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Prevalence and Characterization of Undiagnosed Youths at Risk of *Chlamydia trachomatis* Infection: A Cross-sectional Study

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Objective: The aim of this study was to determine the prevalence of *Chlamydia trachomatis* infection in undiagnosed young people aged between 15 and 24 years.

Materials and Methods: A convenience sample of 623 youths, with a mean (SD) age of 20.1 (2.2) years, was recruited from key spaces in the North Metropolitan area of Barcelona in Catalonia, Spain. Participants completed a 21-item questionnaire and provided a urine sample or vaginal swab for testing.

Results: The most common age at the first sexual intercourse was 16 years (24.6%), followed by 15 years (21.3%). Only 32.6% reported always use of condoms, 49.2% sometimes, and 15.6% never. A positive test for chlamydia was found in 34 participants (5.5%; 95% CI, 3.8–7.5), with no difference by sex. A positive test was significantly more common among the participants who were working, who had been diagnosed with a sexually transmitted disease (STD) at some point in their life, and who used web pages/apps to find new sexual partners more than once a month. In the multivariate analysis, working status was an independent factor associated with chlamydial infection (adjusted odds ratio[OR], 8.88; 95% CI, 1.71–46.17), whereas not having been previously diagnosed with an STD (OR, 0.34; 95% CI, 0.07–1.49)

and never using the Internet to find sexual partners (OR, 0.16; 95% CI, 0.03–0.80) were protective factors against chlamydial infection.

Conclusions: The prevalence of *C. trachomatis* infection was 5.5%. Working status, a previous diagnosis of STD, and use of the Internet to find new sexual partners were associated with chlamydial test positivity.

Key Words: *Chlamydia trachomatis*, young people, sexually transmitted disease, prevalence

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KEY MESSAGES

- *Chlamydia trachomatis* infection is a common sexually transmitted disease poorly defined in asymptomatic adolescents and young people.
- Screening of asymptomatic patients is an important strategy for controlling the transmission of *C. trachomatis* among young people.
- In 623 asymptomatic young people aged 15–24 years recruited from key spaces in the community, the prevalence of *C. trachomatis* infection was 5.5%.
- Working status, a previous diagnosis of sexually transmitted disease, and use of the Internet to find new sexual partners were associated with chlamydial test positivity.

Youth is defined as the period between the ages of 15 and 24 years. According to Eurostat statistics, in 2019, approximately 10% of the European population was composed of youths.¹ In multinational cohort of adolescents from randomly selected schools in 10 European countries, experience of sexual intercourse was reported by 19.2% participants at a median age of 15 years.² Data of the National Survey of Family Growth in the United States revealed that 42% and 38% of never-married female and male teenagers, respectively, have had sexual intercourse.³ Decreasing age at the first intercourse has been related to increasing odds of concurrent partnership and contraceptive nonuse.⁴ In these scenarios, sexually transmitted diseases (STDs) in adolescents and youths are a public health care problem of increasing concern. *Chlamydia trachomatis* is one of the most prevalent pathogens related to STDs with almost two-thirds of infections in youth aged 15–24 years.⁵ Chlamydial infections typically present with mild and nonspecific signs and symptoms, and many infections are asymptomatic resulting in delayed diagnosis and uninterrupted transmission. Accurate estimation of chlamydia prevalence in different populations is limited by heterogeneity within surveyed populations and variations in sampling methodology and data reporting.^{6,7} For 2017, according to the surveillance report of the European Centre for Disease Prevention and Control, the crude notification rate was 146 cases per 100,000 population.⁸ However, notification rates varied considerably across Europe, with the highest country-specific rates more than 5,000 times higher than the lowest rates, as a reflection of the differences in

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The study was approved by the ethics committees of the participating centers and the ethics clinical research committee of IDIAP Jordi Gol, Barcelona, Spain.

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chlamydia testing, case finding, and reporting rather than indication of actual differences in chlamydia prevalence.

Gaps in the knowledge about chlamydia prevalence in certain subgroups, such as the youth, have been recognized.^{9–11} Screening of asymptomatic patients is considered an important strategy for controlling the transmission of *C. trachomatis* among young people. However, many young people at risk for *C. trachomatis* infection may not seek sexual health care because of the asymptomatic nature of the bacterial infection and other barriers, such as fear for the sampling methods, a positive test result, and associated stigmatization and privacy concerns.^{12,13} Different attempts beyond regular sexual health care have been proposed to increase testing among young people,¹⁴ such as population-based screening, partner notification approaches, respondent driven sampling, and convenience sampling methods. Although convenience sampling lacks clear generalizability and representativeness, it is quick and inexpensive, participants are easy to reach, and is time and cost-effective.¹⁵

To assess the prevalence and distinctive features of chlamydial infection in young people, we conducted a cross-sectional study in a convenience sample of undiagnosed youths at risk of *C. trachomatis* infection.

MATERIALS AND METHODS

Study Design

Between January 2018 and November 2019, a cross-sectional study was conducted among young people aged 16–24 years from the North Metropolitan Area of Barcelona, in Catalonia, Spain. This is one of the 3 healthcare areas of the Barcelona region consisting of the official union of adjacent cities and municipalities comprising the territorial regions of Barcelonès Nord, Maresme, Vallès Occidental, and Vallès Oriental, with a reference population of 1,986,032 inhabitants. The study researchers were staff registered midwives from 7 public sexual and reproductive healthcare centers belonging to the Catalan Health Institute, in which sexual and reproductive care is provided including preventive, educational, and promotional services.¹⁶ The main objective of the study was to assess the effectiveness of a convenience sample to detect *C. trachomatis* infection among undiagnosed youths aged 16–24 years at risk. Secondary objectives were to establish the prevalence of *C. trachomatis* infection in this age group, to characterize distinctive features of chlamydial infection, and to identify barriers and facilitators to chlamydial infection.

The study was approved by the ethics committees of the participating centers and the ethics clinical research committee of IDIAP Jordi Gol, Barcelona, Spain. Written informed consent was obtained from all participants.

Participants and Study Procedures

Inclusion criteria were boys or girls, or transgender males and females, aged between 16 and 24 years, and having had at least 1 sexual intercourse within the previous year. Eligible participants who had language difficulties to complete a study questionnaire, which was written in Catalan, or who did not sign the written informed consent were excluded. The study procedures consisted of recruitment of a convenience sample of eligible participants, completion of a study questionnaire on personal aspects of sexual health, and chlamydial infection testing in biological specimens. Participation in the study was voluntary and unpaid.

Subjects included in the convenience sample were recruited from key spaces for the presence of youth, which included institutes of secondary education, university campus (Tecnocampus Mataró), sports centers (basket and swimming clubs, Sabadell), and annual festivals of 6 local cities (Terrassa, Arenys de Mar, Santa Eulàlia de Ronçana, Ripollet, Santa Coloma de Gramenet,

Sabadell). Attendees at the institutes of secondary education and sports centers received a 45-minute educational session on STDs with a special focus on *C. trachomatis* infection and were informed on the services available at the sexual and reproductive healthcare centers, and participation in the study was offered. At the university campus and annual festivals, stands or tents were placed in strategic places (e.g. close to chemical toilets) in which study researchers provided information on STDs and *C. trachomatis* infection and invited young people to take part in the study. In all settings, those who agreed to participate and met the inclusion criteria, signed the informed consent form, completed a self-administered 21-item questionnaire, and provided a biological specimen for testing (urine samples for boys and vaginal swabs for girls). The study questionnaire included data on socio-demographic variables, knowledge and previous diagnosis of STDs, sexual health, and use of information and communication technology (ICT). There were open and closed questions as well as 5-point Likert scales, from “very high” to “inexistent” or from “a lot” to “nothing.” The study questionnaire is shown in the Supplementary material, <http://links.lww.com/LGT/A278>.

Men delivered a sample containing the first stream of urine and women self-collected a vaginal discharge sample in a swab. During the recruitment in the key space, the samples were stored in an ice refrigerator that allowed their preservation until they were transported to the primary health care center where biological samples were stored at 2°C–8°C and delivered rapidly by messenger to the reference laboratory on the same day (usually within less than 24 hours). Specimens were never kept at room temperature.

Urine and vaginal samples were analyzed in 2 reference laboratories using a multiplex real-time PCR assay (Anyplex II STI-7 Detection, Seegene, Seoul, Korea), nucleic acid amplification test, or real-time PCR that detects serovars A-K, L1, L2, and L3.

Statistical Analysis

According to an estimated prevalence of 8.5% of *C. trachomatis* infection in people younger than 25 years, the sample size was calculated for a 95% CI of ± 0.05 with a design effect of 0.2 and an estimation error of 4.45% in a reference population of 131,052 people (52% boys, 48% girls) aged between 16 and 24 years,¹⁶ a total of 500 participants (260 boys and 240 girls) will be necessary. Categorical variables are expressed as frequencies and percentages, and continuous variables as mean and SD or median and interquartile range (25th–75th percentile). Only at least 80% completed questionnaires were analyzed. The χ^2 was used to assess relationship between positive chlamydia testing and the variables included in the study questionnaire. Logistic regression analysis was used to assess predictors of a positive or negative test for chlamydial infection. Odds ratio (OR) and 95% CIs were calculated. Statistical significance was set at $p < .05$.

RESULTS

Of a total of 644 participants who met the inclusion criteria and agreed to take part in the study, 21 were excluded because of incomplete questionnaires (less than 80% completed) or lack of delivery of the biological specimen. Therefore, the study population included 623 participants, 232 boys and 391 girls, with a mean (SD) age of 20.1 (2.2) years. Most participants (83.3%) were born in Spain including Catalonia (49.8%). Salient socio-demographic findings included to study and/or to work as the most frequent occupational status in 95.7% of the participants, secondary and university education in 91%, and more than 30€ as the amount of money spent per week in 47.7%.

Results of the study questionnaire regarding sexual health and use of ICT in the overall study population and stratified by sex are shown in Table 1. Having sex with boys and girls was

TABLE 1. Results of the study questionnaire regarding sexual health

Questionnaire items	All Participants (N = 623)	Boys (n = 232)	Girls (n = 391)
Who do you have sex with?			
Boys	357 (57.4)	13 (5.6)	344 (88.0)
Girls	220 (35.4)	205 (88.4)	15 (3.8)
Boys and girls indistinctively	41 (6.6)	11 (4.7)	30 (7.7)
Do not known/no answer	4 (0.6)	3 (1.3)	2 (0.5)
Age at the first sexual intercourse			
<15 y	130 (20.9)	52 (22.4)	78 (20.0)
15–24 y	472 (75.8)	170 (73.3)	302 (77.2)
Do not known/no answer	21 (3.4)	10 (4.3)	11 (2.8)
Use a condom if you have sex			
Always	203 (32.6)	85 (36.6)	118 (30.2)
Sometimes	296 (47.5)	107 (46.1)	189 (48.3)
Never	94 (15.1)	29 (12.5)	65 (16.6)
Do not known/no answer	30 (4.8)	11 (4.7)	19 (4.9)
Sexual partners in the last 6 mo			
None	28 (4.5)	20 (8.6)	8 (2.1)
One	363 (58.3)	111 (47.8)	252 (64.5)
Between 2 and 9	198 (31.8)	87 (37.5)	111 (28.4)
≥10	10 (1.6)	6 (2.6)	4 (1.0)
Do not known/no answer	24 (3.8)	8 (3.5)	16 (4.1)
Concurrent sexual partnership			
Yes	80 (12.8)	40 (17.2)	40 (10.2)
No	516 (82.8)	180 (77.6)	336 (85.9)
Do not known/no answer	27 (4.3)	12 (5.2)	15 (3.8)
Perception of the risk for <i>C. trachomatis</i> infection			
Very high	137 (22.0)	53 (22.8)	84 (21.5)
Quite high	200 (32.1)	48 (20.7)	152 (38.9)
Medium	94 (15.1)	38 (16.4)	56 (14.3)
Low	102 (16.4)	44 (19.0)	58 (14.8)
Inexistent	73 (11.8)	42 (18.1)	31 (7.9)
Do not known/no answer	17 (2.7)	7 (3.0)	10 (2.6)
Diagnosis of an STD at any point in your life			
Yes	30 (4.8)	7 (3.0)	23 (5.9)
No	545 (87.5)	203 (87.5)	342 (87.5)
Do not known/no answer	48 (7.7)	22 (9.5)	26 (6.7)
How did you know that you had the STD			
Symptoms and seek medical care	10 (1.6)	1 (14.3)	9 (39.1)
Medical care for another reason and testing	7 (1.1)	2 (28.6)	5 (21.7)
A friend told me that testing was necessary	2 (0.3)	0	2 (8.7)
A friend gave me a notification card for testing	1 (0.2)	1 (14.3)	0
Do not known/no answer	3 (0.5)	3 (42.9)	7 (30.4)
Use of web pages to learn more about STD			
Yes, more than once a month	81 (13.0)	24 (10.3)	57 (14.6)
Yes, less than once a month	159 (25.5)	50 (21.6)	109 (27.9)
No, never	260 (41.7)	151 (65.1)	109 (27.9)
Do not known/no answer	11 (1.8)	7 (3.0)	4 (1.0)
Use of web pages or apps to find new sexual partners			
Yes, more than once a month	22 (3.5)	12 (5.2)	10 (2.6)
Yes, less than once a month	33 (5.3)	18 (7.8)	15 (3.8)
No, never	365 (58.5)	94 (40.5)	271 (69.3)
Do not known/no answer	203 (32.6)	108 (46.6)	95 (24.3)

reported by 57.4% and 35.4% of the participants, respectively, and with boys and girls indistinctively by 6.6%. The most common age at the first sexual intercourse was 16 years (24.6%), followed by 15 (21.3%) and 17 years (17.8%). Overall, 75.8% of the participants

had the first sexual intercourse between 15 and 24 years of age. Only 32.6% reported always use of condoms, 47.5% sometimes, and 15.1% never. Having one sexual partner in the last 6 months was the most common answer (58.3%), followed by 2 (14.5%),

3 (8%), and 4 (5.8%) partners, with concurrent sexual partner relationships in 12.8% of the cases. The risk of being infected by *C. trachomatis* was considered “very high” or “quite high” by more than one-half of the participants (54.1%). Only 30 (4.8%) of the participants had been previously diagnosed with an STD, being *C. trachomatis* infection as the most frequent STD, and knowing to have the disease because of having symptoms and seeking medical care in 10 of the cases (33.3%). With regard to the use of the Internet resources to learn more about sexual health or to find new sexual partners, 41.7% and 58.5% of the participants, respectively, answered “no, never,” whereas 13% and 3.5% answered affirmatively with a frequency of use of more than once a month. Among those who stated to use web pages or apps to find sexual partners, <http://www.tinder.com> was the most popular. Differences in the percentages of responses to the items of sexual health and use of ICT between boys and girls were not found.

Figure 1 shows the percentage of responses regarding the use of information on sexual health offered by web pages and apps, categorized in a 5-point Likert scale from “a lot” to “nothing.” In general, 46% of the participants rated “a lot” and “quite a lot” the use of those resources with information on centers where the diagnosis of STD is made. The interest regarding information on sexual and reproductive health, STD, videos on how to notify exposure to STD to sexual partners, or models of notification cards for sexual partners was majority rated in the categories of “normal,” “a little,” and “nothing.”

A positive test for the presence of *C. trachomatis* was found in 34 participants (5.5%; 95% CI, 3.8–7.5), 12 boys (5.2%; 95% CI, 2.7–8.9), and 22 girls (5.6%; 95% CI, 3.6–8.4; $p = .804$). The median age of the participants with *C. trachomatis* infection was 21.1 years (interquartile range, 19.5–22.0). The mean (SD) number of sexual partners in the previous 6 months for participants with positive and negative *C. trachomatis* tests were 2.1 (1.5) and 1.9 (2.4), respectively. Among the positive group, 20.6% reported 1 sexual partner, 73.5% reported 2 sexual partners, and 2.9% reported 3 sexual partners. The corresponding percentages among the negative group were 12.5%, 84.4%, and 1.0%, respectively. As shown in Table 2, a positive test was significantly

more common among the participants who were working, who had been diagnosed with an STD at some point in their lives, and who used web pages or apps to find new sexual partners more than once a month. In the multivariate analysis, working status was an independent factor associated with chlamydial infection (adjusted OR, 8.88; 95% CI, 1.71–46.17), whereas not having been diagnosed of an STD at any point in life (OR, 0.34; 95% CI, 0.07–1.49) and never using web pages or apps to find new sexual partners (OR, 0.16; 95% CI, 0.03–0.80) were protective factors against chlamydial infection.

DISCUSSION

In a convenience sample of 623 young people aged between 15 and 24 years recruited from a northern region in close proximity with the city of Barcelona, the prevalence of *C. trachomatis* infection was 5.5%. Three variables were associated with positivity to chlamydial testing: current working status, previous diagnosis of STD, and use of the Internet to find new sexual partners at least once a month. In the logistic regression model, working status was the only predictor of test positivity, whereas not being diagnosed with STD and no use of the Internet to find sexual partners were protective factors.

The prevalence rate of *C. trachomatis* infection of 5.5% is similar to data reported in other studies. In a cross-sectional analysis of a prospective representative cohort study of 14,322 young adults aged 18–26 years living in the United States, the overall prevalence of chlamydial infection was 4.19%, with women being more likely to be infected than men.¹⁷ We also found a slightly higher prevalence of chlamydial infection in females (5.6%) than in males (5.2%). In another study of 509 active students (median age, 17.9 years) recruited from technical colleges in the United Kingdom, the overall *C. trachomatis* positivity was 5.1%.¹⁸ However, in a representative nationwide sample of German adolescent boys and girls all from 15 to 17 years of ages, Desai et al.¹⁹ reported an overall markedly lower prevalence of 0.2%, which increased to 2% among those aged 17 years. In our study, we did not stratify by age, although the median age of positive participants was

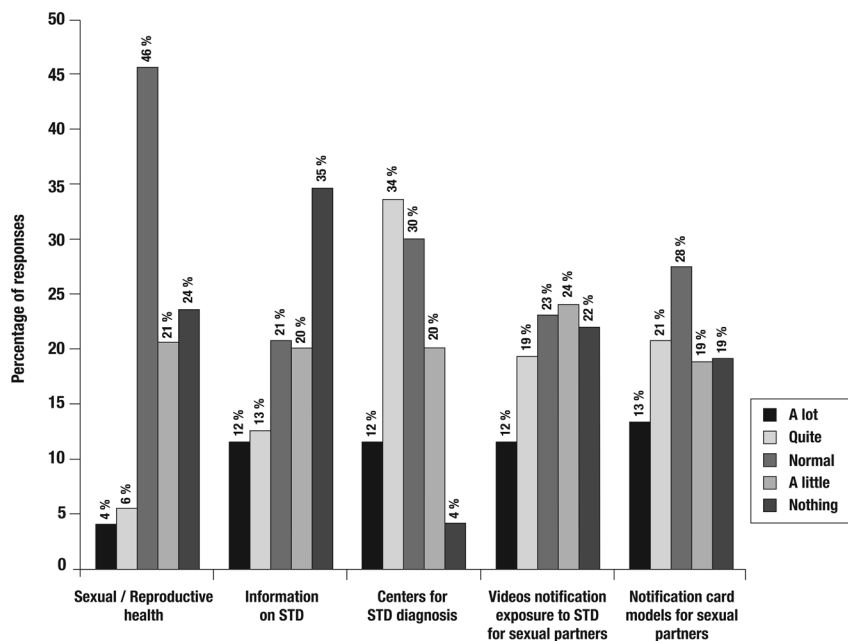


FIGURE 1. Percentage of responses regarding the use of information on sexual health offered by web pages and apps (categorized in a 5-point Likert scale from “a lot” to “nothing”).

TABLE 2. Results of laboratory tests: positive results according to items of the questionnaire

Questionnaire Items	Total Number	Positive test for <i>C. trachomatis</i> Infection (n = 34)		
		n (%)	95% CI	P
What is your occupational situation?				
I study	315	7 (2.2)	0.9–0.45	
I work	66	10 (15.2)	7.5–26.1	0.001
I study and work	215	13 (6.1)	3.3–10.1	
Unemployed	23	2 (8.7)	1.1–28.0	
Do not know/no answer	4	2 (50)	6.8–93.2	
Have you been diagnosed with an STD at some point in your life?				
Yes	30	9 (30.0)	14.7–49.4	0.001
No	545	24 (4.4)	2.8–6.5	
Do not know/no answer	48	1 (2.1)	0.1–11.1	
Do you use web pages or apps to find new sexual partners?				
Yes, more than once a month	22	4 (18.2)	5.2–40.3	0.025
Yes, less than once a month	33	1 (3.0)	0.1–15.8	
No, never	365	15 (4.1)	2.3–6.7	
Do not know/no answer	203	14 (6.9)	3.8–11.3	

21 years, which is notably higher than the upper range of 17 years in the study of Desai et al.¹⁹ In this study of the prevalence of *C. trachomatis* infection in 1,815 urine specimens from young German adolescents aged 12 to 17 years, the overall prevalence of 0.9% increased with age to 2% among those aged 17 years.¹⁹

The present study was promoted by staff healthcare personnel from public sexual and reproductive healthcare centers, which are integrated in the primary healthcare network of the Catalan Health Institute, which is the largest public health service in Catalonia providing healthcare to nearly 6 million users.¹⁶ A systematic review of primary care integration of sexual and reproductive health services for chlamydia testing of the World Health Organization–European region showed data heterogeneity and lack of unified reporting indicators for testing uptake in primary care across the European region.²⁰ In some countries, such as United Kingdom, the chlamydia screening policy establishes that testing should be offered as an integrating component of existing sexual and reproductive health services including primary care based services, this organizational structured is very similar to that in our country. In addition, the present study developed a community-based intervention to promote *C. trachomatis* screening in undiagnosed young people 24 years or younger and indicates the utility of interventions across a range of different settings frequented by young people. In a review of current practices to increase chlamydia screening in the community, interventions incorporating social marketing principles, such as face-to-face interactions, were more likely to provide positive results in engaging people to act overcoming the barriers to presenting to a center for screening.²¹

In relation to data on sexual health, it should be noted that age at the first sexual intercourse was less than 15 years in 20.9% of the participants. In a cross-sectional study of 6,791 heterosexually active women, ages 21–44 years, from the 2006 to 2010 National Survey of Family Growth,⁴ age at first intercourse less than 15 years was reported by 25.2% of women with concurrent partnerships and by 10.9% of monogamous partnership. In this study, compared with women whose sexual debut was 18 years or older, those younger than 15 years at sexual initiation had 3.7 times the odds of reporting concurrent partnerships.⁴ Concurrent partnership was found in 12.8% of the participants in our study, but a relationship between age at first intercourse and concurrent partnership was not assessed.

Of note, a large percentage of the participants (47.5%) reported that they used condoms “sometimes” only; moreover, 15.1% reported “never” use of condoms. Despite the implementation

of HIV/STD prevention interventions, condom use remains low as shown in a study of African Americans and Black adolescents.²² Emotional and relationship factors, including relationship power, relationship intimacy, and types of sexual partners (steady vs. casual) have been associated with decisions regarding condom use and nonuse in adolescent populations.²² In a random sample of 3,486 adolescents studying in secondary schools in Budapest (Hungary), condom use by those reporting having had sex in the past 5 weeks was classified as consistent/every time in 40%, irregular in 25.6%, and none in 34.3% of the cases.²³ However, in a study of 20 European countries of trends of early (<15 years) and very early (<13 years) sex between 2002 and 2010, the overall sexual intercourse initiation remained quite stable, whereas condom use increased, particularly among girls.²⁴

Interestingly, there was a relatively scarce use of the Internet resources to acquire knowledge about STD or to find new sexual partners. In adult populations, it has been shown that persons who seek sexual partners via the Internet report more total sexual partners, more unprotected sex acts, higher rates of alcohol and other substance use in conjunction with sexual activity, and more STDs.²⁵ The Internet provides an opportunity to learn about sexuality and to gain information on topics, such as sexual health and relationships, but adolescents seem to be more likely to rely on and have greater trust in traditional sexuality education sources, such as school, family members, and friends. In a study of 58 in-depth interviews with juniors and seniors in 3 public high schools in New York City and Indiana, most of the adolescents used the Internet on a daily basis, but few considered it a main source of information about contraception or abstinence and were reluctant on sexual health information on the Internet.²⁶ In a purposive sample of 49 young people aged between 16 and 19 years and recruited from areas across Scotland, main barriers to engagement in sexual health information online were difficulty filtering overabundant content, difficulties in navigating large organizations' Web sites, difficulties in finding locally relevant information about services, and reticence to access sexual health information on social networking platforms or through smartphone applications.²⁷

Limitations of the study include those inherent to disadvantages of a convenience sample in terms of generalizability and representativeness of the study population. Female participants were more represented than males, but the reason of a higher number of participating females is unknown. The fact that young females may be more familiarized with consultations for reproductive reasons may account in part

for sex differences in participation. In addition, information on the total number of potentially eligible participants who were approached in the key spaces and denied participation was not registered.

CONCLUSIONS

In a convenience sample of undiagnosed young people aged 16–24 years recruited in the North Metropolitan Area of Barcelona, the prevalence of *C. trachomatis* infection was 5.5%. Working status, a previous diagnosis of STD, and use of web pages or apps to find new sexual partners were associated with chlamydial test positivity.

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