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# Sexual and testing behaviour associated with *Chlamydia trachomatis* infection: a cohort study in an STI clinic in Sweden

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## ABSTRACT

**Background:** Genital chlamydia infection (chlamydia) is the most commonly reported sexually transmitted infection (STI) in Sweden. To guide prevention needs, we aimed to investigate factors associated with chlamydia.

**Methods:** A cohort of visitors aged 20–40 years at an urban STI clinic in Sweden was recruited. Behavioural data were collected using a self-administered questionnaire. Self-sampled specimens were tested for chlamydia by a DNA amplification assay. Statistically significant ($p<0.05$) and epidemiologically relevant covariates were entered in a multivariate Poisson model adjusted for potential confounders (age and gender). Backward stepwise elimination produced a final model. Multiple imputation was used to account for missing values.

**Results:** Out of 2814 respondents, 1436 were men with a chlamydia positivity rate of 12.6% vs 8.9% in women. Lifetime testing for chlamydia and HIV was high (82% and 60%, respectively). Factors significantly associated with chlamydia were: 20–24 years old (adjusted risk ratio (ARR)=2.10, 95% CI 1.21 to 3.65); testing reason: contact with a chlamydia case (ARR=6.55, 95% CI 4.77 to 8.98) and having symptoms (ARR=2.19, 95% CI 1.48 to 3.24); 6–10 sexual partners (ARR=1.53, 95% CI 1.06 to 2.21); last sexual activity 'vaginal sex and oral sex and anal sex and petting' (ARR=1.84, 95% CI 1.09 to 3.10); alcohol use before sex (ARR=1.98, 95% CI 1.10 to 3.57); men with symptoms (ARR=2.09, 95% CI 1.38 to 3.18); tested for chlamydia (ARR=0.72, 95% CI 0.55 to 0.94).

**Conclusions:** Risk factors associated with chlamydia were consistent with previous reports in similar settings and suggest no major changes over time. Increased risk for chlamydia infection associated with high-risk behaviour (eg, alcohol use, increased number of sexual partners) supports the need for behavioural interventions in this population such as promotion of safer sex behaviour (condom use) and testing.

## Strengths and limitations of this study

- This large cohort allowed us to assess behavioural data linked to the laboratory verified chlamydia status.
- Laboratory verification of chlamydia status allowed unbiased ascertainment of the outcome in our study.
- Handling missing data by multiple imputations allowed a more valid inference by increasing the power of the study and less biased inference as opposed to complete case analysis.
- The observational study design is linked to a number of biases (such as recall bias and social desirability bias).
- This study has limited generalisability outside of populations attending sexually transmitted infection clinics.

## INTRODUCTION

Sweden is one of the European Union countries where reported *Chlamydia trachomatis* infection (chlamydia) rates are high, alongside the UK, Denmark, Iceland, Finland and Norway.[1] The number of chlamydia cases reported to the Swedish national surveillance system through mandatory reporting has increased by over 70% since 2000, from 217 cases/100 000 population to 370/100 000 population in 2014, with the highest burden among individuals aged 15–29 years.[2] In order to tackle high chlamydia rates and reduce potential serious sequelae of the reproductive system,[3 4] the National Board of Health and Welfare of Sweden launched in 2009 the National Action Plan for Chlamydia Prevention with a focus on young people aged 15–29 years.[5] The main objectives of the plan were to increase testing coverage and to promote safe sex (condom use), which required monitoring of sexual behaviours associated with chlamydia.

Current knowledge from developed countries suggests that young age (under 25 years), younger age at first intercourse, multiple sexual partners within the past year and during one's lifetime, recent change of partner, inconsistent condom use with casual or new partners, previous sexually transmitted infection (STI), alcohol and drug use

(as markers of risk-taking behaviour), race (non-white), and socioeconomic status are all associated with increased risk of chlamydia,[6–10] and condom use is associated with reduced risk of chlamydia.[11] In Sweden, studies about risk factors for chlamydia infection have been scattered in time and population. These include studies on healthcare clinic patients,[12–14] in the general population with a focus on socioeconomic factors with self-reported chlamydia status,[15] and in self-recruited users of a website for ordering home-based chlamydia sampling kits.[16] Owing to the change in the sexual behaviour of the general population over the past two decades[17] and lack of recent evidence on factors associated with chlamydia, this study was initiated in Sweden in a population with expected higher prevalence of chlamydia and other STIs.

With the goal of guiding healthcare professionals to identify high-risk individuals, and public health professionals in designing and applying targeted interventions, this paper presents results from a cohort study to investigate how sexual behaviour, testing behaviour and demographic factors were associated with chlamydia infection diagnosis in a large urban STI clinic.

## METHODS

### Participants and setting

The study design, setting and participants have been described in a published study protocol.[18] Briefly, a prospective cohort of visitors to a drop-in STI clinic for adults over 20 years of age in Stockholm was recruited between December 2007 and June 2008.[18] The clinic offered free of charge testing, treatment of STIs and counselling for contraception and sexual health. The clinic also carried out contact tracing (mandatory in Sweden) for notifiable cases of STIs, including genital chlamydia infection.

All visitors presenting for chlamydia testing, irrespective of symptom presence, were consecutively invited to take part in the study. Inclusion criteria were 20–40 years of age, agreeing to answer a paper questionnaire before testing for chlamydia, and allowing its linkage with the subsequent *C. trachomatis* laboratory testing result. During the recruitment period, 5 244 individuals visited the clinic and of those 3 500 received the questionnaire (published earlier:

http://www.biomedcentral.com/content/supplementary/1471-2458-9-198-S1.doc).[18] In total, 2 814 individuals agreed to take part in the study (recruitment rate 53.7% (2 814/5 244)).[18]

### Outcome and exposures

The outcome of the study was infection with *C. trachomatis* (positive or negative) verified by DNA amplification assay (ProbeTec by Becton-Dickinson, USA) from the samples provided by study participants; from women, a self-collected vaginal swab was put into first void urine, and from men, urine samples.[18] All chlamydia-positive individuals were provided with treatment free of charge according to the established treatment protocol. Patients with chlamydia also underwent contact tracing as a mandatory part of the national management of chlamydia infection.[18]

We grouped exposures extracted from the questionnaire into thematic blocks: (1) demographic background (eg, gender, age); (2) testing for and having had STIs; (3) sexual experiences/behaviour (eg, number of sexual partners during the past 12 months, current steady relationship, type of the last sexual partner, condom use with new or casual partners); (4) substance use (eg, alcohol and drug use during the past 6 months before having sex); and (5) gender-specific exposures: for men—getting a woman unintentionally pregnant, and for women—having used emergency contraceptive pills. Information on presenting symptoms was extracted from a case report form by healthcare staff. Categorisation of all covariates of interest is shown in table 1.

### Statistical methods

We used a Pearson $\chi^2$ test to explore differences in demographic and behavioural characteristics stratified by chlamydia infection status (positive, negative). Crude risk ratios (RRs) associated with chlamydia diagnosis were estimated for all exposures using log-binomial regression. In order to avoid potential problems with multicollinearity during modelling, we investigated whether independent variables were closely related to each other based on their Spearman correlation and $\chi^2$ test. Potential variables to be included in the multivariable model were selected according to their epidemiological relevance and data quality (in terms of missing values); a variable preselection process can be found in online supplementary table S1a.

Owing to missing values in our data set (table 1), we created 100 imputed data sets for model building, where plausible values for missing responses were imputed. The implementation of the imputation algorithm for our data set is described elsewhere.[19] Since the log-binomial model with outcome positive Ct test had convergence problems, we instead fitted a multivariable Poisson regression model with robust SEs.[20] The Poisson models were fitted introducing all statistically significant covariates ($p<0.05$) from the univariate analysis, as well as standard confounders (age and gender) and covariates which were deemed epidemiologically relevant by the authors (see online supplementary table S1a). We applied a backward elimination approach for the model building by removing covariates with the highest p value based on the Wald test. After arriving at the final model, gender-specific covariates (see table 1) were included, and those with p value <0.05 were retained. In order to explore possible effect modification with gender, we explored interactions between all covariates and gender in the final regression model. Statistically significant interactions ($p<0.05$) with gender were kept in the final model. We report pooled RR estimates from the 100 imputed data sets with 95% CI based on Rubin's formula.[21]

**Table 1** Participants, *Chlamydia trachomatis* positivity and unadjusted univariate risk ratios by demographic characteristics and behaviours (n=2 814)

| Covariate | Total study population N (%) | Positive for *Chlamydia trachomatis* n (n/N, %) | Crude risk ratio (95% CI) | p Value* |
|---|---|---|---|---|
| *Demographic background* | | | | |
| Gender | | | | |
| Women | 1378 (49) | 122 (8.9) | 0.70 (0.57 to 0.87) | 0.002 |
| Men | 1436 (51) | 181 (12.6) | 1.00 | |
| Age group | | | | |
| 20–24 | 832 (29.6) | 114 (13.7) | 1.49 (0.97 to 2.28) | 0.065 |
| 25–29 | 1209 (42.9) | 115 (9.5) | 1.03 (0.67 to 1.58) | 1.000 |
| 30–34 | 523 (18.6) | 51 (9.8) | 1.06 (0.66 to 1.69) | 0.896 |
| 35–40 | 250 (8.9) | 23 (9.2) | 1.00 | |
| Marital status | | | | |
| Married and cohabitation | 319 (11.3) | 29 (9.1) | 1.00 | |
| Living apart | 395 (14.1) | 41 (10.4) | 1.14 (0.73 to 1.79) | 0.614 |
| Single | 1895 (67.3) | 210 (11.1) | 1.22 (0.84 to 1.76) | 0.330 |
| Other | 187 (6.6) | 22 (11.8) | 1.29 (0.77 to 2.19) | 0.360 |
| Missing information | 18 (0.6) | 1 (5.6) | 0.61 (0.09 to 4.24) | 1.000 |
| Occupation | | | | |
| Employed | 1925 (68.4) | 222 (11.5) | 1.16 (0.67 to 2.02) | 0.661 |
| Students | 761 (27) | 67 (8.8) | 0.89 (0.50 to 1.59) | 0.731 |
| Others | 121 (4.4) | 12 (9.9) | 1.00 | |
| Missing information | 7 (0.2) | 2 (28.6) | 2.88 (0.79 to 10.45) | 0.170 |
| Having children | | | | |
| Yes | 204 (7.3) | 27 (13.2) | 1.25 (0.86 to 1.80) | 0.242 |
| No | 2601 (92.4) | 276 (10.6) | 1.00 | |
| Missing information | 9 (0.3) | 0 | – | – |
| *Testing for and having had STIs* | | | | |
| Reason for current chlamydia testing | | | | |
| Casual sex/check-up | 1828 (64.9) | 93 (5.1) | 1.00 | |
| Contact with chlamydia case | 461 (16.4) | 127 (27.6) | 5.41 (4.23 to 6.93) | <0.001 |
| Symptoms | 486 (17.3) | 81 (16.7) | 3.28 (2.47 to 4.34) | <0.001 |
| Other reason | 28 (1.0) | 0 | – | – |
| Missing information | 11 (0.4) | 2 (18.2) | 3.42 (0.58 to 20.13) | 0.264 |
| Presenting symptoms at clinic visit | | | | |
| Yes | 601 (21.4) | 93 (15.5) | 1.62 (1.29 to 2.03) | <0.001 |
| No | 2189 (77.8) | 209 (9.6) | 1.00 | |
| Missing information | 24 (0.8) | 1 (4.2) | 0.44 (0.06 to 2.99) | 0.722 |
| Chlamydia testing (lifetime) | | | | |
| Never | 453 (16.1) | 59 (13.0) | 1.00 | |
| <4 times | 1737 (61.7) | 191 (11.0) | 0.84 (0.64 to 1.11) | 0.245 |
| ≥4 times | 573 (20.4) | 49 (8.6) | 0.66 (0.46 to 0.94) | 0.024 |
| Don't remember | 41 (1.5) | 4 (9.8) | 0.75 (0.29 to 1.96) | 0.806 |
| Missing information | 10 (0.3) | 0 | – | – |
| HIV testing (lifetime) | | | | |
| Never | 1062 (37.7) | 147 (13.8) | 1.00 | |
| <4 times | 1498 (53.2) | 139 (9.3) | 0.67 (0.54 to 0.83) | <0.001 |
| ≥4 times | 178 (6.3) | 7 (3.9) | 0.28 (0.14 to 0.60) | <0.001 |
| Don't remember | 63 (2.2) | 10 (15.9) | 1.15 (0.64 to 2.06) | 0.707 |
| Missing information | 13 (0.5) | 0 | – | – |
| Chlamydia testing (past 12 months) | | | | |
| Yes | 1209 (42.9) | 115 (9.5) | 0.83 (0.65 to 1.05) | 0.124 |
| No | 1176 (41.8) | 135 (11.5) | 1.00 | |
| Don't remember | 87 (3.1) | 11 (12.6) | 1.10 (0.62 to 1.96) | 0.728 |
| Missing information | 342 (12.2) | 42 (12.3) | 1.07 (0.77 to 1.48) | 0.702 |
| Chlamydia infection (lifetime) | | | | |
| Never | 1517 (53.9) | 141 (9.3) | 1.00 | |
| <4 times | 876 (31.1) | 105 (12.0) | 1.29 (1.02 to 1.64) | 0.043 |

Continued

Table 1 Continued

| Covariate | Total study population N (%) | Positive for *Chlamydia trachomatis* n (n/N, %) | Crude risk ratio (95% CI) | p Value* |
|---|---|---|---|---|
| ≥4 times | 13 (0.5) | 3 (23.1) | 2.48 (0.91 to 6.78) | 0.116 |
| Don't remember | 56 (2.0) | 8 (14.3) | 1.54 (0.79 to 2.98) | 0.239 |
| Missing information | 352 (12.5) | 46 (13.1) | 1.41 (1.03 to 1.92) | 0.038 |
| Chlamydia infection (past 12 months) | | | | |
| Yes | 254 (19.6) | 32 (12.6) | 1.06 (0.72 to 1.55) | 0.821 |
| No | 670 (51.7) | 80 (11.9) | 1.00 | |
| Don't remember | 26 (2.0) | 6 (23.1) | 1.93 (1.93 to 4.02) | 0.119 |
| Missing information | 347 (26.7) | 44 (12.7) | 1.06 (0.75 to 1.50) | 0.762 |
| Not applicable due to reporting never having chlamydia infection | 1517 | – | – | – |
| Any STI except chlamydia (lifetime) | | | | |
| No | 1628 (57.8) | 167 (10.3) | 1.00 | |
| Yes | 609 (21.6) | 70 (11.5) | 1.12 (0.86 to 1.46) | 0.397 |
| Do not know | 506 (18.0) | 58 (11.5) | 1.12 (0.84 to 1.48) | 0.456 |
| Missing information | 71 (2.5) | 8 (11.3) | 1.10 (0.56 to 2.14) | 0.693 |
| *Sexual experiences/behaviour* | | | | |
| Current steady relationship | | | | |
| Yes | 1012 (36.0) | 104 (10.3) | 1.00 | |
| No | 1442 (51.3) | 161 (11.2) | 0.92 (0.73 to 1.16) | 0.509 |
| Missing information | 360 (12.7) | 38 (10.6) | 0.95 (0.68 to 1.32) | 0.779 |
| Concurrent sexual contacts (past 12 months) | | | | |
| Yes | 587 (42.8) | 73 (12.4) | 1.37 (0.96 to 1.95) | 0.094 |
| No | 485 (35.4) | 44 (9.1) | 1.00 | |
| Missing information | 300 (21.8) | 25 (8.3) | 0.92 (0.57 to 1.47) | 0.796 |
| Not applicable due to reporting no current steady relationship | 1442 | – | – | – |
| Number of sexual partners (past 12 months) | | | | |
| 0–2 partners | 622 (22.1) | 63 (10.1) | 1.00 | |
| 3–5 partners | 1141 (40.6) | 112 (9.8) | 0.97 (0.72 to 1.30) | 0.868 |
| 6–10 partner | 618 (22.0) | 79 (12.8) | 1.26 (0.92 to 1.72) | 0.154 |
| ≥11 partners | 461 (5.7) | 25 (15.5) | 1.53 (1.00 to 2.36) | 0.068 |
| Missing information | 272 (9.7) | 24 (8.8) | 0.87 (0.56 to 1.36) | 0.624 |
| Number of casual sexual partners (past 12 months) | | | | |
| 0 partners | 375 (13.3) | 35 (9.3) | 1.00 | |
| 1–2 partners | 991 (35.2) | 101 (10.2) | 1.09 (0.76 to 1.57) | 0.686 |
| 3–5 partners | 691 (24.6) | 70 (10.1) | 1.09 (0.74 to 1.60) | 0.747 |
| 6–10 partner | 300 (10.7) | 42 (14.0) | 1.50 (0.98 to 2.29) | 0.067 |
| ≥11 partners | 93 (3.3) | 15 (16.1) | 1.73 (0.99 to 3.03) | 0.063 |
| Missing information | 364 (12.9) | 40 (11.0) | 1.18 (0.77 to 1.81) | 0.467 |
| Time since the last sexual contact | | | | |
| Past 7 days | 1313 (46.6) | 117 (8.9) | 0.71 (0.51 to 0.97) | 0.037 |
| 1–4 weeks | 997 (35.4) | 126 (12.6) | 1.00 (0.73 to 1.37) | 1.000 |
| 1–3 months | 372 (13.2) | 47 (12.6) | 1.00 | |
| ≥4 months | 107 (3.8) | 8 (7.5) | 0.59 (0.29 to 1.21) | 0.169 |
| Don't remember | 9 (0.3) | 1 (11.1) | 0.88 (0.14 to 5.69) | 1.000 |
| Missing information | 16 (0.6) | 4 (25.0) | 1.98 (0.81 to 4.82) | 0.145 |
| Type of last sexual partner | | | | |
| Steady partner | 824 (29.3) | 84 (10.2) | 1.00 | |
| Recurrent partner | 752 (26.7) | 76 (10.1) | 0.99 (0.74 to 1.33) | 1.000 |
| Casual unknown partner | 285 (10.1) | 27 (9.5) | 0.93 (0.62 to 1.40) | 0.819 |
| Casual known partner | 279 (9.9) | 32 (11.5) | 1.13 (0.77 to 1.65) | 0.573 |
| Other type | 227 (8.1) | 27 (11.9) | 1.17 (0.78 to 1.75) | 0.465 |
| Missing information | 447 (15.9) | 57 (12.7) | 1.25 (0.91 to 1.72) | 0.190 |
| Type of last sexual contact | | | | |
| Vaginal and oral and petting | 880 (31.3) | 95 (10.8) | 1.00 | |
| Vaginal | 609 (21.6) | 69 (11.3) | 1.05 (0.78 to 1.41) | 0.801 |

Continued

**Table 1** Continued

| Covariate | Total study population N (%) | Positive for *Chlamydia trachomatis* n (n/N, %) | Crude risk ratio (95% CI) | p Value* |
|---|---|---|---|---|
| Vaginal and oral | 426 (15.2) | 35 (8.2) | 0.76 (0.53 to 1.10) | 0.167 |
| Vaginal and petting | 230 (8.2) | 16 (6.9) | 0.64 (0.39 to 1.07) | 0.108 |
| Vaginal and oral and petting and anal | 98 (3.5) | 19 (19.4) | 1.80 (1.15 to 2.81) | 0.019 |
| Other type of sex | 218 (7.8) | 22 (10.1) | 0.93 (0.60 to 1.45) | 0.902 |
| Missing information | 353 (12.5) | 47 (13.3) | 1.23 (0.89 to 1.71) | 0.236 |
| Condom use with new/casual partners | | | | |
| Never or seldom | 843 (30.0) | 105 (12.5) | 1.00 | |
| Often or always | 1956 (69.5) | 197 (10.1) | 0.81 (0.65 to 1.01) | 0.063 |
| Missing information | 15 (0.5) | 1 (6.7) | 0.54 (0.08 to 3.59) | 1.000 |
| Taking responsibility for obtaining condom | | | | |
| Never or often not | 562 (20.0) | 65 (11.6) | 1.00 | |
| Sometimes | 1288 (45.8) | 151 (11.7) | 1.01 (0.77 to 1.33) | 1.000 |
| Always | 951 (33.8) | 84 (8.8) | 0.76 (0.56 to 1.04) | 0.090 |
| Missing information | 13 (0.5) | 3 (23.1) | 2.00 (0.72 to 5.52) | 0.191 |
| *Substance use* | | | | |
| Alcohol use before having sex (past 6 months) | | | | |
| No | 243 (8.6) | 16 (6.6) | 1.00 | |
| Sometimes | 845 (30.0) | 91 (10.8) | 1.64 (0.98 to 2.73) | 0.066 |
| Several times | 1689 (60.0) | 194 (11.5) | 1.74 (1.07 to 2.85) | 0.020 |
| Don't remember | 24 (0.8) | 1 (4.2) | 0.63 (0.09 to 4.57) | 1.000 |
| Missing information | 13 (0.5) | 1 (7.7) | 1.17 (0.17 to 8.14) | 0.600 |
| Alcohol impact on taking higher sexual risks than expected by respondent (n=2534)† | | | | |
| No impact | 525 (20.7) | 55 (10.5) | 0.83 (0.60 to 1.17) | 0.292 |
| Little impact | 533 (21.0) | 67 (12.6) | 1.00 | |
| Some impact | 1013 (40.0) | 107 (10.6) | 0.84 (0.63 to 1.12) | 0.237 |
| Big impact | 438 (17.3) | 51 (11.6) | 0.93 (0.66 to 1.30) | 0.694 |
| Don't remember | 15 (0.6) | 3 (20.0) | 1.59 (0.56 to 4.49) | 0.423 |
| Missing information | 10 (0.4) | 2 (20.0) | 1.59 (0.45 to 5.61) | 0.370 |
| Drug use before having sex (past 6 months) | | | | |
| No | 2510 (89.2) | 268 (10.7) | 1.00 | |
| Sometimes | 203 (7.2) | 21 (10.3) | 0.97 (0.64 to 1.48) | 1.000 |
| Several times | 65 (2.3) | 10 (15.4) | 1.44 (0.81 to 2.58) | 0.224 |
| Don't remember | 9 (0.3) | 1 (11.1) | 1.04 (0.16 to 6.63) | 1.000 |
| Missing information | 27 (1.0) | 3 (11.1) | 1.04 (0.36 to 3.04) | 0.762 |
| Drug impact on taking higher sexual risks than expected by respondent (n=268)† | | | | |
| No impact | 122 (45.5) | 15 (12.3) | 1.07 (0.44 to 2.59) | 1.000 |
| Little impact | 52 (19.4) | 6 (11.5) | 1.00 | |
| Some impact | 56 (20.1) | 7 (12.5) | 1.08 (0.39 to 3.01) | 1.000 |
| Big impact | 34 (12.7) | 3 (8.8) | 0.76 (0.20 to 2.85) | 1.000 |
| Don't remember | 2 (0.8) | 0 | – | – |
| Missing information | 2 (0.8) | 0 | – | – |
| *Gender-specific covariates for men only (n=1436):* | | | | |
| Have ever got a woman unintentionally pregnant | | | | |
| No | 896 (62.4) | 102 (11.4) | 1.00 | |
| At least once | 427 (29.7) | 66 (15.5) | 1.36 (1.02 to 1.81) | 0.042 |
| Don't remember | 87 (6.1) | 11 (12.6) | 1.11 (0.62 to 1.99) | 0.725 |
| Missing information | 26 (1.8) | 2 (7.7) | 0.68 (0.18 to 2.59) | 0.759 |
| *For women only (n=1378):* | | | | |
| Current contraception method | | | | |
| No birth control | 16 (1.2) | 1 (6.3) | 1.00 | |
| Any hormonal contraception | 419 (30.4) | 40 (9.5) | 1.53 (0.22 to 10.42) | 1.000 |
| Barrier method | 409 (29.7) | 34 (8.3) | 1.33 (0.19 to 9.12) | 1.000 |
| Calendar method | 308 (22.4) | 28 (9.1) | 1.45 (0.21 to 10.02) | 1.000 |
| Wish pregnancy, no contraception | 170 (12.3) | 14 (8.2) | 1.32 (0.19 to 9.38) | 1.000 |
| Sterilisation | 4 (0.3) | 1 (25.0) | 4.00 (0.31 to 51.03) | 0.368 |
| Missing information | 52 (3.8) | 4 (7.7) | 1.23 (0.15 to 10.24) | 1.000 |

Continued

Table 1 Continued

| Covariate | Total study population N (%) | Positive for *Chlamydia trachomatis* n (n/N, %) | Crude risk ratio (95% CI) | p Value* |
|---|---|---|---|---|
| Use of emergency contraceptive pills (lifetime) | | | | |
| No | 413 (29.5) | 43 (10.4) | 1.00 | |
| At least once | 944 (69.0) | 77 (8.2) | 0.78 (0.55 to 1.12) | 0.178 |
| Missing information | 21 (1.5) | 2 (9.5) | 0.91 (0.24 to 3.52) | 1.000 |
| Did abortion (lifetime) | | | | |
| No | 971 (70.5) | 89 (9.2) | 1.00 | |
| At least once | 378 (27.4) | 30 (7.9) | 0.87 (0.58 to 1.29) | 0.522 |
| Missing information | 29 (2.1) | 3 (10.3) | 1.13 (0.38 to 3.36) | 0.744 |

*p Value for the crude risk ratio estimate from a likelihood ratio test.
†Follow-up question, if answered previous question.
STI, sexually transmitted infection.

The final model included the variable 'lifetime HIV testing'. Since 'chlamydia testing (past 12 months)' was highly correlated with variable 'lifetime HIV testing' (Spearman correlation coefficient 0.84) and was considered more epidemiologically relevant, we performed a sensitivity analysis where HIV testing was substituted with chlamydia testing in the same model; the latter is included in the Results section, while the former is included in the online supplementary material.

All statistical tests were two-sided and performed at the significance level 0.05. Statistical analyses were performed with STATA V.12.1 statistical software (Stata Corp. 2011. Stata Statistical Software: Release 12. College Station, Texas, USA: Stata Corp LP).

## RESULTS

### Demographic and behavioural characteristics

Out of 2 814 study participants, 1 378 (49%) were women. The majority of study participants were single (67.3%), and mean age was 27.4 years (27.0 for women and 27.8 for men). Among the study participants, 303 (10.7%) tested positive for chlamydia, with a higher positivity rate observed among men, 20–24 years old and single marital status (table 1 and online supplementary table S2a).

A large proportion (82%, 2310/2814) of the study participants reported lifetime testing for chlamydia (table 1). Only 43% reported having been tested for chlamydia during the previous 12 months. Lifetime testing for HIV infection was reported by 60% of respondents (1676/2814). One-third of the study participants reported a previous history of chlamydia: 9% reported having had it during the past 12 months, while other STIs except chlamydia (gonorrhoea, syphilis, genital warts, herpes infection) were reported by 22% of respondents, including one respondent with HIV infection.

About one-third of the respondents were currently in a steady relationship and of those 52.5% (531/1012) reported having had concurrent sexual contacts during the past 12 months. The median number of sexual partners during the past 12 months was four partners for both genders. Nevertheless, the mean number of sexual partners (5.9 partners) was significantly higher (p<0.001) in the age group 20–24 years compared with the lowest mean number of partners (4.8) in the age group 30–34 years. The range of reported sexual partners for women was 1–53 partners, while for men it was 1–120 partners. Having had casual sexual partner(s) was reported by 2075 (74%) of the respondents with a median number of two casual sexual partners for women and three for men during the past 12 months. Again, the mean number of casual sexual partners (3.8 partners) was significantly higher (p<0.001) in the age group 20–24 years compared with the lowest mean number of casual partners (2.9) in the age group 30–34 years. Of the study participants, 30% never or seldom used condoms with new or casual partners. The number of sexual partners and condom non-use was significantly different for the youngest age group (20–24 years) compared with the age group 35–40 years: among those who reported 6–10 partners, condom non-use was 40.6% among 20–24 years old versus 20.6% in the age group 35–40 years (p=0.032); and in the category >11 sexual partners, condom non-use was 53.5% among 20–24 years old versus 40.0% in the age group 35–40 years (p=0.432). Among those reporting four times or more chlamydia lifetime testing, condom non-use (never or seldom; 35.4%) was significantly higher than among those never tested (26.2%; p=0.002); this was, however, not the case among those reporting four times or more lifetime testing for HIV (p=0.384) nor those reporting testing for chlamydia during the past 12 months (p=0.445). Alcohol consumption before having sex during the past 6 months was reported by 90% of participants, while using drugs before having sex was reported only by 10% of the respondents (table 1).

### Association of participant and behavioural characteristics with chlamydia infection

The multivariate model suggested a statistically significant strong protective effect of having been tested for

chlamydia during the past 12 months compared with not tested: adjusted RR (ARR) 0.72, 95% CI 0.55 to 0.94 (table 2). In turn, the following factors were all associated with a statistically significant increased risk for chlamydia: being tested due to contact tracing/having a chlamydia-positive partner; symptoms as reason for testing; reporting 6–10 sexual partners during the past 12 months; reporting last sexual contact as 'vaginal and oral and anal and petting'; using alcohol before having sex; as well as presenting symptoms (table 2). The most pronounced increased risk was observed for those being tested due to contact with a chlamydia case (ARR 6.55, 95% CI 4.77 to 8.98). The model also suggested that the risk for chlamydia among those reporting physical symptoms was different for men and women (significant interaction term 'gender×symptoms', p=0.017), resulting in a significant increased risk for men (ARR 2.09, 95% CI 1.38 to 3.18) and a non-significant effect for women (ARR 1.08, 95% CI 0.71 to 1.65; table 2).

The sensitivity analysis revealed that presence of covariate 'chlamydia testing (past 12 months)' (table 2) in the model instead of 'lifetime HIV testing' (see online supplementary table S3) arrived at almost identical estimates.

**Table 2** Adjusted risk ratios for *Chlamydia trachomatis* diagnosis in the chlamydia testing model

| Covariate | Adjusted risk ratio (95% CI) | p Value* |
|---|---|---|
| Gender | | |
| Women | 1.15 (0.84 to 1.56) | 0.382 |
| Men | 1.00 | |
| Age group | | |
| 20–24 | 2.10 (1.21 to 3.65) | 0.008 |
| 25–29 | 1.57 (0.91 to 2.72) | 0.105 |
| 30–34 | 1.47 (0.81 to 2.66) | 0.206 |
| 35–40 | 1.00 | |
| Reason for current chlamydia testing | | |
| Casual sex/check-up | 1.00 | |
| Contact with chlamydia case | 6.55 (4.77 to 8.98) | <0.001 |
| Symptoms | 2.19 (1.48 to 3.24) | <0.001 |
| Ct test (past 12 months) | | |
| No | 1.00 | |
| Yes | 0.72 (0.55 to 0.94) | 0.014 |
| Don't remember | 1.10 (0.65 to 1.87) | 0.730 |
| Number of sexual partners (past 12 months) | | |
| 0–2 partners | 1.00 | |
| 3–5 partners | 1.12 (0.81 to 1.55) | 0.498 |
| 6–10 partner | 1.53 (1.06 to 2.21) | 0.023 |
| ≥11 partners | 1.61 (0.94 to 2.76) | 0.082 |
| Time since the last sexual contact | | |
| Past 7 days | 0.70 (0.48 to 1.01) | 0.056 |
| 1–4 weeks | 0.95 (0.66 to 1.37) | 0.784 |
| 1–3 months | 1.00 | |
| ≥4 months | 1.47 (0.71 to 3.05) | 0.301 |
| Don't remember | 1.37 (0.20 to 9.43) | 0.751 |
| Type of the last sexual contact | | |
| Vaginal and oral and petting | 1.00 | |
| Vaginal | 1.17 (0.86 to 1.61) | 0.319 |
| Vaginal and oral | 0.77 (0.51 to 1.17) | 0.219 |
| Vaginal and petting | 0.81 (0.47 to 1.40) | 0.460 |
| Vaginal and oral and petting and anal | 1.84 (1.09 to 3.10) | 0.023 |
| Alcohol use before having sex (past 6 months) | | |
| Yes | 1.98 (1.10 to 3.57) | 0.023 |
| No | 1.00 | |
| Men presenting symptoms at clinic visit† | | |
| Yes | 2.09 (1.38 to 3.18) | 0.001 |
| No | 1.00 | |
| Women presenting symptoms at clinic visit† | | |
| Yes | 1.08 (0.71 to 1.65) | 0.706 |
| No | 1.00 | |

*p Value from the Wald test.
†p=0.017 for the interaction term 'gender×symptoms'.

## DISCUSSION

### Main findings and its relation to other studies

In this study at an STI clinic in Stockholm (Sweden), overall chlamydia prevalence was 10.7%. Factors independently associated with chlamydia diagnosis were age 20–24 years, being tested due to contact with a chlamydia case or having symptoms, having 6–10 sexual partners during the past 12 months, being tested for chlamydia during the past 12 months, using alcohol before having sex during the past 6 months and practising exclusively multiple sexual activities (including anal sex) during the last sexual contact.

The overall chlamydia positivity rate in our study population was higher than that observed in the comprehensive Swedish chlamydia surveillance data for Stockholm County and the whole of Sweden:[2] for example, the positivity rate among men between 2006 and 2008 was on average 11.7% in Stockholm County surveillance data compared with 12.6% in our study; the positivity rate in the age group 20–24 years was on average 10.6% in Stockholm County surveillance data compared with 13.7% in our study. Such higher chlamydia positivity rates have previously been reported in STI clinic settings and were expected due to more selected individuals attending such type of clinics.[9 12 22]

We identified a number of risk factors associated with chlamydia diagnosis which are consistent with risk factors found in previous studies within and outside Sweden.[6 7 9 10 12 22] Younger individuals (20–24 years) had a significant two times higher risk to be diagnosed with chlamydia compared with those 35–40 years, and this was consistent with earlier reports on higher chlamydia risk among younger individuals, which might be attributed to the higher number of sexual partners and lower condom use in the younger individuals, which was supported by descriptive results in our study.[6 7 9 10] Furthermore, study participants who reported contact with a chlamydia case (having a partner with chlamydia or receiving a contact tracing letter) were strongly associated with increased risk of chlamydia. In Sweden,

patients with chlamydia are required by the Communicable Disease Act to notify their sexual contacts in order for them to be laboratory tested and thus interrupt further the transmission chain. Contact tracing is one of the powerful tools for identifying asymptomatic chlamydia-infected sexual partners of a chlamydia case.[23]

We also identified that reporting 6–10 sexual partners during the past 12 months was associated with chlamydia. This is in agreement with previous studies which found that a greater number of sexual partners was associated with increased risk for chlamydia, and that the risk increased in a dose–response manner with each increased level of number of sexual partners.[7 10] Moreover, alcohol use in close proximity to the sexual encounter was associated with increased risk of chlamydia, indicating an increase practice of unprotected sex. Similar findings were reported previously and were identified as an important area of public health intervention.[24]

Another behaviour associated with a significant increased risk for chlamydia was sexual contact of the type 'vaginal sex and oral sex and petting and anal sex'. This category included self-reported anal intercourse, which has been reported to be a high-risk behaviour[25] and to be increasingly common in Swedish women.[26] Therefore, sexual history-based testing for chlamydia infection should be applied for enabling more effective interruption of chlamydia transmission.[27–29] We also found significant differences between men and women presenting symptoms for chlamydia: for men chlamydia symptoms were positively associated with chlamydia diagnosis, while for women they were not. This can be due to the anatomical differences,[30] which were also investigated in our study by looking at interaction of covariates with gender.

We also identified a strong protective effect of testing for chlamydia infection during the past 12 months. Promotion of chlamydia and HIV testing is an important part of the public health effort to reduce transmission of these infections in Sweden, and is likely to be contributing to the frequent chlamydia and HIV testing behaviour reported in our study. It may also be a sign that this population might be health conscious, and people consider themselves at higher risk for STIs/HIV. Testing is intensively promoted within the chlamydia prevention programme in Sweden, leading to nearly 500 000 chlamydia tests performed annually in a population of almost 10 million, resulting in an overall positivity rate of 7% between 2009 and 2013.[2]

Although we could not confirm the effect of non-condom use as a risk factor on chlamydia in our study, an indication of practice of unprotected sexual contacts was that nearly 22% of study participants reported having previous STI infections other than chlamydia, and 30% reported never or seldom used condoms with new and casual partners. Furthermore, our results on the statistically significant increased risk for chlamydia for study participants reporting a greater number of sexual partners (more than six sexual partners) and for those reporting all types of sexual activities suggest the practice of unprotected sex. However, we could not confirm the association between condom non-use and chlamydia infection in the adjusted analysis in our study, despite significant differences in association between the number of sexual partners and condom non-use by age group. In Sweden, safer sex behaviour (condom use) is promoted in order to reduce chlamydia transmission, especially in adolescents and young adults. In the general population, however, risky sexual behaviour (including multiple sexual partnerships and casual sexual contacts) has been found to have increased significantly in the years before this study was conducted (1989–2007).[17]

## Strengths and limitations

We were able to recruit nearly 3000 individuals and obtain a specimen for testing, thus ensuring that chlamydia infection was laboratory verified and could be linked with participants' sexual behaviour data. In doing so, we were able to revise knowledge on the relationship between behaviour and chlamydia. Our findings were consistent with prior studies within and outside Sweden. We were also able to investigate statistical interaction between gender and other covariates in the model, which is rarely reported in research of sexual behaviour and STIs.

This study had a number of limitations, which may have affected our results. First, participation bias may be present if individuals with stigmatised or risky behaviour chose not to take part in the study. Second, social desirability bias potentially might have taken place since sensitive topics (such as sexual behaviour, substance use) were asked, which was investigated further.[19] Respondents might have answered in a way which is more socially accepted than the actual behaviour they exhibit; thus, risky behaviour might have been underreported. Some of the studies involving research on sexual behaviour have demonstrated discrepancies in actual and reported sexual behaviour.[31] Third, recall bias in retrospective reporting of the behaviour could also have taken place, since we gathered data on behaviour 6–12 months back. This could have led to underreporting or missing data. The latter, however, was handled in our data by multiple imputations of the missing values, thus increasing the study power.[32] Furthermore, we were not able to assess the effect of ethnicity and gender of sexual partners on chlamydia diagnosis in our sample, even though chlamydia prevalence rates might differ across subpopulations and therefore pose different risks and require different approaches for prevention.[7 8 33–36] Finally, our study population was a population attending an STI clinic, which differs from the general population, and therefore generalisation of the results cannot be done except to populations in similar healthcare settings.

## CONCLUSIONS

In this study among visitors to an STI clinic, we confirmed previously reported risk factors associated with chlamydia infection, suggesting that there have been no major changes in the behaviour associated with chlamydia compared with similar studies within and outside Sweden. The strongest risk factor was contact with a chlamydia case identified through contact tracing, which reinforces the important role of contact tracing in chlamydia case ascertainment. Increased risk for chlamydia infection associated with high-risk behaviour (eg, alcohol use, increased number of sexual partners) supports the need for behavioural interventions in this population such as promotion of safer sex practice (condom use) and testing. We suggest that these updated data on factors associated with chlamydia be used by healthcare providers at STI clinics to identify individuals at higher risk for chlamydia. Additionally, further research should be encouraged to explore how individuals apply current chlamydia prevention strategies, for example, practising both testing and condom use, or favouring one over the other.

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**Contributors** IV developed the analysis plan, conducted the data management and statistical analyses and wrote the manuscript; AP contributed to the development of the analysis plan, supervised the statistical analyses and critically reviewed the manuscript; LM conceptualised the study and critically reviewed the manuscript; BH contributed to the development of the analysis plan and critically reviewed the manuscript; PS contributed to the development of the analysis plan and critically reviewed the manuscript; SK-B conceptualised the study, contributed to the development of the analysis plan and critically reviewed the manuscript. All authors have read and approved the final version of the manuscript.

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