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Is elimination of cervical cancer in sight in England?

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ABSTRACT

Objective: The age-standardised rate of cervical cancer is 8.5 per 100,000 in England, double the WHO "elimination" goal of 4.0 per 100,000, despite England being close to the target coverage for both HPV vaccination and cervical screening. Our aim was to see whether trends in mortality and incidence rates suggest that England is on the path to elimination.

Methods: We discuss trends in mortality since 1953 by birth cohort, and cancer and cancer-in-situ incidence since 2000 by age group in relation to screening and vaccination.

Results: Mortality trends suggest a steep decline in HPV prevalence from women born in the 1880s to those born in the 1930s followed by a continuing increase. Cancer incidence and mortality then fell steeply after the introduction of national screening in 1988. Since 2004 women were invited for their first screen at age 25. From 2000-2004 to 2010-2014 invasive cancer incidence at age 25–29 doubled and mortality increased by 77 %. From 2015 to 2022 cervical cancer incidence fell by 90 % below age 25 and by 80 % at age 25–29 following the introduction of HPV vaccination for girls born since 1991.

Conclusions: Raising the age of starting screening from 20 to 25 transiently increased incidence and mortality in women born 1984-1990. Vaccination may enable the NHS to reach its target for cervical cancer incidence of 4.0 per 100,000 by 2040. Whether the switch from cytology to primary HPV testing in 2019 will reduce rates among unvaccinated women born before 1991 is not yet clear.

1. Introduction

The World Health Organisation (WHO) considers cervical cancer to be eliminated as a public health problem when the incidence rate falls below 4.0 per 100,000, and suggests this will require vaccinating at least 90 % of girls and screening at least 70 % of women twice in their lifetime with a high performance test (i.e. HPV screening) (WHO, 2020). NHS England has pledged to achieve this by 2040 (NHS England, 2023). In 2023 83.3 % of girls aged 15–16 years had received the HPV vaccine (UKHSA, 2024), and screening coverage, though lower than pre-pandemic levels, was 69 % (NHS Digital, 2023), but the age-standardised incidence rate is still 8.5 per 100,000. We examined mortality and incidence trends within birth cohorts and age groups to see whether England is on the path to the WHO's "elimination" goal.

2. Methods

Mortality rates with cervical cancer (ICD C53) as the underlying cause for England and Wales (ONS, 2006–2022) were grouped into 5-year periods from 1953 to 57 to 2018–2022 and 5-year age-groups from 20 to 24 to 80–84 years giving synthetic birth cohorts centred at 5-year intervals from 1883 to 1993. Cancer registration rates for England were published by the Office for National Statistics (ONS, 2004-2017) and subsequently by NHS Digital (NHS Digital, 2019-2021). Changes in screening policy or screening coverage are quickly reflected in cancer registration statistics, so we collated annual rates by age group from 2000 to 2022 for invasive cervical cancer and for cancer-in-situ of the cervix (ICD D06). We discuss the issues that may have affected changes in registration rates over the past 20 years, particularly in younger women.

This research is based on publicly available data and is therefore exempt from ethical review.

3. Results

Fig. 1 shows cervical cancer death rates by birth cohort in England and Wales from 1953 to 2022. The cohorts have been divided into 3 groups; note the changing scale used on the graphs as the death rate has

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reduced in later birth cohorts. Fig. 1a shows a flattening of rates after age 50 for largely unscreened birth cohorts (born from 1883 to 1903). The death rate at age 75–84 fell from 33 per 100,000 in the 1883 birth cohort, who were aged 17 in 1900, to 16 per 100,000 in the 1918 cohort, who were aged 17 in 1935 (Fig. 1a). Fig. 1b shows birth cohorts from 1923 to 1963 who were invited for screening as part of the NHS Cervical Screening Programme, which began in 1988. The arrows show the age of each birth cohort at first invitation in 1988. The cohort death rate at age 40–44 halved from 13 per 100,000 in the 1918 cohort to 6.5 in the 1933 cohort, who were aged 17 in 1950. However, rates increased among younger women from 1.6 per 100,000 at age 30–34 in the 1933 cohort to 4.4 per 100,00 in the 1953 cohort (Fig. 1b). Fig. 1c shows later birth cohorts, who were offered screening from age 20, then from age 25 for women born since 1984. Their mortality rates are substantially lower than previous birth cohorts.

Fig. 2 shows age-specific incidence rates for cervical cancer (Fig. 2a) and cervical cancer in-situ (Fig. 2b) in England from 2000 to 2022. Different patterns are seen for invasive cancer and cancer-in-situ, notably that cancer-in-situ diagnoses become increasingly rare after age 40. There are no marked trends above age 30 apart from a slight continuing increase in cancer incidence rates in women aged 30–49. Possible reasons for the extraordinary and abrupt changes in women aged 20–24 and 25–29 are discussed below.

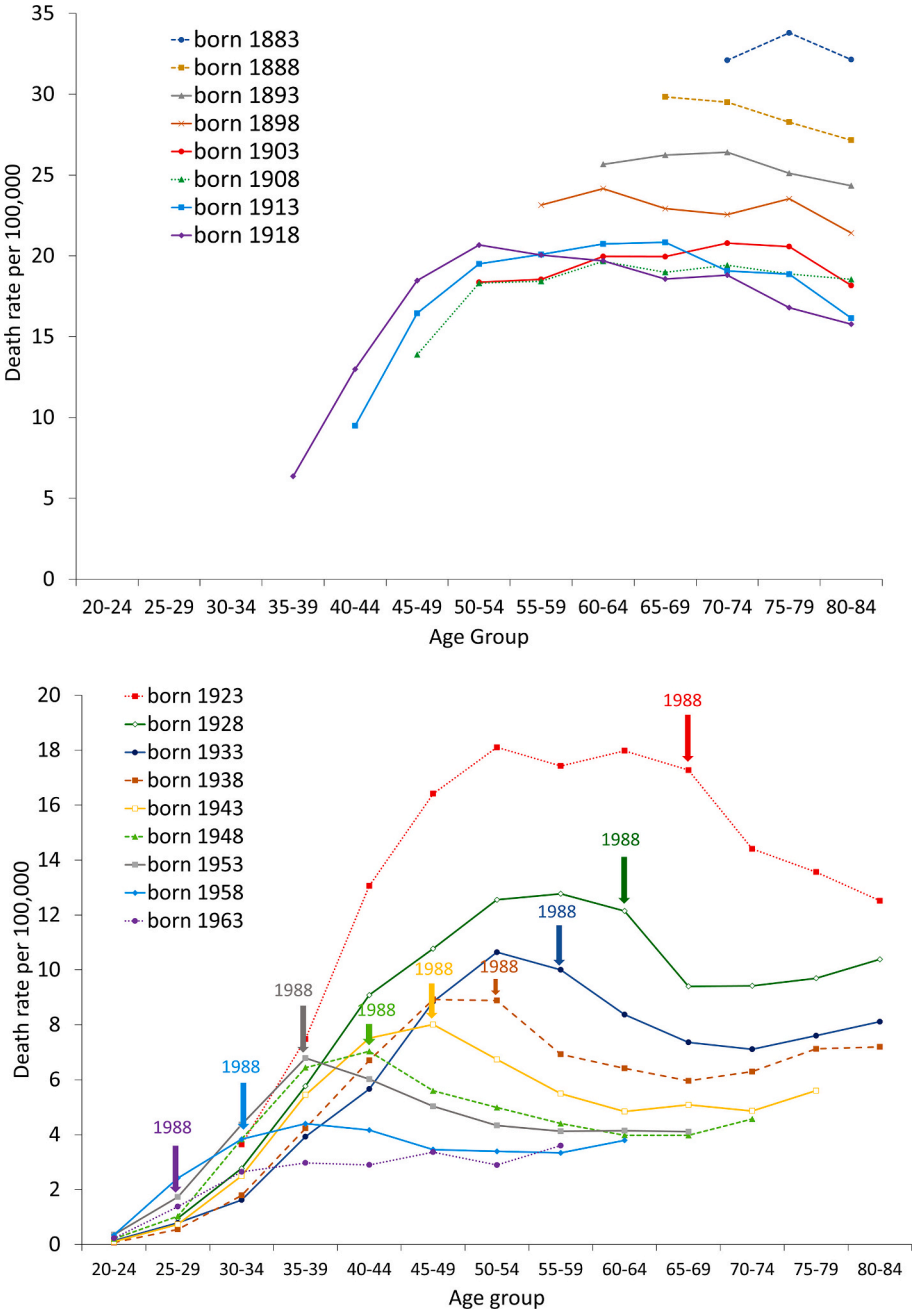

Fig. 1. Cervical cancer death rates by birth cohort for women (England and Wales, 1953–2022). Note the changing scale used on the graphs as the death rate has reduced in later birth cohorts.
1a: 1883-1918 birth cohorts. Women who were not invited for screening within the organised screening programme.
1b: 1923-1963 birth cohorts. Women who were first invited for screening within the organised screening programme at various ages indicated by the arrows (1988).
1c: 1968-1993 birth cohorts. Women were invited for screening from age 20 (until 2004 - born before 1984) or from age 25 (born since 1984).

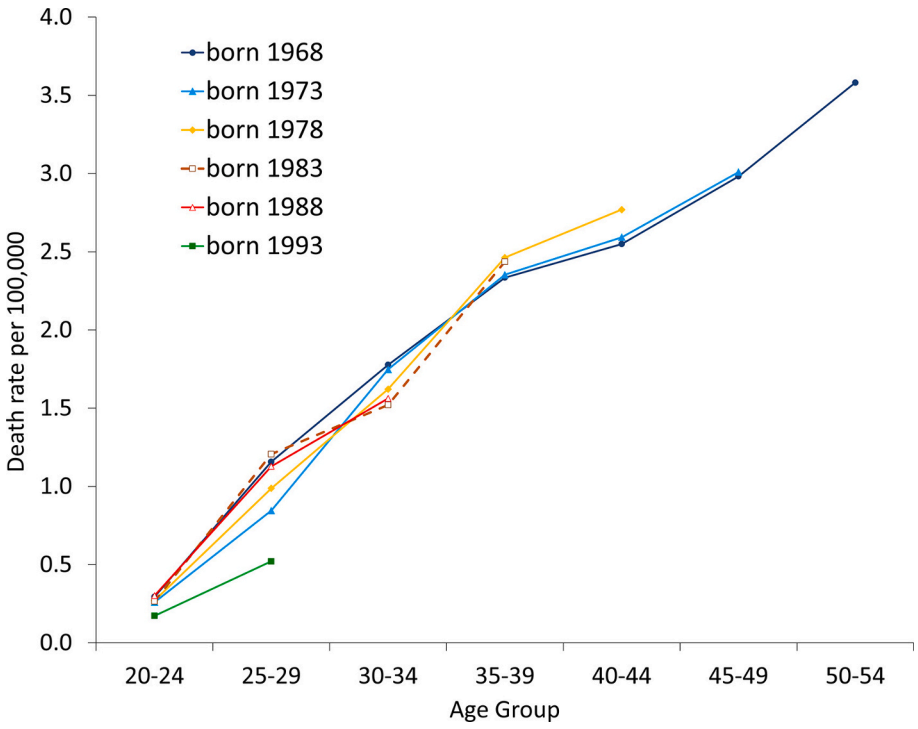

Fig. 1. (*continued*).

4. Discussion

The falling cervical cancer mortality in the 1883–1933 birth cohorts, which predated widespread screening, suggests that HPV infection in young women may have been 3–4 times more common in 1900 than in 1950, although improvements in treatment and awareness may also be a factor. The rate then rose rapidly in young women, presumably due to increasing HPV infection rates and earlier age of first intercourse, and by 1988 England had one of the highest incidence rates in the world in women aged under 35 (Peto et al., 2004). The NHS offered opportunistic cervical screening from the 1960s and national roll-out of the organised call-recall programme was completed in 1988, when all women aged 20 to 64 were invited for screening every 3–5 years. This reversed the rising trend and within 15 years the annual number of deaths was halved. The NHS Cervical Screening Programme was even more successful than these data suggest, as the rising rates in younger birth cohorts might in the absence of screening have resulted in up to 6000 deaths per year (Peto et al., 2004). Death rates have been much lower in women born since 1968 who were offered screening from age 20, or from age 25 for those born since 1984 (Fig. 1c). Screening reduces cervical cancer incidence through detection and treatment of premalignant disease, but the effect on mortality is even greater because many cancers are screen-detected at stage 2 or less. National mortality rates are not adjusted for hysterectomy. Redburn & Murphy (Redburn and Murphy, 2001) estimated that 20 % of women born in 1922 and 28 % of those born in 1942 had a hysterectomy, reducing the mortality rate among women aged over 70 by almost a third. In the US almost half of all women aged 70 have had a hysterectomy (Rositch et al., 2014).

The virtually constant death rate after age 50 and the rapid increase up to age 50 seen in each birth cohort born before the 1920s (Fig. 1a) reflects the natural history of cervical cancer in the absence of screening (Peto et al., 2004). After the roll-out of national screening in 1988 mortality rates began to decline sharply in every birth cohort then aged over 35 and increased less steeply in younger women (Fig. 1b), but increased after age 65 when screening stops and an increasing proportion of cervical cancers are diagnosed at stage 2 or above (PHE, 2011). Women born before the mid-1950s were screened only with cytology and were discharged from the Cervical Screening Programme without ever having an HPV test. We have argued for a national catch-up to offer HPV testing to these women (Gilham et al., 2021) and are currently piloting an at-home urine HPV test in those aged 65–79 who ceased screening before the introduction of primary HPV testing in 2019.

4.1. Age at starting screening

Before national screening began in 1988 cancer mortality in every birth cohort born from 1938 to 1958 was higher than in the cohort born 5 years earlier, presumably reflecting rising HPV prevalence. In each case the effect of beginning screening 5 years earlier was so large that their risks were reversed, showing that screening should begin before age 30. After 2004, when the age at first invitation was raised from 20 to 25, cancer-in-situ diagnosis rates among women aged 20–24 declined sharply followed by steep increases in both cancer-in-situ and invasive cancer at age 25–29 in women born after 1984. The justification for raising the age at first invitation from 20 to 25, that progressing lesions will still be screen-detectable (Sasieni et al., 2003), ignores the risks of progression of cancer-in-situ to cancer and of stage 1 cancer to stage 2+. The incidence rate per 100,000 at age 25–29 doubled from 96 in 2000–2004 to 199 in 2010–2014 and the mortality rate at age 25–29 increased by 77 % from 7.5 (64 deaths in 2000–2004) to 13.3 (128 deaths in 2010–2014). The increase in stage 2+ cancers has been noted previously (Castanon and Sasieni, 2018) and a recent analysis restricted to data since 2006 confirms that most of the increase in cancer incidence in women born since 1984 was diagnosed when they were first screened around the age of 25 (Falcaro et al., 2025), but the increase in mortality seems to have been overlooked. The marked effect of younger age at starting screening on mortality in successive earlier cohorts indicates that these transient large increases in incidence and mortality below age 30 were caused mainly by raising the screening age from 20 to 25, although the slowly rising trend in cancer incidence since 2000 among women in their 30s and 40s suggests that a continuing increase in HPV prevalence in successive birth cohorts also contributed.

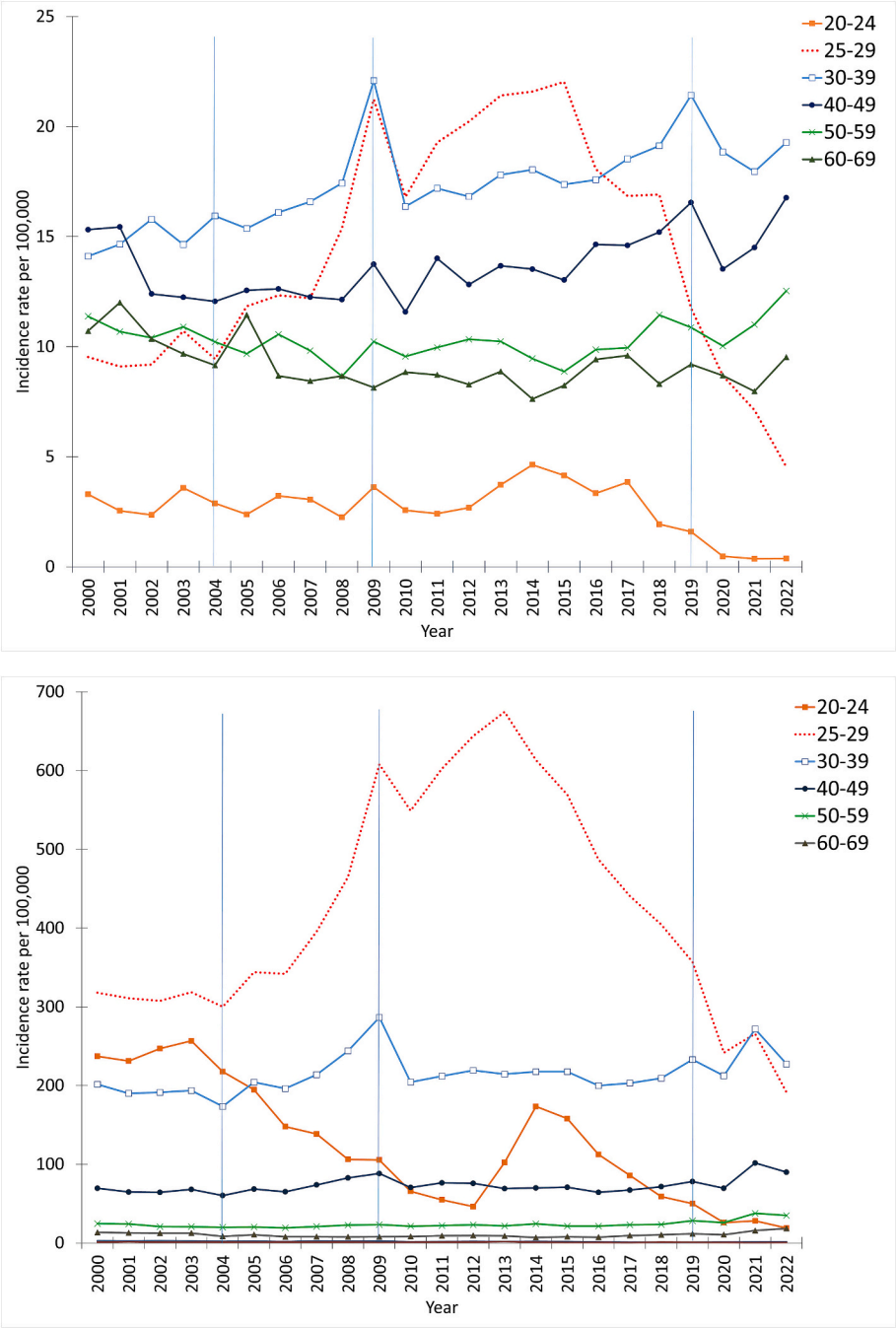

Fig. 2. Cervical cancer and cancer-in-situ incidence rates in England, 2000–2022 by age group. Vertical lines indicate the years 2004, 2009 and 2019.
2a Cervical cancer incidence rates.
2b Cervical cancer-in-situ incidence rates.

4.2. Other changes since 2000

Steep increases in cancer-in-situ and invasive cancer diagnoses at age 20–24 from 2012 to 2014 and matching decreases from 2013 to 2015 at age 25–29 followed the reduction in 2012 in the age at first invitation from 25 to 24.5, reflecting transfer of screen-detected cancers between these age groups (Castanon and Sasieni, 2018). Cancer-in-situ and cancer diagnoses increased transiently in 2009 (Fig. 2) when attendance increased following the widely publicized death of a 27-year-old celebrity from cervical cancer (Castanon and Sasieni, 2018). The small increase in cancer incidence in 2019 at age 30–49 coincided with the introduction of primary HPV testing. Follow-up of the English pilot data has shown that HPV screening with cytology triage detects disease earlier than cytology screening with HPV triage, but with little difference in cumulative risks over two rounds of screening (Rebolj et al., 2022). Rates since 2020 are distorted by the temporary suspension of the NHS Cervical Screening Programme during the Covid-19 pandemic followed by a drop in attendance (NHS Digital, 2023). This may explain the drop in cancer diagnoses in 2020 followed by increases in 2021 and 2022. It is thus too early to assess the impact of primary HPV testing.

4.3. Vaccination

The school-based HPV vaccination programme for 12–13 year old

girls began in 2008 and included a catch-up programme for girls aged 17–19 in 2008–09 for those born after September 1990. Cancer-in-situ and invasive cancer incidence rates among women aged under 30 have decreased steeply since 2015 as the proportion who were vaccinated increases. The effects of vaccination are seen in the first women who were vaccinated aged 18–19 with a single dose coverage of 66.1 % (UKHSA, 2010) attended screening for the first time. The death rate fell sharply in the 1993 birth cohort (Fig. 1c), and a more detailed analysis estimated an 86 % reduction in invasive cervical cancer and 96 % reduction in cancer-in-situ between 2006 and 2020 among later birth cohorts who were vaccinated at age 12–13 compared to the last cohort of women who were not offered vaccination (Falcaro et al., 2024). These reductions include the additional effects of herd immunity and cross-protection from non-vaccine HPV types. Virtual elimination of the vaccine HPV types is thought to be possible with long-standing vaccination coverage above 80 % in girls only (Brisson et al., 2016). The minority of those born since 1991, who were not vaccinated and unfortunately cannot be identified via cervical screening records, will presumably remain at higher lifetime risk due to exposure through sexual contacts from older cohorts or from other countries.

The age-standardised cervical cancer incidence rate in 2022 among English women was 8.5 per 100,000. Assuming no change in the effect of screening, aging of vaccinated cohorts alone is likely to result in the incidence rate in England dropping to about 4.0 per 100,000 by 2040 as per the NHS target. However, the trends in age-specific incidence rates among women born before 1991 suggest that their rate is unlikely to fall below 10 per 100,000 unless the introduction of primary HPV testing increases the effectiveness of the NHS Cervical Screening Programme.

5. Conclusions

The NHS cervical cancer "elimination" target of 4.0 per 100,000 may be reached by 2040 because of the dramatic reduction in cervical cancer rates among women born since 1991 who have been offered HPV vaccination. However, cancer rates in women born before 1991 have slightly increased over the last 20 years. Cervical cancer is likely to become so rare among vaccinated cohorts that the NHS Cervical Screening Programme will not be cost effective unless women born after 1990 are screened less frequently. Women vaccinated against 2 oncogenic types (those born 1991–2008) will still require some screening, possibly 2 or 3 times per lifetime (Landy et al., 2018), and it is important for vaccinated women to understand that their risk is not zero. Both vaccinated and unvaccinated women should be managed with an individualised risk-based approach for the Cervical Screening Programme to remain efficacious which will require linkage of vaccination and screening records.

CRediT authorship contribution statement

Clare Gilham: Writing – review & editing, Writing – original draft, Conceptualization. **Julian Peto:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

All data used are in the public domain and freely available online.

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