorubicin hydrochloride	2mg/ml	injection
30836	doxorubicin powder for solution for injection 10mg	doxorubicin hydrochloride	10mg	powder for solution for injection
33878	MYOCET powder for concentrate for solution for infusion 50mg [CEPHALON]	doxorubicin hydrochloride	50mg	powder for concentrate for solution for infusion
56410	Caelyx 50mg/25ml concentrate for solution for infusion vials (Janssen-Cilag Ltd)	Doxorubicin hydrochloride liposomal pegylated	2mg/1ml	Solution for infusion
31539	epirubicin hydrochloride injection (powder) 20mg	epirubicin hydrochloride	20mg	injection (powder)
39387	epirubicin hydrochloride injection 100mg/50ml	epirubicin hydrochloride	100mg/50ml	injection
40251	epirubicin hydrochloride injection 200mg/100ml	epirubicin hydrochloride	200mg/100ml	injection
29652	epirubicin hydrochloride injection 2mg/ml	epirubicin hydrochloride	2mg/ml	injection

Prodcode	Product name	Drug substance name	Substance strength	Formulation
40816	epirubicin hydrochloride injection 50mg/25ml	epirubicin hydrochloride	50mg/25ml	injection
49856	Enbrel 50mg/1ml solution for injection pre-filled syringes (Pfizer Ltd)	Etanercept	50mg/1ml	Solution for injection
41058	ENBREL FOR PAEDIATRIC USE powder for solution for injection 25mg [PFIZER]	etanercept	25mg	powder for solution for injection
35419	ENBREL injection solution 25mg [PFIZER]	etanercept	25mg	injection solution
36556	ENBREL injection solution 50mg [PFIZER]	etanercept	50mg	injection solution
14886	ENBREL powder for solution for injection 25mg [PFIZER]	etanercept	25mg	powder for solution for injection
19257	ENBREL powder for solution for injection 50mg [WYETH PHAR]	etanercept	50mg	powder for solution for injection
47843	Etanercept 10mg powder and solvent for solution for injection vials	Etanercept	10mg	Powder For Solution For Injection
28325	epirubicin hydrochloride powder for solution for injection 50mg	epirubicin hydrochloride	50mg	powder for solution for injection
28889	PHARMORUBICIN injection solution 2mg/ml [PHARMACIA]	epirubicin hydrochloride	2mg/ml	injection solution
43639	PHARMORUBICIN powder for solution for injection 50mg [PHARMACIA]	epirubicin hydrochloride	50mg	powder for solution for injection
62759	Eribulin 880micrograms/2ml solution for injection vials	Eribulin	.44mg/1ml	Solution for injection
13604	ESTRACYT capsules 140mg [PHARMACIA]	estramustine sodium phosphate	140mg	capsules
13735	estramustine phosphate capsules 140mg	estramustine sodium phosphate	140mg	capsules
50998	Etanercept 50mg/1ml solution for injection pre-filled syringes	Etanercept	50mg/1ml	Solution for injection
36008	etanercept injection solution 25mg	etanercept	25mg	injection solution
35126	etanercept injection solution 50mg	etanercept	50mg	injection solution
36263	EPOSIN concentrate for solution for infusion 20mg/ml [MEDAC UK]	etoposide	20mg/ml	concentrate for solution for infusion
48177	Etoposide 100mg/5ml solution for infusion vials	Etoposide	20mg/1ml	Solution for infusion
63011	Etoposide 500mg/25ml solution for infusion vials	Etoposide	20mg/1ml	Solution for infusion
18751	etoposide capsules 100mg	etoposide	100mg	capsules
8756	etoposide capsules 50mg	etoposide	50mg	capsules
31115	etoposide concentrate for solution for infusion 20mg/ml	etoposide	20mg/ml	concentrate for solution for infusion
37375	VEPESID capsules 100mg [BRISTOL]	etoposide	100mg	capsules
29761	VEPESID capsules 50mg [BRISTOL]	etoposide	50mg	capsules
44387	etoposide phosphate lyophilised powder for injection 100mg	etoposide phosphate	100mg	lyophilised powder for injection
29743	FLUDARA ORAL tablets 10mg [GENZYME]	fludarabine phosphate	10mg	tablets
24681	fludarabine powder for solution for injection 50mg	fludarabine phosphate	50mg	powder for solution for injection
18476	fludarabine tablets 10mg	fludarabine phosphate	10mg	tablets
18070	Fluorouracil 250mg capsules	Fluorouracil	250mg	Capsule
15921	etanercept powder for solution for injection 25mg	etanercept	25mg	powder for solution for injection
26387	etanercept powder for solution for injection 50mg	etanercept	50mg	powder for solution for injection
43781	AFINITOR tablets 10mg [NOVARTIS]	everolimus	10mg	tablets
65378	Everolimus 500microgram tablets	Everolimus	500microgram	Tablet
46070	everolimus tablets 5mg	everolimus	5mg	tablets
47398	Golimumab 50mg/0.5ml solution for injection pre-filled syringes	Golimumab	100mg/1ml	Solution for injection
46370	golimumab pre-filled pen injection solution 50mg	golimumab	50mg	injection solution
18070	fluorouracil capsules 250mg	fluorouracil	250mg	capsules
19556	FLUORO-URACIL capsules 250mg [CAMBRIDGE]	fluorouracil	250mg	capsules
39388	fluorouracil injection 1g/20ml	fluorouracil	1g/20ml	injection
20229	FLUORO-URACIL injection 25mg/ml [CAMBRIDGE]	fluorouracil	25mg/ml	injection
36575	fluorouracil injection 50mg/ml	fluorouracil	50mg/ml	injection
58240	Fluorouracil 2.5g/100ml solution for infusion vials	Fluorouracil sodium	25mg/1ml	Solution for infusion
55091	Fluorouracil 500mg/10ml solution for injection vials	Fluorouracil sodium	50mg/1ml	Solution for injection
40780	gemcitabine powder for solution for infusion 1g/vial	gemcitabine hydrochloride	1g/vial	powder for solution for infusion
33418	gemcitabine powder for solution for infusion 200mg/vial	gemcitabine hydrochloride	200mg/vial	powder for solution for infusion
6884	HYDREA capsules 500mg [SQUIBB]	hydroxycarbamide	500mg	capsules

Prodcode	Product name	Drug substance name	Substance strength	Formulation
47127	Hydroxycarbamide 100mg tablets	Hydroxycarbamide	100mg	Film Coated Tablets
50565	Hydroxycarbamide 300mg capsules	Hydroxycarbamide	300mg	Capsule
59007	Hydroxycarbamide 500mg capsules (A A H Pharmaceuticals Ltd)	Hydroxycarbamide	500mg	Capsule
66728	Idelalisib 100mg tablets	Idelalisib	100mg	Tablet
65085	Zydelig 100mg tablets (Gilead Sciences International Ltd)	Idelalisib	100mg	Tablet
6333	hydroxycarbamide capsules 500mg	hydroxycarbamide	500mg	capsules
21295	GLIVEC capsules 100mg [NOVARTIS]	imatinib mesilate	100mg	capsules
33823	GLIVEC tablets 100mg [NOVARTIS]	imatinib mesilate	100mg	tablets
28800	GLIVEC tablets 400mg [NOVARTIS]	imatinib mesilate	400mg	tablets
33330	HYDROXYCARBAMIDE capsules 500mg [MEDAC UK]	hydroxycarbamide	500mg	capsules
39548	hydroxycarbamide film coated tablets 1000mg	hydroxycarbamide	1000mg	film coated tablets
38319	hydroxycarbamide oral solution 500mg/5ml	hydroxycarbamide	500mg/5ml	oral solution
3873	hydroxyurea capsules 500mg	hydroxycarbamide	500mg	capsules
65463	Siklos 1000mg tablets (Nordic Pharma Ltd)	Hydroxycarbamide	1gram	Tablet
31339	idarubicin hydrochloride capsules 10mg	idarubicin hydrochloride	10mg	capsules
31984	idarubicin hydrochloride capsules 5mg	idarubicin hydrochloride	5mg	capsules
43168	ifosfamide injection 2g/vial	ifosfamide	2g/vial	injection
21286	imatinib capsules 100mg	imatinib mesilate	100mg	capsules
29229	imatinib tablets 100mg	imatinib mesilate	100mg	tablets
21318	imatinib tablets 400mg	imatinib mesilate	400mg	tablets
64636	Inflectra 100mg powder for concentrate for solution for infusion vials (Hospira UK Ltd)	Infliximab	100mg	Powder for solution for infusion
40983	irinotecan hydrochloride concentrate for solution for infusion 40mg/2ml	irinotecan hydrochloride	40mg/2ml	concentrate for solution for infusion
59339	Irinotecan 40mg/2ml concentrate for solution for infusion vials (Hospira UK Ltd)	Irinotecan hydrochloride trihydrate	20mg/1ml	Solution for infusion
16822	infliximab powder for concentrate for solution for infusion 100mg	infliximab	100mg	powder for concentrate for solution for infusion
18460	ARAVA tablets 100mg [AVENTIS]	leflunomide	100mg	tablets
16522	ARAVA tablets 10mg [AVENTIS]	leflunomide	10mg	tablets
17642	ARAVA tablets 20mg [AVENTIS]	leflunomide	20mg	tablets
48217	Leflunomide 10mg tablets (medac UK)	Leflunomide	10mg	Tablet
62993	Leflunomide 20mg tablets (Sandoz Ltd)	Leflunomide	20mg	Tablet
4970	leflunomide tablets 100mg	leflunomide	100mg	tablets
4971	leflunomide tablets 10mg	leflunomide	10mg	tablets
6934	leflunomide tablets 20mg	leflunomide	20mg	tablets
60630	Lenalidomide 2.5mg capsules	Lenalidomide	2.5mg	Capsule
44529	lenalidomide capsules 10mg	lenalidomide	10mg	capsules
46205	lenalidomide capsules 15mg	lenalidomide	15mg	capsules
40626	lenalidomide capsules 25mg	lenalidomide	25mg	capsules
42056	lenalidomide capsules 5mg	lenalidomide	5mg	capsules
58227	Revlimid 10mg capsules (Celgene Ltd)	Lenalidomide	10mg	Capsule
56818	Revlimid 15mg capsules (Celgene Ltd)	Lenalidomide	15mg	Capsule
41139	REVLIMID capsules 25mg [CELGENE]	lenalidomide	25mg	capsules
22392	REMICADE powder for concentrate for solution for infusion 100mg [SCHERING-P]	infliximab	100mg	powder for concentrate for solution for infusion
58862	Ipilimumab 200mg/40ml solution for infusion vials	Ipilimumab	5mg/1ml	Solution for infusion
25848	CCNU capsules 10mg [LUNDBECK]	lomustine	10mg	capsules
8404	CCNU capsules 40mg [LUNDBECK]	lomustine	40mg	capsules
12067	lomustine capsules 40mg	lomustine	40mg	capsules
30014	MITHRACIN injection 2.5mg/vial [PFIZER]	mannitol/sodium phosphate/plicamycin	2.5mg/vial	injection
31494	mithramycin injection 2.5mg/vial	mannitol/sodium phosphate/plicamycin	2.5mg/vial	injection
26343	ALKERAN tablets 2mg [WELLCOME]	melphalan	2mg	tablets
23270	ALKERAN tablets 5mg [WELLCOME]	melphalan	5mg	tablets
16929	melphalan tablets 2mg	melphalan	2mg	tablets
12150	melphalan tablets 5mg	melphalan	5mg	tablets
26580	melphalan injection 100mg/vial	melphalan hydrochloride	100mg/vial	injection
37099	melphalan powder for solution for injection 50mg	melphalan hydrochloride	50mg	powder for solution for injection
57239	Mercaptopurine 20mg/ml oral suspension	Mercaptopurine	20mg/1ml	Oral suspension
56753	Mercaptopurine 25mg tablets	Mercaptopurine	25mg	Tablet
55772	Mercaptopurine 25mg/5ml oral suspension	Mercaptopurine	5mg/1ml	Oral suspension
61545	Mercaptopurine 50mg tablets (Aspen Pharma Trading Ltd)	Mercaptopurine	50mg	Tablet

Prodcode	Product name	Drug substance name	Substance strength	Formulation
52333	Mercaptopurine 75mg/5ml oral suspension	Mercaptopurine	15mg/1ml	Oral suspension
19982	mercaptopurine capsules 10mg	mercaptopurine	10mg	capsules
47369	Mercaptopurine Oral solution	Mercaptopurine		Oral Liquid
32972	mercaptopurine tablets 10mg	mercaptopurine	10mg	tablets
3450	mercaptopurine tablets 50mg	mercaptopurine	50mg	tablets
29675	PURI-NETHOL tablets 50mg [ALKOPHARMA]	mercaptopurine	50mg	tablets
21753	MAXTREX tablets 10mg [PHARMACIA]	methotrexate	10mg	tablets
13428	MAXTREX tablets 2.5mg [PHARMACIA]	methotrexate	2.5mg	tablets
57441	Methotrexate 10mg tablets (A A H Pharmaceuticals Ltd)	Methotrexate	10mg	Tablet
58885	Methotrexate 10mg tablets (Sigma Pharmaceuticals Plc)	Methotrexate	10mg	Tablet
59538	Methotrexate 10mg tablets (Teva UK Ltd)	Methotrexate	10mg	Tablet
57174	Methotrexate 10mg tablets (Waymade Healthcare Plc)	Methotrexate	10mg	Tablet
61151	Methotrexate 10mg/0.2ml solution for injection pre-filled disposable devices	Methotrexate	50mg/1ml	Solution for injection
56037	Methotrexate 2.5mg tablets (A A H Pharmaceuticals Ltd)	Methotrexate	2.5mg	Tablet
51120	Methotrexate 2.5mg tablets (Alliance Healthcare (Distribution) Ltd)	Methotrexate	2.5mg	Tablet
62833	Methotrexate 2.5mg tablets (DE Pharmaceuticals)	Methotrexate	2.5mg	Tablet
60979	Methotrexate 2.5mg tablets (Morningside Healthcare Ltd)	Methotrexate	2.5mg	Tablet
58303	Methotrexate 2.5mg tablets (Orion Pharma (UK) Ltd)	Methotrexate	2.5mg	Tablet
49951	Methotrexate 2.5mg tablets (Sandoz Ltd)	Methotrexate	2.5mg	Tablet
52606	Methotrexate 2.5mg tablets (Sigma Pharmaceuticals Plc)	Methotrexate	2.5mg	Tablet
59685	Methotrexate 2.5mg tablets (Teva UK Ltd)	Methotrexate	2.5mg	Tablet
53385	Methotrexate 2.5mg tablets (Waymade Healthcare Plc)	Methotrexate	2.5mg	Tablet
61085	Methotrexate 2.5mg tablets (Waymade Healthcare Plc)	Methotrexate	2.5mg	Tablet
61122	Methotrexate 25mg/0.5ml solution for injection pre-filled disposable devices	Methotrexate	50mg/1ml	Solution for injection
59723	Methotrexate 7.5mg/5ml oral solution	Methotrexate	1.5mg/1ml	Oral solution
40371	methotrexate injection 10mg/0.2ml	methotrexate	10mg/0.2ml	injection
32865	methotrexate injection 10mg/1ml	methotrexate	10mg/1ml	injection
46152	methotrexate injection 12.5mg/0.25ml	methotrexate	12.5mg/0.25ml	injection
40281	methotrexate injection 15mg/0.3ml	methotrexate	15mg/0.3ml	injection
27404	methotrexate injection 15mg/1.5ml	methotrexate	15mg/1.5ml	injection
46156	methotrexate injection 17.5mg/0.35ml	methotrexate	17.5mg/0.35ml	injection
40273	methotrexate injection 20mg/0.4ml	methotrexate	20mg/0.4ml	injection
45165	methotrexate injection 20mg/1ml	methotrexate	20mg/1ml	injection
26064	methotrexate injection 20mg/2ml	methotrexate	20mg/2ml	injection
46129	methotrexate injection 22.5mg/0.45ml	methotrexate	22.5mg/0.45ml	injection
40328	methotrexate injection 25mg/0.5ml	methotrexate	25mg/0.5ml	injection
45558	methotrexate injection 25mg/1.25ml	methotrexate	25mg/1.25ml	injection
24634	methotrexate injection 25mg/2.5ml	methotrexate	25mg/2.5ml	injection
44908	methotrexate injection 30mg/0.6ml	methotrexate	30mg/0.6ml	injection
46039	methotrexate injection 30mg/1.5ml	methotrexate	30mg/1.5ml	injection
40301	methotrexate injection 7.5mg/0.15ml	methotrexate	7.5mg/0.15ml	injection
35402	methotrexate injection 7.5mg/0.75ml	methotrexate	7.5mg/0.75ml	injection
36800	methotrexate oral solution 10mg/5ml	methotrexate	10mg/5ml	oral solution
36849	methotrexate oral suspension 10mg/5ml	methotrexate	10mg/5ml	oral suspension
28041	methotrexate oral suspension 12.5mg/5ml	methotrexate	12.5mg/5ml	oral suspension
35752	methotrexate oral suspension 7.5mg/5ml	methotrexate	7.5mg/5ml	oral suspension
18424	methotrexate sodium tablets 2.5mg	methotrexate	2.5mg	tablets
41585	METHOTREXATE SODIUM tablets 2.5mg [WYETH PHAR]	methotrexate	2.5mg	tablets
17035	methotrexate suspension 2.5mg/5ml	methotrexate	2.5mg/5ml	suspension
877	methotrexate tablets 10mg	methotrexate	10mg	tablets
34929	METHOTREXATE tablets 10mg [HOSPIRA]	methotrexate	10mg	tablets
823	methotrexate tablets 2.5mg	methotrexate	2.5mg	tablets
41104	METHOTREXATE tablets 2.5mg [CP PHARM]	methotrexate	2.5mg	tablets
20951	METHOTREXATE tablets 2.5mg [GOLDSHIELD]	methotrexate	2.5mg	tablets
32111	METHOTREXATE tablets 2.5mg [HOSPIRA]	methotrexate	2.5mg	tablets
30780	METHOTREXATE tablets 2.5mg [PHARMACIA]	methotrexate	2.5mg	tablets
40356	METOJECT injection 10mg/0.2ml [MEDAC UK]	methotrexate	10mg/0.2ml	injection
37117	METOJECT injection 10mg/1ml [MEDAC UK]	methotrexate	10mg/1ml	injection

Prodcode	Product name	Drug substance name	Substance strength	Formulation
46098	METOJECT injection 12.5mg/0.25ml [MEDAC UK]	methotrexate	12.5mg/0.25ml	injection
40284	METOJECT injection 15mg/0.3ml [MEDAC UK]	methotrexate	15mg/0.3ml	injection
27400	METOJECT injection 15mg/1.5ml [MEDAC UK]	methotrexate	15mg/1.5ml	injection
46265	METOJECT injection 17.5mg/0.35ml [MEDAC UK]	methotrexate	17.5mg/0.35ml	injection
40292	METOJECT injection 20mg/0.4ml [MEDAC UK]	methotrexate	20mg/0.4ml	injection
14348	METOJECT injection 20mg/2ml [MEDAC UK]	methotrexate	20mg/2ml	injection
46197	METOJECT injection 22.5mg/0.45ml [MEDAC UK]	methotrexate	22.5mg/0.45ml	injection
40293	METOJECT injection 25mg/0.5ml [MEDAC UK]	methotrexate	25mg/0.5ml	injection
33601	METOJECT injection 25mg/2.5ml [MEDAC UK]	methotrexate	25mg/2.5ml	injection
40280	METOJECT injection 7.5mg/0.15ml [MEDAC UK]	methotrexate	7.5mg/0.15ml	injection
35865	METOJECT injection 7.5mg/0.75ml [MEDAC UK]	methotrexate	7.5mg/0.75ml	injection
61050	Metoject PEN 10mg/0.2ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
61171	Metoject PEN 15mg/0.3ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
61181	Metoject PEN 17.5mg/0.35ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
61180	Metoject PEN 20mg/0.4ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
61169	Metoject PEN 25mg/0.5ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
62421	Metoject PEN 27.5mg/0.55ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
61488	Metoject PEN 30mg/0.6ml solution for injection pre-filled pen (medac UK)	Methotrexate	50mg/1ml	Solution for injection
27342	MAXTREX injection 2.5mg/ml [PHARMACIA]	methotrexate sodium	2.5mg/ml	injection
51667	Methotrexate 200mg/8ml solution for injection vials	Methotrexate sodium	25mg/1ml	Solution for injection
65584	Methotrexate 2mg/ml oral solution sugar free	Methotrexate sodium	2mg/1ml	Oral solution
51321	Methotrexate 50mg/2ml solution for injection vials	Methotrexate sodium	25mg/1ml	Solution for injection
53696	Methotrexate 50mg/2ml solution for injection vials (A A H Pharmaceuticals Ltd)	Methotrexate sodium	25mg/1ml	Solution for injection
49547	Methotrexate 5g/200ml solution for infusion vials	Methotrexate sodium	25mg/1ml	Solution for infusion
36167	methotrexate injection 1000mg/10ml	methotrexate sodium	1000mg/10ml	injection
46407	methotrexate injection 1000mg/40ml	methotrexate sodium	1000mg/40ml	injection
12816	methotrexate injection 100mg/ml	methotrexate sodium	100mg/ml	injection
7337	methotrexate injection 10mg/0.4ml	methotrexate sodium	10mg/0.4ml	injection
7336	methotrexate injection 12.5mg/0.5ml	methotrexate sodium	12.5mg/0.5ml	injection
16540	methotrexate injection 15mg/0.6ml	methotrexate sodium	15mg/0.6ml	injection
18890	methotrexate injection 17.5mg/0.7ml	methotrexate sodium	17.5mg/0.7ml	injection
14347	methotrexate injection 20mg/0.8ml	methotrexate sodium	20mg/0.8ml	injection
34258	METHOTREXATE injection 20mg/0.8ml [CENT HOME]	methotrexate sodium	20mg/0.8ml	injection
17672	methotrexate injection 22.5mg/0.9ml	methotrexate sodium	22.5mg/0.9ml	injection
16519	methotrexate injection 25mg/1ml	methotrexate sodium	25mg/1ml	injection
8583	methotrexate injection 25mg/ml	methotrexate sodium	25mg/ml	injection
27642	methotrexate injection 27.5mg/1.1ml	methotrexate sodium	27.5mg/1.1ml	injection
30703	methotrexate injection 30mg/1.2ml	methotrexate sodium	30mg/1.2ml	injection
41086	methotrexate injection 5000mg/50ml	methotrexate sodium	5000mg/50ml	injection
32229	methotrexate injection 500mg/20ml	methotrexate sodium	500mg/20ml	injection
24783	methotrexate injection 50mg/2ml	methotrexate sodium	50mg/2ml	injection
8327	methotrexate injection 50mg/3ml	methotrexate sodium	50mg/3ml	injection
30932	methotrexate injection 5mg/0.2ml	methotrexate sodium	5mg/0.2ml	injection
9528	methotrexate injection 5mg/2ml	methotrexate sodium	5mg/2ml	injection
16570	methotrexate injection 7.5mg/0.3ml	methotrexate sodium	7.5mg/0.3ml	injection
14748	methotrexate sodium injection 25mg/ml	methotrexate sodium	25mg/ml	injection
29069	methotrexate sterile powder 500mg/vial	methotrexate sodium	500mg/vial	sterile powder
57103	Metoject 27.5mg/0.55ml solution for injection pre-filled syringes (medac UK)	Methotrexate sodium	50mg/1ml	Solution for injection
66487	Zlatal 12.5mg/0.5ml solution for injection pre-filled syringes (Nordic Pharma Ltd)	Methotrexate sodium	25mg/1ml	Solution for injection
37396	MYELOBROMOL tablets 125mg [DURBIN]	mitobronitol	125mg	tablets
44478	LYSODREN tablets 500mg [LAB HRA]	mitotane	500mg	tablets
35826	mitotane tablets 500mg	mitotane	500mg	tablets

Prodcode	Product name	Drug substance name	Substance strength	Formulation
39366	mitoxantrone concentrate for solution for infusion 10mg/5ml	mitoxantrone hydrochloride	10mg/5ml	concentrate for solution for infusion
41267	mitoxantrone concentrate for solution for infusion 20mg/10ml	mitoxantrone hydrochloride	20mg/10ml	concentrate for solution for infusion
33174	mitoxantrone concentrate for solution for infusion 2mg/ml	mitoxantrone hydrochloride	2mg/ml	concentrate for solution for infusion
15405	NOVANTRONE concentrate for solution for infusion 2mg/ml [WYETH PHAR]	mitoxantrone hydrochloride	2mg/ml	concentrate for solution for infusion
45393	ARZIP tablets 500mg [WINTHROP]	mycophenolate mofetil	500mg	tablets
57593	CellCept 500mg tablets (Waymade Healthcare Plc)	Mycophenolate mofetil	500mg	Tablet
16919	CELLCEPT capsules 250mg [ROCHE]	mycophenolate mofetil	250mg	capsules
21732	CELLCEPT oral suspension 1g/5ml [ROCHE]	mycophenolate mofetil	1g/5ml	oral suspension
30581	CELLCEPT powder for concentrate for solution for infusion 500mg [ROCHE]	mycophenolate mofetil	500mg	powder for concentrate for solution for infusion
18804	CELLCEPT tablets 500mg [ROCHE]	mycophenolate mofetil	500mg	tablets
57272	Mycophenolate mofetil 125mg/5ml oral suspension	Mycophenolate mofetil	25mg/1ml	Oral suspension
60231	Mycophenolate mofetil 250mg capsules (A A H Pharmaceuticals Ltd)	Mycophenolate mofetil	250mg	Capsule
54317	Mycophenolate mofetil 250mg capsules (Sandoz Ltd)	Mycophenolate mofetil	250mg	Capsule
53255	Mycophenolate mofetil 250mg capsules (Sigma Pharmaceuticals Plc)	Mycophenolate mofetil	250mg	Capsule
58530	Mycophenolate mofetil 500mg tablets (Sigma Pharmaceuticals Plc)	Mycophenolate mofetil	500mg	Tablet
4438	mycophenolate mofetil capsules 250mg	mycophenolate mofetil	250mg	capsules
16879	mycophenolate mofetil oral suspension 1g/5ml	mycophenolate mofetil	1g/5ml	oral suspension
7077	mycophenolate mofetil powder for concentrate for solution for infusion 500mg	mycophenolate mofetil	500mg	powder for concentrate for solution for infusion
4230	mycophenolate mofetil tablets 500mg	mycophenolate mofetil	500mg	tablets
50669	Mycophenolate motefil 500mg tablets (Sandoz Ltd)	Mycophenolate mofetil	500mg	Tablet
47746	Mycophenolate motefil 500mg tablets (Wockhardt UK Ltd)	Mycophenolate mofetil	500mg	Tablet
45489	MYFENAX capsules 250mg [TEVA]	mycophenolate mofetil	250mg	capsules
45043	MYFENAX tablets 500mg [TEVA]	mycophenolate mofetil	500mg	tablets
35301	mycophenolic acid gastro-resistant tablets 180mg	mycophenolate sodium	180mg	gastro-resistant tablets
26097	mycophenolic acid gastro-resistant tablets 360mg	mycophenolate sodium	360mg	gastro-resistant tablets
27290	MYFORTIC tablets 180mg [NOVARTIS]	mycophenolate sodium	180mg	tablets
27289	MYFORTIC tablets 360mg [NOVARTIS]	mycophenolate sodium	360mg	tablets
23832	ELOXATIN powder for concentrate for solution for infusion 100mg [SANOFI S]	oxaliplatin	100mg	powder for concentrate for solution for infusion
50277	Oxaliplatin 100mg/20ml concentrate for solution for infusion vials (A A H Pharmaceuticals Ltd)	Oxaliplatin	5mg/1ml	Solution for infusion
39895	oxaliplatin concentrate for solution for infusion 100mg/20ml	oxaliplatin	100mg/20ml	concentrate for solution for infusion
39553	oxaliplatin concentrate for solution for infusion 50mg/10ml	oxaliplatin	50mg/10ml	concentrate for solution for infusion
36714	oxaliplatin powder for concentrate for solution for infusion 100mg	oxaliplatin	100mg	powder for concentrate for solution for infusion
27293	oxaliplatin powder for concentrate for solution for infusion 50mg	oxaliplatin	50mg	powder for concentrate for solution for infusion
41191	natalizumab concentrate for solution for infusion 300mg/15ml	natalizumab	300mg/15ml	concentrate for solution for infusion
47754	Paclitaxel 100mg/16.7ml solution for infusion vials	Paclitaxel	6mg/1ml	Solution for infusion

Prodcode	Product name	Drug substance name	Substance strength	Formulation
39919	paclitaxel albumin bound powder for suspension for infusion 100mg	paclitaxel	100mg	powder for suspension for infusion
45147	paclitaxel concentrate for solution for infusion 150mg/25ml	paclitaxel	150mg/25ml	concentrate for solution for infusion
35854	paclitaxel concentrate for solution for infusion 30mg/5ml	paclitaxel	30mg/5ml	concentrate for solution for infusion
14381	paclitaxel concentrate for solution for infusion 6mg/ml	paclitaxel	6mg/ml	concentrate for solution for infusion
35384	TAXOL concentrate for solution for infusion 30mg/5ml [BMS]	paclitaxel	30mg/5ml	concentrate for solution for infusion
16173	TAXOL concentrate for solution for infusion 6mg/ml [BMS]	paclitaxel	6mg/ml	concentrate for solution for infusion
61366	Abraxane 100mg powder for suspension for infusion vials (Celgene Ltd)	Paclitaxel albumin	100mg	Powder for suspension for infusion
37272	pemetrexed powder for concentrate for solution for infusion 500mg	pemetrexed disodium	500mg	powder for concentrate for solution for infusion
43888	pentostatin powder for solution for injection 10mg	pentostatin (deoxycoformycin)	10mg	powder for solution for injection
38254	TYSABRI concentrate for solution for infusion 300mg/15ml [BIOGEN]	natalizumab	300mg/15ml	concentrate for solution for infusion
45820	nilotinib capsules 150mg	nilotinib hydrochloride monohydrate	150mg	capsules
28605	NATULAN capsules 50mg [CAMBRIDGE]	procarbazine hydrochloride	50mg	capsules
17186	procarbazine capsules 50mg	procarbazine hydrochloride	50mg	capsules
38317	nilotinib capsules 200mg	nilotinib hydrochloride monohydrate	200mg	capsules
39111	rituximab concentrate for intravenous infusion 10mg/ml	rituximab	10mg/ml	concentrate for intravenous infusion
44222	raltitrexed powder for concentrate for solution for infusion 2mg	raltitrexed	2mg	powder for concentrate for solution for infusion
22640	razoxane tablets 125mg	razoxane	125mg	tablets
12066	RAZOXIN tablets 125mg [CAMBRIDGE]	razoxane	125mg	tablets
33728	RAPAMUNE oral solution 1mg/ml [PFIZER]	sirolimus	1mg/ml	oral solution
23289	RAPAMUNE tablets 1mg [PFIZER]	sirolimus	1mg	tablets
28999	RAPAMUNE tablets 2mg [PFIZER]	sirolimus	2mg	tablets
20097	sirolimus oral solution 1mg/ml	sirolimus	1mg/ml	oral solution
6600	sirolimus tablets 1mg	sirolimus	1mg	tablets
6484	sirolimus tablets 2mg	sirolimus	2mg	tablets
44783	sirolimus tablets 500 micrograms	sirolimus	500 micrograms	tablets
65704	Adoport 0.75mg capsules (Sandoz Ltd)	Tacrolimus	750microgram	Capsule
63866	Adoport 2mg capsules (Sandoz Ltd)	Tacrolimus	2mg	Capsule
44804	ADOPORT twice daily capsules 1mg [SANDOZ]	tacrolimus	1mg	twice daily capsules
44640	ADOPORT twice daily capsules 500 micrograms [SANDOZ]	tacrolimus	500 micrograms	twice daily capsules
28490	rituximab concentrate for solution for infusion 100mg/10ml	rituximab	100mg/10ml	concentrate for solution for infusion
44641	ADOPORT twice daily capsules 5mg [SANDOZ]	tacrolimus	5mg	twice daily capsules
37506	ADVAGRAF once daily modified release capsules 1mg [ASTELLAS]	tacrolimus	1mg	once daily modified release capsules
40765	ADVAGRAF once daily modified release capsules 3mg [ASTELLAS]	tacrolimus	3mg	once daily modified release capsules
39633	ADVAGRAF once daily modified release capsules 500 micrograms [ASTELLAS]	tacrolimus	500 micrograms	once daily modified release capsules
38919	ADVAGRAF once daily modified release capsules 5mg [ASTELLAS]	tacrolimus	5mg	once daily modified release capsules
46325	MODIGRAF granules for oral suspension 1mg [ASTELLAS]	tacrolimus	1mg	granules for oral suspension
46324	MODIGRAF granules for oral suspension 200micrograms [ASTELLAS]	tacrolimus	200micrograms	granules for oral suspension
54198	Prograf 1mg capsules (Lexon (UK) Ltd)	Tacrolimus	1mg	Capsule
3683	PROGRAF twice daily capsules 1mg [ASTELLAS]	tacrolimus	1mg	twice daily capsules
5870	PROGRAF twice daily capsules 500 micrograms [ASTELLAS]	tacrolimus	500 micrograms	twice daily capsules
13271	PROGRAF twice daily capsules 5mg [ASTELLAS]	tacrolimus	5mg	twice daily capsules
55066	Tacrolimus 2.5mg/5ml oral solution	Tacrolimus	500microgram/1ml	Oral solution
63924	Tacrolimus 2mg capsules	Tacrolimus	2mg	Capsule

Prodcode	Product name	Drug substance name	Substance strength	Formulation
54048	Tacrolimus 500micrograms/5ml oral suspension	Tacrolimus	100microgram/1ml	Oral suspension
63720	Tacrolimus 750microgram capsules	Tacrolimus	750microgram	Capsule
36294	rituximab concentrate for solution for infusion 500mg/50ml	rituximab	500mg/50ml	concentrate for solution for infusion
33123	tacrolimus concentrate for solution for infusion 5mg/1ml	tacrolimus	5mg/1ml	concentrate for solution for infusion
43081	tacrolimus granules for oral suspension 1mg	tacrolimus	1mg	granules for oral suspension
43082	tacrolimus granules for oral suspension 200micrograms	tacrolimus	200micrograms	granules for oral suspension
40453	TORISEL concentrate for solution for infusion 30mg/1.2ml [PFIZER]	temsirolimus	30mg/1.2ml	concentrate for solution for infusion
62957	Tocilizumab 400mg/20ml solution for infusion vials	Tocilizumab	20mg/1ml	Solution for infusion
46348	tocilizumab concentrate for solution for infusion 200mg/10ml	tocilizumab	200mg/10ml	concentrate for solution for infusion
37985	tacrolimus once daily modified release capsules 1mg	tacrolimus	1mg	once daily modified release capsules
40964	tacrolimus once daily modified release capsules 3mg	tacrolimus	3mg	once daily modified release capsules
38113	tacrolimus once daily modified release capsules 500 micrograms	tacrolimus	500 micrograms	once daily modified release capsules
38989	tacrolimus once daily modified release capsules 5mg	tacrolimus	5mg	once daily modified release capsules
44926	tacrolimus oral suspension 2.5mg/5ml	tacrolimus	2.5mg/5ml	oral suspension
37155	tacrolimus suspension 1mg/ml	tacrolimus	1mg/ml	suspension
41502	tocilizumab concentrate for solution for infusion 80mg/4ml	tocilizumab	80mg/4ml	concentrate for solution for infusion
64612	Apremilast 30mg tablets			
2839	tacrolimus twice daily capsules 1mg	tacrolimus	1mg	twice daily capsules
6495	tacrolimus twice daily capsules 500 micrograms	tacrolimus	500 micrograms	twice daily capsules
5089	tacrolimus twice daily capsules 5mg	tacrolimus	5mg	twice daily capsules
55010	Vivadex 5mg capsules (Dexcel-Pharma Ltd)	Tacrolimus	5mg	Capsule
33519	UFTORAL capsules 224mg + 100mg [MERCK SER]	tegafur/uracil	224mg + 100mg	capsules
33520	uracil with tegafur capsules 224mg + 100mg	tegafur/uracil	224mg + 100mg	capsules
55077	Temodal 100mg capsules (Merck Sharp & Dohme Ltd)	Temozolomide	100mg	Capsule
35226	TEMODAL capsules 20mg [SCHERING-P]	temozolomide	20mg	capsules
29700	TEMODAL capsules 250mg [SCHERING-P]	temozolomide	250mg	capsules
33803	TEMODAL capsules 5mg [SCHERING-P]	temozolomide	5mg	capsules
21249	temozolomide capsules 100mg	temozolomide	100mg	capsules
42372	temozolomide capsules 140mg	temozolomide	140mg	capsules
32490	temozolomide capsules 20mg	temozolomide	20mg	capsules
21250	temozolomide capsules 250mg	temozolomide	250mg	capsules
27922	temozolomide capsules 5mg	temozolomide	5mg	capsules
33385	thiotepa powder for solution for injection 15mg	thiotepa	15mg	powder for solution for injection
26502	LANVIS tablets 40mg [ALKOPHARMA]	tioguanine	40mg	tablets
20094	tioguanine tablets 40mg	tioguanine	40mg	tablets
33227	HYCAMTIN powder for concentrate for solution for infusion 4mg [GLAXSK PHA]	topotecan hydrochloride	4mg	powder for concentrate for solution for infusion
47396	Topotecan 1mg capsules	Topotecan hydrochloride	1mg	Capsule
41960	topotecan powder for concentrate for solution for infusion 1mg	topotecan hydrochloride	1mg	powder for concentrate for solution for infusion
59362	Trabectedin 1mg powder for solution for infusion vials	Trabectedin	1mg	Powder for solution for infusion
24448	treosulfan capsules 250mg	treosulfan	250mg	capsules
23871	TREOSULFAN capsules 250mg [FARILLON]	treosulfan	250mg	capsules
32604	vinblastine sulphate injection 10mg/10ml	vinblastine sulphate	10mg/10ml	injection
31223	vinblastine sulphate injection 10mg/vial	vinblastine sulphate	10mg/vial	injection
42684	vinorelbine concentrate for solution for infusion 10mg/1ml	vinorelbine	10mg/1ml	concentrate for solution for infusion
33171	vinorelbine injection solution 10mg/ml	vinorelbine	10mg/ml	injection solution
46838	Vinorelbine 80mg capsules	Vinorelbine Tartrate	80mg	Capsules
32774	vinorelbine capsules 20mg	vinorelbine tartrate	20mg	capsules
60112	Erivedge 150mg capsules (Roche Products Ltd)	Vismodegib	150mg	Capsule
65140	Vismodegib 150mg capsules	Vismodegib	150mg	Capsule
59842	Azacitidine 100mg powder for suspension for injection vials			

Prodcode	Product name	Drug substance name	Substance strength	Formulation
3918	AZATHIOPRINE 10 MG TAB			
8776	AZATHIOPRINE 100 MG TAB			
15556	AZATHIOPRINE 125 MG TAB			
52921	Azathioprine 125mg/5ml oral suspension			
58142	Brentuximab vedotin 50mg powder for solution for infusion vials			
17206	AZATHIOPRINE 50 MG SUS			
66436	Cetuximab 500mg/100ml solution for infusion vials			
50494	Etanercept 50mg/1ml solution for injection 1ml pre-filled disposable devices			
58819	Herceptin 600mg/5ml solution for injection vials (Roche Products Ltd)			
20721	CCNU			
26806	DECADRON 2 MG TAB			
64427	Idelalisib 150mg tablets			
62157	Hydroxycarbamide 500mg/5ml oral suspension			
1901	IMURAN 10 MG TAB			
62007	Leflunomide 15mg tablets			
65629	Mercaptopurine 30mg capsules			
66583	Mercaptopurine 75mg tablets			
56041	Ipilimumab 50mg/10ml solution for infusion vials			
27579	METHOTREXATE			
61081	Methotrexate 12.5mg/0.25ml solution for injection pre-filled disposable devices			
61273	Methotrexate 15mg/0.3ml solution for injection pre-filled disposable devices			
61137	Methotrexate 17.5mg/0.35ml solution for injection pre-filled disposable devices			
61140	Methotrexate 20mg/0.4ml solution for injection pre-filled disposable devices			
61082	Methotrexate 22.5mg/0.45ml solution for injection pre-filled disposable devices			
65531	Otezla tablets treatment initiation pack (Celgene Ltd)			
21889	METHOTREXATE 25MG/1ML			
62753	Methotrexate 27.5mg/0.55ml solution for injection pre-filled syringes			
61796	Methotrexate 30mg/0.6ml solution for injection pre-filled disposable devices			
61172	Methotrexate 7.5mg/0.15ml solution for injection pre-filled disposable devices			
61211	Metoject PEN 12.5mg/0.25ml solution for injection pre-filled pen (medac UK)			
61419	Metoject PEN 22.5mg/0.45ml solution for injection pre-filled pen (medac UK)			
61178	Metoject PEN 7.5mg/0.15ml solution for injection pre-filled pen (medac UK)			
37395	MYELOBROMOL (NAMED PATIENT ONLY) 125 MG TAB			
63210	Rapamune 0.5mg tablets (Pfizer Ltd)			
64152	Tacrolimus 1mg modified-release tablets			
26332	THIOTEPA 15 MG INJ			
62009	Trabectedin 250microgram powder for solution for infusion vials			
28726	TREOSULFAN LEO			
61908	Pertuzumab 420mg/14ml solution for infusion vials			

Appendix 18 Completeness of recording of variables to identify dose and duration of immunosuppressive treatment before 'hot decking' technique*

Data available from CPRD	Zoster burden study (% complete data)		Zoster vaccine uptake study (% complete data)	
	Prescriptions for oral corticosteroids	Prescriptions other immunosuppressive medications' prescriptions	Prescriptions oral corticosteroids	Prescriptions other immunosuppressive medications
Total quantity[a]	99.3%	99.7%	99.6%	99.8%
Dose in mg	100%	100%	100%	100%
Numeric daily dose[b]	55.3%	55%	82.2%	53.5%
Number of packs[c]	4.3%	4.2%	4.8%	3.1%
Number of days[d]	5.6%	3.7%	5%	3%

* Based on[46]
[a] Total quantity of the product entered by GP
[b] Total number of tablets per day for particular prescription
[c] Number of individual product packs prescribed for particular prescription
[d] Number of total treatment days for that prescription

Appendix 19 Code list seasonal influenza vaccine

medcode	readcode	readterm
6	65E..00	Influenza vaccination
10821	68NV.00	Influenza vacc consent given
12336	ZV04800	[V]Influenza vaccination
13025	U60K400	[X]Influenza vaccine causing adverse effects therapeutic use
21123	ZV04811	[V]Flu - influenza vaccination
49070	F034G00	Post influenza vaccination encephalitis
94301	65E0.00	First pandemic influenza vaccination
95092	65E1.00	Second pandemic influenza vaccination
97941	65E2.00	Influenza vaccination given by other healthcare provider
98047	68Nr.00	Consent given for pandemic influenza vaccination
98183	65E9.00	PANDEMRIX - first influenza A (H1N1v) 2009 vaccination given
98184	65EA.00	PANDEMRIX - second influenza A (H1N1v) 2009 vaccination give
98203	65EB.00	PANDEMRIX - 1st flu A (H1N1v) 2009 vac by othr hlth provider
98217	65E3.00	1st pandemic influenza vacc give by other healthcare providr
98234	65E5.00	CELVAPAN - first influenza A (H1N1v) 2009 vaccination given
98302	65E6.00	CELVAPAN - second influenza A (H1N1v) 2009 vaccination given
98303	65E8.00	CELVAPAN - 2nd flu A (H1N1v) 2009 vacc by othr hlth provider
98304	65EC.00	PANDEMRIX - 2nd flu A (H1N1v) 2009 vac by othr hlth provider
98306	65E4.00	2nd pandemic influenza vacc give by other healthcare providr
98449	65E7.00	CELVAPAN - 1st flu A (H1N1v) 2009 vacc by othr hlth provider
99801	68Nt.00	Consent given for influenza A subtype H1N1 vaccination
104688	65ED.00	Seasonal influenza vaccination
104958	68NV000	Consent given for seasonal influenza vaccination
105077	65E2000	Seasonal influenza vaccin given by other healthcare provider
105195	65ED000	Seasonal influenza vaccination given by pharmacist
106994	65EE000	Administration of first intranasal influenza vaccination
106995	65EE100	Administration of second intranasal influenza vaccination
107156	65EE.00	Administration of intranasal influenza vaccination
107297	65ED100	Administration of first intranasal seasonal influenza vacc
107315	65E0000	Administration of first intranasal pandemic influenza vacc
107352	65ED300	Administration of second intranasal seasonal influenza vacc
107413	65E2100	First intranasal seasonal flu vacc gvn by othr hlthcare prov
107573	65ED200	Seasonal influenza vaccination given while hospital inpt
107646	65E1000	Administration of second intranasal pandemic influenza vacc
107730	65E2200	Secnd intranasal seasonal flu vacc gvn by othr hlthcare prov
108772	65E3000	First intranasal pndmc influenza vcc gvn othr hlthcare prvdr
110182	65E2400	1st intramuscular seasonal influenza vacc given by other HCP
110219	65E2300	2nd intramuscular seasonal influenza vacc given by other HCP
110854	65ED400	Administration of first inactivated seasonal influenza vacc

prodcode	productname
398	Influenza inactivated split virion Vaccination (Aventis Pasteur MSD)
639	Influenza vaccine (split virion, inactivated) suspension for injection 0.5ml pre-filled syringes
834	Begrivac vaccine suspension for injection 0.5ml pre-filled syringes (Novartis Vaccines and Diagnostics Ltd)
922	Influenza inactivated surface antigen Vaccination
1329	Fluvirin vaccine suspension for injection 0.5ml pre-filled syringes (Novartis Vaccines and Diagnostics Ltd)
2139	Fluarix vaccine suspension for injection 0.5ml pre-filled syringes (GlaxoSmithKline UK Ltd)
2552	Influvac Sub-unit vaccine suspension for injection 0.5ml pre-filled syringes (Abbott Healthcare Products Ltd)
2601	Mfv-ject Vaccination (Aventis Pasteur MSD)
7951	FLUVIRIN AQUEOUS ML VAC
9710	Agrippal vaccine suspension for injection 0.5ml pre-filled syringes (Novartis Vaccines and Diagnostics Ltd)
10030	Inflexal V vaccine suspension for injection 0.5ml pre-filled syringes (Janssen-Cilag Ltd)
11824	Enzira vaccine suspension for injection 0.5ml pre-filled syringes (Pfizer Ltd)
13595	Fluzone Vaccination (Aventis Pasteur MSD)
16585	Viroflu vaccine suspension for injection 0.5ml pre-filled syringes (Janssen-Cilag Ltd)
18612	Mastaflu vaccine suspension for injection 0.5ml pre-filled syringes (Masta Ltd)
23251	FLUVIRIN PRE-FILLED SYRINGE
24779	Influenza inactivated split virion Paediatric vaccination
27407	Imuvac vaccine suspension for injection 0.5ml pre-filled syringes (Abbott Healthcare Products Ltd)
30156	Invivac vaccine suspension for injection 0.5ml pre-filled syringes (Abbott Healthcare Products Ltd)
30198	Influenza inactivated split virion Vaccination (sanofi pasteur MSD Ltd)
32391	Influenza vaccine (surface antigen, inactivated) suspension for injection 0.5ml pre-filled syringes (Novartis Vaccines and Diagnostics Ltd)
38421	Influenza inactivated split virion Vaccination (Evans Vaccines Ltd)
40760	Influenza vaccine (split virion, inactivated) 15microgram strain suspension for injection 0.1ml pre-filled syringes
40876	Influenza vaccine (split virion, inactivated) 9microgram strain suspension for injection 0.1ml pre-filled syringes
41150	Pandemrix vaccine emulsion and suspension for emulsion for injection (GlaxoSmithKline UK Ltd)
41168	Influenza H1N1 vaccine (split virion, inactivated, adjuvanted) emulsion and suspension for emulsion for injection
41240	Influenza H1N1 vaccine (whole virion, Vero cell derived, inactivated) suspension for injection
41925	Celvapan (H1N1) vaccine (whole virion, Vero cell derived, inactivated) suspension for injection (Baxter Healthcare Ltd)
43825	Intanza 15microgram strain vaccine suspension for injection 0.1ml pre-filled syringes (sanofi pasteur MSD Ltd)
43827	Intanza 9microgram strain vaccine suspension for injection 0.1ml pre-filled syringes (sanofi pasteur MSD Ltd)
44759	INFLUENZA PRE-FILLED SYRINGE
45661	Influenza vaccine (split virion, inactivated) suspension for injection 0.5ml pre-filled syringes (Pfizer Ltd)
47932	Fluenz vaccine nasal suspension 0.2ml unit dose (AstraZeneca UK Ltd)
48085	Influenza inactivated split virion Vaccination (Chiron UK Ltd)
48658	Influenza vaccine (split virion, inactivated) suspension for injection 0.5ml pre-filled syringes (sanofi pasteur MSD Ltd)
48740	Influenza vaccine (surface antigen, inactivated) suspension for injection 0.5ml pre-filled syringes
49716	Influenza vaccine (surface antigen, inactivated, virosome) suspension for injection 0.5ml pre-filled syringes
51087	Optaflu vaccine suspension for injection 0.5ml pre-filled syringes (Novartis Vaccines and Diagnostics Ltd)
51289	Influenza vaccine (live attenuated) nasal suspension 0.2ml unit dose
54677	Preflucel vaccine suspension for injection 0.5ml pre-filled syringes (Baxter Healthcare Ltd)
57140	Influenza vaccine (live attenuated) nasal suspension 0.2ml unit dose

57401	Influvac Desu vaccine suspension for injection 0.5ml pre-filled syringes (Abbott Healthcare Products Ltd)
57678	Fluenz vaccine nasal suspension 0.2ml unit dose (AstraZeneca UK Ltd)
57917	Fluarix Tetra vaccine suspension for injection 0.5ml pre-filled syringes (GlaxoSmithKline UK Ltd)
61580	Influenza vaccine (split virion, inactivated) suspension for injection 0.25ml pre-filled syringes
61792	Fluenz Tetra vaccine nasal suspension 0.2ml unit dose (AstraZeneca UK Ltd)
61898	Influenza vaccine (split virion, inactivated) suspension for injection 0.5ml pre-filled syringes (A A H Pharmaceuticals Ltd)
63690	Inflexal V suspension for injection 0.5ml pre-filled syringes (sanofi pasteur MSD Ltd)
65205	FluMist Quadrivalent vaccine nasal suspension 0.2ml unit dose (AstraZeneca UK Ltd)

Code	Immunisation type
4	FLU
71	PFLUGEN
72	PFLUGSK
73	PFLUGSKO
74	PFLUGS
75	PFLUBAXO
76	PFLUBAX
78	PFLUGENO
84	FLUSOHP
85	FLUSPHARMA
89	FLUSIN
97	FLUSINOHP
100	FLUSIMOHP