Title: High-risk human papillomavirus (HPV) infection and cervical cancer prevention in Britain: Evidence of differential uptake of interventions from a probability survey

Running title: Uptake of cervical cancer prevention programmes in Britain

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Background: The third British National Survey of Sexual Attitudes and Lifestyles (Natsal-3) provides an opportunity to explore high-risk human papillomavirus (HR-HPV), and uptake of cervical screening and HPV vaccination in the general population.

Methods: Natsal-3, a probability sample survey of men and women aged 16-74, resident in Britain, interviewed 8869 women in 2010-12. We explored risk factors for HR-HPV (in urine from 2569 sexually-experienced women aged 16-44), non-attendance for cervical screening in the past 5 years and non-completion of HPV catch-up vaccination.

Results: HR-HPV was associated with increasing numbers of lifetime partners, younger age, increasing area-level deprivation and smoking. Screening non-attendance was associated with younger and older age, increasing area-level deprivation (age-adjusted odds ratio 1.91, 95% confidence interval, 1.48 to 2.47 for living in most vs. least deprived two quintiles), Asian/Asian British ethnicity (1.96, 1.32 to 2.90), smoking (1.97, 1.57 to 2.47) and reporting no partner in the past 5 years (2.45, 1.67 to 3.61 vs. 1 partner) but not with HR-HPV (1.35, 0.79 to 2.31). Lower uptake of HPV catch-up vaccination was associated with increasing area-level deprivation, non-white ethnicity, smoking and increasing lifetime partners.

Conclusions: Socio-economic markers and smoking were associated with HR-HPV positivity, non-attendance for cervical screening and non-completion of catch-up HPV vaccination.

Impact: The cervical screening programme needs to engage those missing HPV catch-up vaccination to avoid a potential widening of cervical cancer disparities in these cohorts. As some screening non-attenders are at low-risk for HR-HPV, tailored approaches may be appropriate to increase screening among higher-risk women.

Introduction

In over 99% of cases, cervical cancer is associated with persistent infection with one or more high-risk human papilloma virus (HR-HPV) genotypes (1). Every year in Britain approximately 2,900 women are diagnosed with cervical cancer (2) and it is the most common cancer in women under 35 years (3). Worldwide the burden of cervical cancer varies substantially and 85% of cases occur in low-to-middle income countries (4). In many high-income countries, including Britain, incidence and mortality have decreased over the past few decades, since the introduction of cervical cancer screening programmes (5). In Britain, cervical screening uptake is high (around 80%) (6) but cervical cancer incidence and mortality are higher in more deprived areas (7,8). The two recent Cancer Reform Strategies (2011 and 2007) (9,10) have highlighted the need to reduce these inequalities. Understanding the burden of HR-HPV prevalence and uptake of cervical cancer prevention programmes (HPV immunisation and cervical screening) will help address this aim.

In Britain, there have been two recent notable changes in cervical cancer control. First, since 1996, increases in cervical cancer incidence have been seen in women aged 20-29 years (11), among whom screening uptake is lower and declining (12). Changes in both smoking and sexual behaviour may be contributing to the upward trend (11). Second, in September 2008, the UK introduced a school-based HPV immunisation programme against HPV-16/18 (the types associated with over 70% of cervical cancers) for girls aged 12 years which has achieved a fairly uniformly high uptake (>80% from 2008-12) (13). A catch-up programme was implemented in schools and general practice over the first few years for girls aged up to 18 years. Coverage in these catch-up cohorts was lower and more variable (13) and showed some tendency to be lower in more deprived areas (14)(15)(16). We have already reported that Britain's third National Survey of Sexual Attitudes and Lifestyles (Natsal-3) found that women with more partners and those living in more deprived areas were less likely to complete the catch-up immunisation schedule (17).

If non-participation in cervical screening and HPV immunisation is not independent or participation is lower amongst individuals at risk of HR-HPV infection, their effectiveness may be limited. Natsal-3 provides an opportunity, unique in Britain, to explore individual-level data on participation in cervical screening and HPV immunisation in relation to detailed demographic characteristics, sexual behaviours and the presence of HR-HPV and to explore overlap between risk factors for HR-HPV infection and participation in prevention programmes and thus to inform the provision of future services.

Materials and Methods

Participants & procedure

Natsal-3 is a stratified probability sample survey of 8869 women and 6293 men aged 16-74 years, resident in Britain. The overall response rate was 57.7%. Interviews were carried out between September 2010 and August 2012. Participants were interviewed using computer-assisted personal interviewing with computer-assisted self-interview (CASI) for the more sensitive questions. Details of the methods have been published previously (18,19).

Natsal-3 included questions on socio-demographic characteristics, including educational level and occupation, allowing derivation of the National Statistics Socio-economic Classification (NS-SEC). Area-level deprivation was determined from postcodes using the Index of Multiple Deprivation (IMD) (20), a multi-dimensional measure of deprivation.

Women who reported some sexual experience (although not necessarily a sexual partner) were routed into the CASI section of the questionnaire (N=8538) where cervical screening and HPV immunisation questions were asked. Women aged 26 years and over at interview (N=5614) were asked “When did you last have a cervical smear test?” with the following five answer options: i) I have never had one, ii) less than 3 years ago, iii) between 3 and 5 years ago, iv) between 5 and 10 years ago and v) more than 10 years ago (adapted from (21)).

Women eligible for the HPV immunisation programme (those born on or after 01/09/1990, up to 21 years by the end of the interview period, N=1094) were asked “Have you ever been vaccinated against cervical cancer (received HPV vaccination)?” with the following three answer options: i) Yes – I have completed three doses of the vaccine, ii) Yes – I have had one or two doses of the vaccine, but not all three doses and iii) No. Women who had not been vaccinated and those who had only received one or two doses were defined as not having completed the recommended 3-dose vaccination course. Women who reported not having been vaccinated were asked whether they had been offered the vaccination.

Urine collection and testing

Briefly, at the end of the interview a subsample of 16–44 year olds who reported at least one lifetime sexual partner were invited to provide a urine sample to be tested for STIs and 60% agreed (17). Written consent was provided for testing without return of results (22). Full details of the urine collection methods have been described previously (17,18).

Urine samples from 2569 women were tested for HPV (17). An *in house* Luminex®-based genotyping assay was used for the detection of HPV types (23). HPV types 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59 and 68 were defined as HR-HPV according to the WHO International Agency for Research on Cancer definition (24).

Ethics

The Natsal-3 study was approved by the Oxfordshire Research Ethics Committee A [Ref: 10/H0604/27] (22).

Statistical analysis

Analyses were carried out using Stata (version 13) accounting for the stratification, clustering and weighting of the sample. To account for differences in the probability of selection for and response to providing a urine sample, an additional weight was applied to the urine data (17,18).

Logistic regression models were used to explore the factors associated with HR-HPV detection (N=2569), non-attendance for cervical screening in the past 5 years (N=5012) and non-completion of HPV catch-up vaccination (N=1050). Limited results have been presented previously (17) but are expanded here to present a more comprehensive picture of factors associated with HR-HPV and HPV catch-up vaccination in the general British female population.

Women under 26 or over 64 (60 in Scotland), women reporting having had a hysterectomy (N=365; who would not be invited for screening) and women reporting no lifetime sexual partners (N=39; who are advised that they might decline their screening invitation) were excluded from analyses of cervical screening. Factors associated with non-completion of HPV catch-up vaccination are presented for eligible women (born before 01/09/1995 (England and Wales) or 01/03/1995 (Scotland)).

We hypothesised that cervical screening non-attenders may have differing risk of HR-HPV and cervical cancer based on socio-demographics (e.g. ethnicity) and sexual behaviour (e.g. partner numbers). We explored the characteristics of women not attending for cervical screening, in order to examine how the prevalence of other cofactors for cervical cancer (25) differed by HR-HPV risk.

We explore the overlap between factors associated with HR-HPV and participation in cervical screening and HPV catch-up vaccination.

Results

HR-HPV prevalence

HR-HPV was detected in urine from 15.9% (95% confidence interval (CI) 14.4-17.5) of women aged 16-44 years reporting at least one lifetime partner. HR-HPV prevalence declined above age 24 and was associated with a number of socio-demographic characteristics (Table 1). Prevalence was higher in women not living with a partner, in women of lower socio-economic status, as measured by markers including area-level deprivation (age adjusted OR (AOR) 1.37, 1.05-1.80 for those living in the most deprived vs. least deprived two quintiles) and NS-SEC; and in those of mixed vs. white ethnicity (AOR 2.00, 1.09-3.67). Prevalence was lower in women of Asian/Asian-British ethnicity (AOR 0.40, 0.17-0.97). Prevalence did not vary significantly by sexual identity. Prevalence was higher in women who smoked (AOR 1.91, 1.49-2.43) or reported binge drinking regularly (AOR 1.80, 1.31-2.47).

HR-HPV was strongly associated with markers of more risky sexual behaviour including a younger age (≤16 years) at first heterosexual intercourse, increasing numbers of partners over the lifetime and in the past 5 years, as well as reporting two or more partners without a condom in the past year (AOR 4.31, 2.83-6.55). Prevalence was also higher in women who reported attending a sexual health (GUM) clinic (AOR 2.54, 2.00-3.23) or STI diagnosis/es (AOR 2.36, 1.76-3.16) in the past 5 years.

Cervical screening uptake

Figure 1A shows the time since last cervical screen in women aged 26-74 years. Overall, 96.8% of women aged 26-74 years reported ever having had a cervical screen. Over 70% of women aged 26-49 reported having attended screening within the last 3 years. Around 90% of women aged 50-64 years reported having attended for screening within the last 5 years. A notable proportion of 26-29 and 30-34 year olds reported never having had a cervical screen (12.1% and 5.9%, respectively),.

Table 2 shows factors associated with non-attendance for cervical screening in the past 5 years in women aged 26-64 (those eligible for screening), of which 8.9% (8.0-9.8) were non-attenders. Non-attendance was associated with a number of socio-demographic characteristics including younger

(<30 years) or older (60+ years) age (OR 2.28, 1.72-3.00 and 2.01, 1.32-3.05, respectively, compared to those aged 30-39), lower socio-economic status, including area-level deprivation (AOR 1.91, 1.48-2.47 for most vs. least deprived two quintiles) and having no educational qualifications (AOR 1.95, 1.43-2.66), and being of Asian/Asian British ethnicity (AOR 1.96, 1.32-2.90). Women self-identifying as lesbian were more likely to be non-attenders (AOR 2.94, 1.36-6.38). Non-attendance was also strongly associated with being a current smoker (AOR 1.97, 1.57-2.47). The relationship with markers of risky sexual behaviour was not consistent. Overall, there was no association with age at first heterosexual intercourse or number of lifetime partners, although non-attendance was highest in those with one lifetime partner (11.4%). Women reporting no partners in the past 5 years (AOR 2.45, 1.67-3.61 vs. 1 partner), or no partners without a condom in the past year were more likely to be non-attenders. Non-attendance was lower in women who reported using hormonal contraceptives in the past year (AOR 0.53, 0.41-0.69) and in those who had ever attended a sexual health (GUM) clinic (AOR 0.53, 0.40-0.69) or had an STI diagnosis (AOR 0.49, 0.33-0.71). There was no difference in attendance by HR-HPV status overall (AOR 1.35, 0.79-2.31). Stratification of these analyses by age (<50 and 50+ years) and lifetime partners (1 and 2+) returned similar associations (data not shown).

There were two distinct groups of non-attending women (Table 3). Overall, a quarter of non-attenders reported only 1 lifetime partner. A high proportion of these women were of Asian/Asian British ethnicity (25.5%, 17.2%-36.1%), few smoked (20.3%, 12.6%-31.1%), less than 1% reported first heterosexual intercourse before 16 years and 20.3% (12.6%-31.1%) reported no sexual partner in the past 5 years. Prevalence of HR-HPV in those providing a urine sample was 5.2% (1.4%-17.2%). In contrast, among the three-quarters of non-attenders reporting 2 or more lifetime partners, 89.6% (85.3%-92.7%) were of White ethnicity, 39.8% (34.4%-45.4%) were smokers and 21.7% (17.3%-26.8%) reported first heterosexual intercourse before 16 years. However, a similar proportion reported no partner in the past 5 years (14.5%, 10.6%-19.4%). Prevalence of HR-HPV in non-attenders providing a urine sample with 2 or more lifetime partners was 20.3% (12.9%-30.5%). This

was non-significantly higher than the prevalence in attenders with 2 or more lifetime partners (13.3%, 11.3%-15.7%; p=0.079).

We looked at the reported recent use of healthcare services among non-attenders. Overall, 6.1% (4.3%-8.5%) of non-attenders had been to a sexual health (GUM) clinic in the past 5 years, 14.3% (11.2%-18.0%) had attended an ante-natal clinic in the past 5 years and 19.2% (15.8%-23.1%) had obtained family planning from a clinical source in the past year. In total, 31.7% (27.1%-36.7%) of non-attending women had used one or more of these services. Use of healthcare services did not vary by lifetime partners.

HPV vaccine uptake

HPV catch-up vaccine uptake varied substantially by school year at eligibility (Figure 1B) with 72.9% of women eligible at 14 years reporting having received all 3 doses, compared with only 50.6% of women eligible at 17 years. In contrast, 89.0% of women in the routine programme reported having received all 3 doses (but denominators are small). Few women had received only one or two doses. The proportion of women who reported not having been offered the vaccine was higher in the older catch-up cohorts.

Of women eligible for the HPV catch-up immunisation programme, 38.5% reported not having completed the vaccination course. This was strongly associated with markers of lower socio-economic status (Table 4), non-white ethnicity (AOR 2.01, 1.29-3.13) and smoking (AOR 2.61, 1.93-3.55). Non-completion was also associated with reporting larger numbers of lifetime partners (AOR 1.70, 1.09-2.63 for 5+ vs. 1 lifetime partner). Among those with at least one lifetime partner, non-completion was higher in women reporting first heterosexual intercourse before 16 (AOR 1.68, 1.22-2.30) and unprotected sex with two or more partners in the past year (AOR 1.81, 1.15-2.84). Those using hormonal contraception were less likely to be non-completers (AOR 0.47, 0.34-0.67), while those attending sexual health (GUM) clinics (AOR 1.49, 1.10 2.02) and ever having been pregnant

(AOR 2.94, 2.04-4.23) were more likely to report non-completion. Non-completion was higher in women who were HR-HPV positive (AOR 2.33, 1.45-3.74).

Associations with having had no doses of the vaccine were similar (data not shown), although a stronger association was seen with area-level deprivation and slightly weaker associations with sexual behaviours, GUM clinic attendance and ever having been pregnant.

Overlap between factors associated with HR-HPV infection and uptake of cervical screening & HPV vaccination

Figure 2 shows factors associated with HR-HPV infection (vertical axes) plotted against factors associated with non-attendance for cervical screening (Figure 2A) and non-completion of HPV vaccination (Figure 2B). The top right hand quadrant for each figure indicates increased risk of HR-HPV infection and lower uptake of the cervical cancer prevention programme. The area of the bubble represents the size of the group as a proportion of those eligible for screening. There was evidence of overlap of HR-HPV infection risk and cervical screening uptake for some factors (Figure 2A). Living in more deprived areas and smoking were associated with both HR-HPV infection and non-attendance for cervical screening. These factors were also associated with non-completion of HPV vaccination (Figure 2B). Associations between smoking and HR-HPV infection, and uptake of cervical screening and HPV vaccination persisted after adjustment for area-level deprivation (data not shown). In contrast, HR-HPV prevalence was lower in women of Asian/Asian British ethnicity, another group less likely to attend for screening (Figure 2A). Women with 5 or more lifetime partners and those who reported attending a sexual health (GUM) clinic, had a higher prevalence of HR-HPV infection, and were more likely to have attended for cervical screening but less likely to have completed HPV vaccination.

Discussion

In this cross-sectional probability-sample survey of the British general population we found markers of lower socio-economic status and smoking to be common risk factors for HR-HPV infection and non-uptake of both cervical screening and HPV catch-up vaccination. Overall, cervical screening attendance was not lower in women reporting more risky sexual behaviours and there was no difference in attendance by HR-HPV status. However, our analysis suggests that there are two distinct groups of non-attenders, one of which would be considered at higher risk of developing cervical cancer due to high prevalence of other lifestyle risk factors such as smoking and early age at first sex, whose non-attendance might augment their overall risk of cervical cancer, and one of which would be considered lower risk, whose non-attendance might negate their lower lifestyle risk.

The major strength of this study is that it is a population-based survey with individual-level data from a nationally representative sample. We were able to link behavioural and biological data and look at risk factors for different outcomes in the same survey. One limitation is the accuracy of self-reporting, especially of cervical screening (26,27). Our estimates of cervical screening uptake are higher than official figures, which estimate 5-year coverage in 2011-12 as 78.6% (6), and one other study (28), which asked for year and month of last cervical screen. We believe that social desirability bias is unlikely to have had a substantial effect since this question was asked in the self-completion part of the questionnaire. However, 'telescoping', where an event is remembered as occurring more recently than it did, is a strong possibility both for us and other studies (27,29). Any variation in such a bias by the socio-demographic or behavioural variables that we report could mean that we have over- or under-estimated associations, for example, if telescoping errors were greater amongst more educated women, the association between attendance and education would be over-estimated. Women may also not be able to accurately report their vaccination status (30) and accurate reporting may vary by other variables. Uptake estimates may be affected by biases in the women who agreed to participate in Natsal-3. The Natsal-3 response rate was 57.7%, which is comparable with other population-based surveys completed around the same time (31,32). After weighting our data to match the British population for age, gender and geographic region, the sample was

comparable with the 2011 census data on other key demographic characteristics (18). However, women who do not attend for screening may be less likely to participate in research studies or engage more generally (33).

Another limitation is that urine is a suboptimum specimen for HPV detection (34) with recent estimates of 77% sensitivity of cervical HR-HPV (35) and therefore a likely underestimate of HR-HPV prevalence, although this would weaken, not bias, our identification of risk factors. Finally, due to the years the Natsal-3 fieldwork was carried out, our study could only focus on the catch-up programme, and the factors we describe as associated with vaccination uptake in the catch-up cohorts may not be generalizable to routine vaccination at 12 years of age.

To our knowledge, no population-based studies have examined the associations between cervical screening and sexual behaviour or HR-HPV infection. We found lower screening uptake among women with lower levels of education and of non-White ethnicity as in other British population studies (21,28). Other studies have shown lower uptake of HPV catch-up vaccination in women of Black/Black British and Asian/Asian British ethnicity (36,37). Our sample of women of these ethnic minorities was too small to examine associations between vaccination and each ethnic group but completion of catch-up vaccination was lower in women of non-White ethnicity.

It is a reasonable expectation that herd immunity should lead to a reduction in cervical cancer incidence among unvaccinated women in the catch-up vaccination cohorts (38). However, the effect of multiple risks in some groups of women has the potential to widen inequalities in cervical cancer incidence. Women who live in more deprived areas and who smoke were less likely to complete catch-up vaccination. These women were also at higher risk of HR-HPV and their cervical cancer risk is compounded by smoking, which is itself a cofactor in cervical cancer development (39). Additionally, these women were less likely to attend for cervical screening, thereby losing the opportunity for early detection and treatment of cancer abnormalities. Special efforts may be warranted to ensure women who missed vaccination are engaged by the cervical screening

programme, especially since girls with low intentions to attend for cervical screening may be less likely to be fully-vaccinated (40). Good linkage between vaccination and screening records will be important in order to target those not vaccinated.

As some non-attenders for cervical screening seem to be at low risk for HR-HPV, tailored approaches may be appropriate to increase screening among higher risk women. On the other hand there is evidence of lower uptake of cervical screening among women who may be considered at lower risk for cervical cancer or may perceive themselves to be. For example, as in other studies, we found lower uptake in women self-identifying as lesbian (41,42). Previous studies have also found that women who are not sexually active are less likely to attend for screening (33). Cervical screening prevents approximately 75% of cervical cancers by detecting and treating cervical abnormalities in women who attend regularly (5,43). The odds of cervical cancer are approximately six times higher in women with no adequate screens at age 50-64 compared to those with adequate negative screening (44) so despite being at lower relative risk for cervical cancer, by missing the prevention opportunity offered by cervical screening these women may end up at increased risk. Although they have a lower incidence of cervical cancer overall, Asian/Asian British women aged 65 and over have a higher incidence than do women of White ethnicity (45). Since these women are unlikely to access sexual health services, engaging them in screening through general practice (family doctor) is important. The cervical screening programme also needs to counter this risk-based tendency for non-participation. This will be particularly important in the era of vaccination, where careful messaging will be needed to promote uptake of screening among those who may perceive themselves at less risk.

Overall those at increased risk of HR-HPV were no more or less likely to attend for screening. We found markers of engagement with healthcare, such as sexual health (GUM) clinic attendance and using hormonal contraception, were associated with higher cervical screening attendance. In 2011-12, 17% of women having a cervical screen in England had a test which was outside the invitation

system of the cervical screening programme, i.e. opportunistic tests which were initiated by the person taking the sample or by the woman (46). This underlines the importance of maintaining integrated sexual health services to ensure that screening levels remain high in those at highest risk. However, around 30% of women who had not attended cervical screening in the past 5 years reported attending ante-natal or sexual health (GUM) clinics in the past 5 years or obtaining contraceptives from clinical sources in the past year, suggesting missed opportunities to engage these women with cervical screening.

Changes to the cervical screening programme are likely in coming years, due both to HPV immunisation effects on HPV epidemiology and the use of HPV testing in screening algorithms. HPV testing has already been introduced to help manage women with borderline and mildly abnormal cytology results. A pilot of HPV testing as the primary screening test (in place of cytology) is currently underway (46). It is unclear how changes will impact cervical screening uptake.

To date, there are few data relating to HPV vaccination uptake in the routine cohorts by the variables we have explored. It will be important to study factors associated with routine HPV vaccination uptake in the same way. Uptake of cervical screening among women who have not received HPV vaccination should be studied as these women reach screening age.

As some non-attenders for cervical screening seem to be at low risk for HR-HPV, tailored approaches may be appropriate to increase screening among higher-risk women. Socio-economic markers and smoking were associated with HR-HPV positivity, non-completion of catch-up HPV vaccination and non-attendance for cervical screening. This highlights the importance of general practice considering all aspects of the cervical cancer prevention pathway: vaccination, healthy lifestyle advice and cervical screening. To avoid a potential widening of cervical cancer disparities in the catch-up age cohorts, special efforts may be warranted to ensure that those who missed catch-up HPV vaccination are engaged by the cervical screening programme.

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Table 1: Factors associated with high-risk HPV in urine in sexually-experienced women aged 16-44 years

	%	(95%CI)	OR	(95%CI)	Age adjusted OR	(95%CI)	*Denom. (unwt, wt)* [a]
All	15.9%	(14.4-17.5)	-				*2569, 2189*
Socio-demographic characteristics							
Age (years)			p<0.0001				
16-19	24.40%	(20.0-29.3)	1	-			*377, 203*
20-24	26.60%	(22.8-30.8)	1.13	(0.82-1.56)			*580, 370*
25-34	15.60%	(13.4-18.2)	0.58	(0.42-0.79)			*1108, 779*
35-44	9.30%	(7.1-12.2)	0.32	(0.22-0.47)			*504, 837*
Relationship status at interview			p<0.0001		p<0.0001		
Living with a partner	11.20%	(9.5-13.1)	1	-	1	-	*1256, 1357*
In a steady relationship (but not living with a partner)	26.00%	(22.2-30.1)	2.79	(2.13-3.66)	1.95	(1.44-2.65)	*602, 360*
Previously in a live-in partnership	19.90%	(15.3-25.4)	1.97	(1.37-2.84)	1.92	(1.34-2.76)	*353, 240*
Not in a steady relationship (never lived with partner)	23.90%	(18.8-29.8)	2.49	(1.76-3.54)	1.65	(1.13-2.42)	*355, 229*
Index of Multiple Deprivation (quintiles) [b]			P=0.0238		p=0.0578		
1-2 (least deprived)	13.50%	(11.2-16.1)	1	-	1	-	*873, 778*
3	15.00%	(11.8-18.7)	1.13	(0.80-1.58)	1.12	(0.80-1.57)	*502, 439*
4-5 (most deprived)	18.30%	(15.9-20.9)	1.43	(1.10-1.87)	1.37	(1.05-1.80)	*1194, 973*
Academic qualifications [c]			p=0.6717		p=0.1250		
No academic qualifications	15.10%	(10.5-21.4)	0.99	(0.63-1.56)	1.13	(0.72-1.77)	*215, 191*
Academic qualifications typically gained at age 16	16.70%	(14.1-19.6)	1.12	(0.87-1.44)	1.3	(1.01-1.68)	*877, 748*
Studying for/attained further academic qualifications	15.20%	(13.3-17.4)	1	-	1	-	*1348, 1157*
Housing tenure			p<0.0001		p=0.0011		
Own outright	14.30%	(10.0-19.9)	1.38	(0.88-2.16)	1.15	(0.72-1.81)	*218, 201*
Buying with a mortgage or loan [d]	10.80%	(8.9-13.0)	1	-	1	-	*911, 912*
Rent it	20.50%	(18.0-23.1)	2.13	(1.64-2.78)	1.71	(1.30-2.26)	*1325, 996*
Lives rent free	24.10%	(16.6-33.8)	2.64	(1.59-4.38)	1.53	(0.91-2.56)	*106, 74*
Respondent's National Statistics Socio-Economic Classification			p<0.0001		p=0.0009		
Managerial & prof occupations	10.30%	(8.3-12.7)	1	-	1	-	*709, 714*
Intermediate occupations	16.60%	(13.0-21.1)	1.74	(1.21-2.52)	1.60	(1.11-2.30)	*464, 423*
Semi-routine/routine occupations	18.50%	(15.6-21.7)	1.98	(1.45-2.69)	1.57	(1.14-2.17)	*780, 617*
No job (10+ hrs/week) or not in last 10 years	22.50%	(16.6-29.8)	2.53	(1.62-3.96)	2.08	(1.31-3.31)	*210, 173*
Student in full-time education	19.80%	(15.8-24.6)	2.16	(1.50-3.11)	1.01	(0.66-1.55)	*398, 256*
Ethnic group [e]			p=0.0061		p=0.0150		
White	16.20%	(14.6-18.0)	1	-	1	-	*2312, 1914*
Mixed	29.70%	(19.4-42.7)	2.18	(1.24-3.85)	2.00	(1.09-3.67)	*74, 58*
Asian/Asian British	7.00%	(2.9-15.5)	0.39	(0.16-0.95)	0.40	(0.17-0.97)	*82, 114*
Black/Black British	12.60%	(6.8-22.0)	0.74	(0.38-1.46)	0.69	(0.36-1.32)	*77, 77*
Religion			p=0.0286		p=0.2671		
None	17.70%	(15.7-20.0)	1	-	1	-	*1509, 1189*
Christian - Church of England/Anglican	9.80%	(6.2-15.2)	0.51	(0.30-0.85)	0.7	(0.42-1.19)	*220, 235*
Christian - Roman Catholic	14.20%	(10.3-19.3)	0.77	(0.52-1.14)	0.84	(0.57-1.25)	*261, 226*
Christian - other	17.00%	(13.4-21.5)	0.96	(0.69-1.32)	1.01	(0.73-1.39)	*457, 396*
Non-Christian	10.40%	(5.9-17.7)	0.54	(0.29-1.01)	0.57	(0.31-1.05)	*122, 142*
Sexual identity			p=0.2447		p=0.1893		
Heterosexual/straight	16.10%	(14.5-17.8)	1	-	1	-	*2457, 2108*
Gay/lesbian/bisexual	11.40%	(6.1-20.1)	0.67	(0.34-1.32)	0.62	(0.31-1.26)	*107, 79*
Health behaviours							

Smoking status			p<0.0001		p<0.0001		
Non/Ex-smoker	12.9%	(11.4-14.7)	1	-	1	-	*1702, 1568*
Current smoker	23.4%	(20.1-26.9)	2.05	(1.61-2.60)	1.91	(1.49-2.43)	*867, 622*
Frequency of binge drinking [f]			p=0.0001		p=0.0011		
Never / less than monthly	13.90%	(12.2-15.7)	1	-	1	-	*1730, 1573*
Monthly	19.10%	(15.6-23.2)	1.47	(1.10-1.96)	1.31	(0.98-1.75)	*484, 355*
Weekly or more often	23.80%	(19.1-29.3)	1.94	(1.42-2.66)	1.80	(1.31-2.47)	*355, 261*
Sexual behaviours							
Age at first heterosexual sex (years)			p<0.0001		p=0.0059		
18+	11.0%	(8.5-14.0)	1	-	1	-	*577, 642*
17	12.9%	(9.8-16.7)	1.20	(0.79-1.82)	1.18	(0.78-1.80)	*432, 419*
16	20.5%	(17.2-24.3)	2.10	(1.48-2.97)	1.78	(1.24-2.56)	*659, 517*
<16	20.2%	(17.4-23.4)	2.06	(1.47-2.89)	1.65	(1.17-2.34)	*859, 577*
Number of sexual partners, lifetime [g]			p<0.0001		p<0.0001		
1	4.2%	(2.4-7.2)	1	-	1	-	*342, 361*
2	11.3%	(7.5-16.5)	2.89	(1.40-5.96)	2.74	(1.32-5.69)	*234, 213*
3-4	13.7%	(10.6-17.5)	3.60	(1.91-6.81)	3.71	(1.97-7.01)	*441, 388*
5-9	17.2%	(14.3-20.6)	4.74	(2.55-8.79)	5.67	(3.07-10.46)	*709, 593*
10+	24.0%	(20.9-27.4)	7.19	(3.94-13.10)	9.35	(5.14-17.02)	*822, 614*
No. of sexual partners, past 5 years [g]			p<0.0001		p<0.0001		
0/1	7.1%	(5.7-8.9)	1	-	1	-	*1162, 1258*
2	21.9%	(17.5-26.9)	3.64	(2.52-5.25)	3.34	(2.29-4.86)	*425, 316*
3-4	23.0%	(19.0-27.4)	3.88	(2.77-5.42)	3.43	(2.45-4.79)	*424, 290*
5+	37.5%	(32.7-42.7)	7.82	(5.63-10.86)	6.62	(4.68-9.38)	*544, 313*
Number of sexual partners without a condom, past year [g]			p<0.0001		p<0.0001		
0	11.30%	(8.5-14.8)	1	-	1	-	*449, 405*
1	14.00%	(12.3-15.9)	1.28	(0.91-1.80)	1.35	(0.96-1.90)	*1741, 1566*
2+	40.10%	(33.9-46.5)	5.27	(3.49-7.95)	4.35	(2.87-6.60)	*347, 193*
Sexual health & services							
Used hormonal contraception [h], past year			p=0.0001		p=0.1711		
No	13.1%	(11.1-15.5)	1	-	1	-	*1172, 1137*
Yes	19.7%	(17.5-22.1)	1.63	(1.28-2.07)	1.20	(0.92-1.55)	*982, 1388*
Attended a sexual health (GUM) clinic, past 5 years			p<0.0001		p<0.0001		
No	11.7%	(10.2-13.4)	1	-	1	-	*1779, 1686*
Yes	30.4%	(26.8-34.2)	3.29	(2.62-4.14)	2.54	(2.00-3.23)	*765, 484*
STI diagnosis [i], past 5 years			p<0.0001		p<0.0001		
No	14.7%	(13.2-16.4)	1	-	1	-	*2316, 2038*
Yes	35.3%	(29.2-41.9)	3.16	(2.33-4.28)	2.36	(1.76-3.16)	*237, 134*
Genital warts diagnosis, ever			p=0.2095		p=0.0891		
No	15.8%	(14.3-17.5)	1	-	1	-	*2436, 2085*
Yes	20.2%	(13.9-28.3)	1.35	(0.85-2.14)	1.47	(0.94-2.30)	*117, 86*

a Participants who reported at least one lifetime sexual partner, with urine test results (unweighted, weighted)
b Index of Multiple Deprivation (IMD) is a multi-dimensional measure of area (neighbourhood)-level deprivation based on the participant's postcode. IMD scores for England, Scotland and Wales were adjusted before being combined and assigned to quintiles, using a method by Payne and Abel (Payne and Abel, 2012).
c Participants aged ≥17 years
d Includes 29 women paying part mortgage & part rent (shared ownership)
e Those of Chinese / Other ethnicity are excluded from the denominator due to small numbers
f Binge drinking defined as having six units on one occasion
g Includes both opposite-sex and same-sex partners
h Defined as having used the oral contraceptive pill, hormonal IUD, injections, or implants
i Defined as having been diagnosed with one of chlamydia, gonorrhoea, syphilis, genital herpes, genital warts, trichomonas, non-specific urethritis/non-gonococcal urethritis

Table 2: Factors associated with non-attendance at cervical screening in the past 5 years in women aged 26-64 years

	Not in past 5 years		Not screened vs. screened in past 5 years				
	%	(95%CI)	OR	(95%CI)	Age adjusted OR	(95%CI)	*Denom. (unwt, wt)* [a]
All ages	8.9%	(8.0-9.8)					*5012, 4731*
Socio-demographic characteristics							
Age, years			p<0.0001				
26-29	14.9%	(12.7-17.4)	2.28	(1.72-3.00)			*1121, 547*
30-39	7.1%	(5.9-8.7)	1	-			*1605, 1312*
40-49	6.2%	(4.9-8.0)	0.86	(0.61-1.21)			*1107, 1404*
50-59	9.6%	(7.8-11.9)	1.38	(1.01-1.90)			*826, 1058*
60-64	13.4%	(9.7-18.2)	2.01	(1.32-3.05)			*353, 411*
Relationship status at interview			p<0.0001		p=0.0004		
Living with a partner	8.0%	(7.0-9.1)	1	-	1	-	*3151, 3476*
In a steady relationship (but not living with a partner)	8.4%	(6.3-11.2)	1.06	(0.75-1.50)	1.04	(0.73 - 1.46)	*585, 373*
Previously in a live-in partnership	11.5%	(9.4-14.0)	1.50	(1.14-1.96)	1.43	(1.09 - 1.87)	*1015, 717*
Not in a steady relationship (never lived with partner)	18.5%	(13.1-25.4)	2.61	(1.71-3.99)	2.31	(1.49 - 3.57)	*234, 145*
Index of Multiple Deprivation (quintiles) [b]			p<0.0001		p<0.0001		
1-2 (least deprived)	6.3%	(5.2-7.6)	1	-	1	-	*1885, 1938*
3	8.9%	(7.1-11.2)	1.46	(1.06-2.00)	1.44	(1.05 - 1.98)	*1003, 943*
4-5 (most deprived)	11.5%	(10.1-13.2)	1.95	(1.52-2.50)	1.91	(1.48 - 2.47)	*2124, 1850*
Academic qualifications			p<0.0001		p=0.0001		
No academic qualifications	14.1%	(11.5-17.1)	2.04	(1.53-2.73)	1.95	(1.43 - 2.66)	*751, 764*
Academic qualifications typically gained at age 16	8.1%	(6.8-9.5)	1.09	(0.84-1.42)	1.16	(0.88 - 1.52)	*1828, 1730*
Studying for/attained further academic qualifications	7.4%	(6.3-8.7)	1	-	1	-	*2278, 2102*
Housing tenure			p<0.0001		p<0.0001		
Own outright	9.6%	(7.7-12.0)	1.77	(1.28-2.46)	1.34	(0.93 - 1.92)	*868, 1034*
Buying with a mortgage or loan [c]	5.7%	(4.7-6.9)	1	-	1	-	*2092, 2118*
Rent it	12.6%	(11.0-14.3)	2.40	(1.86-3.08)	2.14	(1.65 - 2.78)	*1967, 1505*
Lives rent free	17.3%	(9.4-29.8)	3.49	(1.70-7.19)	2.88	(1.44 - 5.77)	*71, 59*
Respondent's National Statistics Socio-Economic Classification			p<0.0001		p<0.0001		
Managerial & prof occupations	6.4%	(5.3-7.7)	1	-	1	-	*1868, 1810*
Intermediate occupations	7.0%	(5.5-8.8)	1.10	(0.80-1.53)	1.07	(0.77 - 1.49)	*1160, 1081*
Semi-routine/routine occupations	11.8%	(10.0-13.9)	1.96	(1.49-2.59)	1.88	(1.42 - 2.49)	*1361, 1249*
No job (10+ hrs/week) or not in last 10 years	14.8%	(11.4-18.9)	2.54	(1.77-3.65)	2.40	(1.66 - 3.47)	*475, 474*
Student in full-time education	9.5%	(5.1-17.1)	1.55	(0.77-3.11)	1.32	(0.67 - 2.62)	*124, 95*
Ethnic group			p=0.0066		p=0.0052		
White	8.3%	(7.4-9.2)	1	-	1	-	*4415, 4155*
Mixed	11.7%	(5.7-22.4)	1.46	(0.68-3.17)	1.49	(0.68 - 3.25)	*89, 72*
Asian/Asian British	15.1%	(10.9-20.6)	1.97	(1.32-2.93)	1.96	(1.32 - 2.90)	*254, 256*
Black/Black British	11.8%	(6.8-19.6)	1.48	(0.81-2.71)	1.62	(0.88 - 2.97)	*174, 176*
Other	12.5%	(6.5-22.7)	1.58	(0.78-3.24)	1.52	(0.73 - 3.16)	*69, 63*
Religion			p=0.0076		p=0.0049		
None	9.4%	(8.2-10.9)	1	-	1	-	*2330, 2052*
Christian - Church of England/Anglican	6.3%	(4.8-8.4)	0.65	(0.46-0.92)	0.60	(0.42 - 0.86)	*832, 906*
Christian - Roman Catholic	7.9%	(5.9-10.6)	0.83	(0.58-1.19)	0.80	(0.55 - 1.16)	*582, 558*
Christian - other	9.2%	(7.2-11.7)	0.97	(0.72-1.32)	0.93	(0.68 - 1.28)	*930, 903*
Muslim	13.9%	(8.8-21.1)	1.55	(0.91-2.63)	1.50	(0.88 - 2.56)	*160, 152*
Hindu	19.6%	(11.2-32.1)	2.34	(1.20-4.57)	2.21	(1.13 - 4.32)	*68, 57*

Other	8.6%	(3.8-18.5)	0.91	(0.38-2.18)	0.91	(0.40 - 2.08)	*102, 94*
Sexual identity			p=0.0271		p=0.0234		
Heterosexual/straight	8.70%	(7.9-9.7)	1	-	1	-	*4849, 4599*
Gay/lesbian	20.90%	(11.1-35.7)	2.76	(1.31-5.78)	2.94	(1.36-6.38)	*63, 56*
Bisexual	8.30%	(3.9-16.5)	0.94	(0.43-2.05)	0.93	(0.44-1.98)	*75, 53*
Health behaviours							
Smoking status			p<0.0001		p<0.0001		
Non/Ex-smoker	7.5%	(6.6-8.5)	1	-	1	-	*3700, 3646*
Current smoker	13.5%	(11.5-15.7)	1.92	(1.54-2.40)	1.97	(1.57 - 2.47)	*1312, 1085*
Frequency of binge drinking [d]			p=0.0277		p=0.0473		
Never / less than monthly	9.5%	(8.5-10.6)	1	-	1	-	*3769, 3636*
Monthly	6.7%	(5.0-9.0)	0.69	(0.49-0.96)	0.69	(0.49 - 0.97)	*664, 568*
Weekly or more often	7.1%	(5.3-9.4)	0.73	(0.52-1.02)	0.77	(0.55 - 1.09)	*578, 527*
Sexual behaviours							
Age at first heterosexual sex (years)			p=0.3000		p=0.5485		
18+	9.70%	(8.3-11.2)	1	-	1	-	*1971, 2033*
16/17	8.20%	(6.9-9.7)	0.83	(0.65-1.06)	0.89	(0.69 - 1.14)	*1943, 1825*
<16	8.40%	(6.7-10.5)	0.86	(0.64-1.15)	0.87	(0.64 - 1.18)	*1040, 812*
No. of sexual partners, lifetime [e]			p=0.0612		p=0.2391		
1	11.4%	(9.3-13.9)	1	-	1	-	*832, 923*
2	9.4%	(7.0-12.4)	0.80	(0.54-1.19)	0.81	(0.55 - 1.21)	*468, 478*
3-4	8.5%	(6.8-10.6)	0.72	(0.51-1.02)	0.77	(0.54 - 1.09)	*920, 890*
5-9	8.0%	(6.5-9.9)	0.68	(0.49-0.94)	0.74	(0.54 - 1.03)	*1338, 1246*
10+	7.5%	(6.0-9.3)	0.63	(0.45-0.87)	0.68	(0.48 - 0.96)	*1367, 1105*
No. of sexual partners, past 5 years [e]			p<0.0001		p<0.0001		
0	19.3%	(15.0-24.5)	2.72	(1.94-3.82)	2.45	(1.67-3.61)	*358, 342*
1	8.1%	(7.1-9.2)	1	-	1	-	*3133, 3311*
2	8.2%	(6.1-10.9)	1.02	(0.72-1.45)	0.94	(0.66-1.34)	*625, 471*
3-4	7.1%	(5.1-9.8)	0.87	(0.60-1.25)	0.73	(0.50-1.05)	*489, 328*
5+	8.2%	(5.6-12.0)	1.02	(0.66-1.58)	0.77	(0.49-1.22)	*349, 216*
No. of sexual partners without a condom, past year [e]			p<0.0001		p<0.0001		
0	14.10%	(12.0-16.6)	1	-	1	-	*1263, 1136*
1	7.10%	(6.2-8.1)	0.46	(0.37-0.59)	0.48	(0.38 - 0.62)	*3420, 3358*
2+	8.20%	(5.0-12.9)	0.54	(0.31-0.93)	0.50	(0.28 - 0.89)	*259, 163*
Health-related factors							
Used hormonal contraception [f], past year			p=0.0001		p<0.0001		
No	9.8%	(8.7-10.9)	1	-	1	-	*3369, 3489*
Yes	6.3%	(5.1-7.6)	0.62	(0.48-0.79)	0.53	(0.41 - 0.69)	*1573, 1168*
Ever attended a sexual health (GUM) clinic			p=0.0002		p<0.0001		
No	9.7%	(8.7-10.8)	1	-	1	-	*3611, 3636*
Yes	6.0%	(4.8-7.5)	0.60	(0.46-0.78)	0.53	(0.40 - 0.69)	*1353, 1041*
Ever diagnosed with a STI [g]			p=0.0004		p=0.0002		
No (or only thrush)	9.5%	(8.6-10.6)	1	-	1	-	*4080, 3958*
Yes (excluding thrush)	5.1%	(3.7-7.1)	0.51	(0.35-0.74)	0.49	(0.33 - 0.71)	*882, 717*
STI risk: to self			p=0.0377		p=0.0200		
Greatly at risk / Quite a lot	5.5%	(2.9-10.0)	1	-	1	-	*130, 97*
Not very much	7.1%	(5.6-9.1)	1.33	(0.65-2.71)	1.34	(0.67 - 2.67)	*903, 715*
Not at all at risk	9.3%	(8.3-10.3)	1.78	(0.92-3.44)	1.83	(0.97 - 3.48)	*3958, 3900*
All women aged 26-44 who haven't had a hysterectomy & who provided a urine sample	10.6%	(8.7-12.8)					*1474, 1512* [h]
1+ high-risk HPV type(s)			p=0.2062		p=0.2775		
Negative	10.1%	(8.1-12.5)	1	-	1	-	*1243, 1329*
Positive	13.7%	(9.0-20.5)	1.42	(0.83-2.44)	1.35	(0.79 - 2.31)	*231, 184*

a Participants who haven't had a hysterectomy & who reported at least 1 lifetime sexual partner (unweighted, weighted)
b Index of Multiple Deprivation (IMD) is a multi-dimensional measure of area (neighbourhood)-level deprivation based on the participant's postcode. IMD scores for England, Scotland and Wales were adjusted before being combined and assigned to quintiles, using a method by Payne and Abel (Payne and Abel, 2012).
c Includes 46 women paying part mortgage & part rent (shared ownership)
d Binge drinking defined as having six units on one occasion
e Includes both opposite-sex and same-sex partners
f Defined as having used the oral contraceptive pill, hormonal IUD, injections, or implants
g Defined as having been diagnosed with one of chlamydia, gonorrhoea, syphilis, genital herpes, genital warts, trichomonas, non-specific urethritis/non-gonococcal urethritis
h Participants aged 26-44 years who haven't had a hysterectomy, who reported at least 1 lifetime sexual partner & who provided a urine sample

Table 3: Key characteristics of women who have not attended for cervical screening in the past 5 years, by number of lifetime partners

	Not attended for screening in past 5 years					
	All not attended (100%)		1 lifetime partner [a] (25%)		2+ lifetime partners [a] (75%)	
	%	*(95%CI)*	%	(95%CI)	%	(95%CI)
Denom. (unweighted, weighted)	*496, 420*		*111, 105*		*385, 314*	
Age, years						
26-29	*19.4%*	*(16.3-22.9)*	18.4%	(12.6-26.0)	19.8%	(16.3-23.8)
30-39	*22.3%*	*(18.5-26.7)*	26.5%	(18.3-36.6)	21.0%	(16.8-25.9)
40-49	*20.8%*	*(16.6-25.8)*	14.3%	(7.2-26.3)	23.0%	(18.2-28.7)
50-59	*24.3%*	*(19.9-29.3)*	20.3%	(12.4-31.5)	25.6%	(20.5-31.5)
60-64	*13.1%*	*(9.6-17.6)*	20.6%	(12.5-31.9)	10.6%	(7.1-15.5)
Index of Multiple Deprivation (quintiles) [c]				p=0.4394 [b]		
1-2 (least deprived)	*29.1%*	*(24.4-34.2)*	28.8%	(20.3-39.2)	29.1%	(23.8-35.1)
3	*20.0%*	*(16.0-24.7)*	15.7%	(10.0-23.9)	21.5%	(16.7-27.2)
4-5 (most deprived)	*50.9%*	*(45.7-56.1)*	55.5%	(44.9-65.6)	49.4%	(43.4-55.4)
Academic qualifications				p=0.1289 [b]		
No academic qualifications	*26.7%*	*(22.1-31.8)*	34.7%	(24.2-46.9)	24.1%	(19.4-29.7)
Academic qualifications typically gained at age 16	*34.6%*	*(29.6-39.9)*	26.4%	(17.4-38.0)	37.2%	(31.5-43.2)
Studying for/attained further academic qualifications	*38.7%*	*(33.6-44.1)*	38.9%	(28.4-50.6)	38.7%	(32.9-44.8)
Ethnic group				p<0.0001 [b]		
White	*82.0%*	*(77.5-85.8)*	59.3%	(47.9-69.8)	89.6%	(85.3-92.7)
Mixed	*2.0%*	*(1.0-4.1)*	1.4%	(0.3-5.8)	2.2%	(1.0-4.9)
Asian/Asian British	*9.2%*	*(6.5-12.8)*	25.5%	(17.2-36.1)	3.7%	(2.1-6.6)
Black/Black British	*4.9%*	*(2.8-8.5)*	9.4%	(3.8-21.2)	3.5%	(1.7-6.9)
Other	*1.9%*	*(1.0-3.5)*	4.5%	(1.9-9.9)	1.0%	(0.4-2.7)
Smoking status				p=0.0022 [b]		
Non/Ex-smoker	*65.1%*	*(60.2-69.7)*	79.7%	(68.9-87.4)	60.2%	(54.6-65.6)
Current smoker	*34.9%*	*(30.3-39.8)*	20.3%	(12.6-31.1)	39.8%	(34.4-45.4)
Age at first heterosexual sex (years)				p<0.0001 [b]		
18+	*47.4%*	*(42.4-52.6)*	81.6%	(71.3-88.8)	36.1%	(30.6-41.9)
16/17	*36.1%*	*(31.2-41.2)*	17.5%	(10.4-27.9)	42.3%	(36.5-48.3)
<16	*16.5%*	*(13.1-20.5)*	0.9%	(0.3-2.9)	21.7%	(17.3-26.8)
Sexual partner, past 5 years [a]				p=0.2239 [b]		
No	*15.9%*	*(12.2-20.3)*	20.30%	(12.5-31.4)	14.40%	(10.6-19.2)
Yes	*84.1%*	*(79.7-87.8)*	79.70%	(68.6-87.5)	85.60%	(80.8-89.4)
Denom. (unwt, wt) [d]	*148, 160*		31, 47		117, 112	
1+ high-risk HPV type(s)				p=0.0216 [b]		
Negative	*84.2%*	*(76.2-89.8)*	94.80%	(82.8-98.6)	79.70%	(69.5-87.1)
Positive	*15.8%*	*(10.2-23.8)*	5.20%	(1.4-17.2)	20.30%	(12.9-30.5)

a Includes both opposite-sex and same-sex partners

b P-values for comparison between non-attenders with 1 and 2+ lifetime partners

c Index of Multiple Deprivation (IMD) is a multi-dimensional measure of area (neighbourhood)-level deprivation based on the participant's postcode. IMD scores for England, Scotland and Wales were adjusted before being combined and assigned to quintiles, using a method by Payne and Abel (Payne and Abel, 2012).

d Non-attenders aged 26-44 years who provided a urine sample

Table 4: Factors associated with non-completion of HPV catch-up vaccination

	Not completed		Not completed vs. completed				
	%	(95%CI)	OR	(95%CI)	Age adjusted OR	(95%CI)	*Denom. (unwt, wt)*
All eligible for HPV catch-up vaccination programme	**38.50%**	**(35.3-41.9)**					***1050, 562***
Socio-demographic factors							
Age at interview (years)			p<0.0001				
16-17	28.0%	(23.2-33.4)	1	-			*394, 195*
18-19	41.7%	(36.7-47.0)	1.84	(1.33-2.56)			*449, 241*
20-24	48.7%	(41.3-56.1)	2.44	(1.64-3.63)			*207, 125*
School year at eligibility for HPV vaccination programme			p<0.0001		p=0.0060		
14 (Y10/S3)	27.1%	(20.1-35.3)	1	-	1	-	*153, 78*
15 (Y11/S4)	26.8%	(21.1-33.3)	0.99	(0.61-1.59)	1.01	(0.62-1.65)	*244, 123*
16 (Y12/S5)	35.8%	(29.5-42.6)	1.50	(0.94-2.39)	1.57	(0.90-2.74)	*238, 117*
17 (Y13/S6 or post school)	49.4%	(44.1-54.8)	2.64	(1.69-4.10)	2.87	(1.39-5.95)	*415, 243*
Grouped government office region			p<0.0001		p<0.0001		
Rest of England	36.4%	(32.7-40.2)	1	-	1	-	*803, 421*
London	62.4%	(52.3-71.5)	2.90	(1.87-4.50)	2.76	(1.77-4.30)	*100, 66*
Scotland	19.8%	(13.1-28.8)	0.43	(0.26-0.72)	0.41	(0.24-0.70)	*89, 46*
Wales	44.4%	(31.0-58.6)	1.4	(0.78-2.48)	1.31	(0.74-2.35)	*58, 29*
Index of Multiple Deprivation (quintiles) [a]			p<0.0001		p=0.0001		
1-2 (least deprived)	30.1%	(25.3-35.4)	1	-	1	-	*393, 210*
3	36.7%	(29.4-44.7)	1.34	(0.90-2.01)	1.35	(0.90-2.04)	*209, 116*
4-5 (most deprived)	46.9%	(42.0-51.9)	2.05	(1.50-2.81)	1.99	(1.44-2.74)	*448, 236*
Parents social class			p=0.0308		p=0.0285		
I/II/III	35.1%	(31.2-39.2)	1	-	1	-	*714, 385*
IV/V	44.9%	(37.0-53.1)	1.51	(1.04-2.19)	1.52	(1.05-2.21)	*196, 103*
Academic qualifications [b]			p<0.0001		p<0.0001		
No academic qualifications	75.2%	(55.9-87.9)	6.04	(2.63-13.85)	5.84	(2.50-13.62)	*39, 18*
Academic qualifications typically gained at age 16	57.2%	(49.3-64.7)	2.66	(1.85-3.83)	2.52	(1.75-3.65)	*188, 92*
Studying for/attained further academic qualifications	33.4%	(29.5-37.6)	1	-	1	-	*650, 361*
Ethnic group			p=0.0015		p=0.0001		
White	36.3%	(32.9-39.7)	1	-	1	-	*937, 491*
Non-white	54.1%	(43.5-64.5)	2.07	(1.32-3.25)	2.01	(1.29-3.13)	*113, 71*
Health behaviours							
Smoking status			p<0.0001		p<0.0001		
Non/ex-smoker	31.8%	(28.3-35.7)	1	-	1	-	*737, 400*
Current smoker	55.0%	(48.9-61.0)	2.62	(1.95-3.53)	2.61	(1.93-3.55)	*313, 162*
Frequency of binge drinking [c]			p=0.0665		p=0.1886		
Never / less than monthly	36.8%	(32.9-41.0)	1	-	1	-	*712, 376*
Monthly	36.9%	(30.0-44.5)	1.00	(0.71-1.43)	0.90	(0.62-1.30)	*200, 107*
Weekly or more often	48.4%	(39.4-57.6)	1.61	(1.07-2.42)	1.41	(0.92-2.15)	*137, 78*
Sexual behaviours (all eligible for catch-up vaccination)							
Number of sexual partners, lifetime [d]			p<0.0001		p=0.0107		
0	24.50%	(18.4-31.7)	0.62	(0.38-1.01)	0.72	(0.43-1.18)	*205, 109*
1	34.40%	(27.1-42.5)	1	-	1	-	*203, 113*
2	37.60%	(29.1-46.8)	1.15	(0.69-1.89)	1.12	(0.68-1.84)	*147, 77*
3-4	39.60%	(31.6-48.2)	1.25	(0.77-2.03)	1.22	(0.75-2.00)	*171, 93*
5+	49.90%	(43.6-56.1)	1.89	(1.23-2.91)	1.70	(1.09-2.63)	*317, 167*

All eligible for HPV catch-up vaccination programme with 1+ lifetime partner [d]		**41.90%**	**(38.3-45.6)**					***843, 451***
Sexual behaviours (those with 1+ lifetime partner)								
Had heterosexual sex before 16				p=0.0088		p=0.0014		
	No	37.50%	(32.7-42.6)	1	-	1	-	*456, 252*
	Yes	47.70%	(42.0-53.4)	1.52	(1.11-2.07)	1.68	(1.22-2.30)	*355, 181*
Number of sexual partners, past year [d]				p=0.3294		p=0.2689		
	0/1	39.70%	(35.0-44.6)	1	-	1	-	*475, 260*
	2	44.80%	(36.2-53.6)	1.23	(0.82-1.84)	1.28	(0.85-1.93)	*156, 78*
	3+	45.70%	(38.2-53.3)	1.28	(0.89-1.84)	1.3	(0.90-1.88)	*203, 108*
Number of sexual partners without a condom, past year [d]				p=0.0092		p=0.0065		
	0	38.80%	(31.0-47.2)	1	-	1	-	*196, 106*
	1	39.60%	(34.7-44.7)	1.03	(0.68-1.56)	1.03	(0.69-1.55)	*443, 238*
	2+	53.10%	(45.1-60.9)	1.79	(1.13-2.83)	1.83	(1.16-2.88)	*185, 98*
Health-related factors								
Used hormonal contraception, past year [e]				p<0.0001		p<0.0001		
	No	54.30%	(47.1-61.4)	1	-	1	-	*235, 131*
	Yes	36.40%	(32.4-40.7)	0.48	(0.34-0.68)	0.47	(0.34-0.67)	*570, 299*
Ever attended a sexual health (GUM) clinic				p=0.0044		p=0.0100		
	No	37.20%	(32.6-42.1)	1	-	1	-	*462, 251*
	Yes	47.80%	(42.3-53.3)	1.54	(1.15-2.08)	1.49	(1.10-2.02)	*377, 199*
Ever diagnosed with an STI (excluding thrush) [f]				p=0.1735		p=0.4147		
	No (or only thrush)	41.00%	(37.1-45.0)	1	-	1	-	*730, 395*
	Yes	48.50%	(38.3-58.8)	1.36	(0.87-2.10)	1.2	(0.77-1.88)	*109, 55*
Ever been pregnant				p<0.0001		p<0.0001		
	No	35.40%	(31.4-39.8)	1	-	1	-	*633, 346*
	Yes	63.40%	(55.9-70.2)	3.15	(2.21-4.49)	2.94	(2.04-4.23)	*210, 105*
All eligible for HPV catch-up vaccination programme with 1+ lifetime partner [d] who provided a urine sample		**41.00%**	**(36.1-46.1)**					***481, 273***
HPV markers in urine								
HPV positive				p=0.0302		p=0.0383		
	HPV negative	36.00%	(29.3-43.2)	1	-	1	-	*253, 152*
	HPV positive	47.20%	(40.0-54.6)	1.6	(1.04-2.44)	1.57	(1.02-2.40)	*228, 121*
1+ high-risk HPV type(s)				p=0.0003		p=0.0005		
	Negative	35.30%	(29.6-41.4)	1	-	1	-	*347, 200*
	Positive	56.60%	(46.8-65.9)	2.39	(1.49-3.83)	2.33	(1.45-3.74)	*134, 73*

a Index of Multiple Deprivation (IMD) is a multi-dimensional measure of area (neighbourhood)-level deprivation based on the participant's postcode. IMD scores for England, Scotland and Wales were adjusted before being combined and assigned to quintiles, using a method by Payne and Abel (Payne and Abel, 2012).

b Participants aged ≥17 years

c Binge drinking defined as having six units on one occasion

d Includes both opposite-sex and same-sex partners

e Defined as having used the oral contacepive pill, hormonal IUD, injections, or implants

f Defined as having been diagnosed with one of chlamydia, gonorrhoea, syphilis, genital herpes, genital warts, trichomonas, non-specific urethritis/non-gonococcal urethritis

Figure legends

Figure 1: Uptake of cervical cancer interventions. A) Time since last cervical smear test by age group among women aged 26-74 years; B) HPV vaccination uptake by school year at eligibility for vaccination in either the routine (Year 8/S2) or catch-up programmes

A) Women are eligible for cervical screening every 3-5 years depending on regional protocols (3 yearly to age 49 in England then 5 yearly to age 64; 3 yearly to age 64 in Wales and 3 yearly to age 60 in Scotland).

Denominators exclude women who report having had a hysterectomy & those with no lifetime sexual partners.

*All women in eligible age range for screening

Denominators (unwt., wt.) are: 26-29 (1121, 547), 30-34 (1025,648), 35-39 (580,664), 40-44 (571, 710), 45-49 (536, 694), 50-54 (427,553), 55-59 (399, 505), 60-64 (381,444), 65-69 (349, 387), 70-74 (225, 226), all eligible (5012, 4731)

Percentage screened in past 5 years when women reporting a hysterectomy are included in the denominator (N=5372, 5164) is 86.2%

B) Denominators (unwt., wt.) are: Y10 (153, 78), Y11 (244, 123), Y12 (238, 117), Y13 (415, 243), All catch-up (1050, 562), Routine (44, 21)

Figure 2: Relationship between risk factors for HR-HPV and uptake of cervical cancer programmes: (A) cervical screening and (B) HPV catch-up vaccination

All ORs adjusted for age. 95%CIs for AORs exclude 1 with the exception of the association between hormonal contraception use and HR-HPV (see Tables 1, 2 and 4).

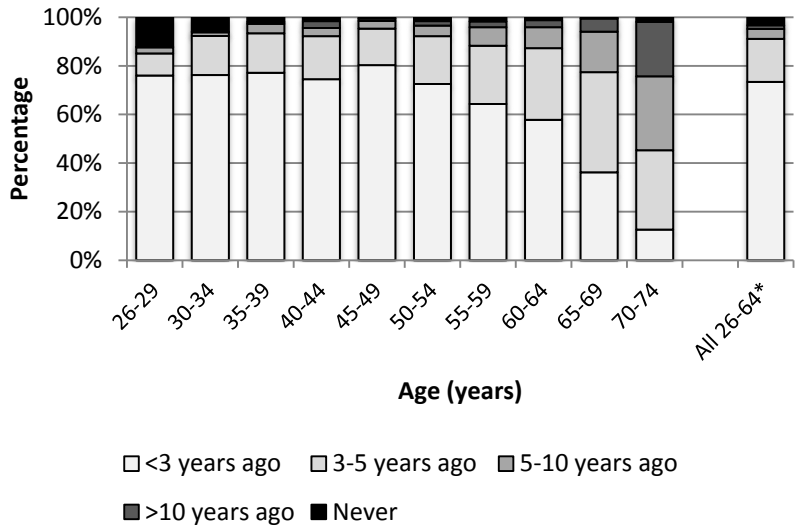
Top right quadrant for each graph indicates increased risk of HR-HPV and lower uptake of cervical cancer prevention programme. The area of the bubble represents the size of the group as a proportion of those eligible for screening. Letters indicate reference groups: a) 1 lifetime sexual partner; b) non/ex-smoker; c) resident in 2 least deprived quintiles; d) White/White British; e) Not used hormonal contraception, past year; f) Never attended a sexual health (GUM) clinic

Role of the sponsor

The sponsors of the study had no role in study design and the collection, analysis and interpretation of data, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

1

A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Age (years)
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3-5 years ago
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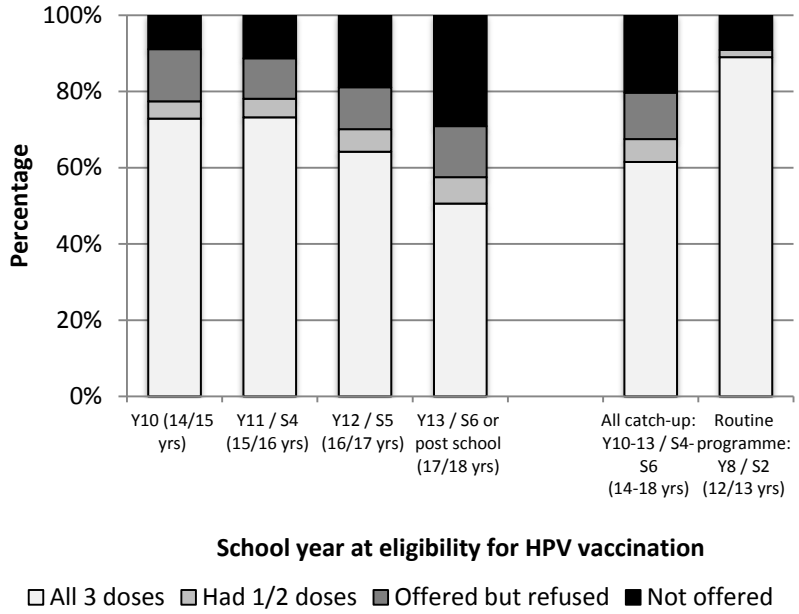
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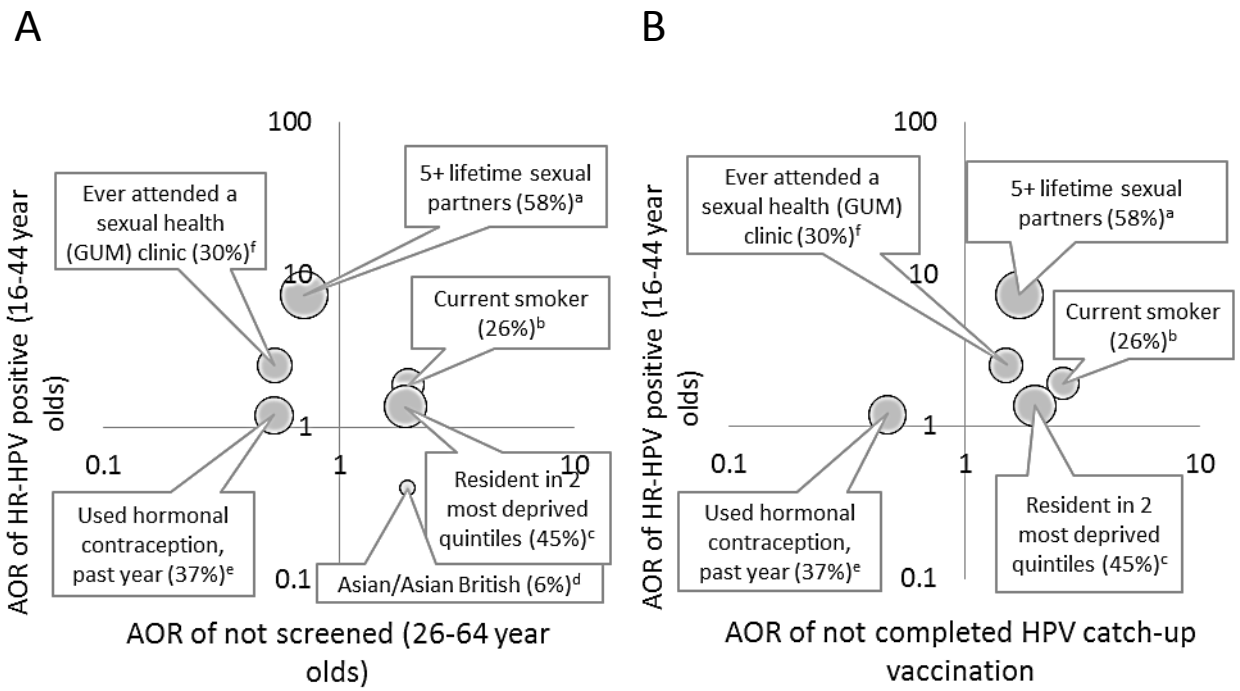
Percentage
Y10 (14/15 yrs)
Y11 / S4 (15/16 yrs)
Y12 / S5 (16/17 yrs)
Y13 / S6 or post school (17/18 yrs)
All catch-up: Y10-13 / S4-S6 (14-18 yrs)
Routine programme: Y8 / S2 (12/13 yrs)
School year at eligibility for HPV vaccination
All 3 doses
Had 1/2 doses
Offered but refused
Not offered

2


A
100
10
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0.1
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1
10
AOR of HR-HPV positive (16-44 year olds)
AOR of not screened (26-64 year olds)
Ever attended a sexual health (GUM) clinic (30%)f
5+ lifetime sexual partners (58%)a
Current smoker (26%)b
Resident in 2 most deprived quintiles (45%)c
Used hormonal contraception, past year (37%)e
Asian/Asian British (6%)d
B
100
10
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AOR of HR-HPV positive (16-44 year olds)
AOR of not completed HPV catch-up vaccination
Ever attended a sexual health (GUM) clinic (30%)f
5+ lifetime sexual partners (58%)a
Current smoker (26%)b
Resident in 2 most deprived quintiles (45%)c
Used hormonal contraception, past year (37%)e