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Prevalence, risk factors, and uptake of interventions for sexually transmitted infections in Britain: findings from the National Surveys of Sexual Attitudes and Lifestyles (Natsal)

Pam Sonnenberg, Soazig Clifton, Simon Beddows, Nigel Field, Kate Soldan, Clare Tanton, Catherine H Mercer, Filomeno Coelho da Silva, Sarah Alexander, Andrew J Copas, Andrew Phelps, Bob Erens, Philip Prah, Wendy Macdowall, Kaye Wellings, Catherine A Ison*, Anne M Johnson*

Summary
Background  Population-based estimates of prevalence, risk distribution, and intervention uptake inform delivery of control programmes for sexually transmitted infections (STIs). We undertook the third National Survey of Sexual Attitudes and Lifestyles (Natsal-3) after implementation of national sexual health strategies, and describe the epidemiology of four STIs in Britain (England, Scotland, and Wales) and the uptake of interventions.

Methods  Between Sept 6, 2010 and Aug 31, 2012, we did a probability sample survey of 15 162 women and men aged 16–74 years in Britain. Participants were interviewed with computer-assisted face-to-face and self-completion questionnaires. Urine from a sample of participants aged 16–44 years who reported at least one sexual partner over the lifetime was tested for the presence of Chlamydia trachomatis, type-specific human papillomavirus (HPV), Neisseria gonorrhoeae, and HIV antibody. We describe age-specific and sex-specific prevalences of infection and intervention uptake, in relation to demographic and behavioural factors, and explore changes since Natsal-1 (1990–91) and Natsal-2 (1999–2001).

Findings  Of 8047 eligible participants invited to provide a urine sample, 4828 (60%) agreed. We excluded 278 samples, leaving 4550 (94%) participants with STI test results. Chlamydia prevalence was 1·5% (95% CI 1·1–2·0) in women and 1·1% (0·7–1·6) in men. Prevalences in individuals aged 16–24 years were 3·1% (2·2–4·3) in women and 2·3% (1·5–3·4) in men. Area-level deprivation and higher numbers of partners, especially without use of condoms, were risk factors. However, 60·4% (45·5–73·7) of chlamydia in women and 43·3% (25·9–62·5) in men was in individuals who had had one partner in the past year. Among sexually active 16–24-year-olds, 54·2% (51·4–56·9) of women and 34·6% (31·8–37·4) of men reported testing for chlamydia in the past year, with testing higher in those with more partners. High-risk HPV was detected in 15·9% (14·4–17·5) of women, similar to in Natsal-2. Coverage of HPV catch-up vaccination was 61·5% (58·2–64·7). Prevalence of HPV types 16 and 18 in women aged 18–20 years was lower in Natsal-3 than Natsal-2 (5·8% [3·9–8·6] vs 11·3% [6·8–18·2]; age-adjusted odds ratio 0·44 [0·21–0·94]). Gonorrhoea (<0·1% prevalence in women and men) and HIV (0·1% prevalence in women and 0·2% in men) were uncommon and restricted to participants with recognised high-risk factors. Since Natsal-2, substantial increases were noted in attendance at health clinics (from 6·7% to 21·4% in women and from 7·7% to 19·6% in men) and HIV testing (from 8·7% to 27·6% in women and from 9·2% to 16·9% in men) in the past 5 years.

Interpretation  STIs were distributed heterogeneously, requiring general and infection-specific interventions. Increases in testing and attendance at sexual health clinics, especially in people at highest risk, are encouraging. However, STIs persist both in individuals accessing and those not accessing services. Our findings provide empirical evidence to inform future sexual health interventions and services.

Funding  Grants from the UK Medical Research Council and the Wellcome Trust, with support from the Economic and Social Research Council and the Department of Health.

Introduction  Diagnosed sexually transmitted infections (STIs) have increased substantially in Britain (England, Scotland, and Wales) since the 1990s and throughout the past decade to the end of 2012, emphasising the importance of sustained public health programmes to identify and treat infections, reduce morbidity and mortality, and prevent onward transmission. Population-based estimates of infection prevalence, risk distribution, and intervention uptake inform the design and delivery of STI control programmes. The National Surveys of Sexual Attitudes and Lifestyles (Natsal)-1 (1990–91) and Natsal-2 (1999–2001) have guided the development of sexual health programmes by providing empirical evidence to understand the heterogeneity of sexual behaviour in the British population, the prevalence of STIs, and the drivers of transmission. Surveillance of STI diagnoses does not measure the true prevalence of STIs in the population because infections are often asymptomatic and undiagnosed. Natsal links prevalence (measured with biological sampling) with population risk factors and can thus assess the extent to which infected and at-risk individuals access specific interventions and services.
Since Natsal-2, several strategies to improve sexual health have been implemented in Britain, as they have been in other developed countries or regions. The British initiatives include the National Strategy for Sexual Health and HIV in England (2001); Respect and Responsibility: Strategy and Action Plan for Improving Sexual Health in Scotland (2005); and the Strategic Framework for Promoting Sexual Health in Wales (2001). All the strategies have broad sexual health objectives and promote a reduction in risk behaviour (eg, increased condom use). Three STI-specific interventions have been implemented: (1) the English National Chlamydia Screening Programme (NCSP) in 2003 (opportunistic screening in sexually active women and men aged 16–24 years); Scottish and Welsh strategies encouraged testing in this age group, but with no formal programme; (2) the UK human papillomavirus (HPV) immunisation programme in 2008, using the bivalent HPV 16/18 vaccine (routine immunisation of girls aged 12–13 years, with a catch-up programme up to age 17 years); and (3) strategies to increase HIV testing in target groups as outlined in the 2008 British HIV Association (BHIVA) National Guidelines. Furthermore, the range and accessibility of STI services has broadened, with modernised sexual health (genitourinary medicine [GUM]) clinics, targets for 48 h waiting times, and expansion of the role of primary care.

We present age-specific and sex-specific estimates for the population prevalence of, and associated risk factors for, infection with Chlamydia trachomatis, high-risk HPV, Neisseria gonorrhoeae, and HIV from a probability sample of 16–44-year-olds in Britain. Additionally, we describe the uptake of interventions and sexual health services, and explore changes since Natsal-1 and Natsal-2.

Methods
Participants and procedures
Natsal-3 is a stratified probability sample survey of 15 162 women and men aged 16–74 years in Britain who were interviewed between Sept 6, 2010, and Aug 31, 2012. The estimated overall response rate was 57.7% and the estimated sample size was 15 162 women and men aged 16–74 years. Natsal-3 is a stratified probability sample survey of 15 162 women and men aged 16–74 years in Britain who were interviewed between Sept 6, 2010, and Aug 31, 2012. The estimated overall response rate was 57.7% and the estimated sample size was 15 162 women and men aged 16–74 years in Britain. Additionally, we describe the uptake of interventions and sexual health services, and explore changes since Natsal-1 and Natsal-2.

We present age-specific and sex-specific estimates for the population prevalence of, and associated risk factors for, infection with Chlamydia trachomatis, high-risk HPV, Neisseria gonorrhoeae, and HIV from a probability sample of 16–44-year-olds in Britain. Additionally, we describe the uptake of interventions and sexual health services, and explore changes since Natsal-1 and Natsal-2.

Participants in Natsal-3 were asked “Have you ever attended a sexual health clinic (GUM clinic)?”. Full details of the methods have been described elsewhere. An anonymised dataset will be deposited with the UK Data Archive and the complete questionnaire and technical report will be available on the Natsal website on the day of publication.

After the interview, we invited a sample of participants aged 16–44 years (all participants aged 16–17 years; all those aged 18–24 years who reported at least one sexual partner over the lifetime; a random subsample of 85% of 25–44-year-olds who reported at least one sexual partner over the lifetime; and any remaining men aged 25–44 years who reported having sex with another man in the past 5 years) to provide a urine sample for STI testing. We used this strategy to maximise information from groups in whom morbidity and interventions are concentrated, with considerations of sample-size calculations and appropriate use of resources. Urine was collected with the FirstBurst device, which collects the first 4–5 mL of voided urine, thus yielding a higher load of C trachomatis than the regular urine cup, which, on the basis of development work for Natsal-3, might also increase detection of HPV DNA and HIV antibody. Samples were posted to Public Health England for testing. All participants were given information about where to obtain free diagnostic STI and HIV testing and sexual health advice.

In view of the low population prevalence of some STIs, our predefined testing strategy aimed to reduce the likelihood of false positives. Detection of C trachomatis and N gonorrhoeae was done with the Aptima Combo 2 assay (Hologic Gen-Probe) as an initial screen, and we confirmed all positive and equivocal results with the Aptima monospecific assays for detection of C trachomatis or N gonorrhoeae. We used an in-house Luminex-based genotyping assay to detect HPV types. We defined high-risk types as 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, and 68. We identified HIV infection with a modified IgG antibody-capture particle-adherence test (GACPAT) to detect HIV-1 and HIV-2 antibodies in urine; we confirmed results with HIV western blot 2.2 (MP Biomedicals, UK).

Statistical analysis
We did all statistical analyses with Stata (version 12.1), accounting for stratification, clustering, and weighting of the sample. We included an additional weight, derived from a logistic regression model, which corrected for unequal probabilities of urine-sample selection, and differential sample response. Generally, before weighting, younger individuals; those who had had same-sex relationships; and those who engaged in high-risk behaviours, such as more partners with whom they had unprotected sex, were more likely to provide a urine sample than were other participants. We present prevalence estimates in women and men, by age group, with 95% CIs, in participants who reported at least one sexual partner over the lifetime. We examined the
associations between chlamydia and high-risk HPV and demographic and behavioural variables with logistic regression and present crude odds ratios (ORs) and adjusted ORs (AORs). Multivariable analyses adjusted for two demographic variables (age and area-level deprivation [index of multiple deprivation; IMD]) and one behavioural factor (number of sexual partners in the past year; a key factor in STI epidemiology and a useful indicator for sexual health-care providers). We considered IMD to be an important predictor and possible confounder, because services and interventions are often commissioned and provided on an area-level basis. We present uptake of interventions by risk factors or target groups, in the relevant age ranges of participants aged 16–44. We compared these findings, when possible, across the three surveys. We estimated the annual rate of chlamydia diagnosis per 100 000 population (an indicator in the Public Health Outcomes Framework for England) from self-reported chlamydia diagnoses in the past year in all participants aged 16–24 years living in England. We report coverage of HPV vaccination in women who reported any sexual experience and were eligible for the HPV catch-up immunisation programme (ie, were born between Sept 1, 1990, and Aug 31, 1995). We obtained ethics approval from Oxfordshire Research Ethics Committee A (reference 09/H0604/27). Participants gave written informed consent to anonymised testing, without the return of results, the ethical rationale for which has been previously described. Details about the preparation, testing, and quality assurance of urine samples have been published elsewhere.

Role of funding source
The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, 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.

Results
Of 9902 participants aged 16–44 years, 8947 (90%) reported at least one sexual partner over the lifetime. Of these individuals, 8047 (90%) were invited to provide a urine sample of whom 4828 (60%) agreed. We excluded 278 samples (on the basis of insufficient samples, mislabeling, or unrecorded consent), leaving 4550 (94%) participants with STI test results (2665 women and 1885 men).

98 participants (62 women and 36 men) tested positive for chlamydia. Table 1 shows the weighted age-specific prevalences in women and men. For women, the highest prevalence was in those aged 18–19 years (table 1). By contrast, for men, the highest prevalence was in those aged 20–24 years (table 1). We detected no positive chlamydia tests in men aged 16–17 years and few positives in those aged 18–19 years (table 1). Individuals living in the most deprived regions were more likely to test positive for chlamydia (table 2). Prevalence of chlamydia increased with increasing numbers of partners in the past year (table 2). However, an estimated 60·4% (95% CI 45·5–73·7%) of prevalent chlamydia in women, and 43·3% (25·9–62·5%) in men, was in those with only one partner in the past year. Reporting of two or more partners without use of a condom in the past year was more strongly associated with chlamydia than were partner numbers alone (table 2).

Prevalence of chlamydia in participants aged 16–24 years—ie, the age group targeted by the NCSP—was 3·1% (2·2–4·3%) in women and 2·3% (1·5–3·4%) in men. Women aged 16–24 years were more likely to...
have reported a chlamydia test in the past year than men (adjusted OR 2·55, 95% CI 2·13–3·07; table 3). The proportions of women and men tested in England were significantly higher than those tested in Scotland or Wales (table 3). Proportions of individuals testing did not differ by area-level deprivation (table 3). Participants with higher numbers of partners in the past year were more likely to report testing than were those with low partner numbers, as were those with a new partner in the past year (data not shown). However, of individuals aged 16–44 years who had detectable chlamydia in their urine the past year (data not shown). However, of individuals aged 16–44 years who had detectable chlamydia in their urine the past year.
(95% CI 14·3–17·6) vs 16·0% (14·2–18·0) in women and 8·6% (6·9–10·7) vs 9·9% (8·2–11·9) in men.

Of women eligible for the HPV catch-up immunisation programme, 61·5% reported completing the three-dose vaccination course (table 3). Vaccination coverage was lowest in individuals from the most deprived areas and in those with more partners (table 3). Prevalence of HPV types 16 and 18 in women aged 18–20 years was 5·8%
which was lower than that noted before introduction of the immunisation programme in Natsal-2 (11·3% [6·8–18·2]; age-adjusted OR 0·44 [0·21–0·94]). Prevalence of HPV types 16 or 18 was likewise reduced in men in Natsal-3 (1·1% [0·4–3·0]) compared with those in Natsal-2 (5·0% [1·7–13·6]; age-adjusted OR 0·20 [0·04–0·93]).

Three women and one man had urine tests that were positive for gonorrhoea, giving a weighted prevalence of less than 0·1% in both women and men aged 16–44 years.

<table>
<thead>
<tr>
<th>Among target groups††</th>
<th>% (95% CI)</th>
<th>Crude OR</th>
<th>AOR*</th>
<th>95% CI</th>
<th>% (95% CI)</th>
<th>Crude OR</th>
<th>AOR*</th>
<th>95% CI</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>People who attended a GUM or sexual health clinic in the past 5 years</td>
<td>58 3% (55·3–61·4)</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>50 8% (46·4–55·1)</td>
<td>·· ·· ··</td>
<td>1270, 737</td>
<td>811, 676</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Those diagnosed with an STI in the past 5 years‡‡</td>
<td>68 3% (62·4–73·6)</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>54·7% (47·1–62·1)</td>
<td>·· ·· ··</td>
<td>376, 210</td>
<td>243, 214</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women who had attended antenatal services in the past 5 years</td>
<td>47 9% (44·7–51·0)</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>1226, 872</td>
<td>·· ··</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women who had had an abortion in the past 5 years§§</td>
<td>48 8% (42·5–55·2)</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>51·6% (41·1–61·9)</td>
<td>·· ·· ··</td>
<td>310, 164</td>
<td>·· ··</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men who had had sex with a man in the past 5 years</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>134, 112</td>
<td>·· ··</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>People of black African ethnic origin</td>
<td>46 1% (35·6–57·0)</td>
<td>·· ·· ··</td>
<td>·· ·· ··</td>
<td>43·9% (30·3–58·6)</td>
<td>·· ·· ··</td>
<td>96, 75</td>
<td>71, 82</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Reported attendance at sexual health clinics in the past 5 years**

| All aged 16–44 years | 21·4% (20·1–22·7) | p<0·0001 | p=0·0001 | 19·6% (18·2–21·2) | p<0·0001 | p=0·0001 | 5234, 3651 | 3546, 3624 |
| By age group (years) | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· |
| 16–24 | 43·8% (41·1–46·5) | 1·00 | 1·00 | 31·4% (28·6–34·4) | 1·00 | 1·00 | 1701, 947 | 1353, 987 |
| 25–34 | 21·3% (19·4–23·4) | 0·35 | 0·55 | 0·46–0·66 | 0·67 | 0·97 | 0·79–1·22 | 2365, 1306 | 1418, 1269 |
| 35–44 | 6·3% (5·0–7·8) | 0·09 | 0·19 | 0·14–0·25 | 0·18 | 0·37 | 0·26–0·51 | 1168, 1398 | 775, 1368 |
| By IMD quintile‡ | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· |
| 1–2 (least deprived) | 18·3% (16·5–20·3) | 1·00 | 1·00 | 17·0% (14·8–19·5) | 1·00 | 1·00 | 1791, 1327 | 1279, 1338 |
| 3 | 19·9% (17·3–22·9) | 1·12 | 1·10 | 0·86–1·40 | 1·22 | 1·25 | 0·94–1·66 | 1022, 726 | 682, 709 |
| 4–5 (most deprived) | 24·6% (22·7–26·6) | 1·45 | 1·41 | 1·18–1·70 | 1·36 | 1·22 | 0·97–1·54 | 2421, 1598 | 1585, 1576 |

| By number of sexual partners in the past 5 years§ | ·· ·· ·· | ·· ·· ·· | ·· ·· ·· |
| 0–1 | 7·7% (6·7–8·9) | 1·00 | 1·00 | 5·8% (4·8–7·1) | 1·00 | 1·00 | 2644, 2113 | 1439, 1795 |
| 2–4 | 30·5% (28·0–33·2) | 5·24 | 3·77 | 3·09–4·59 | 5·20 | 4·12 | 3·11–5·44 | 1625, 992 | 1093, 1001 |
| 5–9 | 55·1% (50·4–59·7) | 14·66 | 8·88 | 6·88–11·46 | 34·9% (30·3–39·9) | 8·69 | 6·37 | 4·64–8·74 | 621, 359 | 554, 453 |
| ≥10 | 65·6% (59·2–71·4) | 22·73 | 12·11 | 8·66–16·96 | 55·9% (50·6–61·1) | 20·54 | 15·36 | 11·15–21·66 | 320, 171 | 441, 359 |

| In people diagnosed with an STI in the past 5 years†† | 83·7% (79·1–87·4) | ·· ·· ·· | ·· ·· ·· |
| In men who had had sex with a man in the past 5 years | ·· ·· ·· | ·· ·· ·· | 45·0% (35·0–55·5) | ·· ·· ·· | ·· ·· ·· | 136, 115 |
More women than men reported HIV testing in the past 5 years (table 3). Testing was highest in individuals aged 25–34 years, in those with more sexual partners, in those who had attended a sexual health clinic, in those who had been diagnosed with an STI in the past 5 years, in people of black African ethnic origin, and in men who had sex with men in the past 5 years. The proportion of men who had sex with men who had HIV tests increased with increasing partner numbers (data not shown), reaching 84·5% (95% CI 69·4–92·9) in men reporting five or more male partners in the past 5 years. The proportion of participants reporting having had an HIV test in the past 5 years was higher in Natsal-3 (27·6% in women and 16·9% in men; table 3) than in Natsal-2 (8·7% vs 9·2%; appendix). HIV testing was generally higher with increasing numbers of sexual partners and in groups specifically targeted for testing (figure 1), with increases in testing mostly occurring in the past 10 years.

In the past 5 years, roughly a fifth of women and men reported attendance at a sexual health clinic, with

<table>
<thead>
<tr>
<th>Table 4: Risk factors for high-risk human papillomavirus in urine among in participants aged 16–44 years, by sex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Women</strong></td>
</tr>
<tr>
<td>% (95% CI)</td>
</tr>
<tr>
<td>All ages</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>16–19</td>
</tr>
<tr>
<td>20–24</td>
</tr>
<tr>
<td>25–34</td>
</tr>
<tr>
<td>35–44</td>
</tr>
<tr>
<td>IMD (quintiles)‡</td>
</tr>
<tr>
<td>1–2 (least deprived)</td>
</tr>
<tr>
<td>≥3 (most deprived)</td>
</tr>
<tr>
<td>Number of sexual partners in the past year§</td>
</tr>
<tr>
<td>0–1</td>
</tr>
<tr>
<td>≥2</td>
</tr>
<tr>
<td>Number of sexual partners without a condom in the past year§¶</td>
</tr>
<tr>
<td>0–1</td>
</tr>
<tr>
<td>≥2</td>
</tr>
<tr>
<td>Age at first sex (years)**</td>
</tr>
<tr>
<td>≥16</td>
</tr>
<tr>
<td>&lt;16</td>
</tr>
<tr>
<td>Ever had same-sex experience?††</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

OR=odds ratio. AOR=adjusted odds ratio. IMD=Index of Multiple Deprivation. *Adjusted for age, IMD quintiles, and number of sexual partners in the past year. ††Participants who reported at least one partner, with a urine test result. IA multidimensional measure of area (neighbourhood)-level deprivation based on the participant’s postcode. We adjusted IMD scores for England, Scotland, and Wales before they were combined and assigned to quintiles, with use of a method by Payne and Abel. §Includes both opposite-sex and same-sex partners. ¶Number of partners without a condom in the past year is adjusted for age and IMD only, because of colinearity with number of sexual partners in the past year. ||Includes individuals with no partners in the past year. **Age at first heterosexual intercourse or first same-sex experience involving genital contact. ††Same-sex experience involving genital contact.

ORs obtained by multiple logistic regression analysis.
attendance highest in the youngest age group, in those with higher numbers of partners, and in women from the most deprived areas (table 3). More than 80% of participants reporting an STI diagnosis in the past 5 years had attended a sexual health clinic (table 3). Figure 2 shows attendance at sexual health clinics in the past 5 years in women and men aged 16–44 years across the three Natsal surveys, by number of partners and age group. We noted a significant increase in clinic attendance over the three surveys, with increasing attendance seen in all subgroups (appendix).

**Discussion**

Findings from this large population-based survey show that the four STIs are distributed heterogeneously in the British population. High-risk HPV was the most prevalent infection, followed by chlamydia; HIV and gonorrhoea were uncommon. Although STI risk increased with increasing partner numbers, most of the chlamydia and HPV infections were in individuals who did not have many recent partners because most of the population had only had one partner in the past year.25 For chlamydia and HPV, broad population-wide interventions are needed. By contrast, we show that gonorrhoea and HIV were restricted to a small proportion of the population who had high risk factors, including other STIs, supporting targeted interventions. STI transmission is a function of individual and partnership risks, as shown by the sex differences in the age distribution of chlamydia, which is related to patterns of sexual mixing, because younger women, on average, have older male partners.29

STI-specific interventions that take account of the epidemic phase30 are key components of STI prevention strategies. More focused interventions that include outbreak investigation and contact tracing might be more cost-effective than generalised screening for rare infections. The very low population prevalence of gonorrhoea allays concerns about widespread or asymptomatic infection in the community. The prevalence of gonorrhoea was substantially higher in people testing positive for chlamydia than it was in the general population, suggesting that, in addition to outbreak investigation, gonorrhoea testing in people with chlamydia identified through population screening might be an appropriate strategy.

Survey participants and those providing urine might not be fully representative of the general population, despite our best efforts to adjust for known biases. To minimise non-participation bias, we weighted Natsal-3
data to correct for differential selection probabilities and for differential non-response (by comparing with census data). Application of the urine selection and non-response weights further reduced participation bias. As discussed elsewhere, to minimise reporting bias, we included an extensive development phase and used computer-assisted self-interview for sensitive questions.

In this population-based study, we undertook tests on urine rather than genital specimens for practicality and acceptability. We recognise that urine is a suboptimum specimen for the detection of some STIs, particularly HPV in men, and that prevalence might be underestimated, although we are able to assess risk factors. Comparisons of urine prevalence estimates between Natsal-2 and Natsal-3 should be made with caution, in view of differences in methods of sample collection, preparation and storage, chlamydia diagnostic tests, and because the surveys were not powered to detect changes in prevalence. Trends in STI prevalence should be considered in the context of possible changes in sexual behaviour over time. Between Natsal-2 and Natsal-3, modest increases in some risk behaviours have taken place (including increases in partner numbers) in women, but evidence shows some reduction in men, by contrast with the increases in both sexes noted between Natsal-1 and Natsal-2.

Compared with Natsal-2, which tested urine from a sample of participants aged 18–44 years, in Natsal-3 we extended the age range to include 16–17-year-olds. This change improved prevalence estimates in the younger age groups, who have the highest prevalence and greatest risk of sequelae and are therefore the age groups at whom interventions are targeted. People remain sexually active into older age, including new partners, which means that STI risk continues. Surveillance data show that the rate of acute STIs diagnosed in sexual health clinics in individuals aged 20–24 years is almost 20 times higher than that in those aged 44–59 years (4278 per 100000 population vs 227 per 100000 population in 2012). Although recent reports have shown increases in some diagnosed STIs in older age groups, the absolute rates are very low. Therefore, even a population-based survey of more than 15000 participants, as in Natsal-3, would not have sufficient power to estimate STI prevalence in those older than 44 years with useful precision.

Attendance at sexual health clinics and uptake of HIV testing have increased substantially in the past two decades. Furthermore, many sexually active young adults reported having had a chlamydia test in the past year. Although it is reassuring that large and increasing proportions of the population at highest risk are accessing services and testing, many people have still not done so. For example, two-thirds of the participants in whom chlamydia was detected in our study did not report a test in the past year, and more than three-quarters had not attended a sexual health service in the past year—far less than the recommendation to test all men in this group annually. Convenience surveys of men who have sex with men have reported that 50–60% of men have been tested in the past year, whereas surveillance data estimate about 10%. Our results provide a valuable population-based estimate by including men who have sex with men who do not necessarily identify as gay or use sexual health services.

One in five sexually active participants reported attendance at a sexual health clinic in the past 5 years, which is consistent with estimates from clinic surveillance data (overall 19–9% of women and 17–2% of men, with age-specific proportions also similar). This finding suggests that a minimum amount of misclassification bias took place when individuals answered the revised question in Natsal-3, despite the broad range of settings used for sexual health services in 2010. 80% of people with an STI diagnosis in the past 5 years reported attendance at a sexual health clinic, suggesting that in most cases, treatment for STIs occurs in specialist services. Uptake of antenatal HIV testing, measured from unlinked anonymous surveillance, was 97% in 2011; however, the reporting of this testing was much lower in Natsal-3 (48%). Although this proportion is significantly higher than the 15% reported in Natsal-2, both

![Figure 2: Change over time in reported attendance at sexual health clinics in the past 5 years, by age group (A, B) and number of partners (C, D)](http://dx.doi.org/10.1016/S0140-6736(13)61947-9)
AddHealth in the USA and Contexte de la Sexualité en France have included testing for multiple sexual partnerships, and provided baseline estimates of type-specific human Chlamydia trachomatis sexually transmitted infections (STIs). Natsal-2 included biological sampling, and tested for

While many developed countries have national sexual health services and surveillance, few population-based surveys (the National Health and Nutrition Examination Survey and AddHealth in the USA and Contexte de la Sexualité en France) have included testing for sexually transmitted infections (STIs). Natsal-2 included biological sampling, and tested for Chlamydia trachomatis, showing a clear association with sexual behaviour, particularly multiple sexual partnerships, and provided baseline estimates of type-specific human papillomavirus (HPV) before the introduction of the HPV vaccination programme in 2008.

Many large-scale population-based public health interventions are not subject to randomised controlled trials and can rely on natural experiments or mathematical modelling to assess effect. Comparison within populations and across countries is difficult because variations might exist in underlying STI epidemiology, health services, surveillance systems, and STI control measures. The UK has a network of accessible, confidential sexual health clinics, a National Health Service that is free at the point-of-care, and an STI surveillance system that has existed for almost a century. The combination of repeated cross-sectional national probability sexual health surveys, with detailed behavioural data and STI testing, surveillance, and comprehensive free open-access services, is, to our knowledge, unique.

**Interpretation**

Our study updates prevalence estimates and risk factors for chlamydia and HPV, and, for the first time, reports population prevalences for gonorrhoea and HIV. With use of data from all three National Survey of Sexual Attitudes and Lifestyles (Natsal) studies, we show increases in reported chlamydia diagnoses and HIV testing, and in attendance at sexual health clinics, especially in individuals at highest risk. We also report coverage of HPV catch-up programmes and early findings of a reduction in HPV types 16 and 18 in women in the eligible age group. Although Natsal is not specifically designed or powered to evaluate particular interventions or initiatives, especially in subgroups of the population, the surveys allow us to track progress and measure some outcomes to complement and validate routinely collected data. Furthermore, Natsal provides empirical population-based estimates of prevalence and uptake according to risk, and behavioural data to populate mathematical models.
estimates of prevalence. Although the finding that eight of the nine HIV-positive participants in Natsal-3 reported previous testing is reassuring, we cannot know at what stage in their infection, or whether, they were diagnosed. National surveillance data show that many people in the community have undiagnosed infection, such that many present with late-stage disease.13 The HIV-positive participants in Natsal-3 all had clearly identifiable risks, reinforcing the need to raise awareness of HIV and its prevention, particularly in the groups most affected. To detect HIV both within and outside the main risk groups, health professionals should take an appropriate history and increase testing in routine clinical practice.

The greatly increased uptake of sexual health services in the past decade, particularly in people at increased STI risk, is encouraging (panel). Three of the interventions we measured are indicators in the Public Health Outcomes Framework7 (chlamydia diagnoses rate, HPV immunisation, and HIV testing [late diagnoses]) and are included in the 2013 Framework for Sexual Health Improvement in England.14 This framework, and the Sexual Health and Wellbeing Action Plan for Wales 2010–15,15 also emphasise the need for high-quality integrated sexual health services and promotion of prevention strategies. At a time of change in the organisation and structure of service delivery and commissioning, these findings provide empirical evidence to inform future sexual health interventions and services.

Conclusions

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