# The relationship between HIV prevalence in MSM and available data on HIV testing. What limits do the observed set upon the unobserved?

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TEXT BOUND INTO

THE SPINE

I, Christine Ann McGarrigle 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.

# ABSTRACT

Estimates of total prevalent human immunodeficiency virus (HIV) infections make an important contribution to public health planning. HIV test data has become increasingly important to the monitoring of the HIV epidemic, however a large proportion of HIV infections remain undiagnosed in the early stages of infection. This thesis aims to develop a method to estimate total HIV infections in men who have sex with men (MSM) in the United Kingdom (UK) using surveillance data on HIV testing.

A conceptual framework for the relationship between HIV testing and risk of HIV infection was developed. A review of literature showed that HIV testing was associated with socio-demographic factors like increasing age and area of residence. HIV testing was also associated with higher-risk behaviours such as unprotected anal intercourse and increased numbers of sexual partners. This thesis identified and quantified factors associated with both HIV testing and risk of HIV infection in MSM in the UK through two studies. The first was an analysis of a national representative study and the second a cross-sectional unlinked anonymous HIV seroprevalence study of MSM attending a genitourinary medicine clinic (GUM) in inner London. An investigation of the National Survey of Sexual Attitudes and Lifestyles found that 36.6% of MSM had HIV tested in the past 5 years. HIV testing was associated with area of residence and increased numbers of sexual partners. The unlinked anonymous study found that MSM who had HIV tested were at higher risk of HIV infection compared to MSM who had not and that history of sexually transmitted infections was associated with HIV infection. A comparative analysis with a community-recruited study of MSM provided upper and lower behavioural bounds.

Finally, a model based on the conceptual framework which extrapolated all diagnosed HIV infections in MSM to give reliable estimates of total HIV infections in the general MSM population, including undiagnosed HIV infections, was developed. This thesis has provided a unique methodology to estimate total HIV infections in MSM in the UK.

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## TABLE OF ABBREVIATIONS

| | |
|---|---|
| AIDS | Acquired Immunodeficiency Syndrome |
| AHR | Adjusted hazard ratio |
| AOR | Adjusted odds ratio |
| ART | Anti-retroviral therapies |
| BASHH | British Association of Sexual Health and HIV |
| CDSC | Communicable Disease Surveillance Centre |
| CI | Confidence Interval |
| EAGA | Expert Advisory Group on AIDS |
| EPP | Estimations and Projections Package |
| GMSHS | Gay Men's Sexual Health Survey |
| GMSS | Gay Men's Sex Survey |
| GP | General Practice |
| GPA | World Global Programme on AIDS |
| GRASP | Gonococcal Resistance to Antimicrobials Surveillance Programme |
| GUM | Genitourinary Medicine |
| HR | Hazard ratio |
| HIV | Human immunodeficiency virus |
| HPA | Health Protection Agency |
| IDU | Injecting Drug User |
| MPES | Multi-parameter evidence synthesis |
| MSM | Men who have sex with men |
| Natsal | National Survey of Sexual Attitudes and Lifestyles |
| OR | Odds Ratio |
| ONS | Office of National Statistics |
| SES | Socioeconomic status |
| SOPHID | Survey of Prevalent HIV Infections Diagnosed |
| SRMD | Specialist and Reference Microbiology Division |
| STD | Sexually transmitted disease |
| STI | Sexually transmitted infection |
| UA | Unlinked Anonymous |
| UAI | Unprotected anal intercourse |
| UAPMP | Unlinked Anonymous HIV Prevalence Monitoring Programme |
| UNAIDS | United Nations Programme on HIV/AIDS |
| UK | United Kingdom |
| VCT | Voluntary confidential HIV testing |
| WHO | World Health Organisation |

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I acknowledge the participants of the National Survey of Sexual Attitudes and Lifestyles, the Gay Men's Sexual Health Survey and the Unlinked Anonymous Genitourinary Medicine Clinic survey and the contribution of the many people who report to, and support the national HIV and STI surveillance systems without whom, this research would not be possible.

Finally I thank my family and friends for all their endless support, in particular Mick for his love, encouragement and patience.

# CHAPTER ONE

## *INTRODUCTION AND BACKGROUND*



**Summary**

This chapter provides some background information, which leads on to the aim and objectives of the thesis. A statement of authorship is given in this chapter.

## 1.1 Introduction

With many infections, the period between infection and disease is short and so disease incidence can be related directly to infection incidence if the ratio of disease to infection is known. When considering infections with a long incubation period (e.g. human immunodeficiency virus (HIV), hepatitis C virus), the situation is more complex and the difficulty in estimating prevalent infections is increased. If all the population at risk were tested frequently throughout their period of risk, and positive results were reported completely, then the annual number of new positives would equal annual incidence. If no one was tested, infection incidence could only be estimated indirectly through combining surveillance data on the outcome of infection (however that outcome is measured) with knowledge of the natural history of the infection.

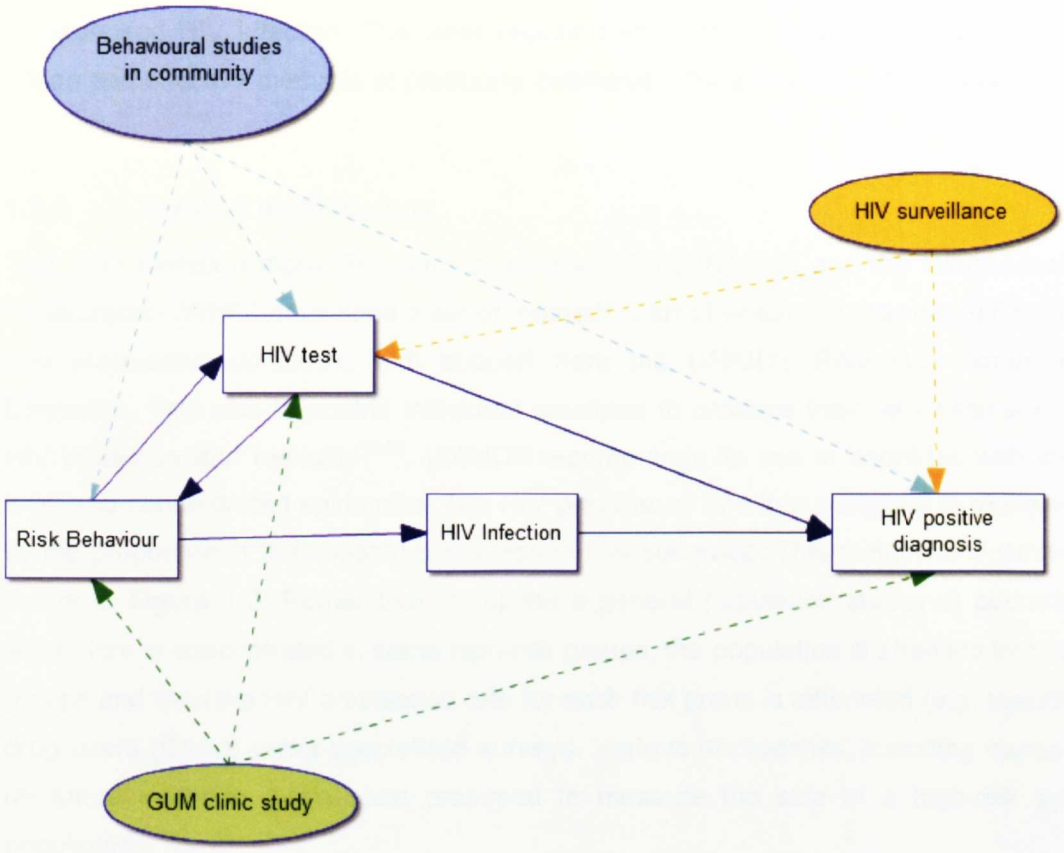
In order to evaluate current transmission of HIV, a measure of current HIV incidence is needed. Previously this had been accomplished using a back-calculation method that used acquired immune deficiency syndrome (AIDS) incidence data, which represents HIV infections that occurred on average 10 years before, along with other data, by calculating back to previous transmission. These patterns were then projected, to estimate future numbers of HIV infected persons[1]. AIDS case reporting is very complete and is a good marker for past HIV incidence up to 1996. However, with the advent of highly active anti-retroviral therapies (ART), there have been substantial decreases in AIDS incidence and AIDS-related mortality in the United Kingdom (UK)[2], and in the rest of the developed world[3,4]. Consequently monitoring the HIV epidemic through AIDS incidence is no longer feasible and, thus, a novel approach to the monitoring of current HIV transmission is needed. HIV test data have thus become increasingly important to the monitoring of the HIV epidemic. Unlinked anonymous (UA) seroprevalence studies have shown that a large proportion of HIV infections remain undiagnosed in the early stages of infection[5]. Estimates of the total number of prevalent HIV infections attributable to the major routes of infection make an important contribution to public health policy. Numbers of persons with severe HIV infection and the proportion of total prevalent infections which are undiagnosed can be used for the planning of health-care services. They can also be used to calculate recent HIV incidence. In addition estimates of the future numbers with severe HIV infection can be used for planning health promotion programmes[6].

Estimates of current transmission of HIV might be improved by exploring the existing surveillance data on HIV testing, utilising survey information on HIV testing patterns

(such as ever tested and frequency, or never) and monitoring this within each major exposure category. Combining all the available data on HIV testing and HIV diagnosis with behavioural data from other sources about high-risk persons would answer the following questions: who tests for HIV infection, who doesn't test for HIV, are the characteristics of people undergoing HIV tests (or not) changing over time, are the risks of HIV in those who are not tested different from those who are, and, from all this, what can be deduced about undiagnosed infections?

HIV surveillance is comprehensive in the UK. Data are captured at different stages of HIV infection; laboratory and clinical reports of HIV diagnosis, clinical reports of AIDS and death reports from the Office of National Statistics (ONS) and clinicians. Additional surveys collect data throughout the natural history of the infection through an annual survey of individuals receiving HIV care and CD4 laboratory surveillance. This thesis is focussed on men who have sex with men (MSM). The thesis will attempt to make use of the usual surveillance data, as well as other sources of surveillance data that focus on MSM as outlined in Figure 1.1. Such additional sources of data include UA surveillance programmes at genitourinary medicine (GUM) clinics, behavioural surveys of MSM recruited through community venues, and surveillance of HIV tests, both positive and negative[7]. HIV surveillance systems capture information on HIV testing, and from HIV infection onwards. Behavioural studies can capture information on MSM at different points both before and after infection. Most data are available at the time point at which risk behaviour may lead to subsequently undergoing an HIV test. Alternatively, knowing a HIV result may influence subsequent risk behaviour. The UA GUM study can capture MSM at the point of HIV test, which is often subsequent to risk behaviour, and at HIV diagnosis. These issues are illustrated below in Figure 1.2. Most surveillance data are cross-sectional and thus do not allow disentangling the direction of association between risk behaviour and HIV testing.

**Figure 1.1 Available surveillance systems in the UK and the stages, both pre and post-HIV infection in MSM at which they collect information**




This thesis will develop a method to estimate total HIV infections in MSM in the UK using surveillance data and the other available data sources that are outlined above. In order to understand the thesis scope, a brief background will be given below on current estimation methods of HIV prevalence in MSM, followed by a description of the thesis scope, aims and objectives. This will be followed by an outline of the structure of the thesis with detailed chapter descriptions.

## 1.2 Background: Estimating total prevalent HIV infections, previous methods

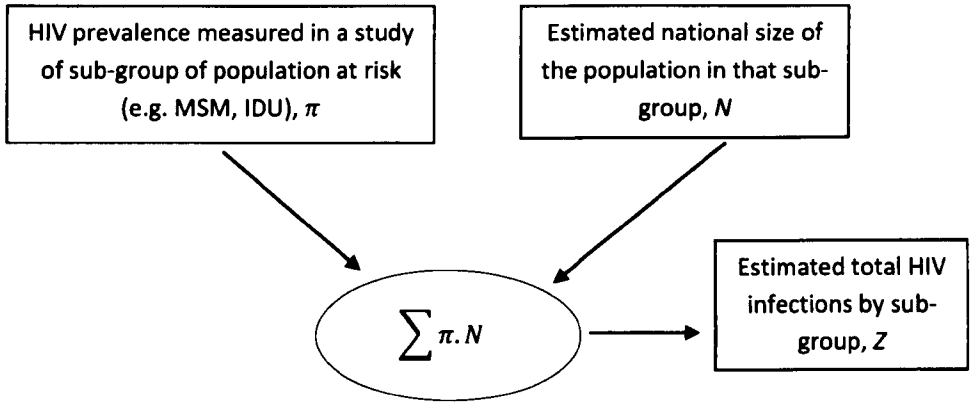
It is difficult to assess the extent of undiagnosed HIV infection in the population because the motivation behind testing is complex. Individuals may be influenced by a range of behavioural and policy factors[8]. The UA methodology approach, based on specimens routinely gathered for other reasons, is particularly useful in contributing to the surveillance of HIV infection in subgroups of the population regardless of their HIV testing behaviour. UA testing allows the measurement of HIV prevalence in populations

with both clinically diagnosed and undiagnosed HIV infection[9,10]. While some mathematical models have been developed in the UK and in Europe and the US[11-17], some simpler methods using surveillance data have been used to estimate undiagnosed HIV infection. The latter require less technical inputs and are relatively cheap and effective methods of producing estimates. These are illustrated below.

### 1.2.1 UNAIDS methodology

The Joint United Nations Programme on HIV/AIDS (UNAIDS) and the World Health Organization (WHO) developed a set of methods, part of which includes the estimation and projections workbook, with support from the UNAIDS Reference Group on Estimates. This was to enable individual countries to produce their own estimates of HIV incidence and mortality[18,19]. UNAIDS recommends its use in countries with low-level and concentrated epidemics. The HIV prevalence rate in a subgroup is multiplied by the proportion of the national population in that subgroup. This method is illustrated simply in Figure 1.2. Rather than complete a general population survey in countries where HIV is concentrated in some high-risk groups, the population is stratified into risk groups and then the HIV prevalence rate for each risk group is estimated (e.g. injecting drug users (IDUs)) using specialised surveys. Various approaches, including capture-recapture methods, have been proposed to measure the size of a high-risk sub-population.

**Figure 1.2 UNAIDS Workbook method to estimate HIV infections in low-level and concentrated epidemics**



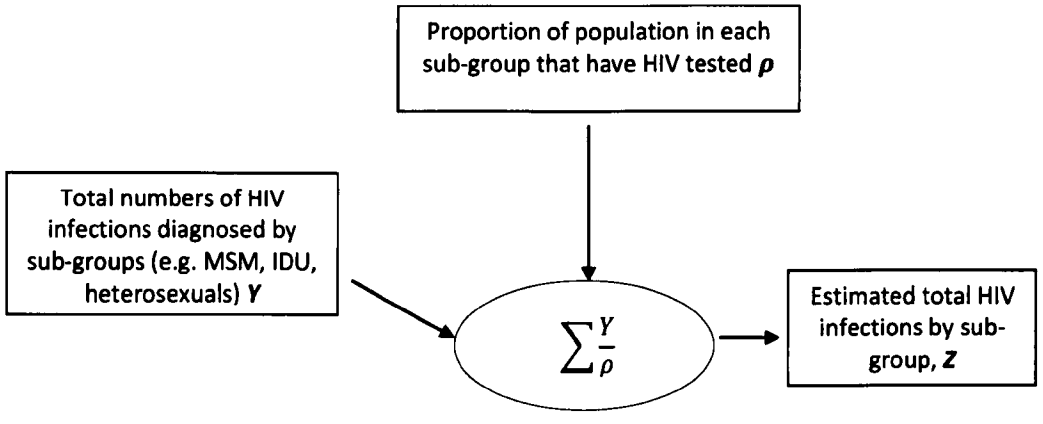

These methods were produced through an expert advisory group and tested by a user group of surveillance experts in Europe. The Estimations and Projections Package (EPP) provides projection curves based on assumptions and inputs that are country-specific. These assumptions are: (1) female-to-male prevalence ratio; (2) effects of HIV on fertility; (3) transmission of HIV from mother to child; (4) survival time from infection

to death for adults and children; (5) age patterns of prevalence; and (6) effects and coverage levels for anti-retroviral therapy (ART)[20].

### 1.2.2 Indirect estimates

A range of 'indirect' methods have been used to estimate total HIV infections as well. For example, the ratio of early to late diagnosed AIDS cases in each risk group has been used to total up the number of non-AIDS diagnosed infections to provide an estimate of all prevalent HIV[21]. The ratio of diagnosed to undiagnosed HIV cases has been used in a similar way[21]. Finally, an estimate of total HIV infections has been represented through indirect estimation by Hughes et al[21] as a combination of total diagnosed HIV infections and the proportion of HIV tests that have been taken within the sub-population. If total diagnosed HIV infections equals the total prevalent HIV infections multiplied by the proportion HIV tested, then the total prevalent HIV infections equals the total MSM with diagnosed HIV infection divided by the proportion of MSM who have HIV tested (see Figure 1.3). Archibald et al used a similar method but to estimate the populations, rather than the infections[22].

**Figure 1.3 The indirect method of estimating total HIV infections**



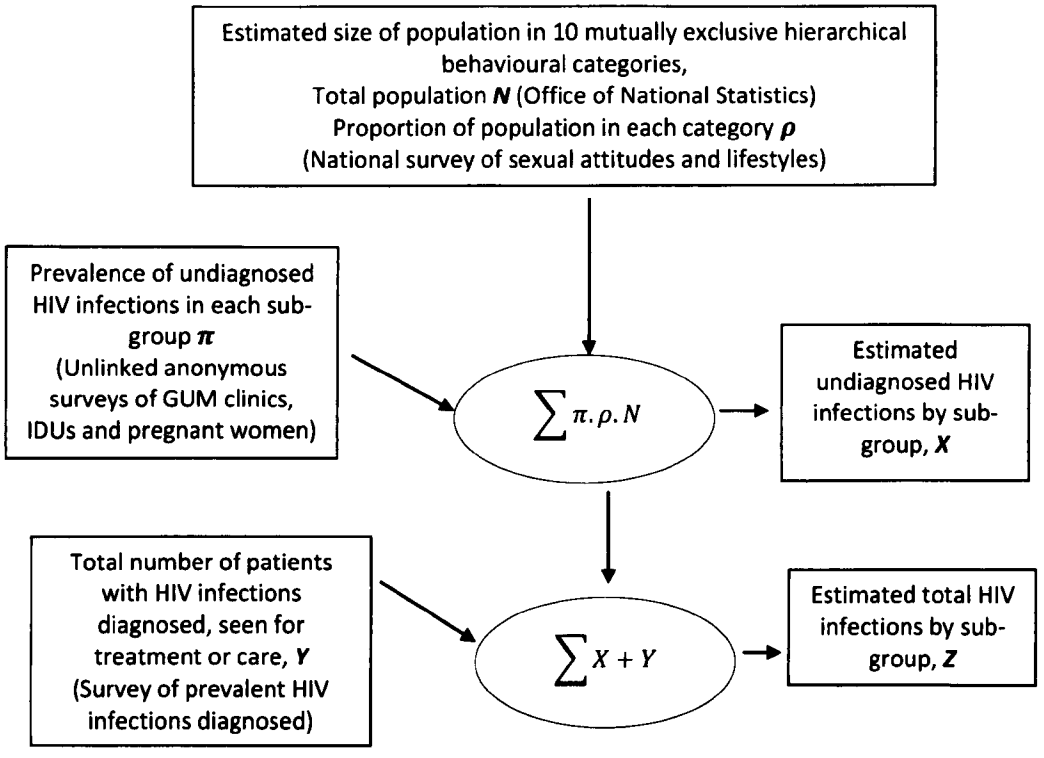

This simplified method requires very little inputs, other than the numbers of HIV infections diagnosed and the numbers HIV tested stratified by age and area-specific categories. This method assumes that the proportion that has not HIV tested have the same probability of being HIV infected as the proportion that have tested. With universal annual testing this would hold true and in fact the results of HIV testing would equal annual HIV incidence. In reality it does not hold (at least in the UK) because people who choose to not test may be different and have a different risk of HIV infection when compared to those who test.

### 1.2.3 Direct estimates

Estimates of prevalent HIV infections have been previously calculated using a "direct method" in the UK. Population estimates derived from the Natsal were combined with prevalence data from the UA HIV Prevalence Monitoring Programme (UAPMP) to produce estimates of the numbers of adults infected and alive in the population, through a series of assumptions based on available data. The method was first developed in 1994[23], and further developed in 1997[24], to use a combination of data from different sources and estimate prevalent undiagnosed infections. Further developments in 2006 by McGarrigle et al[25] focussed on the potential source of error around the necessary assumptions. The direct method estimates the total number of adults aged 16 years or more infected with HIV in the population. The method is based on the principle of combining the total of the diagnosed HIV infections in the UK with estimates of the total undiagnosed prevalent infections. The method is illustrated simply below in Figure 1.4. The numbers of prevalent diagnosed HIV infections for each major behavioural category in the UK were taken to be the number of reported infections from the national Survey of Prevalent HIV Infections Diagnosed (SOPHID), adjusted for under-reporting and for failure to access services in a given year. The total number of undiagnosed infections is estimated by the age- and region-specific undiagnosed infections in different behavioural categories. Each major component of the populations at risk was accounted for separately and adjustments made for overlapping risk groups and differential fertility among HIV infected and uninfected women.

The principle of the method relies on combining data from several sources. The undiagnosed prevalence estimate was derived from the UAPMP surveys which represent four groups: MSM and heterosexuals attending GUM clinics, IDUs attending specialist centres, and the general heterosexual population measured through the survey of pregnant women. This prevalence was adjusted firstly for geographic coverage, and secondly to produce specific prevalence estimates derived for the different behavioural categories that represent varying levels of HIV risk. Each adjusted undiagnosed prevalence estimate was multiplied by the estimated population sizes of that behavioural category. The resulting estimates of the number of undiagnosed HIV infections were finally added to the number of diagnosed HIV infections from SOPHID, producing an estimate of total prevalent HIV infections within each behavioural category. As the undiagnosed estimates were only for adults aged 16 to 44 in Britain, they were then scaled up to include all adults in the UK.

**Figure 1.4 The direct method to estimate total HIV infections in the UK**




## 1.3 Study rationale and thesis scope

This thesis will present the background work for a further development of the indirect estimation method which focussed on the potential source of error around the necessary assumptions. This study will develop an adjustment method which will allow the use of routine surveillance data to calculate an estimate of total HIV infections in the UK. This will utilise available surveillance data, investigate the relationship between HIV testing and risk of HIV infection and provide recommendations for future surveillance which would allow the monitoring of changes within that relationship as service provision and HIV test uptake change over time.

## 1.4 Aims

The aim of this thesis is to estimate total HIV infections in MSM in the UK using surveillance and other available data on HIV testing.

## 1.5 Objectives

This aim will be accomplished through the following objectives:

1. Review current factors associated with HIV testing and sexual behaviour and develop a conceptual framework of the relationship.
2. Describe the trends of HIV, STI, and HIV testing in MSM in the UK.
3. Estimate the size and characteristics of the population of MSM HIV testing and their associated sexual behaviours.
4. Estimate how the association between sexual behaviour and HIV testing may have changed over time.
5. Model the association between HIV testing and HIV prevalence, HIV testing and sexual behaviour in the general population of MSM.
6. Estimate how much the risk of HIV infection is affected by HIV testing history and develop a new method to estimate total HIV infections for MSM.

## 1.6 Outline of thesis

The thesis is presented in eight parts: an introduction to the thesis including project rationale, a systematic literature review and development of a conceptual framework, a description of HIV and sexually transmitted infections (STI) trends in the UK, four chapters that address an aspect of the aim and objectives, a general discussion and appendices.

The adjustment method that will be presented in this thesis is based on (at the time of start of this thesis) newly available data such as Natsal 2000 and community surveys of MSM. The plan was to take into account the differences in HIV prevalence between subgroups (testers, not testers) within the major behavioural categories[25].

The factors associated with both HIV testing and risk of HIV infection will be explored using the survey data available at the time. Hence, background data in Chapters two and three will be presented up to the end of 2002 which corresponds with the year prior to which the survey in Chapter five was carried out and for which total HIV infections estimates are produced in Chapter seven. Overall HIV diagnoses trends are presented for the UK; however, specific rates of STIs and HIV are presented just for England and Wales.

Chapter two provides a review of factors associated with HIV testing and risk of HIV infection, and a conceptual framework for the relationship between HIV testing and risk of HIV infection is developed. This review provides a general context and rationale for

the thesis as a whole while the literature review presented in each of the subsequent chapters provides a more specific context and rationale for each of the studies. Chapter three describes trends in current HIV infections and STIs in MSM in the UK and presents a review of current levels of HIV testing within MSM in the UK.

In order to better understand the assumptions of the estimation method, data from surveys in different settings were analysed as part of this thesis. Chapter four characterises the population of MSM presenting for HIV testing. In this chapter, an analysis of the National Survey of Sexual Attitudes and Lifestyles (Natsal) is carried out, assessing the prevalence of and characteristics associated with HIV testing in a representative sample of MSM in the population. The second part of the chapter assesses whether there has been a change in prevalence of HIV testing, or of the characteristics associated with it, through an analysis comparing the Natsal 2000 survey with the Natsal 1990 survey. The relevance of this is to provide estimates of population testing, and to estimate whether MSM who have had an HIV test are more at risk of HIV than men who have not tested. This analysis had never been carried out on a representative sample before, and thus these are the first national estimates made available. It is relevant to describe changes in the relationship between HIV testing and behaviour as these will affect the interpretation of the study carried out and described in Chapter five and the estimation method developed in Chapter seven.

The survey described in Chapter five measures the association of HIV test history with undiagnosed HIV infection. This is followed in Chapter six with a comparative analysis with another community-recruited survey of MSM to provide upper and lower estimates of behavioural risk associated with HIV infection in these two different populations.

Chapter seven describes the development of an estimation model that uses the analyses from Chapters four to six to estimate total prevalent HIV infections and finishes with sensitivity analyses and comparisons with estimates provided from other methods. In collaboration with a statistician, a Bayesian multi-parameter evidence synthesis (MPES) of surveillance data method for developing plausibility bounds around the estimates was developed through the triangulation of surveillance data[12]. This was based on the direct method principle above (Figure 1.5) and used all the same data inputs. The MPES method developed a Bayesian framework for synthesis of surveillance and other information incorporating a hierarchical structure to spread information more evenly over the parameter space, thus each source of evidence contributes to each parameter. The MPES method is discussed further in Chapter

seven, section 7.7.

Finally, in Chapter eight, recommendations for further research and development of surveillance methods are made based on the findings of this thesis.

## 1.7 Peer review and ethical approval

The studies carried out in Chapters four, five and six received ethical approval. The study proposal for Chapter four was presented to the Natsal Survey Research Board for review and approval. Natsal was approved by the University College Hospital and North Thames Multi-Centre Research Ethics Committee and all the Local Ethics Committees in Britain. The UA survey of GUM clinic attendees received ethical approval from the Local University College London Ethics Committee. Additional ethics approval was obtained for this short survey acquiring additional history on HIV testing, and previous acute STI diagnoses from the University College London Ethics Committee. The survey data used in Chapter six from the Gay Men's Sexual Health Survey (GMSHS) obtained ethical approval from the local University College London Ethics Committee.

## 1.8 Confidentiality of patient identifiable information

All data capture, storage, handling and retrieval procedures were audited by the Communicable Disease Surveillance Centre (CDSC) Caldicott Committee and complied with established Health Protection Agency (HPA) policy for handling patient-identifiable information.

## 1.9 Statement of authorship

The studies that form this thesis are the product of a combined effort of several individuals and institutions, in which I, the author, played an integral part.

Members of Dr John Parry's laboratory at the Centre for Infections HPA laboratory wrote the protocols for the laboratory testing for HIV carried out in the study in Chapter five. The studies in Chapters four and five were instigated, planned, conducted, analysed and interpreted by Christine McGarrigle. Dr Danielle Mercey was in overall charge of the day-to-day management of the study at the Mortimer Market Centre described in Chapter five. She met with the health-care staff and ensured on-going recruiting, standard study procedures, and other management issues. Christine

McGarrigle was responsible for supervising the UA data collection and data management at the CDSC in collaboration with Ms Alison Brown, ensuring that the methodology and analysis were conducted consistently and correctly. Dr John Parry was responsible for the day-to-day supervision of the laboratory aspects of the HIV testing programme. Christine McGarrigle was responsible for setting up the database, and conducted the analyses and statistical interpretation. Alison Brown monitored the timeliness and accuracy of data collection and inputting. The study was conducted according to existent UA survey practice, as part of the national Unlinked Anonymous Seroprevalence Monitoring Programme. The investigations in Chapters five and six were supported by grants from the Department of Health (England).

Other authors collected two datasets used in the thesis. The National Surveys of Sexual Attitudes and Lifestyles 2000 and 1990 used in Chapter four were collected by a collaboration of institutions, the Royal Free and University College Medical School, the London School of Hygiene and Tropical Medicine, and the National Centre for Social Research[26]. The analysis of the data presented here was undertaken by Christine McGarrigle and was an original interpretation of the dataset – data relating to HIV testing from this dataset – and had not been published before. The analysis of the full dataset, including MSM was published by the author and is included in Published papers in this thesis. Ms Julie Dodds provided the data used for the comparison in Chapter six, and the comparison was carried out in collaboration with this survey group; however, Christine McGarrigle developed the aims and objectives, generated the hypotheses and analytical technique used here and carried out the analysis. The estimation method developed in Chapter seven is based on previous methods used in the UK and developed in Canada; however, this is a unique method and interpretation developed by the author.

The author has written all the components of this thesis herself. She was supervised throughout the work programme of this thesis by Professor Laura Rodrigues (primary supervisor), in addition to supervision from Dr Kevin Fenton and Professor Noel Gill. The writing-up phase was supervised by Dr Dorothea Nitsch (primary supervisor).

# CHAPTER TWO

## *REVIEW OF FACTORS ASSOCIATED WITH HIV TESTING AND HIV INFECTION THROUGH SEXUAL BEHAVIOUR*



**Summary**

A systematic review of evidence on factors associated with HIV testing and risk of HIV infection was carried out. Due to heterogeneity of studies and study designs it was not possible to do a formal meta-analysis. However, the data were used to develop a conceptual framework for the associations that will be explored more formally in later parts of this thesis. The results suggest that demographic variables, information on sexually transmitted infections, and previous HIV testing patterns may proxy risk behaviour for HIV infection, in particular unprotected anal intercourse.

## 2.1 Introduction

The aim of this thesis is to estimate total HIV infections in MSM in the UK using surveillance data on HIV testing. Data on diagnosed HIV infections in MSM in the UK are available through national surveillance systems[5]. However, HIV diagnoses are not a true measure of HIV burden in the MSM population in the UK, because not every MSM chooses to undergo HIV testing. Studies have shown that the proportion of MSM who have ever had an HIV test ranges from 53-64% in the UK[27-30] to 83% in Australia[31], 63% in Canada[32] and 84% in the US[33]. In order to understand potential biases in current estimates of total HIV infections, a review of the literature on the relationships between HIV testing and risk of HIV infection was carried out and is presented below. This review will then inform the conceptual framework about key factors that can be collected through surveillance systems. In order to understand how HIV testing is associated with risk of HIV infection, this review will focus on the relationship between HIV testing and factors related to risk of HIV infection in MSM. As unprotected anal intercourse (UAI) is the most important determinant of risk of HIV infection (see Table 2.1), the review will concentrate on this aspect. Following the establishment of this association, the review will then investigate other factors that are related to HIV testing and whether they are also associated with UAI or risk of HIV infection. A conceptual framework for the relationship between HIV testing, UAI and risk of HIV infection and each of the individual factors is presented within each section below as Figures 2.2, 2.4, 2.6, 2.8, 2.10 and 2.12.

## 2.2 Methods

A series of MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'HIV testing'; these were combined with each of the individual areas of interest: 'unprotected anal intercourse', 'age', 'sexually transmitted infection', 'number of sexual partners', 'residence', 'socio-economic status' or 'education'. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers. The inclusion criteria were as follows:

(1) Does the study relate to HIV testing?

(2) Does the study include MSM?

(3) Is there a disaggregated outcome measure of association with HIV testing for MSM?

(4) Does the study focus on demographic and behavioural factors before HIV testing or UAI?

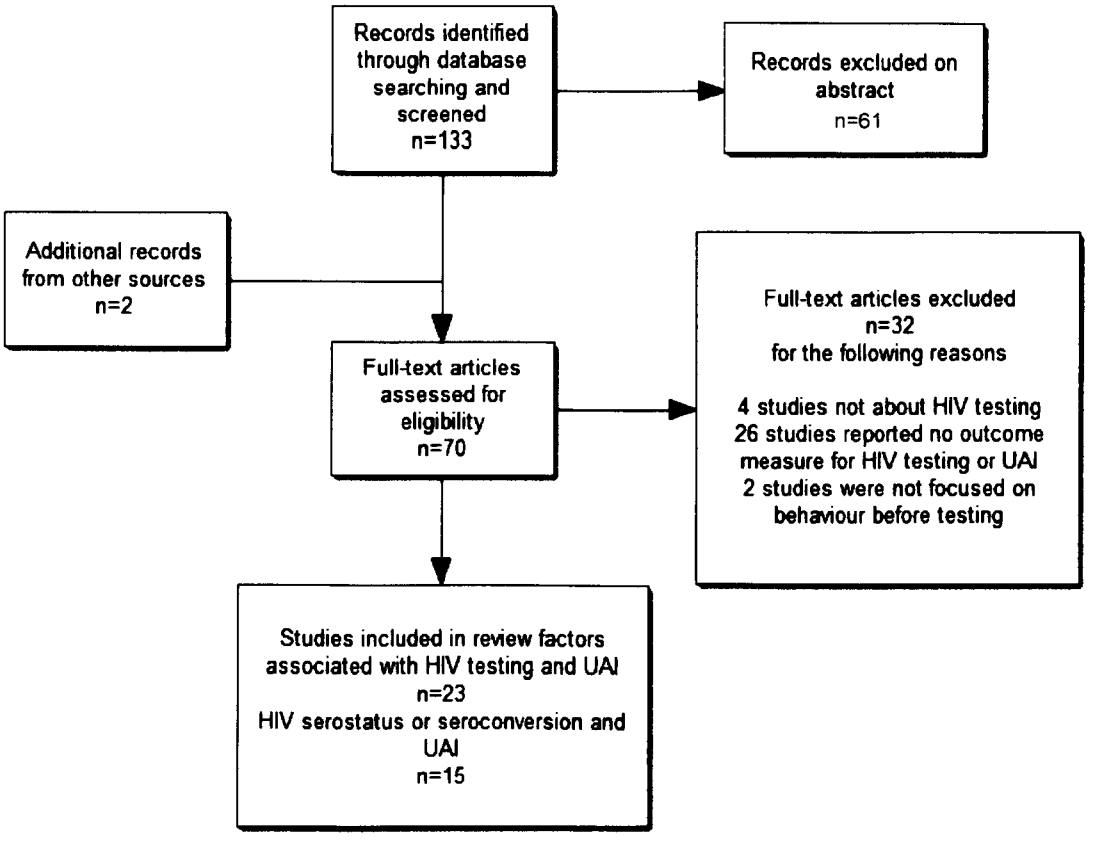
(5) Was the study carried out before 2003?

Only studies carried out up to 2003 were included as both HIV testing policies and factors associated with HIV changed in the mid-2000s, and the purpose of this review was to determine a conceptual framework for the study in Chapter four which was carried out in 2003. A summary of the studies reviewed are presented in Tables 2.1 – 2.7 below, and the numbers of papers extracted and screened are presented in Figures 2.1 – 2.6.

## 2.3 Association between unprotected anal intercourse and HIV seroconversion and HIV testing

To investigate the associations between UAI and HIV seroconversion, and HIV testing, MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'unprotected anal intercourse' and (a) 'HIV testing' and (b) HIV seroconversion/HIV serostatus. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers.

**Figure 2.1 Systematic review data flow for investigation of the association between unprotected anal intercourse HIV testing, and HIV seroconversion**



In total 135 studies and surveys were extracted, of which 61 were excluded on abstract due to non-relevance or date of survey post 2003 (Figure 2.1). A further 32 full-text articles were excluded due to the study not being about HIV testing (4 studies), no measures of association available on HIV testing or UAI or no disaggregate data available for MSM (26 studies), and studies not focussed on behaviours before HIV testing (2 studies). The excluded studies are listed in Table A.1, Appendix A.

UAI is a major risk factor for HIV infection in MSM. This has been determined through HIV seroconversion studies within four cohort studies[34-37] and six case control studies in North America[38-40], Europe[41,42] and Australia[43] and through five cross-sectional studies in the US[44,45], South America[46] and the UK[47,48] that met the inclusion criteria. Table 2.1 provides a descriptive summary of each study.

Three of the US studies collected data from multiple US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. The Canadian studies were based in Vancouver and Montreal. UK studies were in three cities, London, Manchester and Brighton. Participants were mainly recruited from medical settings (primarily HIV clinics) and multiple gay venues and events. Twelve studies used convenience samples, one study used probability sampling based on telephone index, and one used recruitment methods that were more systematic (e.g. every third person who came into the venue) than convenience sampling. Ten studies recruited from HIV test clinics or sexually transmitted disease (STD) clinics, while nine also recruited from the community through gay bars and clubs, advertising in gay media and 'snowballing' techniques. Nine studies used self-administered questionnaires, and seven studies used interviewers to administer the questionnaires. Two studies focussed on young MSM. Sample size varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM. The studies took place over a period of time ranging from 1983 to 2003. The association between UAI and HIV seroconversion remained over time.

**Table 2.1a Review of reported associations between HIV seroconversion and unprotected anal intercourse in MSM. Studies are presented by type of study design, region, and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed sub-groups* |
|---|---|---|---|---|---|---|---|---|---|
| McFarland et al (1997)[39] | US (San Francisco) | Cohort | Repeat HIV tests in MSM attending anonymous HIV test clinics | 1995 | 2822 | HIV seroconversion UAI in last year | Cox proportional hazards analysis; Ethnicity, age<35, UAI, sex HIV+ partner, 10+ partners in last year, popper use | AHR 2.0 (1.3 – 3.0) | Not available |
| Buchbinder et al (2005)[37] | US (6 cities) | Cohort | MSM HIV negative, anal sex with man in past 12 months, Recruited from previous cohorts, STD clinic, bars, clubs, advertising, street outreach, and referral from other participants | Apr 1995-May 1997 | 3257 | HIV seroconversion UAI in prior 6 months | Multivariable proportional hazards model; sexual behaviours, health insurance, age, HIV negative male partners, nitrate inhalant use | UAI with HIV positive partner AHR 3.4 (1.6-7.2) URAI with unknown serostatus partner AHR 2.7 (1.6-4.8) | Not available |
| Koblin et al (2006)[36] | US (6 cities) | Cohort | MSM HIV negative, anal sex with man in past 12 months, Recruited from previous cohorts, STD clinic, bars, clubs, advertising, street outreach, and referral from other participants | Jan 1999 – Feb 2001 | 4295 | HIV seroconversion UAI in prior 6 months | Multivariable proportional hazards model; sexual behaviours, health insurance, age, HIV negative male partners, nitrate inhalant use | UAI with HIV positive partner AHR 3.40 (2.25-5.14) URAI with unknown serostatus partner AHR 2.85 (2.12-3.84) | Not available |
| Strathdee et al (2000)[34] | Canada (Vancouver) | Cohort | MSM 18-30 not previously tested HIV positive. Recruited from community outreach, physicians and clinics | 1998 | 681 | HIV seroconversion UAI partner known to be positive | Univariable only[a] | OR 12.1 (1.7-61.5) | Not available |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed sub-groups* |
|---|---|---|---|---|---|---|---|---|---|
| Weber et al (2001)[35] | Canada (Vancouver and Montreal) | Two Cohort studies | MSM aged 16-30 not previously tested HIV positive. Recruited from community outreach, physicians and clinics | 1998 | 1373 | HIV seroconversion UAI | Univariable adjusted for cohort | OR 2.35 (1.04-5.30) | Not available |
| Ostrow et al (1995)[38] | US (Chicago) | Nested Case control | Cases HIV positive within 6-12 months of previous negative, control negative through study period | 1984 - 1992 | 68 cases 380 controls | HIV seroconversion URAI | Stepwise conditional logistic regression; sexual behaviour, substance use | 1984 - 1988<br>ARR 4.24 (1.96-9.15)<br>1989 – 1992<br>ARR 3.99 (0.79-20.06) | Not available |
| Kippax et al (1998)[43] | Australia (Sidney) | Case control | Case control selected from within an on-going cohort of MSM living in Sydney recruited from gay community events, dance parties and snowballing, press, clinics sex venues | 1993-1997 | 21 cases 369 controls | HIV seroconversion UAI | Logistic regression; age, HIV positive partner, beliefs, condom use, AI always protected, UAI, no AI | AOR 14.25 (1.63 – 124.44) | Not available |
| Williams et al (1996)[41] | UK (London) | Case control | All MSM attending clinic with at least one HIV negative test and one HIV positive, and two matched controls with 2 or more HIV negative tests attending one GUM clinic | Jun 1988 – Jul 1993 | 56 cases 104 controls | HIV seroconversion UAI; condom use, (reference always) | Conditional logistic regression; STI between tests, Known HIV+ partner, condom use, age (to correct for imprecise matching) | Sometimes<br>AOR 7.90 (2.16-28.9)<br>Never<br>AOR 16.2 (3.04-86.3) | Not available |
| Macdonald et al (2007)[42] | UK (London, Brighton & Manchester | Case Control | MSM attending 7 GUM clinics. Computer assisted self-interview (CASI) and selected qualitative interviews | Sep 2002 Oct 2004 | 75 cases 157 controls | HIV seroconversion UAI with 1+ sexual partners | Multivariable analysis; ancillary sexual behaviours, substance use, STIs, venues to meet men | AOR 4.1 (1.8 – 9.3)<br>AOR 2.7(1.3 – 5.5) | Not available |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed sub-groups* |
|---|---|---|---|---|---|---|---|---|---|
| Thiede et al (2009)[40] | US (Seattle) | Case control | MSM aged 18+ sex in past 6 months, recruited through STD clinic, HIV test clinics and outreach services including bathhouses, bars and clubs | Jul 2002-Jun 2005 | 32 controls 110 controls | Recent HIV infection (3 months) UAI Primary partner (PP) and Casual partner (CP) | Multivariable analyses | UAI HIV- CP partner AOR 4.3 (1.3, 13.9) UAI HIV- PP AOR 1.2 (0.3, 4.9) UAI HIV+ any partner AOR 6.8 (1.3, 35.1) UAI HIV+ CP AOR 6.8 (1.3, 35.1) | Not available |

Note: a. These univariable OR were calculated from data presented in paper using STATA 8.0; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval; HR, hazard ratio; AHR, adjusted hazard ratio, ARR, adjusted rate ratio; URAI, unprotected receptive anal intercourse.

**Table 2.1b Review of reported associations between HIV serostatus and unprotected anal intercourse in MSM. Studies are presented by region, and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Dodds et al (2004)[49] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas, 58 sites 57% response to UA HIV test of saliva | 2000 | 1206 | HIV positive Casual UAI partners in last year | Logistic regression Age, education, employment status | AOR 2.21 (1.46 – 3.33) | 18.6% HIV+ UAI 9.1% HIV no UAI |
| Dodds et al (2007)[47] | UK (London, Brighton & Manchester) | Cross-sectional | MSM attending bars, clubs, saunas 90 venues 64% response to UA HIV test of saliva | Jun 2003 – Feb 2004 | 2311 | HIV positive UAI 1+ partner in past year | Logistic regression; age. Education, ethnicity, employment status | London AOR 2.89 (2.01-4.17) Brighton AOR 2.71 (1.39-5.30) Manchester AOR 2.02 (0.88-4.67) | Not available |
| Dodds et al (2007)[47] | UK (London, Brighton & Manchester) | Cross-sectional | MSM attending bars, clubs, saunas 90 venues 64% response to UA HIV test of saliva | Jun 2003 – Feb 2004 | 2311 | HIV positive UAI with casual partners in past year | Logistic regression; age. Education, ethnicity, employment status | London AOR 2.04 (1.42-2.94) Brighton AOR 2.44 (1.22-4.85) Manchester AOR 1.99 (0.86-4.61) | Not available |
| Mckusick et al (1990) [44] | US (San Francisco) | Cross-sectional[a] | MSM attending bathhouses, bars, advertisement for men not attending the above (51% response) | 1983-1984 | 508 | HIV positive at entry UAI in previous month in non-monogamous in 1984 | Logistic regression Relationship status, age, history STD, UAI favourite, believe exposed to HIV, prodromal symptoms, psychosocial variables | Diagnosed as HIV+ AOR 0.16 (0.04-0.59) Diagnosed as HIV- AOR 0.61 (0.19-1.90) | Non-monogamous 31.9% HIV+, 41.3% HIV- Monogamous men 22.9% HIV+, 35.7% HIV- |
| Binson et al (2001)[45] | US (4 cities, New York, Chicago, Los Angeles and San Francisco) | Cross-sectional | MSM (sex in past year). Probability sample Computer-assisted telephone interview | 1997 | 2478 | HIV positive UAI in public setting | Logistic regression; drug use, serostatus frequency of venue use, venue use patterns | AOR 1.89 (1.09-3.25) | Not available |
| Harrison et al (1999)[46] | Brazil | Cross-sectional[b] | MSM recruited from HIV test sites, bars, night clubs, not known to be HIV positive, tested at entry to the cohort | 1994 | 61 HIV positive 183 matched controls | HIV positive at entry to cohort URAI with occasional partner | univariable analysis | OR[c] 1.91 (1.22-3.00) | Not available |

Note: a. Cohort examined predictors of UAI. Initial cross-sectional analysis of MSM at entry to cohort and prior behaviours presented here; b. potentially eligible study subjects for HIV seroincidence trial tested at entry. This outcome is from behaviours prior to entry to the cohort; c. These univariable OR were calculated from data presented in papers using STATA 8.0; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval; HR, hazard ratio; AHR, adjusted hazard ratio, ARR, adjusted rate ratio.

Results of the systematic review of HIV testing and UAI are presented below in Table 2.2. Twenty-three studies that met the inclusion criteria found an association between HIV testing and UAI. The UK studies were based in five cities in England, London, Manchester, Brighton, Oxford and Northampton, and two in Scotland, Edinburgh and Glasgow. Most of the US studies collected data from multiple US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. The Canadian studies were based in Vancouver and Montreal. Participants were mainly recruited from community settings, from multiple gay venues and events and medical settings (primarily HIV test clinics). All the studies were cross-sectional samples. One study used probability sampling based on a telephone index, one based on the proportion of the population who were adult males, while five used recruitment methods that were more systematic (e.g. every third person who came into the venue) than convenience sampling, and the rest were convenience samples. Fourteen studies used self-administered questionnaires, and ten studies used interviewers to administer the questionnaires. Seven studies were focussed on young MSM, and three on ethnic minority MSM, particularly Asian and South Pacific ethnicity. Sample sizes varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM. The studies took place over a period of time ranging from 1987 to 2003. A descriptive summary of these studies is given in Table 2.2 below.

The association between previous HIV testing and UAI remained over time. Seventeen studies that met the inclusion criteria showed that having had a previous HIV test was associated with risk behaviour such as unprotected anal intercourse[30-32,50-63], and five studies showed that MSM who have repeat HIV tests have increased risk behaviours such as UAI with partners of unknown status[27,64-67]. Repeat HIV testers were more likely to have a HIV positive primary partner[64]. Regular HIV testing has been associated with increased health awareness[27], and decreased HIV risk behaviour compared with irregular testing[67] or no difference in HIV risk behaviour compared with non-regular HIV testers[64] and decreased UAI with partners of unknown HIV status[66,68]. However, two of these studies had small sample sizes and three did not control for confounding, while the one larger study by MacKellar et al[66] excluded all MSM who tested HIV positive, thus possibly sampling a population of different MSM who may be lower-risk in their behaviour. While regular testing was not associated with UAI in these four studies, regular HIV testing was associated with an increased numbers of protected sexual partners[66] and increased number of casual partners[67] in the two studies that collected these data. A further US study, while finding that men who had been tested reported higher rates of protected and safer-sex practices, found that they showed no difference in high-risk practices such as UAI[69]. While they may have had

more protected sex proportionately, they correspondingly had more sexual acts, and therefore more unsafe sex[69]. Additional studies found that regular HIV testing was associated with UAI with concordant partners[68] and because the knowledge of HIV status can be incorrect[60], regular testing was associated with higher risk behaviour.

Both HIV testing and UAI were associated with HIV serostatus. HIV incidence at a London GUM clinic was higher in MSM who had three or more previous HIV tests than MSM with one or two previous tests[70]. Ever having an HIV test was associated with HIV infection in both GUM clinic-recruited[68] and community-recruited MSM[49]. UAI was associated with MSM being HIV positive[35,44-47,49]. UAI was associated with other factors that have been associated with risk of HIV infection. These included sites where sexual partners were met; visiting sex venues and bathhouses[45,71], gay bars[72] and cruising[71], with increased numbers of sexual partners[61,73,74],and the use of amyl nitrate (poppers), in both the US, (odds ratios (OR) 1.92, 95% confidence intervals (CI) 1.30 – 1.60)[73], and two studies in Canada (OR 1.70, 95% CI 1.59 – 1.81)[32], (OR 2.20, 95% CI 1.52 – 3.81)[75].

**Table 2.2 Review of reported associations between HIV testing and unprotected anal intercourse in MSM. Studies are presented by region, and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Dawson et al (1991)[56] | UK (4 areas in England, London, Manchester, Oxford, Northampton) | Cross-sectional | MSM attending bars, clubs and gay organisations, GUM clinics. | Oct 1987 – Jul 1989 | 502 | Ever HIV tested<br>URAI | Univariable analysis[a] | OR 1.90 (1.30 – 2.79) | 48% tested<br>58% that had URAI |
| Hart et al (1999)[52] | UK (2 cities in Scotland) | Cross-sectional | MSM attending gay bars (77%,80% per city response) | Dec 1995 – Nov 1996 | 2276 | UAI in past year (reference protected AI)<br>Ever tested for HIV | Logistic regression<br>Age, social class, employment status, education, gay scene, ever STI, STI in past year, partnership status, partners HIV status | AOR 1.40 (1.04-1.87) | 50% overall |
| Nardone et al (1998) [50] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas and GUM clinics, 72 sites (75% response) | Nov 1996-Jan 1997 | 2263 | Previous HIV test<br>UAI in past year | Logistic regression<br>Age, employment status, recruitment, years since first AI | AOR 1.29 (1.26-1.32) | 75% UAI<br>60% Non-UAI<br>64% overall |
| Hart et al (2002)[30] | UK (2 cities in Scotland) | Cross-sectional | MSM attending gay bars 10 bars (75%, 80% per city response) | 1999 | 2498 | UAI in past year<br>Ever HIV test | Logistic regression<br>area, age, number UAI partners, condom use<br>GUM service use, ever STI | AOR 1.57 (1.13-2.18) | 58% UAI<br>46% no UAI<br>50% overall |
| Povinelli et al (1996) [51] | US (Minnesota) | Cross-sectional | MSM adolescents (aged 13-21) enrolled into HIV prevention program, recalled after 3 months | 1989 - 1994 | 501 | Previous HIV testing<br>UAI ever | Stepwise logistic regression,<br>Age, Living with parent, Previous STD, Relationship status, Substance abuse, Perception of risk, homosexual acculturation, contact with health services | AOR 1.78 (1.12-2.82) | 64% UAI<br>36% Non-UAI<br>45% overall |
| Kelly et al (1992)[61] | US<br>(16 city, national sample) | Cross-sectional | MSM attending gay bars. (85% response rate) in small cities | 1991 | 1991 | UAI in past 2 months<br>HIV tested | Multivariable analysis, non-parametric tests, Univariable analysis for HIV testing | (Univariable analysis)<br>OR 1.27 (1.02-1.58) | 72% UAI<br>67% Non-UAI<br>68% overall |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Hays et al (1997)[60] | US (San Francisco) | Cross-sectional | Population-based probability sample of young MSM 18-29 (89% response*) interview and UA HIV test | 1992 | 364 | UAI in past year<br>Ever HIV test | Logistic regression, (UAI within each tested group only), Univariable only for tested vs. untested | (Univariable analysis)<br>OR 1.72 (0.96-3.06) | 88% UAI<br>81% non-UAI<br>84% overall |
| Ruiz et al (1998)[62] | US (California) | Cross-sectional | Young MSM attending gay-identified events and areas (aged 17-25) | 1994 | 836 | UAI in previous 6 months<br>Previous HIV test | Univariable only (excluded in stepwise logistic regression analysis) | (Univariable analysis)<br>OR 1.4 (CI 1.0-2.1) | 80% UAI<br>73% Non-UAI<br>76% overall |
| Sumartojo et al (2008)[55] | US (7 cities) | Cross-sectional | MSM 15-25 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (89.6% response) | 1999 | 2621 | Ever tested<br>UAI with any male partner in last 3 months | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | AOR 1.32 (1.02-1.79) | 78% ever tested<br>Yes 79%<br>No 78% |
| Choi et al (2002)[63] | US (Seattle, Washington & San Diego) | Cross-sectional | A venue-based sample of young Asian and Pacific Island MSM in gay-identified venues completed face-to-face questionnaires and received HIV counselling and testing. | May-August 1999 | 253 | Ever HIV tested HIV tested<br>UAI in past 3 months | Logistic regression; ethnicity, age, education, sexual orientation, birthplace, lifetime number of male sex partners, ever STI, ever IDU, ever used club drugs, and ever attended a circuit party | AOR 2.21 (1.04-4.70) | 71% ever tested |
| Flores et al (2009)[58] | US (13 communities) | Cross-sectional | Survey of interviewer-administered questionnaires of MSM 15-25 of particular ethnic groups recruited using venue-based sampling | 1999-2002 | 10295 | UAI last 3 months<br>Ever HIV tested | Logistic regression; gay identity, ever tested, HIV positive, aware of ART, AIDS prevention, peer norms, high social support | AOR 1.17 (1.05-1.31) | 81.6% ever tested<br>30.0% UAI |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Do et al (2006)[57] | US (2 cities) | Cross-sectional | English–speaking Asian and Pacific Island (API) MSM men aged 15–25 years were sampled from bars, clubs, businesses, special events (e.g., pride festivals), parks or public sex environments frequented by API MSM in San Diego, and Seattle | 1999-2002 | 908 | UAI in last 3 months<br>Recent HIV testing (past year) | Logistic regression; ethnicity, age, education, sexual behaviour, sites for HIV testing | AOR 2.6 (1.3–5.3) 2002 | 37.4% UAI (2002)<br>71.4% HIV tested in past year |
| Myers et al (1993)[59] | Canada (Toronto) | Cross-sectional | Convenience sample in gay bars and bathhouses. Self-completion questionnaire. (72.9% response) | 1990 | 1295 | Previous HIV test<br>Anal intercourse | Logistic regression; (90% CI ); age residence, sexual orientation, sexual behaviour | AOR 4.94(1.59-5.32) | 53% tested |
| Myers et al (1996)[32] | Canada (35 cities) | Cross-sectional | MSM recruited though gay identified venues (88 bars, 22 bathhouses) and community events (15 community dances) Proportional sampling quota by strata based on population of unmarried men 15-64 | Oct 1991-Jan 1992 | 4803 | Ever tested,<br>UAI past 3 months | Logistic regression analyses Geographic region, city size, age, sexual orientation, gay socialisation, relationship status | AOR 1.28 (1.16-1.40) | 63% overall |
| Van de Ven et al (2000)[31] | Australia (5 cities) | Cross-sectional | MSM attending gay festivals, gay social and sex-on –premises venues, and sexual health services (71%-83% by cities) | 1998 | 6831 | Ever had a test<br>Any UAI in previous 6 months (reference any UAI) stratified by regular or casual partners | Logistic regression Age, city, occupation, sexual orientation, gay friends, number of male partners in previous 6 months, sex with regular partners (type), sex with casual partners (type) | Regular partners (RP)<br>No anal/regular<br>AOR 0.68 (0.55–0.85)<br>Casual partners (CP)<br>No casual/anal<br>AOR 0.77 (0.57-1.04) | 83% overall<br>84.0% no regular<br>89.6% any UAI RP<br>83% no casual<br>90.1% any UAI CP |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Jin et al (2002)[54] | Australia (5 cities) | Cross-sectional repeated annually | Reported HIV negative MSM recruited from community sites, gay outdoor events, sex on premises venues, and social venues. Self-completion questionnaire | 1996 - 2001 | 22161 | Tested in past 12 months<br>UAI | Logistic regression; area, recruitment site, age group, gay friends, no. partners, relationship status, UAI, safe sex agreements | UAI regular partner only<br>AOR 1.20 (1.10-1.31)<br>UAI casual partner only<br>AOR 1.23 (1.10-1.38)<br>UAI with both<br>AOR 1.31 (1.15-1.50) | 57.6% tested recently<br>85.3% ever tested |
| | **Repeat HIV Testers** | | | | | | | | |
| Norton et al (1997)[27] | UK (London) | Cross-sectional | One-day HIV testing centre<br>(78% response rate) | Sep 1995 – Jan 1996 | 285 MSM | Repeat testing (1+) (reference first test)<br>UAI in previous 6 months<br>Repeat testing 3+ (reference <3 tests)<br>UAI with 2+ partners | Univariable analysis only | 1+<br>OR 3.38 (1.55-7.54)<br>Repeat 3+<br>OR 2.26 (1.15-4.43) | Repeat HIV testers<br>82% UAI<br>58% non-UAI<br>62% overall |
| Elford et al (2001)[70] | UK (London) | Cross-sectional | Same-day HIV testing centre (75% response 1580 of 2100) | 1997 - 1998 | 337 | Repeat testers 3+ tests) with previous negative test<br>Unprotected penetrative sex in past 3 months | Univariable analysis[a] | OR 2.15 (1.25- 3.71) | Not available |
| Leaity et al (2000)[65] | UK (London) | Cross-sectional | Same-day HIV testing clinic (75% response rate, 1580 of 2100) | 1997 - 1998 | 470 MSM | Repeat testers (1-2, 3+ previous tests) (reference first tests)<br>Unprotected penetrative sex in past 3 months | Univariable analysis only | Repeat testing<br>OR 1.54 (0.98-2.42)<br>3+ testers/rest<br>OR 1.89 (1.24-2.88)<br>3+ testers / 1-2 tested<br>OR 1.78 (1.11-2.87) | Repeat testers<br>77% UAI<br>68% Non-UAI<br>72% overall |
| Philips et al (1995)[64] | US (2 cities) | Cross-sectional | telephone survey MSM<br>(59%-75% response) | 1992 | 2602 | Repeat testing (Tested 3+) (reference 1-2 times), Regular testing (Tested 3+ /every 6 months (reference 1-2 times and/or < once every 6 months)<br>UAI in previous month | Logistic regression (all anal only)<br>Univariable only for UAI | Univariable analysis<br>Repeat testing,<br>OR 1.21 (1.00-1.49)<br>Regular testing,<br>OR 1.12 (0.84-1.48) | Repeat tested<br>54% UAI<br>49% Non-UAI<br>51% overall<br>Regular testing<br>17% UAI<br>14% non UAI<br>15% overall. |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst the listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| MacKellar et al (2002)[66] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3430 | Repeat testing (reference never) UAI unknown HIV status partner | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | AOR 0.6 (0.5 – 0.8) | 36% never tested 39% tested infrequently, 61% once) 50% repeat had tested 4+ times |
| Kalichman et al (1997)[67] | US (Atlanta) | Cross-sectional | MSM attending gay pride festival who had HIV tests and were HIV negative. (90% response) | 1996 | 253 | Repeat testers (3 or more times) (reference non-repeaters,1-2 times) UAI in past 6 months Regular testers (every 6 months) (reference non-regular) UAI in past 6 months | Univariable analysis only[a] | Repeat testing OR 1.40 (0.80-2.43) Regular testing OR 0.75 (0.44-1.27) | 57% repeat ,UAI 49% 1-2, UAI 59% regular, UAI 51% non-regular, UAI |

Note: a. These univariable odds ratios (OR) were calculated from data presented in papers using STATA 8.0; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals; URAI, unprotected receptive anal intercourse.

There was a positive association between HIV testing and UAI. MSM who had previously tested showed an increased likelihood of UAI. This was seen in the UK, US, Canada and Australia in studies carried out between 1990 and 2002. Repeat testing was found to be associated with increased likelihood of UAI in the UK. This positive association was found in a large US study too, but a study of young MSM aged less than 22 found repeat HIV testing to be protective of UAI (OR 0.6, 95% CI 0.6 – 0.8). A further small study (253 individuals) found no evidence of an association between repeat HIV testing and UAI. Both these US studies recruited only MSM who had either never tested or tested HIV negative, excluding all positive MSM.

There are a number of possible reasons for the relationship between HIV testing and UAI. Prior testing may be a marker of sexual risk behaviour. Men may choose to undergo an HIV test because they are, or perceive themselves to be, at risk of HIV infection. The data suggest that men who choose to test for HIV have more risk behaviour (UAI) then those who don't. An alternative explanation is reverse causality, namely that men HIV test to determine their serostatus to then make decisions about UAI based on the test results. There is some evidence for this when comparing men who have previously tested HIV negative with those who have either tested HIV positive or are untested. Men who have tested HIV positive may be motivated to reduce their risk, and some studies have found that testing HIV positive reduces the likelihood of having UAI[52,76]. There was no evidence of a reduction in high-risk behaviour in MSM who had tested HIV negative. They were either more likely to have had UAI compared with men who were untested[33], or showed no difference in the proportion of UAI[76,77]. A case control study among repeat testers in the UK found that previous HIV negative tests and the adoption of risk reduction strategies diminished the perceived threat of HIV infection[78]. This led to loss of control over risk reduction strategies resulting in subsequent UAI.

Clearly an individual's HIV serostatus is an important determinant of future sexual behaviour. It has been shown that some MSM are using HIV testing to determine their HIV status in order to make decisions about their sexual behaviour within relationships based on their test results[54,68,79]. MSM are moving away from the 100% condom use message, and starting to use risk reduction methods instead. This has been termed 'negotiated safety'[80]. However, studies have shown that seroconcordance is often based on perceived status rather than on actual status. Two studies within Britain found that 25% of men who reported that they had UAI with a partner of the same serostatus as themselves had never had a HIV test[28]. Other studies have shown that of

men who stated that they were practising negotiated safety, many of the partners with whom they were engaging in UAI were casual partners of unknown HIV serostatus[30,79].

There is certainly evidence that serosorting (that is choosing a partner of the same HIV serostatus as oneself) has been taking place among HIV positive men to have concordant UAI[81-83]. While some would disclose their status and then have UAI with concordant partners and some did not disclose and still had UAI[81]. The internet in particular has facilitated this disclosure and serosorting between HIV positive men but this has been followed by large rises in STIs in HIV positive MSM[82,84].

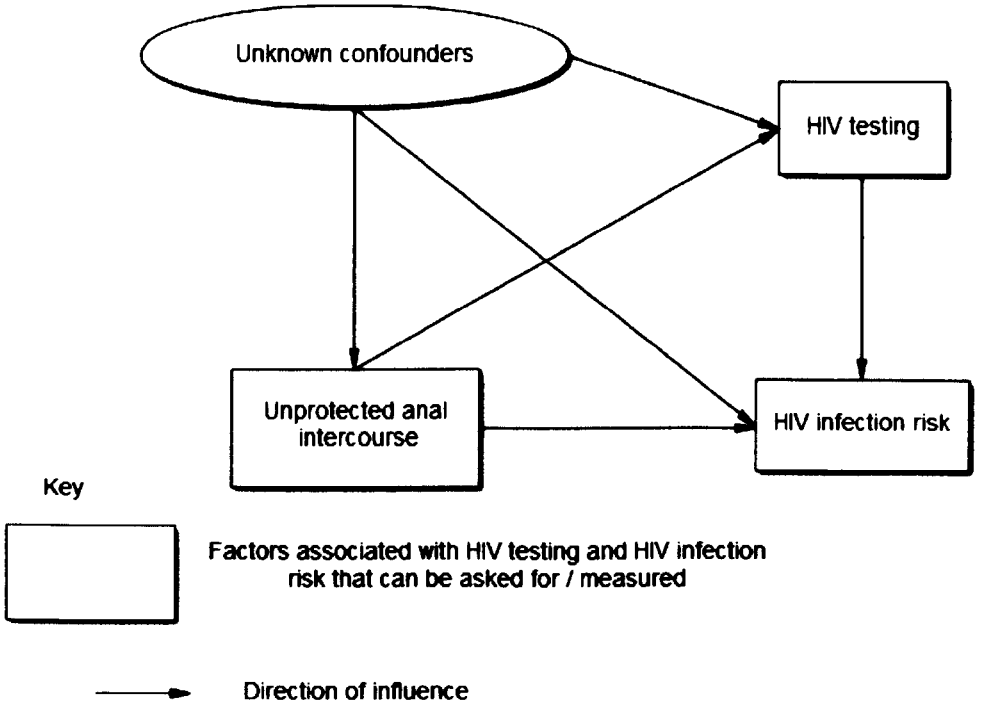
Thus, while HIV testing may denote many different types of behaviour and there are many reasons for having an HIV test, most of the evidence suggests that those who have tested have higher behavioural risk than those who haven't tested. Repeat HIV testers were even more likely to have had UAI than men who had not tested repeatedly (Table 2.2). When comparing UAI by HIV serostatus (Table 2.1b), most of the evidence found that men who had tested negative were more likely to have had UAI then men who were untested and less likely than men who had tested HIV positive. While men within relationships may account for some of this increased UAI and so it could be argued that they are not at increased risk of HIV infection if their partners serostatus is the same as their own[62,85]. Clearly HIV status is not known completely enough to remove the risk of HIV infection.

The studies reviewed sampled MSM from a variety of venues including bars, clubs gay–identified events, sexual health services, the community through advertisement or probability-sample phone surveys and so, overall, are probably representative of MSM. However, cross-sectional studies comparing those who have HIV tested and those who haven't cannot address the pre-existing differences in HIV risk behaviour or motivation to reduce risk behaviour that may have influenced the participant's initial decision to undergo HIV testing. It is not possible to determine the temporal relationship between HIV testing and UAI. Sexual behaviour was obtained through both self-completion questionnaire and face-to-face interview in these studies. Sexual behaviour is open to recall bias and social-desirability bias which may be more likely in the interviewed samples. Thus, as in all behavioural surveys, bias cannot be ruled out, which may affect the measurement of the true association between HIV testing and UAI. Due to the different sampling methods, different outcome and exposure categories between the studies, it is not possible to generate an overall measure of association between

HIV testing and UAI through a meta-analysis.

In summary, MSM who had HIV tested had higher behavioural risk, indicated through UAI, than untested MSM. Although there was some evidence that repeat testing may be associated with health-seeking behaviour, most of the evidence suggests that repeat testers were more likely to have more UAI partners. HIV seroconversion was associated with UAI and HIV positive MSM were more likely to have had UAI than HIV negative MSM. A summary of the likely association between HIV testing, UAI and HIV infection is represented in the conceptual framework in Figure 2.2 below.

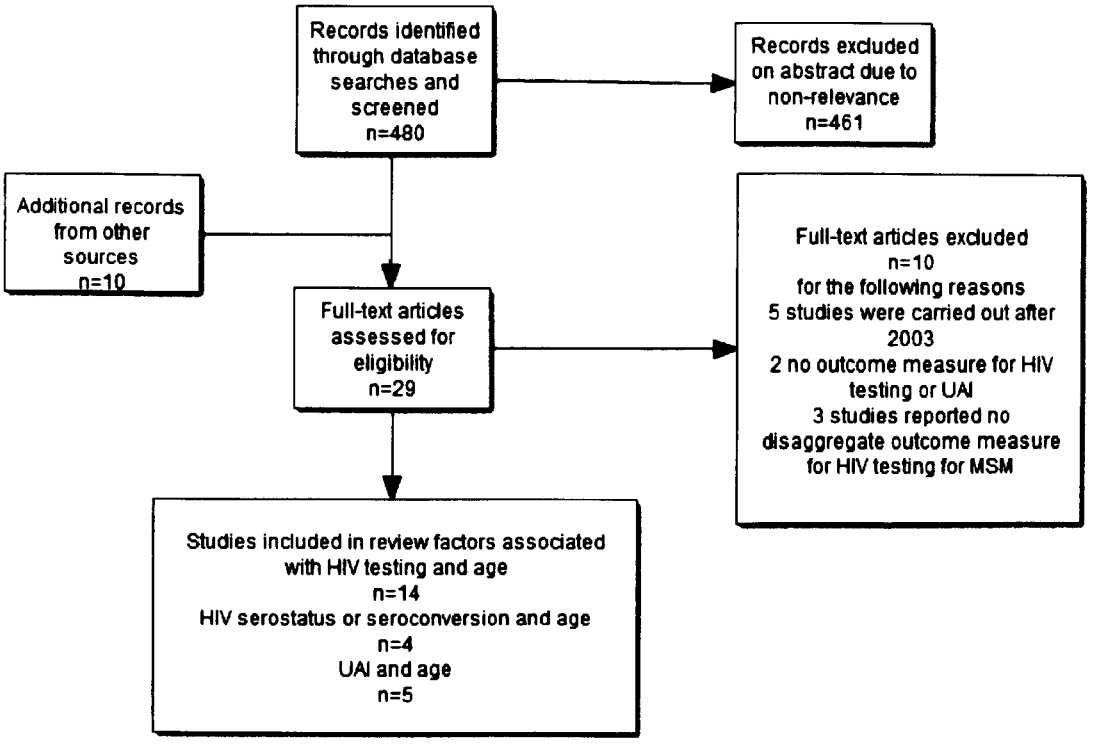
**Figure 2.2 Conceptual framework of the relationship between HIV testing and unprotected anal intercourse**



## 2.4 Association between HIV testing, HIV seroconversion or HIV serostatus, unprotected anal intercourse and age

To investigate the associations between HIV testing, HIV seroconversion or HIV serostatus, UAI and age, a series of MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'age' and (a) 'HIV testing', (b) HIV seroconversion/serostatus and (c) 'unprotected anal intercourse'. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers. In total 490 studies and surveys were extracted, of which 461 were excluded on abstract due to non-relevance or date of survey post 2003 (Figure 2.3). A further ten full-text articles were excluded as the study was carried out after 2003 (5 studies), no measures of association available on HIV testing or UAI (2 studies) or no disaggregate data available for MSM (3 studies). The studies excluded are listed in Table A.2, Appendix A.

**Figure 2.3 Systematic review data flow for investigation of the association between HIV testing, unprotected anal intercourse, HIV seroconversion or HIV serostatus and age**




Fourteen studies that met the inclusion criteria presented an association between HIV testing and age, four reported on HIV serostatus and age, and four reported on UAI and age. The UK studies were based in one city in England, London, and two in Scotland, Edinburgh and Glasgow. Most of the US studies collected data from multiple

US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. A national Canadian study sampled from 35 cities and an Australian study sampled from five large cities. Participants were mainly recruited from community settings, from multiple gay venues and events and medical settings (primarily HIV test clinics). Three of the studies were cohorts, while the rest were cross-sectional convenience samples. Two studies used probability sampling based on a telephone index, one based on the proportion of the population who were unmarried adult males, while seven used recruitment methods that were more systematic in their sampling methodology (e.g. every third person who came into the venue) than convenience sampling. Sixteen studies used self-administered questionnaires, and eight studies used interviewers to administer the questionnaires. Four studies were focussed on young MSM, and two on ethnic minority MSM, Asian and South Pacific ethnicity and Latino MSM. Sample sizes varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM and the Australian study sampled over 22,000 MSM. The studies took place over a period of time ranging from 1989 to 2003. A descriptive summary of these studies is given in Tables 2.3a-2.3c below.

Previous HIV testing was associated with older age in MSM in Europe[30,50,53], Australia[54] and the US[51,55,86] (see Table 2.3a below), although this association was not linear. In MSM in general up to the age group, 26 to 30 years, there was an increased association of previous HIV testing with age, whereas over 30 years this association became more level. In the UK, previous HIV testing, was positively associated with being aged 26 to 30 compared with less than 25, and then no difference in ever HIV tested between MSM aged over 30 compared with MSM aged less than 25[30,50]. In the Netherlands, previous HIV testing was associated with being aged more than 30[53]. These studies were all carried out during the 1990's. In the US study carried out in 2002, previous HIV testing was associated with increasing age[86]. Studies investigating HIV testing in adolescent and young adult MSM in the US found that previous HIV testing increased by year of age in 13-21 year olds, and 15-25 year olds[51,55]. In Canada HIV testing was associated with younger age[32] in a study carried out in the early 1990's.

Recent HIV testing was associated with younger age in the US. MSM aged 23 to 25 years were more likely to have tested than MSM aged 26 to 29[87]. Again a similar non-linear trend was found in Australia, where recent HIV testing in MSM was associated with increasing age up to 30 years; 25 to 29 compared with MSM aged less than 25. There was no difference in recent testing in MSM aged 30 to 39 compared with MSM

aged less than 25, while MSM aged more than 40 had a reduced likelihood of recent HIV testing compared with MSM aged less than 25[54].

Repeat HIV testing – defined as 3 or more tests - was associated with increasing age in the US[66,88] and MSM who had tested once or twice were more likely to be older compared with first-time testers[66]. One US study in the 1992 found an overall deceasing association of repeat HIV testing with age[64], but this was not linear. Repeat HIV testing was more common in MSM aged up to 40 years, and then the proportion repeat tested decreased in MSM aged over 40 years; from 43% in 30 to 40 year olds to 27% (Table 2.3a). Regular testing (every 6 months) was associated with younger age in the US[64,67,88] (Table 2.3a).

Some studies in the US found no association with age[69,89]. However, one excluded all who were positive (more than 15% of the sample), and the second recruited from smaller cities, and in general had a lower testing rate (60%) than has been measured overall in other US studies[69].

**Table 2.3a Review of reported associations between HIV testing and age in MSM. Studies are presented region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Nardone et al (1998)[50] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas and GUM clinics, 72 sites (75% response) | Nov 1996-Jan 1997 | 2263 | Previous HIV test Age group (reference <25 years) | Logistic regression; employment status, recruitment, years since first AI | 25-34 years AOR 1.04 (0.96-1.11) 35+ years AOR 0.76 (0.70-0.83) | 54% <25 years 68% 25-34 years 63 % 35+ years |
| Nardone et al (2001)[28] | UK (London and Edinburgh) | Cross-sectional | MSM attending bars. Sampling frame constructed from all gay bars in London, 42 surveyed, all 5 in Edinburgh. (75% response) | Nov –Dec 1996 | 2397 | Previous HIV test Age group (reference <25 years) | Logistic regression; employment status, city of recruitment | 26-30 years AOR 1.19 (1.03-1.39) 31-35 years AOR 0.88 (0.76-1.02) 36+ years AOR 0.79 (0.67-0.92) Age (per year) AOR 0.98 (0.97-0.99) | 63% London 54% Edinburgh |
| Hart et al (2002)[30] | Scotland (2 cities) | Cross-sectional | MSM attending gay bars 10 bars (75%, 80% per city response) | 1999 | 2498 | Ever HIV test Age over 26 years | Logistic regression; area, number UAI partners, condom use GUM service use, ever STI | AOR 1.62 (1.28-2.06) | 41% 15-25 years 53% 26+ years 50% all ages |
| Stolte et al (2007)[53] | Netherlands (Amsterdam) | Cross-sectional | All new consultations by MSM, self-completed questionnaire, with self-reported HIV negative status | Mar 2002 – Dec 2003 | 1201 | Never tested for HIV Age (reference 30-39 years) | Logistic regression; educational level, Dutch, UAI, STI | <30 years AOR 1.79 (1.26-2.54) | 40% <30 years 26.9% 30-39 years 31.4% 40-49 years 37% 50+ years |
| Helm et al (2009)[86] | US (4 cities) | Longitudinal surveillance study | Routine clinical visits of MSM aged 15-70 at STD clinics in 4 cities | 2002-2006 | 49617 | Never HIV tested Age (per year increase of age) | Generalised estimating analysis; ethnicity, city, concurrent STI, year of HIV test | AOR 0.93 (0.92-0.94) | 56% HIV tested Increased from 49% 2002 to 61% 2006. |
| Povinelli et al (1996)[51] | US (Minnesota) | Cross-sectional | MSM adolescents (aged 13-21) enrolled into HIV prevention program, recalled after 3 months | 1989 - 1994 | 501 | Previous HIV testing Age (per year increase of age) | Stepwise logistic regression; living with parent, Previous STD, Relationship status, Substance abuse, Perception of risk, homosexual acculturation | AOR 1.25 (1.08-1.44) Gay acculturation (most friends understand orientation) AOR 1.82 (1.08-3.07) and ever had a steady male partner, AOR 1.79 (1.05-3.07) | 64% UAI 36% Non-UAI 45% overall |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Sumartojo et al (2008)[55] | US (7 cities) | Cross-sectional | MSM 15-25 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (89.6% response) | 1999 | 2621 | Ever tested<br>Age (linear trend, 1 year increase) | Logistic regression; city, ethnicity, education, psychosocial, sexual behaviour | AOR 1.28 (1.21-1.35) | 78% ever tested<br>15-17 50%<br>18-20 (71%)<br>21-25 (85%) |
| MacKellar et al (2006)[87] | US (7 cities) | Cross-sectional | MSM 23-29 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (58% response) | 1998 - 2000 | 2797 | Recent testing (past 12 months)<br>Age group 23-25 years (reference 26-29 years) | Logistic regression; city, ethnicity, education, psychosocial, sexual behaviour | AOR 1.2 (1.1-1.5) | 54% recent test |
| Myers et al (1996)[32] | Canada (35 cities) | Cross-sectional | MSM recruited though gay identified venues (88 bars, 22 bathhouses) and community events (15 community dances) Proportional sampling quota by strata based on population of unmarried men 15-64 for non-metropolitan regions | Oct 1991-Jan 1992 | 4803 | Ever tested<br>Age per 10 years | Logistic regression; geographic region, city size, sexual orientation, gay socialisation, relationship status | AOR 0.86 (0.82-0.90) | Not available |
| Jin et al (2002)[54] | Australia (5 cities) | Cross-sectional repeated annually | Reported HIV negative MSM recruited from community sites, gay outdoor events, sex on premises venues, and social venues. Self-completion questionnaire | 1996 - 2001 | 22161 | Tested in past 12 months<br>Age group (reference <25 years) | Logistic regression; area, recruitment site, gay friends, no. partners, relationship status, UAI, safe sex agreements | 25-29 years<br>AOR 1.12 (1.01-1.24)<br>30-39 years<br>AOR 0.96 (0.88-1.06)<br>40-49 years<br>AOR 0.73 (0.65-0.81<br>50+ years<br>AOR 0.77 (0.67-0.88) | 57.6% tested recently<br>85.3% ever tested |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| | **Repeat HIV testers** | | | | | | | | |
| Phillips et al (1995)[64] | US (2 cities) | Cross-sectional | Random list-frame household telephone survey and time-period recruitment of gay bars of MSM (59%-75% response) | 1992 | 2602 | Repeat testing (Tested 3+ reference 1-2 times) Regular testing (Tested 3+ and every 6 months ref 1-2 times and/or < once every 6 months) Age (per year increase of age) | Logistic regression; HIV risk measures, attitudes beliefs, social norms and communication, ethnicity, education, area, health insurance | Repeat testing AOR 0.99 (0.98-1.00) Regular testing AOR 0.98 (0.96 – 1.00) | Repeat tested 33% <30 years 40% 30-40 years 27% >40 years Regular testing 43% <30 years 34% 30-40 years 23% >40 years. |
| MacKellar et al (2002)[66] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3430 | Repeat testing (reference never) Age 20-22 years (reference 15-21 years) | Logistic regression; city, ethnicity, education, psychosocial, sexual behaviour | AOR 2.9 (2.2 – 3.8) | 36% never tested 39% tested infrequently, 61% once 50% repeat had tested 4+ times |
| Fernandez et al (2003)[88] | US (Florida) | Cross-sectional | MSM Hispanic/Latino recruited from public venues bars, bathhouses, gyms, parks and street corners. (80% response) | Dec 1999 – Feb 2001 | 538 | Repeat testing, (3+) regular testing Age (per year increase of age) | Logistic regression; education, STD, number sexual partners, UAI, oral sex | repeat testing AOR 1.03 (1.01-1.06) regular testing AOR 0.97 (0.95-1.00) | Not available |

Note. OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals.

As mentioned before, the study populations differ by recruited ages. Due to the different outcome measures and study populations, it was not possible to generate an overall measure of association between HIV testing and age through a meta-analysis. With young MSM, other psychosocial factors, besides sexual behaviour, need to be considered when comparing with older MSM. Thus HIV testing, and its relationship with age, may indirectly be measuring the different sexual identities of MSM in different locations. Myers et al[59] hypothesise that the different testing patterns of older and younger MSM may be due to cultural and societal differences over time within Canada; the fact that the sexual identities of the older MSM had been developed with discrimination and HIV testing is related to sexual identity and openness, hence older MSM were less likely to have HIV tested. Since sexual identity and gay acculturation will increase through teenage and twenties as years of sexual activity increase. This would concur with the increase in HIV testing in MSM with age seen in the UK, Australia and the US. Being of older age increases the likelihood of having an HIV test, compared with younger age, but age is a marker for number of years of sexual activity, which is directly related to probability of having an HIV test[50]. HIV testing was associated with years since first sexual intercourse[50] and number of lifetime sexual partners[31,54,60,62]. Reporting a previous HIV test was associated with gay socialisation in Canada[32] and younger age of self-identification as homosexual or bisexual (OR 0.91, 95% CI 0.85 – 0.99). Gay acculturation were predictors of test seeking in the US[51]. HIV testing was associated with being integrated into the gay scene and going more often to gay bars[60]. A predictor of recent HIV testing was found to be having more gay friends[51,54], and having a higher social support, defined as someone to talk to about AIDS, sex and unsafe sex (OR 1.23, 95% CI 1.12 – 1.35)[55]. A low social support network was associated with UAI in young MSM in Canada (OR 1.65, 95% CI 1.04 – 2.59)[75]. HIV testing had been found to be related to number of friends who have AIDS[27,33] which is strongly age related. Repeat testing was associated with personal knowledge of others who have been infected with HIV which may be age-related (OR 1.14, 95% CI 1.05 – 1.23)[27]. In the UK previous HIV test was independently associated with older age[30,50] and large proportions of undiagnosed infections are in young MSM[90].

**Table 2.3b Review of reported associations between HIV seroconversion and age in MSM. Studies are presented by type of study design, region, and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Harrison et al (1999)[46] | Brazil | Cohort | MSM recruited from HIV test sites, bars, night clubs, not known to be HIV positive | Jul 1995 – May 1997 | 750 30 cases, 670 negatives | HIV seroconversion Age <25 years (reference >25 years) | Cox proportional hazards, logistic regression; sex at first encounter, gonorrhoea, Genital warts, Hepatitis B | ARR 2.6 (1.3 – 5.6) | Not available |
| McFarland et al (1997)[39] | US (San Francisco) | Cohort | Repeat HIV tests in MSM attending anonymous HIV test clinics | 1995 | 2822 | HIV seroconversion Age <35 years (reference >35 years) | Cox proportional hazards analysis; Ethnicity, < UAI, sex HIV+ partner, 10+ partners in last year, popper use | AHR 2.1 (1.4 – 3.2) | Not available |
| Buchbinder et al (2005)[37] | US (6 cities) | Cohort | MSM HIV negative, anal sex with man in past 12 months, Recruited from previous cohorts, STD clinic, bars, clubs, advertising, street outreach, and referral from other participants. | Apr 1995-May 1997 | 3257 | HIV seroconversion Age <35 years (reference >35 years) | Multivariable proportional hazards model; sexual behaviours, health insurance, HIV negative male partners, nitrate inhalant use | AHR 1.7 (0.98-3.0) | Not available |
| **HIV Serostatus** | | | | | | | | | |
| Valleroy et al (2004)[91] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3449 | HIV positive Age 20-22 years (reference 15-21 years) | Logistic regression; city, ethnicity, education, psychosocial, sexual behaviour | AOR 1.4 (1.0-1.9) | 65% tested previously 79% HIV positives 64% HIV negative |
| Dodds et al (2004)[49] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas, 58 sites, 57% response to UA HIV test of saliva | 2000 | 1206 | HIV positive Age group years (reference 40+) | Univariable analysis | <25 OR 0.13 (0.003-0.46) 25-29 OR 0.93 (0.50 -1.71) 30-34 OR 1.09 (0.62 -1.93) 35-39 OR 2.02 (1.16 -3.55) | Not available |

Note. OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals; AHR, adjusted hazard ratio; ARR, adjusted risk ratio.

Younger age was associated with increased likelihood of HIV seroconversion in three cohort studies[37,39,46] (Table 2.3b).

Differences in HIV infection exist by age, and while HIV incidence was associated with age less than 35 in the US[37,39] and age less than 25 in Brazil[46] (Table 2.3b), HIV positive serostatus was associated with older age in the UK[49] and the US[91]. Again this association of HIV positivity with increasing age was not linear. While MSM aged less than 25 were less likely to be HIV positive, MSM aged 35 to 39 years were more likely to be HIV positive than MSM aged 40 or over. In the US study, it was only comparing MSM aged 20 to 22 with 15 to 21 year olds (Table 2.3b).

When considering the age at which an individual has HIV infection, in this context one has to consider the age of the individual found to be HIV positive and the age of the person they got their infection from. The survey results of HIV incidence and HIV testing do not include any data on sexual partnerships. Therefore age is a proxy for a multitude of other factors that are associated with choosing to HIV test and the risk of being HIV positive. Conversely the sexual mixing patterns of younger men may put themselves at higher risk of HIV infection. The tendency of young MSM to have sex with older men will increase their risk of HIV infection since HIV prevalence increases with increasing age, younger MSM may be more likely to meet a sexual partner who is HIV positive[49,62]. There may be some kind of age-cohort sampling bias in the US if more of the older MSM have died, since then a more select low-risk pool is left to be surveyed and take part in cohorts[44].

**Table 2.3c Review of reported associations between UAI and age in MSM. Studies are presented by type of study design, region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Wells et al (1998)[92] | UK (London) | Cross-sectional | MSM attending a same day HIV test clinic (78% response). | Sep 1995-Jan 1996 | 285 | UAI past 6 months<br>Age group (reference 15-24 years) | Univariable analysis only[a] | OR 1.08 (0.55-2.14) | Not available |
| Elford et al (1999)[85] | UK (London) | Cross-sectional | MSM attending 5 London gyms (50.4% response) | Sep-Oct 1997 | 1004 | UAI in previous 3 months<br>Age group (reference <20 years) | Logistic regression; being in a relationship | AOR 0.8 (0.7-0.9) | 73% overall |
| McKusick et al (1990)[44] | US (San Francisco) | Cross-sectional[b] | MSM attending bathhouses, bars, advertisement for men not attending the above (51% response) | 1983-1984 | 508 | UAI in previous month<br>Age >36 years (reference <36 years) | Logistic regression; relationship status, history STD, UAI favourite, believe exposed to HIV, prodromal symptoms, personal efficacy, support, health knowledge, depression, AIDS loss | AOR 0.51 (0.29-0.86) | 69% overall<br>1988 |
| Kelly KA et al (1992)[61] | US (16 city, national sample) | Cross-sectional | MSM attending gay bars. (85% response rate) in small cities | 1991 | 1991 | UAI in past 2 months<br>Age (per year increase of age) | Multivariable analysis, non-parametric tests, analysis of variance | Younger age (p=0.002)<br>30.37 mean age UAI<br>31.79 mean age no UAI<br>F=9.96, p=0.002 | 72% UAI<br>67% Non-UAI<br>68% overall |
| Schwarcz et al (2007)[74] | US (San Francisco) | Cross-sectional | Random-digit dial probability sample survey of households in SF. Computer assisted telephone interview followed by urine sample tested for gonorrhoea, chlamydia & HIV | Jun 2002 – Jan 2003 | 1976 | URAI in HIV negative with partner of unknown or serodiscordant status<br>Age (per year of age) | Logistic regression;, number years in SF, drug use, partner through internet, HIV transmission attitudes | AOR 1.0 (0.9 – 1.0) | Not available |

Note. a. These univariable odds ratios (OR) were calculated from data presented in papers using STATA 8.0; b. Cohort examined predictors of UAI. Initial cross-sectional analysis of MSM at entry to cohort and prior behaviours presented here; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals; URAI, unprotected receptive anal intercourse.

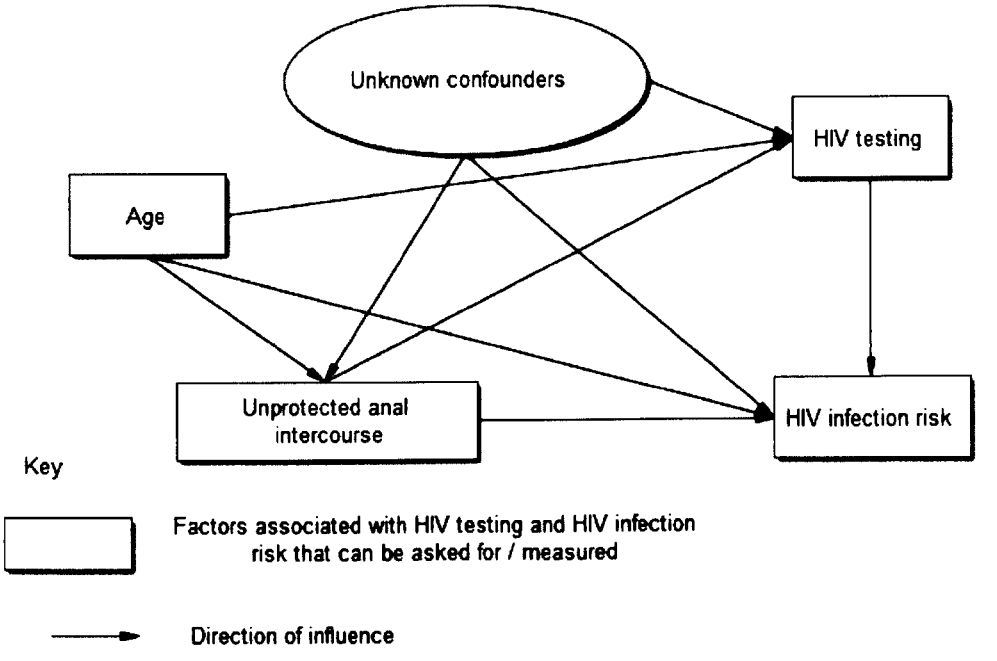
The review of the reported associations between UAI and age is presented in Table 2.3c. UAI was associated with younger age in a cohort study in San Francisco[44] in 1984 (OR 0.51, 95% CI 0.29 – 0.86) aged more than 36 years, but there was no difference in UAI by age in the 1988 follow-up (OR 1.06, 95% CI 0.36 – 3.12). Age was associated with UAI in all studies, but the direction of the association differs by type of study and between countries. These disparities in results can be explained by the variety of different study populations.

Differences in risk of HIV infection, measured by UAI, have been seen by age; however, this difference varied by continent. In their review of age and risk of HIV infection in 1998, Mansergh and Marks concluded that younger age was fairly consistently found to be associated with UAI in North American studies, while only limited evidence was found for the association in European and Australian studies[93]. Some of these regional differences in sexual behaviours may be because, in the US, young gay men are more likely to go to bars than older gay men, and this leads to increased UAI as this is a meeting place for new partners. A study in the UK, which found no age difference in UAI in a same-day HIV test clinic, reported a higher rate of UAI (50%) than reported in other UK studies at this time, and may be representing a self-selected group[92]. UAI was associated with visiting a gay bar in the past 12 months[71].

More recent studies in the UK and in the Netherlands have found that younger gay men were more likely to have been engaged in UAI in the previous year[28,94,95]. Hence as the relationship between UAI and age is changing over time, HIV testing may change with this relationship. UAI has continued to be associated with younger age in the US[74].

A summary of the likely association between HIV testing, UAI and HIV infection and age is represented in the conceptual framework in Figure 2.4.

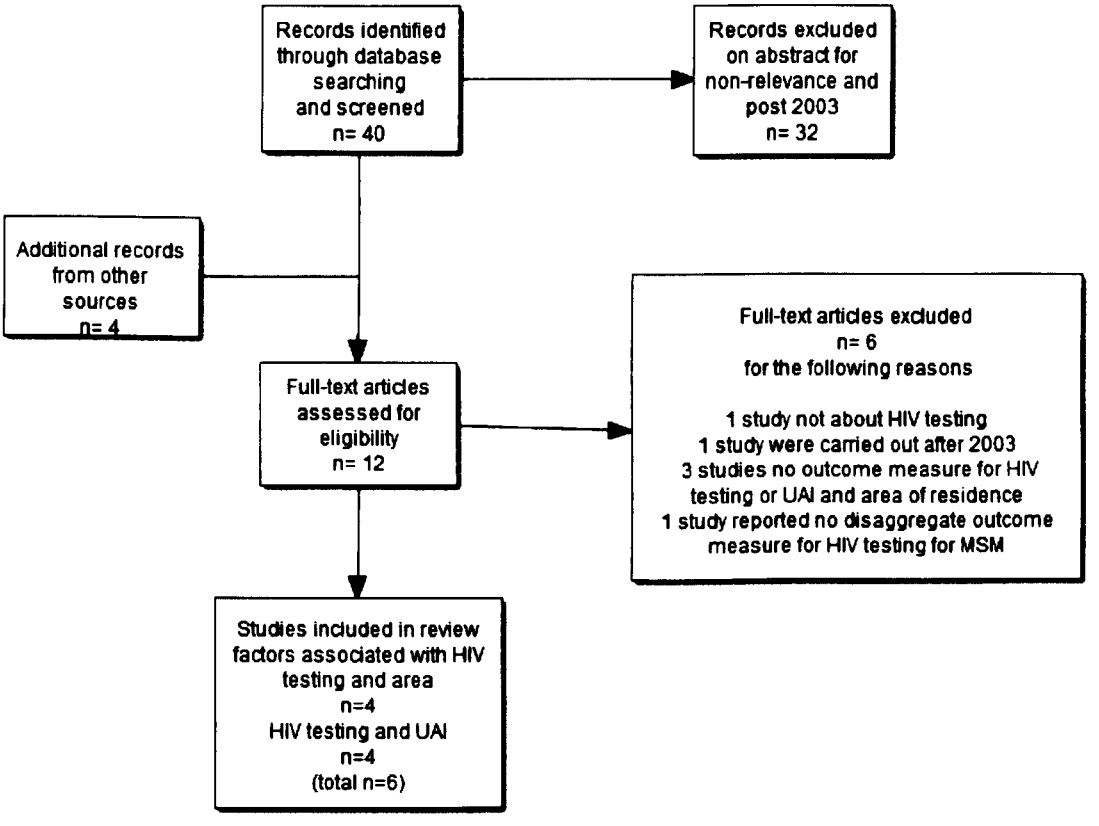
**Figure 2.4 Conceptual framework of the relationship between HIV testing, unprotected anal intercourse and age**



## 2.5 Association between HIV testing, unprotected anal intercourse and area of residence

To investigate the associations between HIV testing, UAI and area of residence MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'residence', and (a) 'HIV testing' and (b) 'unprotected anal intercourse'. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers. In total 44 studies and surveys were extracted, of which 32 were excluded on abstract due to non-relevance or date of survey post 2003 (Figure 2.5). A further 6 full-text articles were excluded due to the study not being about HIV testing (one study), the study carried out after 2003 (one study), no measures of association available on HIV testing or UAI and area of residence (three studies) or no disaggregate data available for MSM (one study). These are listed in Table A.3, Appendix A.

**Figure 2.5 Systematic review data flow for investigation of the association between HIV testing and unprotected anal intercourse and area of residence**




Four studies that met the inclusion criteria presented an association between HIV testing and area of residence and four reported on UAI and area of residence. The UK

studies were based in one city in England, London, and one in Scotland, Edinburgh. The US studies collected data from multiple US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. A national Canadian study sampled from 35 cities and an Australian study sampled from five large cities. Participants were mainly recruited from community settings, from multiple gay venues and events and medical settings (primarily HIV test clinics). All of the studies were cross-sectional convenience samples. One study used probability sampling based on a sampling frame of gay bars in the city, one based on the proportion of the population who were unmarried adult males. Four studies used self-administered questionnaires, and two studies used interviewers to administer the questionnaires. Two studies were focussed on young MSM. Sample sizes varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM and the Australian study sampled over 22,000 MSM. The studies took place over a period of time ranging from 1991 to 2001. A descriptive summary of these studies is given in Tables 2.4a-2.4b.

Of the six studies that met the inclusion criteria, HIV testing has been found to be associated with area of residence in four, that is associated with being from a metropolitan area[28,32,54,59] (see Table 2.4a). This could relate to a number of other factors, such as availability of HIV testing, different policies of offering HIV testing, and different levels of risk behaviour that then prompts HIV testing. Nardone et al surmise that as 'negotiated safety' was a strategy promoted in London but not in Scotland, this could account for some of the different levels of HIV testing between two cities[28]. There are differences in HIV testing levels between urban and rural areas within countries; being resident in a metropolitan area in Canada was found to be independently associated with having a previous HIV test with testing ranging from 55% compared with 37%[59] as was being from a larger city[32]. City of residence was important in Australia with gay men surveyed 30 to 40% less likely to have had HIV tested if they were from Perth of Melbourne compared with Sydney[31,54]. Levels of previous HIV testing ranged from 60% to 85% in the US and 53% to 64% in the UK, but no clear pattern could be seen and much of this disparity could be due to different HIV testing policies.

**Table 2.4a Review of reported associations between HIV testing and area of residence in MSM. Studies are presented by region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Nardone et al (2001)[28] | UK (London and Edinburgh) | Cross-sectional | MSM attending bars. Sampling frame constructed from all gay bars in London, 42 surveyed, all 5 in Edinburgh. (75% response) | Nov –Dec 1996 | 2397 | Previous HIV test London (reference Edinburgh) | Logistic regression; age, employment status | AOR 1.19 (1.09-.30) | 63% London 54% Edinburgh |
| Myers et al (1993)[59] | Canada (Toronto) | Cross-sectional | Convenience sample in gay bars and bathhouses. Self-completion questionnaire. (72.9% response) | 1990 | 1295 | Previous HIV test Metropolitan residence | Logistic regression; (90% CI ); age sexual orientation, sexual behaviour | AOR 2.74 (1.65-4.55) | 53% tested |
| Myers et al (1996)[32] | Canada (35 cities) | Cross-sectional | MSM recruited though gay identified venues (88 bars, 22 bathhouses) and community events (15 community dances) Proportional sampling quota by strata based on population of unmarried men 15-64 for non-metropolitan regions | Oct 1991-Jan 1992 | 4803 | Ever tested City size >500,000(reference <500,000) | Logistic regression; geographic region, age, sexual orientation, gay socialisation, relationship status | AOR 0.79 (0.70-0.88) | Not available |
| Jin et al (2002)[54] | Australia (5 cities) | Cross-sectional repeated annually | Reported HIV negative MSM recruited from community sites, gay outdoor events, sex on premises venues, and social venues. Self-completion Questionnaire | 1996 - 2001 | 22161 | Tested in past 12 months City (reference Sydney) | Logistic regression; age group, gay friends, no. partners, relationship status, UAI, safe sex agreements | Melbourne AOR 0.77 (0.71-0.83) Perth AOR 0.84 (0.75-0.94) Brisbane AOR 0.84 (0.81-0.97) Adelaide AOR 0.93 (0.81-1.08) | 57.6% tested recently 85.3% ever tested |

Note. AOR, adjusted odds ratio; CI, confidence intervals.

**Table 2.4b Review of reported associations between UAI and area of residence in MSM. Studies are presented by region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Nardone et al (2001)[28] | UK (London and Edinburgh) | Cross-sectional | MSM attending bars. Sampling frame constructed from all gay bars in London, 42 surveyed, all 5 in Edinburgh. (75% response) | Nov –Dec 1996 | 2397 | UAI in past year City of survey London (reference/ Edinburgh) | Logistic regression; age, employment status | London AOR 1.19 (1.00-1.20) | 63% London 54% Edinburgh |
| Ruiz et al (1998)[62] | US (California) | Cross-sectional | Young MSM attending gay-identified events and areas (aged 17-25) | 1994 | 836 | UAI in previous 6 months Area Long beach (reference Sacramento county) | Logistic regression; live with partner, exchange partner previous 6 months, drug use | AOR 2.3 (1.6 – 3.3) | 80% UAI 73% Non-UAI 76% overall |
| MacKellar et al (2006)[87] | US (7 cities) | Cross-sectional | MSM 23-29 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (58% response) | 1998 - 2000 | 2797 | Recent testing (past 12 months) City (reference New York) | Logistic regression; ethnicity, age, education, psychosocial, sexual behaviour | Dallas AOR 1.3 (1.0-1.8) Miami AOR (1.3 (1.0-1.8) Baltimore AOR 1.4 (1.0-1.8) Seattle 1.6 (1.2-2.1) Los Angeles AOR 1.8 (1.4-2.4) | 54% recent test |
| Myers et al (1996)[32] | Canada (35 cities) | Cross-sectional | MSM recruited though gay identified venues (88 bars, 22 bathhouses) and community events (15 community dances) Proportional sampling quota by strata based on population of unmarried men 15-64 for non-metropolitan regions | Oct 1991-Jan 1992 | 4803 | UAI past 3 months Area of residence British Columbia and the prairies (reference Atlantic, Quebec and Ontario) | Logistic regression analyses; city size, age, sexual orientation, gay socialisation, relationship status | AOR 1.52 (1.39-1.65) | Not available |

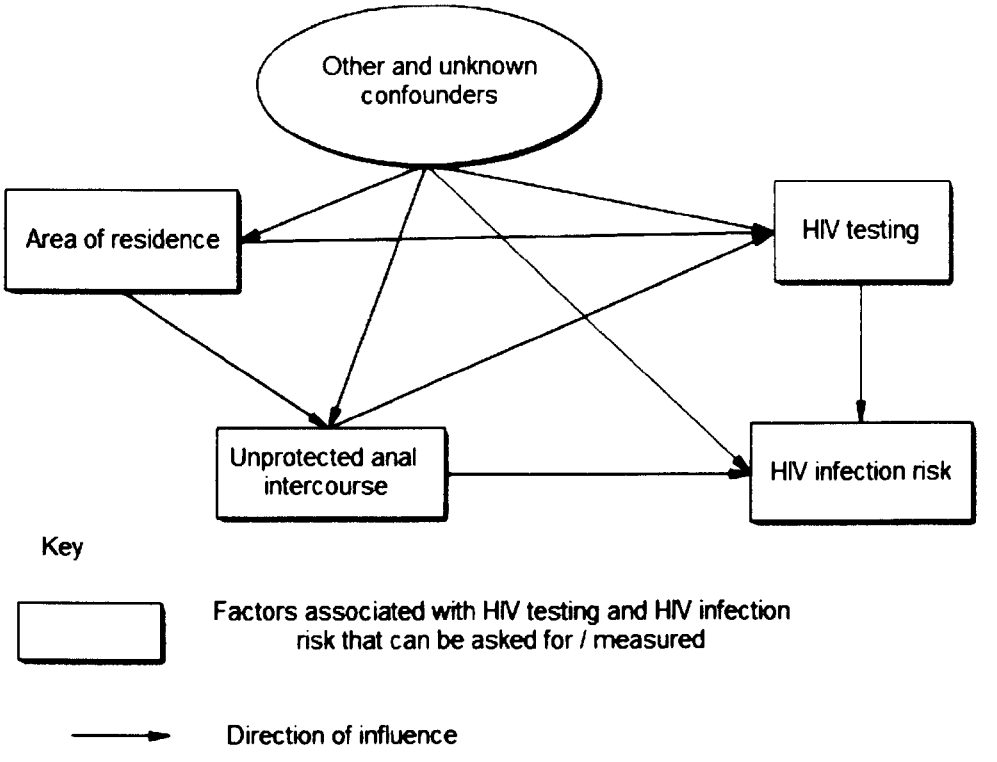
Note. AOR, adjusted odds ratio; CI, confidence intervals.

Being resident in a metropolitan area is related to sexual risk behaviour and four studies found that UAI was associated with area of residence[28,32,62,87]. In metropolitan areas this could be that more socialisation in bars and clubs is possible, giving an increased availability of new sexual partners[29,96] (Table 2.4b). All of these factors will lead to an increase in sexual risk behaviour, which the HIV higher testing rates could be reflecting. However, a larger Canadian study found that UAI was higher in small towns in one particular region in British Columbia than in the more metropolitan areas (OR 1.52, 95% CI 1.39 – 1.65). They concluded that, while geographic differences are important for explaining differences in HIV testing, they seem to be less important in explaining UAI. Thus, policy programmes and social environment appear to be important influences on behaviour such as test-seeking, possibly due to factors such as access to and organisation of services and the degree of anonymity that larger cities provide[32]. HIV testing was lower in smaller cities within the same study (OR 0.79, 95% CI 0.82 – 0.90). The context of behaviours in addition to health policy, cultural and community structures would be needed to fully interpret regional differences in sexual behaviour and health-seeking behaviours.

Areas of residence are related to HIV prevalence[5,97], and so risk of HIV infection could vary by area, as the probability of having UAI with a HIV positive partner will increase in areas with higher background HIV prevalence.

A summary of the likely association between HIV testing, UAI, area of residence and HIV infection (for simplicity subsuming age under 'other and unknown confounders') is represented in the conceptual framework in Figure 2.6 below.

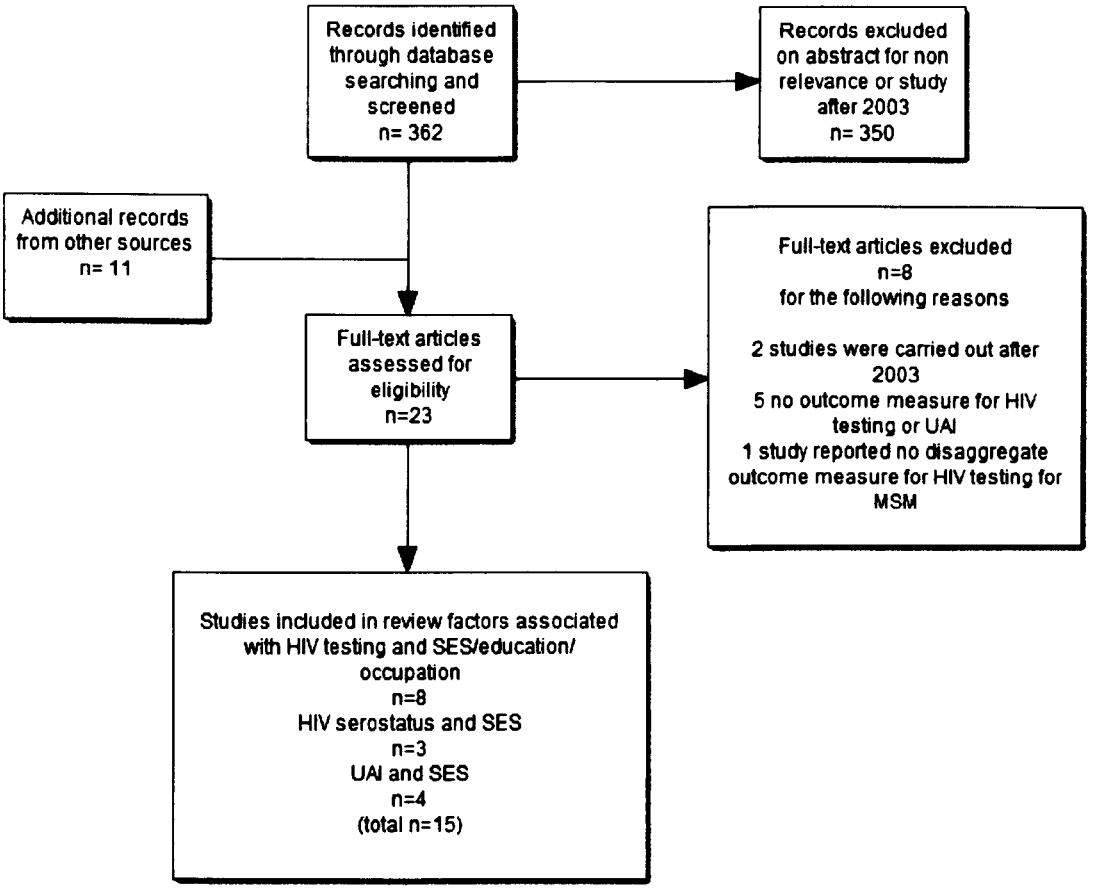
**Figure 2.6 Conceptual framework of the relationship between HIV testing, HIV infection risk, unprotected anal intercourse and area of residence**



## 2.6 Association between HIV testing, unprotected anal intercourse, HIV serostatus and socio-economic status

To investigate the associations between HIV testing, UAI, HIV serostatus and socio-economic status, a series of MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'socio-economic status' or 'education' and (a) 'HIV testing', (b) 'unprotected anal intercourse' and (c) HIV serostatus. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers.

**Figure 2.7 Systematic review data flow for review of association between HIV testing, unprotected anal intercourse, HIV serostatus and socio-economic status**




In total 373 studies and surveys were extracted, of which 350 were excluded on abstract due to non-relevance or date of survey post 2003 (Figure 2.7). A further eight full-text articles were excluded due to the study not being about HIV testing (one study), the studies carried out after 2003 (two studies), no measures of association available on HIV testing or UAI and socio-economic status (six studies) or no

disaggregate data available for MSM (one study). These are listed in Table A.4, Appendix A.

Eight studies that met the inclusion criteria presented an association between HIV testing and socio-economic status, three on HIV serostatus and socio-economic status and four reported on UAI and socio-economic status. The UK studies were based in one city in England, London, and one in Scotland, Edinburgh. The US studies collected data from multiple US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. A national Canadian study sampled from 35 cities and an Australian study sampled from five large cities. Participants were mainly recruited from community settings, from multiple gay venues and events and medical settings (primarily HIV test clinics). All of the studies were cross-sectional convenience samples. One study used probability sampling based on a sampling frame of gay bars in the city, one based on the proportion of the population who were unmarried adult males. Four studies used self-administered questionnaires, and two studies used interviewers to administer the questionnaires. Two studies were focussed on young MSM. Sample sizes varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM and the Australian study sampled over 22,000 MSM. The studies took place over a period of time ranging from 1991 to 2001. A descriptive summary of these studies is given in Tables 2.5a-2.5c.

Socio-economic status was reviewed, and was defined through various methods in the studies, through an individual's occupation, income or education level, rather than area-based measures (see Table 2.5). HIV testing rates have been associated with socio-economic status, although the direction of the relationship varies by country. Previous HIV test was found to be associated with unemployment in London[50]. HIV testing was associated with higher education levels[55] and higher income[87] in the US while testing was associated with high socio-economic status in Australia[31]. Unemployment does not measure educational attainment, however, and HIV positive MSM could be unemployed due to ill health. A study of MSM receiving treatment for STIs between 1990 and 1995 in Switzerland found that MSM with higher education refused HIV testing (OR 2.6, 95% CI 1.1 – 6.1)[98]. This association was still found when the data were stratified by year[98]. However, this study was carried out in the early 1990s when HIV testing was still an irregular occurrence in standard health settings. The MSM were offered voluntary confidential HIV testing when attending for treatment of STI. These men may perceive themselves not to be at risk of HIV, or they may choose to have an HIV test carried out at an alternative testing clinic. Both regular HIV

testing and repeat HIV testing were associated with more education in the US[64,66,88] and while a further study in the US found no difference in educational level in those tested previously from MSM who were untested, repeat testing was associated with lower educational level[69]. In Canada, HIV testing was not found to be related to income or educational level[59]. This Canadian study population had overall a very high educational level and so there may have been little variation in the exposure, making it difficult to detect differences if they did exist.

Socio-economic status is collected and defined in many different ways, and so it is difficult to compare these different data sources. Availability of HIV tests may influence the relationship between testing and socio-economic status. A study in the US found a positive association between being uninsured and seeking HIV testing at public clinics[64]. The availability of free health-care services in the UK, through genitourinary medicine clinics, takes away the issues of affordability of tests. This implies that in the UK socio-economic differences in HIV testing patterns may reflect social differences in risk behaviour. In both the UK and the US, there may be differences in openness to admitting being gay by socio-economic status. This may influence the place of seeking sex, which may be associated with a higher risk for HIV infection for lower socio-economic grouped MSM. People from a more disadvantaged background may be less likely to attend GUM clinics for HIV testing. However, the Natsal found no association between reported GUM clinic attendance and social class[99].

UAI was associated with lower social class in the UK[68], lower education levels in both Canada[32,75] and Scotland[52] and in being an infrequent visitor to the gay scene (adjusted OR 1.48, 95% CI 1.00 – 2.18)[52]. Being HIV positive was associated with lower education in young MSM in Canada[35] and with both less education[49] and unemployment in the UK[47].

**Table 2.5a Review of reported associations between HIV testing and socio-economic status in MSM. Studies are presented by region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association(95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Nardone et al (1998)[50] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas and GUM clinics, 72 sites (75% response) | Nov 1996-Jan 1997 | 2263 | Previous HIV test (Reference unemployed) | Logistic regression; age, recruitment, years since first AI | AOR 1.16 (1.11-1.32) | 63% employed 69% unemployed |
| Paget et al (1997)[98] | Switzerland | Cross-sectional | All patients diagnosed with STI | 1990 - 1995 | 393 | HIV test refusal Education (reference lower) | Logistic regression; number sexual partners, source of STI, | AOR 0.1 (0.0 – 0.7) | 22.6% higher 2.7% basic |
| Sumartojo et al (2008)[55] | US (7 cities) | Cross-sectional | MSM 15-25 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (89.6% response) | 1999 | 2621 | Ever tested Employment | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | AOR 1.34 (1.01-1.78) | 78% ever tested Employed 80% Unemployed 69% |
| MacKellar et al (2006)[67] | US (7 cities) | Cross-sectional | MSM 23-29 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (58% response) | 1998 - 2000 | 2797 | Recent testing (past 12 months) Income (reference <$15,000) | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | $15000-29999 AOR 1.1 (0.9-2.0) >$30000 AOR 1.3 (1.0-1.8) | 47% <$15,000 recent test 54% $15,000-29999 recent test 60% >$30,000 recent test |
| | **Repeat HIV testers** | | | | | | | | |
| Philips et al (1995)[64] | US (2 cities) | Cross-sectional | Telephone survey MSM (59%-75% response) | 1992 | 2602 | Repeat testing (Tested 3+ (reference 1-2 times) Education (increasing) | Logistic regression; HIV risk measures, attitudes beliefs, social norms and communication, age, ethnicity, area, health insurance | AOR 1.12 (1.00-1.26) | Repeat testing 18% high school 40% some college 42% college graduate |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association(95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Fernandez et al (2003)[68] | US (Florida) | Cross-sectional | MSM Hispanic/Latino recruited from public venues bars, bathhouses, gyms, parks and street corners. (80% response) | Dec 1999 – Feb 2001 | 538 | Repeat testing, (3+) Education (graduate school (reference <high school) | Logistic regression; age, STD, number sexual partners, UAI, oral sex | AOR 0.32 (0.13-0.83) | Graduate school 79.8% repeat 88% regular <high school 51.7% repeat 42.3% regular |
| MacKellar et al (2002)[66] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3430 | Repeat testing (reference never) Education technical or college (reference lower) | Logistic regression; city, ethnicity, age, psychosocial, sexual behaviour | AOR 1.6 (1.2 – 2.0) | 36% never tested 39% tested infrequently, 61% once) 50% repeat had tested 4+ times |

Note. AOR, adjusted odds ratio; CI, confidence intervals.

**Table 2.5b Review of reported associations between UAI and socio-economic status in MSM. Studies presented by region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Dawson et al (1994)[58] | UK (4 areas England) | Cross-sectional and UA HIV saliva test | MSM attending GUM clinics, community, gay pubs, advertisements, and follow-up of previous cohort | Mar 1991 – Apr 1992 | 677 | UAI in last month Social class I, II, IIINM / IIIM, IV, V, (reference never employed) | Logistic regression; relationship type, relationship length, HIV status knowledge, cohabitation, place of residence, marital status, age of partners, age differential | AOR 0.52 (0.37-0.75) | Not available |
| Hart et al (1999)[52] | UK (Scotland 2 cities) | Cross-sectional | MSM attending gay bars (77%,80% per city response) | Dec 1995 – Nov 1996 | 2276 | UAI in past year (reference Protected AI) Degree-level education (reference lower than degree) | Logistic regression; age , education, gay scene, ever STI, STI in past year, partnership status, partners HIV status | AOR 0.71 (0.54-0.92) | 32% reported UAI. |
| Myers et al (1996)[32] | Canada (35 cities) | Cross-sectional | MSM recruited though gay identified venues (88 bars, 22 bathhouses) and community events (15 community dances) Proportional sampling quota by strata based on population of unmarried men 15-64 for non-metropolitan regions | Oct 1991-Jan 1992 | 4803 | UAI past 3 months Education (reference secondary and more) | Logistic regression; geographic region, city size, age, sexual orientation, gay socialisation, relationship status | AOR 1.54 (1.38-1.71) | Not available |
| Strathdee et al (1998)[75] | Canada (Vancouver) | Cohort | Baseline data on HIV negative MSM 18-30 recruited through doctors , clinic outreach to cohort through self-completed questionnaire | May 1995 | 439 | UAI with casual partner in past year Education lower than high school (reference high school or more) | Stepwise logistic regression; age, ethnicity, social support, sexual behaviour, drug use | AOR 2.40 (1.23-4.61) | 40% UAI |

Note. AOR, adjusted odds ratio; CI, confidence intervals.

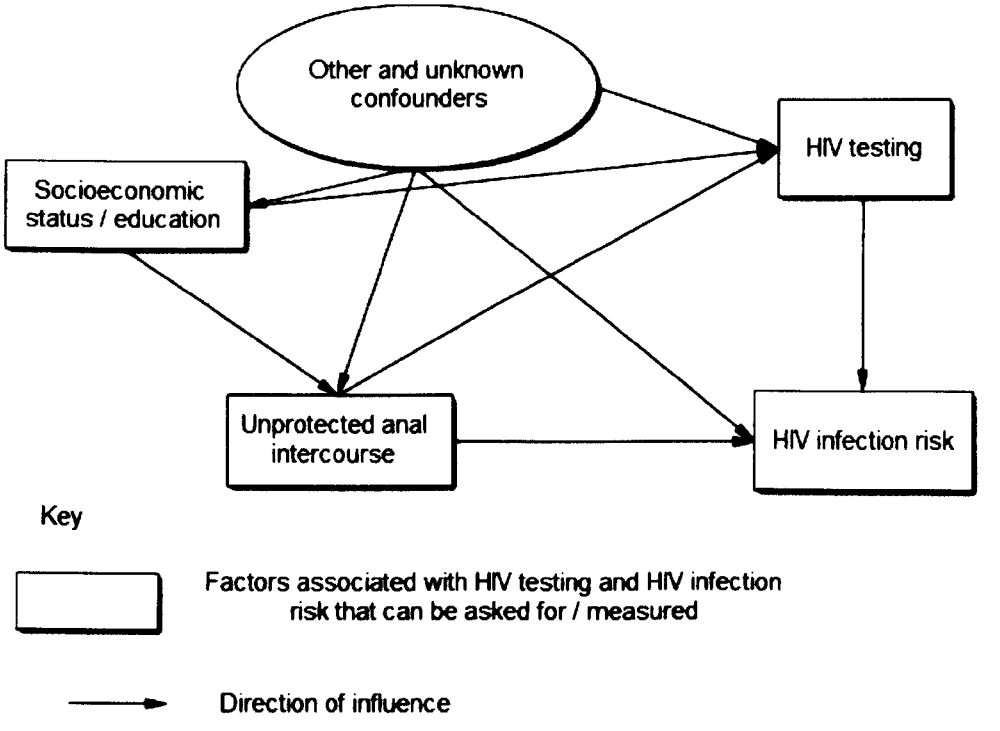
**Table 2.5c Review of reported associations between HIV serostatus and socio-economic status in MSM. Studies presented by region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Dodds et al (2004)[49] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas, 58 sites<br>57% response to UA HIV test of saliva | 2000 | 1206 | HIV positive<br>Employment status (reference employed) | Logistic regression; age, education, | OR 2.26 (1.46-3.51) | Not available |
| Dodds et al (2004)[49] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas, 58 sites<br>57% response to UA HIV test of saliva | 2000 | 1206 | HIV positive<br>Education 3 years or more after 16 (reference none) | Logistic regression; age, employment status | OR 0.46 (0.28-0.75) | Not available |
| Dodds et al (2007)[47] | UK (London, Brighton & Manchester) | Cross-sectional | MSM attending bars, clubs, saunas 90 venues<br>64% response to UA HIV test of saliva | Jun 2003 – Feb 2004 | 2311 | HIV positive<br>Unemployed (reference employed) | Logistic regression; age. Education, ethnicity | London<br>AOR 2.50 (1.66-3.79)<br>Brighton<br>AOR 4.09 (2.12-7.87)<br>Manchester<br>AOR 1.58 (0.58-4.37) | Not available |
| Dodds et al (2007)[47] | UK (London, Brighton & Manchester) | Cross-sectional | MSM attending bars, clubs, saunas 90 venues<br>64% response to UA HIV test of saliva | Jun 2003 – Feb 2004 | 2311 | HIV positive<br>Educated after 16 years (reference <16 years) | Logistic regression; age. ethnicity, employment status | London<br>AOR 0.58 (0.37-0.88)<br>Brighton<br>AOR 0.73 (0.37-1.44)<br>Manchester<br>AOR 0.65 (0.26-1.63) | Not available |
| Weber et al (2001)[35] | Canada (Vancouver and Montreal) | Two Cohorts | MSM aged 16-30 not previously tested HIV positive. Recruited from community outreach, physicians and clinics | 1998 | 1373 | HIV positive at baseline<br>Lower than a high school education (reference high school or more) | Multivariable logistic regression adjusted for cohort | OR 2.15 (1.06-4.41) | Not available |

Note. OR, odds ratio; AOR adjusted odds ratio; CI, confidence intervals.

A summary of the likely association between HIV testing, UAI, socio-economic status or education and HIV infection is represented in the conceptual framework in Figure 2.8 below. Other confounders as for example age and area of residence are grouped with the 'unknown or other confounders' for simplicity.

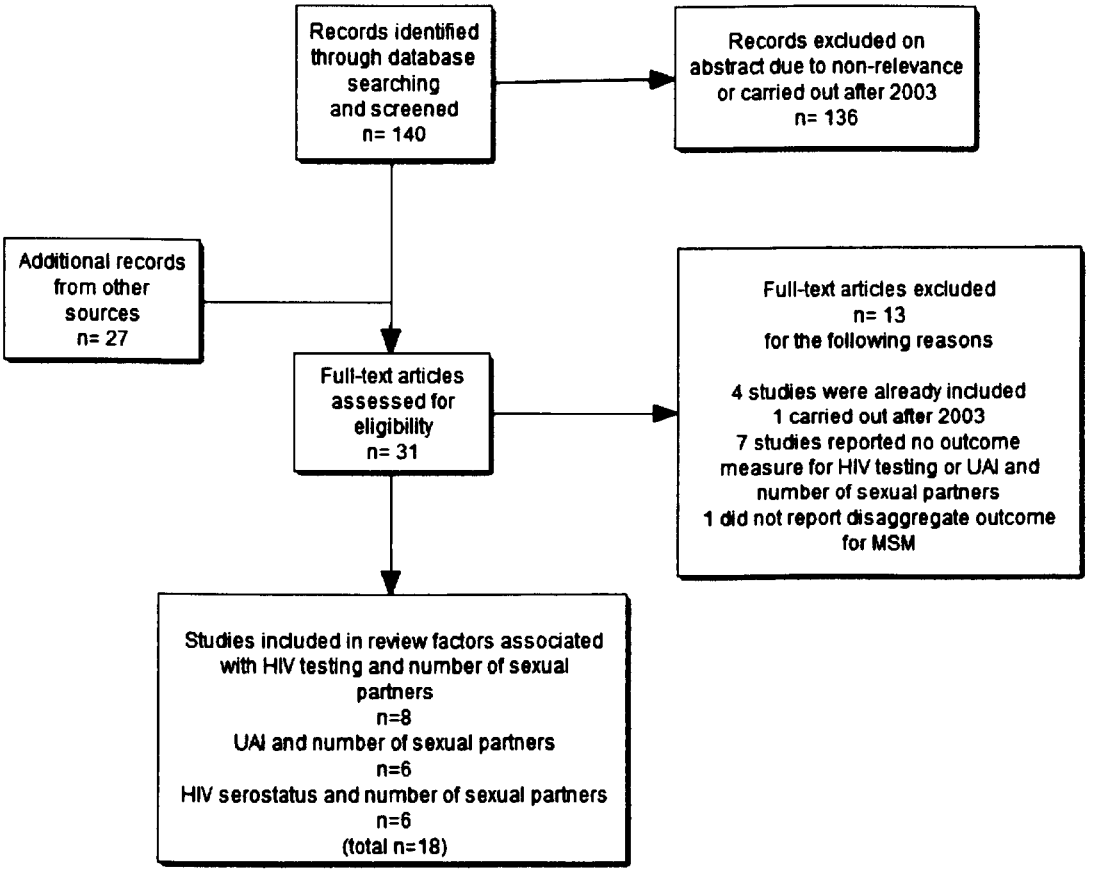
**Figure 2.8 Conceptual framework of the relationship between HIV testing, HIV infection risk, unprotected anal intercourse and socio-economic status**



## 2.7 Association between HIV testing, unprotected anal intercourse, HIV serostatus and number of sexual partners

To investigate the associations between HIV testing, UAI, HIV serostatus and number of sexual partners a series of MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'number of sexual partners' and (a) 'HIV testing' (b) 'unprotected anal intercourse' and (c) 'HIV serostatus'. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers. In total 167 studies and surveys were extracted, of which 136 were excluded on abstract due to non-relevance or date of survey post 2003 (Figure 2.8). A further 13 full-text articles were excluded due to: the study already included (four studies), the studies carried out after 2003 (one study), no measures of association available on HIV testing or UAI and numbers of sexual partners (seven studies) or no disaggregate data available for MSM (one study). These are listed in Table A.5, Appendix A.

**Figure 2.9 Systematic review data flow for investigation of the association between HIV testing and number of sexual partners**



Eight studies that met the inclusion criteria presented an association between HIV testing and number of sexual partners, six on HIV serostatus and number of sexual partners and six reported on UAI and socio-economic status. Most of the studies were from the US and they collected data from multiple US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. The only UK study was based in London. An Australian study sampled from five large cities and one Swiss study reported on number of sexual partners. Participants were mainly recruited from community settings, from multiple gay venues and events and medical settings (primarily HIV test clinics). All, but one of the studies were cross-sectional convenience samples. One study used probability sampling based on a telephone index, one based on the proportion of the population who were unmarried adult males, while two used recruitment methods that were more systematic (e.g. every third person who came into the venue) than convenience sampling. Eight studies used self-administered questionnaires, and five studies used interviewers to administer the questionnaires. Three studies were focussed on young MSM, and one on ethnic minority MSM, in particular Asian and South-Pacific MSM. Sample sizes varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM and the Australian study sampled over 22,000 MSM. Two US studies were small, sampling just over 250 MSM each. The studies took place over a period of time ranging from 1991 to 2001. A descriptive summary of these studies is given in Tables 2.7a-2.7c below.

Previous HIV testing was associated with an increased number of sexual partners[31,54,60,69] and a higher number of sexual partners was associated with recent HIV testing[87] and repeat HIV testing[66,67,88] (see Table 2.6a below). This clearly suggests that as HIV risk behaviour increases, with number of sexual partners, HIV testing increases. Although the timing of the HIV testing to the partner acquisition is not known, increased numbers of partners was associated with increased risk of HIV infection. Though, a study in Switzerland of MSM presenting for treatment of an STI found that MSM with ten or more sexual partners were more likely to refuse the offer of HIV testing[98]. This study was in the early 1990s before the normalisation of HIV testing, and so the associated stigma of an HIV test may have encouraged refusal. Refusal to undergo an HIV test was associated with higher education in this Swiss study[98].

**Table 2.6a Review of reported associations between HIV testing and numbers of sexual partners in MSM. Studies are presented by region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Paget et al (1997)[98] | Switzerland | Cross-sectional | All patients diagnosed with STI | 1990 - 1995 | 393 | HIV test refusal<br>10+ partners in past 6 months (reference 0-1 partners) | Logistic regression; source of STI, education | 2-4 AOR 0.9 (0.4-2.1)<br>5-9 AOR 0.9 (0.3-2.7)<br>10+ AOR 2.6 (1.1-6.1) | 12.5% 0-1<br>12.1% 2-4<br>12.7% 5-9<br>29.7% 10+ |
| Van de Ven et al (2000)[31] | Australia (5 major cities) | Cross-sectional | MSM attending gay festivals, gay social and sex-on –premises venues, and sexual health services (71%-83% by cities) | 1998 | 6831 | Ever had a test<br>Number sexual partners past 6 months (reference no partners) | Logistic regression; Age, city, occupation, sexual orientation, gay friends sex with regular partners (type), sex with casual partners (type) | 11-50 partners<br>AOR 1.76 (1.02-2.00)<br>>50 partners<br>AOR 2.82 (1.50-5.31) | 83% overall |
| Jin et al (2002)[54] | Australia (5 cities) | Cross-sectional repeated annually | Reported HIV negative MSM recruited from community sites, gay outdoor events, sex on premises venues, and social venues. Self-completion | 1996 - 2001 | 22161 | Tested in past 12 months<br>Number sexual partners (reference no partners) | Logistic regression; area, recruitment site, age group, gay friends, relationship status, UAI, safe sex agreements | 2-10 partners<br>AOR 1.61 (1.42-1.83)<br>11-50 partners<br>AOR 2.01 (1.73-2.32)<br>50+ partners<br>AOR 2.36 (1.96-2.86) | 57.6% tested recently<br>85.3% ever tested |
| Roffman et al (1995)[69] | US (16 cities pop<100,000) | Cross-sectional | MSM attending gay bars<br>(85% response) | 1992 | 1820 | Previous HIV test (4 or more months earlier)<br>2+ Sexual partners | Univariable only[a] | OR 1.37 (1.08 – 1.74) | 38% 2+ partners tested<br>31% of untested |
| MacKellar et al (2006)[87] | US (7 cities) | Cross-sectional | MSM 23-29 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (58% response) | 1998 - 2000 | 2797 | Recent testing (past 12 months)<br>Lifetime partners (reference 1-5) | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | 6-19<br>AOR 1.5 (1.1-1.9)<br>>20<br>AOR 1.8 (1.4-2.3) | 43% test<br>53% 6-19<br>59%>20 |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| **Repeat HIV testers** | | | | | | | | | |
| Fernandez et al (2003)[88] | US (Florida) | Cross-sectional | MSM Hispanic/Latino recruited from public venues bars, bathhouses, gyms, parks and street corners. (80% response) | Dec 1999 – Feb 2001 | 538 | Repeat testing<br>Number of sexual partners past 3 months >1 (reference 1) | Logistic regression; age, education, STD, UAI, oral sex | AOR 1.60 (1.04-2.44) | >1 sex partners<br>76.3% repeat<br>43.8% regular<br>0-1 sex partners<br>64.7% repeat<br>41.5% regular |
| MacKellar et al (2002)[66] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3430 | Repeat testing (reference never tested)<br>Number of partners | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | 1+ steady partner<br>AOR 1.7 (1.3 – 2.3)<br>1+ exchange partner<br>AOR 2.1 (1.4 – 3.1)<br>1+ HIV+ partner<br>AOR 2.7 (1.6 – 4.6) | 36% never tested<br>39% tested infrequently, 61% once)<br>50% repeat had tested 4+ times |
| Kalichman et al (1997)[67] | US (Atlanta) | Cross-sectional | MSM attending gay pride festival who had HIV tests and were HIV negative. (90% response) | 1996 | 253 | Repeat testers (3 or more times (reference 1-2)<br>Regular (reference non-regular)<br>Protected AI 2+ partners | Univariable only[a] | Repeat testing<br>OR 2.25 (1.14 -4.61)<br>Regular<br>OR 1.25 (0.69-2.26) | 34% repeat, PAI 2+<br>19% 1-2, PAI 2+37% regular, PAI 2+<br>23% non-regular, PAI 2+ |

Note. a. Univariable OR calculated from data presented in paper using STATA 8.0; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals; PAI, protected anal intercourse.

**Table 2.6b Review of reported associations between UAI and numbers of sexual partners in MSM. Studies are presented by type of study design, region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Ekstrand et al (1999)[73] | US (San Francisco) | Cohort | MSM 18-29 as part of population based probability sample | 1996-1997 | 408 | UAI partner of unknown or discordant status<br>Frequency of sex with men(increasing by number of sexual acts) | Logistic regression | AOR 1.07 (1.02-1.11) | Not available |
| Kelly et al (1992)[61] | US (16 city, national sample) | Cross-sectional | MSM attending gay bars. (85% response rate) in small cities | 1991 | 1991 | UAI in past 2 months<br>Number of different partners in past 2 months | Multivariable analysis, non-parametric tests | Mean numbers partners, 2.96 UAI<br>1.78 no UAI<br>F=13.02 p=0.0001 | 72% UAI<br>67% Non-UAI<br>68% overall |
| Choi et al (2002)[63] | US (Seattle & San Diego) | Cross-sectional | A venue-based sample of young API MSM in San Francisco completed face-to-face questionnaires and received HIV counselling and testing. | 1999 | 253 | UAI in past 3 months<br>Number of sexual partners in past 3 months | Logistic regression; ethnicity, age, education, sexual orientation, birthplace, lifetime number of male sex partners, ever STI, ever IDU, ever used club drugs, and ever attended a circuit party | AOR 1.48 (1.06-2.07) | 71% ever tested |
| Schwarcz et al (2007)[74] | US (San Francisco) | Cross-sectional | Random-digit dial probability sample survey of households in SF. Computer assisted telephone interview followed by urine sample tested for gonorrhoea, chlamydia & HIV | Jun 2002 – Jan 2003 | 1976 | UAI in HIV negative MSM with partner of unknown or serodiscordant status<br>Number partners in last 12 months (reference 6+) | Logistic regression; age, number years in San Francisco, drug use, partner through internet, HIV transmission attitudes | 1 partner<br>AOR 0.05 (0.01 – 0.4)<br>2-5 partners<br>AOR 0.28 (0.1 – 0.6) | Not available |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| | **Relationship status** | | | | | | | | |
| Elford et al (1999)[85] | UK (London) | Cross-sectional | MSM attending 5 London gyms (50.4% response) | Sep-Oct 1997 | 1004 | UAI in previous 3 months<br>Relationship with a man | Logistic regression; age | AOR 2.5 (1.8-3.4) | 73% HIV tested |
| Ruiz et al (1998)[62] | US (California) | Cross-sectional | Young MSM attending gay-identified events and areas (aged 17-25) | 1994 | 836 | UAI in previous 6 months<br>Exchange partner last 6 months | Logistic regression; Site, live with partner, drug use | AOR 2.2 (1.1 – 4.4) | 80% UAI<br>73% Non-UAI<br>76% overall |

Note. OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals

**Table 2.6c Review of reported associations between HIV serostatus and numbers of sexual partners in MSM. Studies presented by type of study design, region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| McFarland et al (1997)[39] | US (San Francisco) | Cohort | Repeat HIV tests in MSM attending anonymous HIV test clinics | 1995 | 2822 | HIV seroconversion 10+ partners in last year (fewer than 10 reference) | Cox proportional hazards analysis; ethnicity, age<35, UAI, sex HIV+ partner, popper use | Adjusted hazards ratio 1.6 (1.1 – 2.4) | Not available |
| Koblin et al (2006)[36] | US (6 cities) | Cohort study | MSM HIV negative, anal sex with man in past 12 months, Recruited from previous cohorts, STD clinic, bars, clubs, advertising, street outreach, and referral from other participants. | Jan 1999 – Feb 2001 | 4295 | HIV seroconversion Number of sexual partners (0-1,2-3 reference) | Multivariable proportional hazards model; sexual behaviours, health insurance, age , nitrate inhalant use | 4-9 partners AHR 1.58 (1.06-2.36) 10+ partner AHR 1.81 (1.23-2.68) | Not available |
| Ruiz et al (1998)[62] | US (California) | Cross-sectional | Young MSM attending gay-identified events and areas (aged 17-25) | 1994 | 836 | HIV positive Number of male partners (reference 1-25 partners) | Logistic regression; site, live with partner, exchange partner previous 6 months, drug use | More than 25 AOR 2.4 (1.3 – 4.3) | 80% UAI 73% Non-UAI 76% overall |
| Valleroy et al (2004)[91] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3449 | HIV positive Number of male partners (reference 1-4 partners) | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | 5-19 AOR 1.9 (1.3-2.9) 20+ AOR 3.0 (2.0-4.7) | 65% tested previously 79% HIV positives 64% HIV negative |
| Webster et al (2005)[100] | US (Florida) | Cross-sectional | Multi-stage probability sample of 18-29 unmarried males MSM and UA saliva HIV antibody test. (90.9% response) | 1996 | 140 | HIV positive Number of lifetime sexual partners (reference <50 partners) | Logistic regression; relationship, residency, beliefs | 50-99 AOR 1.48 (0.46–4.73 10+ AOR 3.74 (1.42-9.80) | Not available |

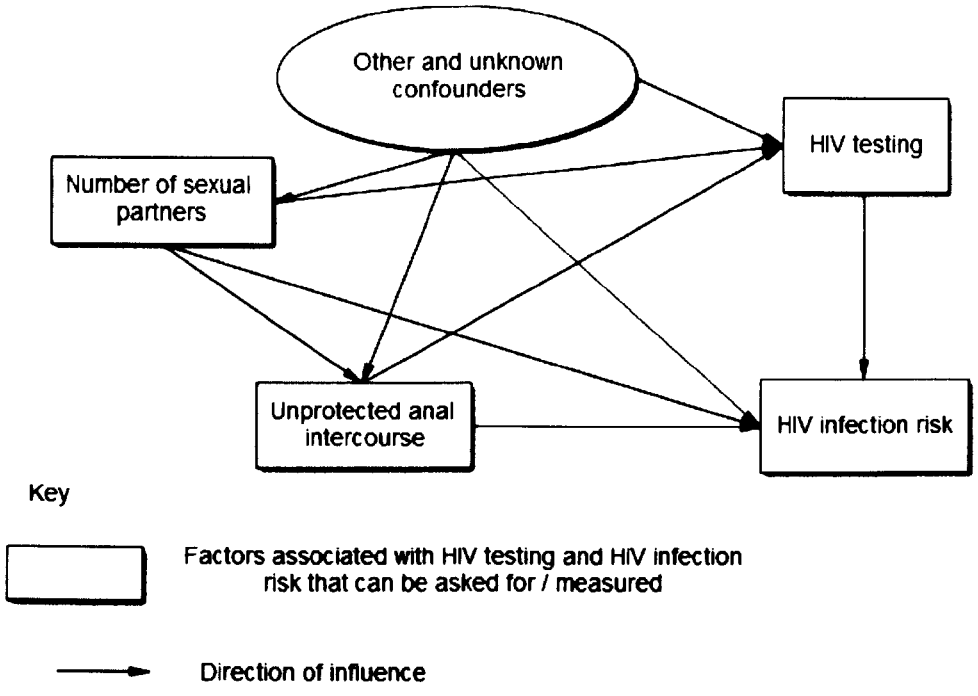
| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Choi et al (2004)[101] | US (San Francisco) | Cross-sectional | A venue-based sample of young API MSM in San Francisco completed face-to-face questionnaires and received HIV counselling and testing. | 2001 | 492 | HIV positive Lifetime number of sex partners 51+ (reference <51) | Logistic regression; ethnicity, age, education, sexual orientation, birthplace, ever STI, ever IDU, ever used club drugs, ever attended a circuit party | AOR 38.96 (8.09–295.3) | Not available |

Note. OR, odds ratio; AOR, adjusted odds ratio; CI, confidence intervals; AHR, adjusted hazard ratio.

UAI was found to be associated with increased number of sexual partners – six or more partners in the past 12 months[61,74] – and greater frequency of sex with men in the past 30 days[73] and acquiring a new partner[62] (Table 2.6b). Risk of HIV infection was associated with more than 25 partners in young MSM[62,91,101], and 10 or more partners in repeat anonymous testers in San Francisco[39] (Table 2.6c). Most of the studies were from the US. The age at which MSM choose to undergo HIV testing was different in the US, compared with the rest of Europe and Australia. The numbers of sexual partners is likely to be age-related in all geographic settings. Hence, the association of numbers of sexual partners with choosing to undergo HIV testing could be different in the US when compared to the UK. Nonetheless the two (very large) Australian studies showed similar associations as seen for the US[31,54]. The single UK study investigated the association of UAI with starting a new relationship, rather than numbers of partners. This UK study found a positive association of UAI with being in a relationship[85]. More published evidence is required from studies collecting data on sexual behaviour and numbers of sexual partners in order to confirm the association between increasing numbers of sexual partners and UAI in the UK.

In summary, in most of the studies, MSM who undergo HIV testing reported increased numbers of sexual partners when compared to those MSM who do not undergo an HIV test. In MSM, having a higher numbers of sexual partners was associated with UAI and a higher risk of HIV infection. A summary of the likely association between HIV testing, UAI, number of sexual partners and HIV infection is represented in the conceptual framework in Figure 2.10 below. Other confounders previously reviewed (age, area of residence and socio-economic status) are grouped with the 'unknown or other confounders' for simplicity.

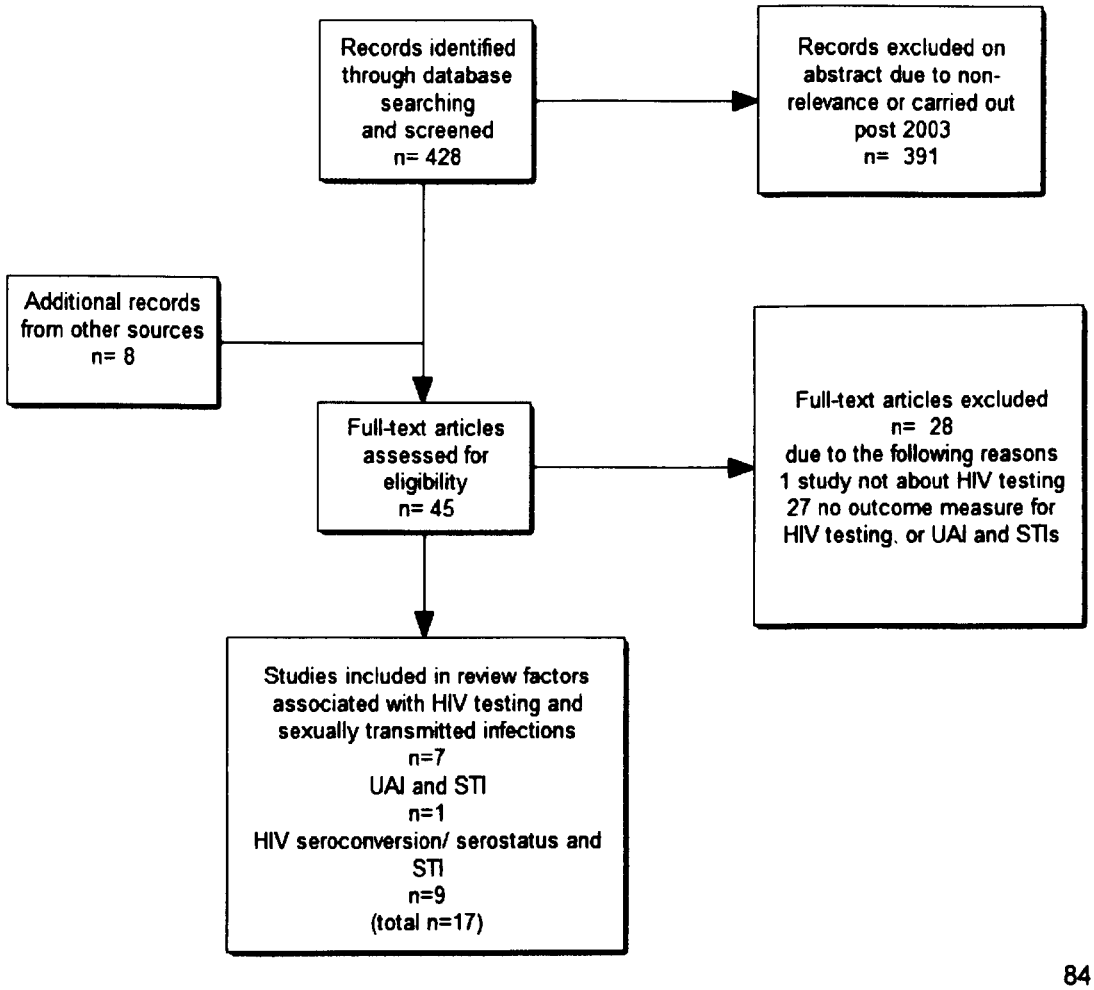
**Figure 2.10 Conceptual framework of the relationship between HIV testing, HIV infection risk, unprotected anal intercourse, and number of sexual partners**



## 2.8 Association between HIV testing, unprotected anal intercourse, HIV seroconversion or HIV serostatus and sexually transmitted infections

To investigate the association between HIV testing, UAI, HIV seroconversion or serostatus and STIs, a series of MEDLINE searches were carried out using PUBMED, AIDSLINE and HealthSTAR via the National Library of Medicine (NLM) gateway on the terms: 'homosexual', 'gay', 'men who have sex with men', 'sexually transmitted infections' and (a) 'HIV testing'; (b) 'unprotected anal intercourse', and (c) 'HIV serostatus' or 'HIV seroconversion'. This was followed up with a 'snowball' search including papers by authors already retrieved and references within retrieved papers. In total 436 surveys were extracted, of which 391 were excluded on abstract due to non-relevance or date of survey post 2003 (Figure 2.11). A further 28 full-text articles were excluded due to the study not being about HIV testing (one study) and no measures of association available on HIV testing or UAI and area of residence (27 studies). The excluded studies are listed in Table A.6, Appendix A.

**Figure 2.11 Systematic review data flow for investigation of the association between HIV testing, unprotected anal intercourse, HIV seroconversion or HIV serostatus and sexually transmitted infections**



Seven studies that met the inclusion criteria presented an association between HIV testing and previous STI, one on UAI and STI, five found an association between HIV seroconversion and previous STI, and four on being HIV positive and previous STI. Most of the studies were from the UK and they collected data from four cities in England (London, Brighton, Manchester and Oxford) and two in Scotland (Glasgow and Edinburgh). The US studies collected from multiple US cities, and the most often surveyed cities were San Francisco, Los Angeles, New York City, Seattle and Chicago. Participants were mainly recruited from community settings, from multiple gay venues and events and medical settings (primarily HIV test clinics). The studies were a mixture of cross-sectional, cohort and case control studies. The majority were convenience samples. Five studies used recruitment methods that were more systematic (e.g. every third person who came into the venue) than convenience sampling. Seven studies used self-administered questionnaires, and ten studies used interviewers to administer the questionnaires. Two studies were focussed on young MSM. One study was a tri-continental collaboration of cohort studies. Sample sizes varied between the studies, although most of the cross-sectional studies sampled at least 2,000 MSM. One US study surveyed almost 50,000 MSM attending STD clinics. The studies took place over a period of time ranging from 1987 to 2006. A descriptive summary of these studies is given in Tables 2.7a-2.7c below.

HIV testing was associated with previous STI diagnosis in MSM in studies in the US[88] and Europe[30,53,56] (see Table 2.7a). Repeat testers were more likely to have a previous STI in the US and the UK[27,65,88] while regular testers in the US were less likely to[88]. In the five studies that met the inclusion criteria, HIV seroconversion was associated with previous STI[36,41,42,46,102] (Table 2.7c). Previous STI was associated with being HIV positive both in the UK[49] and the US[62,86,91]. These are illustrated below in Tables 2.7a-2.7c.

## Table 2.7a Review of associations between HIV testing and sexually transmitted infections in MSM. Studies presented by region and year

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Dawson et al (1991)[56] | UK (4 areas in England) | Cross-sectional | MSM attending bars, clubs and gay organisations, GUM clinics. London, Manchester, Oxford, Northampton | Oct 1987 – Jul 1989 | 502 | Ever HIV tested<br>History gonorrhoea | Univariable analysis[a] | OR 2.74 (1.78 – 4.25) | 37% gonorrhoea in HIV tested<br>18% in not tested |
| Hart et al (2002)[30] | UK (2 cities in Scotland) | Cross-sectional | MSM attending gay bars 10 bars (75%, 80% per city response) | 1999 | 2498 | Ever HIV test<br>Ever STI (No reference) | Logistic regression; area, age, number UAI partners, condom use<br>GUM service use | AOR 1.99 (1.59-2.48) | 41% 15-25<br>53% 26+<br>50% overall |
| MacKellar et al (2006)[87] | US (7 cities) | Cross-sectional | MSM 23-29 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (58% response) | 1998 - 2000 | 2797 | Recent testing (past 12 months)<br>Previous STI (none reference) | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | AOR 1.4 (1.2-1.7) | 52% no STI<br>61% STI |
| Stolte et al (2007)[53] | Netherlands (Amsterdam) | Cross-sectional | All new consultations by MSM, self-completed questionnaire, with self-reported HIV negative status | Mar 2002 – Dec 2003 | 1201 | Never tested for HIV<br>Syphilis at new consultation (no syphilis reference) | Logistic regression, age, educational level, Dutch, UAI | AOR 2.63 (1.53-4.53) | No syphilis 31%<br>Syphilis 49.2% |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| | **Repeat HIV testers** | | | | | | | | |
| Norton et al (1997)[27] | UK (London) | Cross-sectional | One-day HIV testing centre (78% response rate) | Sep 1995 – Jan 1996 | 285 MSM | Repeat testing (1+) (reference first test)<br>Repeat testing 3+ (reference <3 tests)<br>Ever had STI | Univariable[a] only | 1+<br>OR 2.40 (1.40 – 4.14)<br><br>Repeat 3+<br>OR 3.05 (1.68 – 5.57) | STI in repeat HIV testers<br>29% STI never<br>41.3% 1-2 tests<br>62.3% 3+ tests |
| Leaity et al (2000)[65] | UK (London) | Cross-sectional | Same-day HIV testing clinic (75% response rate, 1580 of 2100) | 1997 - 1998 | 470 MSM | Repeat testers (1-2, 3+ previous tests) (reference first tests)<br>Ever had an STD | Univariable[a] only | Repeat testing<br>OR 1.90 (1.23-2.96) | Not available |
| Fernandez et al (2003)[88] | US (Florida) | Cross-sectional | MSM Hispanic/Latino recruited from public venues bars, bathhouses, gyms, parks and street corners. (80% response) | Dec 1999 – Feb 2001 | 538 | Repeat testing, (3+)<br>Previous STD | Logistic regression; age, education, number sexual partners, UAI, oral sex | repeat testing<br>AOR 2.13 (1.42-3.17)<br>Regular testing<br>AOR 0.67 (0.42-1.06) | Not available |

Note. a. These univariable odds ratios (OR) were calculated from data presented in papers using STATA 8.0; OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval.

## Table 2.7b Review of associations between UAI and sexually transmitted infections in MSM

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Hart et al (1999)[52] | UK (2 cities in Scotland) | Cross-sectional | MSM attending gay bars 77–80% per city response) | Dec 1995 – Nov 1996 | 2276 | UAI in past year (reference protected AI)<br>STI in past year | Logistic regression Age, social class, employment status, education, gay scene, ever STI, partnership status, partners HIV status | AOR 2.42 (1.65-3.55) | Not available |

Note. AOR, adjusted odds ratio; CI, confidence intervals.

**Table 2.7c Review of reported associations between HIV serostatus and sexually transmitted infections in MSM. Studies presented by type of study design, region and year**

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Harrison et al (1999)[46] | Brazil | Cohort | MSM recruited from HIV test sites, bars, night clubs, not known to be HIV positive | Jul 1995 – May 1997 | 750 30 cases, 670 negatives | HIV seroconversion Gonorrhoea | Cox proportional hazards, logistic regression; age, sex at first encounter, hepatitis B | ARR 4.5 (1.1 – 19.0) | Not available |
| Koblin et al (2006)[36] | US (6 cities) | Cohort | MSM HIV negative, anal sex with man in past 12 months, Recruited from previous cohorts, STD clinic, bars, clubs, advertising, street outreach, and referral. | Jan 1999 – Feb 2001 | 4295 | HIV seroconversion gonorrhoea | Multivariable proportional hazards model; sexual behaviours, health insurance, age, HIV negative male partners, nitrate inhalant use | AHR 2.49 (1.47-4.22) | Not available |
| Williams et al (1996)[41] | UK (London) | Case control | All MSM attending clinic with at least one HIV negative test and one HIV positive, and two matched controls with 2 or more HIV negative tests attending one GUM clinic | Jun 1988 – Jul 1993 | 56 cases 104 controls | HIV seroconversion STI between tests | Conditional logistic regression; known HIV+ partner, condom use, age (to correct for imprecise matching) | AOR 4.13 (1.28 – 13.3) | Not available |
| Macdonald et al (2007)[42] | UK (London, Brighton & Manchester) | Case Control | MSM attending 7 GUM clinics. CASI and selected qualitative interviews | Sep 2002 Oct 2004 | 75 cases 157 controls | HIV seroconversion Gonorrhoea Syphilis | Multivariable analysis; ancillary sexual behaviours, substance use, venues to meet men | AOR 4.22 (1.82 – 9.74) AOR 4.85 (0.86 – 27.41 | Not available |

| *Author* | *Location* | *Study design* | *Population studied* | *Year* | *N* | *Outcome and exposure* | *Control for confounding* | *Measure of association (95% CI)* | *% HIV tested amongst listed subgroups* |
|---|---|---|---|---|---|---|---|---|---|
| Page-Shafer et al (1997)[102] | US, Netherlands, Canada, Australia (4 cities) | Case control | MSM with documented HIV seroconversion enrolled from cohorts in San Francisco, Vancouver, Amsterdam, and Sydney | 1982 - 1994 | 345 cases 345 controls | HIV seroconversion STI | Conditional logistic regression; RAI, amphetamine use | AOR 3.34(1.93 – 5.80) | Not available |
| Dodds et al (2004)[49] | UK (London) | Cross-sectional | MSM attending bars, clubs, saunas, 58 sites 57% response to UA HIV test of saliva | 2000 | 1206 | HIV positive STI in the past year (reference no STI) | Logistic regression Age, education, employment status | AOR 2.13 (1.40- 3.24) | Not available |
| Helm et al (2009)[86] | US (4 cities) | Longitudinal surveillance | Routine clinical visits of MSM aged 15-70 at STD clinics in 4 cities | 2002-2006 | 49617 | Newly Diagnosed HIV+ Bacterial STI | Generalised estimating analysis, age, ethnicity, city, , year of HIV test | AOR 3.12(1.81- 5.38) | Not available |
| Ruiz J et al (1998) [62] | US (California) | Cross-sectional | Young MSM attending gay-identified events and areas (aged 17-25) | 1994 | 836 | HIV positive History of STD | Logistic regression; Site, live with partner, exchange partner previous 6 months, drug use | AOR 3.5 (2.0-6.2) | 80% UAI 73% Non-UAI 76% overall |
| Valleroy et al (2004)[91] | US (7 cities) | Cross-sectional | MSM 15-22 years randomly sampled at 194 gay identified venues in 7 cities. Only MSM who never previously tested or tested negative (62% response) | 1994 - 1998 | 3449 | HIV positive History of STD | Logistic regression; city, ethnicity, age, education, psychosocial, sexual behaviour | AOR 2.4 (1.7-3.3 ) | 65% tested previously 79% HIV positives 64% HIV negative |

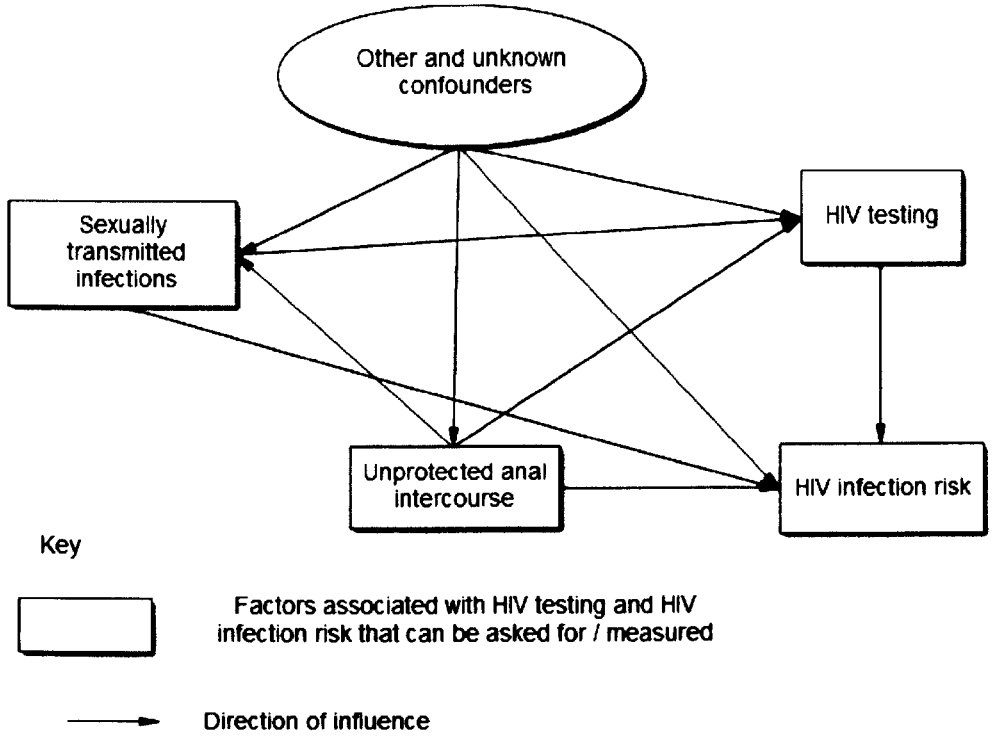
Note. OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval; ARR, adjusted risk ratio; AHR, adjusted hazard ratio.

The positive association between HIV testing and STIs could be due to a number of factors which include symptoms and associated health-seeking behaviours, and/or clinic HIV test policy while symptomatic. MSM may be offered an HIV test at the diagnosis of the STI in the sexual health clinic (depending on the policy). In one UK study, HIV testing was associated with being recruited from a GUM clinic (AOR 1.29, 95% CI 1.25 – 1.32)[50] compared with MSM recruited from bars and clubs. HIV testing was associated with GUM service use in the past year (AOR 2.66, 95% CI 2.66 – 4.24)[30]. The association between HIV testing and having a STI may be due to previous high-risk sexual behaviour that puts the individual at risk of an STI and of HIV infection. MSM reporting UAI were more likely to report an STI in the past year[52] (Table 2.7b). A study of MSM in New York City found syphilis to be associated with UAI and an increased risk of HIV infection[103].

The biological association between STIs and increased risk of HIV infection has been well established[104-106]. Having an STI, in particular ulcerative STIs, makes an individual more susceptible to HIV co-infection due to the damaged mucosal barrier. Additional HIV seroconversion studies have found an association between STI and HIV seroconversion[36,41,42,46,86,102]. HIV seroconversion in a case control study of MSM in the UK was associated with being diagnosed with both gonorrhoea and syphilis[42] (Table 2.7c). The risk of being HIV positive was associated with history of an STI[47,49,62,62,86,91,103], although some of these associations are linked to STI outbreaks in MSM who were already diagnosed HIV positive in particular syphilis[103].

In summary, HIV testing was associated with previous STI in most of the studies. Both UAI and risk of HIV infection were associated with previous STI, and gonorrhoea and syphilis were important, where the STI was reported. A summary of the likely association between HIV testing, STI and HIV infection is represented in the conceptual framework in Figure 2.12 below. For simplicity, the other factors found to be associated in this review (age, socio-economic status and numbers of sexual partners and area) are all included as 'unknown and other confounders'.

**Figure 2.12 Conceptual framework of the relationship between HIV testing, unprotected anal intercourse and sexually transmitted infections**




## 2.9 Evidence of changing sexual behaviours over time; how will this affect the relationship between HIV testing and unprotected anal intercourse

HIV testing was associated with UAI throughout the 1990's and the early 2000's (section 2.3 Table 2.2). The strength of this association decreased over time, as HIV testing 'normalised'. The association between previous HIV testing and UAI was OR 1.90 (95% CI 1.30 – 2.79) in 1987 to 1989 in the UK, and AOR 1.29 (95% CI 1.26 – 1.32) in 1996 to 1997 (Table 2.2). The corresponding increase in HIV testing in MSM reporting UAI over the decade was from 58% in the study in 1987 to 75% in 1997. Within Scotland the association between testing and UAI was AOR 1.57 (1.13-2.18) in 1999, and HIV testing was less common in Scotland (58% tested with UAI). Research on the HIV testing behaviour of MSM in Scotland found this low rate of HIV testing was due to both fear of a positive result, and HIV-related stigma and discrimination within the MSM community[107,108] (Table 2.2). In the US a similar apparent decrease in the strength of the association between testing and UAI was seen; AOR 1.78 (95% CI 1.12 – 2.82) in a study in Minnesota in 1989, to AOR 1.32 (95% CI 1.02 (95% CI 1.02 – 1.79) in seven cities in 1999. HIV testing in MSM reporting UAI increased from 64% to 79% in these studies. This varied by subgroup, and the strength of the association

between testing and UAI in young Asian and Pacific-island MSM remained; AOR 2.21 (95% CI 1.04 - 4.70) to AOR 2.6 (95% CI 1.3 - 5.3) between 1999 and 2002 (Table 2.2).

The strength of the association between HIV seroconversion and UAI remained throughout the 1990's in cohort studies in the US; AHR 2.0 (95% CI 1.3 - 3.0) in 1995 in MSM with reported UAI in past year and AHR 2.85 (2.12 - 3.84) in 1999 to 2001 in MSM with reported UAI with serostatus unknown partners (section 2.3 Table 2.1a). Case control studies in the US, UK, and Australia, all maintained similar associations between HIV seroconversions and UAI throughout the 1990's and up to 2002 (Table 2.3a).

There is evidence that UAI in MSM was increasing over time[48,49,71,72,94,109-115]. This phenomenon was seen throughout Europe[48,49,72,94,110], the US[71,73,109-111,116] and Australia[114,115]. There has been a corresponding increasing trend in STIs in MSM[82] and in HIV diagnoses[117,118]. The re-emergence of syphilis at the end of the 1990s has been seen in Europe, the US and Australia[119-122]. It was suggested that the availability of treatment might have diminished the perceived seriousness of HIV[123]. A meta-analysis review of 25 studies in the US and Europe by Crepaz and colleagues[124] found that there was no evidence to suggest that HIV positive MSM receiving ART or with undetectable viral levels had more UAI than others. Regardless of their HIV serostatus, the likelihood of UAI was higher in people who agreed that receiving ART or having undetectable viral load protects against transmitting HIV, or that availability of ART reduces their concerns about having unsafe sex[124]. More recently evidence suggests that there may be selective serosorting between HIV positive MSM resulting in an increase in STIs in MSM with clinically diagnosed HIV infection[80,83,84,125-129].

Changing sexual behaviour could affect the strength of the relationship between HIV testing and UAI, which would affect the estimates of total HIV infections calculated in Chapter seven. If HIV testing behaviour and its association with high-risk sexual behaviour changes over time, and the groups that HIV test are different now than people who tested 10 years earlier, the relationship between HIV testing and UAI could change. This increase in high-risk sexual behaviour might affect the relationship between HIV testing and risk of HIV infection in three ways:

(1) HIV testing could increase proportionately with UAI so there would be no change in the risk of HIV infection between HIV testers and non-testers.

(2) Alternatively, if HIV testing remains the same, but those who HIV test have

higher risk of HIV infection as they are now having a higher number of UAI events Then the estimated adjustment would underestimate the true difference between HIV testers and non-testers and thus overestimate numbers of undiagnosed HIV infections.

(3) Finally, if the increase in UAI is in non-testers, then the adjustment factor estimated for HIV testers would be too large and this would lead to an underestimate of undiagnosed HIV infections.

Is there any corresponding HIV incidence or diagnosis surveillance data available to monitor these changes? If there was no change in HIV testing then those who test are more likely to become HIV positive and the adjustment factor for non-testers compared with HIV testers would be an underestimate over time. Surveillance data must be able to monitor this prospectively. This could be done through behavioural surveillance surveys. Previous test history collected in all newly diagnosed HIV infections would allow for the monitoring and for alteration of the adjustment factor derived in Chapter seven if the relationship between HIV testing and UAI changed. A notification system that indicated when the change in the relationship between HIV testing and UAI was large enough to affect the estimates would need to be put in place. By how much this relationship would need to change before recalibration of the adjustment factor would be necessary would be determined through sensitivity analyses.

## 2.10 Conclusion

MSM who choose to undergo an HIV seem to have different levels of risk behaviour when compared to men who do not test for HIV. It may be possible to use the pattern of HIV testing as a proxy for different levels of risk behaviour. In cohort studies, risk behaviour is associated with HIV infection. The associations between risk of HIV infection and HIV testing from the literature are summarised below in Table 2.8.

A summary of the associations between HIV testing and UAI, with each of the factors found through this review, by study is included in Table A.7, Appendix A.

**Table 2.8 Summary of known factors (based on this review) with the current understanding of how they are associated with HIV testing and infection**

| *Factor* | *Association with HIV testing in MSM* | *Association with risk of HIV infection in MSM* |
|---|---|---|
| Unprotected anal intercourse | Increased HIV testing | Increased HIV risk |
| Age | HIV tested increases with increasing age | Risk increases with increasing age (number of years since first sex) |
| Socio-economic status (SES) / education | HIV testing associated with higher education and unemployment | HIV risk increases with lower SES and less education |
| Number of sexual partners | Increased HIV testing with numbers of partners | Increased HIV risk with increased number of partners |
| Area of residence | HIV testing higher in urban areas | HIV prevalence varies by area, and so too does risk of infection |
| Sexually transmitted infection | Increased HIV testing | Increased HIV risk as facilitates HIV transmission |
| Behavioural interventions | May lead to an increase in HIV testing, for MSM to determine serostatus | Should reduce risk behaviour |
| Sexual partnership networks | Not associated with HIV testing | HIV risk can be dependent on sexual networks. Area of residence may act as a proxy measure, for locations of higher HIV risk, although the network may be independent of the urban conurbation |
| Anti-retroviral therapies (ART) | Not associated with HIV testing | Lower viral levels should lead to a decrease in HIV transmission; this will lessen the effect of UAI. It may be dependent on the availability of therapy and so will be provision dependent. This may lessen the association with area, if ART is available for all diagnosed HIV positives in high prevalence areas |

The motivation behind HIV testing is complex and an individual's decision to do so can be affected by distal factors unrelated to risk of HIV infection These can include HIV testing policy which is often related to individual GUM clinic HIV testing policy rather than an individual's risk behaviour. The availability of HIV testing can vary according to whether GUM clinic or HIV testing clinic are accessible and close to an individual's

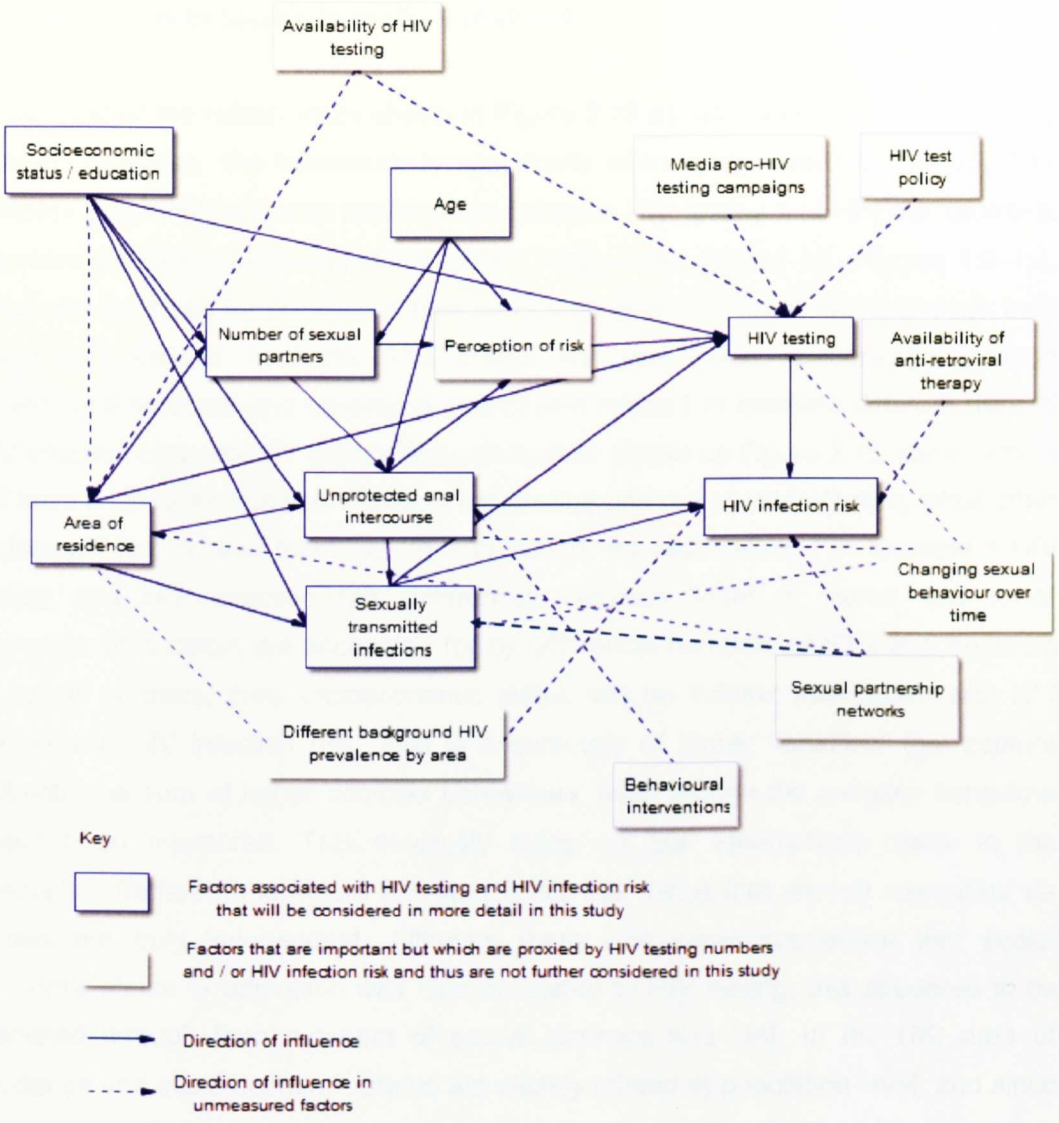
area of residence, and these area-level or ecological covariates are not related to individual-level covariates of risk behaviour. Additionally HIV testing may be affected by media pro-testing campaigns, and health education messages promoting HIV testing. These campaigns should also be related to risk, although they will be subject to self-perception and have been the result of large numbers of "worried-well" coming forward to test in the past[130,131].

These findings are explored further below in a conceptual framework.

## 2.11 Final conceptual framework for the association of HIV testing with risk of HIV infection

Based on the review of the available data presented in this chapter, a conceptual framework (directed acyclic graph) is shown in Figure 2.13. This directed acyclic graph identifies a set of factors that are associated with HIV testing and HIV infection via sexual transmission between MSM. Single-headed arrows represent direct links from exposures to outcomes; in Figure 2.13 the single arrow from UAI to HIV infection represents a direct association of UAI on HIV infection (that is, an association not mediated by another variable in the framework)[132]. The absence of an arrow or a variable implies that the relationship is independent. A dashed line with no arrow-heads represents a relationship that is not specified in the framework. These are for example, other distal factors that will affect risk of HIV infection but will not be associated with HIV testing (such as behavioural interventions, effectiveness and availability of medication and sexual partnership networks, as described in Table 2.8). The ways in which different factors may influence the choice of having an HIV test and/or the risk of HIV infection, either directly or indirectly, are shown. Factors that are important but are proxied by HIV testing and / or HIV infection risk and thus are not considered further in this study are in white surround boxes. For example if the number of people who have an HIV test in a given year is known, how and whether media pro-testing campaigns lead to testing has thus indirectly been quantified, therefore it is unnecessary to measure this factor within the model.

**Figure 2.13 Conceptual framework of the relationship between HIV testing and risk of HIV infection mediated through risk behaviour**




This graph can be viewed as a simplified representation of selected aspects of the associations and provides an easily understood depiction of the assumptions about the relationships between HIV testing, UAI and HIV infection[133]. The framework is useful for identifying variables that must be measured and controlled to obtain un-confounded measures of association given the assumptions outlined in the graph. For example, based on figure 2.13, area of residence is a confounder of the association between STIs and HIV infection risk, whereas HIV testing is on the causal pathway between STI and HIV infection risk. In the conceptual framework, perception of risk acts as an intermediate between UAI, age, STI and HIV testing. Within this conceptual framework, the relationships between the factors are assumed rather than proven. Later analyses will be based on this conceptual framework. If the assumptions of underlying relations

are wrong, the analyses may be biased. This conceptual framework visualises the relations between variables in the analyses. Its explicit framework enables us to test the assumptions by targeted sensitivity analyses.

While most of the relationships shown in Figure 2.13 appear to be consistent in many western countries, the framework is specifically intended to describe the UK. This complex graph of the known relationships between HIV testing and HIV risk contrasts the more simplified relationships implied in Chapter one, section 1.2, Figures 1.2–1.4, which are the basis for previous estimates of total HIV infections in MSM through both direct and indirect methods. This thesis will use these relationships through surveillance methods and develop a quantifiable method to estimate different risks of HIV infection between HIV testers and non-testers. Based on Figure 2.13, some factors will have a direct association with both HIV testing and risk of HIV infection, while other factors will act through them having a more indirect association. For example if HIV testing and HIV infection risk differences between MSM of higher and lower socioeconomic status are accounted for by differential numbers of STIs and numbers of sexual partners, then socioeconomic status has an indirect association with HIV testing and HIV infection risk. This is a summary of 'proxy variables' that capture indirectly the sum of rather complex behaviours, even though the complex behaviour hasn't been measured. This obviously relies on the assumptions made in the conceptual framework in Figure 2.8, specifically that things that are not connected via arrows are truly independent. Although there was some suggestion that socio-economic status or education was directly related to HIV testing, this appeared to be mediated through both numbers of sexual partners and UAI. In the UK, area of residence and socio-economic status are closely related at population level, and since the purpose of this thesis is to arrive at estimates of total HIV infections in a population by area, SES was dropped from the analyses. Similarly, number of sexual partners while associated with HIV testing is probably reflecting UAI. In the UK STIs in MSM are strongly associated with age and STIs are more common in younger men. This is likely to be related to both UAI and sexual networks so age will remain in the framework. STIs in MSM in the UK are also associated with area of residence, sexual networks and changing sexual behaviour over time. Hence, by including the factors **age, area of residence, STIs and HIV testing**, the framework is measuring for the association of UAI with risk of HIV infection.

These assumptions will be tested further in subsequent analyses in Chapters four, five and six. Other factors that are connected to HIV testing and / or HIV infection risk by arrows within the graph (i.e. open backdoor paths) must be considered. If all HIV infections have been diagnosed, how and whether sexual partnerships affect risk of

HIV infection has thus been indirectly quantified and the issue of sexual partnership networks is irrelevant. However if all HIV infections are not known then not knowing sexual partnerships may bias the result unless the model adjusted for area of residence. Another unmeasured factor in the framework is availability of HIV testing. Again if all HIV tests are known, availability of testing is not important, however if not all HIV tests are known, and then availability of testing would bias our results unless the model adjusted for area of residence. Finally changing sexual behaviour over time is related to both HIV testing, STIs and UAI in the framework. Similarly if how many people HIV test is known, changing sexual behaviour over time will not be relevant. However if all tests are not known, then not knowing how sexual behaviour is changing over time will bias the results unless the model adjusts for STIs. The associations between changing sexual behaviour with HIV infection risk and their likely directions are explored in sensitivity analyses in Chapter seven.

The potential effect of the other distal factors on these relationships, such as: HIV testing policy and practice, availability of effective ART, availability of testing, and the effect of media campaigns, will be examined through sensitivity analyses. The importance of time as a factor will be dealt with through sensitivity analyses. The framework will address factors related to HIV testing and risk of HIV infection, levels of risk behaviour, frequency of HIV testing and the importance of population size within risk strata. Sexual partnership networks are more complex and to allow for them would require complex modelling methods and thus are outside the scope of this project. Recommendations for key behavioural data to be collected in the future as part of HIV and STI surveillance datasets will be made following sensitivity analyses in Chapter seven to determine their importance in the estimations of the model.

## 2.12 Plan of analysis

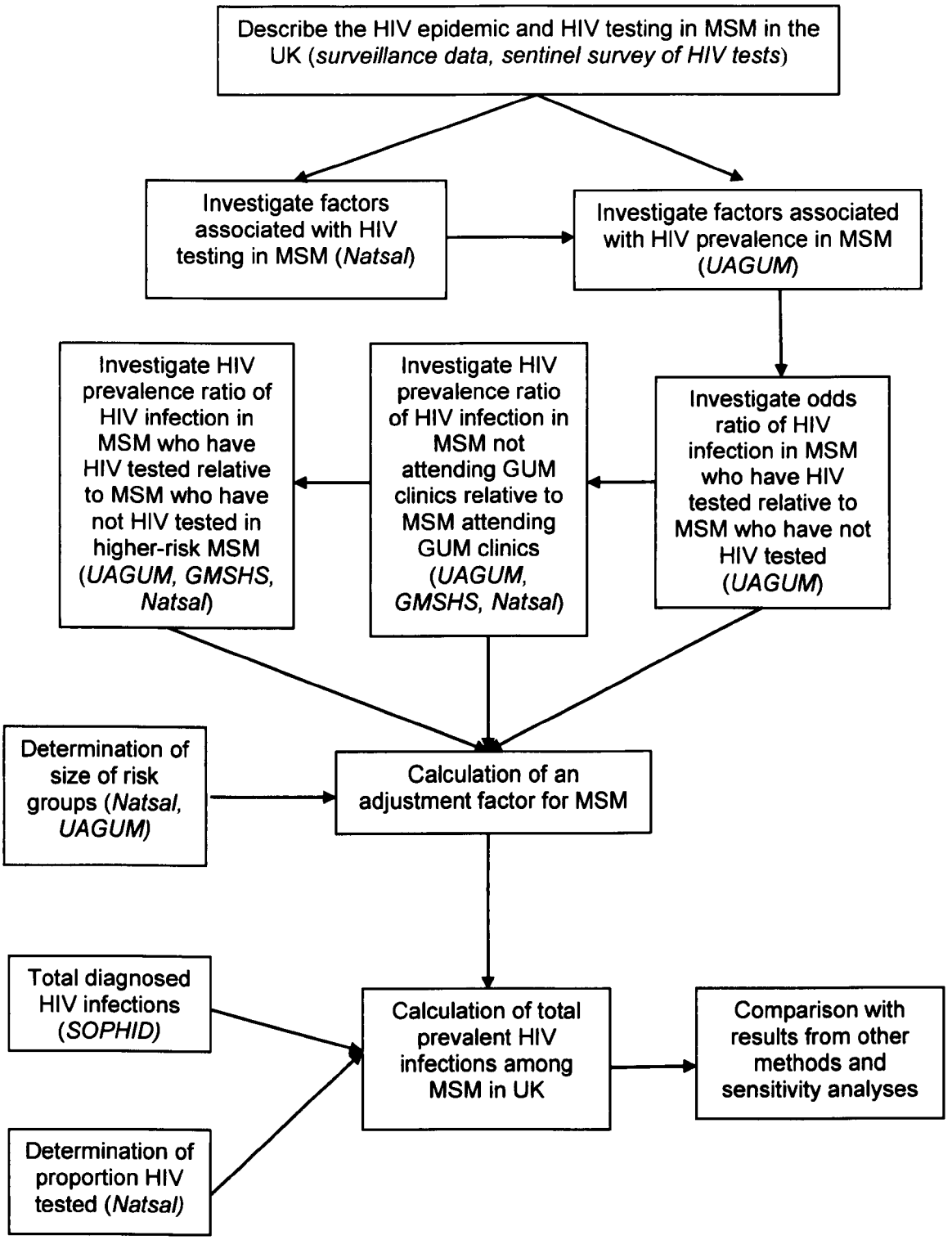
This chapter explored factors that have been previously described to be associated with HIV testing and risk of HIV infection. These associations were then summarised in a conceptual framework. Subsequent chapters in the thesis will explore aspects of this conceptual framework further in a series of independent data-sets. The analyses will quantify associations, which will enable the development of a parametric adjustment model to estimate total HIV infections in MSM in the UK. Seven analyses were carried out as illustrated below in Figure 2.14

1. Description of the **diagnosed** HIV infections in MSM in the UK, and a summary of available surveillance data on HIV testing (Chapter three).
2. Characterisation of the size of the MSM population, the general level of risk

behaviour, and an investigation of the socio-demographic and behavioural characteristics associated with HIV testing in MSM using the Natsal (a UK based more representative survey study), in addition to providing estimates of prevalence of HIV testing by age group (Chapter four).

3. Investigation of the socio-demographic and HIV testing characteristics in MSM attending a GUM clinic in inner London. An UA study was carried out to determine the prevalence of HIV infection in MSM who have HIV tested compared with those have chosen to not have an HIV test (Chapter five).
4. Estimation of the prevalence of HIV infection by risk-behaviour levels, in a higher-risk group of MSM and in MSM who have not attended a GUM clinic compared with MSM who have attended a GUM clinic. This was achieved through a comparison of a UA GUM survey with a community-recruited survey of MSM (GMSHS) following standardisation with Natsal (Chapter six).
5. Calculation of an adjustment factor for MSM to estimate total risk of HIV infection. Natsal was used to estimate the proportions of the population within each subgroup, and the results from Chapters four, five and six were combined to estimate the overall adjustment factor within each age group of MSM (Chapter seven).
6. Estimation of total prevalent HIV infections in MSM in UK, using diagnosed HIV infections from SOPHID, the proportions of MSM who have HIV tested from Natsal, and the calculated adjustment factor (Chapter seven).
7. The model was compared with estimates derived from other methods, and sensitivity analyses were carried out (Chapter seven).

**Figure 2.14 Plan of analysis**




Note: Datasets used are shown in italics. Studies are explained in the plan of analysis as outlined in section 2.12

# CHAPTER THREE

## *DESCRIPTION OF THE HIV EPIDEMIC IN THE UK IN MSM USING SURVEILLANCE DATA*



**Summary**

This chapter includes a description of GUM clinics and their accessibility and an investigation of where HIV tests are being carried out in the UK. This is followed by a review of HIV test policy, and finally trends in HIV testing and a description of HIV and STI trends using available surveillance data. All data are presented up to 2002, the year prior to when the survey in Chapter four was carried out.

## 3.1 History of Genitourinary Medicine clinics in England and Wales – What population do GUM attendees represent?

The origins of surveillance data on STIs in the UK can be traced to the Royal Commission on Venereal Diseases chaired by Lord Sydenham of Combe which started to take evidence in 1913 and reported in 1916. The commission recommended the establishment of a free open-access medical service organised by local authorities and funded 75% by central government and 25% by local government. The clinics were required to make workload returns to the Department of Health (DH) each quarter and these mark the beginning of all further STI surveillance in the UK. The clinics were slow to develop and had little to offer in effective treatment, especially of gonorrhoea, and there was a large backlog of untreated disease to contend with, which was increased by returning soldiers. The first reported results from these clinics, in 1918, showed 27,000 cases of syphilis and 17,000 cases of gonorrhoea. In 1919 the case numbers had increased to 42,000 syphilis and 38,000 gonorrhoea cases. Within a decade, the number of syphilis cases had decreased but gonorrhoea continued to increase over time.

Data on the occurrence of new cases of gonorrhoea was collected on form SBH60 and have been recorded on form KC60 since April 1988. The KC60 form records the number of new diagnoses at GUM clinics each quarter by diagnosis, sex, and age group. In addition, many clinics record data on the proportion of specific infections among new male clinic attenders attributed to sex between men. The catchment population served by each individual clinic is not known accurately, so KC60 data should only be used to generate large-scale (national or regional) STD incidence rates. Electronic delivery of the KC60 is under development and is available in some pilot clinics. This would enable more accurate analyses of STIs.

Data from GUM clinics will underestimate the true rate of diagnosis in the population as not all STIs will be diagnosed and treated in GUM clinics and some will be seen and treated at General Practices (GPs). This effect is likely to be small for MSM. A national survey of MSM carried out in 2003 found that although 79% reported visiting a GP or local doctor in the past year, only 5% reported having a sexual health check-up and 4% an HIV test, as a reason for their last visit to a GP surgery or local doctor[134]. Open access for GUM means that patients may travel outside their area of residence to access services. This will tend to overestimate the rates for London (The survey of prevalent HIV infections diagnosed (SOPHID) recorded that 6% of HIV positive MSM seen for care in London in 2002 were resident outside London), but this effect is likely to be minimal for England and Wales as a whole. Although these limitations may result in a degree of error in the measurement of the rates described in section 3.5.2, this is

likely to be consistent over time.

## 3.2 Review of historical HIV testing policy in England and Wales

HIV testing policy has changed over the past two decades in England and Wales. The Chief Medical Officer's public health strategy in 1991[135] stated that public education about HIV infection and AIDS remained a major part of the government's strategy to prevent HIV transmission and to contain the epidemic. Campaigns were directed at both the general public and particular sectors of the population. Since 1992, all aspects of HIV prevention, whether local, national, general or targeted at particular groups were considered within the general field of sexual health. In 1994 the main aims of the Governments strategy on HIV and AIDS moved towards bringing initiatives to combat HIV infection and AIDS into the mainstream of health care and health promotion. In 1995, the Government strategy called for a more focussed health promotion strategy, placing greater emphasis on appropriate targeting of high-risk groups, i.e. homosexual and bisexual men, people with links to high prevalence countries, IDUs and female partners of men in these groups.

An examination of the policy and practice of testing in GUM clinics in the UK, which was undertaken by the British Co-operative Clinical group in 1999[136], found that a substantial group of people with HIV infection fail to have their infection diagnosed and concluded that the main barriers to HIV testing were non-offering of HIV test to those at high-risk and lack of resources to increase the level of testing. At the time of this study, a new sexual health strategy was under consultation[137], which amongst other things aimed to identify key areas for health promotion and appropriate groups to target for HIV prevention. It had set as a target to reduce by 25% the number of newly acquired HIV infections by the end of 2007, and to reduce undiagnosed HIV by 50% by the end of 2007. At the time it was thought was that this would be achieved through offering all attendees at GUM clinics an HIV test at first STI screening, and the aim was to increase the uptake of testing to 40% by 2004 and to 60% by 2007. This was the situation at the time of when this PhD study set out, and the estimations of total HIV infections presented in Chapter seven are for 2003 to further inform this planned policy.

In general, HIV-related education campaigns have targeted sexual health and practising safer sex, rather than encouraging people to get tested, although this has been changing over time. Local campaigns promoting HIV testing for MSM began in London in 1995, and nationwide campaigns started in 1998. Since 1998 several

campaigns have targeted MSM, encouraging individuals to be HIV tested, citing improved treatment and knowledge of partner's serostatus for determining whether to have UAI as reasons for testing. Throughout the 2000s, HIV testing has been promoted positively for MSM.

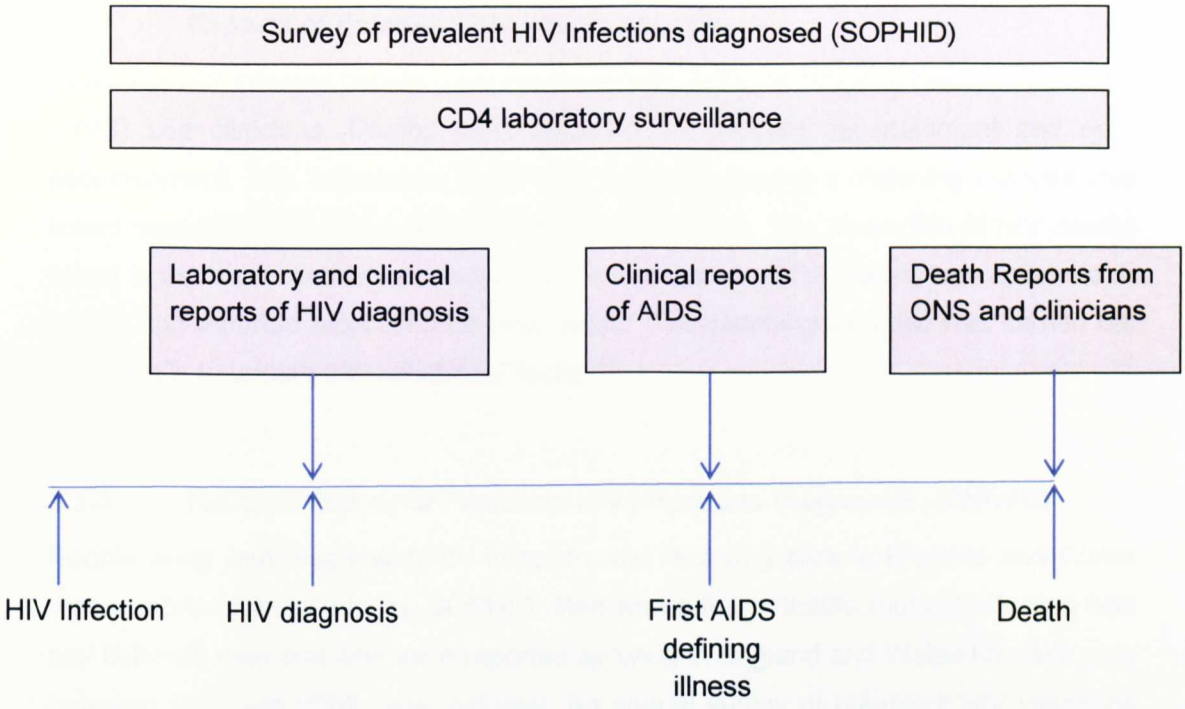
A review of the impact of national anti-HIV sexual health campaigns on the transmission of HIV in England[130] found that awareness of AIDS and campaigns in 1983-4 among MSM coincided with substantial declines in transmission of HIV, although the improving trends in gay sexual health indices in the mid-1980s were not sustained, and high levels of risk-taking behaviour were recorded in MSM in the early 1990s. These increases have continued and there was little evidence of any positive impact of the government's more focussed health promotion strategy[130] on HIV transmission in the 1990s. There was some evidence of changed behaviour following HIV negative testing[76]; however, previous increases in HIV testing following health education campaigns, while showing a large overall increase in the number of tests, had not led to an increase in the diagnosis of HIV infections in high-risk individuals[138].

In an effort to reduce the number of undiagnosed HIV infections in the population and to reduce HIV transmission, testing promotion has been prioritised by the Department of Health's National Strategy for Sexual Health and HIV for England[137]. Key strategies include the provision of clear information to the public about HIV with the aim of encouraging the demand for voluntary HIV testing while improving access to GUM services and increasing the offer of HIV testing. At the same time, there is a growing acknowledgement of the need to remove the exceptionalism and stigma associated with HIV testing by providing these services outside traditional GUM and antenatal settings[139]. Guidelines in 2002 promoted HIV testing of all new attenders at a GUM clinic including those who had recent sexual exposure.

## 3.3 Surveillance data sources used to describe HIV and STI trends

The capture of data through the existing surveillance systems in the UK, at the different stages of HIV infection in MSM is illustrated below in Figure 3.1. The next sections describe these different data-sources in more detail and how these data were analysed to produce the graphs on trends as shown later in this chapter.

**Figure 3.1 The different stages of HIV infection and how they are monitored through current surveillance system in the UK**




Source: Reproduced from HPA, Department of HIV and Sexually Transmitted Infections

### 3.3.1 HIV infection reporting

Newly diagnosed HIV infections in England and Wales were reported to the HPA CDSC. These reports had two sources, from microbiologists reporting specimens sent for testing in their laboratories, and from clinicians reporting newly diagnosed patients. Clinicians extended their reporting, which before had only covered AIDS cases, to include all newly diagnosed infections from the beginning of 2000. Cases were reported using a standard form. Voluntary confidential reporting methods were used to collect a range of epidemiological information including Soundex code[140] (a non-unique alphanumerical code that summarises patient's surname) and date of birth and gender, which permitted the identification of duplicate reports for the same individual from other laboratories and within that laboratory. These were checked by Soundex code, date of birth, sex, and exposure category, using a predefined algorithm of likelihood. If data on fields, such as Soundex, date of birth, gender or exposure category were missing, active follow-up to reporting clinician by telephone was undertaken. Data presented in this thesis include all males reported with a first HIV diagnosis in England and Wales where the probable route of infection was sex between men. Data analysed included all reports received by the end of 2003. In order to minimise the effects of delays in reporting and ascertainment of route of infection these data were censored at the end

of 2002.

### 3.3.2 Reports of deaths in HIV infected people

Deaths in HIV infected people were obtained from both the Office of National Statistics (ONS) and clinicians. Deaths were adjusted for delayed ascertainment and non-ascertainment. This adjustment factor was derived following a matching exercise that linked reported AIDS cases with ONS death certificates. The proportion of HIV deaths found in the death certificates that were not reported as AIDS cases, was assumed to be the non-reported proportion for later years. This matching exercise was carried out periodically to update the adjustment factor[141].

### 3.3.3 National Survey of Prevalent HIV Infections Diagnosed (SOPHID)

People living with diagnosed HIV infection and receiving care in England and Wales were reported annually to the SOPHID. Men where the probable route of infection was sex between men and who were reported as living in England and Wales for each year between 1997 and 2002 were included. An annual survey of prevalent HIV infections that have been diagnosed has been undertaken since 1994[142]. Limited data including Soundex code, exposure category, sex, and date of birth were captured from care providers on HIV infected persons receiving care within a calendar year. The data were adjusted for both under-ascertainment and non-attendance for care. Under-ascertainment was measured by comparing data with laboratory HIV infection reports, CD4 count reports and AIDS case reports of persons not known to have died. The small number of individuals who did not access services within a particular calendar year was estimated by comparing the survey across a three-year period[143]. The non-attendance adjustment for 2002 for example, was based on the numbers of individuals seen for care in both 2000 and 2002, but not 2001, as a proportion of the 2001 SOPHID total. The proportion not seen for care in 2001 was then applied to the 2002 survey data as the best available estimate of non-attendance for that survey year[143].

### 3.3.4 Surveillance of sexually transmitted infections

Surveillance of other STIs in England and Wales was based on statutory quarterly aggregate statistical returns (KC60) from GUM clinics reported to CDSC and CDSC Wales. Male homosexual acquisition of STIs was reported for five acute conditions: uncomplicated gonorrhoea, infectious syphilis (primary, secondary and early latent), genital chlamydia infection, genital warts (first attack) and genital herpes (first attack). Data on acute (male) homosexually acquired conditions were reviewed for the period

1997 to 2002. Information was available by region of diagnosis within England and for Wales for all five conditions. Age group at year of diagnosis was only reported for uncomplicated gonorrhoea in MSM.

### 3.3.5 Estimating the populations of MSM for calculating rates

Natsal 2000 estimated the proportion of men, aged 16 to 44 years, reporting sex with another man in the past 5 years to be 2.6% (95% CI 2.2 - 3.1) in Britain, 5.5% (4.2 – 7.2) in Greater London and 2.1% (1.7 – 2.7) in the rest of Britain[26]. These point prevalences were applied to the 2000 mid-year census[144] estimate of males aged 16 to 44 years to obtain estimates of the numbers of MSM living in England and Wales as a whole and separately for London and the rest of England and Wales and for specific age groups, based on the KC60 age group categories. These were; 16-24 years, 25-34 years, 35-44 years old and 45 and over. It was assumed that the proportion of males aged 35-44 who were MSM was similar to the proportion of men aged 45- 59 who were MSM, and the population of MSM aged 45 to 59 was extrapolated from these data. Estimates were only made for MSM up to 59 years old. It was assumed that there was no difference between the prevalence of MSM in the rest of Britain and the rest of Britain excluding Scotland (otherwise defined as the rest of England and Wales) and this proportion was applied to the census population aged 16 to 44 for this area only, excluding men from Scotland. The population of MSM aged 45 to 59 was again extrapolated. Chi-squared test and Chi-squared test for trend were used to examine changes in the rates per 100,000 populations of diagnoses of HIV and other STIs between 1997 and 2002 using Epi-Info 6 (v.6.04d); 95% confidence intervals around the rates were calculated using STATA 7.0 (StataCorp, 2001).

### 3.3.6 Sentinel survey of first HIV tests

The Sentinel Survey of first HIV tests was set up in 1986 by the Public Health Laboratory Service to monitor trends and determinants of voluntary HIV testing in England through the sentinel surveillance of 18 laboratories and has been published before[145,146]. Seven sentinel laboratories in England (three in London and four outside London) were selected to continue after 1998. They were not a randomly selected sample of laboratories and cannot be assumed to reflect all HIV testing in England. Although these sentinel laboratories accounted for 16% of all HIV tests reported from English GUM clinics in 2000 and areas outside London were well represented.

First tests of individuals were identified on each laboratory database in the laboratory

by matching on either GUM number or name and date of birth. All patient identifiers were then removed before extracts of all first tests were sent to the CDSC for addition to a central database. Variables collected on each patient included: date and final result of test, source of specimen, age, gender, reported risk factors, nature of contact involved in the HIV transmission risk, reasons for testing and symptoms at the time of test. Specimens referred to participating laboratories from other laboratories for confirmatory testing were excluded. Only those tests requested by GUM clinics and GPs were included from all first HIV tests performed from January 1990 to December 2000 in the seven sentinel sites. A total of 206,782 first HIV specimens were tested at the seven sentinel sites over the 10-year period. Ninety-eight per cent were eligible for inclusion in this study. Two laboratories, both in London and with more than 50,000 tests each, accounted for over 50% of the tests. Ninety per cent (182,746/202,892) of the eligible tests were requested from GUM clinics. MSM accounted for 11.2% (22,685/202,892) of individuals tested for HIV, with the proportion ranging from 3.8% (522/13,817) to 19.5% (11,111/56,916) across sites. Overall, in GUM clinics 12% of HIV tests were for MSM. In contrast, 3% of tests requested by GPs were for MSM and 13% for IDUs[147]. Differences in proportions were tested by Pearson's Chi-squared method and Fisher's exact test where appropriate. Point estimates and exact confidence intervals for odds ratios were calculated for comparison of the odds of testing positive by source. Trends were analysed using linear regression using ordinary least squares.

## 3.4 Trends in HIV testing in MSM in the UK

Two decades of intensive HIV health promotion have seen gradual and sustained increases in HIV testing among GUM attendees in the UK up to 2003. Statutory returns made by GUM clinics in England (form KC60) show that the number of episodes of HIV counselling and testing increased by 35% in the last year, 56% in the last 3 years and by 90% in the last 6 years to 201,347 in 2001[148]. Nevertheless, substantial numbers of HIV infected individuals in the UK still do not know their HIV status[25] and therefore cannot receive appropriate care, notify their partners or be guided in safer sexual behaviour in knowledge of their status[97]. At the time of starting this thesis, there is little information on HIV testing trends in General Practice in England[149] or in other settings where individuals at increased risk may be seen (e.g. termination of pregnancy clinics).

### 3.4.1 Trends in HIV testing from sentinel surveillance of first HIV tests

Between 1990 and 2000 the number of overall voluntary HIV tests undertaken at these

seven sentinel sites more than tripled. GUM clinics accounted for most of this increase with a near quadrupling of tests, while little overall change was seen in the number of HIV tests undertaken at GPs. The increased HIV testing at GUM clinics was observed among all exposure groups except heterosexuals with high-risk partners and happened over a period when new attendances at these sites doubled[150]. Much of the increase was due to testing among low-risk heterosexuals, not MSM. This may have been a direct response to sexual health promotion messages throughout the 1990s although other factors such as changing clinic policies regarding the offer of routine HIV testing may also have contributed[151].

### 3.4.2 HIV testing by source of specimen in MSM

More first HIV tests for MSM from GUM clinics than from GPs were reported both within and outside London (Table 3.1). Only 141 tests were done by a GP in London which was 1% of all the tests done in MSM in London. Outside London, there was a higher percentage (6%) of MSM who had an HIV test with their GP. MSM tested outside London were younger than those tested in London with a modal age of 20 to 24 compared with 25 to 29 in London. Overall, HIV positivity was high in MSM (6.8%, 1,550 of 22,685). Within London, HIV positivity was higher among MSM tested at GPs than in those tested at GUM clinics (Table 3.1) (OR 1.98, 95% CI 1.20 - 3.16). There was no difference in HIV positivity in MSM tested in GPs and GUM clinics outside London (OR 0.89, 95% CI 0.53-1.44).

**Table 3.1 Number of first HIV tests for MSM by source and HIV prevalence**

| | London | | Outside London | | Total |
|---|---|---|---|---|---|
| | GP total | GUM total | GP total | GUM total | |
| Total number tested | 141 | 13,734 | 520 | 8,290 | 22,685 |
| HIV prevalence | 15.6% | 8.5% | 3.7% | 4.1 % | 6.8 % |

Source: Chadborn et al. HIV testing in Sentinel surveillance of HIV tests[147]

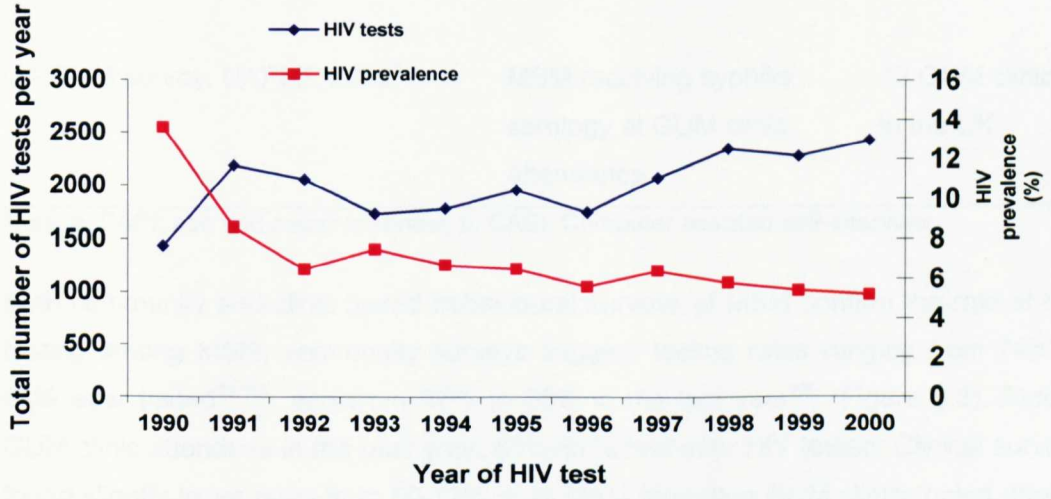
### 3.4.3 Trends in first HIV testing and HIV prevalence in MSM

The annual number of first tests in MSM increased from 1,437 in 1990 to 2,427 in 2000 (Figure 3.2). Linear regression analysis in MSM showed decreases in HIV prevalence over time overall (test for trend: $p<0.01$) (Figure 3.2) and both within (test for trend:

p<0.01) and outside London (test for trend: p=0.02).

The HIV positivity among MSM (6.8%) in this study was similar to that found among testers attending a same-day testing service at a large inner-London hospital in 2000/2001[152]. The data provide evidence of a continual decline in HIV prevalence among MSM first testers at GUM clinics between 1990 and 2000. This could not be accounted for by changes in the age distribution and trends in HIV prevalence were similar in all age groups. Decreasing trends in HIV prevalence in the UK have been reported among MSM GUM clinic attendees tested for syphilis between 1993 and 2000 that were not previously diagnosed with HIV in the Unlinked Anonymous Seroprevalence Surveys[97]. Similar trends among GUM clinic attendees have been found in Amsterdam (first testers)[153] and America (all testers)[154] where declines in HIV prevalence among MSM contrast with stable prevalence among heterosexuals and those with no identified risk.

**Figure 3.2 Trends in HIV testing and HIV prevalence among MSM first testers at GUM clinics. Sentinel Survey of first HIV tests.**




### 3.4.4 How much HIV testing is indicated in MSM from other studies

A review of other available surveillance data in England and Wales was carried out to estimate the concurrent level of HIV testing among MSM from multiple sources. Data reviewed included national HIV surveillance programmes[5], clinician and laboratory reporting of newly diagnosed HIV infections and the UAPMP, as well as other published surveys on HIV testing in MSM[29,155,156]. These are all shown in Table 3.2.

**Table 3.2 Behavioural and clinical surveys of MSM measuring HIV testing rates in Britain**

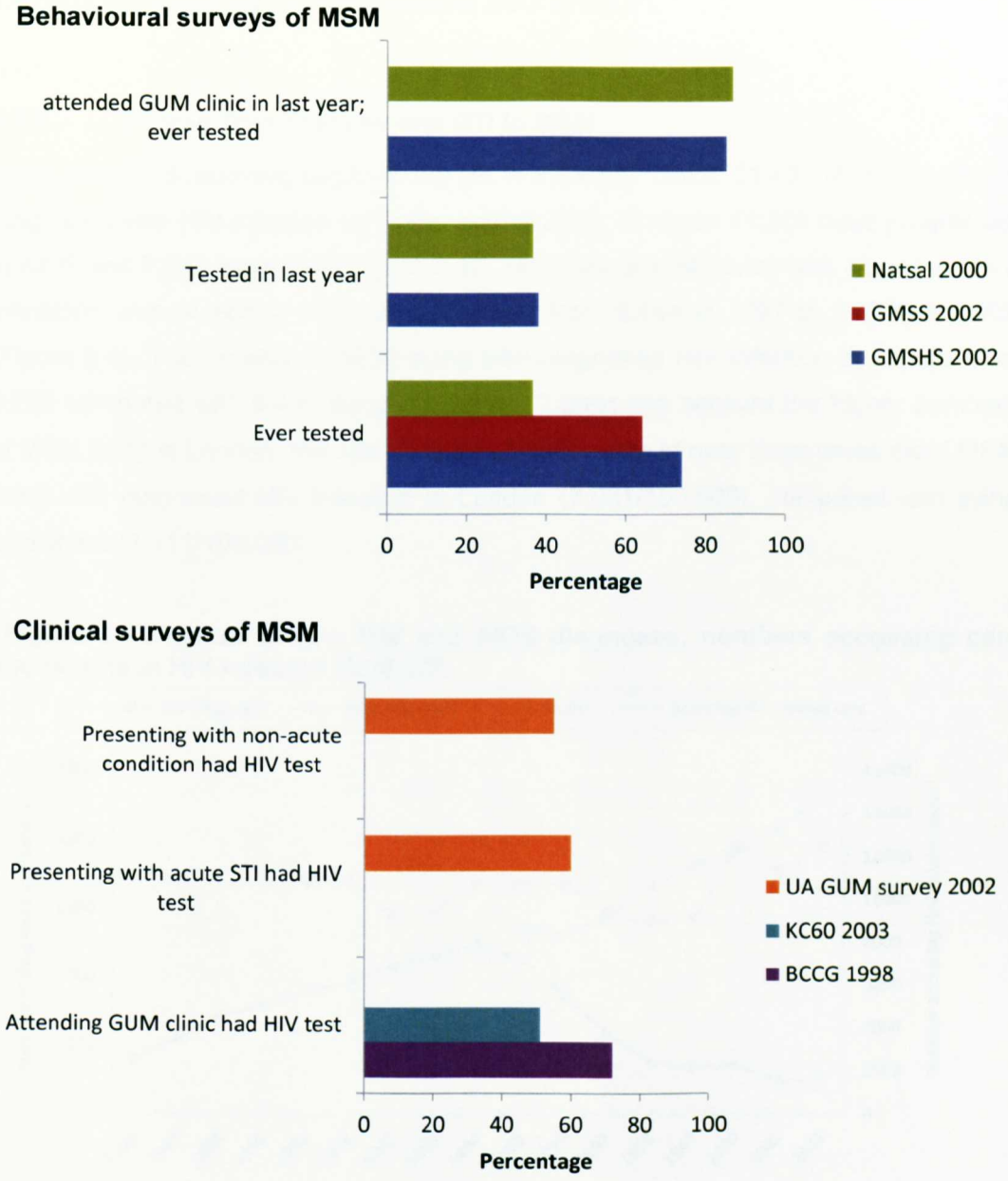
| Survey | Source of survey sample | Areas covered |
|---|---|---|
| Gay Men's Sexual Health Survey (GMSHS) 2002[157] | Self-completion PAPI[a] at Gay bars and clubs | London, Manchester |
| Gay Men's Sex Survey (GMSS) 2002[29] | Self-completion PAPI at Gay Pride festivals | London, Manchester |
| National Survey of Sexual Attitudes and Lifestyles (Natsal) 2000[26] | National probability sample face-to-face and CASI[b] interview | National |
| British Co-operative Clinical Group (BCCG) 1998[156] | Structured retrospective case-note survey of first 100 patients seen | 53 GUM clinics |
| KC60 diagnoses January to March 2003[158] | Episode data from GUM clinics, statutory reports | All GUM clinics in England and Wales |
| UA GUM survey, UAPMP 2002[5] | MSM receiving syphilis serology at GUM clinic attendance | 15 GUM clinics in the UK |

Note. a. PAPI: pen and paper interview; b. CASI: Computer assisted self-interview.

Both community and clinic based behavioural surveys of MSM confirm the rate of HIV testing among MSM; community surveys suggest testing rates ranging from 74% to 64% ever tested[29,155], and from 37% to 38% in the last year[155] (Figure 3.3). Among GUM clinic attendees in the past year, 85%-87% had ever HIV tested. Clinical surveys found slightly lower rates from 60-72% of all MSM attending GUM clinics being offered and accepted an HIV test[5,156] (Figure 3.3). Preliminary analysis of the January to March 2003 KC60 returns from all GUM clinics suggests that the rate of HIV testing in MSM attending clinics is high, an estimate of 51% of MSM attending GUM clinics were offered and accepted a HIV test. A review (using recorded KC60 codes) of all attendees at 15 GUM clinics, receiving syphilis serology who had a HIV test at that presentation, reveals a similar proportion HIV testing, 60% of MSM presenting with an acute STI and 55% of MSM presenting with a non-acute condition (Figure 3.3). Overall

there is some variation of percentages of tested MSM depending on the data source, and when examined within the same study (e.g. Natsal) there appears to be an association with GUM attendance. This will be explored further in Chapter six.

**Figure 3.3 Behavioural and clinical surveys measuring HIV testing rates in the UK**




Note. Natsal: National Survey of Sexual Attitudes and Lifestyles; GMSS: Gay Men's Sex Survey; GMSHS: Gay Men's Sexual Health Survey; UA GUM; Unlinked anonymous genitourinary medicine clinic survey; KC60; Statutory returns of sexually transmitted infections diagnoses; BCCG: British Cooperative Clinical Group

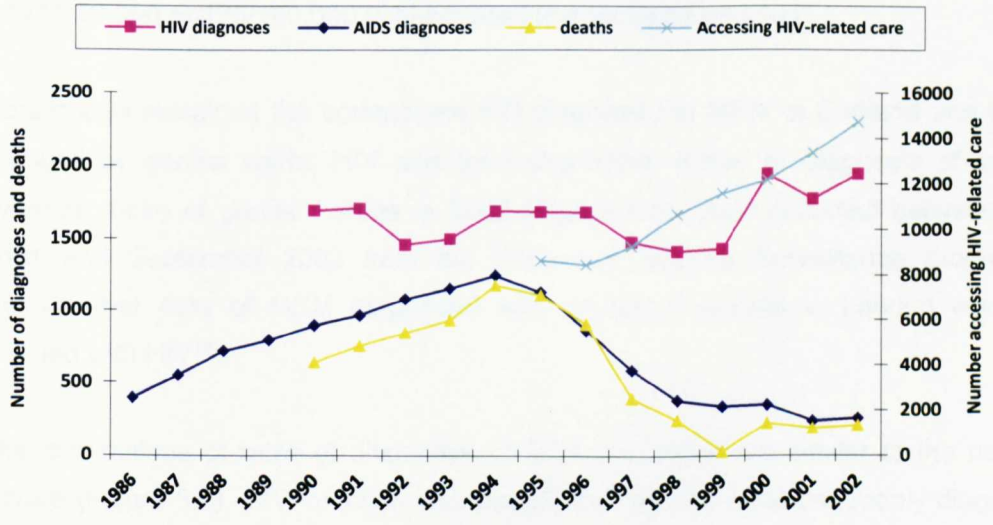
## 3.5 Trends in HIV and STIs in the UK

This section examines trends in diagnoses of HIV and other STIs in MSM in England and Wales. Data from many surveillance and survey sources have been combined to present these trends within the context of the MSM population. In the UK, surveillance of STIs, and for the most part HIV, is based on reports from GUM clinics that provide free, open access and confidential diagnostic services to the public. The surveillance methods are described above in sections 3.3.1 to 3.3.5[5].

### 3.5.1 Overall Trends in HIV and STI in MSM

Since HIV/AIDS reporting began in the UK in the early 1980s, 21,401 MSM have been diagnosed with HIV infection up to the end of 2002, of whom 11,956 have progressed to AIDS and 7,648 have died (Figure 3.4)[5]. Numbers of MSM living with diagnosed HIV infections and accessing HIV care increased from 9,244 in 1997 to 14,709 in 2002 (Figure 3.4). The number of MSM living with diagnosed HIV infection in London was 8,259 compared with 6,450 living elsewhere. Taking into account the higher numbers of MSM living in London, this still gave a population rate of over three times more MSM living with diagnosed HIV infection in London (7,031/100,000), compared with living elsewhere (2,111/100,000).

**Figure 3.4 Number of new HIV and AIDS diagnoses, numbers accessing care and deaths in HIV-infected MSM, UK**




Source: HPA, Department of HIV and Sexually Transmitted Infections. HIV infection reports, AIDS case reports and annual Survey of Prevalent HIV Infections Diagnosed.

### 3.5.2 Trends in Acute STIs in MSM 1997 to 2002

HIV was the third most commonly diagnosed acute STI in MSM in 2002 (Figure 3.5). Between 1997 and 2002, rates of diagnoses of HIV infection increased by 26% from 478/100,000 in 1997 to 601/100,000 in 2002 (Chi-squared test for trend $p<0.001$)[159]. The rate of diagnosis of acute STIs in MSM similarly increased in England and Wales (Figure 3.5). The biggest increases were in the rates of diagnoses of bacterial STIs, particularly between 1999 and 2001, with a doubling in gonorrhoea diagnoses between 1999 and 2001, from 661/100,000 to 1,271/100,000 (Chi-squared test for trend $p<0.001$). These increases were not sustained in 2002 with gonorrhoea declining to 1,210/100,000 (Chi-squared test for trend $p=0.03$), but there was no decrease in men aged 16 to 24 years old, instead rates increased by 84% from 648/100,000 in 1999 to 1,194/100,000 in 2002 (Chi-squared test for trend $p<0.001$). Large increases were seen in genital chlamydia and syphilis between 1999 and 2002: rates of genital chlamydia diagnoses in MSM increased by 144% and rates of diagnosis of syphilis rose 616% from 19/100,000 in 1999 to 225/100,000 in 2002 (Chi-squared test for trend $p<0.001$) (Figure 3.5). This has been associated with a series of large localised outbreaks in Brighton, Manchester, Newcastle upon Tyne and London[160].

In comparison with the bacterial STIs, the increases in diagnosis rates of viral STIs between 1997 and 2002 were steadier, with genital warts rising 36% from 536/100,000 to 727/100,000 (Chi-squared test for trend $p<0.001$) and genital herpes 16% from 1,121/100,000 to 176/100,000 (Chi-squared test for trend $p<0.001$).

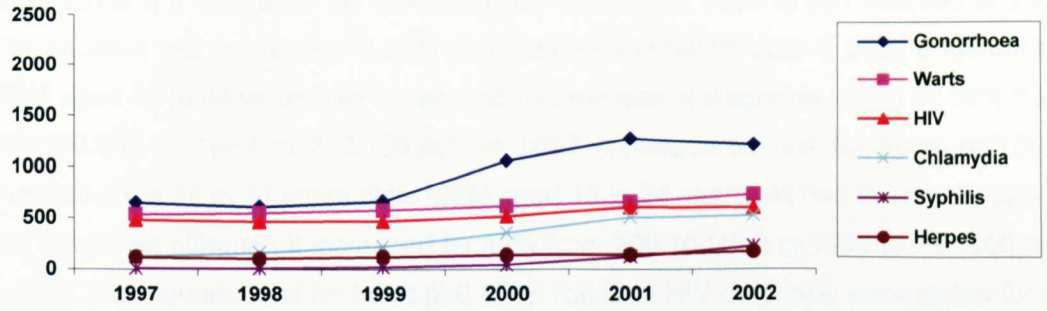
Gonorrhoea remained the commonest STI diagnosed in MSM in England and Wales followed by genital warts, HIV and then chlamydia. Rates of diagnosis of syphilis overtook those of genital herpes in 2002 (Figure 3.5). Data collected between April 2001 and September 2003 from the Enhanced Syphilis Surveillance programme indicate that 46% of MSM diagnosed with infectious syphilis in London were co-infected with HIV[161].

The distributions of rates of diagnoses of STIs in London are similar to the national picture (Figure 3.5). HIV infection was usually the second most commonly diagnosed STI in MSM in London with an annual rate of diagnosis of around 950/100,000 between 1997 and 2000 rising to over 1,100/100,000 in 2001 and 2002 (Chi-squared test, $p=0.001$). Diagnosis rates of STIs however, were higher in London and gonorrhoea rose from 1,107/100,000 in 1998, peaking at 2,088/100,000 in 2001 followed by a slight decline to 1,853/100,000 in 2002 (Chi-squared test for trend, $p<0.001$). A similar pattern was seen for chlamydia, which peaked in 2001

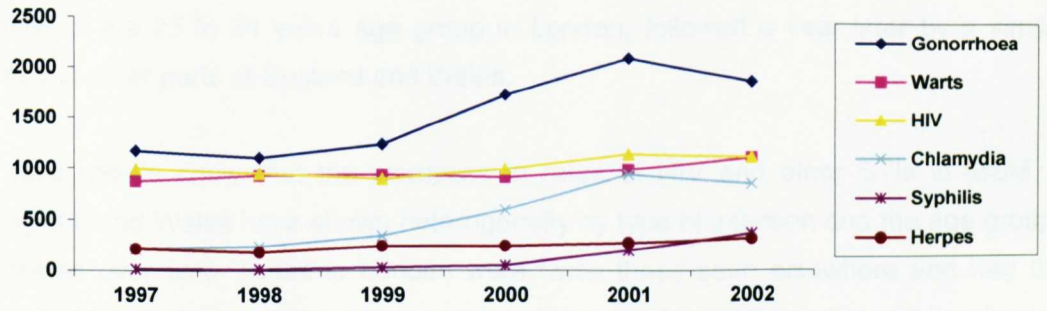
(938/100,000) and declined to 843/100,000 (Chi-squared test, p=0.024) in 2002. Syphilis rose steeply by 628% from 50/100,000 in 2000 to 364/100,000 in 2002 (Chi-squared test, p<0.001). Rates of diagnosis of genital warts were similar to HIV, increasing by 26% from 871/100,000 in 1997 to 1,101/100,000 in 2002 (Chi-squared test, p<0.001). Herpes rose by 47% to 313/100,000 (Chi-squared test, p<0.001) over this period

**Figure 3.5 Trends in acute STIs in MSM including HIV infection, rates per 100,000 population: 1997 to 2002**

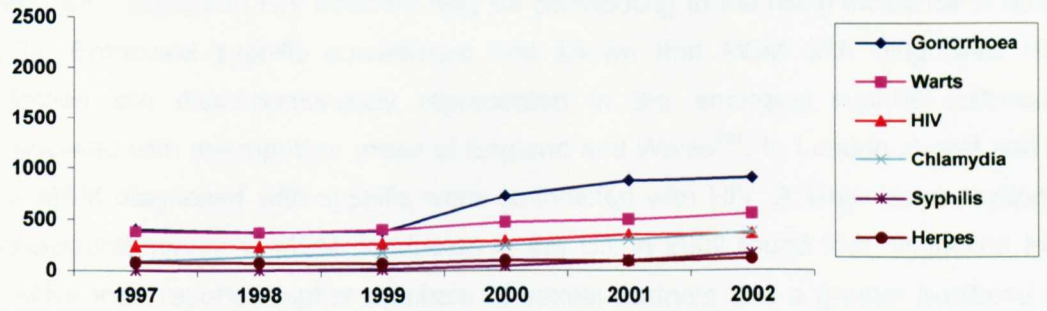
**England and Wales**




**London**




**Outside London**




Source: HPA, Department of HIV and Sexually Transmitted Infections. HIV infection reports and KC60 reports.

Outside London the rate of diagnoses of all STIs increased between 1997 and 2002 (Figure 3.5). Although the rates were lower than those in London, the increases between 1997 and 2002 were of a similar magnitude, except for gonorrhoea and syphilis where larger increases were observed. Gonorrhoea rose steeply between 1999 and 2000 (385/100,000 to 730/100,000, Chi-squared test $p<0.001$) followed by a further increase to 879/100,000 in 2001 (Chi-squared test $p<0.01$) and levelling off to 902/100,000 in 2002. Syphilis increased from 3/100,000 in 1997 to 159/100,000 in 2002 (Chi-squared test for trend $p>0.001$).

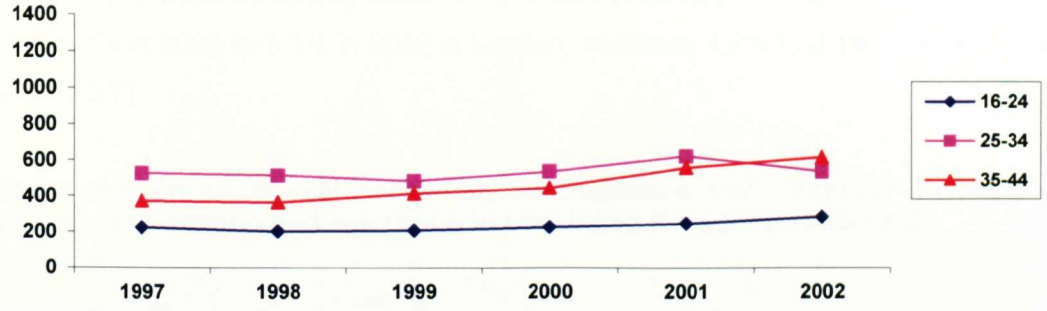
### 3.5.3 Age group specific trends in HIV in MSM

In England and Wales, the rate of HIV diagnosis was highest in MSM aged 25 to 34 years old and it increased by 18% from 527/100,000 in 1997 to 621/100,000 in 2001 (Chi-squared test for trend $p=0.001$) and declined to 534/100,000 in 2002 (Figure 3.6). MSM aged 35 to 44 years had the second highest rate of diagnosis, rising by 69% from 363/100,000 in 1998 to 613/100,000 in 2002 (Chi-squared test for trend $p<0.001$) overtaking the 25 to 34 years olds. MSM aged 16 to 24 years old had the lowest rate of HIV diagnosis although it increased by 42% from 200/100,000 in 1998 to 283/100,000 in 2002 (Chi-squared test for trend $p=0.004$). Rates of HIV diagnosis were higher for all age groups in London compared with elsewhere in England and Wales (Figure 3.6). Between 2000 and 2001 rates of HIV diagnosis in MSM aged 35 to 44 years overtook those in the 25 to 34 years age group in London, followed a year later by a similar trend in other parts of England and Wales.

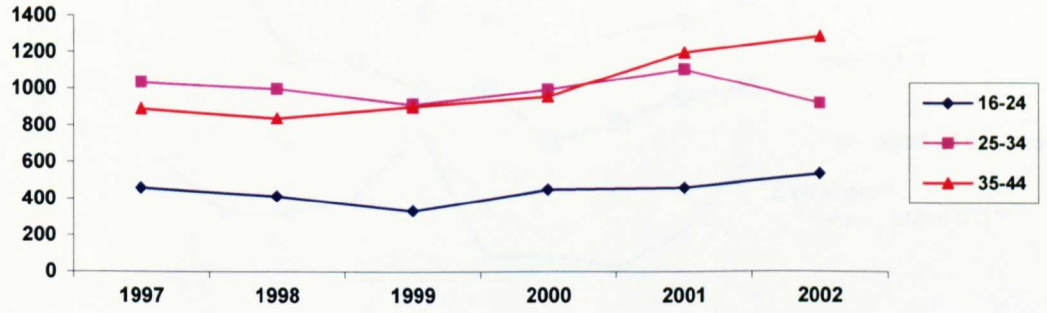
These results show that the increases in rates of HIV and other STIs in MSM in England and Wales have shown heterogeneity by type of infection and the age groups affected over time. Rates in London were twice those seen elsewhere and had the greatest changes over time, but the order of magnitude and the pattern of trends over time were similar with the rest of England and Wales. Increasing numbers of MSM living with diagnosed HIV infection may be contributing to the rising incidence of other STIs. Enhanced syphilis surveillance has shown that MSM with diagnosed HIV infection are disproportionately represented in the emerging syphilis outbreaks associated with metropolitan areas of England and Wales[161]. In London almost half of the MSM diagnosed with syphilis were co-infected with HIV. A large cross-sectional behavioural survey of MSM conducted in the UK in 2002 found that diagnosed HIV positive men reported higher numbers of sexual partners and a greater likelihood of having been involved in HIV serodiscordant UAI compared with HIV negative and untested men[29].

**Figure 3.6 Age-specific trends in HIV infection in MSM, rates per 100,000 population: 1997 to 2002**

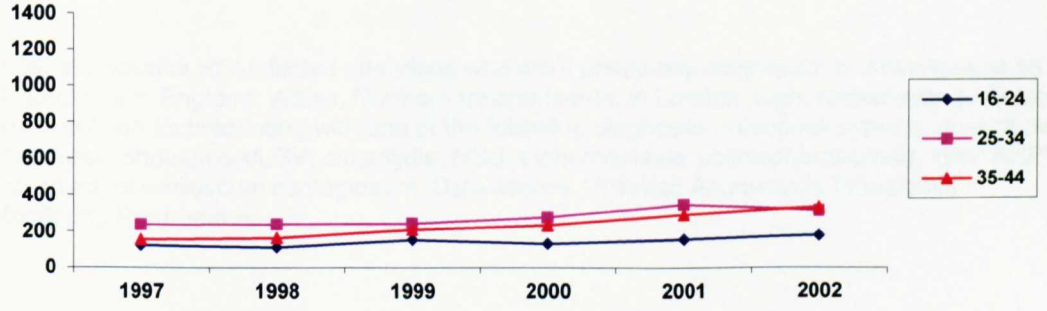
### England and Wales




### London




### Outside London

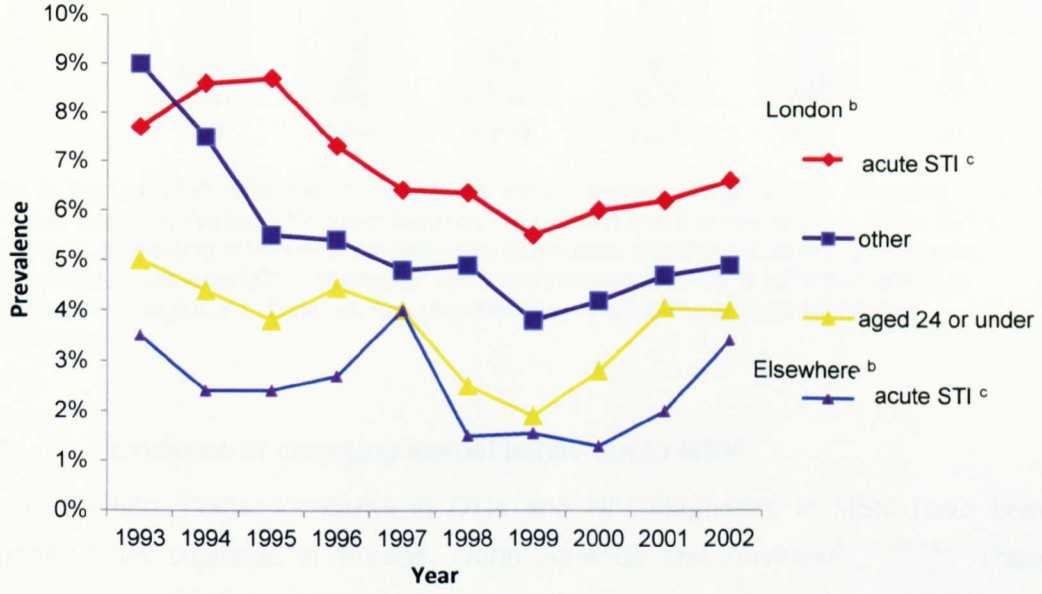



Source: HPA, Department of HIV and Sexually Transmitted Infections. HIV infection reports

### 3.5.4 Trends in undiagnosed HIV infections in MSM

The prevalence of previously undiagnosed HIV infection amongst MSM attending GUM clinics detected through the UAPMP was 5.4% in London and 2.4% elsewhere in England, Wales and Northern Ireland (Figure 3.7)[162]. Since 2000 there has been an increase in previously undiagnosed HIV infection in MSM presenting with an acute STI from 5.8% in 2000 to 6.5% in 2002 in London, and from 1.2% to 3.5% outside London (Figure 3.7).

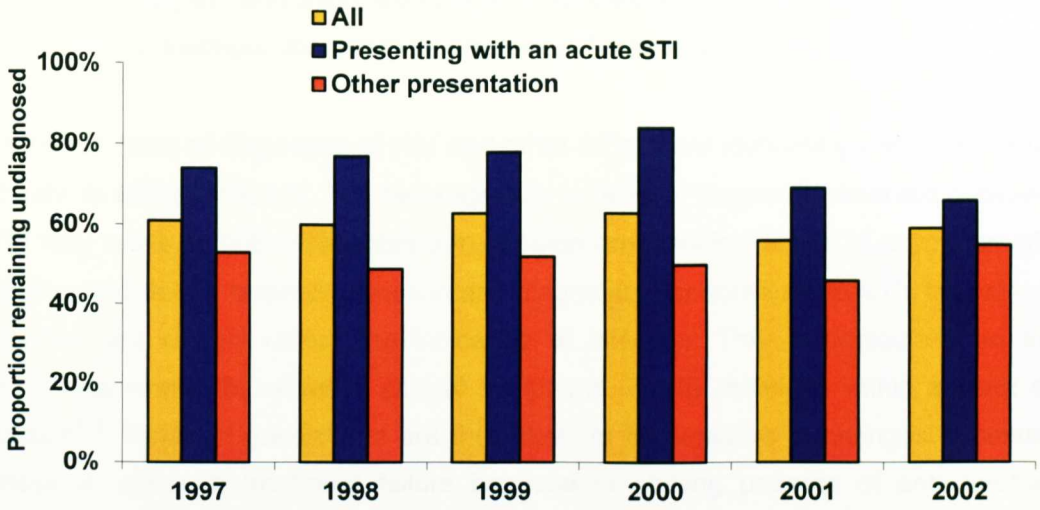
**Figure 3.7 Prevalence of previously undiagnosed HIV infection[a] in MSM by clinical presentation and age group in the United Kingdom, 1993-2002**




Note. a. Excludes HIV-infected attendees who were previously diagnosed. b. Attendees at 15 GUM clinics in England, Wales, Northern Ireland (seven in London, eight elsewhere). c. Acute STI is defined as presenting with one of the following diagnoses: infectious syphilis, gonorrhoea, chancroid/donovanosis/LGV, chlamydia, NSU, trichomoniasis, scabies/pediculosis, HSV &HPV first attack or molluscum contagiosum. Data source: Unlinked Anonymous Prevalence Monitoring Programme.

The proportion of previously undiagnosed HIV infections that are diagnosed at that clinic visit has increased, particularly in those who present with an acute STI (Figure 3.8). It is currently estimated that 62% of MSM attending GUM clinics with undiagnosed HIV infection leave the clinic with their infection undiagnosed (Figure 3.8). This differs by clinical presentation; 66% of previously undiagnosed HIV positive MSM presenting with an acute STI in 2002 still remained undiagnosed after their clinic visit, and 55% of MSM attending without an acute STI remain so. The proportion remaining undiagnosed was higher in London (62%) compared with outside London (45%).

**Figure 3.8 Proportion of HIV infections remaining undiagnosed[a] after clinic[b] visit by clinical presentation[c]: 1997-2002**




Note. a. Excludes HIV-infected attendees who were previously diagnosed; b. Attending 15 GUM clinics in England, Wales & Northern Ireland (7 in London and 8 elsewhere); c. Acute STI is defined as presenting with one of the following diagnoses: infectious syphilis, gonorrhoea, chancroid/donovanosis/LGV, chlamydia, NSU, trichomoniasis, HSV & HPV first attack or molluscum contagiosum. Data source: Unlinked Anonymous Prevalence Monitoring Programme

## 3.6 Evidence of changing sexual behaviour in MSM

Since the late 1990s, increases in STIs and HIV diagnoses in MSM have been reported from countries in Europe, North America and Australia[5,117,163-166]. These increases are generally attributed to changes in the sexual behaviour of MSM, and increases in high-risk sexual behaviour have been reported over this period in many countries that conduct behavioural surveillance[49,115,167]. There have been many explanations suggested to account for these increases in risk taking[113] and in some cases these are controversial. Treatment optimism, defined as a combination of being less worried about HIV because there are better treatments for HIV now and a belief that new drug therapies make people with HIV less infectious, has been offered as an explanation for increased high-risk sexual behaviour[168]. Researchers in London found similar rates of high-risk sexual behaviour reported amongst those optimistic about HIV treatments and those who were not[169], suggesting that treatment optimism alone would not account for the increase in sexual risk taking.

Behavioural surveillance data among MSM in the UK have shown increases in rates of UAI and, specifically, UAI involving HIV discordant or unknown status partners[157]. Data from Natsal 2000[26] have suggested that the prevalence of male homosexual behaviour in the general population has increased, and that some high-risk sexual behaviours

among homosexually active men have also increased[170]. The reasons for this rising risk are unclear. Society's changing attitudes towards homosexuality[171] and treatment optimism[172], coupled with expansions in opportunities and places that facilitate partner acquisition (for example, the internet or saunas)[173] may all be contributing factors.

The rise in rates of diagnoses of HIV and other STIs show increasing levels of sexual ill-health in MSM in the UK. The heterogeneity in rates of diagnosis observed between STIs may relate to both differential transmission probabilities, levels of asymptomatic infection and delays between infection and diagnosis For some acute STIs the rate of diagnosis will closely reflect the incidence of infection. This is particularly so for gonorrhoea where the onset of clinical symptoms usually develops within a week of infection[174]. Rates of gonorrhoea are thus likely to be sensitive to changes in sexual behaviour, although treatment failure because of shifting patterns of antimicrobial resistance may influence trends as well. Sentinel surveillance of antimicrobial resistance is provided by GRASP (Gonococcal Resistance to Antimicrobials Surveillance Programme)[175]. GRASP found that ciprofloxacin resistance (>= 1 mg/l) in isolates from MSM increased from 0.8% in 2000 to 2.2% in 2001 with a further increase to 8.5% in 2002[176]. Clinicians were not notified of this decrease in susceptibility until May 2003 and so improved treatment cannot account for the decrease in rates of diagnosis of gonorrhoea in MSM in London between 2001 and 2002.

A survey that monitored high-risk sexual behaviour in MSM attending commercial venues and GUM clinics in London found that the proportion of men reporting UAI in the past year increased between 1997 and 2001[157]. No further increase was reported for 2002 and the proportion of men reporting UAI with partners of unknown or discordant HIV status decreased slightly from that reported in 2001. The decrease in rates of gonorrhoea observed in London may be explained by this reported behaviour change. This apparent association between trends in high-risk sexual behaviour and gonorrhoea indicates that a diagnosis of gonorrhoea may serve as a proxy marker for high-risk sexual behaviour. This association will be investigated further in Chapters four and five of this thesis to determine if diagnosis with an acute STI can be used as a marker for high-risk sexual behaviour.

# CHAPTER FOUR

## *POPULATION CHARACTERISTICS AND BEHAVIOURS ASSOCIATED WITH HIV TESTING IN A NATIONAL REPRESENTATIVE SURVEY OF SEXUAL ATTITUDES AND LIFESTYLES*

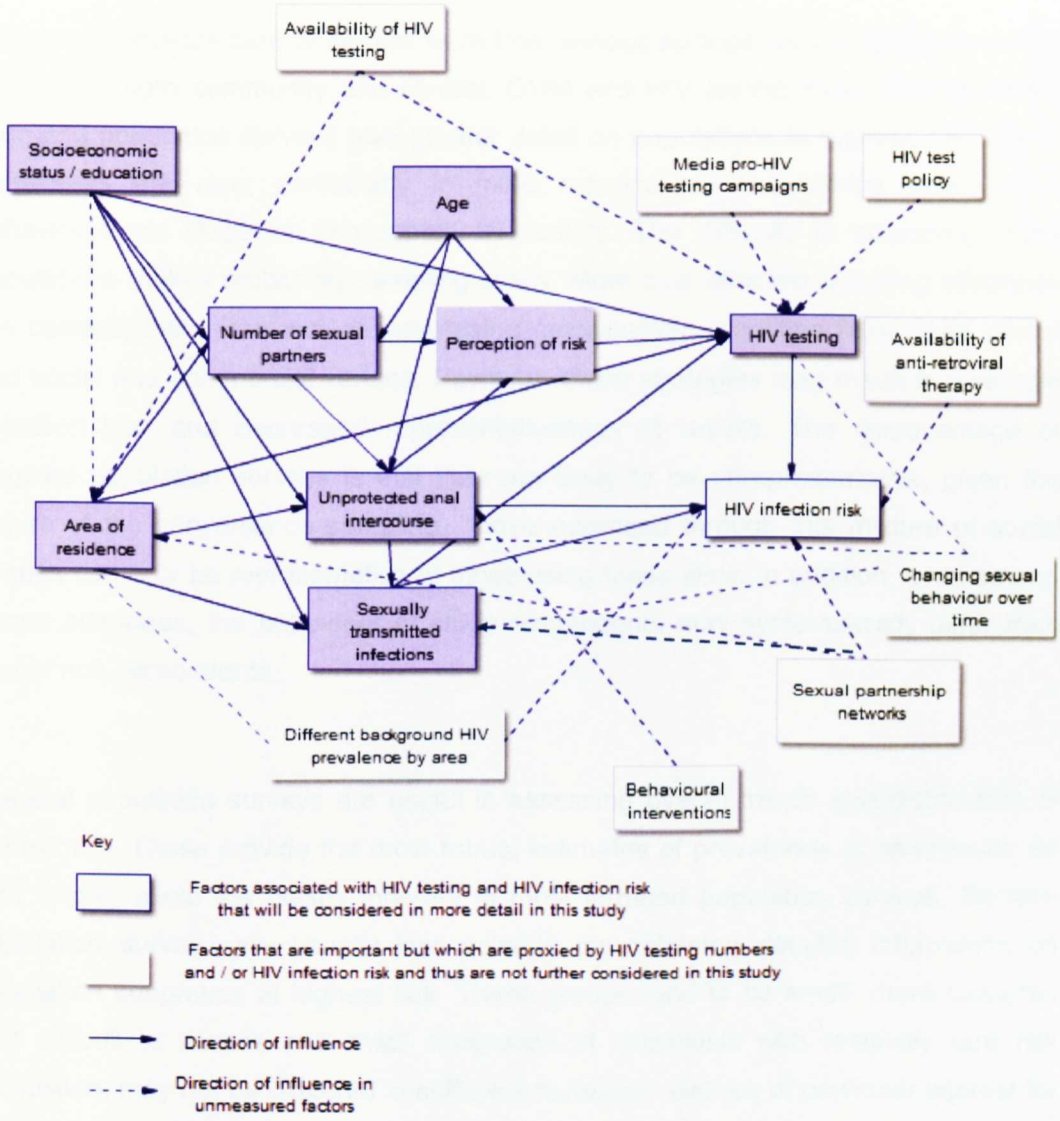



**Summary**

No national population estimates of HIV testing are available for MSM. The Natsal was analysed to estimate prevalence of HIV testing and factors associated with it in MSM. HIV testing was associated with area of residence and increased numbers of sexual partners. Other factors associated with an increased likelihood of HIV testing, were older age, previous STI and cohabitation. HIV testing is associated with high-risk sexual behaviour.

This chapter explores the relationship between factors that are associated with HIV testing in MSM. Below, in Figure 4.1 the factors and their interrelationships which will be explored are highlighted in blue.

**Figure 4.1 Conceptual framework of the relationship between HIV testing and risk of HIV infection mediated through risk behaviour in MSM: investigation of the association of socioeconomic status, area of residence, age, number of sexual partners, unprotected anal intercourse, sexually transmitted infections and perception of risk with HIV testing**



## 4.1 Introduction

In order to diagnose HIV infection, an individual must have a voluntary confidential HIV test. HIV testing is common among homosexual and bisexual men and studies indicate that the proportion of homosexual and bisexual men who have ever had an HIV test ranges from 53-64% in the UK[27,29,48,52] to 83-85%% in Australia[31,54], 63% in Canada[32] and 84% in the US[69,177]. Previous studies in the UK have shown HIV testing to be associated with high-risk sex in both MSM and heterosexuals[27,48,52,178].

These convenience sample studies were from various settings, including recruitment of MSM from both community and clinical, GUM and HIV testing clinic, environments. Targeted population surveys give greater detail on populations at highest risk, where behaviours are rare, particularly in more marginalised populations where such behaviours are illegal or unaccepted by society. The difficulty in accessing these populations makes probability sampling costly. More cost-effective sampling strategies are needed; these can include advertising, snowballing, recruiting from GUM clinics and social and commercial venues. However, these strategies may result in a sample selection bias and decreased representativeness of results. The disadvantage of targeted population surveys is that they are likely to be unrepresentative, given the nature of the convenience sampling. Those accessed through this mixture of social venues can only be representative of those using these sites. In addition, even among venue attendees, the behaviour of study respondents may systematically differ from that of non-respondents.

General population surveys are useful in assessing overall trends and distribution of behaviours. These provide the most robust estimates of prevalence of behaviours, as they largely avoid the biases inherent in most targeted population surveys. General population surveys are usually less suitable for obtaining detailed information on population subgroups at highest risk. These groups tend to be small, more clustered and difficult to access and small subgroups of individuals with relatively rare risk behaviours may not be captured in sufficient numbers. Groups of particular interest for HIV and STI transmission include homosexual and bisexual men, IDUs, commercial sex workers and ethnic minorities, particularly those from or who have contact with countries with a high HIV/STI prevalence. These problems can be overcome through adapting study designs to include oversampling and focussed enumeration[26].

The Natsal was the first ever nationally representative survey of sexual behaviours in

Britain. It was carried out first in 1990 and repeated again in 2000. In 2000, focussed enumeration was carried out to include an increased sample of ethnic minorities; London was oversampled to provide an increased sample of MSM in addition to IDUs and ethnic minorities. The main objectives of Natsal 2000 were to provide a detailed understanding of patterns of sexual behaviour in Britain (including, for example, number of sexual partners, frequency of different sexual practices, and homosexual experience), to provide data for HIV projections in the UK, and to assess whether there had been any changes in behaviour since Natsal I[26]. This analysis was carried out to provide estimates of prevalence of HIV testing in a representative sample of MSM from the general population in Britain, as there are none currently available.

In this chapter, using the Natsal 2000, the following questions were investigated (Objectives 3 and 4, Chapter one section 1.5):

1) What are the population estimates of HIV testing patterns in MSM in Britain?
2) What behaviours and socio-demographics are associated with HIV testing?
3) Have these associations changed between 1990 and 2000?

## 4.2 Methods

### 4.2.1 Participants and survey methodology

The Natsal are stratified probability sample surveys of the general population; of 12,110 in 2000 and 13,765 in 1990 men and women aged 16 to 44 years resident in Britain. The response rates were 65.4% and 66.8%, respectively. Participants were interviewed using a combination of face-to-face interview and computer-assisted interview. A similar methodology was used in both surveys although the method of collection for the most sensitive behaviours changed from pen and paper self-completion (PAPI) in 1990 to computer assisted self-interview (CASI) in 2000. The details of these studies have been reported elsewhere[26,179-181]. Similar questions were asked in both the 2000 and the 1990 survey, although additional questions on various topics were included in 2000. Questions on HIV testing history were asked (if ever had a blood test that involved testing for HIV and when the last test was), reasons for HIV testing as well as perception of personal risk of being infected with HIV. These were among a range of questions on sexual practices, behaviours and attitudes. Factors associated with HIV testing in 2000 were compared with those in Natsal 1990. The sample was broadly representative of the age, marital status, and ethnic structure of the population in the country. The weighted population and the general population comparison are shown in Appendix C Table C.1.

### 4.2.2 Natsal sampling strategy

Natsal was a multi-stage stratified population-representative survey. Postcode sectors were selected as the primary sampling units (PSUs), addresses within them were selected at the second stage and, finally, one eligible adult was randomly selected at the final stage. Natsal 1990 showed that the prevalence of many HIV risk behaviours (such as homosexual contact and injecting drug use) was higher in London than elsewhere in Britain, yet still reasonably rare. Thus addresses in the greater London area were oversampled in order to increase numbers within those groups most at risk of HIV. This would enable analysis to provide more precise estimates of the prevalence of risky sexual behaviours. Natsal 2000 included a boost sample of black and Asian adults. This was to enable analyses to provide some understanding on sexual health inequalities that would otherwise not be possible due to the relatively small proportion of ethnic minority respondents included in national general population surveys. The core and boost samples were independently designed. The second sample, for the ethnic minority boost, was multi-stage and used a combination of full screening and focussed enumeration to determine whether addresses contained residents from the target ethnic groups.

### 4.2.3 Weighting the general population sample

#### 4.2.3.1 Selection probability weighting

Because of the unequal probabilities of selection, the Natsal sample would over-represent residents living in London, in single dwelling addresses, and those living alone. Three sets of weights were applied to correct for these unequal probabilities and to make it a representative sample of the general population in Britain. The detailed methodology is described in the technical report[180].

#### 4.2.3.2 Non-response weighting

Following weighting for selection probability weights, the distribution of the Natsal 2000 sample was compared with mid-1999 population estimates on three demographic variables (age, sex and government office region). Women were still found to be over-represented in the Natsal 2000 sample while men aged 25 to 29 and respondents in London were found to be under-represented. The Natsal team concluded that these differences could be due to differential non-response as well as random sampling variation. To correct for these differences in age, sex and region, a non-response weight was applied[180]. Following this additional weighting, the distributions of age, sex and region for the Natsal 2000 sample were then found to be similar to those of the

general population[180]. The weighted population and the general population comparison are shown in Appendix C Table C.1.

#### 4.2.3.3 Weighting the ethnic minority boost sample

The ethnic minority boost sample did not have equal chances of selection for similar reasons to the general population sample. In order to obtain representative estimates of the four ethnic minority groups, the data were weighted to adjust for the varying probabilities of selection. Unlike for the general population sample, there was no additional non-response weighting for the ethnic minority sample, because the research team stated that no reliable data to estimate differential non-response by age and sex within ethnic minority groups were currently available at the time of the survey[180].

#### 4.2.3.4 Weighting Natsal 1990

The Natsal 1990 dataset (for those aged 16 to 44) was post-stratified to 1991 Census estimates using similar non-response weighting as in Natsal 2000 to allow comparison between Natsal 1990 and Natsal 2000. This corrected for any differences (due to differential non-response and/or random sampling variation) in the age, sex and regional distributions of Natsal 1990 respondents compared with the 1991 Census.

### 4.2.4 Participation biases in Natsal

The response rate was 65.4% in Natsal 2000. The Natsal research team investigated the non-response, particularly associated with refusing the booklet (the detailed sexual behaviour questions). They found that, among participants, after controlling for other variables, booklet refusal was higher amongst ethnic minorities, the lower occupational classes, people with problems of understanding, older people and those married or single. Those who take part in the survey could be different from those who don't and additionally those who do not answer the specific question of interest could differ in sexual behaviour to those who do (item-response bias)[182]. If it is assumed that those who take part do not differ from those who do not, then weighting results in unbiased estimates of population parameters. This is unlikely to be the case for sexual behaviour and differences in behaviour within participants and non-participants has been detected in previous research[183].

As the analyses in this thesis focus on MSM, only the participation bias within this group is relevant. The investigators found that refusal to complete the booklet was lowest in those who reported homosexual experience (both men and women) at 1.8%

compared with 3.3% of those who had no homosexual experience. In Natsal 2000 the non-response on the CASI was 1% from both men and women. While the data were weighted for non-response, this assumes that those who did not respond are similar in sexual behaviour to those who did. The main reason for non-inclusion within the survey was refusal or proxy refusal (27.7%). Other reasons included non-contactable after multiple visits, no information about the address, or other reasons including not speaking English.

Individuals with more chaotic lifestyles possibly with more marginalised behaviours such as injecting drug use or sex workers may be more difficult to contact while having higher HIV risk behaviours. It was noted that lower numbers of sexual partners was associated with non-response to the booklet, and no homosexual experience. How would it affect the conceptual framework of the relationship between HIV testing and risk of HIV infection in this thesis? MSM were less affected by item non-response and so, while the proportion of men estimated to be MSM may be overestimated, the associations between sexual behaviours and HIV testing would be likely to be unchanged. If non-responders had different sexual behaviour and HIV testing patterns for instance, more risky behaviour but less HIV testing, or had less risky sexual behaviour but HIV tested more, then the association between testing and behaviour would be overestimated. Alternatively, if non-responders had more risky behaviour and HIV tested more, then the association between behaviour and HIV testing would be underestimated in our analysis. There is currently no way to determine how the results may be biased. Given the strength and size of the association between sexual behaviour and HIV testing, a reduction in the association in the MSM who were non-responders is unlikely to diminish the association between sexual behaviour and HIV testing to zero, and if anything may increase the association. This thesis will not use data on sexual behaviour to infer HIV infections; instead it will use HIV testing as a proxy variable. Thus, even if there is some bias in the reported data on the association between sexual behaviour and HIV testing due to questionnaire non-response, these data would still be informative.

### 4.2.5 Definitions

HIV testing was defined as voluntary confidential HIV testing and so blood donation was excluded, as this constituted a screening programme rather than individuals choosing to be tested for HIV. HIV testing was defined as an individual who had one or more HIV test in the past 5 years. While the question asked in the 1990 survey was '*Have you ever had a blood test that involved testing for HIV*', no information on when

the test took place was collected. The period for which any HIV testing was available was assumed to be 5 years in the 1990 survey for the comparison because the HIV antibody test only became widely available in October 1984. Men were defined as MSM if they had a homosexual partner in the past 5 years. A homosexual partner was defined as genital contact with another man.

Marital status was collected as a variable in the study. This included the following groupings: single, married, cohabiting and separated/divorced/widowed. Cohabiting was defined as living with another person as a couple, included both same sex and opposite sex cohabitation. In this sample, 90% (95% CI 77.5 – 95.8) of the men who were defined as cohabiting were living with another man, while the other 10% were cohabiting with a woman. This proportion was 96.6% (95% CI 86.2 – 99.2) cohabiting with another man for MSM who had an HIV test.

### 4.2.6 Statistical analysis

Data from targeted oversampling of ethnic minorities (the Natsal ethnic minority boost) were combined with the main survey data to increase the numbers of respondents included in this analysis to provide more robust estimates of HIV testing and sexual behaviours. The full analysis of the general population, including MSM, was published and is presented in Published Papers. An analysis strategy was determined a priori based on the conceptual framework in Chapter two of the relationship between HIV testing and risk of HIV infection in MSM, to investigate the socio-demographic and behavioural variables associated with HIV testing as highlighted in Figure 4.1. Due to the small sample size, further stratification of the variables, place where last HIV test was carried out and perception of self-risk of HIV infection by behavioural variables was not possible. Prevalence (with 95% CI) of HIV testing by both demographic and behavioural characteristics was calculated. To determine what socio-demographic characteristics and sexual behaviours are associated with HIV testing, OR were used to compare the prevalence of behaviours and demographics associated with reporting having had a HIV test as determined through the conceptual framework in Chapter two (Figure 4.1). This analysis focussed on both behaviours and HIV testing in the past 5 years. Logistic regression analyses were used to calculate adjusted OR, controlling for the other socio-demographic and behavioural variables in the model, to determine variables independently associated with HIV testing to establish whether HIV testing was associated with sexual behaviour, when controlling for other socio-demographic variables. Interaction terms between social-demographic and behavioural variables

were explored to investigate if the association of these variables with HIV testing (OR) varied when stratified by other variables or whether risk behaviour associations remain across all socio-demographic groups. To determine whether HIV testing patterns and factors associated with testing have changed between 1990 and 2000, OR were used to compare estimates of HIV testing and the behaviours and demographics associated with it between the 2000 and 1990 surveys. Interaction terms were generated to test whether the magnitude of change in HIV testing and associated behaviours between the two surveys differed by each categorical variable after adjustment for region of residence and age.

All analyses were carried out using the STATA survey analysis software (version 7.0), accounting for stratification, clustering and weighting of the sample.

### 4.2.7 Ethical Approval

The study was approved by the University College Hospital and North Thames Multi-Centre Research Ethics Committee and all the Local Ethics Committees in Britain.

## 4.3 Results

### 4.3.1 Demographic characteristics of the population sample of MSM

Natsal 2000 sampled 183 men fulfilling the criteria of MSM for this study. The weighted sample size was 155. These men represented 2.5% of the total population of men aged 16 to 44. History of a HIV test in the past 5 years was not answered or answered maybe/not sure for 7.1% of the sample, and these were excluded from the sample giving a sample of 155, with a weighted sample of 144. The demographic characteristics of this sample are presented in Table 4.1. The demographics and behavioural characteristics of those who did not answer were not different from those individuals who did.

**Table 4.1 The distribution of demographic and behavioural characteristics, percentages with their 95% confidence intervals, for men who had a homosexual partner in past 5 years by HIV test history[a], Natsal 2000 (column percentages are shown)**

| | Natsal 2000 % (95% Confidence Interval) | | BASE 2000 (UW, WT) |
|---|---|---|---|
| | HIV test in past 5 years | No HIV test in past 5 years | 155, 144 |
| **DEMOGRAPHICS** | | | |
| *Age* | | | |
| 16-24 | 12.1 (4.9 – 26.7) | 25.0 (15.7 – 37.2) | 27, 30 |
| 25-34 | 59.2 (44.0 – 72.8) | 42.2 (32.8 – 53.4) | 71, 69 |
| 35-44 | 28.7 (17.4 – 43.4) | 32.8 (24.1 – 41.8) | 57, 46 |
| *Region* | | | |
| Rest of Britain | 75.9 (63.5 – 85.0) | 65.4 (53.9– 75.3) | 77, 99 |
| Greater London | 24.1 (15.0 – 36.5) | 34.6 (24.7 – 46.1) | 78, 45 |
| *Marital Status* | | | |
| Single | 46.4 (31.5 – 62.0) | 63.3 (52.0 – 72.4) | 100, 81 |
| Married | 0 | 9.5 (4.4 – 19.4) | 7, 9 |
| Cohabiting | 49.3 (33.9 – 64.8) | 24.1 (15.6 – 64.8) | 42, 50 |
| Sep. / widowed / Divorced | 4.3 (1.1 – 15.7) | 3.1 (1.2 – 7.8) | 6, 4 |
| *Social Class[b]* | | | |
| I & II | 60.3 (43.9 – 74.6) | 59.4 (48.2 – 69.7) | 87, 81 |
| III | 30.6 (17.9 – 47.1) | 26.1 (18.1 – 35.9) | 44, 37 |
| IV & V | 9.2 (3.1 – 24.4) | 14.5 (7.9 – 25.2) | 15, 15 |
| *Ethnicity* | | | |
| White | 96.8 (92.3 – 98.7) | 95.8 (89.9 – 98.3) | 143, 139 |
| Other | 3.2 (1.3 – 7.7) | 4.1 (1.6 – 10.1) | 12, 5 |
| **BEHAVIOURS** | | | |
| *Partners in past 5 years* | | | |
| <10 | 53.6 (38.4 – 68.1) | 76.2 (65.9 – 84.1) | 110, 102 |
| 10+ | 46.44 (31.9 – 6136) | 23.8 (15.9 – 34.1) | 56, 42 |
| *Injected drugs in past 5 years* | | | |
| No | 99.7 (97.6 – 99.9) | 97.3 (90.5 – 99.3) | 151, 143 |
| Yes | 0.3 (0.01 – 2.4) | 2.7 (0.7 – 9.5) | 4, 2 |
| *Paid for sex in past 5 years* | | | |
| No | 92.1 (79.8 – 97.2) | 91.4 (84.0 – 95.5) | 135, 131 |
| Yes | 7.9 (2.8 – 20.2) | 8.6 (4.4 – 16.0) | 19, 12 |
| *Reported STI In past 5 years* | | | |
| No | 83.9 (71.4 – 91.6) | 92.0 (83.7 – 96.2) | 128, 126 |
| Yes | 16.0 (8.4 – 28.6) | 8.0 (3.8 – 16.3) | 24, 16 |
| *New sex partners from abroad in past 5 years* | | | |
| No | 53.5 (38.6 – 67.9) | 55.6 (43.0 – 67.5) | 74, 79 |
| Yes | 46.4 (32.1 – 61.4) | 44.4 (32.5 – 57.0) | 79, 63 |

Note. a. Excludes those who did not answer or answered maybe / not sure whether they had a HIV test in the past 5 years; b. Social class categories I and II: professional, managerial and technical, III; skilled non-manual and manual, IV and V semi-skilled manual and unskilled manual; WT = weighted and UW = unweighted bases.

### 4.3.2 Prevalence of having an HIV test in a population sample of MSM

Over a third (36.6%) of men who had a homosexual partner in the last 5 years (MSM) had a HIV test in the past 5 years (Table 4.2). The highest prevalence of HIV testing was in the 25-34 year age group while only a quarter of MSM aged less than 25 reported a HIV test in the last 5 years. HIV testing was more common outside London than in London. Those who reported more than ten partners had the highest prevalence of testing, as did those MSM who reported an STI in the past 5 years and 'marital status' as cohabitating or separated or divorced.

### 4.3.3 Factors associated with HIV testing

HIV testing in the past 5 years was positively associated in univariable analyses with marital status not being single, lower social class and increased numbers of sexual partners. Other variables that showed an increased probability of testing were increasing age, being resident outside London, injecting drug use and reporting an STI in the past 5 years (Table 4.2).

MSM who reported having more than ten male sexual partners in the past 5 years were over three times more likely to have had an HIV test compared with MSM with fewer than ten sexual partners after adjustment for all other demographic and behaviour variables. Cohabitation was associated with having a HIV test (OR 2.88, 95% CI 1.10 – 7.52), as was being resident outside London in the rest of Britain. Other variables which, based on the point estimate appeared associated with having had a HIV test, although not statistically significant, were; increasing age (25-44 AOR 2.58 (95% CI 0.59 – 11.48), 35-44 AOR 1.40 (95% CI 0.32 – 6.17), non-white ethnicity (AOR 4.48, 95% CI 0.66 – 30.29) and injecting drugs in the past 5 years (AOR 5.70, 95% CI 0.31 – 104.56).

### 4.3.4 Changes in prevalence of HIV testing and factors associated with HIV testing in the past decade

There was no evidence that the prevalence of HIV testing had increased between 1990 and 2000 in MSM, age and region adjusted OR 1.01 (95% CI 0.51 – 1.98) (Table 4.2). While the study did not have much power to detect differences, the percentages were similar in both surveys. The prevalence of HIV testing in MSM who reported ten or more sexual partners appeared lower in 2000 (58.0% compared with 66.9%) although there was limited power to detect a difference (age and region adjusted OR 0.48, (95%

CI 0.15 – 1.52). It appeared that the prevalence of HIV testing increased in men reporting fewer than ten homosexual partners in the past 5 years in 2000, compared with 1990, from 19.3% to 28.9% and there was limited power to exclude sampling variation as an explanation of these results (age and region adjusted OR 1.49 (95% CI 0.65 – 3.40) (Table 4.2).

**Table 4.2a The percentage, crude and adjusted odds ratio (95% confidence intervals) for reported HIV testing within the past 5 years for men who had a homosexual partner in past 5 years, a comparison of associations between Natsal 2000 and Natsal 1990 is given**

| | Natsal 2000 % (95% CI) | OR (95% CI) | Adjusted[c] OR (95% CI) | Natsal 1990 % (95% CI) | Natsal 2000 compared with Natsal 1990 Adjusted[de] OR (95% CI) | Respondents BASE 2000 (UW, WT) |
|---|---|---|---|---|---|---|
| All respondents[b] | 36.6 (28.3 – 5.7) | - | - | 33.0 (22.7 – 45.2) | 1.01 (0.51 – 1.98) | 155, 144 |
| **DEMOGRAPHICS** | | | | | | |
| *Age* | | P=0.17 | P=0.34 | | P=0.74 | |
| 16-24 | 22.2 (8.8 – 45.7) | 1.0 | 1.0 | 21.5 (10.3 – 39.5) | 0.89 (0.21 – 3.84) | 27, 30 |
| 25-34 | 46.2 (33.1 – 59.8) | 3.00 (0.89 – 10.0) | 2.58 (0.59 – 11.48) | 38.3 (21.9 – 57.9) | 1.27 (0.50 – 3.20) | 71, 69 |
| 35-44 | 34.3 (21.4 – 50.1) | 1.83 (0.52 – 6.46) | 1.40 (0.32 – 6.17) | 39.7 (19.7 – 63.9) | 0.83 (0.28 – 2.46) | 57, 46 |
| *Region* | | *P=0.15* | *P=0.06* | | *P=0.83* | |
| Rest of Britain | 41.2 (29.8 – 53.6) | 1.0 | 1.0 | 36.5 (22.7 – 52.9) | 1.12 (0.48 – 2.60) | 77, 99 |
| Greater London | 29.3 (20.0 – 40.7) | 0.59 (0.29 – 1.21) | 0.33 (0.10 – 1.03) | 28.2 (15.0 – 46.7) | 0.90 (0.32 – 2.55) | 78, 45 |
| *Marital Status* | | P=0.0.06 | P=0.08 | | P=0.84 | |
| Single | 30.2 (20.7 – 41.8) | 1.0 | 1.0 | 33.1 (20.4 – 48.7) | 0.64 (0.26 – 1.56) | 100, 81 |
| Married | 0 | - | - | - | - | 7, 9 |
| Cohabiting | 54.2 (37.3 – 70.1) | 2.72 (1.15 – 6.41) | 2.88 (1.10 – 7.52) | 50.0 (28.5 – 71.5) | 1.23 (0.37 – 4.07) | 42, 50 |
| Sep./widowed/Divorced | 56.0 (16.4 – 89.2) | 2.94 (0.42-20.46) | 4.68 (0.24-128.53) | - | - | 6, 4 |
| *Social Class*[f] | | P=0.007 | P=0.51 | | P=0.33 | |
| I & II | 38.5 (28.4 – 1.8) | 1.0 | 1.0 | 34.6 (20.0 – 52.7) | 1.13 (0.47 – 2.76) | 87, 81 |
| III | 41.2 (25.2– 59.4) | 1.07 (0.44 – 2.62) | 1.90 (0.64 – 5.64) | 30.1 (15.5 – 50.2) | 1.81 (0.52 – 6.29) | 44, 37 |
| IV & V | 32.8 (11.6 – 64.3) | 0.75 (0.18 – 3.03) | 1.29 (0.24 – 6.83) | 46.4 (20.5 – 74.4) | 0.37 (0.04 – 3.26) | 15, 15 |
| *Ethnicity* | | P=0.75 | P=0.12 | | P=0.71 | |
| White | 37.6 (28.8 – 47.3) | 1.0 | 1.0 | 32.2 (21.8 – 44.7) | 1.05 (0.53 – 2.10) | 143, 139 |
| Other | 32.7 (11.9 – 63.7) | 0.81 (0.21 – 3.10) | 4.48 (0.66 - 30.29) | 40.3 (9.2 – 81.7) | 0.92 (0.10 – 8.19) | 12, 5 |

Note. a. Excludes men who did not have a homosexual partner in past 5 years; b. Excludes those who did not answer or answered maybe / not sure whether they had a HIV test in the past 5 years; c. Adjusted for all demographic and behavioural variables in the table via logistic regression modelling; d. adjusted for region and age, e. OR relative to 1990, Interaction terms were generated to test whether the magnitude of change in HIV testing and associated behaviours between the two surveys differed by each categorical variable after adjustment for region of residence and age. A significant interaction between year of survey and each categorical variable is denoted by $p<0.05$; f. Social class categories I and II: professional, managerial and technical, III; skilled non-manual and manual, IV and V semi-skilled manual and unskilled manual; WT = weighted and UW = unweighted bases.

**Table 4.2b The percentage, crude and adjusted odds ratio (95% confidence intervals) for reported HIV testing within the past 5 years for men who had a homosexual partner in past 5 years. A comparison of associations between Natsal 2000 and Natsal 1990 is given**

| | Natsal 2000 % (95% CI) | OR (95% CI) | Adjusted[c] OR (95% CI) | Natsal 1990 % (95% CI) | Natsal 2000 compared with Natsal 1990 Adjusted[de] OR (95% CI) | Respondents BASE 2000 (UW, WT) |
|---|---|---|---|---|---|---|
| All respondents[b] | 36.6 (28.3 – 45.7) | - | - | 33.0 (22.7 – 45.2) | 1.01 (0.51 – 1.98) | 155, 144 |
| **BEHAVIOURS** | | | | | | |
| *Partners in past 5 years* | | P=0.0.004 | P=0.03 | | P=0.12 | |
| <10 | 28.9 (19.5 – 40.5) | 1.0 | 1.0 | 19.3 (11.6 – 30.5) | 1.49 (0.65 – 3.40) | 110, 102 |
| 10+ | 58.0 (42.2 – 72.3) | 3.40 (1.50 – 7.70) | 3.26 (1.09 – 19.78) | 66.9 (44.0 – 83.8) | 0.48 (0.15 – 1.52) | 56, 42 |
| *Injected drugs in past 5 years* | | P=0.09 | P=0.24 | | P=0.07 | |
| No | 36.9 (28.3 – 46.3) | 1.0 | 1.0 | 33.9 (23.1 – 46.8) | 0.91 (0.45 – 1.84) | 151, 143 |
| Yes | 82.3 (30.1 – 98.0) | 7.96 (0.72 – 87.97) | 5.70 (0.31 – 104.56) | 23.4 (4.4 – 45.2) | 26.82 (0.48 – 1491.1) | 4, 2 |
| *Paid for sex in past 5 years* | | P=0.84 | P=0.53 | | P=0.51 | |
| No | 37.9 (28.9 – 47.9) | 1.0 | 1.0 | 34.9 (24.3 – 47.3) | 0.96 (0.48 – 1.91) | 135, 131 |
| Yes | 34.9 (13.3 – 65.0) | 0.87 (0.23 – 3.25) | 1.48 (0.43 –5.09) | 17.2 (3.1 – 57.4) | 3.66 (0.43 – 31.04) | 19, 12 |
| *Reported STI In past 5 years* | | P=0.18 | P=0.41 | | | |
| No | 35.0 (25.9 – 45.3) | 1.0 | 1.0 | Not asked in | | 128, 126 |
| Yes | 53.2 (29.5 – 75.6) | 2.11 (0.71 – 6.27) | 1.73 (0.47 – 6.35) | 1990 | | 24, 16 |
| *New sex partners from abroad in past 5 years* | | P=0.73 | P=0.73 | | | |
| No | 36.4 (24.9 – 49.8) | 1.0 | 1.0 | Not asked in | | 74, 79 |
| Yes | 39.6 (27.5 – 53.1) | 1.14 (0.53 – 2.47) | 0.84 (0.32 – 2.26) | 1990 | | 79, 63 |

Note. a. Excludes men who did not have a homosexual partner in past 5 years; b. Excludes those who did not answer or answered maybe / not sure whether they had a HIV test in the past 5 years; c. Adjusted for all demographic and behavioural variables in the table via logistic regression modelling; d. adjusted for region and age, e. OR relative to 1990, Interaction terms were generated to test whether the magnitude of change in HIV testing and associated behaviours between the two surveys differed by each categorical variable after adjustment for region of residence and age. A significant interaction between year of survey and each categorical variable is denoted by $p<0.05$; f. Social class categories I and II: professional, managerial and technical, III; skilled non-manual and manual, IV and V semi-skilled manual and unskilled manual; WT = weighted and UW = unweighted bases.

### 4.3.5 Time since last HIV test and perception of risk

Most individuals who had a HIV test did not perceive themselves to be at risk of HIV infection, 87.6% of MSM stated they were 'not very much at risk' or 'not at risk at all of HIV infection'. (Table 4.3) The perception of risk was similar for MSM who had not tested compared with those who reported a HIV test in the past 5 years. MSM who had not tested perceived that they were 'greatly at risk', 3.0% (95% CI 1.0 – 8.3), compared with 0.6% (95% CI 0.01 – 4.2) who had a HIV test in the past 5 years.

Most respondents who reported having a HIV test in the past 5 years had it within the past 2 years (Table 4.3). Just over 76% of MSM, who had a HIV test in the last 5 years, had their last HIV test in the last 2 years, of whom 37% were tested in the last year (Table 4.3).

**Table 4.3 HIV testing among MSM[a] in Britain, the distribution of perception of self-risk of HIV infection and time since last HIV test, percentages with their 95% confidence intervals, among MSM who have had a HIV test, Natsal 2000**

| **HIV test in the past 5 years[b]**<br>Base, unweighted, weighted | ***Yes***<br>*59, 54*<br>*% (95% CI)* | ***No***<br>*96, 90*<br>*% (95% CI)* |
|---|---|---|
| ***Perception of risk of HIV infection to self[c]*** | | |
| Greatly at risk | 0.6 (0.01 – 4.2) | 3.0 (1.0 – 8.3) |
| Quite a lot at risk | 11.1 (5.0 – 23.1) | 13.1 (7.0 – 23.3) |
| Not very much at risk | 50.2 (35.3 – 65.1) | 53.0 (41.3 – 64.4) |
| Not at risk at all | 37.4 (23.4 – 53.8) | 30.8 (20.9 – 42.9) |
| Don't know | 0.6 (0.01 – 4.5) | 0 |
| ***Time since last HIV test*** | | |
| In the last year | 36.2 (23.5 – 51.1) | |
| Between 1 and 2 years ago | 29.4 (16.7 – 46.3) | |
| Between 2 and 5 years ago | 34.4 (21.5 – 50.3) | |

Note. a. Includes men who had 1+ male sexual partner in the past 5 years; b. A test for HIV excluding blood donation; c. all percentages are column-weighted bases; CI, confidence intervals

### 4.3.6 Reason for and place of last HIV test

Most MSM had their last HIV test due to concern, or for a general health check (68.1%, 95% CI 51.3 – 81.2). The majority of MSM (54.2%) had their HIV test at a GUM clinic, while 16.6% reported their last HIV test was at a GP. Place of HIV test varied by age group 66% of MSM aged less than 25 years tested at a GUM clinic compared with 44% of 25-34 year olds and 65% of 35-44 year olds. The proportion of MSM that tested at GPs also varied by age; 34% of MSM aged less than 35 reported their last HIV test to be at a GP compared with 20% of 25-34 year olds and 6% of 35-44 years olds. In contrast, 11% and 16% of 25-34 and 35-44 year olds, respectively, tested at private clinics, compared with no recorded tests in MSM aged less than 25 years. None of these differences were statistically significant.

**Table 4.4 Distribution of place where last HIV test was carried out, percentages and their 95% confidence intervals, by region of residence, Natsal 2000**

| **Percentage had a HIV test in the last 5 years**[a] | London<br>% (95% CI) | Rest of Britain<br>% (95% CI) | Base 2000<br>UW, WT |
|---|---|---|---|
| **Place of HIV test**[b] | | | |
| GP surgery | 13.1 (5.7 – 27.3) | 20.8 (9.0 – 42.1) | 13, 13 |
| National Health Service /Venereal Disease /Sexually Transmitted Disease clinic | 55.0 (40.4 – 68.8) | 52.6 (35.2 – 69.6) | 48, 38 |
| NHS family planning clinic | 1.2 (0.2 – 8.9) | 0 | 1, 0.3 |
| Private clinic or doctor | 13.0 (4.9 – 30.2) | 9.6 (2.8 – 27.8) | 8, 8 |
| Somewhere else | 17.7 (8.8 – 32.3) | 16.9 (6.7 – 36.6) | 12, 12 |

Note. a. A test for HIV excluding blood donation; b. All percentages are column-weighted bases; UW unweighted, WT weighted; CI, confidence intervals.

## 4.4 Discussion

This national, probability sample study provides prevalence of HIV testing in the population and has found that a HIV test in the past 5 years was associated with high-risk behaviours in MSM. Some demographic characteristics were associated with an increased probability of reporting a previous HIV test, including age, region of residence, ethnicity, marital status and social class. There was no evidence of an increase in the prevalence of HIV testing between the two national surveys in 1990 and 2000. Factors associated with HIV testing have remained the same over the decade.

There may be limitations to this survey; both HIV testing and sexual behaviours are self-reported. This may lead to bias due to people's reluctance to disclose sensitive behaviours. The cognitive interviews carried out to validate the methodology concluded that people were happy to self-complete this sensitive behaviour question, and because the individual's HIV status was not requested, it was not thought to be too intrusive[180]. Additionally, the response rate of 65.4% may mean that the individuals who did respond may be different behaviourally from those who did not; the implication of possible participation bias is discussed in section 4.2.4. Improved collection methodology in 2000 to CASI may have led to an increased likelihood of reporting sensitive behaviours, including HIV testing compared with the pen and paper method used in the 1990 survey, thus making comparisons between the surveys invalid. Although comparisons of age-related cohorts between the 1990 and 2000 surveys indicated that this had not led to too much over-reporting[171]. Because HIV status was not collected, reported perception of risk could be confounded by an individual's knowledge of their status. This appears to be more important in MSM; those who reported a HIV test did not perceive themselves to be at risk of HIV infection, while a similar analysis of heterosexuals in Natsal 2000 found that in both men and women the prevalence of HIV testing was greater in those who perceived themselves to be at a greater risk compared with those who perceived they were 'not at risk at all'[8]. This could be due to a number of factors: firstly, that they knew that they were HIV positive already and so were no longer at risk; secondly, that because they had recently had an HIV test, they knew that they were negative; or, thirdly, it could be that although they had HIV tested due to risk behaviour, post-hoc rationalisation following a negative HIV test result had thus led them to believe that they were never at risk of HIV infection.

A further limitation of this study is the small sample size of MSM. By its nature, a representative sample of the population will always produce a small sample size for those behaviours that are less common, or relatively rare. Most of the behaviours and populations of interest for HIV tend to be in more marginalised, more difficult to reach

populations. Traditionally, convenience samples have been used to reach these populations, although they have many limitations, most importantly in determining how representative they are. To overcome this, the Natsal 2000 survey oversampled both MSM and people of ethnic minorities through focussed enumeration and oversampling in London (in particular for MSM). Population weights were then generated by the data survey team at the National Centre for Social Research, based on the sampling probability and the standard census population. This allowed the population to be weighted back to the representative size, but gave a larger sample size for more detailed analyses. However, even using the boosted population sample in these analyses the sample size was small, which meant that there was limited power to detect associations. It limited further analyses of the association of perception of self-risk of HIV infection and place of last HIV test in MSM who had HIV tested. It is a measure of the strength of the association of HIV testing with behaviour variables that even with limited number of observations, a number of associations were detected.

Other convenience samples of MSM in the UK have found higher rates of HIV testing, ranging between 53-64% ever tested[29,155] and 32% in the last year[155]. Of the MSM in this study who reported that they had a HIV test in the past 5 years, a similar proportion had one in the last year (36%). The population of MSM recruited through Natsal is a representative sample of MSM, thus including both MSM at higher and lower behavioural risk. Convenience sample surveys may be sampling men with higher-risk behaviours. A comparison of the characteristics of MSM recruited through Natsal and a convenience sample of MSM recruited through gay venues found that the community survey MSM reported higher levels of risk behaviour and more STIs[184]. The proportion of MSM in Natsal that had attended a GUM clinic in the past 5 years and had a HIV test was similar at 73.8% (95% CI 56.9 – 85.7) in 2000 and 75.8% (95% CI 51.9 – 90.1) in 1990. Similar geographical differences in prevalence of HIV testing have been reported in Canada[32] and Australia[54]. These have been reported to be associated with the differential availability of testing and service provision, and community attachment amongst MSM. Unlike these international comparisons, within this survey the differences in testing were higher rates in the less urban areas, and lower rates in the capital, London. Conversely both Jin[54] and Myers[32] found higher rates of HIV testing in the urban centres rather than rural. This opposing result, while unexpected, is found in some other surveillance sources within the UK. Examining HIV tests carried out in MSM attending GUM clinics in England, Wales and Northern Ireland, as part of a UA survey, found that overall, 60% of attendees in 2002 had a voluntary confidential HIV test at that visit, 55% in London and 65% outside London[162].

UAI was found to be associated with HIV testing and those who were at highest risk were more likely to have tested in a number of surveys[31,54,155]. In this analysis numbers of sexual partners was associated with HIV testing; this was an association found in some other studies[31,54,60,69]. The development of an individual potential risk index by Sigmum and Magnus, based on the basic reproductive ratio of infection[185], found that while the minimum number of partners needed for HIV transmission was lower than for chlamydia as HIV is infectious for longer, the minimum intercourse frequency for transmission is higher. While there is a correlation between number of sexual partners and acquiring HIV infection, there is an even greater correlation between number of sexual partners and transmitting HIV infection. The risk of acquiring HIV is more dependent on sexual networks, and a sexual partner from the 'core-group' or higher-risk activity group[186]. Studies of clusters of gonorrhoea have found it to be strongly linked to sexual networks and core-group mixing[187-189].

Previous studies have shown that numbers of sexual partners is associated with UAI[61,63,71,73,74] and in some cases directly correlated with number of unprotected sexual partners[73]. Thus numbers of sexual partners acts as a good proxy marker for unprotected partners.

HIV testing was associated with higher-risk behaviours and numbers of sexual partners was a strong predictor of HIV testing. This indicates that HIV testing is part of a reasoned decision-making process both on the part of the individual and their health service providers. The association with cohabitation for MSM indicates that HIV testing may be used as a method of determining a sexual partnership strategy[190]. The relationship between HIV testing and 'negotiated safety' is a more complex relationship to understand. The term was coined by Crawford et al[190] in 2001, and dealt with the context of risk taking within a stable relationship. Unprotected sex within a relationship in which both partners are monogamous (or at least have protected sex outside the relationship) is argued to be lower-risk behaviour, rather than the high-risk assigned to it in behavioural surveillance. Behavioural surveillance surveys have since then collected information on the status of partners with which the unprotected sex has taken place with, to assign a risk. However, these arguments are governed by assumptions, many of which rely on perceived serostatus. A number of studies in the UK have examined perception of serostatus and found that over 25% of MSM who report seroconcordant unprotected sexual partners have never themselves had an HIV test[52,85,155]. Additionally, perceived serostatus has been measured by Dodds et al in a UA HIV survey of MSM and found that, of the MSM detected to be HIV positive through UA testing, 28% perceived themselves to be HIV negative, 51% perceived themselves

to be positive, and the remaining 21% reported they did not know their HIV status[155].

No association between HIV testing and social class was found, while the sample size may have been a limiting factor, thus a difference may have existed but the study did not have the power to detect it. No social class difference in HIV testing was found in the general population analysis either[8]. While other studies have found social class differences in HIV testing both in North America[55,64,66,87,88] and Australia[31], this implies that differential access to HIV testing is not a problem in the UK. The social class differences found in the US and Australia may be accounted for by other behavioural factors already controlled for, in particular UAI. It was found that UAI varied by education levels, with UAI associated with lower education both in the UK[52,68] and Canada[32,75].

## 4.5 Conclusions

In summary, in a UK representative survey of MSM, HIV testing was relatively common and associated with high-risk sexual behaviour. Men who had ten or more partners were five times more likely to have had a HIV test in the last 5 years than men who had fewer than ten partners. HIV testing was associated with negotiated safety, i.e. men who were cohabiting with a man were three times more likely to have had a test than men who were single. This means that interpreting the relationship between HIV testing and risk of HIV in MSM will be complex, as testers may represent three types of people. These are:

(1) those who test sporadically because they have high-risk behaviour,
(2) those who test routinely as part of a sexual health strategy,
(3) those who test at the establishment of a stable relationship, as part of the decision-making process around condom use within a relationship.

The next chapter of this thesis will investigate the importance of these differences through a cross-sectional study of MSM attending a GUM clinic in inner London. The study will explore the predictors of HIV testing by previous HIV negative tests, repeat tests and predictors of undiagnosed HIV infection. The study will then quantify the association between HIV testing and HIV infection, using an unlinked anonymous testing methodology.

# CHAPTER FIVE

## *WHAT IS THE ASSOCIATION BETWEEN HIV TESTING HISTORY AND HIV INFECTION, DIAGNOSED AND UNDIAGNOSED? – AN UNLINKED ANONYMOUS CROSS-SECTIONAL SURVEY OF MSM ATTENDING A GUM CLINIC*



**Summary**

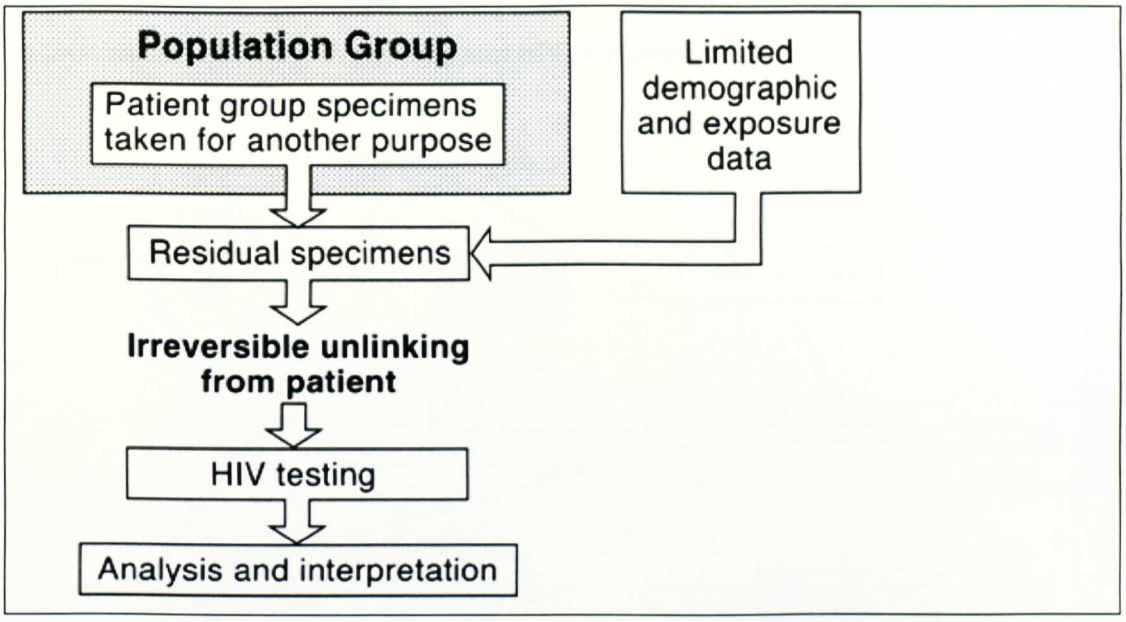
This chapter describes a cross-sectional study of MSM attending a GUM clinic in inner London which collected additional information on past HIV testing and previous STI diagnoses in addition to the routine UA GUM survey data. This allowed the association between HIV testing and HIV infection to be directly measured. Ever HIV testing was associated with age, having a previous acute STI in the past 5 years and diagnosis with another acute STI at the survey visit. HIV test history was positively associated with HIV serostatus. This suggests that overall, MSM who have HIV tested are at higher risk of HIV infection compared with MSM who have not HIV tested, attending a GUM clinic.

## 5.1 Introduction

To have his HIV infection diagnosed, an individual must first choose to have an HIV test. This decision may be influenced by a number of factors as discussed in Chapter two and shown in Chapter four, including some demographic factors such as age and residence, high-risk behaviours and health-seeking behaviours. Data gathered from the results of voluntary confidential HIV testing provide important insights into the burden of HIV infection experienced in the UK in MSM (as presented in Chapter three)[147,159]. However, these results can only apply to those seeking, or being offered, HIV testing. While behavioural surveys show that MSM have a high rate of HIV testing[8,29,49,94], a substantial proportion of MSM report not having had a HIV test.

It is difficult to assess the extent of undiagnosed HIV infection in the population. The UA methodology approach, based on specimens routinely gathered for other reasons, is particularly useful in contributing to the surveillance of HIV infection in all MSM, regardless of their HIV testing behaviour. UA testing allows the measurement of HIV prevalence both in clinically diagnosed and undiagnosed populations[9,10]. Several surveys have been on-going in the UK as part of a national UA programme that began in 1990. The surveys focus on those whose behaviour makes them more vulnerable to HIV infection. These are in sub-populations collecting both blood specimens (including GUM clinic attendees[90,162,191,192], pregnant women[193,194], hospital patients[162], women having terminations of pregnancy[162]) and oral fluid samples through voluntary unlinked surveys of IDUs[195], community surveys of MSM[49] and, most recently, a community survey of Africans in England[196]. Other UA surveys of MSM have been carried out in the USA[197-202] and in France[203,204]. UA testing relies on the availability of residual specimens collected for clinical screening purposes. These specimens are included in surveys and tested for HIV antibodies, following anonymising and unlinking from all identifiers. UA testing for HIV provides an estimate of HIV prevalence and associated risk factors in the population, free from the biases associated with being offered or choosing to have voluntary confidential HIV testing (Figure 5.1).

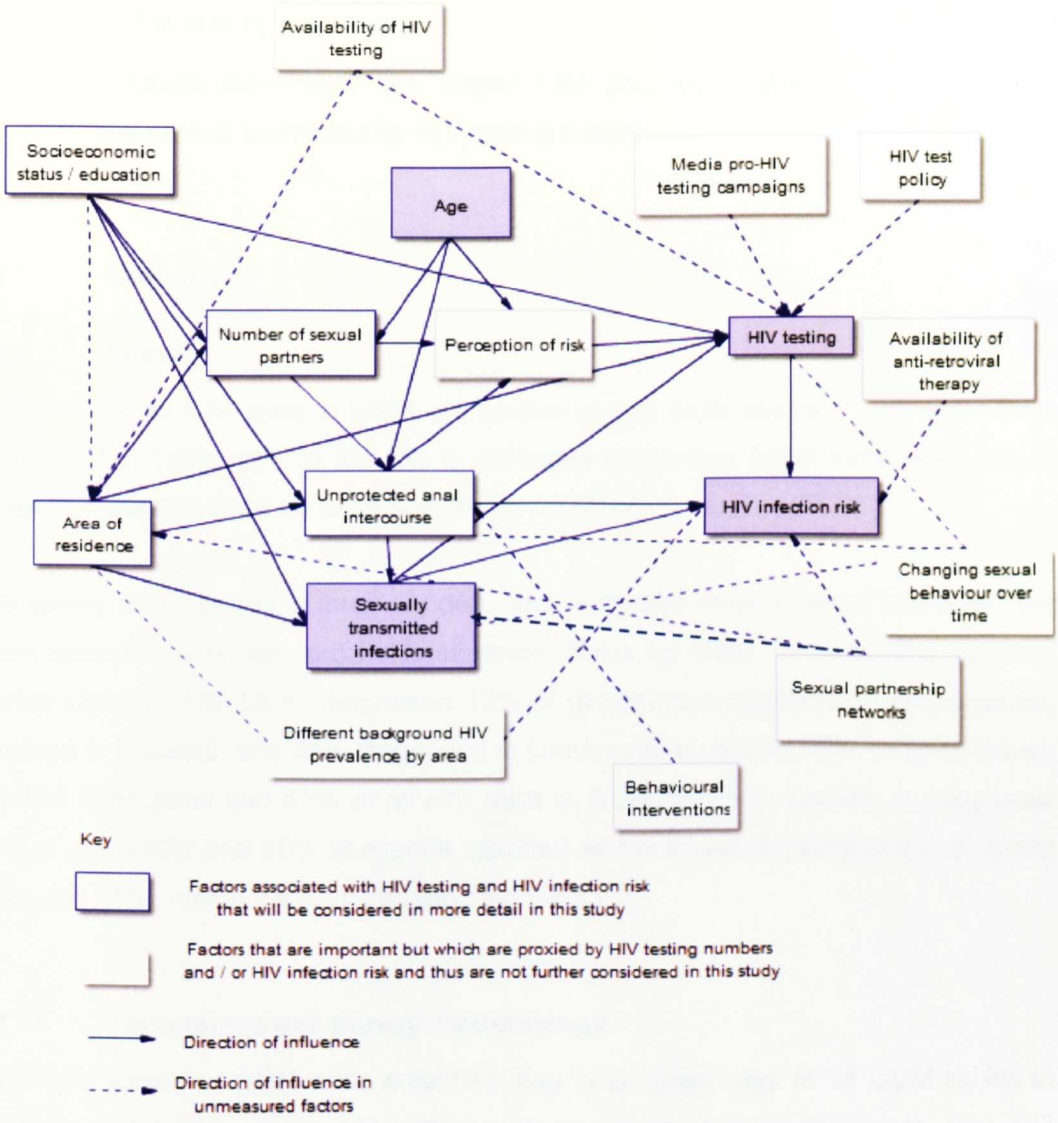
**Figure 5.1 Unlinked anonymous HIV seroprevalence monitoring methodology**




Source: HPA, Department of HIV and Sexually Transmitted Infections

Chapter four showed that HIV testing in MSM was associated with higher-risk behaviours, such as increased numbers of partners, in addition to demographic characteristics, such as area of residence. It provided denominators for the population of MSM that had a HIV test. If the relationship between HIV testing patterns, sexual risk behaviour and risk of HIV infection was known, then surveillance of HIV tests could provide an estimation of the size of population at increased risk of HIV, and the total HIV prevalence within that population could be estimated. This is displayed in Figure 5.2, and the variables that are going to be investigated in this chapter are displayed in blue colour. The study in this chapter was designed to directly quantify the relationship between patterns of HIV testing and risk of HIV infection.

**Figure 5.2 Conceptual framework of the relationship between HIV testing and risk of HIV infection mediated through risk behaviour in MSM: measuring the association between HIV testing and HIV prevalence**




This Chapter describes a cross-sectional study that used an existing survey system, and collected additional data from MSM on their HIV testing history and previous STIs diagnosed at that clinic prior to the surveyed visit. This obtained HIV testing history and HIV infection status (both clinically recognised infection and undiagnosed infection) from a population of MSM attending an inner London GUM clinic. The relationship between HIV testing history and HIV prevalence in GUM attendees was quantified using these data.

In this chapter the following questions are investigated (Objective 5 and Objective 6, Chapter one, section 1.5):

1) Investigate the association between HIV testing and HIV prevalence, both overall and undiagnosed
2) Estimate how much the overall HIV prevalence and undiagnosed HIV prevalence is affected by HIV testing history

## 5.2 Methods

### 5.2.1 Setting

Over 50% of all HIV tests in MSM are carried out at GUM clinics[8,147] (Chapter four, section 4.3.6, Table 4.4). In the UK, in particular in London, MSM more often attend clinics that provide more services specifically for MSM.

The survey clinic, based in inner London, sees a diverse population of attendees, but offers specialist services, and holds separate clinics for MSM. In 2003, the Mortimer Market Centre GUM Clinic diagnosed 12% of gonorrhoea reported as homosexually acquired in England, and 25% diagnosed in London. It carried out 22% of all HIV tests in MSM in England and 43% of all HIV tests in GUM clinics in London. It diagnosed 16% of chlamydia and 10% of syphilis reported as homosexually acquired in England (32% and 26%, respectively, of London diagnoses)[158].

### 5.2.2 Participants and survey methodology

A UA HIV survey of GUM clinic attendees has been under way at 15 GUM clinics in England and Wales since 1990. This collects basic demographic data and STI diagnoses at clinic visit, with a residual blood specimen from routine syphilis screening, which is tested for HIV, after it has been irreversibly unlinked from all patient identifiers[205]. The methodology of this study at the Mortimer Market Clinic was developed to allow the collection of demographic data electronically. This enabled the development of this additional short study within the on-going procedures of the survey, collecting additional information on past HIV testing and previous STI diagnoses. This allowed the association between HIV testing and HIV infection to be directly investigated. Details of how the study was developed, peer-reviewed, and ethics obtained are outlined below.

### 5.2.3 Summary of main study procedures and duration

The recruitment period for the study was between January and June 2003. Specimens from all MSM receiving syphilis tests within the study period were included. Each individual was included only once, the first attendance within the period. The study operated an opt-out methodology, so residual specimen and limited demographic and behaviour data were collected from all individuals unless they stated that they did not wish their blood specimen to be used for any other purpose or in any other research studies. Information leaflets and posters explaining the UA survey methodology were displayed throughout the GUM clinic. The specimens were collected from the clinic laboratory and delivered to the HPA for storing and testing, every 3 weeks throughout the period. Testing of specimens began when the specimens were first collected and continued for 3 months after recruitment was completed.

Detailed explanation of the study procedures, data handling and manipulation, laboratory procedures, ethical approval and statistical methods used for this study are detailed below in sections 5.2.3.1–5.2.3.3 and described below in Figure 5.3. Briefly, the clinician completed the study form during the clinic consultation and a portion of the blood sample taken for syphilis serology was transferred to the study laboratory for testing. An additional electronic extract of data containing information on HIV testing history and STI history at the clinic was taken and all these data were collected in the study database following unlinking from all patient identifiers.

#### 5.2.3.1 Study Methodology: Consultation

The clinician completed the study form (see Appendix D) during the clinic consultation. A unique patient-id number (assigned by the clinic) was attached to the form *[1]* (Figure 5.3). The form was then placed with the patient notes, which were passed to the nurse. When the phlebotomist or nurse took a blood sample for syphilis serology, the study form was placed with the syphilis serology request form and transported to the clinic laboratory with the blood specimen.

At the clinic laboratory a sample of blood (about 1 ml) was taken from the specimen, after syphilis testing was complete, and transferred into a Sarstedt tube, with the unique patient-id number that had been placed on the syphilis request form attached *[2]*. The Sarstedt tubes were kept in a bag and refrigerated. The forms were collected together in a bag and put into a box awaiting collection.

The blood samples and survey forms were collected from the clinic laboratory on a 3-weekly basis and the blood was transported to the HPA Centre for Infections,

Specialist and Reference Microbiology Division (SRMD) for HIV testing and the survey forms sent to the CDSC for data entry.

#### 5.2.3.2 Study Methodology: Data Management

The data management followed two stages, the first was pre-unlinking, when the data still had patient-id attached to allow individual data on HIV testing history and STI history to be extracted from the clinic database and combined with the survey form data. The second was post-unlinking from all patient identifiers, and involved the linking of the survey data to the UA specimen. These two stages are outlined below. The process has been broken down into numbered steps, which are illustrated in Figure 5.3).

***Stage one** (Pre-unlinking):* Patient-id and data on the form were entered into the study database *[3]* (FORM 1). A download of data from the clinic database was extracted, containing the following fields: patient-id, age (single year), gender, syphilis serology results, date of attendance, STI diagnoses (coded as KC60 codes, (see Chapter three, section 3.3.4 and Appendix B)) and the date of these diagnoses. This file was extracted a month after the date of the last visit required, to ensure that all diagnoses relating to the clinic visits had been updated on the patient records. This data file (EXTRACT 1) was imported into the study database *[4]*. The two files (FORM 1 and EXTRACT 1) were matched on patient-id and the additional data were added to the study database *[5]*.

A new form was generated in the laboratory containing a unique barcode number and the patient-id label taken from the specimen (see laboratory procedures below). This was entered into the study database (FORM 2) *[6]*. A duplicate of the unique barcode number remained linked to the specimen. The barcode number when scanned was obscured and could not be seen by the person entering the forms. This file was then matched on patient-id with the study database, thus a barcode number was attached to each individual record *[7]*.

When data matching was completed, the patient-id was deleted from the database *[8]*. At this point the data in the study database (demographic, clinical and behavioural) became permanently unlinked from the patient identifiers but remained linked to the specimen though the barcode number. Each record now had a barcode number as its unique identifier instead of the patient-id number assigned by the clinic.

***Stage two (post-unlinking):*** The study database now contained a unique barcode

number, the data collected on the form at the consultation and the additional fields extracted from the clinic database.

#### 5.2.3.3 Study Methodology: Laboratory procedures and HIV testing

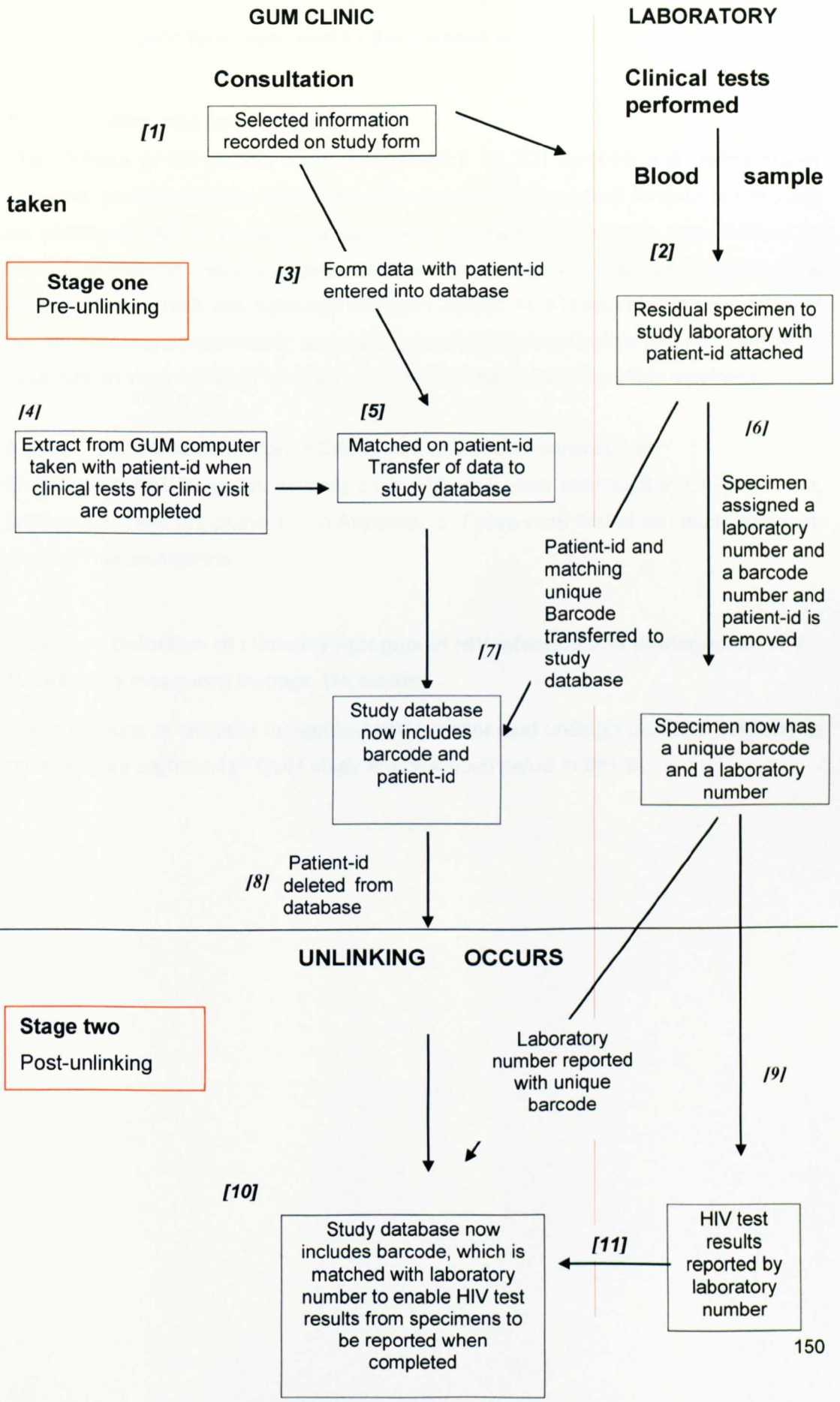
The SRMD received the residual blood specimens after clinical testing was complete *[2]*. The patient-id label was removed from each specimen, and it was assigned a unique barcode number *[6]*. A form containing a duplicate of the barcode number assigned to the specimen, and the patient-id label from the specimen (FORM 2) was then sent to the data management team *[7]*. The unique barcode number and the patient-id number were entered into the study database and, following matching with the demographic data file by patient-id, the patient-id was deleted from the study database *[8]* (***Stage one***).

Before HIV testing, each specimen was assigned a unique laboratory number *[6]*. This was reported to the CDSC with barcode number for entry into the study database (FORM 3) post-unlinking *(**Stage two**) [9]*. The study database now included for each individual record, a unique barcode, and a laboratory number to enable the matching of HIV test results from specimens to the demographic data, which were now unlinked from all patient identifiers *[10]*.

Two screening methods, GACELISA HIV 1+2 (VK61, Abbott/Murex Diagnostics, Dartford, Kent) and GACPAT (SRMD in-house method) were used for testing the blood samples. GACPAT, the less expensive method, was adopted as the screening assay, and GACELISA was used to investigate reactive specimens. A small subset of specimens that were weakly reactive in either assay, or gave discordant reactions, were also examined by a Western blot procedure.

When HIV testing was complete, the results were reported by laboratory number (FORM 4) and entered into the study database *(**Stage two**) [11]*.

**Figure 5.3: Schema of unlinked anonymous study procedures**



### 5.2.4 Definitions used in the UA GUM study

The following definitions were used for the analyses within this study.

#### 5.2.4.1 Men who have sex with men

The clinician at the survey clinic determined if an STI episode was homosexually acquired, as defined in the KC60 data collection form (Appendix D form 1). In this study an additional field on sexual orientation was collected on the study form, defined as homo/bisexual. All male attendees with sexual orientation ticked as homo/bisexual were defined as men who have sex with men (MSM). All STI episodes in any male that had at least one homosexually acquired episode (as defined before and summarised in Appendix B) were selected for electronic data download from the clinic database.

#### 5.2.4.2 HIV test definition, KC60 codes and their interpretation

Definitions for KC60 codes defining clinic episodes were described in Chapter three, section 3.3.4 and are presented in Appendix B. These were coded into acute and non-acute STI presentations.

#### 5.2.4.3 Definition of clinically recognised HIV infection and undiagnosed HIV infection as measured through UA testing

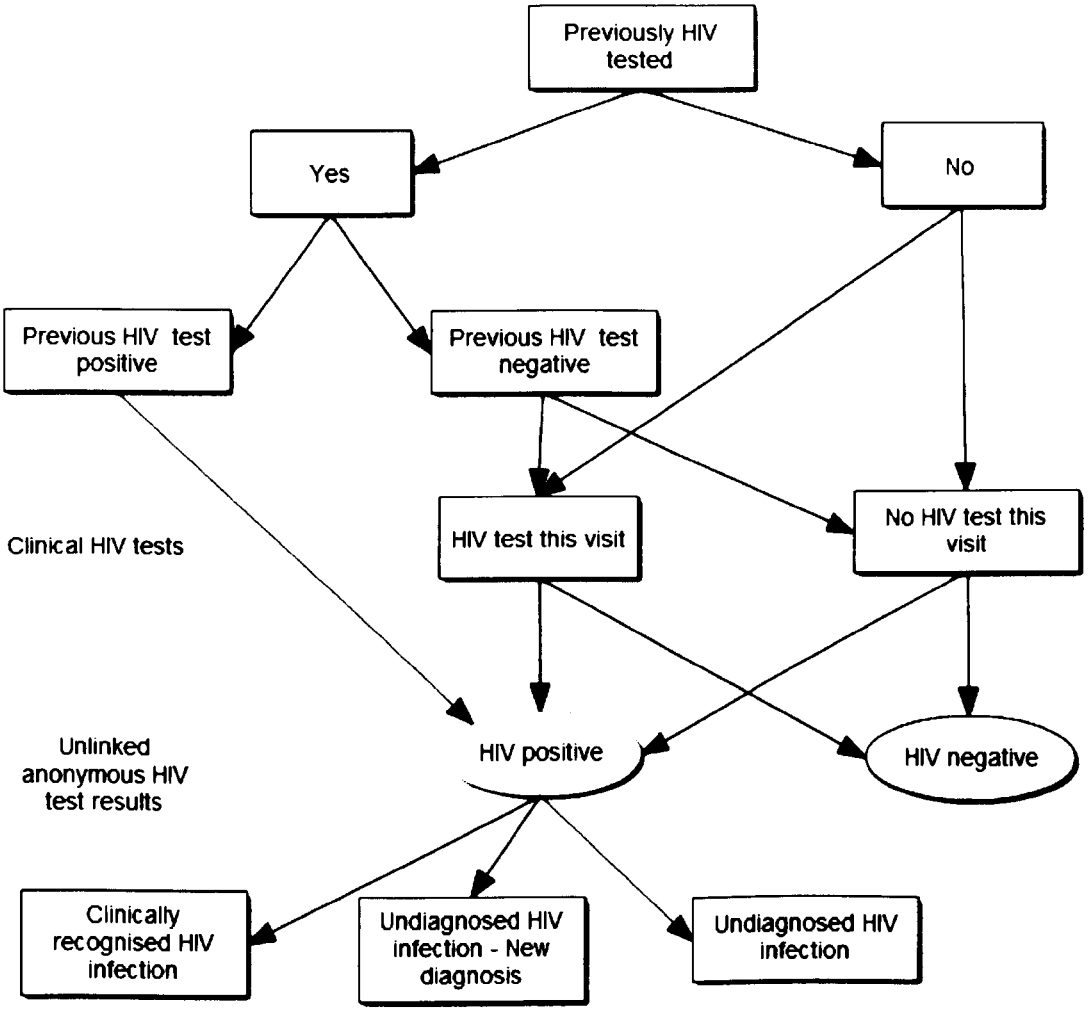
The definitions of clinically recognised HIV infection and undiagnosed HIV infection as measured through the UA GUM study are described below in Box 5.1.

**Box 5.1 Definition of HIV status in UA GUM study**

| HIV status | Specimen HIV test result | Study form | KC60 diagnoses recorded with visit |
|---|---|---|---|
| Clinically recognised HIV infection | HIV positive | Known HIV positive | 'Asymptomatic HIV infections, subsequent presentation'<br>*or*<br>'HIV infection with symptoms, subsequent presentation'<br>*or*<br>'AIDS – subsequent presentation' |
| Undiagnosed HIV infection | HIV positive | Not known to be HIV positive | Not recorded as previously clinically recognised infection |
| 1) Undiagnosed HIV infection – new diagnosis | HIV positive | Not known to be HIV positive | Not recorded as previously clinically recognised infection<br>*and*<br>HIV test recorded at the survey visit<br>*Or*<br>KC60 diagnosis 'asymptomatic HIV infection – first presentation' recorded |
| 2) Undiagnosed HIV infection | HIV positive | Not known to be HIV positive | Not recorded as previously clinically recognised HIV infection,<br>*and*<br>who did not have a HIV test at this visit<br>*and*<br>did not have a new diagnosis of HIV infection recorded at this visit |

These definitions of HIV infection status by HIV testing history collected through the recorded history of HIV tests are illustrated below in Figure 5.4.

**Figure 5.4 Flow chart of HIV infection status by HIV test history: Clinically recognised infection, New diagnosis and Undiagnosed HIV infection**




### 5.2.5 Statistical analyses

An analysis strategy was determined a priori based on the conceptual framework in Chapter two of the relationship between HIV testing and risk of HIV infection in MSM, to investigate the socio-demographic and HIV testing variables associated with HIV prevalence as highlighted in Figure 5.2.

Three HIV testing variables were constructed for these analyses, (i) previous HIV positive test and (ii) previous HIV negative test, were constructed based on the HIV testing algorithm shown in Figure 5.4. Natsal collected information on whether MSM had a previous HIV test; but no information on the result of this test was collected. Thus, a third variable, (iii) Ever HIV tested (including both positive and negative tests), was constructed, which included all MSM who had a previous HIV test, including both

positive and negative tests, before the survey visit, to measure the HIV prevalence in a comparable group to the Natsal denominator.

To describe the demographics of MSM attending a GUM clinic in inner London, prevalence (with 95% CI) of HIV testing and HIV prevalence (overall positive and undiagnosed) by both demographic and STI diagnoses characteristics were calculated. A 95% CI was calculated in each case using a binomial exact distribution. Differences between groups were compared using the Chi-squared test and Chi-squared test for trend. Age-specific prevalence of HIV testing by each testing variable was calculated. To determine what demographic characteristics are associated with previous HIV testing, OR were used to compare the prevalence of STI diagnoses and demographics associated with HIV test history through the conceptual framework in Chapter two (Figure 5.2), controlling for the other socio-demographic and STI variables in the model. This was to investigate variables independently associated with HIV testing and to establish whether STI diagnoses were independently associated with HIV testing when controlling for other demographic variables. Interaction terms between demographic and STI variables were explored to investigate if the association of these variables with HIV testing (OR) varied when stratified by other variables. Two individual analyses were undertaken: the first looked at demographic and behavioural factors associated with ever HIV tested with never as the reference, and the second looked at never HIV tested with ever HIV tested as the reference. One set of results is the inverse of the other; both were done to provide ratios for untested MSM for the adjustment factor calculated in Chapter seven.

A second series of analyses were undertaken to quantify how much HIV prevalence varied by HIV test history, to produce an adjustment factor for the estimation model in Chapter seven. To determine what demographic characteristics, STI diagnoses and HIV testing variables are associated with HIV prevalence (overall prevalence and undiagnosed prevalence), OR were used to compare the prevalence of HIV testing behaviour, STI diagnoses and demographics associated with being HIV positive, both diagnosed and undiagnosed. Logistic regression analyses were used to calculate adjusted OR, controlling for the other socio-demographic and STI diagnoses variables in the model, in order to establish whether HIV testing were independently associated with HIV prevalence, when controlling for other demographic variables. Interaction terms between demographic and STI variables were explored to investigate if the association of these variables with HIV prevalence (OR) varied when stratified by other variables. The importance of STI diagnoses was relevant to determine whether previous STI could be used as a proxy for UAI in surveillance systems; as it is a clinical

diagnosis, it would not be subject to reporting bias and would be routinely available through clinical records. Three individual analyses were undertaken, each one including a different variable on HIV testing examined in section 5.3.3. The first examined factors associated with HIV prevalence, both overall and undiagnosed and included the HIV testing variable, time since last HIV negative test. The second analysis included the HIV testing variable, total numbers of HIV negative tests and the third included ever HIV tested, regardless of the result. Factors from the conceptual framework associated with both HIV testing and HIV prevalence were summarised to determine factors for inclusion in the HIV estimation model in Chapter seven.

All analyses were performed using STATA 7.0.

### 5.2.6 Ethics of unlinked anonymous HIV testing

As part of the UA programme, the survey was carried out in a setting where voluntary confidential HIV testing was readily available to all participants. Posters and leaflets were displayed at the clinic, which informed the clinic attendees that the residual of the specimens they give might be used for additional research. If any individual did not want the residual blood left after clinical testing to be used in research, they could express an objection, and their specimen was excluded from the study. If a patient objected, this information was collected on FORM 1. In this case the demographic data were examined so that a comparison between objectors and those included in the study could be made.

## 5.3 Results

### 5.3.1 Demographic characteristics of a cross-sectional survey of MSM attending an inner London GUM clinic

Overall, 2,210 MSM were surveyed between 1 January 2003 and 30 June 2003. The majority (73.7%) were aged between 25 and 44; 13.0% of MSM were aged less than 25 and 13.3% aged over 45. Overall, 60.0% of attendees had an HIV test at the survey visit (Table 5.1). The age distribution of HIV testers differed from those attendees who did not have a HIV test. There were 18% of HIV testers aged less than 25, but most non-testers (94%) were aged 25 years or more. Non-testers were more likely to be 35 years or older and 19% of non-testers were aged 45 or over, compared with only 10% of testers (see Table 5.1). MSM aged over 25 were less likely to test at the survey visit compared to 16 to 24 year olds; OR 0.46 (95% CI 0.33 – 0.64) for 25 to 34 year olds, OR 0.23 (95% CI 0.47 – 0.33) for 35-44 year olds and OR 0.18 (95% CI 0.12 – 0.26). Almost a quarter of non-testers were diagnosed with an acute STI at the survey visit. MSM diagnosed with an acute STI were 30% less likely to have an HIV test at the survey visit (OR 0.79, 95% CI 0.64 – 0.97). A higher proportion of MSM who did not have a HIV test at this visit had previously had an acute STI diagnosed (26.0%) compared with current HIV testers (18.9%). MSM who had previously had an acute STI diagnosed were 40% less likely to test at the survey visit (OR 0.66, 95% CI 0.54 – 0.81). In particular if this previous STI diagnosis was gonorrhoea it was associated with not testing at this survey visit, OR 0.48 (95% CI 0.35 – 0.67).

### 5.3.2 HIV testing patterns in MSM attending GUM clinic

Overall, 37.4% of MSM surveyed had never HIV tested. Just over a quarter, 26.6%, had a previous HIV test in the past 12 months, 16.0% between 24 and 59 months ago, and 4.3% 60 or more months ago. Whether an HIV test was carried out at the survey visit was associated with previous HIV testing history (Table 5.1). Sixty-four per cent of non-testers had never tested and MSM who had tested 60 or more months ago were 75% less likely to test at the survey visit compared with MSM who had never previously tested negative (OR 0.23, 95% CI 0.18 – 0.29). One third of MSM who HIV tested at the survey visit had a previous HIV test in the past 12 months and a further 34% HIV tested in the past 59 months. Just 17% of non-testers at the survey visit had HIV tested in the past 12 months, and 15% between 12 and 59 months ago. Fewer than 5% of both HIV testers and non-testers had a previous HIV test more than 5 years ago.

**Table 5.1 The association between HIV test at survey visit and demographic and behavioural characteristics, percentages and crude odds ratio (95% confidence intervals), for MSM attending an inner London GUM clinic, January-June 2003**

| Characteristics | Total surveyed n | HIV test at the survey visit n (%)[a] | No HIV test at the survey visit n (%)[a] | OR (95% CI) |
|---|---|---|---|---|
| Total MSM (row %) | 2,210 | 1327(60.0) | 883 (40.0) | |
| **DEMOGRAPHICS** | | | | |
| | | | | P<0.0001 |
| *Age in years* | | | | |
| 16-24 | 288 | 234 (17.6) | 54 (6.1) | 1.0 |
| 25-34 | 889 | 592( 44.6) | 297 (33.6) | 0.46 (0.33 – 0.64) |
| 35-44 | 740 | 373 (28.1) | 367 (41.6) | 0.23 (0.47 – 0.33) |
| 45+ | 293 | 128 (9.6) | 165 (18.7) | 0.18 (0.12 – 0.26) |
| **STI DIAGNOSES HISTORY** | | | | |
| | | | | P=0.0246 |
| *Diagnosed Acute STI at the survey visit* | | | | |
| No | 1752 | 1073 (80.9) | 679 (76.9) | 1.0 |
| Yes | 458 | 254 (19.2) | 204 (23.1) | 0.79 (0.64 – 0.97) |
| | | | | P=0.14 |
| *Gonorrhoea diagnosed at the survey visit* | | | | |
| No | 2096 | 1266 (95.4) | 830 (94.0) | 1.0 |
| Yes | 114 | 61 (4.6) | 53 (6.0) | 0.75 (0.52 – 1.10) |
| | | | | P=0.56 |
| *Syphilis diagnosed at the survey visit* | | | | |
| No | 2186 | 1314 (99.0) | 872 (98.8) | 1.0 |
| Yes | 24 | 13 (1.0) | 11 (1.2) | 0.78 (0.35 – 1.76) |
| | | | | P=0.32 |
| *Herpes diagnosed at the survey visit* | | | | |
| No | 2186 | 1315 (99.1) | 871 (98.6) | 1.0 |
| Yes | 24 | 12 (0.9) | 12 (1.4) | 0.66 (0.30 – 1.48) |

| Characteristics | Total surveyed n | HIV test at the survey visit n (%)[a] | No HIV test at the survey visit n (%)[a] | OR (95% CI) |
|---|---|---|---|---|
| *Other acute STI diagnosed at the survey visit* | | | | P=0.15 |
| No | 1889 | 1146 (86.4) | 743 (84.1) | 1.0 |
| Yes | 321 | 181 (13.6) | 140 (15.9) | 0.84 (0.66 – 1.06) |
| *Previous acute STI* | | | | P=0.0001 |
| No | 1729 | 1076 (81.1) | 653 (74.0) | 1.0 |
| Yes | 481 | 251 (18.9) | 230 (26.0) | 0.66 (0.54 – 0.81) |
| *Previous Gonorrhoea* | | | | P<0.0001 |
| No | 2053 | 1259 (94.9) | 794 (89.9) | 1.0 |
| Yes | 157 | 68 (5.1) | 89 (10.1) | 0.48 (0.35 – 0.67) |
| **HIV TESTING HISTORY** | | | | |
| | | | | P<0.0001 |
| *Date of last negative HIV test* | | | | |
| Never tested[b] | 936 | 371 (28.0) | 56 (64.0) | 1.0 |
| Last year | 588 | 437 (33.0) | 151 (17.1) | 1.16 (0.85 – 1.59) |
| Between 12 and 23 months ago | 354 | 273 (20.6) | 81 (9.2) | 1.11 (0.78 – 1.58) |
| Between 24 and 59 months ago | 236 | 180 (13.6) | 56 (6.3) | 0.72 (0.45 – 1.15) |
| 60 or more months ago | 96 | 65 (4.9) | 31 (3.5) | 0.23 (0.18 – 0.29) |
| *Total number of previous negative HIV tests* | | | | P<0.0001 |
| Never tested[b] | 936 | 371 (28.0) | 565 (64.0) | 0.25 (0.20 – 0.31) |
| 1 | 735 | 533 (40.2) | 202 (22.9) | 1.0 |
| 2 | 371 | 289 (21.8) | 82 (9.3) | 1.34 (0.99 – 1.79) |
| 3-4 | 141 | 111 (8.4) | 30 (3.4) | 1.40 (.91 – 2.17) |
| 5+ | 27 | 23 (1.7) | 4 (0.5) | 2.18 (0.74 – 6.38) |

Note. a. column percentages are shown; b. Includes MSM diagnosed HIV positive previously but with no recorded HIV negative test.

Overall, 33.3% of MSM had one previous HIV test recorded, 16.8% had two tests, 6.4% had between three and four previous tests and 1.2% had five or more tests previously. Numbers of previous HIV negative tests was associated with a HIV test at this visit (Table 5.1). Approximately two thirds of MSM who tested at the survey visit had one or more previous HIV negative tests before this visit while only a third of MSM who did not choose to test at the survey visit had had a previous test (Table 5.1). MSM who had never previously tested negative were less likely to HIV test at the survey visit, when compared with MSM who had one previous negative test, OR 0.25 (95% CI 0.20 – 0.31). MSM who had two previous tests had an increased likelihood to have a HIV test at the survey visit compared with MSM who had just one previous test (OR 1.34, 95% CI 0.99 – 1.79).

**Table 5.2 The distribution of HIV testing variables (column percentages and 95% confidence intervals) for MSM[a] attending an inner London GUM clinic January – June 2003; Time since last negative HIV test by total number of negative HIV tests**

| Total number of HIV negative tests | Time since last negative HIV test | | | |
|---|---|---|---|---|
| | <12 months | Between 12 and 23 months | Between 24 and 59 months | 60 or more months |
| | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) |
| Number surveyed | 587 | 354 | 236 | 96 |
| 1 previous negative test | 52.2 (48.1 – 56.3) | 51.2 (46.9 – 57.6) | 66.9 (60.6 – 72.9) | 87.5 (79.2 – 93.4) |
| 2 | 35.9 (32.0 – 39.9) | 30.8 (26.0 – 35.9) | 17.4 (12.8 – 22.8) | 10.4 (5.1 – 18.3) |
| 3-4 | 9.4 (7.1 – 12.0) | 14.4 (10.9 – 18.5) | 14.0 (9.8 – 19.1) | 2.1 (0.3 – 7.3) |
| 5-10 | 2.4 (1.3 – 4.0) | 2.5 (1.2 – 4.8) | 1.7 (0.5 – 4.3) | 0 |

a. Excludes 936 MSM who had no recorded previous negative HIV test

The total numbers of recorded previous HIV negative tests were associated with time since last HIV negative test. This has been cross-tabulated in more detail in Table 5.2. Most MSM who had tested previously had their last HIV negative test in the past 23 months. MSM with increasing numbers of HIV tests were more likely to have had their last HIV test in the past 23 months compared with men with only one HIV test (Chi-squared test for trend $p<0.001$). Eighty-eight per cent of MSM who had their last test

60 or more months ago only had one previous test compared with 52% of those who had their last test in the past 12 months.

When these HIV testing variables were stratified by age group to allow for the association between increasing age and time since last HIV test, a similar pattern was seen in each age group. Tables of each HIV testing variable by age group have been included in Appendix D, Table D.1. MSM aged greater than 35 were less likely to have tested in the past year compared with MSM aged less than 25; OR 0.59, 95% CI 0.44 – 0.79, for 35 to 44 year olds and OR 0.31, 95% CI 0.20 – 0.46 for MSM aged 45 or more years old (Table 5.3). MSM age 25 to 34 years old were more likely to have tested between 12 and 23 months ago compared with MSM aged less than 25, OR 1.52, 95% CI 1.04 – 2.24. They were more likely to have tested between 24 and 59 months ago (OR 1.76, 95% CI 1.08 – 2.86). MSM aged more than 25 were more likely to have tested 60 or more months ago compared with less than 25 year olds. MSM aged 25 to 34 were 12 times more likely OR 11.76, 95% CI1.60 – 86.24), 34 to 44 year olds were eighteen times (OR 18.58, 95% CI2.55 – 135.4) and over 45 year olds fifteen times more likely to have tested 59 or months ago compared with MSM aged less than 25 (OR 15.49, 95% CI 2.03 – 118.02).

The distribution of the numbers of total previous negative HIV tests was similar. MSM aged 25-34 years old were less likely to have no negative tests recorded compared to MSM aged less than 25, OR 0.67, 95% CI 0.51 – 0.88. MSM aged over 35 were less likely to have one negative HIV test recorded than MSM aged less than 25; OR 0.56, 95% CI 0.42 – 0.75 in 35-44 years olds and OR 0.41, 95% CI 0.29 – 0.59 in MSM aged 45 or more. MSM aged over 35 were between four and six times more likely to have three to four negative tests than MSM aged less than 25 (OR 4.37, 95% 1.73 – 11.04, and OR 6.46, 95% CI 2.47 – 16.89, for 35-44 and 45 or more years respectively, Table 5.3).

When a testing variable that encompassed all HIV tests MSM had, including both those that were HIV positive and HIV negative was examined, three quarters of MSM had ever HIV tested (75%). This varied by age and the likelihood of ever testing was higher in each age group relative to MSM aged less than 25 years old: OR 2.40 (95% CI 1.81 – 3.17) in MSM aged 25-34, OR 2.96 (95% CI 2.20 – 3.97), for 35-44 years old and OR 2.84 (95% CI 1.97 – 4.09) in MSM aged 45 or more. This is detailed further in the next section.

**Table 5.3 Association between HIV testing variables and age group, odds ratios and 95% confidence intervals, in MSM attending an inner London GUM clinic. January – June 2003**

| | | ***Date of last negative HIV test*** | | | | |
|---|---|---|---|---|---|---|
| | | <12 months<br>OR (95% CI) | Between 12 and 23 months ago<br>OR (95% CI) | Between 24 and 59 months ago<br>OR (95% CI) | 60 or more months ago<br>OR (95% CI) | Never tested<br>OR (95% CI) |
| Age group | | p=0.018 | p=0.08 | p=0.0007 | <0.0001 | p=0.0003 |
| | <25 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 25-34 | 0.82 (0.62 – 1.09) | 1.52 (1.04 – 2.24) | 1.76 (1.08 – 2.86) | 11.76 (1.60 – 86.24) | 0.67 (0.51 – 0.87) |
| | 35-44 | 0.59 (0.44 – 0.79) | 1.21 (0.81 – 1.80) | 1.22 (0.74 – 2.04) | 18.58 (2.55 – 135.4) | 1.06 (0.81 – 1.39) |
| | 45+ | 0.31 (0.20 – 0.46) | 1.14 (0.71 – 1.83) | 2.13 (1.23 – 3.69) | 15.49 (2.03 – 118.02) | 1.35 (0.97 – 1.87) |
| | | ***Total number of HIV negative tests*** | | | | |
| | | Never tested negative<br>OR (95% CI) | 1<br>OR (95% CI) | 2<br>OR (95% CI) | 3-4<br>OR (95% CI) | 5-10<br>OR (95% CI) |
| Age group | | P<0.0001 | p<0.0001 | p=0.23 | p=0.0001 | p=0.07 |
| | <25 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| | 25-34 | 0.67 (0.51 – 0.88) | 1.0 (0.76 – 1.31) | 1.43 (0.98 – 2.10) | 3.59 (1.42 – 9.06) | 2.94 (0.37 – 23.37) |
| | 35-44 | 1.05 (0.80 – 1.38) | 0.56 (0.42 – 0.75) | 1.39 (0.94 – 2.05) | 4.37 (1.73 – 11.04) | 5.94 (0.78 – 45.16) |
| | 45+ | 1.35 (0.97 – 1.87) | 0.41 (0.29 – 0.59) | 1.19 (0.75 – 1.90) | 6.46 (2.47 – 16.89) | 1.97 (0.18 – 21.87) |

Note. OR, odds ratios; CI, confidence intervals.

The frequency and distribution of the demographic and behavioural characteristics of all MSM by ever having had an HIV test previous to the survey visit (HIV testing history) are shown in Table 5.4. The proportions that are found to be important in the model in Table 5.5 will be used for the HIV estimation model in Chapter seven. The distribution of age and diagnosed with a previous acute STI varied by whether MSM had ever had an HIV test or not. Results for the association between having had an HIV test, age, and STI diagnosis can be found in Table 5.5.

**Table 5.4 The distribution of demographic and behavioural characteristics by HIV testing history (column percentages and 95% confidence intervals) for MSM attending an inner London GUM clinic, January-June 2003**

| | **Total surveyed** | **Ever HIV tested; Including both positive and negative tests** | **Never HIV tested** |
|---|---|---|---|
| All respondents, n | | 1666 | 544 |
| | | % (95% CI) | % (95% CI) |
| *Age group* | | | |
| 16-24 | 288 | 9.9 (0.85 – 11.4) | 22.3 (19.2 -26.4) |
| 25-34 | 889 | 40.7 (38.3 – 43.0) | 38.8 (34.7 – 43.0) |
| 35-44 | 740 | 35.5 (33.2 – 37.8) | 27.4 (23.7 – 31.3) |
| 45+ | 293 | 13.9 (12.3 – 15.7) | 11.2 (8.7 – 14.2) |
| *Diagnosed gonorrhoea at survey visit* | | | |
| No | 2096 | 95.1 (94.0 – 96.1) | 93.9 (91.6 – 95.8) |
| Yes | 114 | 4.9 (3.9 – 6.0) | 6.1 (4.2 – 8.4) |
| *Diagnosed syphilis at survey visit* | | | |
| No | 2186 | 98.9 (98.3 - 99.4) | 98.9 (97.6 – 99.6) |
| Yes | 24 | 1.1 (0.6 – 1.7) | 1.1 (0.4 – 2.4) |
| *Diagnosed other acute STI at survey visit*[a] | | | |
| No | 1888 | 86.0 (84.3 – 87.6) | 83.6 (80.3 – 86.7) |
| Yes | 322 | 14.0 (12.4 – 15.7) | 16.4 (13.3 – 19.7) |
| *Previous acute STI in past 5 years* | | | |
| No | 1729 | 74.7 (72.5 – 76.7) | 89.2 (86.2 – 91.6) |
| Yes | 481 | 25.3 (23.3 – 27.5) | 10.8 (8.4 – 13.8) |

Note. a. proportion used for estimation model in Chapter seven.

In univariable analysis ever having had an HIV test was associated with being older, and having a previous acute STI in the past 5 years. There was no evidence of an association between any acute STI at the surveyed visit and ever having had an HIV test in MSM. However, MSM who had ever HIV tested were almost three times more likely to have had a previous acute STI compared with MSM who had never HIV tested before this survey visit (OR 2.79, 95% CI 2.08 – 3.73). In multivariable analysis, following adjustment for all demographic and behavioural variables, increasing age remained statistically associated with ever HIV tested. MSM presenting with another acute STI other than gonorrhoea or syphilis were less likely to have ever HIV tested while MSM with a previous history of acute STIs were more likely to have ever HIV tested.

**Table 5.5 Association (crude and adjusted odds ratios with their 95% confidence intervals) between demographic and behavioural characteristics and HIV tested (ever or never separately) for MSM attending an inner London GUM clinic, January-June 2003**

| | Ever HIV tested; including both positive and negative tests | | Never HIV tested | |
|---|---|---|---|---|
| | OR (95% CI) | Adjusted[a] OR (95% CI) | OR (95% CI) | Adjusted[a] OR (95% CI) |
| *Age* | P<0.0001 | P<0.0001 | P<0.0001 | P<0.0001 |
| 16-24 | 1.0 | 1.0 | 1.0 | 1.0 |
| 25-34 | 2.40 (1.81 – 3.17) | 2.22 (1.67 – 2.94) | 0.42 (0.32 – 0.55) | 0.45 (0.34 – 0.60) |
| 35-44 | 2.96 (2.20 – 3.97) | 2.58 (1.91 – 3.48) | 0.34 (0.25 – 0.45) | 0.39 (0.29 – 0.52) |
| 45+ | 2.84 (1.97 – 4.09) | 2.62 (1.81 – 3.79) | 0.35 (0.24 – 0.51) | 0.39 (0.26 – 0.55) |
| *Diagnosed gonorrhoea at survey visit* | P=0.27 | P=0.33 | p=0.27 | P=0.33 |
| No | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 0.79 (0.52 – 1.20) | 0.81 (0.53 – 1.24) | 1.26 (0.83 – 1.92) | 1.24 (0.80 – 1.90) |
| *Diagnosed syphilis at survey visit* | p=0.96 | P=0.77 | P=0.96 | P=0.77 |
| No | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 0.98 (0.39 – 2.48) | 0.87 (0.34 – 2.24) | 1.02 (0.40 - 2.59) | 1.15 (0.45- 2.97) |
| *Diagnosed other acute STI at survey visit* | P=0.094 | P=0.0423 | P=0.094 | P=0.0423 |
| No | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 0.80 (0.61 – 1.04) | 0.75 (0.57 – 0.99) | 1.25 (0.96 – 1.63) | 1.33 (1.01 -1.75) |
| *Previous acute STI in past 5 years* | P<0.0001 | P<0.0001 | P<0.0001 | P<0.0001 |
| No | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 2.79 (2.08 – 3.73) | 2.61 (1.94 – 3.51) | 0.36 (0.27 – 0.48) | 0.38 (0.28 – 0.51) |

Note. a. adjusted for all variables in the model, age, STI diagnosis at survey visit, previous acute STI in past 5 years; All p-values are tests of trend from the estimated parameters within the model.

### 5.3.3 Descriptive analysis of HIV prevalence, clinically recognised and undiagnosed HIV infections

Overall, 24.6% (95% CI 22.8 – 26.5) of MSM sampled were HIV positive, 19.8% had their HIV infection clinically recognised prior to this visit, and 4.8% were undiagnosed prior to this clinic visit (Table 5.6). HIV prevalence was highest in older men, and just over a quarter of men aged over 25 were HIV positive compared with 5% of 16-24 year olds. The majority of HIV positive MSM aged over 35 had their HIV infection clinically recognised prior to this clinic visit (84.6%, 95% CI 80.4 – 88.1). This was a higher proportion than of men aged under 35 (Chi-squared test p=0.001) although the majority of HIV positive men aged less than 35 years old also had their HIV infection clinically recognised (72.9%, 95% CI 65.9 – 79.1) prior to this clinic visit. MSM diagnosed with an acute STI were less likely to be HIV positive and have clinically recognised HIV infection. However, MSM diagnosed with syphilis were more likely to be HIV positive and there was no evidence of a difference in overall HIV prevalence in MSM presenting with gonorrhoea, although a higher proportion had undiagnosed HIV infection. MSM presenting with another acute STI were less likely to be HIV positive, and to have clinically recognised HIV infection prior to that visit. MSM who had a previous acute STI diagnosed in the past 5 years had no difference in HIV prevalence.

Forty-two per cent of MSM with no previously recorded HIV negative test had clinically recognised HIV infection and 7% had undiagnosed HIV infection. The remainder were HIV negative. While overall HIV prevalence was higher in MSM who had ever had a HIV test (including both positive and negative), undiagnosed HIV infection was higher in MSM who had never HIV tested.

**Table 5.6 HIV prevalence (row percentages and 95% confidence intervals) by demographic and behavioural characteristics of MSM attending an inner London GUM clinic, January-June 2003**

| Characteristics | Overall HIV positive | *Clinically recognised HIV infection prior to visit* | *Undiagnosed HIV infection prior to visit* | HIV negative | Number surveyed |
|---|---|---|---|---|---|
| | (n= 544)<br>% (95% CI) | (n=438)<br>*% (95% CI)* | (n=106)<br>*% (95% CI)* | (n=1666)<br>% (95% CI) | |
| Total MSM % | 24.6 (22.8 – 26.5) | 19.8 (18.1 – 21.5)[a] | 4.8 (4.0 – 5.8)[a] | 75.4 (73.5 – 77.2) | 2210 |
| **DEMOGRAPHICS** | | | | | |
| *Age* | | | | | |
| 16-24 | 5.2 (2.9 – 8.4) | 3.1 (1.4 – 5.8) | 2.1 (0.8 – 4.5) | 94.8 (91.6 – 97.1) | 288 |
| 25-34 | 19.5 (16.9 – 22.2) | 14.4 (12.2 –16.9) | 5.1 (3.7 – 6.7) | 80.5 (77.8 – 83.1) | 889 |
| 35-44 | 34.2 (30.8 – 37.7) | 27.6 (24.3 – 30.9) | 6.6 (4.9 – 8.7) | 65.8 (62.3 – 69.2) | 740 |
| 45+ | 35.2 (29.7 – 40.9) | 33.1 (27.7 – 38.8) | 2.0 (0.8 – 4.4) | 64.8 (59.1 – 70.3) | 293 |
| **STI DIAGNOSES** | | | | | |
| *Diagnosed Acute STI at this visit* | | | | | |
| No | 26.0 (23.9 – 28.1) | 21.2 (19.4 – 23.3) | 4.7 (3.7 – 5.8) | 74.0 (71.9 – 76.1) | 1752 |
| Yes | 19.4 (15.9 – 23.4) | 14.0 (10.9 – 17.5) | 5.4 (3.6 – 8.0) | 80.6 (76.6 – 84.1) | 458 |
| *Gonorrhoea* | | | | | |
| No | 24.3 (22.5 – 26.2) | 19.8 (18.2 – 21.6) | 4.4 (4.0 – 5.4) | 75.7 (73.8 – 77.8) | 2096 |
| Yes | 30.7 (22.4 – 40.0) | 19.3 (12.5 – 17.7) | 11.4 (6.2 – 18.7) | 69.3 (60.0 – 77.6) | 114 |
| *Syphilis* | | | | | |
| No | 24.3 (22.6 – 26.2) | 19.6 (18.0 – 21.4) | 4.7 (3.9 – 5.7) | 75.7 (73.8 – 77.4) | 2186 |
| Yes | 50.0 (29.1 – 70.9) | 37.5 (18.8 – 59.4) | 12.5 (2.7 – 32.4) | 50.0 (29.1 – 70.9) | 24 |
| *Other acute STI* | | | | | |
| No | 26.5 (24.6 – 28.6) | 21.4 (19.6 – 23.3) | 5.1 (4.2 – 6.2) | 73.4 (71.4 – 75.4) | 1888 |
| Yes | 13.4 (9.8 – 17.6) | 10.6 (7.4 – 14.4) | 2.8 (1.3 – 5.2) | 86.6 (82.4 – 90.1) | 322 |
| *Previous acute STI in past 5 years* | | | | | |
| No | 24.5 (22.5 – 26.6) | 19.7 (17.8 – 21.6) | 4.0 (3.9 – 6.0) | 75.5 (73.4 – 77.5) | 1729 |
| Yes | 24.9 (21.1 – 29.1) | 20.1 (16.7 – 24.0) | 4.8 (3.1 – 7.1) | 75.1(70.9 – 78.9) | 481 |

| Characteristics | Overall HIV positive | *Clinically recognised HIV infection prior to visit* | *Undiagnosed HIV infection prior to visit* | HIV negative | Number surveyed |
|---|---|---|---|---|---|
| | (n= 544)<br>% (95% CI) | (n=438)<br>*% (95% CI)* | (n=106)<br>*% (95% CI)* | (n=1666)<br>% (95% CI) | |
| **HIV TEST HISTORY** | | | | | |
| *Date of last negative HIV test* | | | | | |
| Never tested negative | 48.8 (45.5 – 52.0) | 41.9 (38.7 – 45.2) | 6.8 (5.3 – 8.7) | 51.3 (48.0 – 54.5) | 936 |
| <12 months ago | 6.6 (4.8 – 8.9) | 3.9 (2.5 – 5.8) | 2.9 (1.7 – 4.6) | 93.4 (91.1 – 95.2) | 588 |
| 12-23 months ago | 6.5 (4.2 – 9.6) | 4.2 (2.4 – 6.9) | 2.3 (1.0 – 4.4) | 93.5 (90.4 – 95.8) | 354 |
| 24 to 59 months ago | 7.6 (4.6 – 11.8) | 2.1 (0.7 – 4.9) | 5.5 (3.0 – 9.2) | 92.4 (88.2 – 95.4) | 236 |
| 60 or more months ago | 8.3 (3.7 – 15.8) | 3.1 (0.6 – 8.7) | 5.2 (1.7 – 11.7) | 91.7 (84.2 – 96.3) | 96 |
| *Number of previous negative HIV tests* | | | | | |
| Never tested negative | 48.8 (45.5 – 52.0) | 41.9 (38.7 – 45.2) | 6.9 (5.3 – 8.7) | 51.3 (48.0 – 54.5) | 936 |
| 1 | 7.6 (5.8 – 9.8) | 4.2 (2.9 – 5.9) | 3.4 (2.2 – 5.0) | 92.4 (90.2 – 94.2) | 735 |
| 2 | 5.1 (3.1 – 7.9) | 2.4 (1.1 – 4.6) | 2.7 (1.3 – 4.9) | 94.9 (92.1 – 96.9) | 371 |
| 3-4 | 7.1 (3.5 – 12.7) | 3.5 (1.2 – 8.1) | 3.5 (1.2 – 8.1) | 92.9 (87.3 – 96.5) | 141 |
| 5+ | 7.4 (0.9 – 24.3) | 3.7 (0.01 – 19.0) | 3.7 (0.0 – 19.0) | 92.6 (75.7 – 99.1) | 27 |
| *Ever HIV tested; including positive and negative previous tests* | | | | | |
| No | 11.9 (9.3 – 15.0) | 0 | 11.9 (9.3 – 15.0) | 88.1 (85.0 – 90.7) | 544 |
| Yes | 28.8 (26.6 – 31.0) | 26.3 (24.2 – 28.5) | 2.5 (1.8 – 3.3) | 71.2 (69.0 – 73.4) | 1666 |

Note. a. Clinically recognised infections and undiagnosed infections are a subset of overall HIV positive. Thus row percentages are a factor of total sample, and add up to overall positive (24.6%).

### 5.3.4 Factors associated with overall HIV prevalence and undiagnosed HIV prevalence

#### 5.3.4.1 Factors associated with overall HIV prevalence

In univariable analysis, overall HIV prevalence was associated with increasing age, being diagnosed with syphilis at that visit, not being diagnosed with another acute STI at that visit. There was no evidence of a difference in HIV prevalence in MSM who were diagnosed with gonorrhoea at the surveyed visit or a previous acute STI in the past 5 years. Overall HIV prevalence was associated with and increased likelihood of having a previous HIV negative test more than 5 years ago, (OR 1.25, 95% CI 0.58 – 2.66) and never testing HIV negative previously (OR 13.04, 95% CI 10.1 – 16.9) compared with testing in the past 5 years (Table 5.7). However, MSM who had never HIV tested were less likely to be HIV positive than those who had ever HIV tested when both previous HIV positive and negative tests were included (OR 0.34, 95% CI 0.25 – 0.44).

In multivariable analysis, following adjustment for age, previous STI, current STI and HIV testing variables (interval since last negative test, total number of previous negative tests, and ever test previously (including both positive and negative tests)), increasing age remained associated with overall HIV prevalence in each model. Gonorrhoea diagnosis was associated with being HIV positive although only borderline associated in Model 1, which included the HIV testing variable time since last negative HIV test. A diagnosis of syphilis was associated with being HIV positive in crude analysis and attenuated in Model 3 when adjusted for ever HIV tested (including both positive and negative tests). While in Model 1 or 2, adjusting for time since last negative tests and number of negative tests showed less marked attenuation. This is due to the positive confounding effects of ever HIV tested (including both positive and negative) which was strongly associated with syphilis (see Table 5.7). MSM presenting with another acute STI other than gonorrhoea or syphilis were less likely to be HIV positive compared with MSM with no other acute STI in each model. A previous history of acute STIs while not associated with being HIV positive in crude analysis, attenuated in Model 1 and Model 2 when adjusting for time since last negative tests, and number of negative tests, while in Model 3 when adjusting for ever HIV tested (including both positive and negative tests) showed less marked attenuation. This is due to the negative confounding effects of number of negative HIV tests and the interval between them which was strongly associated with previous acute STIs (see Table 5.7).

In multivariable analysis, after controlling for demographic and other behaviour variables, never having a previous negative HIV test was independently associated with testing HIV positive in both Model 1 and Model 2. MSM who had no previous negative HIV test recorded at that clinic were more likely to be HIV positive (adjusted OR 14.91, 95% CI 11.31 – 19.66) compared with men who had a previous negative test recorded in the past 5 years (Model 1). MSM who had no previous HIV negative test recorded were more likely to be positive than MSM who had one previous negative test in Model 2 (OR 12.10, 95% CI 8.85 – 16.55). In Model 3, which included MSM who have tested positive at first HIV test, MSM who never HIV tested had a decreased risk of being HIV positive (OR 0.37, 95% CI 0.28 – 0.50).

**Table 5.7 The distribution (column percentages and 95 % confidence intervals) crude and adjusted odds ratio (95% confidence intervals) of being HIV positive for MSM attending an inner London GUM clinic, January-June 2003**

| | | Crude | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|---|
| | % (95% CI) | OR (95% CI) | AOR[a] (95% CI) | AOR[a] (95% CI) | AOR[a] (95% CI) |
| All respondents | | | | | |
| *Age* | | P<0.001 | P<0.0001 | P<0.0001 | P<0.0001 |
| 16-24 | 2.8 (2.9 – 8.4) | 1.0 | 1.0 | 1.0 | 1.0 |
| 25-34 | 31.8 (27.9 – 35.9) | 4.40 (2.55 – 7.59) | 6.71 (3.79 – 11.89) | 6.66 (3.76 – 11.81) | 4.11 (2.37 – 7.15) |
| 35-44 | 46.5 (42.3 – 50.8) | 9.46 (5.50 – 16.25) | 12.89 (7.27 – 22.84) | 13.07 (7.38 – 23.15) | 8.76 (5.05 – 15.18) |
| 45+ | 18.9 (15.7 – 22.5) | 9.87 (5.57 – 17.49) | 11.38 (6.19 – 20.92) | 11.59 (6.30 – 21.32) | 8.89 (4.97– 15.90) |
| *Diagnosed gonorrhoea at the survey visit* | | P=0.12 | P=0.05 | P=0.06 | P=0.007 |
| No | 93.6 (91.2 - 95.5) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 6.4 (4.5 – 8.8) | 1.38 (0.92 – 2.08) | 1.65 (0.99 – 2.74) | 1.63 (0.98 – 2.72) | 1.83 (1.18 – 2.84) |
| *Diagnosed syphilis at the survey visit* | | P=0.006 | P=0.07 | P=0.07 | P=0.009 |
| No | 97.8 (96.2 – 98.8) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 2.2 (1.1 – 3.8) | 3.11 (1.39 – 6.96) | 2.52 (0.92 – 6.88) | 2.51 (0.92 – 6.84) | 3.15 (1.34 – 7.43) |
| *Diagnosed other acute STI at the survey visit*[b] | | P<0.001 | P<0.0001 | P<0.0001 | P<0.0001 |
| No | 92.3 (89.7 – 94.4) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 7.7 (5.6 – 10.3) | 0.43 (0.30 – 0.58) | 0.40 (0.27 – 0.59) | 0.39 (0.27 – 0.58) | 0.45 (0.31 – 0.63) |
| *Previous acute STI in past 5 years* | | P=84 | P=0.006 | P=0.002 | P=0.10 |
| No | 77.9 (74.2 – 81.4) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 22.1 (18.6 – 25.8) | 1.02 (0.81 – 1.29) | 1.52 (1.13 – 2.04) | 1.60 (1.18 – 2.17) | 0.81 (0.64 – 1.04) |

| | | Crude | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|---|
| | % (95% CI) | OR (95% CI) | AOR[a] (95% CI) | AOR[a] (95% CI) | AOR[a] (95% CI) |
| *Date of last negative HIV test* | | P<0.001 | P<0.0001 | NA | NA |
| Less than 5 years ago | 14.7 (11.8 – 18.0) | 1.0 | 1.0 | | |
| More than 5 years ago | 1.5 (0.6 – 2.9) | 1.25 (0.58 – 2.66) | 1.01 (0.47 – 2.18) | | |
| Never tested negative | 83.8 (80.4 – 86.8) | 13.04 (10.1 – 16.9) | 14.91 (11.31 – 19.66) | | |
| *Total number of previous negative HIV tests* | | P<0.001 | NA | P<0.0001 | NA |
| 0 | 84.0 (80.7 – 87.0) | 11.57 (8.56 – 15.63) | | 12.10 (8.85 – 16.55) | |
| 1 | 10.3 (7.9 – 13.2) | 1.0 | | 1.0 | |
| 2 | 3.5 (2.1 – 5.4) | 0.65 (0.38 – 1.19) | | 0.55 (0.32 – 0.94) | |
| 3+ | 2.2 (1.1 – 3.8) | 0.93 (0.49 – 1.78) | | 0.60 (0.31 – 1.18) | |
| *Ever HIV tested; includes positive and negative tests* | | P<0.001 | NA | NA | P<0.0001 |
| Yes | 88.1 (85.0 – 90.7) | 1.0 | | | 1.0 |
| No | 11.95 (9.3 – 15.0) | 0.34 (0.25 – 0.44) | | | 0.37 (0.28 – 0.50) |

Note. a. Mutually adjusted for all demographic and behavioural variables included in this table unless indicated otherwise; b. This OR is used in the estimation model in Chapter seven; All p-values are tests of trend from the estimated parameters within the model; NA, Not applicable as not included in the model.

#### 5.3.4.2 Factors associated with undiagnosed HIV infection

In univariable analysis, undiagnosed HIV infection was associated with increasing age, being diagnosed with syphilis or gonorrhoea at that visit and not being diagnosed with another acute STI at that visit. In the HIV testing variables, undiagnosed HIV infection was associated with never having a previous negative HIV test for each of the HIV test variables: firstly, compared with having a negative HIV test in the last 2 years, secondly, compared with having one previous negative HIV test and, finally, compared with ever having a previous HIV negative test (Table 5.8).

In multivariable analysis, following adjustment for all demographic and behavioural variables, there was an increase in OR of undiagnosed HIV infection with increasing age. Diagnosis with gonorrhoea was associated with an increased likelihood of undiagnosed HIV infection compared with MSM not presenting with this diagnosis in each of the Models. Presenting with another acute STI other than gonorrhoea or syphilis was associated with a lower likelihood of undiagnosed HIV infection in each Model compared with MSM not presenting with another acute STI. This proportion (shown in Table 5.8) will be used in the final estimation model in Chapter seven.

MSM who had never tested negative previously were more likely to have undiagnosed HIV infection compared with those who had tested less than 5 years ago in Model 1 (OR 4.65, 95% CI 3.00 – 7.22) (Table 5.8), and compared with MSM who had one previous negative test in Model 2 (OR 4.17, 95% CI 2.56 – 6.79). Similarly, MSM who had never HIV tested, this time just including previous HIV negative tests (as undiagnosed excludes all MSM with clinically recognised HIV infection), had a higher AOR of having undiagnosed HIV infection prior to this visit (OR 4.70, 95% CI 3.07 – 7.20).

**Table 5.8 The distribution (column % and 95% confidence intervals), crude and adjusted odds ratio (95% confidence intervals) of having undiagnosed HIV infection[a] for MSM attending an inner London GUM clinic, January-June 2003**

| | | Crude | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|---|
| | % (95% CI) | OR (95% CI) | AOR[b] (95% CI) | AOR[b] (95% CI) | AOR[b] (95% CI) |
| *Age* | | P=0.0005 | P=0.0001 | P<0.0001 | P<0.0001 |
| 16-24 | 5.7 (2.1 – 11.9) | 1.0 | 1.0 | 1.0 | 1.0 |
| 25-34 | 42.5 (32.9 – 52.4) | 2.86 (1.21 – 6.78) | 3.73 (1.55 – 8.98) | 3.76 (1.56 – 9.06) | 3.76 (1.56 – 9.04) |
| 35-44 | 43.4 (33.8 – 53.4) | 4.58(1.94 – 10.82) | 5.97 (2.47 – 14.43) | 6.1 (2.56 – 14.96) | 6.13 (2.54 – 14.81) |
| 45+ | 43.4 (33.8 – 53.4) | 1.44 (0.46 – 4.52) | 1.64 (0.51 – 5.26) | 1.69 (0.52 – 5.42) | 1.66 (0.52 – 5.33) |
| *Diagnosed gonorrhoea at this visit* | | P=0.001 | P=0.002 | P=0.002 | P=0.002 |
| No | 87.7 (79.9 – 93.3) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 12.3 (6.7 – 20.0) | 2.81 (1.51 – 5.23) | 2.90 (1.50 – 5.60) | 2.80 (1.49 – 5.56) | 2.90 (1.50 – 5.59) |
| *Diagnosed syphilis at this visit* | | P=0.03 | P=0.0.07 | P=0.06 | P=0.06 |
| No | 97.2 (92.0 – 99.4) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 2.8 (0.6 – 8.0) | 4.01 (1.12 – 14.45) | 3.57 (0.92 – 13.83) | 3.63 (0.94 – 13.9) | 3.67 (0.95 – 14.10) |
| *Diagnosed other acute STI at this visit*[c] | | P=0.03 | P=0.02 | P=0.02 | P=0.02 |
| No | 91.5 (84.5 – 96.0) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 8.5 (4.0 – 15.5) | 0.46 (0.23 – 0.92) | 0.42 (0.21 – 0.86) | 0.42 (0.21 – 0.85) | 0.42 (0.21 – 0.86) |
| *Previous acute STI in past 5 years* | | P=0.99 | P=0.31 | P=0.27 | P=0.30 |
| No | 78.3 (69.2 – 85.7) | 1.0 | 1.0 | 1.0 | 1.0 |
| Yes | 21.7 (14.3 – 30.8) | 1.00 (0.62 – 1.61) | 1.30 (0.78 – 2.16) | 1.35 (0.80 – 2.29) | 1.31 (0.79 – 2.18) |

| | | Crude | Model 1 | Model 2 | Model 3 |
|---|---|---|---|---|---|
| | % (95% CI) | OR (95% CI) | AOR[b] (95% CI) | AOR[b] (95% CI) | AOR[b] (95% CI) |
| *Date of last negative HIV test* | | P<0.001 | P<0.0001 | NA | NA |
| Less than 5 years ago | 34.9 (25.9 – 44.8) | 1.0 | 1.0 | | |
| More than 5 years ago | 4.7 (1.5 – 10.7) | 1.69 (0.65 – 4.40) | 1.46 (0.55 – 3.91) | | |
| Never tested | 60.4 (50.4 – 69.7) | 4.00 (2.60 – 6.01) | 4.65 (3.00 – 7.22) | | |
| *Total number of previous negative HIV tests* | | P<0.001 | NA | P<0.0001 | NA |
| 0 | 61.3 (51.4 – 70.6) | 3.69 (2.29 – 5.93) | | 4.17 (2.56 – 6.79) | |
| 1 | 23.6 (15.9 – 32.8) | 1.0 | | 1.0 | |
| 2 | 9.4 (4.6 – 16.7) | 0.77 (0.37 – 1.62) | | 0.70 (0.33 – 1.49) | |
| 3+ | 5.7 (2.1 – 11.9) | 1.04 (0.42 – 2.60) | | 0.82 (0.32 – 2.13) | |
| *Ever HIV tested; includes only previous negative tests[d]* | | P<0.001 | NA | NA | P<0.0001 |
| Yes | 38.7 (29. – 48.6) | 1.0 | | | 1.0 |
| No | 61.3 (51.4 – 70.6) | 3.93 (2.62 – 5.89) | | | 4.70 (3.07 – 7.20) |

a. Excludes 438 MSM with previously diagnosed HIV infection; b. mutually adjusted for demographic and behavioural variables in this table (unless indicated otherwise) via logistic regression modelling. c. This OR is used in the estimation model in Chapter seven; d. Now only includes previous negative tests as clinically recognised HIV infections excluded; NA Not applicable as not included in the model; AOR adjusted odds ratio; OR, odds ratio; All p-values are tests of trend from the estimated parameters within the model.

### 5.3.5 Factors associated with both HIV testing and risk of HIV infection

The factors that were associated with both HIV testing and risk of HIV infection are summarised in Table 5.9. The variables that were associated both with HIV testing and HIV prevalence are in italic and variables associated with either HIV testing or risk of HIV infection are highlighted in bold. This section first looks at variables associated with HIV testing, then with HIV infection and finally variables associated with both HIV testing and HIV infection.

Increasing age group and a previous diagnosis with an acute STI were positively associated with previous HIV testing. Being diagnosed with an acute STI (other than gonorrhoea or syphilis) at survey visit was negatively associated with previous HIV testing.

Non-linear increasing age (peak at 35-44 years) and a diagnosis of gonorrhoea at survey visit were positively associated with HIV infection. Being diagnosed with an acute STI (other than gonorrhoea or syphilis) at survey visit was negatively associated with HIV infection.

Increasing age group was positively associated with previous HIV testing and HIV infection. Diagnosis with another acute STI (other than gonorrhoea or syphilis) at the survey visit was associated with a reduced odds of ever HIV testing and of HIV infection compared with no other acute STI.

MSM who had an STI other than gonorrhoea or syphilis were less likely to have had a previous HIV test and had lower odds of being HIV positive than MSM without another acute STI. Hence, it was important to distinguish between types of STI in the estimation model. Being diagnosed with gonorrhoea or syphilis at the clinic visit, while both strongly associated with risk of HIV infection, provided no evidence of an association with HIV testing at the same visit. Previous HIV testing history was associated with a HIV test at survey visit. Two thirds of MSM who did not test at survey visit, had never previously HIV tested, while over a half of those who tested, had tested previously in the past 2 years. Surveillance methods collect concurrent HIV test with STI diagnosis, not past HIV test history.

**Table 5.9 Odds ratios with their 95% confidence intervals for variables which are associated with HIV testing, HIV infection and undiagnosed HIV infection in MSM. Results for different logistic regression models for each outcome are shown in separate columns**

| Variables | Number (%) of MSM | AOR (95% CI)[a] | | |
|---|---|---|---|---|
| | | Ever HIV Tested | HIV infection (known and unknown) | Undiagnosed HIV infection |
| *Age group* | | | | |
| <25 | 288(13.0) | *1.0* | *1.0* | *1.0* |
| 25-34 | 889(40.2) | *2.22 (1.67 - 2.94)* | *4.11 (2.37 - 7.15)* | *3.76 (1.56 - 9.04)* |
| 35-44 | 740(33.5) | *2.58 (1.91 - 3.48)* | *8.76 (5.05-15.18)* | *6.13 (2.54-14.81)* |
| 45+ | 293(13.3) | *2.62 (1.81 - 3.79)* | *8.89 (4.97- 15.90)* | *1.66 (0.52 - 5.33)* |
| *Diagnosed with gonorrhoea at survey visit* | | | | |
| No | 2096 | 1.0 | **1.0** | **1.0** |
| Yes | 114 (5.2) | 0.81 (0.53 - 1.24) | **1.83 (1.18 - 2.84)** | **2.90 (1.50 - 5.59)** |
| *Diagnosed with syphilis at survey visit* | | | | |
| No | 2186 | 1.0 | **1.0** | 1.0 |
| Yes | 24 (1.1) | 0.87 (0.34 - 2.24) | **3.15 (1.34 - 7.43)** | 3.67 (0.95-14.10) |
| *Diagnosed with other acute STI survey visit* | | | | |
| No | 1888 | *1.0* | *1.0* | *1.0* |
| Yes | 322(14.6) | *0.75 (0.57 - 0.99)* | *0.45 (0.31 - 0.63)* | *0.42 (0.21 - 0.86)* |
| *Diagnosed with previous acute STI in last 5 years* | | | | |
| No | 1729 | **1.0** | 1.0 | 1.0 |
| Yes | 481(21.8) | **2.61 (1.94 - 3.51)** | 0.81 (0.64 - 1.04) | 1.31 (0.79 - 2.18) |

Note. a. For variables that were associated with both HIV testing and HIV infection OR for the associations are highlighted in italic, for variables associated with either HIV testing or HIV infection OR for the associations are highlighted in bold; b. each OR was adjusted for all the variables within the models presented in Table 5.5, Table 5.7, Table 5.8, these included, age, diagnosed STIs, previous STIs and HIV testing variables; AOR, adjusted odds ratio; CI, confidence intervals.

## 5.4 Discussion

### 5.4.1 Factors associated with overall and undiagnosed HIV prevalence

Three quarters of MSM attending the GUM clinic had ever HIV tested. Previous HIV testing was associated with increasing age, previous acute STIs and not presenting with another acute STI.

Overall HIV prevalence was high in this population of MSM attending an inner London GUM clinic, at 24.6%. Older MSM were more likely to be HIV positive than MSM aged less than 25. Overall HIV prevalence in MSM varied according to clinical presentation at the clinic, and by previous HIV testing patterns within MSM. Undiagnosed HIV prevalence, i.e. HIV infection detected in specimens from attendees without clinically recognised HIV infection before this clinic visit, was also high: 4.8% of the sample had undiagnosed HIV infection. MSM aged 35-44 years were most likely to have undiagnosed HIV infection. Undiagnosed HIV prevalence showed a similar pattern of associations as overall HIV prevalence and varied by clinical presentation of STIs and by previous HIV test history.

A large proportion (42%) of HIV positive MSM are diagnosed at the first HIV test. HIV prevalence increased with time since last HIV negative test. If MSM who have never tested negative (including those diagnosed HIV positive at first test) were compared with MSM with a previous negative test then they were fifteen times more likely to be HIV positive than MSM who had tested in the past 5 years, and 12 times more likely to be HIV positive than MSM with one previous negative test. This was in contrast to the hypothesis that MSM who had previously tested were at higher risk of HIV infection compared with MSM who had not HIV tested. However if known HIV positive MSM with no prior negative HIV test were included into the analysis as 'ever HIV tested', then the overall HIV prevalence was higher for MSM who had ever HIV tested than in MSM who had never tested. Indeed non-testers were 70% less likely to be HIV positive compared with ever HIV testers.

When looking at undiagnosed HIV infection, these HIV positive MSM with no previous negative tests are excluded, i.e. looking at the sub-population of MSM who've had past negative HIV tests and compare them with the MSM who have never tested, then never tested MSM were more likely to have undiagnosed HIV infection. Similar to overall HIV prevalence, the prevalence of undiagnosed HIV infection increased with time since the last negative test.

### 5.4.2 HIV testing as a proxy for sexual behaviour

When each event occurs in a timeline it is difficult to assess through cross-sectional studies which happened first; this survey did show that HIV testing at the clinic visit was associated with new STI diagnoses, and thus associated with UAI. MSM presenting with another acute STI other than gonorrhoea or syphilis were less likely to be HIV positive than those not. This may reflect documented outbreaks of syphilis and gonorrhoea in MSM with clinically recognised HIV infection[161] or the sexual networks in which both HIV infection and syphilis and gonorrhoea are circulating. Thus, MSM who present with syphilis and gonorrhoea may be at a higher level of risk behaviour compared with MSM who present with other acute STIs such as genital warts or chlamydia. Being HIV positive was associated with a new diagnosis of gonorrhoea and with previous negative HIV tests more than 5 years ago. This may be because diagnosed HIV positive MSM attended a GUM clinic for an STI and did not disclose their HIV status to the clinician or these may be new incident HIV infections. It is difficult to determine this; but these results reinforce the need for MSM attending GUM clinics with acute gonorrhoea to be offered and recommended HIV testing as the national standards set in the National Strategy for Sexual Health and HIV state[151].

Sexual behaviour was not collected in this survey, but if HIV testing is thought to be a proxy for sexual behaviour then its association with HIV infection must be similar to the association of UAI with HIV infection. Clearly an individual's HIV infection status is an important determinant of future sexual behaviour. It has been shown that some MSM are using HIV testing to determine their HIV status in order to make decisions about their sexual behaviour within relationships based on their test results[79,190,206]. This has been termed 'negotiated safety'. However, two studies within Britain have shown that between 16% and 25% of MSM surveyed who stated that they had only had UAI with men of the same serostatus, have never had an HIV test[49,52]. In addition, other studies have shown that of men who were practising negotiated safety, many of the partners with whom they had UAI were casual partners of unknown status[79]. Regular testing is described as part of healthy behaviour, for responsible MSM, who choose to test annually or biannually as part of a sexual health check[67]. These associations do not hold true in the UK where the overwhelming reason for HIV testing seems to be associated with risk and even MSM who test regularly may be prompted by an event which causes them to doubt their negative status, and re-test. A case control study of repeat HIV testers in the UK found that among men engaging in high-risk sexual behaviour, negative HIV tests contributed to reduced risk perceptions and continued or increased risk-taking[78]. Qualitative interviews of HIV seroconverters found that HIV negative test results gave the MSM a sense of immunity. They also reassured them

that the UAI which had prompted them to have a HIV test was not as risky for HIV infection as they had thought[78].

There was no difference in the prevalence of HIV testing in MSM by an individual's perception of self-reported perceived risk of HIV infection in Natsal 2000, although a third of men who reported same-sex partners had been tested in the past 5 years[8]. The majority of MSM recruited through a community survey in London reported 'not putting themselves at risk' as the reason for not HIV testing in the last year (34%)[157]. However, of these men 29% reported UAI in the last year. Behavioural surveys in the UK found that men that reported HIV testing in the past year were likely to report both an STI, and UAI in the past year[157]. HIV testing was associated with increasing numbers of sexual partners in Natsal (Chapter three, Table 3.2). So HIV testing may denote many different types of behaviour and there are many reasons for having an HIV test. The overall evidence suggests that those who have ever HIV tested have higher behavioural risk than those who haven't tested.

HIV testing at the clinic must be a combination of both offering and decision making by the MSM, as some of the attendees who have not tested at this visit haven't tested before either, even if they have had previous visits and previous episodes of STI.

### 5.4.3 Limitations of the UA GUM survey

A major strength of this survey was that it enabled the direct measurement of HIV status associated with HIV testing. However, some limitations to the interpretation of the results should be noted. While the UA methodology minimises participation bias within the setting, it is possible that those MSM with lower HIV risk who do not have a HIV test were less likely to seek treatment at GUM clinics. Thus, this survey of GUM clinic attendees provides prevalence and associations with both overall HIV infection and undiagnosed HIV infection for a higher-risk population of MSM. In addition the men surveyed through this survey are only those who have been screened for syphilis at their visit. This may represent a higher-risk population, if only higher-risk MSM who have been at behavioural risk get screened for syphilis at the clinic. The current syphilis testing policy for GUM attendees remains unchanged for many years and recommends screening of all GUM attendees at first visit, and subsequently according to risk[207,208]. Outbreaks of syphilis among MSM since 1997, particularly among HIV positive MSM[160,161,209], have led to recommendations in 2003 to test all MSM attending GUM clinics, regardless of HIV status, as HIV positive men attending specialist HIV services at the clinics were not always routinely tested[210]. This should have led to the testing of

all GUM attendees, thus making the sample surveyed in this clinic more representative of all MSM attending the clinic.

There are limitations to interpretations of UA programme data. There is an assumption that prevalence in the residual specimens and the patient group are equivalent to the population it is taken to represent; that is, that HIV prevalence in MSM attending GUM clinic is representative of all MSM (Figure 5.1). It also assumes that the HIV seroprevalence estimates measured in centres included in the surveys are representative of seroprevalence in all centres within that geographic region. This survey only represents MSM at one inner London clinic and may not be representative of the population of MSM attending other GUM clinics in England.

A further limitation to this study is that it involves only one GUM clinic in inner London. This clinic could be different from other clinics. However, the GUM clinic surveyed, the Mortimer Market Clinic, serves a diverse population of MSM, with one-third born abroad, and they have a broadly similar age distribution to the Natsal national sample of MSM[170]. HIV test history was collected in this survey for all HIV tests previously carried out at the clinic or reported last negative HIV test recorded on the survey card for attendees without clinically recognised HIV infection. This may lead to an under-reporting of true HIV test history, as not all MSM will have had previous negative HIV tests at this clinic, and may not provide information to their clinician on all previous negative HIV tests carried out at other GUM clinics. This would lead to an underestimate of past HIV testing. Overall, 59% reported a previous negative HIV test and a further 16% had previously tested HIV positive without a recorded HIV negative test. Of MSM surveyed through Natsal overall, 35% reported a previous HIV test, and 74% of MSM who had attended a GUM clinic in the past 5 years also had a HIV test in that period[170]. Other convenience samples of MSM surveyed through community surveys gave the following results: of MSM recruited in bars, clubs and saunas, 76% reported a previous HIV test (69% for whom it was negative), 83% of gym attendees surveyed and 55% of gay pride attendees reported ever having a previous HIV test[94,157,211]. HIV status of these previous tests was not collected in the latter two studies.

The survey clinic may have more HIV positive MSM attending although, as long as their previous HIV testing history was recorded, the association with HIV testing could still be measured. If the clinic had more drop-in visits from MSM not disclosing their clinical HIV diagnosed positive status as they require testing for an STI and don't want

to be told to alter their sexual behaviour and so decline HIV testing. A social-desirability effect could systematically bias the study leading to a high undiagnosed HIV prevalence misclassified as undiagnosed. If the HIV testing policy was different at this clinic from others, then the association between testing and risk of HIV infection measured from this study would not be generalisable to the general population of MSM attending GUM clinics.

This study does not collect sexual behaviour data, thus making it difficult to draw associations between high-risk sexual behaviour, HIV testing and HIV infection. However, it did collect biological outcomes, which are robust laboratory-confirmed diagnoses rather than self-reported STI and HIV diagnoses and thus give it a strong reliability.

How would bias in the clinic population affect the association between HIV testing and risk of HIV infection? The possible biases, the mechanism by which they might be introduced, and the effect it would have on the association between HIV testing and HIV prevalence in the study are summarised below in Table 5.10. The HIV prevalence for this study was only for one clinic. This was compared with the survey prevalence in the national study and while the prevalence differed, there was no evidence to suggest that the association between risk of infection in untested compared with tested might differ in London overall. Outside London, this might not be the case, because the background HIV prevalence is lower, and HIV testing prevalence is higher, as seen from Chapter three. The proportion of HIV infections that remain undiagnosed are high outside London compared with in London, based on the national UAPMP GUM survey results.

Differences between the population in the study clinic and the population of all MSM would lead to a lack of generalisability of the study results. Further adjustments to the model would need to be made to take account of some of these possible differences. Whether such differences exist are explored in a formal fashion in Chapter six and then allowed for in the estimation model as detailed in Chapter seven. This will be done in Chapter seven through sensitivity analyses factoring in the range of possible variations.

Finally, while the overall sample size for the survey was high, when stratified, small sample size in some sub-groups may have led to loss of power with resulting inability to detect associations.

**Table 5.10 Possible biases in UA GUM study and how it would affect the association between HIV testing and HIV prevalence**

| Bias | Mechanism | Effect on the association between previous HIV testing and HIV prevalence |
|---|---|---|
| Selection of people at low-risk of HIV into the survey. | If MSM with less risk behaviour HIV test more and have a decreased risk of HIV infection compared with the general population of MSM | Underestimation of the association |
| Selection of people at high-risk of HIV into the survey. | If GUM clinic population had more STIs and increased risk of HIV infection as resident in inner London, and higher HIV testing rates as HIV testing is promoted in GUM clinic | Overestimation of the association |
| Misclassification bias | If MSM not disclosing diagnosed HIV status, this would lead to an increase in newly diagnosed HIV infection, or (if they refuse a test at this occasion) a decrease in HIV testing and an increase in undiagnosed HIV infection | Underestimation of the association |
| Selection of a predominately young and/or educated population which introduces associations not seen in the total population | If people attending a GUM clinic are more likely to be a different SES and/or age from the rest of MSM | This would lead to an association of HIV testing with age or SES which might not be there in the rest of the population, or to not detecting an association with age and SES that was there in the total population (negative confounding) |

## 5.5 Conclusions

In summary, MSM who had a HIV test recorded at the GUM clinic visit were more likely to have a history of testing previously. Ever HIV testing was associated with age, having a previous acute STI in the past 5 years and being diagnosed with another acute STI at the survey visit. Overall HIV prevalence was positively associated with increasing age. HIV prevalence was higher in those with syphilis and gonorrhoea

diagnoses when compared with MSM who were diagnosed with an acute STI other than these. The interval since last negative HIV test was associated with having an undiagnosed HIV infection and the adjusted OR were twice that for MSM who have HIV tested more than 5 years ago compared with MSM who have HIV tested in the past 2 years. The adjusted OR of having undiagnosed HIV infection were six times higher for MSM attending a GUM clinic who have never HIV tested before, compared with MSM who had a negative HIV test in the past 2 years. The peak age of undiagnosed HIV infection was in MSM aged 35-44 years old.

HIV prevalence was associated with HIV test history in MSM and thus HIV test history could be used to estimate how much undiagnosed HIV infection there currently is within a population of MSM.

This study surveyed the sub-population of MSM who attend GUM clinics. These men may not be representative of all MSM, and may have a higher HIV prevalence than MSM who do not attend GUM clinics, as they are diagnosed with STIs which put them at higher risk of HIV infection. It is likely that they have more HIV tests than MSM who do not attend GUM clinics since most HIV tests in Britain are carried out at GUM clinics[8]. To test the hypothesis that lower-risk MSM do not HIV test as often and are less likely to be HIV positive, HIV prevalence in a sample of MSM not attending GUM clinics is needed. However, these are not a population routinely captured through surveillance programmes. A community survey of MSM attending bars and clubs in inner London was carried out in 2001. Chapter six will assess HIV prevalence in MSM recruited as GUM attendees and HIV prevalence in non-GUM recruited MSM using results from this bar- and club-recruited survey.

# CHAPTER SIX

## *HOW DO GUM ATTENDEES COMPARE WITH ANOTHER POPULATION OF MSM? – A COMPARISON OF A UA SURVEY OF MSM ATTENDING BARS AND CLUBS WITH THE UA GUM SURVEY*



### Summary

This study compared HIV prevalence in MSM recruited through a GUM clinic with MSM recruited though bars and venues in the community (both standardised to an external, national population of MSM) to compare HIV prevalence estimates in these two populations. HIV prevalence was higher in the community-recruited population, of whom a sub-set may be at higher risk of HIV compared with the GUM-recruited group.

## 6.1 Introduction

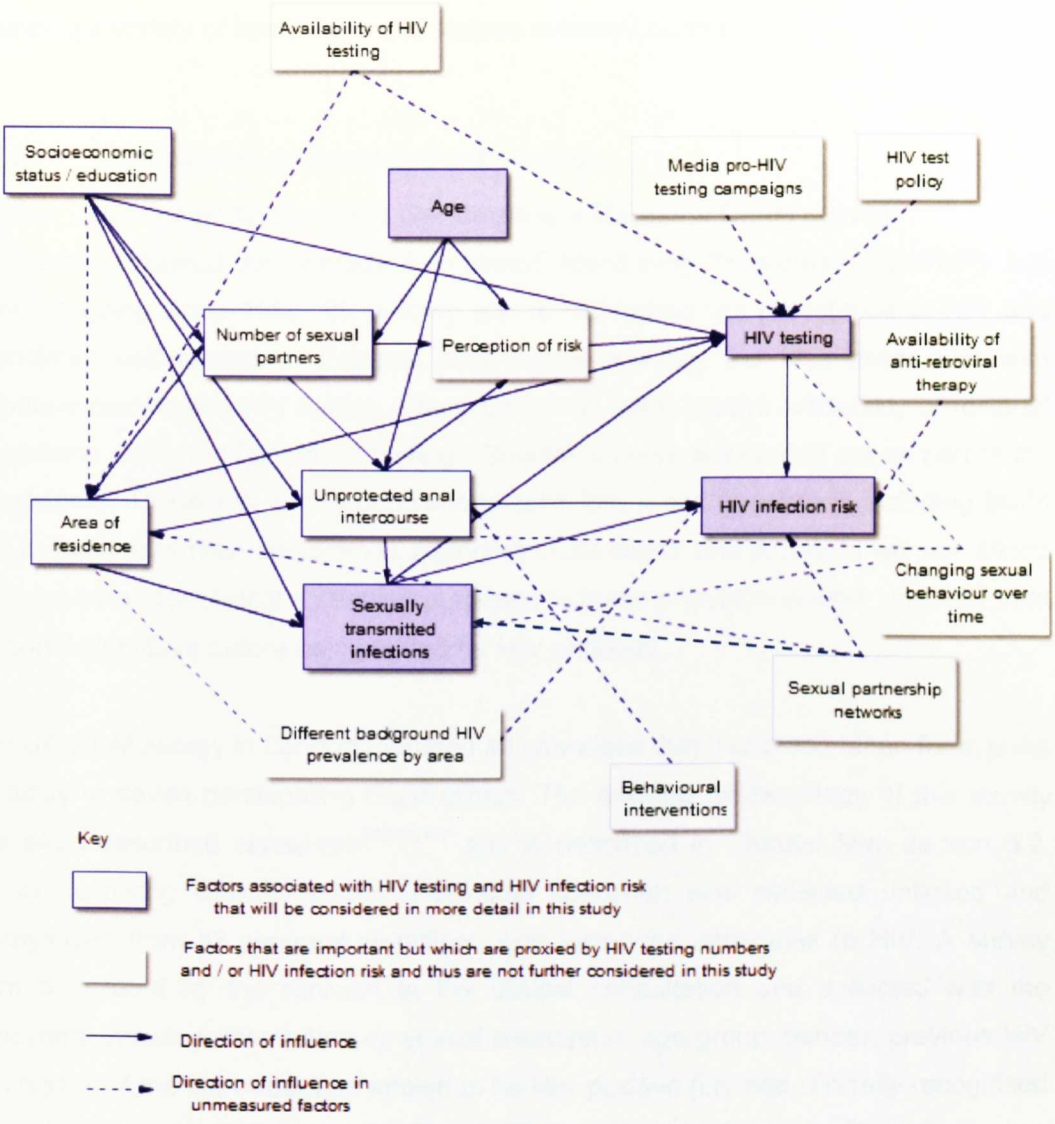
The study in chapter five provided an estimate of the risk of HIV infection by testing patterns in MSM attending a GUM clinic. It showed that **overall** HIV prevalence was higher in MSM who had ever tested compared with those who had not. In contrast, undiagnosed HIV prevalence was higher in MSM who had not HIV tested when compared to people who had ever tested HIV negative before. These findings were conditional on attending a GUM clinic, and thus may not be generalisable. This Chapter investigated the differences in HIV prevalence between MSM recruited through GUM clinics and MSM recruited through a community-based survey to provide a further estimate of risk of HIV infection for non-GUM attendees.

This chapter investigates the following question:

1. How does HIV prevalence in MSM recruited through a GUM clinic compare with the general population of MSM?

Combined with results from Chapter five, this will answer objective 5 (Chapter one, section 1.5), model the association between HIV testing and HIV prevalence, and HIV testing and sexual behaviour in the general population of MSM. The variables that will be investigated in this chapter are highlighted in blue in the conceptual graph below (Figure 6.1).

**Figure 6.1 Conceptual framework of the relationship between HIV testing and risk of HIV infection mediated through risk behaviour: Measuring the association between HIV testing and HIV prevalence**




## 6.2 Methods

HIV prevalence measured in MSM being tested for syphilis from seven GUM clinics in London as part of the UA GUM survey (described in Chapter five)[192] was compared with that in a community-recruited sample of MSM (recruited from 54 venues including bars, clubs and saunas in inner London) as part of the GMSHS[155]. Both studies will be described below.

### 6.2.1 Setting

The UA GUM survey recruited all MSM attending seven London GUM clinics who were screened for syphilis. The GMSHS recruited MSM in the community from 54 venues attending a variety of bars, clubs and saunas in Inner London.

### 6.2.2 Participants and survey methodology

#### 6.2.2.1 Unlinked Anonymous Genitourinary Medicine Clinic survey

A national Unlinked Anonymous Prevalence Monitoring Programme (UAPMP) has been on-going since 1990. Its primary aim is monitoring the prevalence of HIV and associated risk factors in England and Wales avoiding the bias associated with voluntary confidential HIV testing. The programme relies on the availability of residual specimens, collected for clinical testing. Several surveys are carried out as part of the programme. These are in sub-populations collecting blood specimens including MSM and heterosexual men and women attending GUM clinics and pregnant women. Blood samples taken for clinical screening purposes in these populations were unlinked from personal identifiers before being tested for HIV antibody.

The UA GUM survey in London recruited all attendees that had blood taken for syphilis serology at seven participating GUM clinics. The detailed methodology of this survey has been described elsewhere[90,191,192] and is described in Chapter five, section 5.2. Briefly, following clinical testing, a residual specimen was collected unlinked and anonymised from all personal identifiers, and tested for antibodies to HIV. A survey form completed by the clinician at the clinical consultation and collected with the specimen, included information on sexual orientation, age group, gender, previous HIV test history, if the individual was known to be HIV positive (i.e. had clinically recognised HIV infection), and STI diagnoses (list of STI groupings in Appendix B) at the survey visit. This survey form was returned by the clinician to the survey team at the HPA, Centre for Infections, and linked through a barcode to the residual specimen. The residual specimen was tested for antibodies to HIV at the HPA Centre for Infections, using an in-house assay for screening and a commercially available ELISA (GACELISA HIV 1 and 2, Abbott Laboratories, Maidenhead, UK) for confirmatory testing of reactive specimens, and a Western blot (Genelabs HIVblot 2.2) where discordant results were obtained by an established algorithm[212,213].

#### 6.2.2.2 Limitations to interpretation of unlinked anonymous genitourinary medicine clinic survey

There are limitations to the interpretation of UA programme data. UA testing relies on

the availability of residual specimens, collected for clinical testing for other reasons. The UA GUM survey, which includes seven of the 34 GUM clinics in London, assumes that the HIV seroprevalence estimates measured in clinics included in the surveys are representative of seroprevalence in all clinics within that geographic region. The GUM clinics were not selected randomly, although the selection of the clinics was based on the size of the population attending each clinic within each region, to include large, medium and small clinics from each region[214]. While the UA methodology minimises participation bias within its setting, it is possible that MSM who do not attend GUM clinics have a different behavioural association between HIV testing and risk of HIV infection. MSM who attend GUM clinics are likely to be at higher behavioural risk of HIV than MSM who do not attend GUM clinics[99]; MSM recruited from the community also were at higher behavioural risk of HIV if they reported GUM attendance[157]. Clinically diagnosed HIV infection may not be disclosed by MSM attending a GUM clinic for treatment of an STI, thus leading to an overestimate of undiagnosed HIV prevalence. Thus, this population may overestimate HIV prevalence in the general population of MSM, i.e. may not be generalisable. Although prevalence may be overestimated when generalised from GUM clinics to the general population, GUM data may still yield information on trends, provided that behavioural factors associated with GUM clinic attendance and HIV testing remained constant over time.

#### 6.2.2.3 Gay Men's Sexual Health survey

The GMSHS was a community survey of MSM men attending bars, clubs and saunas in Inner London recruited in a 3-week period annually. All men in the venue for over a 1-hour period are handed a questionnaire. The sampling time within the evening varied by venue, as did the exact method of sampling. Some MSM were sampled while queuing at the door to be admitted to the club, while others within a particular area of the bar or club were sampled. The detailed methodology of this survey has been described elsewhere[155]. A sampling frame was constructed by compiling a list of all venues used by MSM in London including GUM clinics, bars, clubs, community groups and saunas. The survey selected 71 recruitment venues from this sample frame of all commercial gay venues (bars, clubs and saunas) and GUM clinics within inner London. A response rate of 68% was calculated based on a total of 2,426 questionnaires being handed out and 1,644 completed[155]. Not all respondents completed the saliva test and the response rate including the saliva test was 58% (1,409/2,426).

Sites at which questionnaires were to be distributed were selected to be representative by geography and type of site. Outdoor public-sex environments were not included in

the study following a pilot study which found a poor response rate of questionnaires at these sites[215]. A sample of a short 20-item self-completion questionnaire covering topics including demographics, sexual behaviour, HIV testing history and perceived HIV status was collected. An oral fluid sample was collected using an Orasure™ (Orasure Technology Ins, Bethlehem PA, USA) collection device, and linked to the questionnaire via a barcode. This specimen was tested for anti-HIV at the HPA Centre for Infections using GACELISA HIV1 and 2 (Abbott Laboratories, Maidenhead, UK). Specimens reactive in the GACELISA assay were also examined by a Western blot test (Genelabs HIV blot 2.2)[216,217].

In 2001 an additional question was added to the self-completion questionnaire asking whether the individual had a test for syphilis in the last year. This was used as a proxy for GUM attendance, to allow a direct comparison with the UA GUM survey, since the residual blood samples tested in the UA GUM survey were from samples taken for syphilis serology.

#### 6.2.2.4 Participation biases in Gay Men's Sexual Health Survey

The GMSHS survey is not representative of the general population of MSM, but of a higher-risk more sexually active group. A comparison of the survey with Natsal 2000 has been published by the survey investigators[184]. They found that while MSM surveyed in the GMSHS had a broadly similar proportion reporting sex in the past year to Natsal 2000, they had higher levels of HIV risk behaviour, were more likely to report previous STIs and HIV testing than the Natsal population. The investigators concluded that the GMSHS was likely to overestimate levels of risk behaviour if taken to reflect all MSM.

A number of possible sources of bias exist for this study. Sexual behaviour research is subject to some biases that may affect the representativeness of results[218]. While random population based survey sampling could overcome some of self-selection biases it would still not fully protect against non-participation bias. In addition targeted population surveys are a useful adjunct to these general population surveys as they give greater detail on populations at highest risk[7]. The disadvantage of targeted surveys is that they are likely to be unrepresentative of the general population of MSM, given the nature of the convenience sampling. Those accessed through this mixture of social venues can only be representative of MSM using these sites, and the sites selected to be in the survey may not be the same as those that were not included. In addition, even among venue attendees the behaviour of study respondents may systematically differ from non-respondents. The GMSHS had a participation rate of

58%; MSM who complete the questionnaire and give a saliva sample for HIV testing may be behaviourally different, or have a different HIV serostatus from those who did not participate. Studies have shown that volunteers in sexual behaviour studies can tend to be more sexually experienced, and have more relaxed sexual attitudes and behaviours than those randomly selected from the general population[219,220]. Behaviours that are thought to be not socially acceptable may not be reported (reporting bias). As the GMSHS was carried out via a self-completion form it should reduce the social-desirability bias that might be more likely in a face-to-face interview. The survey was not weighted to adjust for non-response as it is not attempting to be representative of the general population. In order to overcome this problem, a number of targeted surveys from a range of settings are needed, in order to ensure a better overview on whether associations found in one study remain consistent in a different setting.

### 6.2.3 Definitions of HIV status

An individual was defined as having undiagnosed HIV infection when the specimen tested positive for antibodies to HIV but the survey respondent was not known to have clinically diagnosed HIV infection when the survey form was completed. In the UA GUM survey this was defined as when the individual was not reported as having clinically recognised HIV infection (known to be HIV positive) by the clinician completing the survey form but the residual specimen tested HIV positive (see Box 6.1).

In the GMSHS this was defined as when the individual either reported never having had an HIV test or reported HIV status as being negative but the saliva specimen tested HIV positive (see Box 6.1).

### 6.2.4 Statistical analyses

The GMSHS was stratified into three groups: (i) the overall community-recruited sample, (ii) only those individuals who reported undergoing syphilis testing in the last year (indicating GUM attendance), and (iii) those MSM who did not report syphilis testing in the last year (indicating non-GUM attendance).

The two populations (UA GUM survey and GMSHS) were standardised to an external reference population (the Natsal proportion of national MSM multiplied by the census population of men) to provide comparable undiagnosed HIV prevalence estimates in these two groups, and prevalence ratios were calculated to compare both populations. This comparison was used for providing a lower and higher behavioural risk adjustment

for the estimation model in Chapter seven. This is described in more detail below.

Age-specific overall HIV prevalence was calculated from the total number of HIV positive specimens in each age group divided by the total number of specimens tested in that age group. Age-specific undiagnosed HIV prevalence was calculated from the total number of HIV positive specimens that were defined as undiagnosed in each age group divided by the total number of specimens tested in that age group; 95% confidence intervals were calculated for each proportion.

**Box 6.1 Definition of HIV status in surveys**

| Survey | Reported status in survey | | Specimen HIV test result | HIV status |
|---|---|---|---|---|
| UA GUM survey | Clinician report | Not known to be HIV positive | HIV positive | Undiagnosed HIV infection |
| | | Known to be HIV positive | HIV positive | Diagnosed HIV infection |
| GMSHS | Self-report | Never had an HIV test | HIV positive | Undiagnosed HIV infection |
| | | Reported HIV status negative | HIV positive | Undiagnosed HIV infection |
| | | Reported HIV status positive | HIV positive | Diagnosed HIV infection |

Age-standardised HIV prevalence was calculated using the direct standardisation method[221]. The Natsal 2000 population of MSM (defined in Chapter four, section 4.2.1) was used as an external reference population. Natsal 2000 estimated the proportion of men, aged 16 to 44 years, reporting sex with another man in the past 5 years to be 5.5% (4.2 – 7.2) in Greater London[26]. This point prevalence was applied to the 2000 mid-year census estimate of males aged 16 to 44 years[144] to obtain estimates of the numbers of MSM living in London for specific age groups, based on the UA GUM survey age-group categories. These were 16 to 24 years, 25 to 34 years and 35 to 44 years old. To standardise the two populations, the HIV prevalence calculated from

each survey was applied to Natsal estimate of numbers of MSM in that age group, and this gave the expected numbers of HIV infections, if the survey had the same age structure as the Natsal population. This expected number of HIV infections within each age group was added to give the total numbers of expected HIV infections. This was divided by the Natsal total population of MSM, to give the age-standardised HIV prevalence. This was calculated for both survey populations.

A prevalence ratio was then calculated, with the UA GUM population as the reference. This was to compare the measured overall and undiagnosed HIV prevalence, having accounted for differing age structures within the surveys. This was calculated for the following sub-populations; (1) the overall GMSHS survey population, (2) for the GMSHS respondents who reported that they had a syphilis test in the last year (as a proxy for GUM attendance) , and (3) for those who reported that they did not have a syphilis test in the last year (a proxy for non-GUM attendance). All analyses were carried out in STATA (version 7.0) (STATA corp., Statistical software, TX, USA).

## 6.3 Results

### 6.3.1 Comparison of crude overall HIV prevalence in UA GUM survey with GMSHS survey

When examining associations with age in each study separately, there was some evidence for increased prevalence of HIV with increasing age. Within the UA GUM survey, overall HIV prevalence was higher in MSM aged 25-34 compared with under 25 year olds (12.2% v 7.0%) and MSM aged over 35 (21.2% v 7.0%). Within the GMSHS overall, overall HIV prevalence was higher in MSM aged 25-34 years old compared with the under 25 age group (11.8% v 3.0%), and no evidence of a difference between the 25-34 year olds and the over 35 age groups (11.8% v 14.2%). When stratifying the GMSHS survey by whether they had tested for syphilis in the past, there were similar trends of HIV prevalence by age in both groups.

Crude unadjusted HIV prevalence appeared higher in MSM recruited through the UA GUM survey compared with the GMSHS (Table 6.1). When stratifying the GMSHS survey by whether they had tested for syphilis in the past, overall crude HIV prevalence increased to 20.3% in the group with past syphilis tests compared to 7.3% in those without syphilis tests (Table 6.1).

### 6.3.2 Age-adjusted comparison of overall HIV prevalence in GMSHS survey with UA GUM survey

The age-adjusted overall HIV prevalence for both surveys following direct standardisation to the Natsal 2000 MSM population in London is presented in Table 6.1. The HIV prevalence ratio of having HIV infection in the community-recruited survey compared with the UA GUM survey, following adjustment of the population age structures through direct standardisation, is presented in Table 6.1. The age-adjusted prevalence ratio of overall HIV prevalence when compared with the UA GUM survey for the GMSHS overall was 0.77 (95% CI 0.74 – 0.81). When the GMSHS syphilis-testers sample was compared with the UA GUM survey, the age-adjusted HIV prevalence ratio was 1.35 (95% CI 1.30 – 1.40). The age-adjusted HIV prevalence ratio in the non-syphilis sample (i.e. MSM who did not attend a GUM clinic), compared with in the UA GUM survey, was 0.50 (95% CI 0.48 – 0.52). This means that there was evidence for effect modification, i.e. HIV prevalence ratio of GMSHS relative to UAGUM differed by syphilis testing.

**Table 6.1: Ratio of overall HIV prevalence in MSM in UA GUM survey compared with GMSHS, 2001, following direct standardisation to the Natsal 2000 population of MSM in London**

| Age Group | Study population HIV positive/tested | Crude overall HIV prevalence (95% CI) | Natsal population MSM[a] (in thousands) | Expected Infections following direct standardisation | Age-adjusted overall HIV prevalence (95% CI[b]) | Ratio of overall prevalence relative to UA GUM[c] (95% CI[b]) |
|---|---|---|---|---|---|---|
| **UA GUM Survey** | | | | | | |
| 16-24 | 43/613 | 7.0 (5.1 – 9.3) | 17.2 | 120.65 | | |
| 25-34 | 301/2467 | 12.2 (10.9 – 13.6) | 43.1 | 525.87 | | |
| 35-44 | 502/2364 | 21.2 (19.6 – 22.9) | 29.7 | 630.69 | | |
| Total | *846/5444* | *15.5 (14.6 – 16.5)* | 90.0 | 1277.2 | 14.2 (13.5 – 14.9) | 1.0 |
| **GMSHS – Overall** | | | | | | |
| 16-24 | 6/202 | 3.0 (1.1 – 6.4) | 17.2 | 51.09 | | |
| 25-34 | 68/576 | 11.8 (9.3 – 14.7) | 43.1 | 508.82 | | |
| 35-44 | 75/521 | 14.4 (11.5 – 17.7) | 29.7 | 427.54 | | |
| Total | *149/1299* | *11.5 (9.8 – 13.3)* | 90.0 | 987.45 | 11.0 (10.3 – 11.7) | 0.77 (0.74 – 0.81) |
| **GMSHS – Syphilis testers** | | | | | | |
| 16-24 | 4/53 | 7.5 (2.1 - 18.2) | 17.2 | 129.81 | | |
| 25-34 | 39/195 | 20.0 (14.6 – 26.3) | 43.1 | 862.00 | | |
| 35-44 | 41/166 | 24.7 (18.3 – 32.0) | 29.7 | 733.55 | | |
| Total | *84/414* | *20.3 (16.5 – 24.5)* | 90.0 | 1725.37 | 19.2 (18.5 – 19.9) | 1.35 (1.30 – 1.40) |
| **GMSHS – non-syphilis testers** | | | | | | |
| 16-24 | 2/149 | 1.3 (0.2 - 4.8) | 17.2 | 23.09 | | |
| 25-34 | 29/381 | 7.6 (5.2 – 6.7) | 43.1 | 328.06 | | |
| 35-44 | 34/355 | 9.6 (6.7 – 13.1) | 29.7 | 284.45 | | |
| Total | *65/885* | *7.3 (5.7 – 9.3)* | 90.0 | 635.60 | 7.1 (6.4 – 7.7) | 0.50 (0.48 – 0.52) |

a. MSM defined as men who had a homosexual partner in the past 5 years; b. 95% confidence interval calculated accounting for the differing survey denominator sizes; c. Following age-standardisation using Natsal 2000 MSM population as standard; CI, confidence intervals.

### 6.3.3 Comparison of crude undiagnosed HIV prevalence in UA GUM survey with GMSHS survey

When examining crude undiagnosed HIV prevalence in different age-groups within the surveys, undiagnosed HIV prevalence was higher in MSM aged over 35 within the UA GUM survey compared with under 25-34 year olds (21.2% v 12.2%) There appeared to be no difference in prevalence between MSM aged less than 25 and the 25-34 year olds recruited through the UA GUM survey. Within the GMSHS overall, crude undiagnosed HIV prevalence was higher in the 25-34 year olds compared with the under 25 year old age group (9.9% v 2.0%) and there appeared to be no difference between the 25-34 year olds and the over 35 age groups. When stratifying the GMSHS by previous syphilis testing, the was evidence for higher undiagnosed HIV prevalence in 25-34 year olds compared with MSM aged less than 25; syphilis testers: 9.2% v 3.8% and non-syphilis testers: 5.8% v 1.3%. There was no further increase in prevalence in ages 35 and above with patterns across ages looking broadly similar within the two groups (albeit higher undiagnosed HIV prevalence in syphilis testers).

Crude undiagnosed HIV prevalence of 4.5% was detected in MSM through the UA GUM survey and 5.7% in the community-recruited survey of MSM (GMSHS) in 2001 (Table 6.2). When stratifying the GMSHS survey by whether they had tested for syphilis in the past, crude undiagnosed HIV prevalence increased to 7.7% in the group with past syphilis tests compared to 4.7% in those without syphilis tests (Table 6.2).

### 6.3.4 Age-adjusted comparison of undiagnosed HIV prevalence in UA GUM survey with GMSHS survey

The age-adjusted undiagnosed HIV prevalence for both surveys following direct standardisation to the Natsal 2000 MSM population in London is presented in Table 6.2 below. The prevalence ratio of undiagnosed HIV infection in the UA GUM survey compared with in the community-recruited survey following adjustment of the population age-structures through direct standardisation is presented in Table 6.2. The age-adjusted prevalence ratio of having undiagnosed HIV infection in the GMSHS overall was 1.29 (95% CI 1.21 – 1.38) when compared with the UA GUM survey. Again there was evidence of effect modification by prior HIV test history. The undiagnosed HIV prevalence ratio was 1.74 (95% CI 1.63 – 1.84) when comparing the GMSHS sample of men with prior syphilis tests to the MSM in the UA GUM survey. The age-adjusted prevalence ratio of having undiagnosed HIV infection in MSM without syphilis tests in GMSHS (i.e. MSM who did not attend a GUM clinic) compared with the UA GUM survey was 1.09 (95% CI 1.02 – 1.16).

**Table 6.2: Ratio of undiagnosed HIV prevalence in MSM in UA GUM survey compared with GMSHS, 2001, following direct standardisation to the Natsal 2000 population of MSM in London**

| Age Group | Study population HIV positive/tested | Crude Undiagnosed HIV prevalence (95% CI) | Natsal population MSM[a] (in thousands) | Expected Infections following direct standardisation | Age-adjusted undiagnosed HIV prevalence (95% CI[b]) | Ratio of undiagnosed prevalence relative to UA GUM[c] (95% CI[d]) |
|---|---|---|---|---|---|---|
| **UA GUM Survey** | | | | | | |
| 16-24 | 24/613 | 3.9 (2.5 - 5.8) | 17.2 | 67.08 | | |
| 25-34 | 88/2467 | 3.6 (2.9 - 4.4) | 43.1 | 155.16 | | |
| 35-44 | 132/2364 | 5.6 (4.7 - 6.6) | 29.7 | 166.32 | | |
| Total | *244/5444* | *4.5 (3.9 – 5.1)* | 90.0 | 388.56 | 4.3 (4.0 - 4.7) | 1.0 |
| **GMSHS – Overall** | | | | | | |
| 16-24 | 4/202 | 2.0 (0.5 - 5.0) | 4/202 | 34.40 | | |
| 25-34 | 40/576 | 6.9 (5.0 - 9.3) | 40/576 | 297.39 | | |
| 35-44 | 30/521 | 5.8 (3.9 - 8.1) | 30/521 | 172.26 | | |
| Total | 74/1299 | *5.7 (4.5 – 7.1)* | 74/1299 | 504.05 | 5.6 (5.1 – 6.1) | 1.29 (1.21 – 1.38) |
| **GMSHS – Syphilis testers** | | | | | | |
| 16-24 | 2/53 | 3.8 (0.4 - 13.0) | 17.2 | 65.36 | | |
| 25-34 | 18/195 | 9.2 (5.6 - 14.2) | 43.1 | 396.52 | | |
| 35-44 | 12/166 | 7.2 (3.8 – 12.3) | 29.7 | 213.84 | | |
| Total | *32/414* | *7.7 (5.3 – 10.7)* | 90.0 | 675.72 | 7.5 (6.9 – 8.1) | 1.74 (1.63 – 1.84 |
| **GMSHS – non-syphilis testers** | | | | | | |
| 16-24 | 2/149 | 1.3 (0.2 - 4.8) | 17.2 | 23.09 | | |
| 25-34 | 22/381 | 5.8 (3.6 - 8.6) | 43.1 | 248.87 | | |
| 35-44 | 18/355 | 5.1 (3.0 - 7.9) | 29.7 | 150.59 | | |
| Total | *42/885* | *4.7 (3.4 – 6.4)* | 90.0 | 422.55 | 4.7 (4.3 – 5.2) | 1.09 (1.02 – 1.16) |

a. MSM defined as men who had a homosexual partner in the past 5 year; b. Binomial exact 95% Confidence interval; c. Following age standardisation using Natsal 2000 MSM population as standard; d.95% confidence interval calculated accounting for the differing survey denominator sizes; CI, confidence interval; p-value from univariable test for trend.

## 6.4 Discussion

In this study MSM recruited through a GUM clinic were compared with MSM recruited through a community survey to investigate how representative the GUM-recruited survey population are of all MSM. The study showed that there were sub-populations of MSM amongst the GMSHS with different HIV prevalences when compared to the GUM survey, and that ignoring the existence of these differences based on past syphilis testing may lead to misleading conclusions.

Although the crude prevalence of overall HIV infection showed a higher HIV prevalence in MSM recruited through GUM clinics compared with the community-recruited sample, the overall HIV prevalence was higher in the community-recruited sample with past syphilis tests when compared to GUM attenders. The HIV prevalence was lowest for those community-recruited MSM who had not reported a syphilis test (indicating non-GUM attendance). These differences all remained once the prevalence had been standardised to account for the different age structure in the two survey populations (Table 6.2).

When comparing undiagnosed HIV prevalence, a similar picture emerged with a pronounced higher undiagnosed HIV prevalence in those with past syphilis tests in the GMSHS when compared with the UA GUM survey. The age-adjusted prevalence ratio for having **undiagnosed** HIV infection was slightly higher in MSM in the GMSHS who had not had past syphilis test when compared to the UA GUM survey. This meant that once the prevalence had been standardised to account for the different age structure in the two survey populations the prevalence of undiagnosed HIV infection was higher for **all** community-recruited MSM, both syphilis tested in the past year and non-syphilis tested when compared to the UA GUM survey but to a different extent.

Higher-risk behaviours are reported in individuals attending GUM clinics compared with individuals who have not attended in other surveys[99,222,223] and so one might expect the population recruited through the GUM clinic to have overall higher rates of HIV infection than MSM recruited through a community survey. However, even men recruited through the community who had not attended a GUM clinic in the past year had a higher undiagnosed HIV prevalence than MSM recruited through the UA GUM clinic survey. This difference could be due to several factors: men recruited from the community survey could represent a core group of MSM at higher risk of HIV than other MSM, even when compared with a similar population of MSM who received

syphilis testing in a GUM clinic. Their social behaviours and the source of their recruitment, gay bars, clubs and saunas in London, may indicate different sexual behaviour and higher numbers of sexual partners and acquisition of new partners than other MSM[71,99,170]. Previous studies have found that how connected MSM are to the gay scene, measured as frequency of attendance at bars and clubs, may be interpreted in two ways. In the US it has been found to improve health-seeking behaviour because it provides a forum for sexual health education and information about services and treatments and an increased awareness and improved self-efficacy[44]. Indeed sexual health prevention was found to be successful through a 'buddy system' and peer-influence system in the US[224]. However, a similar prevention method was not found to be effective in England[225,226]. Attendance at gay bars and clubs has been associated with meeting new sexual partners[29,96]. In Canada bar and club attendance was associated with increased STI and number of sexual partners[32]. Outbreaks of syphilis, gonorrhoea and HIV seroconversion have all been associated with bars, saunas and bath houses in the past among MSM[116,227] and again more recently in the US[103,119,228-230]. Convenience samples of MSM recruited from different types of venues may therefore capture and measure behaviour in MSM with different levels of risk behaviour. Surveys have found that MSM recruited through the internet differ demographically from those recruited offline: they tend to be younger, less educated and more likely to be from an ethnic minority group[211]. They are behaviourally different; less likely to only have sex with men, less likely to have ever tested for HIV, less likely to be exposed to health promotion messages and more likely to report higher-risk sexual behaviour[94,211]. When this population of internet-recruited MSM in England was age-standardised and compared with the Natsal 2000 survey, the authors found that MSM recruited from the internet, while broadly similar in social and demographic characteristics and equally likely to have HIV tested, were more likely to report an STI in the past year (16.9% v 4.8%, adjusted odds ratio 4.14, 95% CI 1.76 to 9.74), and UAI in the past 3 months (45% v 36.6%; p = 0.064)[231]. However, few if any studies have compared HIV prevalence as a biological outcome from samples of MSM recruited through two different methods. Thus, this study is unique and has strength in the robustness of the outcome measures.

Some limitations should be noted in the interpretation of these results. HIV clinical diagnosis status was determined differently in the two studies: through clinical notes in the UA GUM survey while knowledge of HIV status was self-reported in the GMSHS community survey. This could lead to an under-reporting of clinically recognised HIV infections in the GMSHS community survey. Survey forms were completed out in the field, and individuals may prefer not to report that they are HIV positive on these forms,

even though they are anonymous. However, the overall measured HIV prevalence (both diagnosed and undiagnosed) of MSM being tested for syphilis in the last year was higher in the community-recruited sample when compared with the UA GUM sample. Thus, the differences in HIV prevalence could be a real difference rather than due to misclassification. Alternatively, it could be hypothesised that MSM with clinically diagnosed HIV infection may report themselves as HIV negative when recruited out in the community, due to issues of privacy and social acceptability, rather than HIV negative men misclassifying themselves as HIV positive. This differential misclassification would lead to an overestimate of undiagnosed HIV infections in the community compared with MSM recruited in the clinic and the findings in the study could be seen as consistent with such a mechanism. In addition to selective misreporting of HIV status there is the issue of non-response bias. The population of MSM recruited through the GMSHS community survey may be skewed towards HIV positive men. HIV positive MSM may be more likely to take part in the survey that is carried out to provide information to improve sexual health services for MSM. Altruism can be a strong motivator particularly amongst MSM who are already HIV positive. A similar community survey of sexual behaviour and HIV prevalence, carried out among Africans in London, Luton and the West Midlands in 2004[196], found through qualitative interviews paralleling the quantitative survey that a need to help the community was a primary reason for participation amongst those recruited [232]. How would participation bias affect the associations between HIV testing and risk of HIV infection? If non-responders had a lower HIV prevalence but had HIV tested more, only analysing responders would lead to an overestimate of the association between HIV testing and risk of HIV infection. Alternatively, if the non-responders had higher HIV prevalence and had HIV tested more, then analyses of the responders would underestimate the association between HIV testing and risk of HIV infection. Again, given the strength of the association between HIV testing and HIV infection, while the magnitude of the association may be altered, depending on the direction of the bias, it would be unlikely to be reduced to zero. Thus, bounds of uncertainty should be considered when using estimates from this study.

The discussion in Chapter five, section 5.4.3 in Table 5.10 summarised some possible biases in the UA GUM survey. How these biases might affect the association between previous HIV testing and HIV prevalence if the population of the study clinic were different from the population of all MSM was discussed. Some of these biases were investigated through this comparative study. Whether there was selection bias through recruitment of high- or low-risk MSM compared to all MSM was addressed. Comparison with the community-recruited survey has shown that the sub-population of

MSM recruited through the GUM survey were not at higher risk of HIV infection compared to the MSM who were recruited through bars and clubs who had also being syphilis tested in the previous year. Thus the association between HIV prevalence and HIV testing will not be overestimated using the UA GUM survey results. MSM recruited through the UA GUM survey had a higher overall HIV prevalence and so were not at lower risk than the community-recruited MSM who had not attended a GUM. This indicates that there is unlikely to be an underestimation of the association between HIV testing and HIV prevalence when using UA survey results in the estimation model in Chapter seven. Undiagnosed HIV prevalence was higher in the community-recruited MSM, once HIV prevalence was age-standardised. This indicates that misclassification bias through non-declaration of clinical diagnosis status in the GUM survey may not be a problem, at least compared with the community-recruited MSM.

These two surveys provide samples from two different sub-populations of sexually active MSM: one who is potentially at higher risk of undiagnosed HIV infection, attending bars, clubs and saunas, and a second population attending GUM clinics, which may represent the broader population including MSM at both high and intermediate risk of HIV infection. To fully understand these differences, comparable sexual behaviour variables would need to be collected through the UA GUM survey. The strength of these individual surveys is in their ability to provide estimates of ranges of HIV prevalence and the uncertainty surrounding them.

## 6.5 Conclusions

Combining results from surveys recruiting MSM from a number of different types of sites and venues and through different methodologies would provide a more accurate and representative overall estimate of behaviour and HIV prevalence within different populations of MSM. This analysis provides plausible ranges by which the estimates of total HIV infections in Chapter seven might be adjusted to account for population and differences of associations within selected sub-groups.

# CHAPTER SEVEN

## *ESTIMATING HIV INFECTIONS IN MSM USING HIV TESTING DATA.*



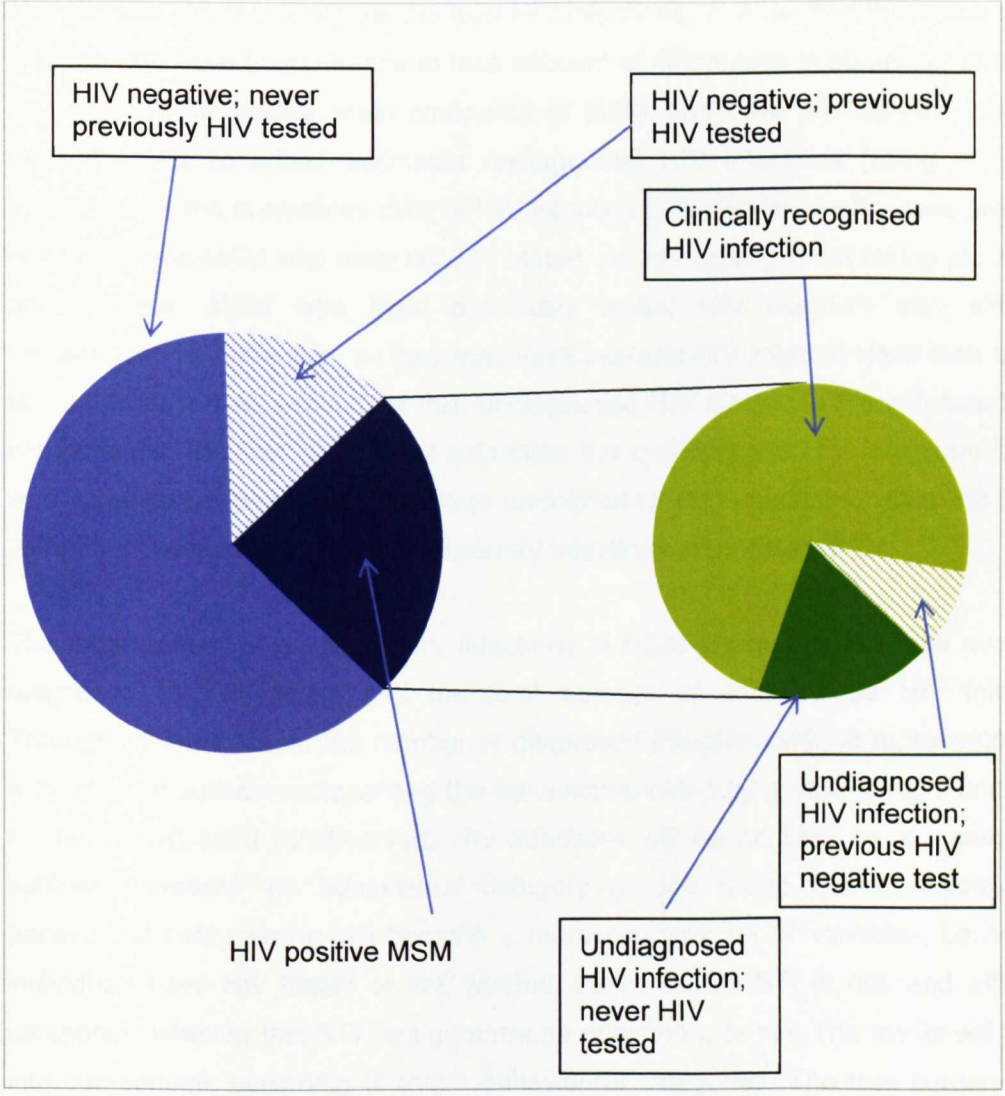
**Summary**

Based on numerical results from the investigations presented in Chapters four, five and six, this chapter describes a parametric model that is based on the conceptual framework described in Chapter two, to enable the estimation of total HIV infections in the general MSM population, including undiagnosed HIV infections. Sensitivity analyses and comparison with estimates of prevalent infections derived from other methods were carried out.

## 7.1 Introduction

Total prevalent HIV infections are represented below in Figure 7.1, as a combination of diagnosed HIV infections and undiagnosed HIV infections, but within a population of MSM who have both previously tested HIV negative and never HIV tested. HIV negative MSM combine MSM who have never HIV tested and MSM who have previously tested negative. HIV positive MSM are a combination of MSM who have clinically diagnosed HIV infection (i.e. they have had a positive HIV test), undiagnosed HIV positive MSM, who have had a previous negative HIV test, and undiagnosed MSM who have never tested. Thus, MSM can be divided into two groups, those who have HIV tested, and those who have never tested. Those who have tested will be both HIV positive and HIV negative, as will those who have never tested.

**Figure 7.1 Total prevalent HIV infections in MSM; clinically diagnosed and undiagnosed HIV infections by previous HIV negative test status**



The current direct method to estimate total HIV infections in the UK was described in Chapter one, Figure 1.4. Briefly, this method estimates total HIV infections through combining data from multiple sources: estimating undiagnosed HIV infections using undiagnosed HIV prevalence from UAPMP surveys and applying this to sub-populations at risk derived from Natsal and adding these to the total diagnosed infections to give total prevalent HIV infections. The Estimating Undiagnosed from the Observed Method that will be described in this Chapter uses aspects of the direct estimation, in that it adds up diagnosed and undiagnosed HIV infections in different strata to produce a total of HIV infections, *Z*. This novel method also uses aspects of the indirect estimation method (which estimates total prevalent HIV infections through combining diagnosed HIV infections with the proportion who have HIV tested), i.e. by working out what the undiagnosed HIV infections may have been, given what is known about the diagnosed infections and the differences between testers and non-testers.

The ultimate aim is to estimate the total HIV infections, *Z*. A method that relies on data in those who have tested needs to take account of differences in behaviour and risk of HIV infection for testers when compared to MSM who have not tested. Hence, the method needs to adjust estimated undiagnosed HIV infections (using an indirect approach) for the prevalence ratio of HIV infection between MSM who have previously HIV tested and MSM who have not HIV tested. As HIV testing is not taking place on an annual basis, MSM who have previously tested HIV negative may still have undiagnosed HIV infection, as they may have become HIV infected since their last HIV test. In order to take account of this, undiagnosed HIV infections are estimated in two components. The first component estimates the undiagnosed HIV infections in MSM who have tested previously, but have undiagnosed HIV infections, while the second component estimates the undiagnosed HIV infections in untested MSM.

The total number of prevalent HIV infections in MSM is equal to the total number of diagnosed HIV infections and the total number of undiagnosed HIV infections. Throughout this section, the number of diagnosed infections will be represented by *Y* with different suffixes representing the behavioural category g, age group i, and region r. The undiagnosed (unobserved) HIV infections will be denoted by *X*, again where suffixes represent the behavioural category g, age group i, and region r. The behavioural categories g will become a more complex set of variables, i.e. whether individuals have HIV tested or not, whether they have an STI or not, and within STI categories, whether that STI was gonorrhoea or syphilis, or not. The model will be split into components according to these behavioural categories. The true burden of HIV infections, *Z*, will then be the sum of all diagnosed and undiagnosed HIV infections

within the different strata of age, region and behavioural categories. The entity *Z* is not actually observed, since the number of undiagnosed HIV infections is unknown.

$$\sum_{g=1}^{G}\sum_{r=1}^{R}\sum_{i=1}^{I} Z = \sum_{g=1}^{G}\sum_{r=1}^{R}\sum_{i=1}^{I}(Y_{gri} + X_{gri}) \quad (1)$$

Total HIV infections have been estimated through indirect estimation from the total diagnosed HIV infections (*Y*) as the proportion of the sub-population that has had an HIV test. For example, if only 50% of MSM have tested, and the total diagnosed HIV infections *Y* represents the proportion of those testers that were positive, then the total number of HIV infections would be twice the total diagnosed HIV infections ($\frac{Y}{0.5}$). Hence, the method assumes that the proportion of the population that have not HIV tested (for example 50% of the total population) has the same probability of being HIV infected as the proportion that has tested. Clearly this is a very strong assumption to make. Only with universal annual testing would this hold true and in fact the results of HIV testing would equal annual HIV incidence. Analyses in Chapter four showed that MSM who had HIV tested in the past 5 years had higher numbers of sexual partners than MSM who had not HIV tested and results in Chapter five show that HIV prevalence in MSM differed by previous HIV testing history.

The method that will be introduced in this chapter is based on the principle that if *Y* is multiplied by an adjustment factor to estimate *X*, then knowing *Y* and *X* will in turn allow the calculation of *Z*. This adjustment factor relates to prevalence ratio of being HIV infected in MSM who have not HIV tested to MSM who have HIV tested. Hence, the adjustment factors will be derived based on findings from previous chapters which showed that choice of testing and risk of HIV infection given a test, differed by behavioural category, circumstances of testing, age, region and other factors.

The total number of HIV infections, *Z*, is unknown in the total population of MSM; however, existing survey data can give an indication of how big *Z* is relative to *Y* (diagnosed HIV infections). Survey data from Chapters four, five and six will provide information on how this relationship of *Z* to *Y* varies by the type of population studied. Thus, this leads us to choose a model where type of behaviour is looked at first (whether HIV tested or not and within that, diagnosed with an acute STI or not). Then within behavioural categories, the model is further stratified by region, and within region, stratified by age group. The observed numbers, *Y* and $\rho$ (the proportion HIV tested) are region and age-specific. The unobserved numbers *X* are calculated within behavioural category, region and age-specific strata. Different adjustment factors were

applied within the model for HIV test status, acute STI status, and region before stratifying by age.

## 7.2 Definition of the model

This section will define and describe a model to estimate the numbers of total HIV infections in MSM from the numbers of total diagnosed HIV infections in MSM and the proportion of MSM who have HIV tested. Thus, it will estimate the numbers of undiagnosed HIV infections in both MSM who have previously tested HIV negative, and in MSM who have never HIV tested as shown above in the smaller pie chart in Figure 7.1. This section describes the model in general, and the detail of how it works across the strata of region and age will be explained later in sections 7.3 and 7.4.

Assuming there was no difference between MSM choosing to have an HIV test and those who don't, the total number of prevalent HIV infections in those tested (*Y*, i.e. diagnosed HIV infections) would be equal to the total HIV infections, *Z*, multiplied by the proportion $\rho$ of MSM who have had an HIV test.

$$Y = Z.\rho \qquad (2)$$

Still assuming that those who have not tested have the same prevalence of HIV infections as those who have tested, and then the total number of HIV infections equals

$$Z = \frac{Y}{\rho} \text{ and it follows that } X = \frac{Y}{\rho} - Y$$

$$X = \frac{Y(1-\rho)}{\rho} = Y(\frac{n\ not\ tested}{n\ tested}) \qquad (3)$$

Hence, this would assume that the undiagnosed infections are equal to the diagnosed infections times the **odds** of not having had an HIV test. However, the data shown in previous chapters suggest that this assumption cannot be made about HIV prevalence in MSM who are not tested. MSM with previous tests have different risk behaviour when compared to those who do not test. Hence, the number of undiagnosed HIV infections, *X*, will be different from $(\frac{Y}{\rho} - Y)$. If it is expanded (3) to include an adjustment $\alpha$ for the prevalence ratio of HIV infection in MSM who have not HIV tested to tested MSM, this gives

$$X_{gri} = (\frac{YY_{ri}}{\rho_{ri}} - Y_{ri})\alpha_{gr} \qquad (4)$$

$X_{gri}$ is calculated in this case for g, r, and i based on $Y_{ri}$, $\rho_{ri}$, and $\alpha_{gr}$. Behavioural categories are derived for $X$ only. If it is assumed that the prevalence ratio of HIV infection in MSM who have not HIV tested relative to MSM who have tested ($\pi$) is known then

$$\alpha = \pi \quad = \text{HIV prevalence in MSM without HIV tests/HIV prevalence in MSM with prior tests.} \qquad (5)$$

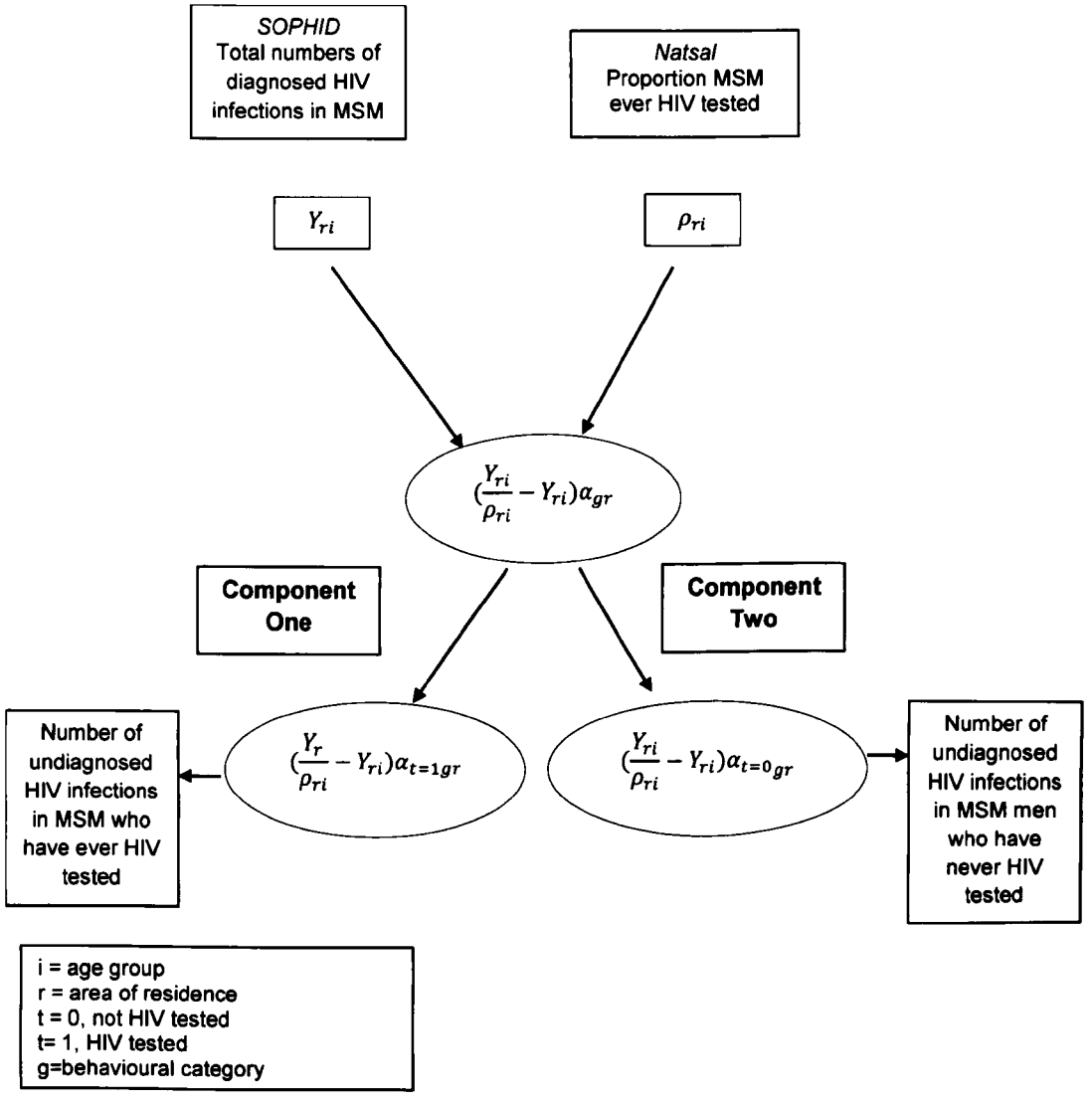
Generally it can be assumed that alpha is smaller than one because this thesis has shown that MSM who test are self-selected to a higher risk population. However, knowing the 'truth', i.e. $\pi$ , is not equally possible for all settings and the mechanism of self-selection to HIV test may differ by setting. Hence, this model derives adjustment factors $\alpha_{GUMgr}$ and $\alpha_{GPgr}$ by setting in which HIV testing can occur: GUM clinics and GP. This model assumes that total prevalent HIV infections among MSM are the sum of MSM who have tested positive, either at GUM clinics or their GPs. The importance of each setting is dependent on geographical location and availability of services and this may vary between regions of the country. This study used data from the UA GUM survey and thus focused on HIV testing in the GUM setting. It is assumed that the factors associated with testing HIV positive at GUM clinics are similar to those of testing positive at the GP surgery, and thus assumed that $\alpha_{GUMgr} = \alpha_{GPgr}$ and $Z$ is calculated using only $\alpha_{GUMgr}$.

To test if this assumption is valid, a sensitivity analysis will be carried out in section 7.6.3. This will estimate by how much the estimates would change if the OR of having HIV infection differed in MSM HIV tested at GPs compared with MSM tested at GUM clinics. This will test different assumptions on the proportions testing at GPs, and focus on the possibility that these proportions and risks may change over time.

Apart from setting, the model will take into account whether MSM had a previous HIV test or not. This is shown in Figure 7.2, together with the source of data to be used to inform each parameter. If the proportion of MSM who have tested is used to estimate the total HIV infections, $Z$, and if MSM who have tested have a different HIV prevalence from MSM who have not tested, then the MSM who have previously HIV tested negative, but now have undiagnosed HIV infections, $U$ must be accounted for. This is derived from the UA GUM survey carried out in Chapter five. In order to do this, undiagnosed HIV infections are estimated in two components based on the behavioural

category 'HIV tested'. The first component estimates the undiagnosed HIV infections in MSM who have tested previously, but have undiagnosed HIV infections, while the second component estimates the undiagnosed HIV infections in untested MSM.

**Figure 7.2 Overall outline of the estimation model**

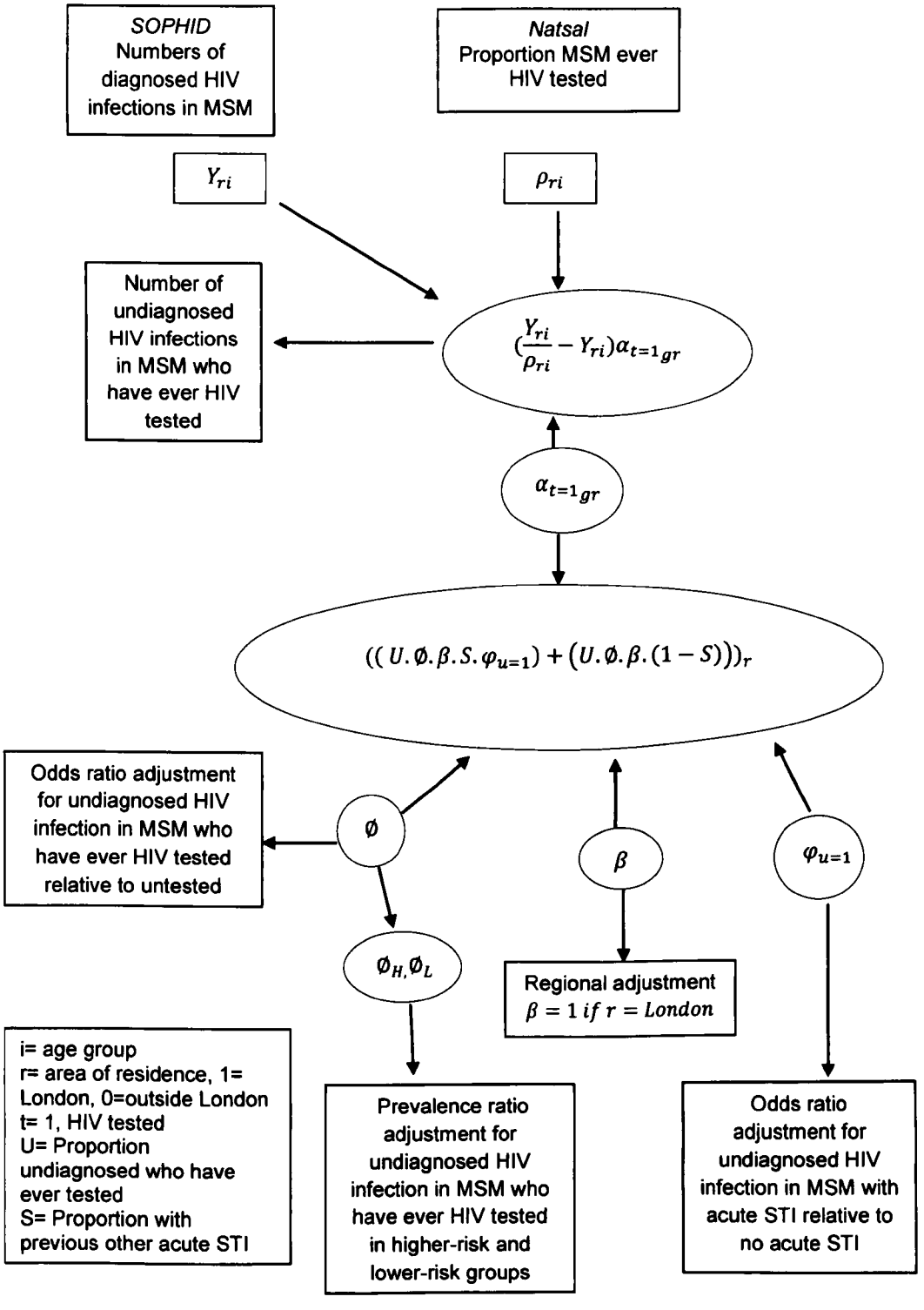



The central part of the figure is the unobserved quantity $X_{gri}$, the number of undiagnosed HIV infections, shown as an ellipsoid, and according to equation (4). The observed inputs $Y_{ir}$ and $\rho_{ir}$ are derived from the Natsal and SOPHID datasets. The adjustment factor $\alpha_{gr}$ differs depending on whether the individual has had a previous HIV test (i.e. t=1, Component One) or not (i.e. t=0, Component Two).

The following will explain the derivation of Components One and Two separately, as shown in Figures 7.3 and 7.4.

## 7.3 Component One: Estimating undiagnosed HIV infections in MSM who have previously HIV tested

**Figure 7.3 Structure of model to estimate the numbers of undiagnosed HIV infections in MSM who have ever HIV tested (Component One)**




The first component estimates the numbers of undiagnosed HIV infections in MSM who had ever HIV tested. Not all HIV infected MSM who have HIV tested now have diagnosed HIV infection. If the adjustment factor was applied to diagnosed HIV

infections to indirectly estimate total numbers of all HIV infections, the proportion of MSM that had previously had a negative HIV test but whose HIV infection remains undiagnosed, would not be accounted for. This would lead to an underestimate of the undiagnosed HIV infections. An additional adjustment factor (Ø) accounting for these undiagnosed HIV infections as described in equation 6 below was added. The key difference is that these MSM have previously tested, and so the correction factor alpha in this subgroup needs to correct the numbers back to those in 'testers' using Ø.

The estimation of undiagnosed people with prior tests was stratified by the proportion of MSM presenting with an acute STI, as undiagnosed HIV infection was independently associated with an acute STI. While this was reflecting current outbreaks of STIs among MSM and may be changeable over time, the adjustment was important in 2003 and this factor was included in the adjustment. This is shown above in Figure 7.3.

As in the previous figure the central part is estimating the quantity *X* of undiagnosed (or unobserved) infections in those who have had a previous HIV test, but not at the current time. In a GUM clinic, this quantity will differ dependent on whether a person is attending because of an acute STI (those with acute STI have different HIV infection risk compared with those without STI), for example, by stratifying by other acute STI. Being diagnosed with another acute STI (other than gonorrhoea or syphilis) at the surveyed GUM clinic visit was associated with a reduced odds of ever HIV testing. It was associated with lower odds of HIV infection. An adjustment factor was calculated through analyses in Chapter five based on the OR of undiagnosed HIV infection in MSM with other acute STIs relative to no acute STIs and the proportions of MSM that had other acute STIs. These were included in the model as illustrated in equation 6 and shown in Figure 7.3.

In mathematical terms for each category included in the model, an adjustment will be calculated for the proportion of MSM that have HIV tested within that category. For all parts of component one, the model has to use an $\alpha$. that takes account of the proportion of testers with undiagnosed HIV infection (*U*) and a correction factor that cancels out the odds of not having had an HIV test when estimating *X*=*Y*(odds of not having had an HIV test). This is done by using:

$\phi$ = odds ratio for undiagnosed HIV infection in MSM who have ever HIV tested relative to untested

*U* = proportion of undiagnosed HIV infections in MSM that have previously HIV tested

Estimation of undiagnosed HIV infections are stratified by presence or absence of other acute STI

$S$ = proportion of MSM with other acute STI, 1 – $S$ = proportion without other acute STI

$\psi_{u=1}$ = odds ratio for undiagnosed HIV infection in MSM with other acute STI relative to no acute STI

then the adjustment for MSM who have HIV tested but who have undiagnosed HIV infection, taking the behavioural categories, previous HIV testing and previous acute STI infection into account, is

$$\alpha_{t=1} = ((U.\emptyset.S.\varphi_{u=1}) + (U.\emptyset.(1-S))) \qquad (6)$$

For example to calculate the undiagnosed HIV infections in MSM in London aged less than 25, who have ever tested, this would be done separately by STI diagnosis, first for those who have an acute STI (s=1), and then for those who don't have an acute STI (s=0).

$$X_{r=London,i=<25,t=1,} = X_{r=London,i=<25,t=1,s=1} + X_{r=London,i=<25,t=1,s=0}$$

In a first step the total numbers of diagnosed HIV infections in MSM in London, aged less than 25 would be divided by the proportion of MSM in London aged less than 25 that have HIV tested. The diagnosed numbers would then be subtracted to give the unadjusted estimated undiagnosed HIV infections, $(\frac{Y_{r=london,i=<25}}{\rho_{r=London,i=<25}} - Y_{r=london,i=<25})$.

To derive the numbers of undiagnosed infections in men with acute STI the unadjusted estimate would then be multiplied by the proportion of MSM that have an acute STI (other than gonorrhoea or syphilis) *S*. It would then be multiplied by the adjustment factor $\varphi_{u=1}$ to account for the OR of undiagnosed HIV infection in this group relative to those without an acute STI. This would be followed by multiplying by the proportion tested with undiagnosed HIV infection *U*. Finally it would be multiplied by the adjustment factor ∅ to take account of the OR of undiagnosed HIV infection in MSM who are tested relative to untested.

To estimate the numbers of undiagnosed HIV infections without an acute STI, the unadjusted estimated undiagnosed HIV infections would be multiplied by the proportion who did not have an acute STI (1-*S*) followed by *U and* ∅. These estimated numbers of undiagnosed HIV infections are then added together to give the total estimated number of undiagnosed HIV infections in MSM aged less than 25 in London who have ever tested.

$$X_{r=London,i=<25,t=1} = \left(\frac{Y_{r=london,i=<25}}{\rho_{r=London,i=<25}} - Y_{r=london,i=<25}\right).U.\emptyset.S.\varphi_{u=1} + \left(\frac{Y_{r=london,i=<25}}{\rho_{r=London,i=<25}} - Y_{r=london,i=<25}\right).U.\emptyset.(1-S) \quad (7)$$

This would be repeated for the other age-groups, 25-34, 35-44 and 45 or more years, giving the total estimated number of undiagnosed HIV infections in MSM in London who have ever tested.

The model needs to take account of the difference in prevalence of HIV infection in MSM who have HIV tested outside London relative to MSM in London due to differential uptake of HIV testing, different rates of diagnosis of HIV infections and different background HIV prevalence. The study in Chapter five was only in one clinic in London. It was assumed that the adjustment factor $\alpha_{t=1}$ was correct for all MSM in London and $\beta_{R=1} = 1$ when *r =1=* London. To estimate the regional adjustment factor for MSM resident outside London, the UAPMP GUM survey (Chapter three) provided values for the HIV diagnosis ratio ($\epsilon$) and the HIV prevalence ratio ($\mu$) while the Natsal study in Chapter four provided a value for the OR of HIV testing outside London relative to London ($\theta$). The HIV diagnosis ratio ($\epsilon$) was calculated from the proportion of HIV infections detected through unlinked anonymous testing, that were clinically diagnosed through voluntary confidential HIV testing at GUM clinics outside London, compared to the proportion diagnosed in London.

$\beta_{R=0}$ = (the proportion of HIV infections diagnosed outside London / proportion of HIV infections diagnosed in London) / ((OR HIV testing outside London) x (HIV prevalence outside London / HIV prevalence London))

$$\beta_{R=0} = \frac{\epsilon}{\theta.\mu} \quad (8)$$

This model uses numbers of diagnosed HIV infections in individuals (observed) and estimates undiagnosed (unobserved) based on these. Total HIV infections in the model is by region, and total HIV infections are calculated by using observed infections, and because odds and prevalence ratios are used to correct numbers, the differences in population sizes have been indirectly captured and so no additional adjustment for the relative sizes of the MSM population outside London compared to London is needed. Then equation 6 becomes

$$\alpha_{t=1} = \beta_{r=1}\left((U.\emptyset.S.\varphi_{u=1}) + \left(U.\emptyset.(1-S)\right)\right) + \beta_{r=0}((U.\emptyset.S.\varphi_{u=1}) + \left(U.\emptyset.(1-S)\right)) \quad (9)$$

Thus to calculate the number of undiagnosed HIV infections for outside London, similar to above in equation 7, undiagnosed HIV infections within each individual age group would be estimated, from diagnosed HIV infections and proportions tested outside London, with the additional regional adjustment $\beta_{r=0}$ added to the other adjustments as shown in equation 9.

The study in Chapter five was of MSM attending a GUM clinic and the Chapter six has shown that results from UA GUM may be not entirely representative. Hence, the study estimated a range of plausible values for undiagnosed infections using results from Chapter six. This included a lower and an upper 'behavioural range' HIV prevalence ratio of undiagnosed HIV infection in untested relative to tested. An upper behaviour range factor was calculated taking account of the results that people who have attended GUM clinics in the past may be people who have had higher-risk sexual behaviours. A lower behavioural range factor took account of the fact that UA GUM users may be at a higher risk of HIV when compared to a person who does not engage in high-risk sexual behaviours. The problem is that UA GUM attendees are a mix of people from both ends since the reasons for prior HIV testing may vary. This was discussed in Chapters four and five. The lower behavioural adjustment factor $\emptyset_L$ was the standardised HIV prevalence ratio in community-recruited MSM who had not attended a GUM clinic relative to HIV prevalence in MSM within the UA GUM study $\vartheta_n$, multiplied by the OR of undiagnosed HIV infection in tested MSM relative to untested, $\emptyset$. This entered equation 10 for a lower-risk adjustment factor $\alpha_{t=1L}$ as follows to provide a lower range for *X*.

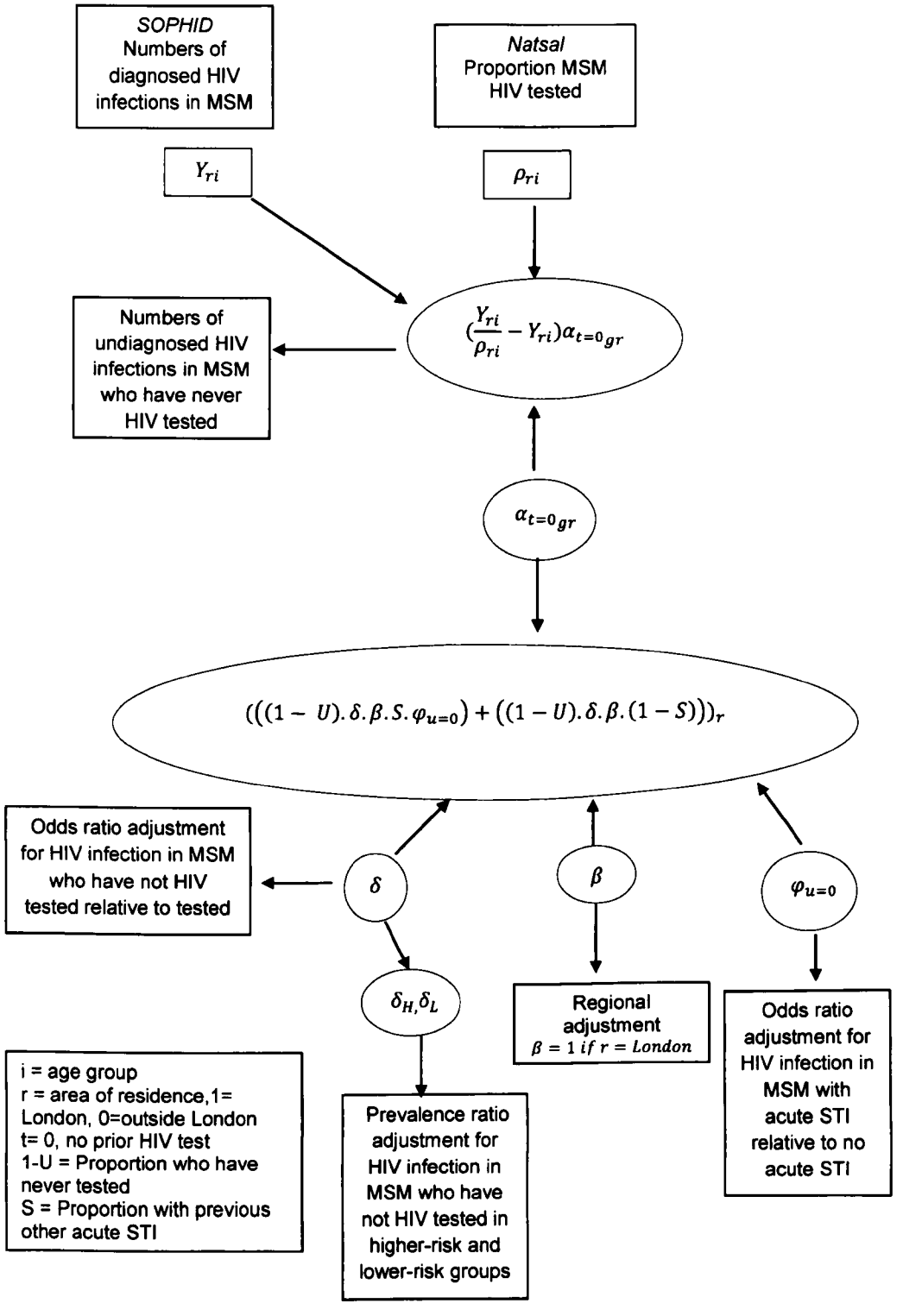
$$\alpha_{t=1L} = \beta_{r=1}.\Big((U.\emptyset_L.S.\varphi_{u=1}) + \big(U.\emptyset_L.(1-S)\big)\Big) + \beta_{r=0}.\big((U.\emptyset_L.S.\varphi_{u=1}) + \big(U.\emptyset_L.(1-S)\big)\big) \quad (10)$$

Similarly an upper behavioural range factor $\emptyset_H$ was calculated in Chapter six from a higher-risk population of sexually active MSM attending bars, clubs and saunas. This was the standardised HIV prevalence ratio in the GMSHS survey relative to the prevalence in the UA GUM survey, $\vartheta_m$, multiplied by $\emptyset$. This entered the equation for $\alpha_{t=1H}$ to provide a higher-risk adjustment factor shown in equation 11 to give an upper range for *X*.

$$\alpha_{t=1H} = \beta_{r=1}.\Big((U.\emptyset_H.S.\varphi_{u=1}) + \big(U.\emptyset_H.(1-S)\big)\Big) + \beta_{r=0}.\big((U.\emptyset_H.S.\varphi_{u=1}) + \big(U.\emptyset_H.(1-S)\big)\big) \quad (11)$$

## 7.4 Component Two: Estimating undiagnosed HIV infections in MSM who have never had a HIV test

**Figure 7.4 Structure of model to estimate the numbers of undiagnosed HIV infections in MSM who have never HIV tested (Component Two)**




The second component will estimate the numbers of undiagnosed HIV infections in MSM who have never HIV tested. The diagnosed population of HIV positive MSM will

be stratified by each of the categories included in the model and an adjustment factor for each category will be calculated. The equation (4) will be extended for each of the relevant parameters that are calculated. The odds ratio of HIV infection in untested MSM relative to tested $\delta$, was calculated from Chapter five with an upper and lower behavioural range calculated from Chapter six which enters the formula for the final adjustment factor for untested MSM, $\alpha_{t=0}$, in the model. This is illustrated in equation (12) below.

As in the previous figure, the central part of Figure 7.4 is estimating the quantity $X$ of undiagnosed (or unobserved) infections in those who have never tested. In a GUM clinic, this quantity will differ dependent on whether a person is attending because of an acute STI (those with acute STI have different HIV infection risk compared with those without STI), for example by stratifying by other acute STI. Being diagnosed with another acute STI (other than gonorrhoea or syphilis) at the surveyed GUM clinic visit was associated with a reduced odds of ever HIV testing and of HIV infection. An adjustment factor for acute STI will be included, and was calculated through analyses in Chapter five based on the prevalence of HIV infection amongst MSM that had (or had not) acute STIs as illustrated in equation (12) and shown in Figure 7.4

In mathematical terms for each category included in the model, an adjustment factor will be calculated for the proportion of MSM that have never HIV tested within that category. If for example stratifying by other acute STI:

If $\delta$ = OR of HIV infection in MSM who have not HIV tested relative to tested
$1-U$ = proportion of undiagnosed HIV infected MSM that have not HIV tested: because undiagnosed HIV infections in those with prior tests have already been counted in component one, these can't be counted again.
$S$ = proportion of MSM with other acute STI, 1-$S$ = proportion without other acute STI
$\psi_{u=0}$ =OR of HIV infection for MSM with other acute STI relative to no acute STI

then the adjustment factor for MSM who have not tested and have undiagnosed HIV infection, taking previous acute STI infection into account, is

$$\alpha_{t=0} = (((1-U).\delta.S.\varphi_{u=0}) + ((1-U).\delta.(1-S))) \qquad (12)$$

As explained previously for component one, to estimate undiagnosed HIV infections in untested MSM aged <25 in London, the following would be applied

$$X_{r=London,i=<25,t=0} = \left(\frac{Y_{r=london,i=<25}}{\rho_{r=London,i=<25}} - Y_{r=london,i=<25}\right).(1-U).\delta.S.\varphi_{u=0} + \left(\frac{Y_{r=london,i=<25}}{\rho_{r=London,i=<25}} - Y_{r=london,i=<25}\right).(1-U).\delta.(1-S) \quad (13)$$

This would be repeated again for each of the age groups, and the estimated numbers of undiagnosed HIV infections in untested MSM would be added together.

The prevalence ratio of HIV infection in MSM who have not HIV tested outside London will differ from MSM in London due to differential uptake of HIV testing, different rates of HIV diagnosis and different background HIV prevalence. The same regional adjustment factor $\beta$ as described for component one will be applied. Again it is assumed that $\alpha_{t=0}$ is correct for London and $\beta = 1$ when *r* = *1*=London. This is shown in equation (14).

If $\beta_{r=0}$ = (the proportion of HIV infections diagnosed outside London / proportion of HIV infections diagnosed in London) / ((OR HIV testing outside London) x (HIV prevalence outside London / HIV prevalence London)) or $\beta_{r=0} = \frac{\varepsilon}{\theta.\mu}$

then

$$\alpha_{t=0} = \beta_{r=1}.\Big(\big((1-U).\delta.S.\varphi_{u=0}\big) + \big((1-U).\delta.(1-S)\big)\Big) + \beta_{r=0}.\big(\big((1-U).\delta.S.\varphi_{u=0}\big) + \big((1-U).\delta.(1-S)\big)\big) \quad (14)$$

Thus to calculate the undiagnosed number of HIV infections for outside London, similar to equation (13), undiagnosed HIV infection within each individual age group would be estimated, from diagnosed HIV infections and proportions tested from outside London, with the additional regional adjustment $\beta_{r=0}$ added as shown in equation (14).

The study in Chapter five was of MSM attending a GUM clinic. A lower behavioural range for the prevalence ratio of HIV infection in untested relative to tested in MSM, $\delta_L$, was calculated through analyses in Chapter six. This was obtained through calculating the standardised prevalence ratio of HIV prevalence in community-recruited MSM who had not attended a GUM clinic relative to the UA GUM study ($\vartheta_n$). This was multiplied by the OR adjustments $\delta$ to calculate $\delta_L$, a lower range factor, which provided a lower-risk adjustment factor $\alpha_{t=0L}$ shown in equation (15) and a lower range for *X*.

$$\alpha_{t=0L} = \beta_{r=1}.\Big(\big((1-U).\delta_L.S.\varphi_{u=0}\big) + \big((1-U).\delta_L.(1-S)\big)\Big) + \beta_{r=0}.\big(\big((1-U).\delta_L.S.\varphi_{u=0}\big) + \big((1-U).\delta_L.(1-S)\big)\big) \quad (15)$$

Similarly an upper behavioural range for the prevalence ratio of HIV infection in untested relative to tested adjustment, $\delta_H$, was calculated in Chapter six from a higher-risk population of sexually active MSM, attending bars, clubs and saunas. This was the standardised HIV prevalence ratio in the GMSHS survey relative to the UA GUM survey $\vartheta_m$. This was multiplied by the OR adjustments $\delta$ to calculate $\delta_H$, an upper range factor, which provided a higher-risk adjustment $\alpha_{t=0H}$ shown in equation (16) and a higher range for *X*.

$$\alpha_{t=0H} = \beta_{r=1}.\Big(\big((1-U).\delta_H.S.\varphi_{u=0}\big) + \big((1-U).\delta_H.(1-S)\big)\Big) + \beta_{r=0}.\big(\big((1-U).\delta_H.S.\varphi_{u=0}\big) + \big((1-U).\delta_H.(1-S)\big)\big) \quad (16)$$

## 7.5 Estimating total HIV infections in MSM

The number of undiagnosed HIV infections in MSM in the general population *X* was estimated using a model consisting of two separate components as outlined above (Figure 7.2). Component One (Figure 7.3) estimated the numbers of undiagnosed HIV infections in MSM who have tested negative previously but had undiagnosed HIV infection. Component Two estimated the numbers of HIV infections in MSM who have never HIV tested and had undiagnosed infection (Figure 7.4). The number of total HIV infections *Z* was estimated by adding *X* to *Y*, diagnosed HIV infections, represented by prevalent diagnosed individuals receiving care through the SOPHID surveillance survey as described in Chapter three, section 3.3.3. Table 7.1 lists all parameters by model component, and the subsequent section describes how the parameters were estimated and which results were used in the final model.

Analyses in Chapters four, five and six showed the factors that affected HIV testing and risk of HIV infection in MSM and were summarised in Table 5.9, Chapter 5; section 5.3.5. These included age group and being diagnosed with an acute STI. These factors were therefore included in the model to extrapolate HIV diagnoses to all HIV infected MSM using HIV testing prevalence. Since both HIV testing and HIV infection risk were associated with age, all analyses and modelling was age-specific. Overall adjustment factors, $\alpha_{t=1}$, and $\alpha_{t=0}$, were calculated that combine the effects of all the relevant variables. The odds ratios for the adjustment factors to be applied by age group and region were derived based on analyses in Chapter five with adjustments according to GUM attendance derived from Chapter six and these are shown in Table 7.1. The diagnosed population of HIV positive MSM was stratified by each of the categories included in the model and an adjustment factor for each category was calculated.

The regional adjustment $\beta_{r=0}$ $(\frac{\varepsilon}{\theta}.\mu)$ was calculated. The UAPMP GUM survey (Chapter three, section 3.5.4) provided values for the diagnosis ratio; the proportion of HIV infections detected through unlinked anonymous testing in HIV positive MSM that were clinically diagnosed outside London relative to London, which was ( $\epsilon = \frac{0.45}{0.62} = 0.72$). The prevalence ratio in MSM attending GUM clinics outside London relative to London was again provided by the UAPMP GUM survey and was ($\mu = \frac{2.5}{5.4} = 0.44$). Finally the Natsal study in Chapter four (Table 4.2a) provided the value for OR of HIV testing if outside London relative to London $(\theta = \frac{1}{0.33} = 3.03)$.

Total numbers of prevalent diagnosed HIV infections, *Y*, in MSM resident in Britain were used as described in Chapter three, section 3.3.3. These were then adjusted for cross-boundary flow between regions for care and for non-attendance for care in a year, based on the 3 previous years[143]. Deaths in HIV infected MSM within the year 2003, received from the Office of National Statistics (ONS), were age-stratified and subtracted from the 2003 total to give total numbers living with diagnosed infections. This provided London, outside London, Scotland and Wales, age-specific numbers of MSM with diagnosed HIV infections $Y_{ri}$. Numbers of total diagnosed HIV infections for Northern Ireland were the total number of HIV infections diagnosed up to the end of 2003 minus all deaths up to the of 2003 from the ONS. Prevalence rates of HIV testing in MSM, $\rho_{ri}$, were derived from Natsal 2000 in Chapter four. Uncertainties regarding assumptions made throughout the modelling analyses were explored in sensitivity analyses. All estimates were rounded to the nearest ten.

The adjustments $\emptyset$ and $\delta$ were derived based on analyses in Chapter five with adjustments $\varphi$ and $S$, according to acute STI diagnoses, and an upper and lower range adjustment $\alpha_L$, $\alpha_H$ derived from Chapter six. These are shown below in Table 7.2.

**Table 7.1 Parameter estimations for number of undiagnosed HIV infections for estimating undiagnosed based on the observed method model**

| Item | Definition | Equation | Input factor | Source |
|---|---|---|---|---|
| ***Component One*** | | | | |
| $Y$ | Total numbers of prevalent diagnosed HIV infections by age group and area of residence | $Y_{i,=1,r=1}$ | *222* | SOPHID surveillance survey, Chapter three, section 3.3.3 |
| | | $Y_{i=2,r=1}$ | *2647* | |
| | | $Y_{i,3,r=1}$ | *5315* | |
| | | $Y_{i,4,r=1}$ | *882* | |
| | | $Y_{i,4,r=2}$ | | |
| | | $Y_{i=1,,r=2}$ | *481* | |
| | | $Y_{i=2,r=2}$ | *2094* | |
| | | $Y_{i=3,r=2}$ | *3354* | |
| | | $Y_{i=4,r=2}$ | *1270* | |
| $\rho$ | Prevalence of HIV testing by age group and area | $\rho_{i=1,r=1}$ | *0.17* | Natsal survey, Chapter four, section 4.3.2 |
| | | $\rho_{i=2,r=1}$ | *0.35* | |
| | | $\rho_{i=3,r=1}$ | *0.26* | |
| | | $\rho_{i=4,r=1}$ | *0.26* | |
| | | $\rho_{i=1,r=2}$ | *0.24* | |
| | | $\rho_{i=2,r=2}$ | *0.50* | |
| | | $\rho_{i=3,r=2}$ | *0.37* | |
| | | $\rho_{i=4,r=2}$ | *0.37* | |
| $\emptyset$ | OR of undiagnosed HIV infection in MSM HIV tested relative to untested | $\emptyset$ | *0.21* | Chapter 5 section, 5.3.4.2, Table 5.8 |
| $\emptyset_L$ | Prevalence ratio of HIV infection in lower-risk MSM, who have not attended a GUM clinic | $\emptyset \cdot \vartheta_n$ | *0.10* | Chapter 5 section 5.3.4.2, Table 5.8 and Chapter 6, section 6.3.2, Table 6.1 |
| $\emptyset_U$ | Prevalence ratio of HIV infection in higher-risk MSM | $\emptyset \cdot \vartheta_m$ | *0.28* | Chapter 5 section 5.3.4.2, Table 5.8 and Chapter 6, section 6.3.2, Table 6.1 |
| $U$ | Proportion of MSM with undiagnosed HIV infection that have HIV tested | $U$ | *0.39* | *Chapter 5 section 5.3.4.2, Table 5.8* |

| Item | Definition | Equation | Input factor | Source |
|---|---|---|---|---|
| $S$ | Proportion of MSM with previous other acute STI | $S$ | *0.146* | *Chapter 5 section 5.3.5, Table 5.9* |
| $\varphi$ | OR of undiagnosed HIV infection in MSM with other acute STI relative to no other acute STI | $\varphi_{u=1}$ | *0.45* | *Chapter 5 section 5.3.4.2, Table 5.8* |
| $\beta$ | Regional Adjustment | $\beta_{r=1}$ | *1* | |
| | | $\beta_{r=0} = (\frac{\varepsilon}{\theta} . \mu)_{r=0}$ | *0.5* | Chapter 3 section 3.5.4 and Chapter 4 section 4.3.3, Table 4.2a: derived Chapter 7, section 7.5 |
| ***Component two*** | | | | |
| $Y$ | As above | | | |
| $\rho$ | As above | | | |
| $\delta$ | OR of HIV infection in MSM untested relative to tested | $\delta$ | *0.37* | Chapter 5 section 5.3.4.1, Table 5.7 |
| $\delta_L$ | Prevalence ratio of HIV infection in lower-risk MSM, untested relative to tested, who have not attended a GUM clinic | $\delta . \vartheta_n$ | *0.184* | Chapter 5 section 5.3.4.1, Table 5.7 and Chapter 6, section 6.3.2, Table 6.1. |
| $\delta_U$ | Prevalence ratio of HIV infection in MSM in higher-risk men, untested relative to tested | $\delta . \vartheta_m$ | *0.50* | Chapter 5 section 5.3.4.1, Table 5.7 and Chapter 6, section 6.3.2,Table 6.1 |
| $U$ | As above | | | |
| $S$ | As above | | | |
| $\varphi$ | OR of HIV infection in untested MSM with other acute STI relative to no acute STI | $\varphi_{u=0}$ | *0.42* | *Chapter 5 section 5.3.4.1, Table 5.7* |
| $\beta$ | As above | | | |

Note: $\vartheta_n$ = prevalence ratio non-syphilis GMSHS relative to UA GUM; $\vartheta_m$= prevalence ratio syphilis GMSHS relative to UA GUM; $\varepsilon$= HIV diagnosis ratio outside London relative to London (0.72); $\theta$= OR of being tested outside London (3.03); $\mu$=HIV prevalence ratio outside London relative to London (0.44).

**Table 7.2 Estimation of adjustment factors for Component One and Component Two; adjustment for prevalence of HIV infection in MSM**

| | Acute STI status[a] | Equation | adjustment $\alpha$ | (Lower, upper) adjustment $\alpha_L, \alpha_H$ |
|---|---|---|---|---|
| $\alpha_{t=1}$ | | | | |
| London | Other acute STI | $U.\emptyset.S.\varphi_{u=1}.\beta_{r=1}$ | 0.00538 | (0.00256, 0.00717) |
| | No acute STI | $U.\emptyset.\beta_{r=1}.(1-S)$ | 0.06994 | (0.03481, 0.09448) |
| Rest of UK | Other acute STI | $U.\emptyset.S.\varphi_{u=1}.\beta_{r=0}$ | 0.00269 | (0.00128, 0.00359) |
| | No acute STI | $U.\emptyset.\beta_{r=0}.(1-S)$ | 0.03497 | (0.01740, 0.04724) |
| $\alpha_{t=0}$ | | | | |
| London | Other acute STI | $(1-U).\delta.S.\varphi_{u=0}.\beta_{r=1}$ | 0.0138 | (0.00688, 0.01870) |
| | No acute STI | $(1-U).\delta.\beta_{r=1}.(1-S)$ | 0.19274 | (0.09592, 0.26004) |
| Rest of UK | Other acute STI | $(1-U).\delta.S.\varphi_{u=0}.\beta_{r=0}$ | 0.00692 | (0.00344, 0.00935) |
| | No acute STI | $(1-U).\delta.\beta_{r=0}.(1-S)$ | 0.09637 | (0.04796, 0.13019) |

Note. a. Other acute STI defined as presenting with one of the following diagnoses: chancroid/ donovanosis/LGV, chlamydia, NSU, trichomoniasis, scabies/pediculosis, HSV &HPV first attack or molluscum contagiosum.

## 7.6 Results

This section presents results of the estimates of *Z*, total numbers of HIV infections in MSM in the UK using the Estimating Undiagnosed from the Observed Method developed in this chapter, adjusting for prevalence of HIV in those who were untested. A comparison of by how much the estimates changed because of the adjustment factor was made, followed by sensitivity analyses testing the assumptions made within the model. Finally, the estimations produced by the model were compared with results from other estimation methods.

### 7.6.1 Numbers of HIV infections in MSM in the general population.

Estimates of total numbers of HIV infections amongst MSM (*Z*) are presented in Table 7.3. A range of estimates are provided giving a higher and lower estimate based on the higher-risk MSM recruited through the GMSHS and lower-risk MSM who have not attended a GUM clinic in the past year. In 2003 an estimated 24,800 MSM were living with HIV, of whom 8,460 (34%) were unaware of their infection.

**Table 7.3 Estimated number of prevalent HIV infections in MSM in the UK 2003; estimating undiagnosed from the observed method**

| | Diagnosed infections | Undiagnosed infections | (Range[a]) | Total HIV infections | (Range) |
|---|---|---|---|---|---|
| London | | | | | |
| <25 | 220 | 320 | (160 – 430) | 540 | (380 – 650) |
| 25-34 | 2,650 | 1,380 | (690 – 1,860) | 4,030 | (3,330 – 4,030) |
| 35-44 | 5,320 | 4,370 | (2,170 – 5,900) | 11,050 | (7,490 – 11,220) |
| 45+ | 880 | 730 | (360 – 980) | 1,860 | (1,240 – 1,860) |
| | ***9,070*** | ***6,790*** | ***(3,380 – 9,170)*** | ***15,860*** | ***(12,440 – 18,240)*** |
| Outside London | | | | | |
| <25 | 500 | 220 | (110 – 300) | 720 | (610 – 800) |
| 25-34 | 2,110 | 300 | (150 – 410) | 2,410 | (2,260 – 2,530) |
| 35-44 | 3,370 | 830 | (410 – 1,120) | 4,200 | (3,790 – 4,500) |
| 45+ | 1,290 | 320 | (160– 430) | 1,610 | (1,450 – 1,720) |
| ***Total Outside London*** | ***7,270*** | ***1,670*** | ***(830 – 2,260)*** | ***8,940*** | ***(8,110 – 9,550)*** |
| **Total UK** | **16,340** | **8,460** | **(4,210 – 11,430)** | **24,800** | **(20,550 – 27,790)** |

Note. a. Range calculated from the adjustment factors $\alpha_H, \alpha_L$.

### 7.6.2 Comparison of the Undiagnosed from the Observed Method with unadjusted indirect method estimations

To investigate the importance of adjusting the estimates of undiagnosed HIV infections with the adjustment factor ($\alpha$), the unadjusted indirect method estimate was compared with the Estimating Undiagnosed from the Observed Method estimate in Table 7.4. The Estimating Undiagnosed from the Observed Method estimate was found to be 52.4% lower (24,800 compared with 52,120). This showed that not adjusting the indirect estimation method would lead to overestimation of the numbers of undiagnosed HIV infections, *X*. The reduction in estimated undiagnosed HIV infections, *X*, was similar in London and the rest of the UK.

**Table 7.4 Comparison of estimates from Estimating Undiagnosed from the Observed Method with unadjusted indirect estimations**

| | Estimating Undiagnosed from Observed Method estimate (range[a]) | Unadjusted indirect estimate (range) | % reduction in estimates through adjustment |
|---|---|---|---|
| London | 15,860 | 33,150 | -52.2% |
| | (12,440 – 18,240) | (16,500 – 44,780) | |
| Outside London | 8,940 | 18,970 | -52.9% |
| | (8,110 – 9,550) | (9,440 – 25,630) | |
| Total | 24,800 | 52,120 | -52.4% |
| | (20,550 – 27,790) | (25,940 – 70,410) | |

Note. a. range calculated from the adjustment factors $\alpha_{H,}\alpha_{L}$.

### 7.6.3 Sensitivity analyses

Sensitivity analyses were undertaken in areas of uncertainties surrounding the model to determine how sensitive the outcome, estimates of numbers of undiagnosed HIV infections, may be to the behavioural-risk gradient defined through the adjustment factors $\alpha_{t=1}$ and $\alpha_{t=0}$. This was carried out through describing plausible ranges of key variables and examining the robustness of particular assumptions. Four different scenarios were considered.

1. Effect of changes in OR of HIV infection, $\delta$, $\emptyset$, in HIV untested MSM relative to tested due to changes in HIV testing in HIV positive and HIV negative MSM
2. Effect of changes in the estimate of proportions of HIV infections in MSM who have HIV tested and have undiagnosed infection $U$

3. Effects of changes in GUM attendance patterns
4. Effects of changes in place of HIV test, leading to a higher proportion of MSM testing at GPs

#### 7.6.3.1 Effect of changes in OR of HIV infection, $\emptyset, \delta$ in untested MSM relative to tested MSM due to changes in HIV testing in HIV positive and HIV negative MSM

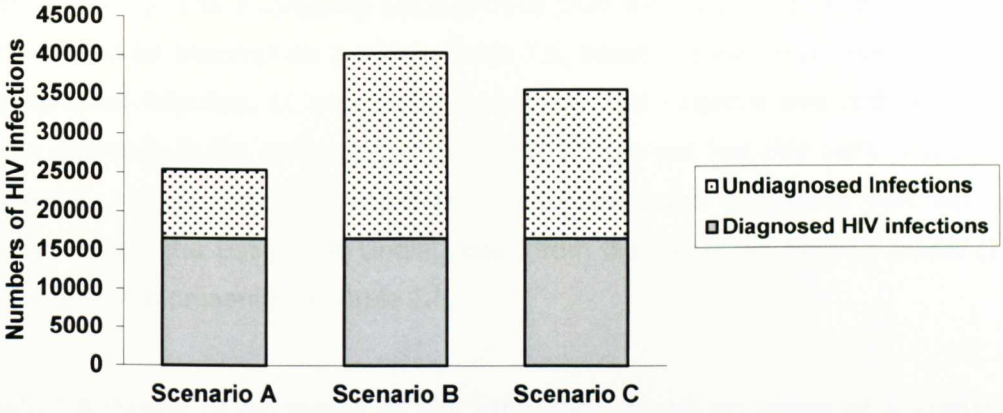
HIV testing information used in the model was gathered through two surveys – (1) the Natsal survey of all MSM analysed in Chapter four and (2) the survey of MSM attending a GUM clinic analysed in Chapter five. Three scenarios were explored that would affect three possible directions of the relationship between HIV infection and HIV testing. These are shown below in Figure 7.5.

The first scenario (A) assumed that MSM who HIV test have higher risk of HIV infection then MSM who do not test, thereby applying the adjustment factors $\alpha_{t=1}$, $\alpha_{t=0}$ shown in Table 7.2 to all MSM who have tested, and producing estimates as shown in Table 7.3.

The second scenario (B) assumed that HIV testing is related to MSM being in a monogamous relationship and thus testers have lower-risk of HIV infection than untested MSM, assuming a similar but opposite OR of HIV infection $\emptyset, \delta$ in untested MSM relative to tested MSM leading to an adjustment factor opposite to that found in scenario A.

The third scenario (C) considered MSM who tested annually regardless of their behaviour with changing HIV test policies whereby these MSM were assumed to revert to having the adjustment factors $\alpha_{t=1}$ and $\alpha_{t=0}$ of 1.0.

**Figure 7.5 Sensitivity analyses of the effect of changes in the adjustment factor $\alpha$ between HIV positive and HIV negative MSM: three scenarios**




The total HIV infections, *Z*, for 2003 were adjusted, assuming the above scenarios, and results are presented in Figure 7.5. If it is assumed that untested MSM have lower HIV prevalence than MSM who tested (A) and an adjustment is made to the indirect method, the numbers of HIV infections, *Z*, estimated in the population would be 24,800 (8,460 undiagnosed). If, however, HIV testing was assumed to be related to MSM being in a monogamous relationship (B), and untested men had, for example, 30% higher prevalence of HIV, then estimates of undiagnosed HIV infections increased to 40,460 (23,720 undiagnosed). If annual testing was undertaken unrelated to risk (C), then 35,520 MSM would be estimated to be living with HIV, of whom 18,970 (53.4%) had undiagnosed HIV infection. This undiagnosed proportion would not remain at this high level since the proportion of MSM tested would be expected to increase over time. In the event of annual HIV testing, numbers diagnosed would begin to equal HIV incidence over time and the proportion undiagnosed (*U*) would decrease. Scenario A leads to the lowest estimates of undiagnosed HIV infections, scenario B the highest, and scenario C while higher now, would eventually through successful diagnoses lead to a decrease in undiagnosed HIV infections. This is assuming that all MSM would test annually, including men at increased risk of HIV infection.

#### 7.6.3.2 Effect of changes in the estimate of proportions of HIV infections in MSM who have HIV tested and have undiagnosed infection *U*

If the proportion of HIV infections in MSM who have tested negative and have undiagnosed HIV infections (*U*) changed, for instance due to more regular systematic HIV testing rather than HIV testing relating to risk behaviour, this proportion would be expected to decline annually. The effect of a range of either a decrease or an increase (although this is an unlikely scenario) in this proportion is illustrated in Table 7.5

(assumption 1). This change is unlikely to take place independently of the never tested proportion (1-$\rho$) of MSM. It would be expected that this proportion might decline simultaneously. The Estimating Undiagnosed from the Observed Method model was recalculated for assumption 3 and 4, Table 7.5, assuming the proportion of MSM with undiagnosed infection, *U*, who tested previously HIV negative was reduced to zero, and a decrease in the proportion of people who have not had HIV tests (1-$\rho$) by 39% and 80%, respectively. All recalculated estimates were compared with estimates produced from the Estimating Undiagnosed from the Observed Method model (Table 7.3). These are presented in Table 7.5.

**Table 7.5 Range of estimates of HIV infections based on range of assumptions about the proportion of HIV infections in MSM who have ever HIV tested and have undiagnosed infections**

| | Estimated total HIV infections (range[a]) | Estimated total undiagnosed HIV infections (range) | % HIV infections undiagnosed |
|---|---|---|---|
| Estimating Undiagnosed from the Observed Method model: assuming *U*=0.39[b] | 24,800 (20,550 – 27,790) | 8,460 (4,210 – 11,430) | 34.1% |
| Assumption 1: assuming *U*=0.80, all else unchanged | 23,010 (19,660 – 25,350) | 6,670 (3,320 – 9,010) | 29.0% |
| Assumption 2: assuming *U*=0, all else unchanged | 26,490 (21,390 – 30,050) | 10,150 (5,050 – 13,710) | 38.2% |
| Assumption 3: assuming *U*=0 and a corresponding 39% decrease in $(1-\rho)$ | 22,430 (19,370 – 24,430) | 6,090 (3,030 – 8,230) | 27.2% |
| Assumption 4: *U*= 0 and a corresponding 80% decrease in $(1-\rho)$ | 20,070 (18,190 – 21,370) | 3,720 (1,850 – 5,030) | 18.5% |

Note a. Range calculated from the adjustment factors $\alpha_L, \alpha_H$; b. The measured proportion of MSM with undiagnosed HIV infection that had ever HIV tested in UA GUM survey Chapter five, Table 5.8.

The OR of undiagnosed HIV infection in MSM who have ever tested, ∅, was lower compared with untested MSM (Table 7.1). When the proportion of previously HIV negative MSM with undiagnosed infection, *U*, was increased in the model (assumption 1, Table 7.5), the overall estimated numbers of undiagnosed HIV infections, *X*, decreased. Increasing *U* to 80% (assumption 1, Table 7.5) decreased the estimated numbers of undiagnosed HIV infections by 21% and decreasing *U* to 0% (assumption 2, Table 7.5), increased the estimated numbers of undiagnosed HIV infections, *X*, by 20%. Assuming a corresponding drop in the proportion of HIV untested MSM overall $(1-\rho)$, led to further declines in estimated numbers of undiagnosed HIV infections. A

39% decrease (assumption 3, Table 7.5) produced a 16% decline in estimated numbers of undiagnosed HIV infections. Finally, an 80% decrease (assumption 4, Table 7.5) in the proportion untested, resulted in a 56% lower estimate of undiagnosed HIV infections when compared with the baseline Estimating Undiagnosed from the Observed method model (Table 7.5).

#### 7.6.3.3 Effects of changes in GUM attendance patterns on estimates of unobserved HIV infections

The effect of changing assumptions about GUM attendance patterns was explored. GUM attendance could change for various reasons. The first most likely change might be if MSM were to attend a GUM clinic specifically for a HIV test, unrelated to risk, due to a change in HIV test promotion and policy. This would lead to a reduction in $\delta$, the prevalence ratio in untested MSM attending the GUM clinic. The proportion of MSM without previous HIV tests $(1-\rho)$ would become smaller as the total number attending the GUM clinic increased. This would affect the adjustment factors, $\alpha_{t=0}$, and $\alpha_{t=0}$ would move towards 1.0. With increased HIV testing, undiagnosed HIV infections would decrease, assuming HIV positive MSM were equally like to test as HIV negative MSM, and as the proportion untested $(1-\rho)$ becomes smaller it would have less impact on the model.

To investigate how Z, the estimate of number of total HIV infections in MSM, would change if GUM clinic attendance changed, different outputs using a plausible range of key variables were calculated. All comparisons were made to estimates produced from the Estimating Undiagnosed from the Observed Method model, Table 7.3. The ranges of probable changes due to increased HIV testing resulting in a changed OR of HIV infection in non-testers, $\delta$, are shown below in Table 7.6.

As HIV testing increases, the proportion of untested MSM $(1-\rho)$ decreases, thus resulting in a lower estimate of $X$ (undiagnosed HIV infections), as in assumptions 1 and 2, Table 7.6 below. If it is assumed that the OR $\delta$ moves towards 1.0 when MSM HIV test more routinely unrelated to risk behaviour, then $X$ increases as in assumption 3, Table 7.6. However, as the corresponding proportion of untested MSM $(1-\rho)$ decreases, so too does $X$ (assumption 4, Table 7.6). Thus, if the prevalence ratio $\delta$ was not changed within the model when the clinic population who are undergoing HIV testing changed, then the Estimating Undiagnosed from the Observed Method model would underestimate the true numbers of undiagnosed HIV infections.

**Table 7.6 Range of estimates of total HIV infections in MSM through Estimating Undiagnosed from the Observed Method model based on varying assumptions about changing GUM clinic attendance due to increased HIV testing and corresponding changes in the OR of HIV infection $\delta$ in untested MSM**

| | Estimated total HIV infections $Z$ (range[a]) | Estimated total undiagnosed HIV infections $X$ (range) | % HIV infections undiagnosed |
|---|---|---|---|
| Estimating Undiagnosed from the Observed Method estimate: | 24,800 (20,550 – 27,790) | 8,460 (4,210 – 11,430) | 34.1% |
| Assumption 1: an increase in MSM attending GUM clinic for HIV test only, by 50%, all else remains the same[b] | 20,700 (18,480 – 22,260) | 4,430 (2,200 – 5,990) | 21.4% |
| Assumption 2: an increase in MSM attending GUM clinic for HIV test only, by 100%, all else remains the same[b] | 18,770 (17,550 – 19,630) | 2,430 (1,210 – 3,284) | 12.9% |
| Assumption 3: an increase in MSM attending GUM clinic for HIV test only, by 50%, and a 50% decrease $\delta$[c] | 19,150 (20,140 – 20,140) | 2,810 (1,400 – 3,800) | 14.7% |
| Assumption 4: an increase in MSM attending GUM clinic for HIV test only, by 100%, and a 75% decrease $\delta$[c] | 18,340 (17,340 – 18,340) | 2,000 (990 – 2,700) | 10.9% |

Note. a. Range calculated from the adjustment factors $\alpha_L, \alpha_H$; b. Assumes the proportion presenting with another acute STI $S$, and OR of HIV in non-testers, $\delta$, undiagnosed testers, $\emptyset$, and other acute STIs $\varphi$ remain the same; c. Assumes that the proportion presenting with another acute STI $S$, the OR of undiagnosed HIV in undiagnosed testers $\emptyset$ and in other acute STI $\varphi$ remain the same

A second change to GUM attendance could arise during an outbreak of an acute STI, for example syphilis or gonorrhoea. This could lead to an increased proportion of MSM who might be HIV positive, or newly HIV infected MSM attending the GUM clinic. This would result in an increase in HIV diagnosis in higher-risk MSM, thus increasing the OR of HIV infection $\delta$ in non-testers relative to testers and it would move towards zero. If this change was not taken into account in the adjustment factor $\alpha_{t=0}$, the Estimating Undiagnosed from the Observed Method model would overestimate $X$ (undiagnosed HIV infections).

To investigate how $Z$, the estimate of number of total HIV infections in MSM, would change if GUM clinic attendance changed due to new outbreaks of STIs, different

outputs using a plausible range of key variables were calculated. All comparisons were made to estimates produced from the Estimating Undiagnosed from the Observed Method model, Table 7.3. The ranges of probable changes due to new outbreaks of STIs resulting in changed OR of HIV infection in non-testers $\delta$ are shown below in Table 7.7.

**Table 7.7 Range of estimates of total HIV infections in MSM through the Estimating Undiagnosed from the Observed Method based on varying assumptions about changing GUM clinic attendance due to outbreaks of STIs and corresponding changes in OR of HIV infection δ in non-testing MSM**

| | Estimated total HIV infections *Z* (range[a]) | Estimated total undiagnosed HIV infections *X* (range) | % HIV infections undiagnosed |
|---|---|---|---|
| Estimating Undiagnosed from the Observed Method estimate: | 24,800 (20,550 – 27,790) | 8,460 (4,210 – 11,430) | 34.1% |
| Assumption 1: an increase in MSM attending GUM clinic for Acute STIs (e.g. gonorrhoea or syphilis) and HIV test, by 25%, and no change $\delta$[b] | 24,600 (20,450 – 27,500) | 8,260 (4,110 – 11,160) | 33.6% |
| Assumption 2: an increase in MSM attending GUM clinic for STIs (e.g. gonorrhoea or syphilis) and HIV test, by 50%, and no increase in $\delta$[c] | 24,410 (20,360 – 27,240) | 8,070 (4,020 – 10,900) | 33.6% |
| Assumption 3: an increase in MSM attending GUM clinic for Acute STIs (e.g. gonorrhoea or syphilis) and HIV test, by 25%, and a 25% increase in $\delta$ | 23,090 (19,700 – 25,460) | 6,750 (3,360 – 9,110) | 29.2% |
| Assumption 4: an increase in MSM attending GUM clinic for STIs (e.g. gonorrhoea or syphilis) and HIV test, by 50%, and a 50% decrease in $\delta$[c] | 21,450 (18,890 – 23,250) | 5,110 (2,540 – 6,900) | 23.8% |

Note. a. Range calculated from the adjustment factors $\alpha_L, \alpha_H$; b. Assumes the proportion presenting with another acute STI $S$, and OR of HIV infection in non-testers $\delta$, undiagnosed testers $\emptyset$ and other acute STIs $\varphi$ remain the same; c. Assumes that the proportion presenting with another acute STI $S$, OR of undiagnosed HIV infection in testers $\emptyset$ and in other acute STI $\varphi$ remain the same

Estimated numbers of *X*, undiagnosed HIV infections, decreased as the proportion of MSM HIV tested $\rho$, increased (assumptions 1 and 2, Table 7.7). If the increased proportion of MSM HIV tested were at higher risk of HIV infection, then the OR of HIV infection in untested relative to tested $\delta$, would get larger and move towards zero. The

model is sensitive to changes in $\delta$, combined with increased HIV tested proportion $\rho$, as shown in assumptions 3 and 4, Table 7.7 above. The estimated numbers of undiagnosed HIV infections *X*, reduced by 40% when both the proportion untested $(1-\rho)$ and the OR of HIV infection in untested relative to tested $\delta$, were reduced by 50%. The model would produce overestimates of undiagnosed HIV infections if the profile of MSM having HIV tests changed to an increased proportion of MSM with higher risk of HIV infection, if the adjustment factor $\alpha_{t=0}$ was not updated.

#### 7.6.3.4 Effects of changes in place of HIV test, leading to a higher proportion of MSM testing at GPs

Finally the effect of changes in place where MSM attend for an HIV on *X*, the estimated numbers of undiagnosed HIV infections from the model, was investigated.

The proportion of MSM who reported their last HIV test at a GP was 16.6% (Chapter four, Table 4.4). A sentinel survey of first HIV tests between 1990 and 2000 found that overall 2.9% of all first tests took place at GPs, while the rest took place at GUM clinics (Chapter 3, Table 3.1). A higher proportion of first tests in MSM at GPs within London were HIV positive (15.6% compared with 8.5%) although this was still a low number of MSM tested (141 compared with 13,734). There was no evidence of a difference in positivity outside London (3.7%, 4.1%) (Chapter 3, Table 3.1).

HIV testing practice could change with more MSM attending GPs for an HIV test instead of a GUM clinic. This would be more likely to take place as part of the initiative to normalise HIV testing and encourage annual HIV testing, rather than attending a GP through illness and a HIV test being undertaken as part of treatment and diagnosis. In the former case, one would hypothesise that MSM testing at GPs were lower risk, while HIV testing continuing at GUM clinics would be higher-risk MSM, attending for diagnosis and treatment for other STIs. In this case, since the model only monitors GUM clinic testers, the OR of HIV infection adjustments for both undiagnosed tested MSM, $\emptyset$, and untested MSM, $\delta$, would increase towards zero. The untested proportion $(1-\rho)$ would be expected to decline over time. Therefore, if the OR of HIV infection adjustments $\emptyset, \delta$ in the model were not increased to account for this change in MSM HIV testing at GUM clinics, the model would overestimate undiagnosed HIV infections. This would have the same effect on the estimate as shown in Table 7.7 and discussed in Section 7.6.3.3, final paragraph. An alternative method of estimating total HIV tests outside the GUM clinic would be needed to update the total proportion of MSM HIV tested. Effectively an $\alpha_{GP}$ would need to be calculated, and be applied to the total diagnosed HIV infections over time. A surveillance system that monitors HIV tests at

GPs would be necessary to undertake this new addition to the model and monitor it over time for changes.

#### 7.6.3.5 Multiple Imputation methods

Multiple imputation is a general approach to the problem of missing data in large datasets. These methods are used in single data-sets, and are not used to combine a range of data from different sources (which is what this thesis did). Multiple imputation allows for the uncertainty about the missing data by creating several different plausible imputed datasets in which the observed data set limits on the unobserved and combining results obtained from each of them to create a new dataset without missing data[233]. This method is often used for randomised controlled trials where every observation is important. This model is based on a series of different datasets. There is one similarity – as in multiple imputation it is assumed that missing data were missing at random, that is any systematic differences between the observed and missing data can be explained by the observed, and that the reasons for the missing data are unrelated to unobserved outcomes. The premise of this thesis and multiple imputation methods are similar in that there are data that allow us to make assumptions about people who are not taking part, i.e. for whom it is known that they exist but a directly observed measurement is not available. However, to determine plausible ranges for the unobserved, no multiple imputations were undertaken within the multiple data sets used in Chapters four to six.

### 7.6.4 Comparison of HIV estimates from the Estimating Undiagnosed from the Observed Method model with results from other estimation methods

The model has provided a point estimate of the numbers of HIV infections in MSM in the UK in a given year using diagnosed HIV infections and the proportion of MSM HIV tested. The other UK method used to estimate total HIV infections, *Z*, in 2003, the direct estimates method was published in 2006 by McGarrigle et al[25]. This method was described in Chapter one, section 1.2.3. Briefly, it produces estimates of undiagnosed HIV infections by multiplying undiagnosed HIV prevalence estimates from UA surveys in behavioural groups by the population in that group. The undiagnosed infections are then added to the diagnosed to give total prevalent HIV infections. It estimated 24,500 prevalent HIV infections in MSM in the UK in 2003, of whom 6,400 (26%) were undiagnosed. This Estimating Undiagnosed from the Observed Method provided estimates that were close to the national published estimates, although the proportions undiagnosed were higher from the Estimating Undiagnosed from the Observed Method model (34%).

Further estimates of $Z$, total HIV infections, for 2003 were produced using the direct estimate method but through Bayesian MPES and published by Goubar et al[234]. This method is explained briefly in Chapter one, section 1.6 and further in section 7.7 below. They estimated a total of 19,400 (17,200 to 22,300) prevalent HIV infections in MSM aged 15-44 in England and Wales, of whom 8,200 (6,100 to 11,100) (42.3%) were undiagnosed. Estimates for MSM in England and Wales aged 15-44 using this Estimating Undiagnosed from the Observed Method model, using the adjustment factor and the same numbers of diagnosed HIV infections, were 18,430 (17,110 to 22,270), of whom 7,230 (3,600 to 9,760) (39.2%) were undiagnosed. The model described in this chapter provides estimates of HIV infection in MSM very similar to those provided by the MPES method.

HIV testing in MSM has increased since the beginning of the implementation of an opt-out HIV test policy throughout the GUM clinics following recommendations in 2006[235] in England and Wales, and the Scottish sexual health strategy in 2005[236]. To further test the model, estimates of $Z$, total numbers of HIV infections, were calculated for 2009, using available data, and then compared with estimates for 2009 produced by the MPES method. To update the Estimating Undiagnosed from the Observed Method model to 2009 some assumptions were made, since the model used the proportions HIV tested $\rho$ from Natsal 2000 and there is no current update for these proportions. To approximate the population increases in HIV testing in MSM to $\rho$, the proportionate increases in HIV testing seen in MSM attending GUM clinics taken from the UAPMP GUM survey between 2003 and 2008, were examined. The UAPMP GUM survey was carried out at 17 GUM clinics nationally and the increases in HIV testing measured were assumed to be equal to the proportionate population increases. Thus, an increase in HIV testing of 36% in London and 39% outside London were applied to $\rho$ in the Estimating Undiagnosed from the Observed Method model. It was assumed that these increases to $\rho$ were equal across the age groups. These results are presented below in Table 7.8.

The Estimating Undiagnosed from the Observed Method model estimated results similar overall to the MPES method although the estimated numbers of undiagnosed HIV infections were closer in London than the outside London numbers. This may be due to changes in prevalence of HIV infection when comparing London and Outside London since 2003. Given the large changes in HIV testing policy and practice implemented at GUM clinics since 2003, the adjustment factor for OR of HIV infection in untested MSM $\delta$ is likely to have changed since 2003, The Estimating Undiagnosed from the Observed Method model was recalculated, this time assuming a reduction in

the OR of HIV infection amongst untested MSM $\delta$ relative to tested, and with no adjustment factor for outside London. It was assumed that untested MSM at GUM clinics would be even less at risk of an undiagnosed HIV infection, given the increase in HIV offering and testing at GUM clinics. The adjustment for London was removed as there was no evidence to update this adjustment. The second estimate produced numbers of undiagnosed HIV infections more similar to the MPES method.

**Table 7.8 Comparisons of estimates of total HIV infections in MSM (*Z*) 2009 through Estimating Undiagnosed from the Observed Method[a] model using 2009 diagnosed HIV infections (*Y*) with published estimates produced through MPES method**

| | Estimated total HIV infections *Z* (range[b]) | Estimated total undiagnosed HIV infections *X* (range) | % HIV infections undiagnosed |
|---|---|---|---|
| **Assuming all adjustments in $\alpha_{t=1}$ , $\alpha_{t=0}$ are equal to 2003** | | | |
| Estimating Undiagnosed from the Observed Method[c] | | | |
| London | 19,030 (15,850 – 21,250) | 6,330 (3,150 – 8,550) | 33.3% |
| Rest of UK | 15,030 (14,190 – 15,620) | 1,680 (840 – 2,270) | 11.2% |
| *Total UK* | *34,060 (30,040 – 36,880)* | *8,010 (3,990 – 10,820)* | *23.5%* |
| **Adjustment to $\delta, \beta$** | | | |
| Estimating Undiagnosed from the Observed Method[d] London | 18,100 (15,390 – 20,000) | 5,400 (2,690 – 7,300) | 29.8% |
| Rest of UK | 16,200 (14,770 – 17,200) | 2,840 (1,420 – 3,840) | 17.5% |
| *Total UK* | *34,300 (30,160 – 37,190)* | *8,250 (4,100 – 11,140)* | *24.0%* |
| MPES Method[e] | | | |
| London | 18,020 (15,980 – 21,660) | 5,320 (3,330 – 8,940) | 29.5% |
| Rest of UK | 17,050 (16,440 – 17,470) | 3,670 (3,110 – 4,080) | 21.5% |
| *Total UK* | *34,070 (32,420 – 39,130)* | *8,990 (6,440 – 13,020)* | *26.4%* |

Note. a. $\rho$ increased by 36% in London and 39% outside London, from UAPMP GUM survey increase in testing at GUM clinics; b. Range calculated from adjustment factors $\alpha_L, \alpha_H$; c. Assumed that OR of HIV infection $\delta$ , $\emptyset$ and outside London adjustment $\beta$ remained the same as 2003; d. Assumed that OR of HIV infection $\delta$ reduced by 20% and no $\beta$ adjustment; e. Results reproduced from method by Presanis et al[234] updated and published by HPA, 2011.

## 7.7 Discussion

The Estimating Undiagnosed from the Observed Method model, using an adjustment factor ( $\alpha_{t=1}$, $\alpha_{t=0}$) produced estimates of numbers of undiagnosed HIV infections (*X*) similar to other published estimates for 2003. The model was sensitive to changes in the OR of HIV infection in untested MSM relative to tested, $\delta$, and the proportion of MSM with undiagnosed HIV infection that have tested, $U$. The estimates produced by the model for 2009 showed some deviations from published estimates. The OR of HIV infection ∅ and $\delta$ may have changed since 2003, given the changes to the proportions of MSM that have HIV tested. An update of the key parameters used to produce the adjustment factor ( $\alpha_{t=1}$, $\alpha_{t=0}$) may produce a more accurate estimate for 2009, e.g. OR of HIV infection for untested MSM, $\delta$, the proportion presenting with other acute STIs, $S$, and the OR of HIV infection, $\varphi$, for this group, and the proportion of MSM, $U$, and OR of undiagnosed HIV infection in tested MSM, ∅. Additionally, over the intervening period, large increases in the offer and uptake of HIV tests at GUM clinic have been seen through the UK. A review of factors associated with offering and accepting an HIV test to MSM at GUM clinics, carried out between January 2003 and May 2005; found that similar factors were associated with both the offer and uptake of HIV testing as were found in this thesis[237]. The offer of a test was associated with not attending with symptoms of an STI, more sexual partners, and previously HIV tested[237]. While MSM accepting a test was associated with decreasing age, no symptoms of an STI, risk from UAI, no previous HIV test in addition to less time to wait for results[237]. Many clinics changed their HIV testing policy over this time period, moving to an opt-out rather than an opt-in HIV testing policy. This would lead to an increase in HIV testing, regardless of risk behaviour, and should ultimately lead to the OR of HIV infection in untested MSM relative to tested, $\delta$, moving towards 1.0.

This Estimating Undiagnosed from the Observed Method does have limitations. The main limitation is that the HIV adjustment factors $\alpha_{t=1}$ and $\alpha_{t=0}$ were calculated based on data from one inner London GUM clinic. MSM attending this clinic may differ behaviourally and in testing history from MSM attending other GUM clinics nationally. Outside London risks may be different from London, and the model did show some divergence when estimating undiagnosed HIV infections (*X*) outside London when compared with estimates from other methods. Additionally HIV testing histories were only collected within the clinic. MSM may test at many different clinics, and not report this HIV testing to their care provider at GUM consultation. This could underestimate the proportion of MSM HIV tested, and bias the results.

The model estimated undiagnosed HIV infections, *X*, based on data from MSM

attending a GUM clinic. While adjustments were made for MSM not attending GUM clinics, and represented as the lower range of the estimate, the method could be strengthened by including an additional component, $\alpha_{GP}$, that included MSM who HIV test at sites other than GUM clinics, and in particular at GPs. New national guidelines on HIV testing were produced jointly by the British Association of Sexual Health and HIV (BASHH), the British HIV Association and the British Infection Society in 2008, with wide representation from other relevant bodies and parties across the UK[238]. These guidelines recommend the expansion of HIV testing beyond antenatal and GUM clinic settings and advocate the routine offer of an HIV test to all adults registering in GP and all general medical admissions in higher prevalence areas. As HIV testing increases in settings outside GUM clinics, this additional component would become increasingly important to produce accurate estimates.

There were missing data within each of the datasets, and multiple imputation methodology could have been carried out to improve the estimations. In the future, more rigorous methods of handing missing data (e.g. multiple imputation) could be used. This could be done by assuming a range of values for each of the missing variables in the individuals, assuming them to be distributed across the missing as they were in the complete cases. This could either confirm or refute whether any additional variable not found in this analysis was associated with both HIV testing and risk of HIV infection and, if so, whether it should be added as an additional strata to the model. The importance of collecting this variable though surveillance would then need to be communicated to the data providers. An audit of why it is not collected completely at clinic level would need to be carried out.

Finally, this method does not have statistical limits, i.e. it does not allow for sampling variation of the adjustment factors which were based on estimates from different datasets. The estimates of HIV infections derived from this Estimating Undiagnosed from the Observed Method were compared with estimates produced by the MPES method. The MPES method developed a Bayesian framework for synthesis of surveillance and other information, carried out through Markov chain Monte Carlo methods, and thus takes account of sampling variation in the original estimates. The MPES method is very similar to the method in this chapter, namely a 'direct' approach in that the population is split into risk groups, and estimates of risk group size and of risk group prevalence and diagnosis rates (to produce undiagnosed HIV prevalence) are combined to derive estimates of the number of undiagnosed infections, *X*, and of the overall number of infected individuals, *Z*. In the direct method each parameter was informed by a single item of evidence, and it is assumed that each item is unrelated. It

was not possible to produce meaningful statistical limits around the direct method estimates. However, the MPES model incorporated a hierarchical structure to spread information more evenly over the parameter space, thus each source of evidence contributes to each parameter. This method allowed a quantification of the uncertainty within the estimate and a range to be produced for the estimate. The schematic diagram of influence from the Goubar et al publication[12] is represented below in Figure 7.8.

**Figure 7.6 Bayesian multiparameter evidence synthesis of surveillance to estimate HIV infections, taken from Goubar et al J. R. Statist. Soc. A (2008) 171;3:541–580**

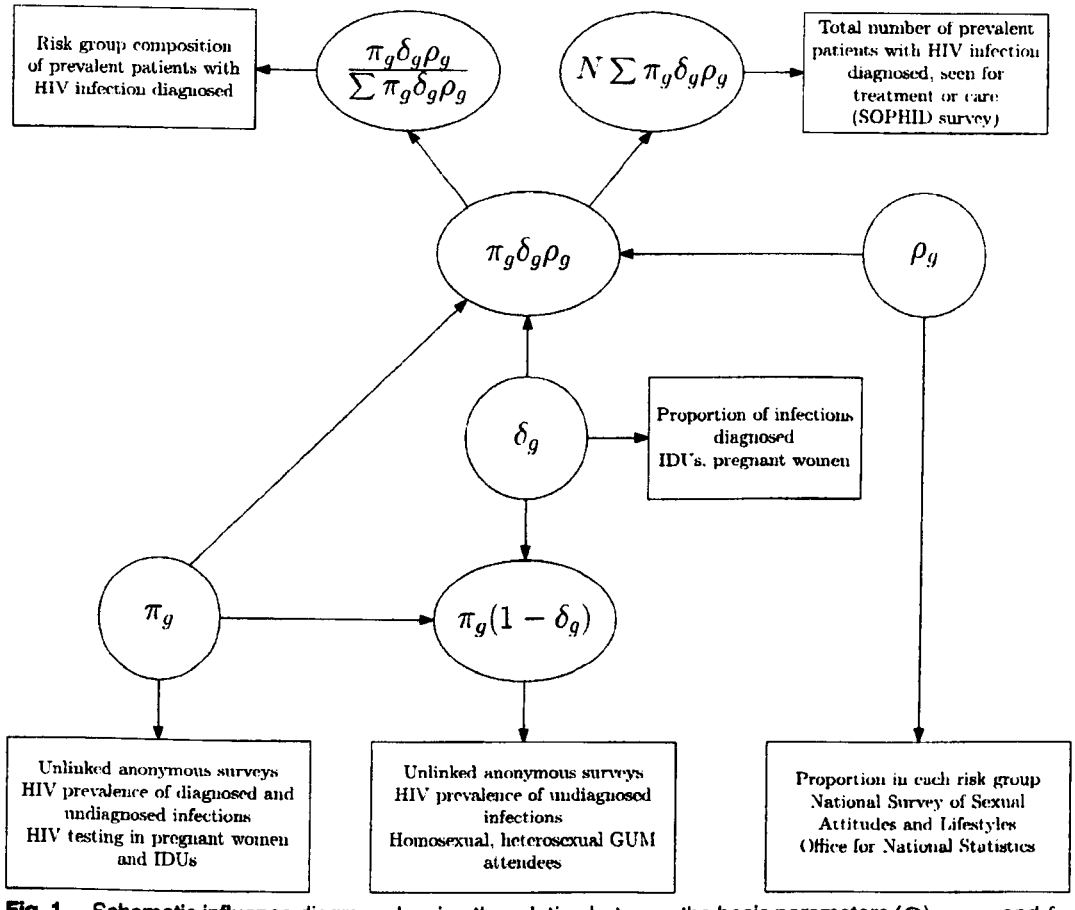



**Fig. 1.** Schematic influence diagram showing the relation between the basic parameters (○) $\pi_g$, $\rho_g$ and $\delta_g$ and the six types of data: $g$ indicates a risk group and $N$ is the population size

The novel, and computationally much simpler method presented in this chapter uses similar data sources and does not rely on the population risk group sizes (Natsal and ONS), instead it uses the numbers of diagnosed HIV infections, *Y*, from SOPHID and the proportion of MSM who have HIV tested $\rho$ (Natsal), and indirectly estimates the undiagnosed HIV infections from the diagnosed HIV infections. This Estimating Undiagnosed from the Observed Method model did not produce any confidence limits;

although the range for the estimates produced based on higher- and lower-risk behavioural groups were similar to the ranges produced by the Bayesian MPES method.

## 7.8 Conclusions

In summary the Estimating Undiagnosed from the Observed Method, with the newly developed adjustment factor provided estimates for total HIV infections in MSM, *Z*, using total number of diagnosed HIV infections and information on HIV testing. This provided an easily calculated method for estimating undiagnosed HIV infections, *X*, based on existing available surveillance data. The adjustment factor calculated was a useful adjunct to this method as it reduced the previous overestimations associated with the method and yet still provides a cost-effective and easy method to estimate prevalent HIV infections. Sensitivity analyses showed how the adjustment factor for untested MSM might change according to some factors over time. These factors would need to be prospectively monitored through surveillance systems to detect the changes which could then be accounted for in the future models.

# CHAPTER EIGHT

## *CONCLUSIONS AND RECOMMENDATIONS*



### Summary

This chapter contains the conclusions of the thesis and recommendations for policy and future surveillance systems. Key findings are described, including clarification in areas where some anomalies were found. Recommendations for policy changes based on the conclusions of this thesis are made. This is followed by recommendations for surveillance mechanisms that would enable the prospective monitoring of factors associated with the outcomes of the estimation model.

The aims and objectives of the thesis set out in sections 1.4 and 1.5 were met by the original studies conducted within this thesis. A systematic review investigated the relationship between HIV testing and risk of HIV infection in MSM and a conceptual framework of the relationship was developed (Chapter two). The trends of HIV, STI, and HIV testing in MSM in the UK were described (Chapter three). The first national study estimating the size and characteristics of the population of MSM HIV testing and their associated sexual behaviours was carried out (Chapter four). The association between HIV testing and HIV infection was modelled in different behavioural groups of MSM (Chapter five and six). Finally a model to estimate total HIV infections in MSM was developed using this relationship between HIV testing and HIV infection (Chapter seven).

## 8.1 Key Findings

This thesis investigated and measured the relationship between HIV testing and risk of HIV infection, through risk behaviours. It identified and described the factors that affect both HIV testing and risk of HIV infection: age, area of residence, and acute STIs diagnosed. It reviewed the literature which provided compelling evidence that these variables proxy unobserved high-risk behaviours and thus allow estimating HIV infections at a population level.

At the time of this thesis, nationally over a third of MSM (36.6%) reported an HIV test, and this was associated with increasing numbers of sexual partners (AOR 3.26, 95%CI 1.09 – 19.78) (Chapter four). Measuring HIV infection through UA testing of specimens, found that increasing age was associated with ever HIV testing and HIV infection (Chapter five). Being diagnosed with an acute STI, other than gonorrhoea or syphilis, was associated with a reduced likelihood of ever HIV testing and with lower HIV infection relative to no other acute STI. While diagnosis with gonorrhoea and syphilis were strongly associated with HIV infection, they were not associated with HIV testing (Chapter five). MSM recruited through the community to studies had a higher risk of HIV infection, and GUM clinic attendance was associated with higher risk of HIV infection (Chapter six). A model that estimated numbers of total prevalent HIV infections in MSM, using surveillance data on diagnosed HIV infections and proportions of MSM HIV tested, was developed. This built on previous work by developing an adjustment factor for untested MSM compared with HIV tested MSM. In 2003 an estimated 24,800 (range: 20,550 – 27,790) MSM were living with HIV, of whom 8,460 (range: 4,210 – 11,430) (34%) were unaware of their infection (Chapter seven).

The next section provides some clarification in areas where some anomalies were found within the thesis.

## 8.2 Diagnosis of Gonorrhoea or Syphilis and HIV testing

Because of the rising trends in gonorrhoea in MSM (section 3.5.2), it was expected to be a marker for high-risk behaviour, and therefore useful in the model. A new diagnosis of gonorrhoea and previous negative HIV tests more than 5 years ago were associated with being HIV positive (section 5.3.5). The reason for this could be twofold. This may be because diagnosed HIV positive MSM attended a GUM clinic for diagnosis and treatment of an STI and did not disclose their HIV status to the clinician (social-desirability bias). Alternatively, these may be new incident HIV infections. It is difficult to determine which scenario is true. However, gonorrhoea diagnosis was not found to be associated with HIV testing (section 5.3.5). These results reinforce the need for MSM attending GUM clinics with acute gonorrhoea to be offered and recommended HIV testing as the national standard set in the National Strategy for Sexual Health and HIV state[151]. A follow-up audit of clinical practice at GUM clinics in England and Wales in 2004 carried out by the BASHH and the HPA to inform new HIV test guidelines, also found this failure to HIV test MSM presenting with an acute STI. The most often cited reason for not receiving voluntary counselling and testing (VCT) was deferral because of concerns relating to the accuracy of HIV testing shortly after exposure. The rate of re-attendance for the second test was low[237].

## 8.3 HIV testing and undiagnosed HIV infections

While previous HIV testing was associated with higher risk of HIV infection, undiagnosed HIV infections occurred in those who never had an HIV test when all clinically recognised HIV infections were excluded (section 5.3.4.2). This was because most of HIV infections were diagnosed at first HIV test (88.1%). Overall HIV prevalence was higher in men who had attended a GUM clinic compared with men who had not. However, the proportion of HIV infections that were undiagnosed was higher in the non-GUM attending sample (64.6% compared with 38.1% in the community sample and 28.8% in GUM-recruited sample) (section 6.3.3). Targeted prevention is necessary to reach this group of MSM and provide opportunities for their HIV infection to be diagnosed. Alternative testing sites outside the GUM clinics have been proposed and currently evaluations are being carried out of where the best sites for HIV testing might be to allow access to HIV testing to all[239-241]. If barriers to HIV testing exist, further research is needed to understand what they are and if they are with the provider or the

individual. Voluntary confidential HIV testing is an important strategy for facilitating the management of HIV infection in the individual and reducing the likelihood of onward transmission through behavioural change and decreased viral load through antiretroviral treatment.

The reasons for not HIV testing in MSM in the UK are multi-factorial and change over time. The majority of MSM recruited through a community survey in London in 2002 reported 'not putting themselves at risk' as the reason for not HIV testing in the last year (34%)[157]. While the majority of MSM in the Natsal study who did not test in the past 5 years perceived themselves to be either 'not very much at risk' or 'not at risk at all' of HIV infection (84%)[8]. Research in Scotland found that fear of a positive result, along with HIV-related stigma and discrimination within the gay community, discouraged HIV testing[107,108]. However service provision and clinic policy are also important factors in HIV testing decisions. A national study of testing in MSM attending GUM clinics found that MSM attending for the treatment of an STI were less likely to be offered an HIV test, and lower uptake of tests following offer was associated with symptomatic STI infection, increasing age, no previous HIV test and the time to wait for results[237].

While there has been some normalisation of HIV testing over the previous decade, with an increase in HIV testing, associated with lower-risk behaviours, this has not been substantial and much of the MSM surveyed in 2000 did not report a HIV test in the past 5 years. While HIV testing was associated with risk behaviours, and reported STI, the opportunities to offer and recommend HIV testing to those at increased risk of infection, should be acted upon. National standards for HIV testing have been set in the National Strategy for Sexual Health and HIV[151], including an increase in the offer and uptake of HIV and STI testing.

## 8.4 Limitations of estimation methodology

The following section discusses some of the limitations of the research design and methodology from the knowledge that was acquired while undertaking the research. Some alternative or additional approaches that might be pursued are outlined for the future.

The validity of the project depends upon how representative the MSM surveyed were of all MSM in the UK. The calculation of the adjustment factor was based on data from the study in Chapter four in an inner London GUM clinic, assuming that they are

representative of all MSM. To test the model within changing parameters, it was updated with data from 2009 and this highlighted some concerns with the model estimation for outside London. Further development of the model is needed and a study investigating the differences in untested and tested MSM outside London would provide a more representative sample. The addition of an extra regional stratum for MSM may help, as HIV prevalence in MSM outside London is not uniform. Areas such as Brighton and the South east, and Manchester have been shown through syphilis and gonorrhoea outbreaks to be higher-risk areas for MSM[161].

The relationship between HIV testing and risk of HIV infection is a complicated one, which will vary on an individual level. It was difficult to collect all the relevant behavioural information within existing disease surveillance mechanisms and not all factors associated with HIV testing and HIV infection could be measured. This thesis was working within the constraints of available surveillance data, as this was the principle aim of the project which was to provide estimates within existing HIV surveillance systems[242].

This model is country-specific; because the estimates and relationships are all within the context of the UK service provision and demographic and behavioural factors within MSM in the UK. However, these parameters could be generated for other countries, with some sentinel survey data in MSM to inform the adjustments. Finally the associations between HIV testing and behaviour are changing over time, and this requires closer monitoring in order to reproduce accurate estimates for future years. Currently the model does not include a component for MSM tested at GPs. As testing practice changes and expands outside of GUM clinics, the model would need to be updated accordingly.

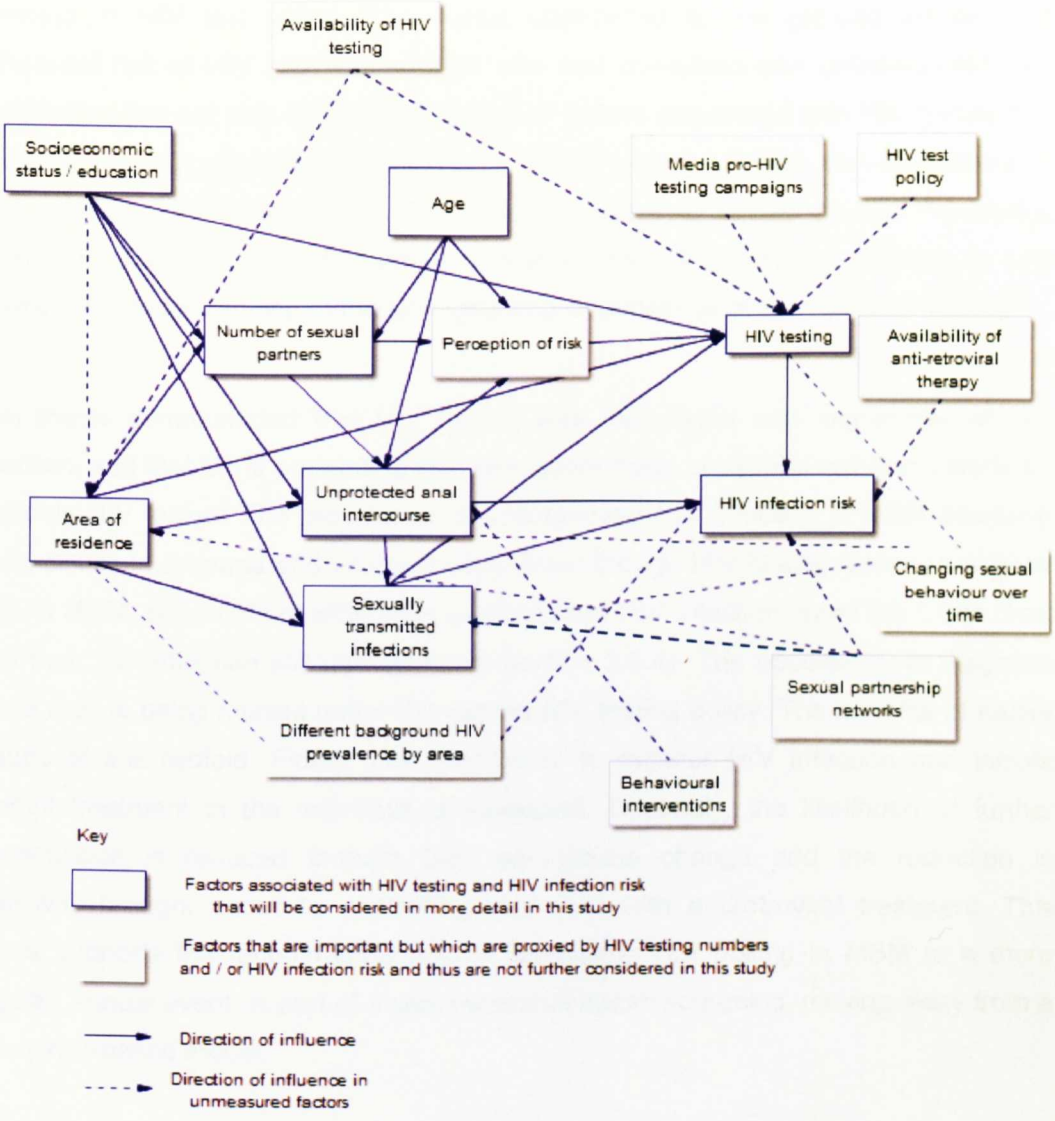
Further limitations of the thesis were in missing data and selection and measurement biases and these were discussed within each chapter study. Even within these limitations, this thesis provides a unique contribution to estimations of numbers of total prevalent HIV infections in the UK as each parameter can be subjected to sensitivity analyses.

## 8.5 Was the conceptual framework for measuring the association between HIV testing and risk of HIV infection correct?

After the analyses and estimation model carried out in this thesis, the conceptual framework from Chapter two can be reviewed again (Figure 8.1). The conceptual framework does have limitations. The graph doesn't look at location of HIV testing (e.g. GUM clinics versus GP). The associations between the factors within the graph may be different by place of HIV test. There is some evidence arising from this thesis that sexual behaviours lead to different associations (e.g. UA GUM survey and GMSHS comparison in Chapter six). If the associations are the same, regardless of place of test, then the framework will still be correct. If the associations are different, the white boxes in the graph which weren't measured (HIV test policy, availability of testing), become more important as they may relate to place of HIV test. These may imply different associations between sexual behaviour and HIV testing in each location. The differences in HIV prevalence in UA GUM and GMSHS may be related to sexual partnership networks, and changing sexual behaviour within sub-groups within the population of MSM. Again these were factors not measured within the model.

These issues could be clarified by collecting additional information on UAI and number of sexual partners within existing surveillance systems in addition to developing surveillance of HIV tests carried out in alternative locations to GUM clinics.

**Figure 8.1 Conceptual framework of the relationship between HIV testing and risk of HIV infection mediated through risk behaviour**




Drug and alcohol use were not included in the framework. These have been shown to be linked to increased risk behaviour which has led to HIV seroconversion in the UK[42,78]. While these are undoubtedly important when considering HIV transmission and HIV prevention, they are outside the scope of current surveillance data, and so have not been considered for this model.

## 8.6 Implications for policy and practice

This section makes recommendations for policy changes based on the conclusions of the thesis. In Chapter four, the first national study of HIV testing and demographic and

behavioural factors associated with HIV testing in MSM was reported. The full population analysis was published in a peer-reviewed journal to inform the public health planning of HIV test policy. This thesis contributed to the growing evidence of differential risk of HIV infection in MSM who test compared with untested MSM. Its contribution lies not only in the identification of factors associated with HIV testing and HIV infection, but provides national figures of HIV testing in MSM, and estimations of total numbers of HIV infections. The European Working Group on HIV Prevalence Estimations has encouraged countries to develop multiple estimation methods to help develop the understanding of the strengths and weaknesses of the various methods[17].

This thesis demonstrated that HIV testing was associated with higher risk of HIV infection, and that MSM presenting with new gonorrhoea or syphilis infections were not routinely HIV tested. The prevalence of undiagnosed HIV infection in MSM attending GUM clinics in England and Wales is high. Even though HIV testing rates are already high in MSM, two-thirds of MSM with undiagnosed HIV infection leave the GUM clinic with their HIV infection still undiagnosed (section 3.5.4). The opportunity to diagnose these men is being missed under the current HIV testing policy. The benefits of earlier diagnosis are twofold. Firstly, the opportunity to monitor HIV infection and initiate prompt treatment in the individual is increased. Secondly, the likelihood of further transmission is reduced through both behavioural change and the reduction in infectivity brought about by controlling viral load with antiretroviral treatment. This thesis supports the recommendations for increasing HIV testing in MSM to a more regular, annual event as part of a general sexual health screening, moving away from a solely risk-based model.

Increased offering and recommendation of HIV testing would reduce the proportion of undiagnosed HIV infections in MSM attending GUM clinics. The implications of a change in policy need consideration. Some have argued that promoting HIV testing could cause increased psychological worry for individuals who perceive themselves to be at risk and reinforce high-risk sexual behaviours in individuals that test negative[33,60,77]. There is currently little evidence to support the hypothesis that possible adverse effects of test promotion could outweigh the benefits of earlier HIV diagnosis. A policy change to increase the offer of HIV testing to MSM may have little impact on clinic workload, since this may standardise already existing heterogeneous clinic practices.

The English National Strategy for Sexual Health and HIV has prioritised the uptake of

HIV testing as a core HIV prevention intervention with two main aims[137]. The first is to reduce the number of HIV infected individuals who remain undiagnosed after attending a GUM clinic. The second is to encourage HIV testing of people at a wider range of sites including primary care and general medical settings[137]. This has been proposed at the European level[243]. On-going surveillance of HIV testing will provide a key mechanism for monitoring progress on these goals. Alongside increased offers of HIV testing, this thesis supports the need for targeting groups at high risk of HIV infection with HIV testing interventions, including MSM presenting with acute STI such as gonorrhoea and syphilis. Such focussed promotion of HIV testing will be more cost-effective than testing of individuals at lower risk, as fewer HIV tests are needed to diagnose one HIV infection. Implementing an annual offer and recommendation of HIV test to all MSM attending GUM clinics would reach the objective of reducing undiagnosed HIV infections in MSM through HIV testing in GUM clinics. This strategy would build on the existing policy but, in addition, ensure that all MSM are actively offered and recommended an annual HIV test throughout their GUM clinic attendance career. This would ensure earlier HIV diagnoses among asymptomatic MSM presenting at GUM services. The policy has the advantage of being targeted at MSM who are at significantly higher behavioural and STI transmission risk.

Following recommendations for annual HIV testing in the annual report 2003[244], the Department of HIV and STI at the HPA were invited to present evidence for it to the Expert Advisory Group on AIDS (EAGA). The policy recommendation, of which I was lead author, was presented in 2004, and is included in Appendix E. This was followed by an audit of clinical practice and policy carried out by BASHH and HPA, with represented to the EAGA In 2006. This formed the basis of the national guidelines on HIV testing produced in 2008. The BASHH guidelines (2008)[238] recommend that all patients should be offered VCT on their first clinical attendance including patients presenting with STI. It was recommended that all MSM should HIV test annually, or more often, if clinical symptoms are suggestive of seroconversion or on-going risk exposure[238]. Finally, following invited commentary from key stakeholders some clinical and voluntary organisations thought the proposal didn't go far enough, but that opt-out[i] HIV testing as part of a sexual health screen for MSM at first visit and additionally according to risk should be considered, given the proven success in increased offer and uptake from the antenatal testing model. An audit covering 83% of GUM clinics in 2004[237] ascertained that about half of clinics operated an opt-out HIV test policy and

[i] Opt-out testing policy: A HIV test forms part of a sexual health screen and is routinely offered and carried out unless the patient declines. The patient must actively refuse a test (informed consent via leaflet or discussion is presumed).

half an opt-in[ii]. This is supported by evidence from the UK and the US and other countries which has shown an increase in test uptake and a decrease in undiagnosed infections following opt-out test policies[245-248].

## 8.7 Recommendation for future work

As HIV testing expands out of GUM clinics to alternative settings, in particular GPs, an additional component to the indirect model to be developed would be HIV testing at GPs. The adjustment factor in the estimation model would need to include an additional adjustment for the proportion of HIV tests that will be carried out at GPs in the future, as testing practice will change over the next decade and become normalised. HIV surveillance systems will collect information on HIV tests through sentinel surveillance mechanisms; however, some measure of the risk of being HIV positive in these men would need to be estimated.

This model can be used to estimate total HIV infections in cost-constrained countries where limited surveillance data are available, but recent sentinel estimates of HIV testing exist. The size and overall direction of the relationship is likely to differ in populations differing in development, culture and epidemiological patterns that characterise the transmission of HIV. If these were considered within the available surveillance and epidemiological data, the model could be adapted for use in other countries and other population groups such as heterosexuals.

## 8.8 Recommendations for future surveillance mechanisms

The following section makes recommendations for surveillance mechanisms that would enable the prospective monitoring of factors associated with the outcomes of the estimation model.

Disease surveillance provides information for action. The need for detailed surveillance data has been previously emphasised in the UK Department of Health publication 'Getting ahead of the curve'[249] and this thesis highlighted the limited range of datasets available, together with the problems associated with interpretation. Accurate estimates of numbers of total prevalent HIV infections are important for public health planning,

[ii] Opt-in testing policy: A HIV test is offered to a patient on its own or as an optional addition to a sexual health screen (SHS). The patient must actively agree to the test as an 'extra' to the SHS.

they inform public health interventions and the targeting of sexual health promotion and disease control strategies. Estimates of HIV prevalence from MSM attending GUM clinics are readily accessible, and current estimation methods use these together with estimates of the population of MSM[12,25]. However, diagnosed HIV infections include MSM tested both at GPs and GUM clinics, and so a method that estimates total numbers of HIV infections from all MSM is a useful addition to the field[17].

This thesis was written at a time of increasing STI diagnoses in MSM. Behavioural change is a key factor in the primary prevention of HIV infection. Potential modifiable risk factors and determinants of HIV infection that could be targeted through educational campaigns to reduce the probability of disease occurrence were identified through this study. Sexual behaviour remains the key determinant of STI and HIV transmission. Not all factors could be measured in the model as only available surveillance data were used. Factors that were important but were not available included sexual behaviours such as UAI and numbers of sexual partners (section 2.11, Figure 2.13). Current surveillance systems collect limited data on the behavioural determinants of STI transmission and while they are good for monitoring trends, they do not provide information on the sexual behaviours or mixing patterns that may be underlying this trend[7]. Where data on UAI and numbers of sexual partners exist they are often limited to facilitate ease of completion by busy clinical staff, and there are issues about non-response in particular in the area of sexual health. Hence, there is a trade-off between the information that can be collected reliably and in complete fashion on large numbers of people and information that may be very detailed but which may be not representative and generalisable. Most systems rely on methods more focused on disease outcome, practicality, uniformity, and speed rather than on obtaining full demographic and behavioural details so that representative data can be collected. Generally, the additional data collected are minimal (typically age, sex, sexual orientation). However, the enhanced KC60 surveillance system will not only allow more risk factor information to be collected on an individual basis, but will allow rates of co-infection and re-infection of STI to be examined and core groups to be more accurately described[250,251].

Public health surveillance of sexual behaviour is needed to measure risk behaviours that will allow the monitoring of the effectiveness of prevention programmes and may provide early warning signs for the spread of HIV and STIs or help determine which areas are in need of greater efforts[252,253]. Behavioural surveillance programmes have enabled the description of population patterns of risk behaviours for STI and HIV transmission and aid in the understanding of how epidemics of STI are generated. The

triangulation of a small set of core measures selected from surveillance data and other complementary sources can strengthen the interpretation of these data because the relationship between sexual behaviour and STI transmission is complex. This has been accomplished in many other countries including some in Asia[254-257], Africa[258], Europe[259], and the United States[260]. Behavioural surveillance generally aims to monitor trends in two broad groups of indicators: firstly, those that allow the identification of population subgroups at increased risk, for example, age, sex, sexual orientation, and ethnicity; and secondly, those behaviours that are amenable to change, for example number and type of sexual partnerships, condom use, UAI. The validity and reliability of sensitive data on behaviour are critical as they are self-reported and cannot be directly measured[218]. National population surveys, while useful for creating a national picture, are unable to produce robust local data and thus there are limitations to local decision making.

The World Global Programme on AIDS (GPA) and UNAIDS, in collaboration with national and international partners have developed a standard set of HIV prevention indicators for this purpose[261,262]. The GPA developed ten prevention indicators of health, knowledge and behaviour that are central to HIV prevention. These range from indicators of population knowledge of preventative practices, reported sexual behaviour and use of condoms in the general population, through STI service evaluation, to indicators of the impact of the programme. The indicators are meant to be simple, relatively easy to measure and interpret and operationally useful. In aggregate, the prevention indicators are intended to provide evidence that overall prevention efforts are reducing HIV incidence rather than evaluate specific prevention projects.

Behavioural surveillance programmes have now been implemented in the United States[260,263], Switzerland[259], Australia[264], and Hong Kong[265]. Standardised behavioural indicators for Europe have been developed recently through a European working group, organised by the European Centre for Disease Prevention and Control, which had an individual group to focus on indicators for MSM[266,267]. Such a coherent system for monitoring indicators uses data resources more efficiently, allows comparison of indicators internationally and reduces duplication of effort.

Prevention indicators have been developed in the past in England and Wales derived from HIV and STI surveillance data[205]. The indicators used have been limited by the fact that they were not comparable with international prevention indicators and they have not been tied into the outcomes set out in the HIV prevention framework for MSM in England and Wales[268]. In the past, quantitative surveys have been limited in their

collection of non-standardised demographic, behavioural and outcome indicators that restrict comparability between them. A move to more standardised indicators would aid cross-comparability between surveys[7,28]. A number of annual surveys of MSM attending social venues[48,52,269], GUM clinics[48], and Gay Pride events[270] are currently carried out in the UK. These use a stable set of behavioural indicators that can be monitored repeatedly. The example given in this thesis, namely the three surveys which developed and used a common set of core behaviour questions that allow comparisons of the three populations of MSM gave simple methods to deal with the issue of generalisability and allowing for ranges of HIV prevalence in different behavioural risk groups[7].

As shown in this thesis, prevention indicators should therefore investigate trends of infection alongside trends in behaviour that may lead to infection[240], or proxies thereof. Triangulation of surveillance, programme evaluation and research data can help to substantiate the link between interventions and observed behaviour changes. They have been instrumental in helping to refine public health interventions and inform the targeting of sexual health promotion and disease control strategies. The formalisation and coordination of behavioural surveillance in the UK could optimise our ability to measure the impact of interventions and health promotion strategies on behaviour. This will be particularly useful for monitoring the progress towards specific disease control targets set in the Department of Health's new Sexual Health and HIV Strategy. Additionally, they would prospectively monitor the factors most closely associated with risk of HIV infection and HIV testing and could feed into the estimation model developed in this thesis.

A combination of approaches could be used in the UK. In association with key external partners, the HPA can collate data derived from on-going local and national sexual behavioural surveillance and research programmes both within and outside the HPA. A streamlining of current behavioural data collection through existing surveillance systems is needed[7]. Collaborative partnerships with academic and research institutions involved in behavioural research should be established to define and collate key behavioural indicators relevant to HIV and other STI transmission. These indicators will include sexual behaviours such as number of sexual partners, types of sexual intercourse (vaginal, anal, and oral), and potentially preventative behaviours such as condom use and health service use for HIV and other STI screening. This would give an overview of behaviours at the population level in both the general population and in those with disease. A surveillance system, which will allow the prospective monitoring of the important risk indicators, could then be established.

## 8.9 Conclusion

It was proposed that HIV test policy should be changed to recommend annual HIV testing as part of a sexual health screen in MSM. Future surveillance should include centralised collation of behavioural surveillance indicators that include numbers of sexual partners and UAI. In conclusion, this thesis has provided a unique methodology to estimate HIV infections in MSM in the UK which can easily be adapted to allow for changes in assumptions, and thus is useful in addition to the existing estimation methods.

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259. Dubois-Arber F, Jeanin A, Spencer B. Long term evaluation of a national AIDS prevention strategy: the case of Switzerland. AIDS 1999;13(18):2571-82.
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264. Dore GJ, Kaldor JM. Sexually transmitted diseases surveillance in Australia: towards a coordinated national system. Commun Dis Intell 1998;22(4):49-52.
265. Lau JTF, Siah PC. Behavioural surveillance of sexually-related risk behaviours of the Chinese male general population in Hong Kong: a benchmark study. AIDS Care 2001;13(2):221-32.
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## APPENDIX A Studies excluded from review and a tabulated summary of factors associated with HIV testing and UAI from reviews in Chapter two

### Table A.1 Studies excluded from review of factors associated with HIV testing and UAI

| Study | Reason for Exclusion |
|---|---|
| Abdullah ASM, Hedley AJ, Fielding R, Ebrahim SH. Determinants of HIV antibody testing among selected groups of Chinese residents in Hong Kong. International Journal of STD & AIDS 2004;**15**:608-614 | No separate results presented for MSM |
| Alves K, Page-Shafer K, Caseiro M, et al. Risk Factors for Incident HIV Infection Among Anonymous HIV Testing Site Clients in Santos Brazil: 1996 – 1999. JAIDS 2003;**32**:551-559 | No separate results presented for MSM |
| Burchell AN, Calzavara LM, Myers T et al. Voluntary HIV Testing Among Inmates: Sociodemographic, Behavioural Risk, and Attitudinal Correlates. JAIDS 2003;**32**:534-541 | No separate results presented for MSM |
| Chesney MA, Chambers DB, Kahn, JO. Risk Behaviour for HIV Infection in Participants in Prevetive HIV Vaccine Trials: A Cautionary Note. Journal Of Acquired Immune Deficiency Syndromes and Human Retrovirology 1997;**16**:266-271 | No separate results presented for MSM |
| Doll LS, O'Malley PM, Pershing AL, Darrow WW, Hessol NA, Lifson AR. High-Risk Sexual Behaviour and Knowledge of HIV Antibody Status in the San Francisco City Clinic Cohort. Health Psychology 1990;**9**:253–256 | No measure of association with HIV testing or UAI, only investigates impact of test and counselling on subsequent sexual behaviour |
| Elford J, Bolding G, Davis M, Sherr L, Hart G. Web-Based Behavioural Surveillance Among Men Who Have Sex With Men: A Comparison of Online and Offline Samples in London, UK. J Acquir Immune Defic Syndr 2004; **35**:421–426 | No measure of association with HIV testing or UAI, only for mode of recruitment, online or offline |
| Fernyak SE, Page-Shafer K, Kellog TA, McFarland W, Katz MH. Risk behaviours and HIV incidence Among Repeat Testers at Publicly Funded HIV Testing Sites in San Francisco. JAIDS 2002;**31**:63 – 70 | No separate results presented for MSM, included with injecting drug users |
| Folch C, Gary Marks G, Esteve A, Zaragoza K, Muñoz R, Casabona J. Factors associated with Unprotected sexual Intercourse with steady male, Casual male, and female Partners among men who have sex with men in Barcelona, Spain. AIDS Education and Prevention, 18(3), 227–242, 2006 | No measure of association with HIV testing or UAI only by knowledge of status and subsequent behaviour |
| Frazier IH, McCamish M, Hay I, North P. The Medical Journal of Australia 1988;**149**:365 – 367 | No measure of association with HIV testing or UAI, only by knowledge of status and subsequent behaviour |
| Hickson F, Reid D, Weatherburn P, Stephens M, Nutland W, Bookye. HIV, sexual risk, and ethnicity among men in England who have sex with men. Sex Transm Infect 2004;**80**:443-450 | No measure of association with HIV testing or UAI, only by ethnicity |
| Houston S, Archibald CP, Strike C, Sutherland D. Factors associated with HIV testing among Canadians: results of a | No separate results presented for MSM |

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| population based survey. International Journal of STD and AIDS 1998;**9**:341 – 346 | |
| Kellog TA, McFarland W, Perlman JL, et al. HIV incidence Among Repeat Testers at a County Hospital, San Francisco, California, USA. JAIDS 2001;**28**:59-64 | No separate results presented for MSM, included with Injecting Drug Users |
| Knussen C, Flowers P, Church S. The intentions of gay men in taking a HIV test. Culture, Health and Sexuality 2004;**6**:45-59 | Measures of association for intention to test only, not actual HIV testing |
| Kelly JA, Amirkhanian YA, McAuliffe TL, et al. HIV Risk Behaviours and Risk-Related Characteristics of Young Russian Men Who Exchange Sex for Money or Valuables From Other Men. AIDS Education and Prevention 2001;**13**:175 – 188 | No measure of association with HIV testing or UAI, only with exchanging sex for money |
| Lam TH, Janghorbani M, Fan S, Fielding R. Voluntary HIV antibody testing amongst youth in Hong Kong. International Journal of STD & AIDS 2003;**14**:132- 138 | No separate results presented for MSM |
| Maguen S, Armistead LP, Kalichman S. Journal of Adolescent Health 2000;**26**:252-257 | No separate results presented for MSM |
| Manning SE, Thorpe LE, Ramaswamy C, Hajat A, Marx MA, Karpati AM, Mostashari F, Pfeiffer MR, Nash D. Estimation of HIV prevalence, risk factors, and testing frequency among sexually active men who have sex with men, aged 18-64 years--New York City, 2002. J Urban Health. 2007 Mar;84(2):212-25 | No measures of association for HIV testing |
| Miller LG, Simon PA, Miller ME, Long A, Yu EI, Asch SM. High-Risk Sexual Behaviour in Los Angeles: Who Receives Testing for HIV. JAIDS 1999;**22**:490-497 | No separate results presented for MSM |
| Molitor F, Truax SR, Ruiz JD, Sun RK. Association of Methamphetamine Use During Sex With Risky Sexual Behaviours and HIV Infection Among Non-Injection Drug Users. West J Med 1998;**168**:93-97 | No measure of association with HIV testing or UAI, only with methamphetamine use |
| Momas I, Helai H, Pretet S, Marsal L, Poinsard R. Demographic and behavioural predictors of knowledge and HIV seropositivity: Results of a survey conducted in three anonymous and free counselling and testing centers. European Journal of Epidemiology1997;**13**:255-260 | No separate results presented for MSM |
| Ni H, Hedberg K, Torok J, Dubickas SH, Fleming D. Trends in HIV Counseling and Testing of Clients Attending a Public Sexually Transmitted Disease Clinic in Portland, Oregan, 1989-1995. Journal of Acquired Immune Deficiency Syndromes and Human Retrovirology 1997;**15**:151-156 | No separate results presented for MSM |
| Peterman TA, Zaidi AA, Wroten J. Decreasing prevalence hides a high HIV incidence: Miami. AIDS 1995;**9**:965–970 | No separate results presented for MSM |
| Remafedi G. Predictors of Unprotected Intercourse Among Gay and Bisexual Youth: Knowledge, Beliefs and Behaviour. Pediatrics 1994;**94**:163 – 168 | No separate results presented for MSM, included with injecting drug users |
| Roffman RA, Kalichman SC, Kelly JA, Winett RA, Solomon LJ, Sikkema KJ, et al. HIV antibody testing of gay men in smaller US cities. AIDS Care 1995;7(4):405-13 | No measure of association between HIV testing and UAI |

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|---|---|
| Sinclair M, Bor R, Evans A, Glass D, Levitt D, Johnson MA. The socio-demographic profiles, risk categories and prevalence of HIV infection among people attending a London same-day testing clinic, 2000-2001. International Journal of STD & AIDS 2004; 15: 33-37 | No separate results presented for MSM |
| Skolnik HS, Phillips KA, Binson D, Dilley JW. Deciding Where and How to Be Tested for HIV: What Matters Most? JAIDS 2001;**27**:292 – 300 | No separate results presented for MSM |
| Stumoller F, Penna TL, Vieria de Souza CT, Lambert J on behalf of the Oswaldo Cruz Foundation STD/HIV Prevention Group. Int J Infect Dis 2002;**6**:259-265 | No measure of association for HIV testing or UAI |
| Suliugoi B, Giuliani M, Galai N, Balducci M and the STD Surveillance Working Group. HIV incidence among repeat HIV testers with sexually transmitted diseases in Italy. AIDS 1999;**13**:845 – 850 | No separate results presented for MSM |
| Schwarcz SK, Spitters C, Ginsberg MM, Anderson L, Kellog TM, Katz MH. Predictors of Human Immunodeficiency Virus Counselling and Testing Among Sexually Transmitted Disease Clinic Patients. Sex Trans Dis.1997;**24**:347–352 | No separate results presented for MSM |
| Van de Ven P, Prestage G, French J, Knox S, Kippax S. Increase in unprotected anal intercourse with casual partners among Sydney gay men in 1996-98. Aust N Z J Public Health 1998 Dec;22(7):814-8 | No measure of association for HIV testing or UAI just trend over time |
| Webster RD, Darrow WW, Paul JP, Roark RA, Taylor RA, Stempel RR. Community planning, HIV prevention, and a needs assessment for men who have sex with men: the South Beach Health Survey. Sex Transm Dis 2005 May;32(5):321-7 | No measure of association for HIV testing and UAI |
| Wortley PM, Chu SY, Diaz T, et al. HIV Testing patterns: where, why, and when were persons with AIDS tested for HIV. AIDS 1995;**9**:487-492 | No separate results presented for MSM |
| Xia Q, Osmond DH, Tholandi M, Pollack LM, Zhou W, Ruiz JD, Catania JA. HIV prevalence and sexual risk behaviours among men who have sex with men: results from a state-wide population-based survey in California. J Acquir Immune Defic Syndr. 2006 Feb 1;41(2):238-45 | No measure of association for HIV testing or UAI |

**Table A.2 Studies excluded from review of factors associated with HIV testing and age**

| Study | Reason for Exclusion |
|---|---|
| Hightow LB, Miller WC, Leone PA, Wohl DA, smurzynski M, Kaplan. Predictors of Repeat Testing and HIV Seroconversion in a Sexually Transmitted Disease Clinic Population. Sex Transm Dis 2004;**31**(8):455-459 | No separate measures of association for MSM |
| Huhn GD, McIntyre, AF, Broad JM, Holmes SW, Studzinski A, Rabins C, Dworkin MS Factors Associated With Newly Diagnosed HIV Among Persons With Concomitant Sexually Transmitted Diseases. Sex Transm Dis 2008; 35(8):731-737 | No measures of association with HIV testing for MSM separately |
| Lau JTF, Wang M, Tse YK, Gu J, Tsui HY, Zhang Y, Wang Y, Cheng F. MSM in China.HIV-related behaviors among men who have sex with men in China: 2005-2006. AIDS Educ Prev 2009;**21**(4):325–339 | Outside inclusion criteria. Carried out after 2002 |
| Melbye M, Biggar RJ. Interactions between Persons at Risk for AIDS and the General Population in Denmark. Am. J. Epidemiol. (1992) 135(6): 593-602 | No separate data for MSM |
| Sandfort TGM, Nel J, Rich E, Reddy V, Yi H. HIV testing and self-reported HIV status in South African men who have sex with men: results from a community-based survey . Sex Transm Infect 2008;84:425–429 | Out of Inclusion criteria carried out Nov 2003-2005 |
| Sinclair M, Bor R, Evans A, Glass D, Levitt D, Johnson MA. The sociodemographic profile, risk categories and prevalence of HIV infection among people attending a London same-day testing clinic,2000–2001. Int J STD & AIDS 2004;15:33–3 | No measure of association for HIV testing or UAI |
| Thomas B, Mimiaga MJ, Menon S, Chandrasekaran V, Murugesan P, Swaminathan S, Mayer KH,Safren SA. MSM in India unseen and unheard: predictors of sexual risk behaviour and HIV infection among men who have sex with men in Chennai, India. AIDS Educ Prev 2009;21(4);372–383 | Outside inclusion criteria. Carried out after 2002 |
| Williamson LM, Flowers P, Knussen C, Hart GJ.HIV testing trends among gay men in Scotland, UK (1996-2005): implications for HIV testing policies and prevention. Sex Transm Infect 2009 85: 550-554 | Outside criteria, includes tests 2003-2005 which include opt-out policy |
| Xia Q, Osmond DH, Tholandi M, Pollack LM, Zhou W, Ruiz JD, Catania JA. HIV prevalence and sexual risk behaviors among men who have sex with men: results from a statewide population-based survey in California. J Acquir Immune Defic Syndr. 2006 Feb 1;41(2):238-45 | No measure of association for HIV testing or UAI |
| Xu JJ, Zhang M, Brown K, Reilly K, Wang H. Hu Q, Ding H, Chu Z, Bice T, Shang H. Syphilis and HIV Seroconversion Among a 12-Month Prospective Cohort of Men Who Have Sex With Men in Shenyang, China. Sex Transm Dis 2010;37(7):432-443 | Outside inclusion criteria. Carried out in 2006 |

**Table A.3 Studies excluded from review of factors associated with HIV testing and area**

| Study | Reason for Exclusion |
|---|---|
| Clark JL, Konda KL, Segura ER, Salvatierra HJ, Leon SR, Hall ER, Caceres CF, Klausner JD, Coates TJ. Risk factors for the spread of HIV and other sexually transmitted infections among men who have sex with men infected with HIV in Lima, Peru. Sex Transm Infect 2008;84:449–454 | Outside inclusion criteria, carried out May 2007 |
| Dodds JP, Mercey DE, Parry JV, Johnson AM. Increasing risk behaviour and high levels of undiagnosed HIV infection in a community sample of homosexual men. Sex Transm Infect 2004 Jun;80(3):236-40 | No outcome measure for area |
| Dodds JP, Johnson AM, Parry JV, Mercey DE. A tale of three cities: persisting high HIV prevalence, risk behaviour and undiagnosed infection in community samples of men who have sex with men.Sex Transm Infect. 2007 Aug;83(5):392-6. Epub 2007 May 1 | No outcome measure for area |
| Dougan S, Elford J, Chadborn TR, Brown AE, Roy K, Murphy G, Gill ON; Group Investigating Rising HIV Diagnoses Among MSM in UK. Does the recent increase in HIV diagnoses among men who have sex with men in the UK reflect a rise in HIV incidence or increased uptake of HIV testing? Sex Transm Infect. 2007 Apr;83(2):120-5; discussion 125. Epub 2006 Nov 7 | Not about HIV testing |
| McGarrigle CA, Mercer CH, Fenton KA, Copas AJ, Wellings K, Erens B, et al. Investigating the relationship between HIV testing and risk behaviour in Britain: National Survey of Sexual Attitudes and Lifestyles 2000. AIDS 2005;19(1):77-84 | No separate outcome measure for MSM |
| Roffman RA, Kalichman SC, Kelly JA, Winett RA, Solomon LJ, Sikkema KJ, et al. HIV antibody testing of gay men in smaller US cities. AIDS Care 1995;7(4):405-13 | No outcome measure for area of residence |

**Table A.4 Studies excluded from review of factors associated with HIV testing and SES**

| Study | Reason for Exclusion |
|---|---|
| Choi KH, Han CS, Hudes ES, Kegeles S. Unprotected sex and associated risk factors among young Asian and Pacific Islander men who have sex with men. AIDS Educ Prev 2002 Dec;14(6):472-81 | No measure of association between HIV testing and SES |
| Clark JL, Konda KL, Segura ER, Salvatierra HJ, Leon SR, Hall ER, Caceres CF, Klausner JD, Coates TJ. Risk factors for the spread of HIV and other sexually transmitted infections among men who have sex with men infected with HIV in Lima, Peru. Sex Transm Infect 2008;84:449–454 | Outside inclusion criteria, carried out May 2007 |
| Hart GJ, Williamson LM, Flowers P, Frankis JS, Der GJ. Gay men's HIV testing behaviour in Scotland. AIDS Care 2002 Oct;14(5):665-74 | No measure of association between HIV testing and SES or education reported |
| Hays RB, Paul J, Ekstrand M, Kegeles SM, Stall R, Coates TJ. Actual versus perceived HIV status, sexual behaviors and predictors of unprotected sex among young gay and bisexual men who identify as HIV-negative, HIV-positive and untested. AIDS 1997 Oct;11(12):1495-502 | No measure of association between HIV testing and SES |
| Lemcke A, Kjoller M, Ekholm O, Smith E. HIV testing in the Danish population: a national representative survey, 2000. Scand J Public Health 2007;35(6):631-9 | No separate outcome measures for MSM |
| McKusick L, Coates TJ, Morin SF, Pollack L, Hoff C. Longitudinal predictors of reductions in unprotected anal intercourse among gay men in San Francisco: the AIDS Behavioral Research Project. Am J Public Health 1990 Aug;80(8):978-83 | No measure of association between HIV testing and SES |
| Sandfort TJM, Nel J, Rich E, Reddy V, Yi H. HIV testing and self-reported HIV status in South African men who have sex with men: results from a community-based survey. Sex Transm Infect 2008;84:425–429 | Outside inclusion criteria, carried out Nov 2003-2005 |
| Webster RD, Darrow WW, Paul JP, Roark RA, Taylor RA, Stempel RR. Community planning, HIV prevention, and a needs assessment for men who have sex with men: the South Beach Health Survey. Sex Transm Dis 2005 May;32(5):321-7 | No measure of association between HIV testing and SES |

**Table A.5 Studies excluded from review of factors associated with HIV testing and number of sexual partners**

| Study | Reason for Exclusion |
|---|---|
| Cribier B, Schmitt MP, Le Coz C, Grosshans E. Changes in sexual behaviour of patients attending an HIV testing centre: a prospective study 1988-1994. Genitourin Med 1996; 72: 37-42. 15 | No separate measure of association for MSM |
| Do TD, Chen S, McFarland W, Secura GM, Behel SK, MacKellar DA, et al. HIV testing patterns and unrecognized HIV infection among young Asian and Pacific Islander men who have sex with men in San Francisco. AIDS Educ Prev 2005 Dec;17(6):540-54 | Larger study including this data published 2006 and included |
| Hart GJ, Williamson LM, Flowers P, Frankis JS, Der GJ. Gay men's HIV testing behaviour in Scotland. AIDS Care 2002 Oct;14(5):665-74 | No association between HIV testing and number of sexual partners once other factors were controlled for. |
| Heckman TG, Kelly JA, Roffman RA, Sikkema KJ, Perry MJ, Solomon LJ, et al. Psychosocial differences between recently HIV tested and non-tested gay men who reside in smaller US cities. Int J STD AIDS 1995 Nov;6(6):436-40 | This study was included already in Roffman et al 1995 |
| Johnson EH, Jackson LA, Hinkle Y, Gilbert D, Hoopwood T, Lollis CM, et al. What is the significance of black-white differences in risky sexual behavior? J Natl Med Assoc 1994 Oct;86(10):745-59 | This study was included already in Roffman et al 1995 |
| Katz MH, Schwarcz SK, Kellogg TA, Klausner JD, Dilley JW, Gibson S, et al. Impact of highly active antiretroviral treatment on HIV seroincidence among men who have sex with men: San Francisco. Am J Public Health 2002 Mar;92(3):388-94 | No measures of association for HIV testing |
| Lau RK, Jenkins P, Caun K, Forster SM, Weber JN, McManus TJ, et al. Trends in sexual behaviour in a cohort of homosexual men: a 7 year prospective study. Int J STD AIDS 1992 Jul;3(4):267-72 | No measures of association for HIV testing |
| Manning SE, Thorpe LE, Ramaswamy C, Hajat A, Marx MA, Karpati AM, Mostashari F, Pfeiffer MR, Nash D. Estimation of HIV prevalence, risk factors, and testing frequency among sexually active men who have sex with men, aged 18-64 years--New York City, 2002. J Urban Health. 2007 Mar;84(2):212-25 | No measures of association for HIV testing |
| Osmond DH, Pollack LM, Paul JP, Catania JA. Changes in Prevalence of HIV infection and Sexual Risk Behaviour in Men Who Have Sex With Men in San Francisco: 1997-2002. Am J Public Health 2007;97:1677-83 | No measures of association for HIV testing or UAI |
| Roark RA, Webster RD, Darrow WW, Stempel RR. HIV testing among men who have sex with men: how often should one test? J Public Health Manag Pract 2005 Jan;11(1):18-2 | Duplicate publication of Webster et al Sex Transm Dis 2005 May;32(5):321-7[100] |
| Sanchez T, Finlayson T, Drake A, Behel S, Cribbin M, Dinenno E, et al. Human immunodeficiency virus (HIV) risk, prevention, and testing behaviors--United States, National HIV Behavioral Surveillance System: men who have sex with men, November 2003-April 2005. MMWR Surveill Summ 2006 Jul 7;55(6):1-16 | Outside inclusion criteria, carried out after 2002 |

| | |
|---|---|
| Strathdee SA, Martindale SL, Cornelisse PG, Miller ML, Craib KJ, Schechter MT, et al. HIV infection and risk behaviours among young gay and bisexual men in Vancouver. CMAJ 2000 Jan 11;162(1):21-5 | No association between HIV testing and numbers of sexual partners |

**Table A.6 Studies excluded from review of factors associated with HIV testing and STI**

| Study | Reason for Exclusion |
|---|---|
| Binson D, Woods WJ, Pollack L, Paul J, Stall R, Catania JA. Differential HIV risk in bathhouses and public cruising areas. Am J Public Health 2001;91(9):1482-6 | No outcome measure for HIV testing and STI |
| Bolding G, Davis M, Hart G, Sherr L, Elford J. Gay men who look for sex on the Internet: is there more HIV/STI risk with online partners? AIDS 2005 Jun 10;19 (9):961 -8 2005 Jun 10;19:961-8 | No outcome measure for HIV testing and STI |
| Choi KH, Han CS, Hudes ES, Kegeles S. unprotected sex and associated risk factors among young Asian and Pacific Islander men who have sex with men. AIDS Educ Prev 2002 Dec;14(6):472-81 | No outcome measure for HIV testing and STI |
| KH, McFarland W, Neilands TB, Nguyen S,Louie B, Secura GM, et al. An opportunity for prevention: prevalence, incidence, and sexual risk for HIV among young Asian and Pacific Islander men who have sex with men, San Francisco. Sex Transm Dis 2004 Sep;31(8):475-80 | No outcome measure for HIV testing and STI |
| Dilley JW, Woods WJ, Sabatino J, Lihatsh T, Adler B, Casey S, et al. Changing sexual behavior among gay male repeat testers for HIV: a randomized, controlled trial of a single-session intervention. J Acquir Immune Defic Syndr 2002 Jun 1;30(2):177-86 | Not about behaviour before HIV test |
| Do TD, Hudes ES, Proctor K, Han CS, Choi KH. HIV testing trends and correlates among young Asian and Pacific Islander men who have sex with men in two U.S. cities. AIDS Educ Prev 2006 Feb;18(1):44-55 | No outcome measure for HIV testing and STI |
| Flores SA, Bakeman R, Millett GA, Peterson JL. HIV risk among bisexually and homosexually active racially diverse young men. Sex Transm Dis 2009 May;36(5):325-9 | No outcome measure for HIV testing and STI |
| Hays RB, Paul J, Ekstrand M, Kegeles SM, Stall R, Coates TJ. Actual versus perceived HIV status, sexual behaviors and predictors of unprotected sex among young gay and bisexual men who identify as HIV-negative, HIV-positive and untested. AIDS 1997 Oct;11(12):1495-502 | No outcome measure for HIV testing and STI |
| Hickson F, Reid D, Weatherburn P, Stephens M, Nutland W, Boakye P. HIV, sexual risk, and ethnicity among men in England who have sex with men. Sex Transm Infect 2004;80:443-50 | No outcome measure for HIV testing and STI |
| Jin FY, Prestage G, Law MG, Kippax S, Van d, V, Rawsthorne P, et al. Predictors of recent HIV testing in homosexual men in Australia. HIV Med 2002 Oct;3(4):271-6 | No outcome measure for HIV testing and STI |
| Kalichman SC, Schaper PE, Belcher L, Abush-Kirsh T, Cherry C, Williams EA, et al. It's like a regular part of gay life: repeat HIV antibody testing among gay and bisexual men. AIDS Educ Prev 1997 Jun;9(3 Suppl):41- | No outcome measure for HIV testing and STI |

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| | |
|---|---|
| Kelly JA, Murphy DA, Roffman RA, Solomon LJ, Winett RA, Stevenson LY, et al. Acquired immunodeficiency syndrome/human immunodeficiency virus risk behavior among gay men in small cities. Findings of a 16-city national sample. Arch Intern Med 1992 Nov;152(11):2293-7 | No outcome measure for HIV testing and STI |
| Lattimore S, Thornton A, Delpech V, Elford J. Changing patterns of sexual risk behavior among London gay men: 1998-2008. Sex Transm Dis 2011 Mar;38(3):221-9 | No outcome measure for HIV testing and STI |
| McKusick L, Coates TJ, Morin SF, Pollack L, Hoff C. Longitudinal predictors of reductions in unprotected anal intercourse among gay men in San Francisco: the AIDS Behavioral Research Project. Am J Public Health 1990 Aug;80(8):978-83 | No outcome measure for HIV testing and STI |
| Nardone A, Frankis JS, Dodds JP, Flowers PN, Mercey DE, Hart GJ. A comparison of high-risk sexual behaviour and HIV testing amongst a bar-going sample of homosexual men in London and Edinburgh. Eur J Public Health 2001 Jun;11(2):185-9 | No outcome measure for HIV testing and STI |
| Phillips KA, Paul J, Kegeles S, Stall R, Hoff C, Coates TJ. Predictors of repeat testing among gay and bisexual men. AIDS 1995;9:769-75 | No outcome measure for HIV testing and STI |
| Schwarcz SK, Spitters C, Ginsberg MM, Anderson L, Kellog T, Katz MH. Predictors of Human Immunodeficiency Virus counseling and testing among sexually transmitted disease clinic patients. Sex Transm Dis 1997;24:347-52 | No outcome measure for HIV testing and STI |
| Schwarcz SK, Kellogg TA, McFarland W, Louie B, Klausner J, Withum DG, et al. Characterization of sexually transmitted disease clinic patients with recent human immunodeficiency virus infection. J Infect Dis 2002 Oct 1;186(7):1019-22 | No outcome measure for HIV testing and STI |
| Sumartojo E, Lyles C, Choi K, Clark L, Collins C, Guenther Grey C, et al. Prevalence and correlates of HIV testing in a multi-site sample of young men who have sex with men. AIDS Care 2008;20(1):1-14 | No outcome measure for HIV testing and STI |
| Thiede H, Jenkins RA, Carey JW, Hutcheson R, Thomas KK, Stall RD, et al. Determinants of Recent HIV Infection Among Seattle-Area Men Who Have Sex With Men. Am J Public Health 2009;99:S157-S164 | No outcome measure for HIV testing and STI |
| Torian LV, Makki HA, Menzies IB, Murrill CS, Weisfuse IB. HIV infection in men who have sex with men, New York City Department of Health sexually transmitted disease clinics, 1990-1999: a decade of serosurveillance finds that racial disparities and associations between HIV and gonorrhea persist. Sex Transm Dis 2002 Feb;29(2):73-8 | No outcome measure for HIV testing and STI |
| Truong H.M., Kellogg T, Klausner JD, Katz MH, Dilley J, Knapper K, et al. Increases in sexually transmitted infections and sexual risk behaviour without a | Ecological analysis. No measures of association |

| | |
|---|---|
| concurrent increase in HIV incidence among men who have sex with men in San Francisco: a suggestion of HIV serosorting? Sex Transm Infect 2006;82(461):466 | |
| Van de Ven P, Prestage G, Knox S, Kippax S. Gay men in Australia who do not have HIV test results. Int J STD AIDS 2000 Jul;11(7):456-60 | No outcome measure for HIV testing and STI |
| Webster RD, Darrow WW, Paul JP, Roark RA, Woods WJ, Stempel RR. HIV infection and associated risks among young men who have sex with men in a Florida resort community. J Acquir Immune Defic Syndr 2003 Jun 1;33(2):223-31 | No outcome measure for HIV testing and STI |
| Williamson LM, Hart GJ, Flowers P, Frankis JS, Der GJ. The Gay Men's Task Force: the impact of peer education on the sexual health behaviour of homosexual men in Glasgow. Sex Transm Infect 2001 Dec;77(6):427-32 | Study not about HIV testing |
| Xia Q, Osmond DH, Tholandi M, Pollack LM, Zhou W, Ruiz JD, et al. HIV prevalence and sexual risk behaviors among men who have sex with men: results from a statewide population-based survey in California. J Acquir Immune Defic Syndr 2006 Feb 1;41(2):238-45 | No outcome measure for HIV testing and STI |
| Strathdee S, Hogg R, Martindale S, et al. Determinants of Sexual Risk-Taking Among Young HIV-Negative Gay and Bisexual Men. Journal of Acquired Immune Deficiency Syndromes & Human Retrovirology 1998;19:61-6 | No outcome measure for HIV testing and STI |

**Table A.7 Summary chart of factors associated with HIV testing from reviews in Chapter two**

| | Socio-demographic variables | | | | | Behavioural variables | | | Biological | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Age | Education | Income /employment | Socio-economic status | Area of residence | UAI | Numbers of sexual partners | STI diagnoses | HIV seroconversion | HIV serostatus positive |
| **HIV testing** | | | | | | | | | | |
| **UK** | | | | | | | | | | |
| Dawson et al (1991) | | | | | | √[a] | | √[a] | | |
| Dodds et al (2004) | | | | | | | | | | √ |
| Hart et al (1999) | | | | | | √ | | | | |
| Hart et al (2002) | √ | | | | | √ | | √ | | |
| Macdonald et al (2007) | | | | | | | | | √ | |
| Nardone et al (1998) | √ | | √ | | √ | √ | | | | |
| Nardone et al (2001) | √ | | | | | | | | | |
| Williams et al (1996) | | | | | | | | | √ | |
| ***Other Europe*** | | | | | | | | | | |
| Paget et al (1997) | | √[b] | | | | | √[b] | | | |
| Stolte et al (2007) | √ | | | | | √ | √ | | | |
| ***United States*** | | √ | | | | | | | | |
| Choi et al (2002) | | | | | | √ | | | | |
| Do et al (2006) | | | | | | √ | | | | |
| Flores et al (2009) | | | | | | √ | | | | |
| Helms et al (2009) | √ | | | | | | | | | |
| Hays et al (1997) | | | | | | ns[a] | | | | |
| Kelly et al (1992) | | | | | | √ | | | | |
| Mackellar et al (2006) | √ | | √ | | | | √ | √ | | |
| Povenelli et al (1996) | √ | √ | | | | √ | | | | |
| Roffman et al(1996) | | | | | | | √[a] | | | |
| Ruiz et al (1998) | | | | | | √[a] | | | | |
| Sumartojo et al (2008) | √ | | √ | | | √ | | | | |
| ***Canada*** | | | | | | | | | | |
| Myers et al (1993) | | | | | √ | √ | | | | |
| Myers et al 1996) | √ | | | | √ | √ | | | | |
| ***Australia*** | | | | | | | | | | |
| Jin et al (2002) | √ | | | | √ | √ | √ | | | |
| Van de Ven et al (2000) | √ | | | | | ns | √ | | | |
| **Repeat HIV testing** | | | | | | | | | | |
| ***UK*** | | | | | | | | | | |
| Elford et al (2001 | | | | | | √[a] | | | | |
| Leaity et al (2000) | | | | | | √[a] | | √ | | |
| Norton et al (1997) | | | | | | √[a] | | √ | | |
| ***US*** | | | | | | | | | | |
| Fernandez et al (2003) | √ | √ | | | | | √ | √ | | |
| Kalichman et al (1997) | | | | | | ns[a] | √[a] | | | |
| MacKellar et al (2002) | √ | √ | | | | ns[b] | √ | | | |
| Philips et al (1995 | √ | √ | | | | √[a] | | | | |

Ns. Not statistically significant. a. Univariable analysis only. b. associated with not UAI

## Table A.8 Summary chart of factors associated with UAI from reviews in Chapter two

| | Socio-demographic variables | | | | | Behavioural variables | | Biological | |
|---|---|---|---|---|---|---|---|---|---|
| **Studies** | Age | Education | Income | Socio-economic status | Area of residence | Numbers of sexual partners | STI diagnoses | HIV seroconversion | HIV serostatus positive |
| **UK** | | | | | | | | | |
| Dawson et al (1994) | | | | √ | | | | | |
| Dodds et al (2004) | | | | | | | | | √ |
| Dodds et al (2007) | | | | | | | | | √ |
| Elford et al (1999) | √ | | | | - | √ | | | |
| Hart et al (1999) | | √ | | | | | √ | | |
| Macdonald et al (2007) | | | | | | | | √ | |
| Nardone et al (2001) | | | | | √ | | | | |
| Wells et al (1998) | √[a] | | | | | | | | |
| Williams et al (1996) | | | | | | | | √ | |
| United States | | | | | | | | | |
| Binson et al (2001) | | | | | | | | | √ |
| Buchbinder et al (2005) | | | | | | | | √ | |
| Choi et al (2002) | | | | | | √ | | | |
| Ekstrand et al (1999) | | | | | | √ | | | |
| Kelly et al (1992) | √ | | | | | √ | | | |
| Koblin et al (2006) | | | | | | | | | |
| McKusick et al (1990) | √ | | | | | | | | ns |
| MacFarland et al (1997) | | | | | | | | √ | |
| Ostrow et al (1995) | | | | | | | | √ | |
| Ruiz et al (1998) | | | | | √ | √ | | | |
| Schwarcz et al (2007) | √ | | | | | √ | | √ | |
| Thiede et al (2009) | | | | | | | | √ | |
| **Canada** | | | | | | | | | |
| MacKellar et al (2006) | | | | | √ | | | | |
| Myers et al (1996) | | √ | | | √ | | | | |
| Strathdee et al (1998) | | √ | | | | | | √[a] | |
| Weber et al (2001) | | | | | | | | √[a] | |
| **Australia** | | | | | | | | | |
| Kippax et al (1998) | | | | | | | | √ | |
| **South America** | | | | | | | | | |
| Harrison et al (1999) | | | | | | | | | √ |

Note. Ns, Not statistically significant; a. Univariable analysis only; b. associated with not UAI.

## APPENDIX B KC60 codes for acute STIs

**Table B.1 KC60 Codes Diagnosed coded as acute STIs**

| Code, | Condition | Acute STI |
|---|---|---|
| A1, A2 | Infectious syphilis | Yes |
| A3 | Early latent syphilis | Yes |
| A4, A5, A6 | Latent syphilis | No |
| A7, A8 | Congenital syphilis | No |
| A9 | Epidemiological treatment of syphilis | No |
| B1, B2 | Uncomplicated gonorrhoea | Yes |
| B3 | Gonococcal ophthalmia neonatorum | No |
| B4 | epidemiological treatment of suspected gonorrhoea | Yes |
| B5 | Gonococcal complications | No |
| C1,C2,C3 | Chancroid/LGV/Donovanosis | Yes |
| C4A, C4C | Uncomplicated chlamydial infection | Yes |
| C4B | Complicated chlamydial infection | No |
| C4E | Epidemiological treatment of chlamydia | Yes |
| C4H | Uncomplicated non-gonococcal , non-specific urethritis in males | Yes |
| C4I | Epidemiological treatment of non-specific genital infection | Yes |
| C5 | Complicated infection (non-chlamydial/non-gonococcal) excluding PID and epididymitis | No |
| C6A | Trichomoniasis | Yes |
| C6B | Anaerobic /Bacterial vaginosis and anerobic balanitis | No |
| C6C | Other vaginosis/vaginitis/balanitis | No |
| C7a | Anogenital candidosis | No |
| C7B | Epidemiological treatment of C6 and C7 | No |
| C8, C9 | Scabies/Pediculosis pubis | Yes |
| C10A | Anogenital herpes simplex, first attack | Yes |
| C10B | Anogenital herpes simplex: recurrence | No |
| C11A | Anogenital warts infection, first attack | Yes |
| C11B | Anogenital warts infection: recurrence | No |
| C11C | Anogenital warts infection: Re-registered cases | No |
| C12 | Molluscum contagiosum | Yes |
| C13 | Antigen positive viral hepatitis | No |
| C14 | Other viral hepatitis | No |
| D2A | Urinary tract infection | No |
| D2B | Other conditions requiring treatment | No |
| E1A | Asymptomatic HIV infection – First presentation | No |
| E2A | HIV infection with symptoms (not AIDS) – first presentation | No |
| E1B, E2B | Subsequent HIV presentation (not AIDS) | No |
| E3A | AIDS first presentation | No |
| E3B | AIDS: subsequent presentation | No |

## APPENDIX C Table C.1 Comparison of Natsal 2000 general population sample with population estimates

| | (a) Natsal 2000 Sample after selection weighting | | | (b) Population estimates | | | (c) Natsal 2000 Sample after final weighting | | |
|---|---|---|---|---|---|---|---|---|---|
| **Age group** | Men | Women | All | Men | Women | All | Men | Women | All |
| | % | % | % | % | % | % | % | % | % |
| 16-19 | 13.6 | 11 | 12.1 | 12.2 | 12 | 12.1 | 12.1 | 12 | 12 |
| 20-24 | 14.3 | 13.4 | 13.8 | 14.5 | 14.4 | 14.4 | 14.6 | 14.4 | 14.5 |
| 25-29 | 15.6 | 17.1 | 16.5 | 17.6 | 17.4 | 17.5 | 17.6 | 17.4 | 17.5 |
| 30-34 | 19.6 | 20.7 | 20.2 | 19.8 | 19.8 | 19.8 | 20 | 19.9 | 19.9 |
| 35-39 | 18.6 | 20 | 19.4 | 19.4 | 19.5 | 19.4 | 19.3 | 19.4 | 19.4 |
| 40-44 | 18.2 | 17.8 | 17.9 | 16.4 | 16.9 | 16.7 | 16.5 | 16.9 | 16.7 |
| Row % | 43.5 | 56.5 | | 51.0 | 49.0 | | 50.9 | 49.1 | |
| **Government Office Region** | Men | Women | All | Men | Women | All | Men | Women | All |
| | % | % | % | % | % | % | % | % | |
| North East | 5.7 | 5.4 | 5.5 | 4.3 | 4.4 | 4.4 | 4.4 | 4.5 | 4.5 |
| North West | 11.4 | 12.7 | 12.1 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 |
| Yorkshire & Humberside | 9.2 | 9.1 | 9.2 | 8.7 | 8.6 | 8.6 | 8.8 | 8.6 | 8.7 |
| East Midlands | 7.8 | 7.9 | 7.9 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| West Midlands | 8.7 | 8.1 | 8.4 | 9.0 | 9.0 | 9.0 | 9.1 | 9.0 | 9.0 |
| South West | 9 | 7.8 | 8.3 | 7.8 | 7.8 | 7.8 | 7.9 | 7.8 | 7.8 |
| Eastern | 8 | 9.7 | 9 | 9.2 | 9.2 | 9.2 | 9.1 | 9.2 | 9.1 |
| Inner London | 4.7 | 4.3 | 4.5 | 6.1 | 6.1 | 6.1 | 5.9 | 6.0 | 6.0 |
| Outer London | 7.1 | 7.4 | 7.2 | 8.5 | 8.3 | 8.4 | 8.5 | 8.3 | 8.4 |
| South East | 14.1 | 13.6 | 13.8 | 13.9 | 13.9 | 13.9 | 14 | 13.9 | 14 |
| Wales | 5.0 | 5.0 | 5.0 | 4.8 | 4.8 | 4.8 | 4.6 | 4.7 | 4.7 |
| Scotland | 9.3 | 9.0 | 9.1 | 8.9 | 9.2 | 9.0 | 8.9 | 9.1 | 9.0 |
| **Marital status** | Men | Women | All | Men | Women | All | Men | Women | All |
| | % | % | % | % | % | % | % | % | |
| Single | 39.5 | 28.2 | 33.1 | 38.8 | 31.3 | 35.2 | 39.3 | 29.9 | 34.7 |
| Married | 40.1 | 45.7 | 43.3 | 42.4 | 45.7 | 44.1 | 39.8 | 44.2 | 42 |
| Separated | 1.5 | 2.8 | 2.2 | 1.9 | 3.1 | 2.5 | 1.6 | 2.8 | 2.2 |
| Divorced | 2.8 | 4.7 | 3.9 | 2.6 | 5.5 | 4 | 2.8 | 4.6 | 3.7 |
| Widowed | 0.1 | 0.3 | 0.2 | 0.1 | 0.5 | 0.3 | 0.1 | 0.3 | 0.2 |
| Cohabiting | 16 | 18.2 | 17.3 | 14.1 | 13.8 | 14 | 16.5 | 18.2 | 17.3 |
| **Social Class*** | Men | Women | All | Men | Women | All | Men | Women | All |
| | % | % | % | % | % | % | % | % | |
| Professional | 7.2 | 3.3 | 5 | 6.2 | 2.7 | 4.5 | 7.5 | 3.3 | 5.5 |
| Managerial and technical | 28.8 | 27.3 | 28 | 26.2 | 22.8 | 24.6 | 29.2 | 27.2 | 28.2 |
| Skilled non-manual | 13.2 | 37.8 | 26.9 | 14.5 | 38.5 | 26.1 | 13.3 | 38 | 25.1 |
| Skilled manual | 30.9 | 8.5 | 18.5 | 30 | 7.6 | 19.2 | 30.5 | 8.4 | 19.9 |
| Partly skilled manual | 15 | 18.3 | 16.9 | 17.1 | 22.4 | 19.6 | 14.7 | 18.3 | 16.4 |
| Unskilled manual | 4.8 | 4.8 | 4.8 | 6.0 | 6.1 | 6.0 | 4.9 | 4.7 | 4.8 |
| **% in households:*** | | % | | | % | | | % | |
| With no children | | 46.1 | | | 51.4 | | | 48.2 | |
| With children | | 53.9 | | | 48.6 | | | 51.8 | |

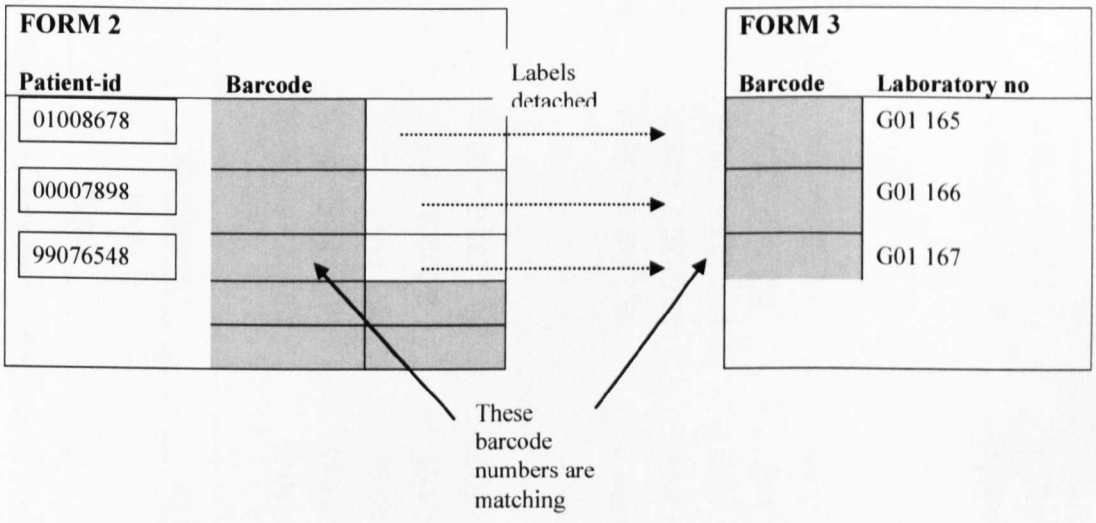
*Estimates based on the 1998 Health Survey for England. **Source**: National survey of sexual attitudes and lifestyles. Technical report

## APPENDIX D Examples of forms used in unlinked anonymous survey of MSM attending a GUM clinic

**FORM 1**

**UNLINKED ANONYMOUS SEROPREVALENCE SURVEY**

| | | | | | |
|---|---|---|---|---|---|
| **Sexual Orientation:** | Homo/bisexual | ☐ | Heterosexual | ☐ | |
| **Ever injected drugs:** | Yes | ☐ | No | ☐ | Not asked ☐ |
| **Date of last negative HIV test:** | Mth/year..../… | | Date not known | ☐ | |
| **Never tested:** | | ☐ | (tick if yes) | | |
| **Known HIV positive:** | | ☐ | (tick if yes) | | |
| **Patient spontaneously objects** | | ☐ | (tick if yes) | | |




**FORM 4**

| Laboratory no | HIV Result |
|---|---|
| G01 165 | HIV negative |
| G01 166 | HIV negative |
| G01 167 | HIV positive |

**Table D.1 HIV testing variables by age group (column percentages and 95% Confidence Intervals) in MSM attending an inner London GUM clinic. January – June 2003**

| **Age Group** | **<25** | **25-34** | **35-44** | **45+** | **Total** |
|---|---|---|---|---|---|
| Numbers surveyed | 288 | 889 | 740 | 293 | **surveyed** |
| **HIV Testing variables** | % (95% CI) | % (95% CI) | % (95% CI) | % (95% CI) | |
| *Date of last negative HIV test* | | | | | |
| <12 months | 34.7 (29.2 – 40.5) | 30.5 (27.5 – 33.6) | 23.8 (20.8 – 27.0) | 14.0 (10.2 – 18.5) | 588 |
| 12-23 months ago | 12.8 (9.2 – 17.3) | 18.3 (15.8 – 21.0) | 15.1 (12.6 – 17.9) | 14.3 (10.5 – 18.9) | 354 |
| 24 to 59 months ago | 7.3 (4.6 – 10.9) | 12.1 (10.1 – 14.5) | 8.8 (6.8 – 11.1) | 5.1 (2.9 – 8.3) | 236 |
| 60+ months | 0.3 (0.01 – 1.9) | 3.9 (2.8 – 5.4) | 6.1 (4.5 – 8.1) | 5.1 (2.9 –3) | 96 |
| Never HIV tested negative | 44.8 (39.0 – 50.7) | 35.1 (32.0 – 38.3) | 46.2 (42.6 – 49.9) | 52.2 (46.3 – 58.1) | 936 |
| *Total number of HIV negative tests* | | | | | |
| *Never HIV tested negative* | 44.8 (39.0 – 50.7) | 35.2 (32.1 – 38.4) | 46.1 (42.4 – 49.7) | 52.2 (46.3 – 58.1) | 936 |
| 1 | 39.9 (34.2 – 45.8) | 40.0 (36.7 – 43.2) | 27.3 (24.1 – 30.7) | 21.5 (16.9 – 26.7) | 735 |
| 2 | 13.2 (9.5 – 17.7) | 17.9 (15.4 – 20.6) | 17.4 (14.8 – 20.4) | 15.4 (11.4 – 20.0) | 371 |
| 3-4 | 1.7 (0.6 – 4.0) | 6.0 (4.5 – 7.7) | 7.2 (5.4 – 9.3) | 10.2 (7.0 – 14.3) | 141 |
| 5-10 | 0.3 (0.01 – 1.9) | 1.0 (0.5 – 1.9) | 2.0 (1.1 – 3.3) | 0.7 (0.1 – 2.4) | 27 |
| *Ever HIV tested; including positive and negative tests* | | | | | |
| No | 42.7 (36.9 – 48.6) | 23.7 (21.0 – 26.7) | 20.1 (17.3 – 23.2) | 20.8 (16.3 – 25.9) | 544 |
| Yes | 57.3 (51.4 – 63.1) | 76.3 (73.3 – 79.0) | 79.9 (76.8 – 82.7) | 79.2 (74.1 – 83.7) | 1666 |

# APPENDIX E Paper prepared for the Expert Advisory Group in AIDS



**Recommendation for annual HIV testing of men who have sex with men attending genitourinary medicine clinics in England and Wales**

Paper prepared for the Expert Advisory Group on AIDS. 19 February 2004

HIV and Sexually Transmitted Infections Department
Health Protection Agency Communicable Disease Surveillance Centre

## 1 Background

1.1 One of the primary aims of the National Strategy for Sexual Health and HIV(1) is to reduce the transmission of HIV and STIs, with a national goal of achieving a 25% reduction in the number of newly acquired HIV infections by 2007. To achieve this goal, national standards for HIV testing have been set, including an increase in the offer and uptake of HIV and STI testing. This is to be achieved through offering all genitourinary medicine (GUM) clinic attendees an HIV test on their first screening for STIs, and subsequently according to risk.

1.2 Since 1999 there has been an increase in new diagnoses of HIV in men who have sex with men (MSM), 1617 new diagnoses in 2002 have been reported so far, and this is likely to rise as delayed reports are received (Figure 1)(2). Those currently being diagnosed appear to be a mix of old and new infections. However the lack of change in CD4 cell count and median age at diagnosis suggests that a similar number of new infections are occurring as are diagnosed each year (Figure 2). In addition, estimates of annual incidence among MSM attending GUM clinics receiving syphilis serology between 1995 and 2002 showed a stable incidence of between 2-3.5%(3).

## 2 Evidence for policy change

2.1 The prevalence of previously undiagnosed HIV infection amongst MSM attending GUM clinics detected through the unlinked anonymous surveillance programme was 5.4% in London and 2.4% elsewhere in England, Wales and Northern Ireland (Figure 3)(2). Since 2000 there has been a significant increase in previously undiagnosed HIV infection in MSM presenting with an acute STI from 5.8% in 2000 to 6.5% in 2002 in London, and from 1.2% to 3.5% outside London (Figure 3). The proportion of previously undiagnosed HIV infections that are diagnosed at that clinic visit has increased, particularly in those who present with an acute STI (Figure 4).

2.2 However, we currently estimate that 62% of MSM attending GUM clinics with undiagnosed HIV infection leave the clinic with their infection undiagnosed (Figure 4). This differs by clinical presentation; 66% of previously undiagnosed HIV positive MSM presenting with an acute STI in 2002 still remained undiagnosed after their clinic visit, and 55% of MSM attending without an acute STI remain so. The proportion remaining undiagnosed was higher in London (62%) compared to outside London (45%).

2.3 The current rate of HIV testing in MSM attending GUM clinics is already high. Behavioural surveys of MSM all indicate similar HIV testing rates, of MSM attending bars and clubs in 2002, 74% had ever tested, and 38% in the last year (51% of all that had ever tested)(4). Of MSM who had attended a GUM

clinic in the past year, 85% had ever HIV tested, a significant increase in 2001(4). Of MSM surveyed at "Pride festivals" 64.2% reported that they had ever had a HIV test(5). The National survey of sexual attitudes and lifestyles (Natsal 2000) found 36.7% of MSM reported that they had a HIV test in the past 5 years, 36.6% of whom had it in the last year. However 86.6% of MSM who had attended a GUM clinic in the past 5 years had a HIV test in that period and 50.7% attending in the past year reported a HIV test in the past year(6).

2.4 A survey of HIV test policy and practice carried out through the British Co-operative Clinical Group in 1998 found that 72% of all sexually active homosexual men attending GUM clinics had a HIV test at that visit, 97% of those requesting a test and 36% of those who did not request a test were offered and accepted a test(7).

2.5 Numbers of first HIV tests in MSM collected through laboratory surveillance have remained similar over recent years (Figure 5)(8). Preliminary analysis of the January-March 2003 KC60 returns from all GUM clinics suggests that the rate of HIV testing in MSM attending clinics is high, an estimate of 51% of MSM attending GUM clinics were offered and accepted a HIV test. A review of all attenders at 15 GUM clinics, receiving syphilis serology who had a HIV test at that presentation, (utilising recorded KC60 codes) reveals a similar proportion HIV testing, 60% of MSM presenting with an acute STI and 55% of MSM presenting with a non-acute condition (Figure 6).

## 3 Policy objective

3.1 The first strategic aim of the latest Community HIV and AIDS Prevention Strategy (CHAPS), '*Making it Count 2003*' (9) for MSM is to reduce the average time between HIV infection and HIV diagnosis in men who become infected. The benefits of early diagnosis are the opportunity to manage HIV infection in the individual and reduce the likelihood of onward transmission through behavioural change and decreased viral load through antiretroviral treatment. Increased offering and recommendation of HIV testing would reduce the proportion of undiagnosed HIV infections in MSM attending GUM clinics.

3.2 The implications of a change in policy need consideration. These include the impact on workload and cost in GUM clinics, increased psychological worry for MSM and potential reinforcement of high-risk sexual behaviours in individuals that test negative. However there is currently little evidence to support these latter hypotheses of adverse affects and these are outweighed by the proven benefits of HIV diagnosis. A policy change to increase the offer of HIV testing to MSM may have little impact on clinic workload, since this may standardise existing clinic practices as evidenced by the surveillance data.

## 4 Ways of achieving objectives

To achieve the objective of reducing undiagnosed HIV infections in MSM through HIV testing in GUM clinics, a number of strategies may be considered:

1) **Increasing the coverage of HIV tests being offered to MSM at their first visit to a GUM clinic.** This recommendation aims to improve the

implementation of the current recommendation. However, the main problem with this strategy is that as the median age at HIV seroconversion for MSM is likely to be higher than the median age at first GUM attendance, this policy is likely to miss HIV seroconversions occurring after the first GUM HIV test.

2) **Annual offer and recommendation of HIV test to all MSM attending at subsequent GUM visits.** This policy would build on objective 1, but in addition ensure that all MSM attending GUM services are actively offered and recommended an annual HIV test. This would ensure earlier HIV diagnoses among asymptomatic MSM presenting at GUM services. The policy has the advantage of being targeted at MSM who are at significantly higher behavioural and STI transmission risk than non- GUM clinic attenders.

3) **Recommend that all sexually active MSM have annual tests.** This more general policy has the advantage of raising awareness of the need for HIV testing among all MSM and would be relevant to those in contact with and those not accessing GUM services. A potential problem with this strategy is the non-specific nature of the recommendation (so those at highest risk may not feel the message is meant for them or those at low risk may test repeatedly and unnecessarily). This recommendation also removes the responsibility for active intervention by health care providers in contact with MSM, and places the onus on MSM to get their annual HIV tests.

## 5 Policy Recommendations

5.1 Based on the evidence of the extent of undiagnosed HIV infection EAGA are asked to consider that the standard of care for all MSM attending GUM clinics should include the offer and recommendation of a HIV test annually as part of a sexual health screen.

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**Figure 1: Number of new HIV and AIDS diagnoses and deaths in those infected by sex between men by year of diagnosis/occurrence. UK data**

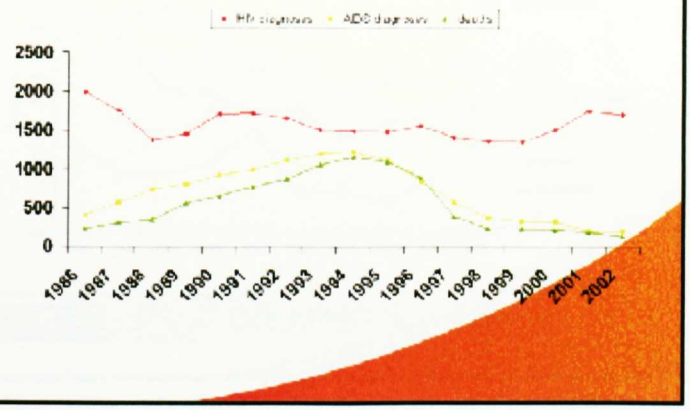
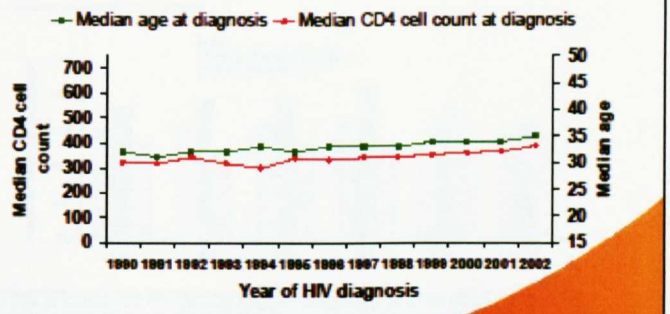



**Figure 2: Median CD4 cell count[1] and median age at diagnosis of MSM; England and Wales, 1990 - 2002**




1. CD4 count within 6 months of HIV diagnosis

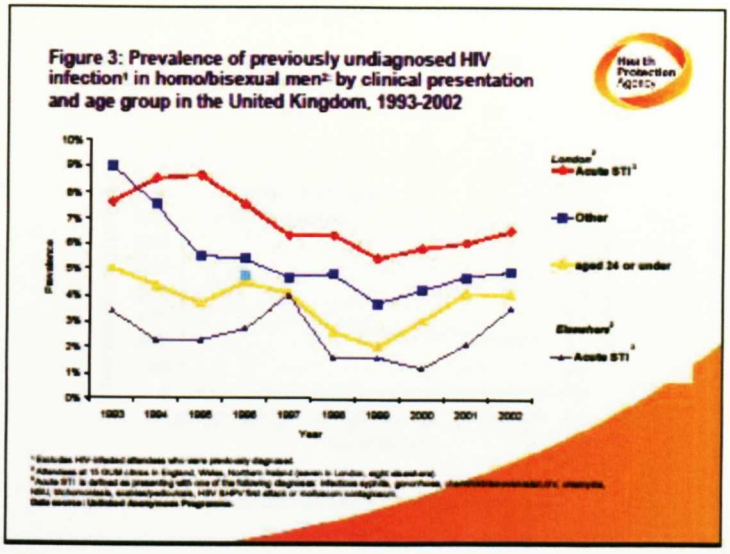


Figure 3: Prevalence of previously undiagnosed HIV infection[1] in homo/bisexual men[2] by clinical presentation and age group in the United Kingdom, 1993-2002
Prevalence
Year
London[2]
Acute STI[3]
Other
aged 24 or under
Elsewhere[2]
Acute STI[3]

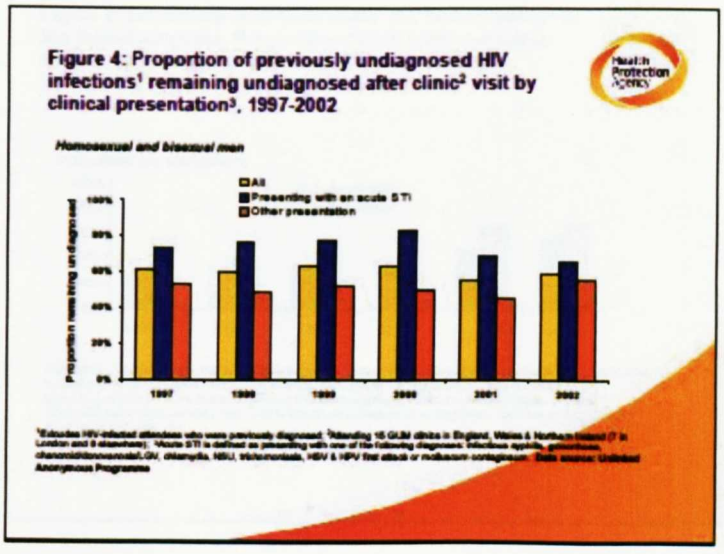
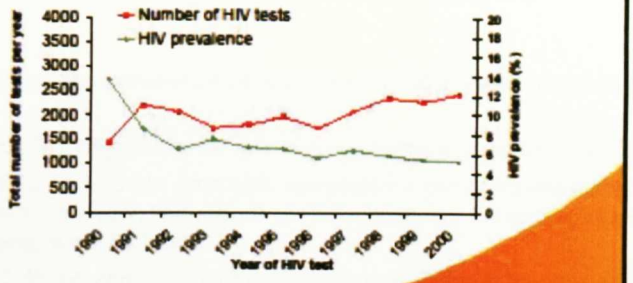


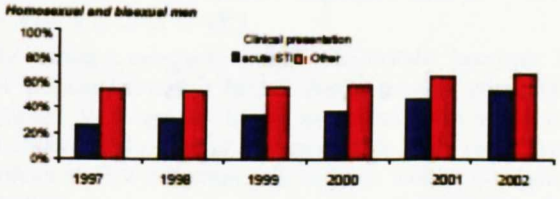
Figure 4: Proportion of previously undiagnosed HIV infections[1] remaining undiagnosed after clinic[2] visit by clinical presentation[3], 1997-2002
Homosexual and bisexual men
All
Presenting with an acute STI
Other presentation
Proportion remaining undiagnosed

**Figure 5: Trends in HIV testing and HIV prevalence among first testers at GUM clinics: MSM**




Data Source: Sentinel survey of HIV tests. Chadborn T, et al. Sex Transm Infect (in press)

**Figure 6: Effectiveness of GUM clinic[1] HIV testing policy[2] in the United Kingdom. *Proportion of GUM clinic attendees having a voluntary confidential HIV test at the clinic attendance by clinical presentation, 1997-2002***




[1]Attending 15 GUM clinics in England, Wales & Northern Ireland (7 in London and 8 elsewhere) and 12 GUM clinics in Scotland. [2]Excludes HIV-infected attendees who were previously diagnosed. 3Acute STI is defined as presenting with one of the following diagnoses: infectious syphilis, gonorrhoea, chancroid/donovanosis/LGV, chlamydia, NSU, trichomoniasis, HSV & HPV first attack or molluscum contagiosum. Data source: Unlinked Anonymous Programme

# Investigating the relationship between HIV testing and risk behaviour in Britain: National Survey of Sexual Attitudes and Lifestyles 2000

Christine A. McGarrigle[a], Catherine H. Mercer[b], Kevin A. Fenton[a,b], Andrew J. Copas[b], Kaye Wellings[c], Bob Erens[d] and Anne M. Johnson[b]

**Objectives:** To estimate the prevalence of, and identify factors associated with, HIV testing in Britain.

**Design:** A large, stratified probability sample survey of sexual attitudes and lifestyles.

**Methods:** A total of 12 110 16–44 year olds completed a computer-assisted face-to-face interview and self-interview. Self-reports of HIV testing, i.e. the timing, reasons for and location of testing, were included.

**Results:** A total of 32.4% of men and 31.7% of women reported ever having had an HIV test, the majority of whom were tested through blood donation. When screening for blood donation and pregnancy were excluded, 9.0% of men and 4.6% of women had had a voluntary confidential HIV test (VCT) in the past 5 years. However, one third of injecting drug users and men who have sex with men had a VCT in the past 5 years. VCT in the past 5 years was significantly associated with age, residence, ethnicity, self-perceived HIV risk, reporting greater numbers of sexual partners, new sexual partners from abroad, previous sexually transmitted infection diagnosis, and injecting non-prescribed drugs for men and women, and same-sex partners (men only). Whereas sexually transmitted disease clinics were important sites for VCT, general practice accounted for almost a quarter of VCT.

**Conclusion:** HIV testing is relatively common in Britain; however, it remains largely associated with population-based blood donation and antenatal screening programmes. In contrast, VCT remains highly associated with high-risk (sexual or drug-injecting) behaviours or population sub-groups at high risk. Strategies to reduce undiagnosed prevalent HIV infection will require further normalization and wider uptake of HIV testing.


*AIDS* 2005, **19**:77–84

**Keywords: HIV, HIV risk, HIV testing, probability survey, sex survey, sexual behaviours**

## Introduction

In 2002, an estimated 49 500 individuals in the United Kingdom were living with HIV infection, 31% of whom were undiagnosed [1]. In England, a goal of the *National Strategy for Sexual Health and HIV* [2] is to reduce the prevalence of undiagnosed HIV infection by 50% within the next 4 years. The implementation of the strategy has

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encouraged the promotion of HIV testing at sexually transmitted disease (STD) clinics in addition to well-established antenatal and blood donation screening programmes. A further refinement of the strategy to encourage the uptake of HIV testing, especially among men who have sex with men (MSM) has been identified as a priority by the Chief Medical Officer (England) [3].

The motivation behind HIV testing is complex, and an individual's decision to be tested may be affected by a range of factors including HIV testing policy, the effectiveness and availability of medication, the availability of testing, and health education messages promoting HIV testing. Studies have shown that HIV testing is common among MSM, ranging from 37–64% in the UK [4–8] to 83–85% in Australia [9,10], 63% in Canada [11], and 84% in the United States [12,13]. Previous studies, including both general population probability sample and convenience sample studies undertaken in community, STD clinic and HIV testing clinic settings in the United Kingdom, have shown strong associations between HIV testing uptake and high-risk sexual behaviours in both MSM and heterosexual individuals [4,6,7,14,15]. However there are no current estimates of the prevalence of HIV testing in the general population in Britain. In this paper we report population estimates of HIV testing patterns and associated behaviours from the second British National Survey of Sexual Attitudes and Lifestyles (Natsal 2000).

## Methods

### Participants and survey methodology

Natsal 2000 and its additional ethnic minority boost sample is a stratified probability sample survey of the general population of 12110 men and women aged 16–44 years resident in Britain. The study was undertaken between 1999 and 2001, and the response rate was 65.4%. Participants were interviewed using a combination of computer-assisted face-to-face interview and computer-assisted self-interview for collecting more sensitive questions including questions on HIV testing. The methodological details and outcomes related to high-risk behaviours have been reported elsewhere [16–18]. In addition to a range of questions on sexual practices, behaviours and attitudes, we asked all respondents about their HIV testing history (if they had ever had a blood test that involved testing for HIV and when the last test was), the reasons for HIV testing, as well as the self-perception of personal risk of being infected with HIV.

### Statistical analysis

Data from targeted over-sampling of ethnic minorities (the Natsal ethnic minority boost) were combined with the main survey data to increase the numbers of respondents included in this analysis. Natsal 2000 data were weighted to account for differential selection probabilities in the survey, and then post-stratified to British population estimates of the age, sex and region distribution from mid-1999, as previously described [16–18]. Odds ratios were used to measure the association of behavioural, demographic and risk perception factors with reporting a voluntary HIV test in the past 5 years, i.e. excluding HIV testing through blood donation and antenatal screening. Logistic regression analyses were used to calculate adjusted odds ratios (AOR), to identify factors independently associated with HIV testing in this time frame. We performed all analyses using the survey analysis software Stata (version 8.0; Stata Corp., College Station, TX, USA), accounting for stratification, clustering and weighting of the sample.

The study was approved by the University College Hospital and North Thames Multi-Centre Research Ethics Committee and all the Local Ethics Committees in Britain.

## Results

### Prevalence of and reason for HIV testing

Overall, 32.4% [95% confidence interval (CI) 30.8–34.1] of men and 31.7% (95% CI 30.5–33.0) of women reported ever having had an HIV test (Table 1). Just under a quarter reported an HIV test in the past 5 years: 23.8% (95% CI 22.3–25.2) of men and 23.5% (95% CI 22.3–24.7) of women. The majority of both men and women were tested through blood donation, whereas 16.5% of women who had ever been tested, and 17.0% who had been tested in the past 5 years, reported pregnancy as the main reason for their last HIV test (Table 1). A greater proportion of men reported both a 'general health check' and 'concern of risk to self' as a reason for their last HIV test than women, both ever and in the past 5 years. These reasons accounted for a quarter of all HIV tests in men, although because men are not routinely screened as a result of pregnancy these differences are expected.

As both antenatal screening for HIV (pregnancy given as the main reason for an HIV test in women) and blood donation constitute screening programmes rather than individuals choosing to be tested for HIV, blood donation and antenatal screening were excluded from further analyses of demographic and behavioural factors associated with voluntary confidential HIV testing (VCT). Table 1 shows the prevalence of VCT in the past 5 years, with adjusted odds ratios (AOR) associated with having an HIV test by demographic, social and behaviour variables. Overall, 9.0% (95% CI 8.1–10.0) of men and a significantly lower proportion of women, 4.6% (95% CI 4.0–5.2), chose to have an HIV test in the past 5 years.

In univariate analysis having an HIV test in the past 5 years was associated with being aged 25–34 years and being of a

**Table 1. The frequency of reporting HIV testing; ever and in the past 5 years by age group and sex, and the reason for an HIV test.**

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | 16–24 years % (95% CI) | 25–34 years % (95% CI) | 35–44 years % (95% CI) | All % (95% CI) | 16–24 years % (95% CI) | 25–34 years % (95% CI) | 35–44 years % (95% CI) | All % (95% CI) |
| Ever HIV tested | | | | | | | | |
| All respondents[a] | 15.7 (12.9–18.8) | 35.8 (33.4–38.2) | 39.5 (36.9–42.2) | 32.4 (30.8–34.1) | 18.4 (16.1–20.9) | 37.1 (35.0–39.3) | 34.7 (32.6–36.9) | 31.7 (30.5–33.0) |
| Base (UW, WT) | 1073, 1318 | 1794, 2138 | 1741, 2082 | 4608, 5538 | 1274, 1292 | 2526, 2061 | 2444, 2042 | 6244, 5395 |
| Main reason for HIV test, of those tested | | | | | | | | |
| Pregnancy | 1.3 (0.2–7.3) | 1.9 (1.1–3.3) | 1.8 (1.0–3.4) | 1.8 (1.2–2.7) | 18.2 (13.7–23.9) | 17.5 (14.9–20.4) | 14.9 (12.3–17.8) | 16.5 (14.7–18.5) |
| Blood donation | 55.1 (45.3–64.5) | 57.1 (52.7–61.0) | 65.1 (60.9–69.0) | 60.5 (57.6–63.3) | 51.5 (44.2–58.7) | 60.1 (56.7–63.8) | 68.3 (64.8–71.7) | 62.4 (60.0–64.8) |
| Insurance, mortgage | 1.6 (0.6–4.2) | 5.7 (4.0–8.1) | 6.9 (5.0–9.4) | 5.8 (4.6–7.2) | 2.3 (0.7–7.0) | 1.6 (0.9–2.8) | 2.2 (1.4–3.5) | 1.9 (1.3–2.8) |
| General health check | 20.2 (14.4–27.5) | 13.9 (11.2–17.2) | 11.2 (9.0–14.0) | 13.4 (11.6–15.4) | 11.2 (7.5–16.6) | 7.6 (6.0–9.7) | 3.9 (2.7–5.6) | 6.6 (5.5–7.9) |
| Concern of risk to self | 13.2 (8.0–21.0) | 13.5 (10.7–16.8) | 7.5 (5.6–10.6) | 10.7 (9.1–12.6) | 12.1 (8.3–17.4) | 7.1 (5.6–9.1) | 5.5 (4.1–7.4) | 7.2 (6.1–8.4) |
| Other | 8.7 (4.8–15.4) | 7.8 (5.9–10.3) | 7.5 (5.6–10.1) | 7.8 (6.5–9.4) | 4.7 (2.4–8.8) | 6.0 (4.5–7.9) | 5.1 (3.7–7.0) | 5.4 (4.4–6.7) |
| Base (UW, WT) | 167, 207 | 668, 765 | 673, 823 | 1508, 1794 | 265, 237 | 975, 765 | 880, 708 | 2126, 1710 |
| HIV test in the past 5 years | | | | | | | | |
| All respondents[b] | 14.8 (12.2–18.0) | 26.2 (24.0–28.5) | 26.9 (24.6–29.4) | 23.8 (22.3–25.2) | 18.0 (15.7–20.5) | 28.2 (26.2–30.3) | 22.3 (20.5–24.2) | 23.5 (22.3–24.7) |
| Base (UW, WT) | 1071, 1315 | 1784, 2126 | 1727, 2026 | 4582, 5506 | 1274, 1292 | 2513, 2050 | 2424, 2027 | 6211, 5369 |
| Main reason for HIV test | | | | | | | | |
| Pregnancy | 1.4 (0.2–0.8) | 2.0 (1.1–3.8) | 2.4 (1.1–3.8) | 2.1 (1.3–3.3) | 18.6 (13.9–24.4) | 19.3 (16.2–22.8) | 13.4 (10.6–16.7) | 17.0 (14.9–19.4) |
| Blood donation | 54.4 (44.4–64.1) | 54.7 (49.3–60.0) | 67.0 (62.2–71.5) | 59.9 (56.5–63.2) | 51.5 (44.2–58.8) | 60.1 (55.9–64.1) | 71.7 (67.5–75.6) | 62.7 (59.8–65.4) |
| Insurance, mortgage | 1.7 (0.6–4.5) | 7.4 (5.1–10.5) | 5.6 (3.6–8.5) | 5.8 (4.4–7.5) | 2.4 (0.8–7.2) | 1.8 (0.9–3.4) | 2.0 (1.1–3.5) | 2.0 (1.2–3.1) |
| General health check | 21.1 (15.0–29.0) | 15.5 (12.1–19.5) | 11.4 (8.8–14.6) | 14.6 (12.5–17.0) | 11.5 (7.6–16.9) | 7.6 (5.7–10.0) | 3.1 (2.0–4.6) | 6.7 (5.5–8.2) |
| Concern of risk to self | 12.2 (7.3–19.5) | 13.4 (10.2–17.5) | 7.5 (5.2–10.7) | 10.7 (8.8–13.0) | 12.4 (8.4–17.8) | 6.8 (5.1–9.1) | 4.6 (3.0–7.0) | 7.0 (5.8–8.6) |
| Other | 9.3 (5.1–16.3) | 7.0 (4.9–10.0) | 7.5 (4.1–9.2) | 7.0 (5.5–8.9) | 3.7 (1.8–7.7) | 4.5 (3.0–6.5) | 5.3 (3.5–7.8) | 4.6 (3.6–6.0) |
| Base (UW, WT) | 159, 195 | 483, 567 | 456, 556 | 1098, 1308 | 266, 232 | 745, 578 | 560, 452 | 1565, 1261 |

CI, Confidence interval; UW, unweighted; WT, weighted. All percentages are of column-weighted bases. Bases vary from totals in previous item because of item non-response.
[a]Excludes those who did not answer or answered maybe/not sure whether they had ever had an HIV test.
[b]Excludes those who did not answer or answered maybe/not sure whether they had had an HIV test in the past 5 years.

**Table 2. The frequency, odds and adjusted odds ratio (95% confidence intervals) for reported voluntary HIV testing[a] within the past 5 years.**

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | % (95% CI) | OR (95% CI) | Adjusted[b] OR (95% CI) | Base (UW, WT) | % (95% CI) | OR (95% CI) | Adjusted[b] OR (95% CI) | Base (UW, WT) |
| All respondents[c] | 9.0 (8.1–10.0) | | | 4546, 5506 | 4.6 (4.0–5.2) | | | 6156, 5322 |
| Demographics | | | | | | | | |
| Age (years) | | $P = 0.0006$ | $P = 0.0321$ | | | $P = 0.0001$ | $P = 0.3309$ | |
| 16–24 | 6.8 (5.3–8.7) | 1.0 | 1.0 | 1064, 1303 | 5.4 (4.1–7.0) | 1.0 | 1.0 | 1266, 1285 |
| 25–34 | 11.3 (9.7–13.1) | 1.74 (1.26–2.38) | 1.64 (1.17–2.13) | 1639, 2109 | 5.6 (4.7–6.6) | 1.03 (0.73–1.45) | 1.40 (0.89–2.19) | 2494, 2033 |
| 35–44 | 8.0 (6.8–9.5) | 1.18 (0.86–1.63) | 1.65 (1.11–2.44) | 1716, 2049 | 3.0 (2.4–3.8) | 0.54 (0.37–0.78) | 1.25 (0.73–2.11) | 2396, 2003 |
| Region | | $P = 0.0000$ | $P = 0.0031$ | | | $P = 0.0001$ | $P = 0.0005$ | |
| Rest of Britain | 7.6 (6.7–8.6) | 1.0 | 1.0 | 3322, 4318 | 3.9 (3.4–4.6) | 1.0 | 1.0 | 4545, 4586 |
| Greater London | 17.3 (14.8–20.2) | 2.55 (2.02–3.22) | 1.58 (1.17–2.13) | 1224, 780 | 8.5 (7.0–10.3) | 2.27 (1.73–2.98) | 1.79 (1.29–2.47) | 1611, 736 |
| Marital status | | $P = 0.0011$ | $P = 0.8514$ | | | $P = 0.0000$ | $P = 0.1938$ | |
| Married | 6.8 (5.7–8.2) | 1.0 | 1.0 | 1993, 2284 | 2.6 (2.0–3.3) | 1.0 | 1.0 | 2493, 2439 |
| Single | 10.1 (8.8–11.8) | 1.53 (1.19–1.98) | 0.97 (0.66–1.41) | 1595, 1990 | 6.0 (4.8–7.3) | 2.40 (1.70–3.37) | 1.00 (0.61–1.64) | 2007, 1475 |
| Cohabiting | 10.8 (8.6–13.6) | 1.66 (1.19–2.30) | 0.88 (0.60–1.28) | 622, 933 | 6.2 (4.7–8.0) | 2.48 (1.67–3.69) | 1.09 (0.67–1.76) | 950, 989 |
| Sep./widowed/divorced | 12.3 (8.5–17.5) | 1.91 (1.21–3.02) | 1.09 (0.63–1.90) | 328, 249 | 7.4 (5.5–9.8) | 3.02 (2.04–4.49) | 1.65 (0.99–2.76) | 698, 411 |
| Social class[d] | | $P = 0.0458$ | $P = 0.1440$ | | | $P = 0.3546$ | $P = 0.4585$ | |
| I, II and III | 9.6 (8.6–10.7) | 1.0 | 1.0 | 3382, 4113 | 4.8 (4.1–5.5) | 1.0 | 1.0 | 4174, 3601 |
| IV, V and unemployed | 7.2 (5.5–9.3) | 0.73 (0.54–0.99) | 0.78 (0.57–1.09) | 842, 987 | 4.1 (3.0–5.5) | 0.85 (0.60–1.20) | 0.86 (0.59–1.27) | 1245, 1095 |
| Ethnicity | | $P = 0.0000$ | $P = 0.0002$ | | | $P = 0.0001$ | $P = 0.2404$ | |
| White | 8.4 (7.5–9.4) | 1.0 | 1.0 | 3783, 5016 | 4.3 (3.8–5.0) | 1.0 | 1.0 | 5127, 4901 |
| Black Caribbean | 16.9 (11.1–24.7) | 2.23 (1.35–3.67) | 1.48 (0.80–2.73) | 153, 82 | 7.3 (3.6–14.2) | 1.73 (0.81–3.71) | 1.36 (0.53–3.49) | 255, 78 |
| Black African | 29.3 (20.7–39.7) | 4.55 (2.82–7.34) | 3.45 (1.85–6.41) | 168, 57 | 12.5 (7.8–19.3) | 3.14 (1.84–5.36) | 2.33 (1.04–5.25) | 210, 50 |
| Indian | 8.5 (3.6–18.7) | 1.02 (0.41–2.54 | 1.23 (0.43–3.50) | 132, 78 | 2.6 (1.1–6.0) | 0.59 (0.25–1.44) | 0.86 (0.32–2.30) | 175, 91 |
| Pakistani | 4.7 (2.2–9.9) | 0.54 (0.24–1.22) | 0.87 (0.40–1.93) | 123, 40 | 3.8 (1.6–8.7) | 0.86 (0.34–2.14) | 1.92 (0.68–5.41) | 128, 39 |
| Other | 16.9 (11.5–24.2) | 2.23 (1.40–3.55) | 2.51 (1.44–4.38) | 176, 177 | 8.1 (4.9–13.1) | 1.95 (1.13–3.67) | 1.41 (0.78–2.55) | 251, 152 |
| Behaviours | | | | | | | | |
| Partners in past 5 years | | $P = 0.0000$ | $P = 0.0028$ | | | $P = 0.0000$ | $P = 0.0000$ | |
| 0–1 | 5.1 (4.2–6.3) | 1.0 | 1.0 | 1928, 2563 | 1.9 (1.5–2.5) | 1.0 | 1.0 | 3515, 3156 |
| 2–4 | 9.4 (7.8–11.3) | 1.92 (1.43–2.58) | 1.59 (1.09–2.32) | 1331, 1533 | 6.7 (5.5–8.1) | 2.79 (1.85–4.21) | 3.07 (2.05–4.60) | 1739, 1394 |
| 5–9 | 13.8 (11.0–17.1) | 2.96 (2.12–4.14) | 2.42 (1.42–3.54) | 664, 727 | 11.3 (8.6–14.8) | 4.56 (3.14–6.61) | 3.96 (2.34–6.70) | 511, 437 |
| 10+ | 20.3 (16.7–24.5) | 4.74 (3.43–6.55) | 2.30 (1.39–3.80) | 489, 497 | 15.9 (11.2–22.0) | 7.41 (5.21–10.54) | 4.15 (2.02–8.56) | 222, 199 |
| Injected drugs in past 5 years | | $P = 0.0000$ | $P = 0.0005$ | | | $P = 0.0000$ | $P = 0.0046$ | |
| No | 8.7 (7.8–9.6) | 1.0 | 1.0 | 4489, 5391 | 4.5 (3.9–5.1) | 1.0 | 1.0 | 6130, 5299 |
| Yes | 31.7 (20.0–46.4) | 4.89 (2.61–9.17) | 4.08 (1.84–9.06) | 56, 69 | 28.5 (14.3–48.9) | 8.55 (3.55–20.64) | 4.80 (1.62–14.18) | 24, 20 |
| Paid for sex in past 5 years (men only) | | $P = 0.0003$ | $P = 0.4035$ | | | | | |
| No | 8.7 (7.8–9.7)) | 1.0 | 1.0 | 4291, 5220 | Women not asked | | | na |
| Yes | 16.7 (12.0–22.7) | 2.08 (1.40–3.10) | 0.81 (0.49–1.34) | 253, 239 | | | | |
| Reported STI in past 5 years | | $P = 0.0000$ | $P = 0.0042$ | | | $P = 0.0000$ | $P - 0.0000$ | |
| No | 8.3 (7.4–9.3) | 1.0 | 1.0 | 4250, 5135 | 3.5 (3.0–4.0) | 1.0 | 1.0 | 5647, 4920 |
| Yes | 29.8 (21.2–37.8) | 4.48 (2.92–6.86) | 2.29 (1.30–4.03) | 153, 151 | 23.1 (17.9–30.0) | 8.46 (5.85–12.23) | 4.41 (2.87–6.78) | 266, 206 |
| New sex partners from abroad in past 5 years | | $P = 0.0000$ | $P = 0.0002$ | | | $P = 0.0000$ | $P = 0.0001$ | |
| No | 7.2 (6.4–8.2) | 1.0 | 1.0 | 3466, 4430 | 3.7 (3.2–4.3) | 1.0 | 1.0 | 5967, 4683 |
| Yes | 21.0 (17.8–24.6) | 3.41 (2.68–4.34) | 1.90 (1.36–2.67) | 772, 733 | 16.3 (12.8–20.6) | 5.03 (3.62–6.97) | 2.27 (1.49–3.45) | 503, 359 |
| Same-sex partners in past 5 years[e,f] | | $P = 0.0000$ | $P = 0.0000$ | | | $P = 0.0000$ | $P = 0.2507$ | |
| None | 8.2 (7.4–9.2) | 1.0 | 1.0 | 4382, 5269 | 4.2 (3.7–4.8) | 1.0 | 1.0 | 5919, 5138 |
| 1–9 | 28.9 (19.6–40.4) | 4.55 (2.69–7.67) | 3.66 (1.88–7.15) | 108, 104 | 16.0 (10.9–22.9) | 4.32 (2.72–6.86) | 1.43 (0.78–2.62) | 184, 147 |
| 10+ | 57.8 (41.9–72.3) | 15.33 (7.97–29.46) | 5.08 (2.16–11.92) | 54, 43 | [e] | | | |

CI, Confidence interval; OR, odds ratio; STI, sexually transmitted infection; WT, weighted; UW, unweighted.
[a]Excludes testing through blood donation and antenatal screening.
[b]Adjusted for all demographic and behavioural variables in the table via logistic regression modelling.
[c]Excludes those who did not answer or answered maybe/not sure whether they had had an HIV test in the past 5 years.
[d]Social class categories I and II: professional, managerial and technical; III: skilled non-manual and manual; IV and V: semi skilled manual and unskilled manual.
[e]As a result of small numbers for women this category has been grouped to same-sex partners in past 5 years, yes, no.
[f]The frequency of reported voluntary HIV testing in the past 5 years for men who had any same-sex partners in the past 5 years (%, 95% CI) was 36.9%; 95% CI 28.8–45.9.

higher social class in men, and living in Greater London, not having been married, and being black Caribbean, black African, and of other ethnicity for men and women. Greater numbers of sexual partners, reporting a previous sexually transmitted infection (STI), acquiring new sexual partners from abroad, and increasing numbers of same-sex partners were all associated with HIV testing in the past 5 years for both men and women. Nearly one third of injecting drug users had had an HIV test in the past 5 years.

In multivariable analysis, after adjustment for all demographic and behavioural variables, the demographic variables remaining statistically associated with having had an HIV test in the past 5 years were similar for both men and women. Men aged 25 years and over were more likely to have been tested than men aged under 25 years, whereas there was no difference in testing by age for women. Individuals living in Greater London had a significantly greater AOR of having had an HIV test compared with those resident in the rest of Britain (AOR 1.58 for men and 1.79 for women). The odds of HIV testing varied by ethnicity even after adjustment, with men of black African and 'other' ethnicity more likely to be tested compared with white men (AOR 3.45 and 2.51), whereas in women there was no difference, after adjustment (Table 2).

In multivariable analysis, after controlling for demographic and other behaviour variables, the magnitude of the associations of HIV testing with each behavioural variable reduced, but a significant association remained. The likelihood of having had an HIV test in the past 5 years increased with increasing numbers of sexual partners. Women who had had 10 or more sexual partners in the past 5 years, had an AOR of 4.15 of reporting an HIV test, compared with women who had had at most one partner, whereas men with 10 or more sexual partners had an AOR of 2.30. Acquiring new sexual partners abroad was also independently associated with HIV testing in the past 5 years, as well as reported STI in the past 5 years and injecting drug use for both men and women. Men who reported having more than 10 male sexual partners in the past 5 years had an AOR of 5.08 of having an HIV test compared with men who had no male partners.

## Time since last HIV test and perception of risk

The prevalence of reported HIV testing varied according to an individual's perception of their self-perceived risk of HIV infection (Table 3). The prevalence of HIV testing was greater in all men who stated that they were 'not very much at risk' or 'greatly or quite a lot at risk' compared with those who perceived that they were 'not at risk at all' after adjustment for age ($P < 0.0001$). In women, the prevalence of testing by self-perceived risk was also greater in those who perceived themselves to be at a greater risk after adjustment for age. Both men and women who reported that they 'don't know' if they were at risk of HIV infection were more likely to have had an HIV test than those who reported that they were 'not at risk at all'. There was no difference in the prevalence of HIV testing in MSM by risk perception ($P = 0.6385$), although one third of men who had same-sex partners had been tested in the past 5 years.

Over half the respondents who reported choosing to have an HIV test in the past 5 years (i.e. excluding blood donation and antenatal screening) tested within the past 2 years; 28.3% (95% CI 23.8–33.3) of men and 25.4% (95% CI 20.2–31.4) of women reported their last HIV test in the past year, and 25.7% (95% CI 21.4–30.5) and 25.9% (95% CI 20.8–31.8), respectively, between one and 2 years ago. Among MSM, two thirds tested within the

**Table 3. Relationship between perception of self-risk of HIV infection and voluntary HIV testing[a] (age-adjusted odds ratio and 95% confidence interval) by sex and sexuality.**

| Perception of risk of HIV infection to self | % (95% CI) of reporting an HIV test in past 5 years | Age adjusted OR (95% CI) | *P* value | Base (UW, WT) |
|---|---|---|---|---|
| All men | | | | |
| Not at all at risk | 7.7 (6.7–8.9) | 1.0 | <0.0001 | 2659, 3382 |
| Not very much at risk | 10.5 (8.9–12.4) | 1.51 (1.19–1.91) | | 1596, 1799 |
| Greatly/quite a lot at risk | 13.4 (9.6–18.3) | 2.17 (1.41–3.32) | | 270, 262 |
| Don't know | 26.3 (11.0–50.6) | 4.40 (1.54–12.62) | | 21, 19 |
| All women | | | | |
| Not at all at risk | 3.8 (3.3–4.5) | 1.0 | 0.0051 | 4223, 3746 |
| Not very much at risk | 6.0 (4.8–7.5) | 1.51 (1.11–2.06) | | 1689, 1396 |
| Greatly/quite a lot at risk | 8.2 (4.8–13.8) | 2.34 (1.30–4.24) | | 207, 150 |
| Don't know | 7.7 (14.7–32.0) | 2.49 (0.39–15.72) | | 37, 29 |
| Men who have sex with men[b] | | | | |
| Not at all at risk/don't know | 40.6 (25.8–57.3) | 1.0 | 0.6385 | 48, 52 |
| Not very much at risk | 35.14 (24.2–47.8) | 0.66 (0.27–1.61) | | 96, 79 |
| Greatly/quite a lot at risk | 30.6 (14.9–52.7) | 0.80 (0.21–3.02) | | 26, 21 |
| Don't know | – | | | |

CI, Confidence interval; OR, odds ratio; WT, weighted; UW, unweighted.
[a]Excludes testing through blood donation and antenatal screening.
[b]Men who reported a same-sex partner in the past 5 years.

**Table 4. Place where last HIV test was carried out by sex and sexuality (excluding blood donation and antenatal screening).**

| Place of HIV test[a] | All men % (95% CI) | All women % (95% CI) | Men who have sex with men % (95% CI) |
|---|---|---|---|
| GP surgery | 28.5 (24.0–33.6) | 20.0 (15.1–25.6) | 18.4 (8.4–35.8) |
| STD clinic | 34.1 (29.1–39.5) | 44.0 (37.8–50.3) | 52.0 (36.3–67.4) |
| NHS family planning clinic | 2.8 (1.6–4.8) | 3.0 (1.8–5.3) | 0.5 (0–3.9) |
| Private clinic or doctor | 14.4 (11.0–18.6) | 13.1 (9.6–17.5) | 11.3 (4.5–25.6) |
| Somewhere else | 20.1 (16.1–24.8) | 19.9 (15.2–25.6) | 17.7 (7.9–35.0) |
| Base[b], unweighted, weighted | 498, 488 | 346, 241 | 62, 56 |

CI, Confidence interval; GP, general practitioner; NHS, National Health Service; STD, sexually transmitted diseases.
[a]All percentages are of column-weighted bases.
[b]Excludes those who did not have an HIV test, did not answer or answered maybe/not sure whether they had had an HIV test in the past 5 years.

past 2 years; 37.8% (95% CI 24.7–53.0) in the past year and 28.6% (95% CI 16.5–44.8) between one and 2 years ago.

### Place of last HIV test

The most commonly reported place where an HIV test was carried out was at an STD clinic for women (44.0%) and men (34.1%). General practice was also commonly reported for men (28.5%) and women (20.0%) (Table 4). Twenty per cent of men and women had had an HIV test 'somewhere else'. The majority of MSM (52.0%) had had their HIV test at an STD clinic, whereas 18.4% reported that their last HIV test was at a general practitioner's surgery.

## Discussion

Natsal 2000, a national probability sample survey, provides estimates of the prevalence of HIV testing in the general population, and has found that overall over a third of British men and women have tested for HIV in their lifetime, the majority of whom have been tested through blood donation. When HIV screening through blood donation and pregnancy are excluded, testing for HIV in the past 5 years was associated with high-risk behaviours in both men and women. We also found reported HIV testing to be associated with certain demographic characteristics, including older age, residence in London, and black-African ethnicity. These may reflect both lifetime opportunity for HIV testing, self-perceived risk of HIV infection, and individual attitudes towards HIV testing. With the exception of older age, many of these characteristics are also associated with a greater burden of STI [1,17] and an increased likelihood of attending an STD clinic.

Robust prevalence estimates of HIV testing uptake in the general population are not available in many countries. In the USA, the general population prevalence of HIV testing was greater at 45.6%, whereas this excluded blood donors, it included testing through other screening programmes such as military service, immigration, marriage licence and occupational exposure, which together accounted for 45.2% of all HIV tests in men and 27.8% in women [19]. Canadian estimates of general population voluntary HIV testing are also greater than the UK, at 17.8% of men and 15.6% of women [20]. Convenience samples of MSM in the UK have reported greater rates of HIV testing, ranging between 53–64% ever tested [5,21] and 32% in the past year [21]. However, of the MSM in our study who reported that they had had an HIV test in the past 5 years, a similar proportion reported an HIV test in the past year (36%). MSM recruited through Natsal include both MSM at higher and lower behavioural risk, as Natsal is a probability survey of the general population. In contrast, convenience sample surveys may be sampling men with higher risk behaviours. Nonetheless, the proportion of those MSM from Natsal 2000 who had attended an STD clinic in the past 5 years and had also had an HIV test has been found to be similar to other studies at 74% [8]. Geographical differences in the prevalence of voluntary HIV testing in both MSM and the general population have been reported in the USA [19], Canada [11], and Australia [10]. These have been associated with the differential availability of testing and service provision, and community attachment among MSM [10,11]. Unprotected anal intercourse, and HIV-positive partners were also found to be associated with HIV testing in MSM, and those who were at greatest risk were more likely to have been tested [10].

Our study has some limitations, as non-respondents may be different from those who chose to participate; however, the direction of this bias is unknown. Probability sample surveys, by their nature, do not achieve large samples of high-risk populations, although this was addressed in this survey through oversampling in London, and the focussed enumeration of ethnic minorities to achieve larger sample sizes in these groups, which were then weighted to correct for unequal selection probabilities. As both HIV testing and sexual

behaviours were self-reported in Natsal 2000, this may lead to bias because of individual's reluctance to disclose sensitive behaviours. However, the cognitive interviews carried out to validate the methodology for Natsal 2000 concluded that individuals were happy to report their HIV testing behaviours, and as the respondent's HIV status was not requested, this subject was not considered to be too intrusive [18]. Improved data collection methodology in 2000 with the use of computer-assisted self-interview (CASI) may have further facilitated the reporting of sensitive behaviours, including HIV testing. Comparisons of age-related cohorts between the 1990 and 2000 surveys indicated that it is possible that there has been a change in the willingness to report some experiences, perhaps in particular for those that are most socially sensitive [22]. Because HIV status was not collected in our survey, the reported self-perception of risk could be informed by an individual's knowledge of his or her own HIV status. This appears to be more important in MSM as there was no evidence of a difference in the likelihood of reporting an HIV test in the past 5 years in those who did not perceive themselves to be at risk of HIV infection. However, in all men and women, the probability of reporting an HIV test in the past 5 years was greater in those who perceived themselves to be at risk or did not know if they were at risk.

HIV testing was associated with higher risk behaviours and numbers of sexual partners, and the numbers of same-sex partners for men. This suggests that HIV testing largely remains part of a reasoned decision-making process both on the part of the individual and their health service providers. Although HIV testing was associated with risk behaviours, and reporting STI diagnoses, the opportunities to offer and recommend HIV testing to those at increased risk of infection should be encouraged. A substantial number of HIV tests were reported to have taken place outside the STD clinic setting. If barriers to HIV testing exist, further research is needed to understand what they are and if they are with the provider or the individual. Voluntary confidential HIV testing is an important strategy for facilitating the management of HIV infection in the individual and reducing the likelihood of onward transmission through behavioural change and decreased viral load through antiretroviral treatment. National standards for HIV testing have been set in the National Strategy for Sexual Health and HIV [2], including an increase in the offer and uptake of HIV and STI testing. In order to decrease undiagnosed HIV infections, care should also be taken to ensure that HIV testing is available to all.

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ORIGINAL ARTICLE

# Trends in, and determinants of, HIV testing at genitourinary medicine clinics and general practice in England, 1990–2000

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**Objectives:** To describe the trends in and determinants of HIV testing and positivity at genitourinary medicine (GUM) clinics and in general practice (GP) in England between 1990 and 2000.
**Methods:** Data on all first HIV specimens from GUM and GP clinics and tested at seven sentinel laboratories were related to key demographic, clinical, and behavioural variables.
**Results:** During the observation period, 202 892 eligible first HIV tests were reported. 90% (182 746) of specimens were from GUM clinics, of which 55% were from heterosexuals, 12% from men who have sex with men (MSM), and 3% from injecting drug users (IDU). In contrast, only 3% of GP specimens were from MSM and 13% from IDUs. The total number of first HIV tests increased threefold between 1990 and 2000. Overall, 1.6% of GUM and 0.9% of GP first testers were diagnosed HIV positive. In GUM clinics, HIV positivity was highest among heterosexuals who have lived in Africa (11.7%), MSM (6.9%), and IDUs (2.8%) and lowest among heterosexuals with no other specified risk (0.3%). Consistently lower prevalences were observed in GP settings. HIV positivity among GUM first testers declined in MSM, from 13.6% in 1990 to 5.2% in 2000 ($p<0.01$), and in IDUs, from 7.5% in 1990 to 2.0% in 2000 ($p=0.03$). Prevalence remained constant in the groups heterosexually exposed to HIV infection.
**Conclusions:** HIV testing in GUM settings increased over the decade, with a concomitant reduction in HIV positivity among MSM and IDUs. Increased testing among heterosexual first testers overall was not associated with declining positivity.

By the end of June 2002, over 4400 HIV infections newly diagnosed in the United Kingdom in 2001 had been reported to the Communicable Disease Surveillance Centre (CDSC) with 26 635 HIV infected individuals reported as being seen for care during that year in the United Kingdom.[1] Two decades of intensive HIV health promotion have seen gradual and sustained increases in HIV testing among GUM attendees in the United Kingdom. Statutory returns made by GUM clinics in England (form KC60) show that the number of episodes of HIV counselling and testing increased by 35% in the last year, 56% in the past 3 years, and by 90% in the past 6 years to 201 347 in 2001.[2] Nevertheless, substantial numbers of HIV infected individuals in the United Kingdom still do not know their HIV status[3] and therefore cannot receive appropriate care, notify their partners, or be guided in safer sexual behaviour in knowledge of their status.[4]

In an effort to reduce the number of undiagnosed HIV infections in the population and to reduce HIV transmission, testing promotion has been prioritised by the Department of Health's National Strategy for Sexual Health and HIV for England.[5] Key strategies include the provision of clear information to the public about HIV with the aim of encouraging the demand for voluntary HIV testing while improving access to GUM services and increasing the offer of HIV testing. At the same time, there is a growing acknowledgement of the need to remove the exceptionalism and stigma associated with HIV testing by providing these services outside traditional GUM and antenatal settings.[6] Currently, there is little information on HIV testing trends in general practice in England[7] or in other settings where individuals at increased risk may be seen (for example, termination of pregnancy clinics).

This study aimed to explore trends in HIV testing in GUM clinics and the comparative trends in GP practices using data derived from an existing sentinel laboratory surveillance programme.[8] In this paper we focus on changes in HIV testing over time by exposure category and sex, and compare the numbers of HIV tests and HIV positivity across risk groups.

## METHODS

### Study description

The denominator study was set up in 1986 by the Public Health Laboratory Service (PHLS) to monitor trends and determinants of voluntary HIV testing in England through the sentinel surveillance of 18 laboratories.[8] Seven sentinel laboratories in England (three in London and four outside London) were selected to continue after 1998 on the basis of their ability to provide complete electronic records of their HIV tests to Communicable Disease Surveillance Centre (CDSC). They were not a randomly selected sample of laboratories and cannot be assumed to reflect all HIV testing in England. However, these sentinel laboratories accounted for 16% of all HIV tests reported from English GUM clinics in 2000 and areas outside London were well represented. All laboratories participated in a national external quality assurance scheme for HIV (NEQAS). There is no evidence to suggest that any differences in the sensitivity of HIV tests for different subtypes would have a significant effect on detected HIV positivity between exposure categories or over time.[9] Enhanced epidemiological data on exposure, reasons for testing, and HIV related symptoms at the time of test have been routinely collected at these centres on all HIV test request forms, which collected the same core dataset.

Variations between sites were accommodated by regrouping data into broader categories for this analysis.

### Data extraction

First tests of individuals were identified on each laboratory database in the laboratory by matching on either GUM number or name and date of birth. All patient identifiers were then removed before extracts of all first tests were sent to CDSC for addition to a central database. Variables collected on each patient included date and final result of test, source of specimen, age, sex, reported risk factors, nature of contact involved in the HIV transmission risk, reasons for testing, and symptoms at the time of test. Specimens referred to participating laboratories from other laboratories for confirmatory testing were excluded.

### Data preparation

For this analysis all first HIV tests performed between 1 January 1990 and 31 December 2000 in the seven sentinel sites were selected. HIV tests from hospital wards and other clinics were excluded leaving only those tests requested by GUM clinics and GPs. We excluded individuals recorded as known to be HIV positive (because this would not have been their first test), those with unknown or equivocal test results, and people aged less than 15 or of unknown age. We also excluded individuals whose HIV test was clearly prompted by some other reason than a perception of HIV risk: pregnant women, organ/tissue donors, and individuals with either antiretroviral treatment or special survey reported as the reason for their test. Exposure categories were assigned to the individuals tested according to their reported risk factors and the nature of contact through which HIV may have been transmitted. This allocation used a hierarchical algorithm (fig 1): men who have sex with men (MSM); injecting drug users (IDU); recipients of blood/blood products or tissues (Blood); heterosexuals with high risk partners (HET HRP); heterosexuals who have lived in Africa (HET LA); heterosexuals with no other specified risk (HET OT). Those with no identified risk behaviour and those with other risk behaviours reported were grouped as such. For each centre, data were checked for evidence of inconsistent data entry. This identified HIV tests for which the source of test had been systematically misclassified over a period of time at one laboratory. Tests were reallocated to the GUM clinic.

### Statistical analysis

Stata 7.0 software was used for statistical analyses of the data. Differences in proportions were tested by Pearson's $\chi^2$ method and Fisher's exact test where appropriate. Point estimates and exact confidence intervals for odds ratios were calculated for comparison of the odds of testing positive by exposure, source, and sex. Trends were analysed using linear regression using ordinary least squares.

## RESULTS

### Overall description of sample

A total of 206 782 first HIV specimens were tested at the seven sentinel sites over the 10 year period; 98% were eligible for inclusion in this study. Two laboratories, both in London and with more than 50 000 tests each, accounted for over 50% of the tests. Ninety per cent (182 746/202 892) of the eligible tests were requested from GUM clinics. The majority of tests (77%) were performed on samples from heterosexuals with no other specified risk and individuals with no identified risk (50% and 28% respectively at GUM clinics and 17% and 56% respectively at GPs). MSM accounted for 11.2% (22 685/202 892) of individuals tested for HIV, with the proportion ranging from 3.8% (522/13 817) to 19.5% (11 111/56 916) across sites.

### HIV testing by source of specimen

More first HIV tests from GUM clinics than from GPs were reported in each exposure category, both within and outside London (table 1). Overall, in GUM clinics 12% of HIV tests were for MSM and only 3% for IDUs. In contrast, 3% of tests requested by GPs were for MSM and 13% for IDUs. Overall, a higher proportion of individuals tested at GUM clinics (55%) were heterosexuals than those tested at GPs (22%) ($p<0.01$). In contrast, individuals with no identified risk accounted for 28% of the individuals tested at GUM clinics and 56% of those tested at GP ($p<0.01$).

Significant sex differences in HIV testing were observed between exposure categories. Females accounted for over 70% (4082 of 5164 overall) of heterosexuals with high risk partners in both GUM clinics and at GP practices, both within

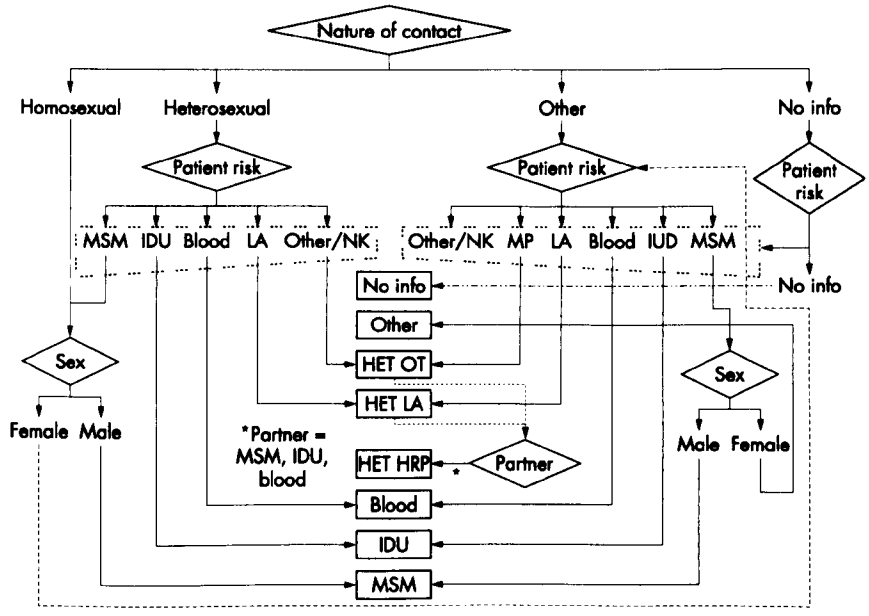


**Figure 1** Algorithm for the hierarchical categorisation of exposures. The patient risk has decreasing hierarchy from MSM to Other/NK. MSM = men who have sex with men, IDU = injecting drug user, Blood = haemophiliac or transfusion/transplant recipient, MP = multiple heterosexual partners, HET = heterosexual, OT = no other specified risk, LA = lived in Africa, HRP = high risk partner.

**Table 1** Number and percentage of HIV tests by source and exposure category*

| | London | | Outside London | |
|---|---|---|---|---|
| **Exposure category** | **GP total (%)** | **GUM total (%)** | **GP total (%)** | **GUM total (%)** |
| Sex between men | 141 (2) | 13734 (15) | 520 (4) | 8290 (9) |
| Injecting drug use | 981 (15) | 2273 (3) | 1556 (11) | 2408 (3) |
| Blood or tissues | 33 (1) | 352 (0) | 114 (1) | 303 (0) |
| **Heterosexual:** | | | | |
| High risk partner | 89 (1) | 2196 (2) | 430 (3) | 2470 (3) |
| Lived in Africa | 146 (2) | 3642 (4) | 254 (2) | 1008 (1) |
| Other | 660 (10) | 41744 (46) | 2829 (21) | 49669 (54) |
| No identified risk | 3887 (61) | 25419 (28) | 7310 (53) | 25645 (28) |
| Other risk | 479 (8) | 1619 (2) | 717 (5) | 1974 (2) |
| Total | 6416 (100) | 90979 (100) | 13730 (100) | 91767 (100) |

*Includes people of unknown sex. GP = general practice; GUM = genitourinary medicine.

and outside London (table 2), but 30% or less of tested IDUs at all sources (data not shown). Among heterosexuals who have lived in Africa, men accounted for 61% (609 of 1003) of tests at GUM clinics and 69% (176 of 254) of tests at GPs outside London (with a more even balance in London).

The overall modal age group for each exposure category was 25–29 years of age except for the female heterosexuals with high risk partners who were generally younger (table 2). MSM and IDUs tested outside London were younger than those tested in London. Male heterosexuals with no other specified risk were younger than females except at GUM clinics within London.

## Trends in HIV testing

The annual number of first tests increased from 8328 in 1990 to 26 389 in 2000. There was a linear increase from 1996 to 2000 ($p<0.01$) averaging 1932 tests per year. The total contribution of HIV tests from GUM clinics increased from 6398 in 1990 to 23 923 in 2000 ($p<0.01$). There was no significant linear change in the total number of tests at GPs (1930 in 1990 to 2466 in 2000, $p = 0.58$).

At GUM clinics, HIV tests increased from all exposure groups except heterosexuals with high risk partners, the recipients of blood/blood products or tissues and those with other risk behaviours. Heterosexuals with no other specified

**Table 2** Distribution of HIV prevalence within exposure categories by source and region

| | London | | | Outside London | | | |
|---|---|---|---|---|---|---|---|
| | **GP** | **GUM** | **OR* (95% CI)** | **GP** | **GUM** | **OR* (95% CI)** | **Total** |
| **Homosexual and bisexual men** | | | | | | | |
| Total number tested | 141 | 13734 | | 520 | 8290 | | **22685** |
| HIV prevalence | **15.6%** | **8.5%** | 1.98 (1.20–3.16) | **3.7%** | **4.1%** | 0.89 (0.53 to 1.44) | **6.8%** |
| Modal age group | 25–29 | 25–29 | | 20–24 | 20–24 | | 25–29 |
| **Injecting drug users** | | | | | | | |
| Total number tested | 981 | 2273 | | 1556 | 2408 | | **7175** |
| HIV prevalence | **1.3%** | **4.4%** | 0.29 (0.15 to 0.52) | **0.5%** | **1.3%** | 0.38 (0.15 to 0.85) | **2.1%** |
| Modal age group | 30–34 | 25–29 | | 20–24 | 20–24 | | 25–29 |
| **Female heterosexuals:** | | | | | | | |
| Total number tested (%) | 472 (100) | 26289 (100) | | 1654 (100) | 26670 (100) | | **55085** (100) |
| HIV prevalence | **2.5%** | **1.6%** | 1.64 (0.83 to 2.92) | **0.4%** | **0.3%** | 1.45 (0.56 to 3.14) | **0.9%** |
| Modal age group | 20–24 | 20–24 | | 20–24 | 20–24 | | 20–24 |
| **High risk partner** | | | | | | | |
| Total number tested (%) | 74 (16) | 1740 (7) | | 311 (19) | 1957 (7) | | **4082** (7) |
| HIV prevalence | **0.0%** | **0.6%** | n/a | **0.0%** | **0.2%** | n/a | **0.3%** |
| Modal age group | 20–24 | 25–29 | | 25–29 | 20–24 | | 20–24 |
| **Lived in Africa** | | | | | | | |
| Total number tested (%) | 65 (14) | 1754 (7) | | 78 (5) | 394 (1) | | **2291** (4) |
| HIV prevalence | **16.9%** | **16.1%** | 1.06 (0.50–2.09) | **7.7%** | **9.1%** | 0.83 (0.28 to 2.09) | **14.6%** |
| Modal age group | 25–29 | 25–29 | | 25–29 | 25–29 | | 25–29 |
| **Other** | | | | | | | |
| Total number tested (%) | 333 (71) | 22795 (87) | | 1265 (76) | 24319 (91) | | **48712** (88) |
| HIV prevalence | **0.3%** | **0.5%** | 0.57 (0.01 to 3.25) | **0.1%** | **0.2%** | 0.49 (0.01 to 2.92) | **0.3%** |
| Modal age group | 25–29 | 25–29 | | 25–29 | 25–29 | | 25–29 |
| **Male heterosexuals:** | | | | | | | |
| Total number tested (%) | 399 (100) | 21129 (100) | | 1854 (100) | 26340 (100) | | **49722** (100) |
| HIV prevalence | **3.8%** | **1.4%** | 2.71 (1.48 to 4.60) | **0.2%** | **0.3%** | 0.68 (0.18 to 1.80) | **0.8%** |
| Modal age group | 25–29 | 25–29 | | 20–24 | 20–24 | | 25–29 |
| **High risk partner** | | | | | | | |
| Total number tested (%) | 13 (3) | 446 (2) | | 118 (6) | 505 (2) | | **1082** (2) |
| HIV prevalence | **0.0%** | **1.6%** | n/a | **0.0%** | **0.6%** | n/a | **0.9%** |
| Modal age group | 25–29 | 25–29 | | 25–29 | 20–24 | | 25–29 |
| **Lived in Africa** | | | | | | | |
| Total number tested (%) | 76 (19) | 1869 (9) | | 176 (9) | 609 (2) | | **2730** (5) |
| HIV prevalence | **13.2%** | **10.0%** | 1.37 (0.62 to 2.74) | **1.7%** | **6.2%** | 0.26 (0.05 to 0.84) | **8.7%** |
| Modal age group | 25–29 | 25–29 | | 35–39 | 25–29 | | 25–29 |
| **Other** | | | | | | | |
| Total number tested (%) | 310 (78) | 18814 (89) | | 1560 (84) | 25226 (96) | | **45910** (92) |
| HIV prevalence | **1.6%** | **0.6%** | 2.87 (0.91 to 6.97) | **0.1%** | **0.2%** | 0.38 (0.01 to 2.21) | **0.3%** |
| Modal age group | 20–24 | 25–29 | | 20–24 | 20–24 | | 25–29 |

*Odds ratios compare HIV prevalence of GP to GUM (GP = general practice; GUM = genitourinary medicine).

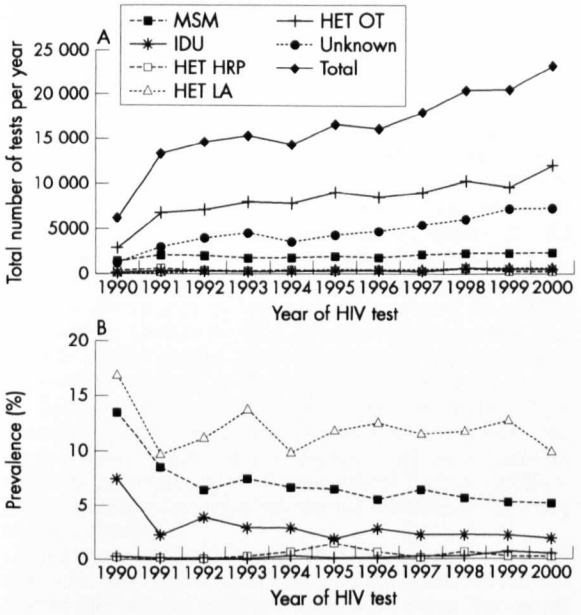


**Figure 2** Trends in (A) HIV testing and (B) HIV prevalence among first testers at GUM clinics. MSM = men who have sex with men; IDU = injecting drug users; HET HRP = heterosexuals with high risk partners; HET LA = heterosexuals who have lived in Africa; HET OT = heterosexuals with no other specified risk; Unknown = no identified risk reported.

risk and people with no identified risk accounted for most of the overall increase (fig 2A). Consequently, the proportion of HIV tests among MSM declined from 23% in 1990 to 10% in 2000 ($p = 0.01$), from 4% to 2% ($p = 0.02$) among IDUs, and from 5% to 1% ($p = 0.00$) among heterosexuals with high risk partners.

At GPs, the proportion of tests requested by IDUs increased over time (4% (84/1930) in 1990 to 21% (524/2466) in 2000, $p<0.01$), which contributed to the gradual declines in the proportion of tests requested from MSM ($p<0.01$), heterosexuals with high risk partners ($p<0.01$), heterosexuals who have lived in Africa ($p = 0.02$), and heterosexuals with no other specified risk ($p<0.01$).

### HIV prevalence

Marked geographic heterogeneity in HIV positivity was observed in those being tested for the first time. Sites in London had generally higher positivity than those outside (2.6% compared to 0.7%, $p<0.01$). At GUM clinics, HIV prevalence was generally significantly higher in all exposure categories in London compared to outside London (table 2). This was also the case at GPs except where the numbers tested or the numbers tested positive were small.

Overall, HIV positivity was high in heterosexuals who have lived in Africa (11.4%, 572 of 5021), in MSM (6.8%, 1550 of 22 685) and in recipients of blood/blood products or tissues (4.3%, 34 of 794). HIV positivity was 0.4% (23 of 5164) in heterosexuals with high risk partners and 0.3% (317 of 94 622) in heterosexuals with no other specified risk. HIV positivity in female heterosexuals who have lived in Africa was higher overall than that in males in the same exposure category (14.6% *v* 8.7%; odds ratio (OR) 1.80 (95% CI 1.50 to 2.16)) (table 2). This contrasts with a higher prevalence in male heterosexuals with high risk partners than in females (0.9% *v* 0.3%, OR 2.92 (1.14 to 7.23)).

Within London, HIV positivity was higher among MSM tested at GPs than in those tested at GUM clinics (15.6% *v* 8.5%, OR 1.98 (1.20 to 3.16)). A similar difference was weakly significant for male heterosexuals with no other specified risk (1.6% *v* 0.6%, OR 2.87 (0.91 to 6.97)). In contrast, prevalence was lower among IDUs tested at GPs than at GUM clinics (1.4% *v* 4.4%, OR 0.30 (0.15 to 0.54)). HIV positivity was also lower at GPs than at GUM clincs outside London among IDUs and among male heterosexuals who have lived in Africa (0.5% *v* 1.3%, OR 0.38 (0.15 to 0.85) and 1.7% *v* 6.2%, OR 0.26 (0.05 to 0.84) respectively).

### Trends in HIV prevalence at GUM clinics

Linear regression analysis in MSM showed significant decreases in HIV prevalence over time overall ($p<0.01$) (fig 2B) and both within London ($p<0.01$) and outside London ($p = 0.02$). A significant decline was also seen for IDUs tested in London ($p = 0.02$) but there was no evidence of a decline outside London ($p = 0.22$). No other strongly significant trends were observed. However, HIV prevalence among heterosexuals with no other specified risk decreased from 0.43% in 1990 to 0.16% in 1996 and then increased to 0.57% in 2000. Similar trends were seen in both heterosexual males and females, both within and outside London. The numbers of individuals first tested at GPs in each year were not large enough for analysis of trends within exposure groups.

## DISCUSSION

Between 1990 and 2000 the number of voluntary HIV tests undertaken at these seven sentinel sites more than tripled. GUM clinics accounted for the majority of this increase with a near quadrupling of tests while little overall change was seen in the number of HIV tests undertaken at GPs. The increased HIV testing at GUM clinics was observed among all exposure groups except heterosexuals with high risk partners and occurred over a period when new attendances at these sites doubled.[10] Our data confirm that much of the increase was due to testing among low risk heterosexuals. This may have been a direct response to sexual health promotion messages throughout the 1990s although other factors such as changing clinic policies regarding the offer of routine HIV testing may also have contributed.[11]

Trends in HIV positivity among first time testers varied considerably by exposure category. The HIV positivity among heterosexuals who have lived in Africa (11.4%) and among MSM (6.8%) in our study were similar to those found among testers attending a same day testing service at a large inner London hospital in 2000–1[12] (11.2% and 6.2% respectively), although the positivity found there among low risk heterosexuals (1.8% in males and 1.4% in females) were much higher than in our study. Our study suggests that equivalent numbers of heterosexual men and women who have lived in Africa were tested for HIV in England during the past decade, consistent with other community based studies in England.[13] Despite this, our study documents a significantly lower HIV positivity among males who have lived in Africa compared with females and may help to explain why men account for less than 40% of black Africans reported to the national surveillance scheme of newly diagnosed HIV patients since 1995.[1]

The data provide evidence of a continual decline in HIV prevalence among MSM and IDU first testers at GUM clinics between 1990 and 2000. This could not be accounted for by changes in the age distribution of first testers and trends in HIV prevalence were similar in all age groups. Decreasing trends in HIV prevalence in the United Kingdom have been reported among male homosexual and bisexual GUM clinic attenders tested for syphilis between 1993 and 2000 that were not previously diagnosed with HIV in the unlinked anonymous seroprevalence surveys.[4] Similar trends among

GUM clinic attenders have been found in Amsterdam (first testers)[14] and America (all testers),[15] where declines in HIV prevalence among MSM and IDU contrast with stable prevalence among heterosexuals and those with no identified risk.

Our study has limitations. In this study we focused on positivity as a proxy for prevalence, and therefore cannot infer incidence or changes in incidence. It has previously been suggested that a decrease in prevalence can mask stable or increasing incidence,[16] evident from studies in the Netherlands,[17] the United States,[15] and England.[18]

There was marked heterogeneity among the seven participating laboratories in terms of case mix and prevalence. This will be masked by their aggregation into London and outside London regions. The heterogeneity is most evident in the analysis of trends in the numbers HIV testing at GPs.

There is limited information from this study about variations in HIV prevalence according to behavioural risk. In particular, identification of repeat testers as a proxy for high risk behaviour would have provided further classification of exposure categories but was not available in this study of first HIV tests.

Matching HIV tests using identical clinic number or identical name and date of birth to identify the first test of individuals cannot completely identify all repeat tests on all individuals. This may have allowed HIV tests that were not the first test of the individual to have been included in the analysis. Also, the hierarchical classification of HIV exposure categories is intended to assign patients the "exposure of greatest risk" if multiple risk behaviours have been reported. This will tend to oversimplify patients' exposures but similar assumptions have been made in other HIV surveillance systems.[19]

Finally, the classification of exposure categories was incomplete, as patient HIV exposure information was not fully available from GUM clinics or GPs. Failure to complete forms could have led to misclassification bias, as exposures may be less likely to be reported in the absence of high risk behaviours. This may have led to overestimation of prevalence in each exposure category and underestimation of the number of heterosexuals tested. There was a low prevalence among those with no identified risk (0.9% males, 0.4% females), which suggests the majority were heterosexuals with no other specified risk.

The results of our paper will nevertheless be of interest to those involved in sexual health policy. The English National Strategy for Sexual Health and HIV has prioritised the uptake of HIV testing as a core HIV prevention intervention with two main aims.[5] The first is to reduce the number of HIV infected individuals who remain undiagnosed after attending a GUM clinic. The second is to encourage HIV testing of people at a wider range of sites including primary care and general medical settings.[5] Ongoing surveillance of HIV testing as outlined in this paper will provide a key mechanism for monitoring progress on these goals. Alongside increased offers of HIV testing, this analysis supports the need for targeting groups at high risk of HIV infection with HIV testing interventions, including MSM, IDU, and adults who have had heterosexual contact in Africa. Such focused promotion of HIV testing will be more cost effective than testing of individuals at lower risk, as fewer HIV tests are needed to diagnose one HIV infection. However, it is estimated that nearly twice as many HIV infected heterosexuals were living with undiagnosed HIV as homosexual or bisexual men at the end of 2001[1] and it is known that a large proportion of heterosexuals were not diagnosed until late in the course of infection between 1990 and 2000 in England.[20] The strategy for sexual health addresses these issues through targeted campaigns to encourage the uptake of HIV testing in high risk groups and policies to increase the offer of HIV tests at healthcare sites, which should also capture heterosexual individuals with high risk behaviours. However, it should be acknowledged that GUM clinics will need to be supported as promotion of HIV testing further adds to their workload.

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## CONTRIBUTORS

TRC was the main author and current project coordinator: responsible for recent data collection, data analysis, report drafting, and editing; CAM contributed to scientific interpretation of data, the critique and revision of drafts, and was involved in the approval of the final version of the submitted paper; PAW was responsible for the conception and design of the study and the majority of data collection: also helped with the critique and the revision and approval of the paper; KAF was responsible for final approval of paper, contributed significantly to the scientific interpretation of data, and the critique and revised draft versions.

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Conflict of interest: None

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# A VIEW FROM THE SOUTH

## Conference presentations (it' s all a matter of timing)

| | |
|---|---|
| Juniors | 19 presented of whom 2 ran over time (11%) |
| Consultants | 9 presented of whom 4 ran over time (44%) |
| Senior academics | 18 presented of whom 9 ran over time (50%) |
| | Test for trend p=0.011 |

| | |
|---|---|
| Juniors v consultants | difference 33% (95% CI 1 to 64) |
| Juniors v senior academics | difference 39% (95% CI 10 to 62) |
| Consultants v senior academics | difference 6% (95% CI −30 to +39) |

Many chairs at academic meetings remind the speakers to stick to time, and it is now commonplace to hear a warning alarm as the presentation should be nearing its end. Despite this some people run over time. Theoretically, this observation should be evenly distributed among junior and senior speakers, although anecdotally this does not appear to be the case. The objective of this study was to determine the proportion of speakers who overran their allotted time, by grade of speaker.

All individuals giving an oral presentation at the Medical Society for the Study of Venereal Disease (MSSVD) annual spring meeting (2001) were included.

Each speaker was placed into one of three groups:

(1) Juniors (junior doctors, nurses, health advisers, junior scientists)

(2) Consultants

(3) Academic consultants and senior scientists (professors, senior lecturers)

A record was made of each speaker's allotted time (according to the conference programme) and the actual time spent speaking (using a stopwatch). Time given to questions was not included.

Remarks to the speakers about time keeping were noted.

The results are given in the tables

At the start of each session only juniors were reminded of the importance of sticking to time.

### COMMENT

Irrespective of seniority all speakers at academic conferences should limit their presentations to their allotted times. However, both consultants and senior academics were statistically significantly more likely to run over time in their presentations when compared with juniors. There was no evidence of any difference between consultants and senior academics.

Ideally, conferences should promote through presentation and discussion the development of ideas, the ongoing progression of research, and the practical application of such research in the real world. Time is often limited by the amount of material being presented. It is one of the chair's responsibilities to keep oral presentations to time. If talks are allowed to overrun, time for other valued academic pursuits,[1] discussion, and poster observations are consequently shortened.

Wiese *et al*,[2] through a structured instruction programme, improved both the quality and efficiency of oral presentations among a group of medical undergraduates. It is probable that the results in this study are a consequence of similar preparations. Many a speaker will remember as a junior writing and rewriting their talks; and rehearsing their presentation in front of colleagues in an attempt to get it perfect for the conference.

It was also observed at this meeting that chairs reserved their warnings of time keeping and threats of interruption to junior speakers—that is, the group least likely to run over time.

As a result of this study should chairs now concentrate such words on the groups of speakers most likely to run over time?

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REVIEW

# Behavioural surveillance: the value of national coordination

**C A McGarrigle, K A Fenton, O N Gill, G Hughes, D Morgan, B Evans**

*Sex Transm Infect* 2002;**78**:398–405

Behavioural surveillance programmes have enabled the description of population patterns of risk behaviours for STI and HIV transmission and aid in the understanding of how epidemics of STI are generated. They have been instrumental in helping to refine public health interventions and inform the targeting of sexual health promotion and disease control strategies. The formalisation and coordination of behavioural surveillance in England and Wales could optimise our ability to measure the impact of interventions and health promotion strategies on behaviour. This will be particularly useful for monitoring the progress towards specific disease control targets set in the Department of Health's new Sexual Health and HIV Strategy.

Sexually transmitted infections (STI) and HIV result in considerable morbidity and mortality with substantial social and economic cost.[1] They place considerable burden on healthcare resources required for their treatment and prevention as well as long term management required for their sequelae including ectopic pregnancy, cervical cancer, and infertility. STIs are important in their own right but may also be markers for risk of HIV. Teenagers and young adults, women, and some ethnic minority groups are disproportionately affected.[2–5] Sexual behaviour remains the key determinant of STI transmission. Thus, the key indicators for understanding and monitoring transmission rates need to be appropriate for the population and risk group under consideration.

There is evidence of deterioration in sexual health in the United Kingdom. Surveillance data indicate large recent increases in the numbers and rates of bacterial and viral STIs in the United Kingdom. In 2001 there were 673 000 new episodes seen at genitourinary medicine (GUM) clinics in England.[6] New diagnoses of STI between 1996 and 2001 rose by 86% for gonorrhoea, 501% for infectious syphilis, and by 106% for genital chlamydia. The highest numbers of HIV diagnoses were seen in 2001 and there is evidence to suggest that HIV transmission is not slowing.[7] There have also been outbreaks of syphilis in homosexual men, many of whom have HIV.[8 9] These rises have been attributed to increasing high risk sexual behaviour, including unprotected sex and high rates of partner change particularly in young heterosexuals[10 11] and men who have sex with men (MSM).[8 9 12] Data from the National Survey of Sexual Attitudes and Lifestyle (Natsal) confirm this.[13] Similar increases have been seen in western[14 15] and eastern Europe[16 17] and the United States.[18–20] The resurgence of acute STI, the emergence of STI outbreaks among MSM, and concomitant increases in the risk of HIV transmission are cause for concern.

HIV and STI surveillance data in the United Kingdom are useful for monitoring trends in diagnoses. However, they are relatively poor indicators of infection incidence and burden in the population as they are influenced by a number of factors including frequency of symptomatic disease, test sensitivity and uptake, health seeking behaviours, and referral patterns. These factors also limit their usefulness for measuring the success of prevention programmes. Several factors unrelated to prevention programmes can contribute to observed stabilisation or decrease in STI and HIV prevalence in a given setting. These can include mortality, saturation effects in subpopulations at higher risk, differential migration patterns, or sampling bias.

Although disease surveillance data suggest deterioration in sexual health in the United Kingdom since the mid-1990s, they do not provide information on the sexual behaviours or mixing patterns that may be underlying this trend. Public health surveillance of sexual behaviour is needed to measure risk behaviours that will both allow the monitoring of the effectiveness of prevention programmes and may provide early warning signs for the spread of HIV and STIs. This has been achieved in many other countries including some in Asia,[21–23] Africa,[24] Europe,[25] and the United States.[26] Trends over time are needed because while one-off studies can provide useful baseline information trends are necessary for interpretation. The outcome should be timely, relevant, and have high quality data, which can allow those in health promotion and disease prevention to respond effectively to observed changes.[27]

## WHAT IS BEHAVIOURAL SURVEILLANCE?

Behavioural surveillance is the ongoing systematic collection, analysis, and interpretation of behavioural data relevant to understanding trends in the sexual transmission of infection.[28] This should be followed by timely dissemination of these data to those responsible for prevention and control. Knowledge of the size of the population groups at risk, and the nature and determinants of risk within those populations are necessary. Behavioural surveillance generally aims to monitor trends in two broad groups of indicators;

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firstly, those that allow the identification of population subgroups at increased risk—for example, age, sex, sexual orientation, and ethnicity. Secondly, those behaviours that are amenable to change—for example, number and type of sexual partnerships, condom use, unprotected anal intercourse. The validity and reliability of sensitive data on behaviour are critical as they are self reported and can't be directly measured.[29] The triangulation of a small set of core measures selected from surveillance data and other complementary sources can strengthen the interpretation of these data as the relation between sexual behaviour and STI transmission is complex.

Any attempt to establish behavioural surveillance in England and Wales should therefore seek to answer the following questions: which behaviours are important determinants of current STI and HIV transmission? How are these behaviours distributed and how can they be measured over time? What key behavioural data are not currently being collected? How best can these gaps be filled?

## HOW MAY IT BE ACHIEVED?

### General population surveys

Behavioural surveillance is generally conducted at two levels, among the general population and within targeted risk groups. General population surveys are useful in assessing overall trends and distribution of behaviours that may be associated with STI transmission. These provide the most robust estimates of prevalence of behaviours, as they largely avoid the biases inherent in most targeted population surveys. Although regular repeated surveys are needed to measure changes in behaviours over time their expense may make this difficult. Adding additional questions to existing population social surveys is a method that has been successfully deployed in other countries[30] as a cost effective way of getting population based estimates. This has been suggested for collecting sexual behaviour data in the United Kingdom.[29] A large number of surveys are currently carried out which could be used in this way.[31 32] This kind of survey makes it possible to access a general population sample, but does limit the number of questions that can be asked.

General population surveys are usually less suitable for obtaining detailed information on population subgroups at highest risk. These groups tend to be small, more clustered, and difficult to access and small subgroups of individuals with relatively rare risk behaviours may not be captured in sufficient numbers. Groups of particular interest for HIV and STI transmission include homosexual and bisexual men, injecting drug users, commercial sex workers, and ethnic minorities, particularly those from or who have contact with countries with a high HIV/STI prevalence. These problems can be overcome through adapting study designs to include oversampling and focused enumeration.[13]

### Targeted population surveys

Targeted population surveys are also a useful adjunct to these general population surveys as they give greater detail on populations at highest risk. However, the difficulty in accessing these populations makes probability sampling costly. More cost effective sampling strategies are needed; these can include advertising, snowballing, recruiting from GUM clinics, and social and commercial venues. However, these strategies may result in a sample selection bias and decreased representativeness of results. Targeted behavioural surveillance can include serial cross sectional surveys, using the same sampling strategy and using core questions to ascertain the prevalence of risk behaviours.

The disadvantage of targeted population surveys is that they are likely to be unrepresentative, given the nature of the convenience sampling. Those accessed through this mixture of social venues can only be representative of those using these sites. In addition, even among venue attenders the behaviour of study respondents may systematically differ from non-respondents. In order to overcome this problem, surveys from a range of settings are needed, in order to achieve a more representative sample. New and innovative ways of accessing these populations are needed—for example, accessing MSM through internet chatrooms.[33 34] Cross comparability of surveys done in different populations accessed through different means will allow an overview picture of the distribution of behavioural risk within the population under investigation. Questions that will allow the linking of the populations will enhance the interpretation of the individual surveys.[35]

### Behavioural surveillance in England and Wales: assessing the existing capacity

#### Disease surveillance

Current surveillance systems collect limited data on the behavioural determinants of STI transmission. Where they exist they are often limited to facilitate ease of completion by busy clinical staff. Most systems rely on methods more focused on disease outcome, practicality, uniformity, and rapidity rather than on obtaining full demographic and behavioural details. Generally, the additional data collected are minimal (typically age, sex, sexual orientation) (table 1). These allow the grouping of diseases by risk factors, although clearly these are not behaviours amenable to change. Some enhanced surveillance systems have been developed that include more detailed behavioural data to allow the characterisation of those with diagnosed infections[36 37] (table 1) For example, the enhanced KC60 surveillance system will not only allow more risk factor information to be collected on an individual basis, but will also allow rates of co-infection and re-infection of STI to be examined and core groups to be more accurately described.[1 38]

There is comprehensive national surveillance of AIDS cases and diagnosed HIV infections.[39–41] This surveillance system has recently been enhanced, and now clinicians are also asked to report all newly diagnosed HIV infections. The new clinician HIV and AIDS report form collects more behavioural data at the time of first HIV diagnosis (table 1) and provides the most comprehensive picture of all surveillance systems.

The unlinked anonymous HIV seroprevalence surveys provide sentinel HIV prevalence data and have been ongoing since 1990.[42] Limited demographic and behavioural data are collected with the unlinked residual specimens following clinical tests. The surveys cover both those at higher risk of infection, such as homosexual men and heterosexuals attending GUM clinics and injecting drug users attending services, and a more general population sample through monitoring HIV prevalence in over 60% of all pregnant women. The survey of injecting drug users differs in that a voluntary saliva sample is provided with a self completed questionnaire detailing demographic, sexual, and drug injecting behaviour. This survey represents some of the most detailed sexual behaviour data collected within the existing surveillance systems.[43]

Data from the National Blood Service (NBS) provide prevalence information in a lower risk population group, as the criteria for donation excludes those at increased risk of blood borne infections, including men who have had sex with men, those who have ever injected drugs, and those who have had heterosexual contact with high risk partners[44] (table 1). Laboratory reports for confirmed acute hepatitis B are also routinely collected nationally.[45 46]

## BEHAVIOURAL SURVEYS

Table 2 illustrates existing ongoing behavioural surveys carried out by different academic and research groups in Britain. Two general population surveys of adults are currently carried out. The first, Natsal, a probability sample study has been carried out twice a decade apart,[13 47] remains the largest probability sample study of its kind in Britain. The 2000 survey

**Table 1** Data currently available from HIV and STI surveillance—ongoing surveillance

| Name and custodian | Description | Geographical area | Population covered | Time period | Demographic | Behavioural | Biological | Reference |
|---|---|---|---|---|---|---|---|---|
| **Sexually transmitted infection surveillance** | | | | | | | | |
| New episodes seen at genitourinary medicine clinics (KC60). CDSC | Statutory reporting of all episodes diagnosed at GUM clinics | National | All episodes diagnosed at GUM clinics | 1917– | Age group, sex | Sexual orientation (selected diagnoses) | STI diagnosis | 6 |
| Enhanced Surveillance of sexually transmitted infections in England. CDSC | Individual based KC60 by clinic, statutory reporting | London | All individuals attending GUM clinics | 2000– | Age, sex, ethnicity, residence | Sexual orientation, previous STI, coinfections, repeat infections | STI diagnoses | |
| Gonococcal resistance to antimicrobials surveillance programme (GRASP). CDSC | Active, sentinel surveillance system prompted by laboratory referrals of gonococcal isolates to determine the epidemiology of antimicrobial resistance in north. *N gonorrhoeae* in England and Wales. Sampling for 3 months of each year. | 30 GUM clinics | Individuals with antibiotic resistant gonococcol infections | 2000–3 | Age, sex, ethnicity, residence | Sexual orientation, number of sexual partners, region of sex abroad, concurrent STI, previous gonorrhoea | Gonorrhoea, antibiotic resistance, site of infection | 37 |
| Routine laboratory treponemal reporting. CDSC | Laboratory surveillance, additional information completed by clinicians sending specimen. Currently under review. | 6 reference laboratories | All cases of infectious syphilis referred to reference laboratory for confirmation | 1996– | Age, sex, country of birth, ethnicity, source of specimen | Sexual orientation, country where infection acquired and partners infection, pregnancy | Final syphilis diagnosis | 69 |
| Enhanced surveillance for infectious syphilis in the London Region. CDSC. | An enhanced study to monitor the number of cases and associated risk factors for infectious syphilis in London. Established in response to clusters of syphilis in homosexual men. | London | All cases of infectious syphilis (primary, secondary, and early latent) diagnosed at GUM clinics | April 2001– | Sex, age, county of birth, ethnicity | Sexual orientation, relevant social networks, reason for attending, number of sexual partners, where infection likely acquired, commercial sex workers | Stage of infection, HIV status (if known) | 36 |
| **HIV infection surveillance** | | | | | | | | |
| HIV laboratory reports. CDSC | Reporting system from laboratories | National | All newly diagnosed HIV infections | 1985– | Sex, age, ethnicity | Likely route of infection and location of infection if acquired heterosexually. Previous negative tests. | HIV-1/2 infection | 39 |
| AIDS case reports. CDSC | Reporting system from clinicians | National | All newly diagnosed AIDS cases | 1985–99 | Sex, age, ethnicity, country of birth | Likely route of infection and location of infection if this is ongoing heterosexual spread. Previous negative tests | AIDS case diagnoses. Pre-AIDS ARV treatment | 39 |
| Clinician HIV reporting. CDSC | Reporting system from clinicians | National | All newly diagnosed HIV infections | 2000– | Sex age, ethnicity, country of birth, date of entry to UK | Various, depending on likely route of infection., including year of first sex, previous HIV tests, GUM clinic attendance and pregnancy history. | AIDS case diagnoses. Pre-AIDS ARV treatment | 39 |
| HIV infection route follow up. CDSC | Investigation, to interview where necessary of all newly diagnosed infections with no identified risk factor for HIV, to establish likely route of infection, or confirm ongoing heterosexual transmission in UK. | National | Newly diagnosed HIV infections reported with no identified likely route of infection | 1991– | Sex age, ethnicity, country of birth, date of entry to UK, marital status | Detailed sexual behaviour, including previous STI and HIV test behaviour | HIV diagnosis | 40 |
| Survey of prevalent HIV infections diagnosed (SOPHID). CDSC | Annual cross sectional survey of all HIV diagnosed individuals receiving care | National | Prevalent diagnosed HIV infections | 1995– | Sex, age, ethnicity | Likely route of infection | CD4 count, level of antiretroviral therapy | 41 |
| Unlinked anonymous survey of dried blood spots. CDSC | Repeated cross sectional survey unlinking and testing residual infant blood collected for metabolic testing for maternal HIV antibody | National (6 regions) | Pregnant women giving birth | 1992– | Age, ethnicity, country of birth, area of residence | | Infant blood tested for maternal HIV antibody | 42 |

**Table 1** continued

| Name and custodian | Description | Geographical area | Population covered | Time period | Demographic | Behavioural | Biological | Reference |
|---|---|---|---|---|---|---|---|---|
| Unlinked anonymous survey of GUM clinic attenders. CDSC | Repeated cross sectional survey unlinking and testing residual blood for HIV | Sentinel (15 GUM clinics) | GUM clinic attenders receiving syphilis testing | 1990– | Sex age, country of birth | Sexual orientation, STI diagnoses at visit, last HIV negative test | Serum sample tested for HIV, STI diagnoses | 42 |
| Unlinked anonymous survey of injecting drug users. CDSC | Repeated voluntary anonymous cross sectional survey with self completed questionnaire and saliva sample | Sentinel | Injecting drug users contacting services | 1990– | Sex, age | Sexual orientation number of sexual partners, condom use, drug injecting practices, previous HIV test | Saliva tested for HIV, hepatitis B and C | 42 |
| Blood (and tissue) donations. National Blood Service | Testing of all donations. Detailed information collected for all confirmed positives | National | Population selected to donate blood (and tissues) | 1995– (HIV 1986– HCV 1991) | Sex, age, ethnicity, country of birth, region of residence | Possible exposures to infection and location and time. Details of high risk partners, if heterosexual. Previous negative tests | HIV, HBV, HCV and *T pallidum* | 44 |
| Antenatal screening. National Blood Service | Antenatal screening of pregnant women carried out by the National Blood Service | Selected areas | Pregnant women | HBV 2000– HIV 2001– | Age, ethnicity, region | | HIV, HBV | 44 |
| Laboratory reports of acute hepatitis. CDSC | Laboratory reports of acute hepatitis B | National | Laboratory confirmed acute hepatitis | 1985– | Sex, age | Sexual orientation | HBV | 45, 46 |

also collected and tested urine samples for genital *Chlamydia trachomatis* using ligase chain reaction (LCR) techniques to provide the first national prevalence estimates.[48] The second, the Omnibus survey is a multipurpose survey of the adult population routinely carried out by the Office for National Statistics. A module on contraceptive use and general sexual health including condom use has been included annually since 1997[49] (table 2).

A national survey of young people is currently being carried out by the Teenage Pregnancy Unit, as part of an evaluation of the teenage pregnancy strategy (table 2). An individual based tracking survey will be repeated three times a year to collect information from young people aged 13–21 and parents of young people aged 10–17 over a 3 year period. It will collect information on knowledge, attitudes, and behaviours around sex and relationships.[50]

A number of annual surveys of homosexual men attending social venues,[51–53] GUM clinics,[51] and Gay Pride events[54] are currently carried out (table 2). These use a stable set of behavioural indicators that can be monitored repeatedly. The three surveys developed and used a common set of core behaviour questions that allow comparisons of the three populations of MSM. A number of other surveys of injecting drug users[55 56] and among ethnic minorities[2 4 57 58] have also been carried out but none have been sustained. There is clearly a need for more ongoing investment and support to continue projects once established.

## HOW DO WE USE BEHAVIOURAL DATA?

Behavioural surveillance data can be used in a number of ways. They can allow the monitoring of the risk behaviours underlying HIV and STI transmission over time. UNAIDS has recommended that behavioural data collection should be a central part of HIV and STI surveillance programmes.[28 59]

A range of indicators can be used to measure the effectiveness of both HIV and STI prevention interventions in England and Wales. These include the behavioural determinants of disease transmission (for example, condom use, reported sexual partnerships) as well as disease incidence and prevalence in England and Wales. These "prevention indicators" have been developed to monitor four key areas relevant to HIV transmission and disease prevention and include HIV prevalence, HIV incidence, risk behaviour, and healthcare utilisation.[42] The indicators for monitoring the success (or failure) of HIV prevention in men who have sex with men are illustrated in table 3. Similar indicators have been used elsewhere,[25 26 60] although the use of behaviour change as a proxy marker for STI incidence has raised debate.[61 62] The disproportionate effect of some factors on the transmission dynamics of STI means that reported risk behaviour doesn't entirely correlate with transmission. The role of sexual networks in transmission is important and behavioural surveillance cannot always measure these. Prevention indicators have been evaluated in a number of settings, however, and found to be useful for measuring the success of prevention programmes, although multiple sources of data are necessary to provide context.[63] This in turn facilitates more effective HIV prevention and community planning. Prevention indicators may be developed using a variety of available data within ongoing surveillance systems. This allows the interpretation of HIV and STI trends within different population groups, and through the monitoring of risk behaviours, can indicate when outbreaks of infection may occur.[64]

A potential research priority highlighted in the new national strategy for sexual health and HIV was a need for better understanding of the sexual networks, health seeking behaviour, and risk behaviour of targeted groups.[65] The monitoring of behavioural indicators within different population groups would provide data on both health seeking behaviours

**Table 2** Behavioural surveillance data currently available from external academic and research groups,—ongoing surveillance

| Name and custodian | Description | Geographical area | Population covered | Time period | Demographic | Behavioural | Biological | Reference |
|---|---|---|---|---|---|---|---|---|
| National Survey of Sexual Attitudes and lifestyles (I and II). Department of STD Royal Free and University College Medical School. | A survey of sexual attitudes and lifestyles in British population, using stratified probability sample of men and women aged 16–44. Interviews using CAPI and CASI | National | General population, 11161 surveyed | 2000 | Ethnic, socioeconomic, and demographic data | Sexual behaviour and attitudes, including partner formation, sexual mixing and STI acquisition | Urine sample tested for chlamydia | 13 |
| Omnibus Study, Office for National Statistics. | Multipurpose survey of population. Interviewing carried out each month; questions cover a variety of topics reflecting different users requirements. Random probability sample of 3000 private households selected monthly using postcode address file as sampling frame. Uses CAPI | National | General population, adults aged 16 and over | 1997– | Age, ethnicity, residence | Contraception, condom use, sexual orientation, number of sexual partners in past year, knowledge of STIs | | 49 |
| Evaluation of teenage pregnancy strategy. Tracking survey. Teenage pregnancy unit. London School of Hygiene and Tropical Medicine, University College London and BMRB Social Research. | Individual based tracking survey of knowledge attitudes and behaviour, using random location sampling. Fieldwork included 200 sampling panels in England using areas with higher density of 13–44 year olds. Interviews using CAPI, and self completion for sex questions | National | 12150 young people (aged 13–21) and parents of young people (aged 10–17). | Oct 2000– March 2003 | Age, sex, socioeconomic status | Knowledge attitudes and behaviour around sex and relationships and impact of awareness of teenage pregnancy strategy's media campaign | | 50 |
| Gay Men's Sexual Health Survey. Department of Sexually Transmitted Diseases. Royal Free and University College Medical School. | Repeated cross sectional survey to estimate prevalence of high risk sexual behaviour among homo/bisexual men in London. Sites selected to be representative of GUM clinics and commercial venues. Original sampling frame defined using a register of all known primarily gay venues in London | Inner London, Brighton and Manchester in 2000 | Homosexual men resident, socialising or using sexual health services in London | 1996– | Age, ethnicity, residence, education and employment and health service use including perceived HIV status and HIV testing history. | Number of sexual partners, age of first anal intercourse, age of last sex partner, condom use and HIV status of UAI partners | Saliva sample, tested for HIV, since 2000 | 51 |
| Gay Men's Sex Survey. Sigma Research. | Repeated cross sectional survey of homo/bisexual men. Self completed questionnaire. Questions vary by city, but set of core questions collected through the study period. Additional recruitment has been done through HIV health promotion agencies and free gay newspaper | National (7 cities) | Homo/bisexual men attending Gay Pride festivals and events | 1993– (excluding 1996) | Age, ethnicity, education, residence, health service use including previous HIV tests, perceived HIV status and previous STIs | Sexual behaviour and attitudes including condom use, number of partners, serostatus of partners | | 54 |
| The 4 Gym Study. Camden and Islington Community Health Services NHS Trust and The Royal Free Hospital School of Medicine | Repeated cross sectional questionnaire survey of MSM attending gyms, including peer education evaluation | Inner London | Homosexual men attending 5 gyms in inner London | 1997– | Age, residence, ethnicity, education | Sexual orientation, drug use, last HIV test, number of sexual partners, HIV status of partners | | 52 |
| Royal Free Hampstead NHS Trust Hospital | Repeated cross sectional questionnaire survey of all attending for HIV tests within a period of time. Investigates the sexual behaviours of those seeking HIV tests Comparison of behaviours of first testers with repeat testers. | One London HIV testing clinic | Population attending HIV testing clinic including heterosexuals and homosexuals | 1995–6, 1998–9, 2002–3 | Age, ethnicity, residence, education | Number of sexual partners, health care use, previous HIV tests, reason for tests | HIV test result | 70 |

**Table 3** Prevention indicators for HIV and hepatitis transmission in homo/bisexual men

| | Area | Subcategory | |
|---|---|---|---|
| **Prevalence markers** | | | |
| New diagnoses of HIV infections | UK | <25 | |
| | | >25 | |
| | | Total | |
| Prevalent diagnosed HIV infections receiving care | England | All | |
| First HIV tests at six sentinel laboratories | England | Total | |
| | | Proportion positive | |
| Prevalence of previously undiagnosed HIV infection in GUM clinic attenders† | London | <25 | |
| | Elsewhere in England and Wales | <25 | |
| **Incidence markers** | | | |
| Median age at diagnosis of HIV infection | UK | All | |
| Median CD4 counts at year of HIV infection diagnosis‡ | England and Wales | <25 | |
| | | >25 | |
| Laboratory reports of acute hepatitis B acquired through sex between men | England and Wales | All | |
| **Markers of risk** | | | |
| Homosexually acquired gonorrhoea | England and Wales | All | |
| Acute STI in HIV positive GUM clinic attenders | England and Wales | Known positive | Proportion with STI |
| | | | Number with STI |
| | | | Total |
| Percentage reporting unprotected anal intercourse in the past year | London | Any partners | |
| | | Partners of unknown or serodiscordant HIV status | |
| **Markers of healthcare utilisation** | | | |
| Attending GUM clinic in the past year | London | Proportion | |
| | | Number | |
| Having an HIV test in the past year | London | Proportion | |
| | | Number | |
| HIV tests carried out at GUM clinics§ | England and Wales | Number | |

†Undiagnosed before the clinic attendance.
‡Mean CD4 count.
§HIV testing with counselling: new episodes seen at genitourinary medicine clinics.

and risk behaviours. Behavioural surveillance could also measure progress towards increased HIV testing of GUM clinic attendees through monitoring HIV testing patterns in different population groups.

Finally, behavioural surveillance data will enable us to identify priority areas for further in-depth epidemiological or socioanthropological research. Much of this research should be developed in collaboration with local academic and service partners in the most vulnerable areas or population groups.

## WHAT ARE OUR OPTIONS?

Behavioural surveillance programmes have now been implemented in the United States,[26 66] Switzerland,[25] Australia, and Hong Kong.[67] The United States has formed a HIV/STD Behavioural Surveillance Working Group to build and maintain a behavioural surveillance system for HIV and STI. They have achieved this through developing standardised measures of risk behaviours for comparability of data across systems and used these in monitoring a combination of general population, at-risk populations, and infected populations. Modules of questions have been provided at the national level for states to use as appropriate.[66] In addition, HIV prevention indicators have been developed, which have set out specific indicators suitable for monitoring at state and local level. Collection of data for these is coordinated at local level.

Canada has similarly combined national behaviour telephone surveys with more targeted behavioural surveys in homosexual men and injecting drug users (IDU) although they have not established nationally standardised modules of questions. Australia has used a combination of targeted behavioural surveys in MSM and IDU, from which key indicators are coordinated nationally with HIV surveillance and incidence data. They are currently moving towards national coordination of STI surveillance,[68] and the development of a coordinated national approach to collection of behavioural risk factor data. The first national survey of sexual health and sexual behaviour and attitudes administered through telephone interview is currently being carried out. Hong Kong has established a behavioural surveillance system, carrying out an annual general population survey of sexual behaviour in men aged 18–60 using a combination of personal interview and a prerecorded telephone interview using a mobile phone.[23]

A combination of approaches could be used in England and Wales. A behavioural surveillance unit (BSU) within the HIV and STI Division has now been established at the Communicable Disease Surveillance Centre (CDSC). In association with key external partners the unit aims to collate data derived from ongoing local and national sexual behavioural surveillance and research programmes within CDSC and outside.

The BSU will streamline current behavioural data collection through existing surveillance systems. Collaborative partnerships with academic and research institutions involved in behavioural research will be established to define and collate key behavioural indicators relevant to HIV and other STI transmission. These indicators will include sexual behaviours such as number of sexual partners, types of sexual intercourse (vaginal, anal, and oral), and potentially preventative behaviours such as condom use and health service use for HIV and other STI screening. This would give an overview of behaviours at the population level in both the general population and in those with disease. A surveillance system, which will allow the prospective monitoring of the important risk indicators, could then be established.

A set of core questions will be established, which will draw on existing validated questions used in a variety of studies. This will enable improved comparability of data from diverse sources, at both national and local level. It will provide a comprehensive picture of sexual health, which can be monitored over time.

**Key points**

- Surveillance data show large recent rises in STIs in the UK but lack details on the sexual behaviours and mixing patterns underlying these trends
- Behavioural surveillance has successfully monitored the effectiveness of prevention programmes internationally
- Key indicators will be produced from the wealth of existing disease and behavioural survey data available
- The impact of interventions and health promotion strategies on behaviour in England and Wales can be measured using these indicators

As a secondary, longer term objective, the BSU will work towards developing new behavioural surveillance systems for monitoring groups where there are currently inadequate data. Specially designed studies will be developed to complete the knowledge gaps—for example, in primary care and in ethnic minorities, where data cannot be obtained through enhancing existing systems. Again this is likely to be best achieved in partnership with external collaborators.

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