BMJ Open

# Sexually transmitted infections among patients attending a sexual assault centre: a cohort study from Oslo, Norway



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| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2022-064934 |
| Article Type: | Original research |
| Date Submitted by the Author: | 20-May-2022 |
| Complete List of Authors: | Skjælaaen, Katarina; University of Oslo, Department of General Practice; City of Oslo Health Agency, Oslo Sexual Assault Centre<br>Nesvold, Helle; City of Oslo Health Agency, Oslo Sexual Assault Centre<br>Brekke, Mette; University of Oslo, General Practice Research Unit<br>Sare, Miriam; Oslo University Hospital, Department of Microbiology<br>Landaas, Elisabeth Toverud; Oslo University Hospital, Department of Microbiology; University of Oslo, Institute of Clinical Medicine<br>Mdala, Ibrahimu; University of Oslo, Department of General Practice<br>Olsen, Anne Olaug; University of Oslo, Department of Community Medicine and Global Health; Norwegian Institute of Public Health, Department of Infection Control and Vaccine<br>Vallersnes, Odd Martin; University of Oslo, Department of General Practice; City of Oslo Health Agency, Oslo Accident and Emergency Outpatient Clinic |
| Keywords: | FORENSIC MEDICINE, GENITOURINARY MEDICINE, Epidemiology < INFECTIOUS DISEASES, MICROBIOLOGY, SEXUAL MEDICINE |
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# Sexually transmitted infections among patients attending a sexual assault centre: a cohort study from Oslo, Norway

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Word count: 2,963

## ABSTRACT

**Objectives**: We estimate the prevalence of sexually transmitted infection (STI) among patients after sexual assault, assess the possible value of azithromycin prophylaxis, and identify risk factors for assault related STI and for not presenting at follow-up.

**Design**: Prospective observational cohort study.

**Setting**: Sexual assault centre in Oslo, Norway.

**Participants**: 645 patients, 602 (93.3%) females and 43 (6.7%) males, attending the centre from May 2017 to July 2019.

**Outcome measures**: Microbiological testing at the primary examination and at follow-up consultations after 2, 5, and 12 weeks. Relative risk for assault related STI and for not presenting at follow-up.

**Results**: At primary examination the prevalence of genital chlamydia was 8.4%, *Mycoplasma genitalium* 6.4%, and gonorrhoea 0.6%. In addition, the prevalence of bacterial STI diagnosed at follow-up and possibly from the assault was 3.0% in total; 2.5% for *Mycoplasma genitalium,* 1.4% for genital chlamydia, and 0.2% for gonorrhoea. This prevalence did not change when azithromycin was no longer recommended from January 2018. There were no new cases of hepatitis B, hepatitis C, HIV, or syphilis. We found no specific risk factors for assault related STI. Patients with previous contact with child welfare service less often presented to follow-up, relative risk (RR) 2.0 (95% confidence interval 1.1–3.5), as did patients with a history of sex work, RR 3.6 (1.2–11.0), or substance abuse, RR 1.7 (1.1–2.7).

**Conclusions**: Most bacterial STIs were diagnosed at the primary examination, hence not influenced by prophylaxis. There was no increase in bacterial STI diagnosed at follow-up when azithromycin prophylaxis was not routinely recommended, supporting a strategy of starting treatment only when an infection is diagnosed or when the patient is considered at

high risk. Sex work, substance abuse, and previous contact with child welfare services were associated with not presenting to follow-up.

**Trial registration:** ClinicalTrials.gov ID: NCT03132389

## STRENGHTS AND LIMITATIONS

- Microbiological samples were taken both at the primary examination and at follow-up consultations.
- The study population is representative for patients attending the Oslo Sexual Assault Centre, apart from migrants probably being underrepresented.
- As only about 10% of sexual assault victims attend a sexual assault centre, the results may not be representative for sexual assault victims in general.
- A sexually transmitted infection might stem from other sexual contacts than the assault, information we did not gather.
- The study may be underpowered for identifying risk factors.

**Keywords:** Sexual assault, sexually transmitted infection, chlamydia, *Mycoplasma genitalium,* gonorrhoeae, azithromycin

## INTRODUCTION

Sexual violence is a fundamental violation of human rights and a global public health problem.[1, 2] A broad range of physical and psychological health consequences after sexual assault may have significant and long-lasting effects on an individual's well-being and functioning.[1, 2] In a European survey, 3–14% of women reported having been raped, varying between countries.[3] In a Norwegian survey, 9% of women and 1% of men reported having been raped, and 34% of women and 11% of men reported having been sexually assaulted or abused.[4]

After a sexual assault, the risk of sexually transmitted infection (STI) often causes great concern to the individual. The World Health Organization (WHO) describes a 50–80% increased risk of STI among women exposed to sexual violence.[1] Reviews from 2000 report STI prevalence in the range of 0–56% after sexual assault, probably reflecting variations in local population prevalence and study inclusion criteria.[5, 6] More recent European studies report prevalences of *Chlamydia trachomatis* after sexual assault at 6–15%, *Mycoplasma genitalium* at 2%, and *Neisseria gonorrhoeae* at 0–5%.[7-13] The prevalence of STI is higher among patients at sexual assault centres than in the general population,[11, 12, 14] though similar to or lower than among patients tested for STI for other clinical reasons.[11, 13]

Screening for and managing STI are well established procedures after sexual assault.[5, 6, 15-21] Over the last century, the main concern has shifted from syphilis and gonorrhoea to HIV and hepatitis and the increase in multi-resistant bacteria. Accordingly, recommendations for screening and prophylaxis need to be reconsidered from time to time. Since the prevalence of STI varies between geographical areas, recommendations should be adapted to the local STI panorama and medical services.[6] Hence, there is a continuous need for updated studies from

different areas. Current Norwegian guidelines recommend screening for chlamydia, gonorrhoea, syphilis, HIV, hepatitis B and C, and other infections if indicated.[21]

The International Federation of Gynecology and Obstetrics (FIGO) and the US Centers for Disease Control and Prevention (CDC) recommend empiric prophylactic treatment with antibiotics against chlamydia, gonorrhoea, and trichomoniasis after a sexual assault.[15, 20] At the Oslo Sexual Assault Centre (SAC), a single dose of azithromycin for chlamydia was routinely recommended, in line with Norwegian guidelines. Increasing macrolide resistance in *Mycoplasma genitalium* led to the end of this procedure in January 2018,[22] giving us the opportunity to evaluate any concurrent change in the prevalence of STI.

### Objectives

Our main objective was to estimate the prevalence of STI after sexual assault in the Oslo area in Norway. Our secondary objectives were to identify risk factors for assault related STI and for not presenting at follow-up consultations, and to evaluate the change in azithromycin prophylaxis policy. We also describe patient and assault characteristics.

## METHODS

### Design

Prospective observational cohort study among patients attending a sexual assault centre from May 2017 to July 2019.

### Setting

The Oslo SAC sees about 600 patients per year and serves a population of about 1.2 million. It is integrated in a large primary care emergency clinic. The SAC services are available for

persons alleging sexual assault, free of charge and independent of police reporting. Patients younger than 14 years are examined at paediatric hospital departments.

At the primary examination, the patient's history is systematically obtained, including details of the assault and the assailant(s), medical history, and vulnerability factors. Medical and medicolegal examinations include microbiological testing, pregnancy test, forensic swabs, and injury documentation. Necessary treatment is provided, including emergency contraception. Psychosocial counselling includes 1–6 follow-up consultations with a nurse or social worker.

In addition to the primary examination, the Oslo SAC offers three medical follow-up consultations, at 2, 5, and 12 weeks. Both medical and psychosocial issues are addressed, including relevant microbiological sampling and necessary treatment.

Until 20 January 2018, azithromycin 1000 mg was routinely recommended as chlamydia prophylaxis to patients presenting within a week of the assault. Since then, chlamydia prophylaxis has not been generally recommended. Hepatitis B vaccination is offered at the primary examination and repeated twice during follow-up. HIV post-exposure prophylaxis (four weeks of emtricitabine, tenofovir, and raltegravir) is recommended based on individual risk in patients presenting within 72 hours of the assault.[21]

**Participants**

Patients 14 years of age and older presenting at the Oslo SAC were eligible for inclusion in the study. Based on an estimated prevalence of STI of 7% among SAC patients, we calculated that a sample size of 625 participants was needed to make comparisons with the general

population. Patients were recruited by SAC nurses and doctors, at the primary examination or at follow-up. During the recruitment period, 1374 patients presented at the Oslo SAC, amongst whom 645 (46.9%) consented to participate.

**Data collection and classification**

Data were collected from the patients' electronic medical records and archived paper files. We registered age at primary examination, sex, time since assault, previous contact with health and social services, vulnerability factors (as reported by the patient or from the medical records), type of crime scene, assault characteristics, number of assailants, assailant's relation to victim, oral/genital/anal injuries, symptoms of STI, microbiological tests, prophylaxis/treatment given at primary examination and/or follow-up consultations, and whether the patient presented at follow-up consultations.

**Microbiological sample collection**

At the primary examination, samples were obtained using genital swabs (preferably collected from the cervix and vagina, otherwise in urine or by vaginal self-testing, and in urine or from the urethra for men). Oropharyngeal swabs were routinely taken for *Neisseria gonorrhoeae* only. Anorectal swabs were taken in cases with anal penetration or suspected anal penetration, or when the circumstances were unclear. Samples were collected using Sigma Transwab Liquid Amies. Furthermore, blood samples were collected for serological testing for hepatitis B, hepatitis C, HIV, and syphilis. Other STIs were tested for if clinically indicated.

During follow-up, samples were repeated; at 5 weeks if azithromycin had been given, at 2 weeks if not. At 12 weeks follow-up, serology was taken for hepatitis B, hepatitis C, and

syphilis. HIV serology was repeated at all follow-up consultations. If a patient did not present to follow-up, repeated active out-reach was tried, and testing offered at a later consultation.

**Microbiological diagnostic tests**

Microbiological analyses were performed at the Department of Microbiology at Oslo University Hospital. Polymerase chain reaction (PCR) was used for the detection of *Chlamydia trachomatis, Mycoplasma genitalium* (until 10 April 2019), and *Neisseria gonorrhoeae* (AmpliSens® Chlamydia trachomatis-FRT for the former, in-house real-time PCR assays for the latter two, and in some cases Fast-track diagnostics for confirmation of *Neisseria gonorrhoeae*). For *Neisseria gonorrhoea*e, swabs were also cultured, independent of the PCR result. Lymphogranuloma venereum PCR was performed on anorectal samples positive for *Chlamydia trachomatis*, and *Mycoplasma genitalium* positive specimens were examined with PCR for macrolide resistance (both in-house real-time PCR assays).

Blood samples were examined for serologic markers for HIV (HIV antigen/antibody combined), hepatitis B (hepatitis B surface antigen and antibody and core antibody), hepatitis C (hepatitis C antibody), syphilis (*Treponema pallidum* antibody) (all using Abbott Architect assays). Positive results were confirmed with alternative tests (available upon request).

**Outcome measures**

We calculated the prevalence of STI at the primary examination as the rate of detected infections among the patients tested for each specific agent.

To estimate the prevalence of bacterial STI possibly from the assault and assess the azithromycin prophylaxis policy, we defined prevalence within different time frames from assault to primary examination, and prevalence at follow-up:

A. Within two days: Positive tests possibly representing infections transmitted before the assault. However, due to the high sensitivity of PCR testing, an early positive test might also represent infected body fluids deposited at the assault.[18, 23] Newly deposited agents can be detected for a period, then enter an undetectable incubation phase before becoming manifest infections. The two-day time frame was set based upon the two days when semen is likely to be retrieved.[23]
B. Day 3–7: Incubation period. Infections from the assault probably not yet detectable (except gonorrhoea). Positive tests probably representing infections transmitted before the assault.
C. Week 1–4: Positive tests possibly representing infection transmitted at assault, manifest after incubation, but possibly also pre-existing infection.
D. At follow-up, infection possibly transmitted at the assault: Positive test for genital chlamydia or *Mycoplasma genitalium* at follow-up combined with negative test at primary examination within a week of the assault. Cases negative both at primary examination and at follow-up were considered not infected. Cases negative at primary examination but not tested at follow-up were considered not infected if the primary examination was more than a week after the assault, otherwise they were excluded. The same definition was used for gonorrhoea, but with the cut-off set at two days. This definition probably misses some assault related infections as the incubation time may be longer than a week (two days for gonorrhoea).

The results in definitions A, B, and C will not be affected by prophylaxis, but these patients will need treatment. In definition D, test results at follow-up will be affected by whether azithromycin was given or not.

Definition D was used when estimating risk factors for assault related STI. Risk factors were estimated as relative risks.

Seroconversion assessment was based on serologic tests done at 12 weeks follow-up.

**Statistical analyses**

Statistical analyses were performed using SPSS 27 or an online calculator from Epitools (https://epitools.ausvet.com.au). Associations between categorical variables were established from the chi-square test, or Fisher's exact test when appropriate. Age comparisons were done using Mann-Whitney U-test. Relative risks were estimated in Stata SE 17.

**Patient and public involvement**

No patient involved.

**RESULTS**

Among the 645 patients included, 602 (93.3%) were female, and 43 (6.7%) were male. Median age was 23 years (interquartile range 19–28) among females, and 26 years (22–32) among males (p=0.003).

In total 191 (29.6%) patients had previously been in contact with psychiatric outpatient services for adults, and 106 (16.4%) with similar services for children/adolescents (Table 1).

There was a history of mental disorder among 288 (44.7%) of patients, previous trauma (including sexual assault) among 247 (38.3%), and substance abuse among 74 (11.5%). Of the assailants, 98.9% were male (Table 2).

**Table 1. Background data and assault characteristics for patients attending a sexual assault centre in Oslo, Norway**

| | Females n (%) | Males n (%) | Total n (%) |
|---|---|---|---|
| **Vulnerability factors** | | | |
| *Mental disorder*[a] | 271 (45.0) | 17 (39.5) | 288 (44.7) |
| *Previous trauma* | 232 (38.5) | 15 (34.9) | 247 (38.3) |
| *Substance abuse* | 64 (10.6) | 10 (23.3)* | 74 (11.5) |
| *Sex work* | 12 (2.0) | - | 12 (1.9) |
| *Physical/mental disability* | 3 (0.5) | 1 (2.3) | 4 (0.6) |
| *Resident at institution* | 3 (0.5) | - | 3 (0.5) |
| *Other* | 24 (4.0) | 2 (4.7) | 26 (4.0) |
| *No vulnerability factors reported* | 229 (38.0) | 18 (41.9) | 247 (38.3) |
| **Previous contact with health/social services** | | | |
| *Adult psychiatric outpatient service* | 179 (29.7) | 12 (27.9) | 191 (29.6) |
| *Child/adolescent psychiatry service* | 105 (17.4) | 1 (2.3)* | 106 (16.4) |
| *Admitted psychiatric hospital* | 45 (7.5) | 3 (7.0) | 48 (7.4) |
| *Child welfare service* | 45 (7.5) | 1 (2.3) | 46 (7.1) |
| *Addiction outpatient service* | 35 (5.8) | 7 (16.3)* | 42 (6.5) |
| **Crime scene**[b] | | | |
| *Assailant's residence* | 195 (32.4) | 10 (23.3) | 205 (31.8) |
| *Patient's residence* | 121 (20.1) | 7 (16.3) | 128 (19.8) |
| *Other person's residence* | 98 (16.3) | 8 (18.6) | 106 (16.4) |
| *Public place indoors*[c] | 73 (12.1) | 11 (25.6)* | 84 (13.0) |
| *Outdoors* | 57 (9.5) | -* | 57 (8.8) |
| *Vehicle* | 25 (4.2) | 3 (7.0) | 28 (4.3) |
| *Other/no information* | 33 (5.5) | 4 (9.3) | 37 (5.7) |
| **Type of assault** | | | |
| *Penetration total* | 459 (76.2) | 25 (58.1)* | 484 (75.0) |
| *Penetration attempted* | 13 (2.2) | 1 (2.3) | 14 (2.2) |
| *Penetration suspected* | 121 (20.1) | 14 (32.6) | 135 (20.9) |
| *No penetration* | 9 (1.5) | 3 (7.0)* | 12 (1.9) |
| *Penetration in vagina* | 460 (76.4) | 1 (0.2)*** | 461 (71.5) |
| *Penetration in mouth* | 129 (21.4) | 18 (41.9)** | 147 (22.8) |
| *Penetration in anus* | 94 (15.6) | 26 (60.5)*** | 120 (18.6) |
| *Penetration with penis* | 438 (72.8) | 26 (60.5) | 464 (71.9) |
| *Penetration with fingers* | 169 (28.1) | 10 (23.3) | 179 (27.8) |
| *Penetration with foreign object* | 7 (1.2) | 4 (9.3)** | 11 (1.7) |
| *Penetration not further specified* | 106 (17.6) | 10 (23.3) | 116 (18.0) |
| *Patient had to penetrate other person* | 1 (0.2) | 5 (11.6)*** | 6 (0.9) |
| *Patient had to execute other sexual action* | 67 (11.1) | 15 (34.9)*** | 82 (12.7) |
| *Other kind of assault* | 26 (4.3) | 5 (11.6)* | 31 (4.8) |
| *Amnesia but strong suspicion of assault* | 154 (25.6) | 13 (30.2) | 167 (25.9) |
| **Injuries sustained**[d] | | | |
| *Genital injuries* | 140 (23.3) | -*** | 140 (21.7) |
| *Anal injuries* | 46 (7.6) | 6 (14.0) | 52 (8.1) |
| *Oral injuries* | 35 (5.8) | 1 (2.3) | 36 (5.6) |
| **Total** | 602 (100) | 43 (100) | 645 (100) |

Penetration where and with what also registered for cases with attempted or suspected penetration.
[a]Encompassing personality disorders, depression, post-traumatic stress syndrome, severe anxiety disorders, attention deficit hyperactivity disorder, and a few patients with psychotic disorders.
[b]More than one crime scene in 6 cases.
[c]Mainly hotels, bars, clubs.
[d]Mainly minor and few, e.g. superficial small tears, ecchymoses, and abrasions.
Comparisons between sexes: *p < 0.05; **p < 0.01; ***p < 0.001.

**Table 2. Assailant characteristics in sexual assaults on patients attending a sexual assault centre in Oslo, Norway**

| | Female patients n (%) | Male patients n (%) | Patients total n (%) |
|---|---|---|---|
| **Gender**[a] | | | |
| *Male* | 671 (99.3) | 44 (93.6)* | 715 (98.9) |
| *Female* | 5 (0.7) | 3 (6.4)* | 8 (1.1) |
| | | | |
| **Relation** | | | |
| *Met same day* | 188 (26.9) | 9 (16.4) | 197 (26.2) |
| *Stranger* | 161 (23.1) | 19 (34.5) | 180 (23.9) |
| *Acquaintance* | 167 (23.9) | 7 (12.7) | 174 (23.1) |
| *Friend* | 57 (8.2) | 2 (3.6) | 59 (7.8) |
| *Met via the internet* | 34 (4.9) | 8 (14.5)** | 42 (5.6) |
| *Intimate partner present/past* | 33 (4.7) | 2 (3.6) | 35 (4.6) |
| *Authority figure* | 16 (2.3) | - | 16 (2.1) |
| *Family member* | 6 (0.9) | 1 (1.8) | 7 (0.9) |
| *Other/no information* | 36 (5.2) | 7 (12.7) | 43 (5.7) |
| | | | |
| **Total**[b] | 698 (100) | 55 (100) | 753 (100) |

[a]Missing information in 30 cases; 22 among females and 8 among males.
[b]One assailant in 537 (83.3 %) cases, two in 40 (6.2 %), three or more in 23 (3.6 %), unknown in 45 (7.0 %).
Comparisons between sexes: *p < 0.05; **p < 0.01; ***p < 0.001.

Most patients, 563 (87.3%), presented to primary examination within one week of the assault, 452 (70.2%) within 48 hours, and 350 (54.3%) within 24 hours. Only 42 (6.5%) presented later than 4 weeks. In total 497 (77.1%) patients presented to at least one follow-up consultation, 270 (41.9%) presented to all three. Patients with previous contact with child welfare services less often presented to follow-up, relative risk (RR) 2.0 (95% confidence interval 1.1–3.5), as did patients with a history of sex work, RR 3.6 (1.2–11.0) or substance abuse, RR 1.7 (1.1–2.7) (Supplementary table 1).

At the primary examination *Chlamydia trachomatis* was diagnosed in 52/620 (8.4%) patients, *Mycoplasma genitalium* in 34/529 (6.4%), and *Neisseria gonorrhoeae* in 4/635 (0.6%) (Table 3). There were no new cases of hepatitis B, hepatitis C, HIV, or syphilis. Five patients had

pelvic inflammatory disease; only one of whom had STI diagnosed (positive for *Chlamydia trachomatis*, *Mycoplasma genitalium*, and *Neisseria gonorrhoeae*).

**Table 3. Sexually transmitted infections at primary examination among patients attending a sexual assault centre in Oslo, Norway**

| | Females n/N (%) | Males n/N (%) | Total n/N (%) |
|---|---|---|---|
| ***Chlamydia trachomatis*** | | | |
| *Patients total* | 50/578 (8.7) | 2/42 (4.8) | 52/620 (8.4) |
| *Cervix/vagina/urethra/urine*[a] | 49/573 (8.6) | 0/42* | 49/615 (8.0) |
| *Anus* | 12/243 (4.9) | 2/30 (6.7) | 14/273 (5.1) |
| ***Mycoplasma genitalium*** | | | |
| *Patients total* | 34/494 (6.9)[b] | 0/35 | 34/529 (6.4)[b] |
| *Cervix/vagina/urethra/urine*[a] | 28/490 (5.7)[c] | 0/34 | 28/524 (5.3)[c] |
| *Anus* | 8/212 (3.8)[d] | 0/25 | 8/237 (3.4)[d] |
| ***Neisseria gonorrhoeae*** | | | |
| *Patients total* | 4/593 (0.7) | 0/42 | 4/635 (0.6) |
| *Cervix/vagina/urethra/urine*[a] | 2/573 (0.3) | 0/41 | 2/614 (0.3%) |
| *Anus* | 1/238 (0.4) | 0/30 | 1/268 (0.4) |
| *Oropharynx* | 4/522 (0.8) | 0/36 | 4/558 (0.7) |
| **Hepatitis B** | | | |
| *Known chronic contagious infection* | 1/584 (0.2) | 1/42 (2.4) | 2/626 (0.3) |
| *Previous infection* | 10/584 (1.7) | 1/42 (2.4) | 11/626 (1.8) |
| *Previously vaccinated* | 181/584 (31.0) | 15/42 (35.7) | 196/626 (31.3) |
| *Positive vaccination status during follow-up*[e] | 360/420 (85.7) | 24/32 (75.0) | 384/452 (85.0) |
| **Hepatitis C** | | | |
| *Known previous infection* | 12/585 (2.1) | 2/42 (4.8) | 14/627 (2.2) |
| **HIV** | | | |
| *Known infection* | 1/586 (0.2) | 0/42 | 1/628 (0.2) |
| **Syphilis** | | | |
| *Known previous infection* | 1/576 (0.2) | 2/39 (5.1)* | 3/615 (0.5) |

Proportions stated as positive tests (n) per patients tested (N).
Fourteen patients were tested for lymphogranuloma venereum, all negative.
Seven patients were tested for Trichomonas, all negative.
No condylomas were diagnosed (visual inspection).
[a]Females sampled from cervix and/or vagina or in urine, males sampled from urethra or in urine.
[b]Fourteen cases macrolide resistant.
[c]Twelve cases macrolide resistant.
[d]Four cases macrolide resistant.
[e]Seroconversion assessment three months after primary examination.
Comparisons between sexes: *p < 0.05; **p < 0.01; ***p < 0.001.

Azithromycin prophylaxis was given to 153/645 (23.7%) patients (131/218 (60.1%) before 20 January 2018 and 22/427 (5.2%) after), hepatitis B vaccination to 415/645 (64.3%), and HIV post-exposition prophylaxis to 144/602 (23.9%) females and 20/43 (46.5%) males. Antibiotic treatment was ascertained for all diagnosed patients except 2/58 with genital chlamydia, 8/45 with *Mycoplasma genitalium,* and 1/5 with gonorrhoea (Supplementary table 2).

Bacterial STI possibly from the assault was diagnosed at the primary examination in 55/447 (12.3%) patients using definition A and in 5/56 (8.9%) using definition C, and at follow-up in 15/495 (3.0%) patients using definition D (Table 4). Changing the azithromycin prophylaxis recommendation did not affect the prevalence. We found no specific risk factors for assault related STI.

**Table 4. Sexually transmitted infections diagnosed after assault among patients attending a sexual assault centre in Oslo, Norway**

| | Azithromycin prophylaxis recommended n/N (%) | Azithromycin prophylaxis not recommended n/N (%) | p-value | Total n/N (%) |
|---|---|---|---|---|
| **A. Positive test at primary examination within two days of assault. Infectious agents possibly deposited at assault.** | | | | |
| **Genital chlamydia** | 13/138 (9.4) | 21/297 (7.1) | 0.51 | 34/435 (7.8) |
| ***Mycoplasma genitalium*** | 8/138 (5.8) | 17/228 (7.5) | 0.69 | 25/366 (6.8) |
| **Gonorrhoea** | 0/142 | 4/304 (1.3) | 0.31 | 4/446 (0.9) |
| **Any of the above** | 19/142 (13.4)[a] | 36/305 (11.8)[a] | 0.75 | 55/447 (12.3)[a] |
| **B. Positive test at primary examination 3–7 days after assault. Incubation period – infection probably from before assault.** | | | | |
| **Genital chlamydia** | 3/39 (7.7) | 8/68 (11.8) | 0.74 | 11/107 (10.3) |
| ***Mycoplasma genitalium*** | 1/38 (2.6) | 4/55 (7.3) | 0.65 | 5/93 (5.4) |
| **Gonorrhoea** | 0/41 | 0/68 | - | 0/109 |
| **Any of the above** | 4/41 (9.8) | 10/68 (14.7)[a] | 0.65 | 14/109 (12.8)[a] |
| **C. Positive test at primary examination 1–4 weeks after assault. Infection possibly from assault, manifest after incubation.** | | | | |
| **Genital chlamydia** | 1/18 (5.6) | 3/36 (8.3) | 1.00 | 4/54 (7.4) |
| ***Mycoplasma genitalium*** | 1/17 (5.9) | 1/31 (3.2) | 1.00 | 2/48 (4.2) |
| **Gonorrhoea** | 0/19 | 0/37 | - | 0/56 |
| **Any of the above** | 2/19 (10.5) | 3/37 (8.1)[a] | 1.00 | 5/56 (8.9)[a] |
| **D. Negative test at primary examination within a week of assault[b], positive at follow-up. Infection possibly from assault.** | | | | |
| **Genital chlamydia** | 1/138 (0.7) | 5/289 (1.7) | 0.67 | 6/427 (1.4) |
| ***Mycoplasma genitalium*** | 2/139 (1.4) | 7/222 (3.2) | 0.49 | 9/361 (2.5) |
| **Gonorrhoea** | 1/162 (0.6) | 0/328 | 0.33 | 1/490 (0.2) |
| **Any of the above** | 4/162 (2.5) | 11/333 (3.3)[a] | 0.78 | 15/495 (3.0)[a] |

[a]Some patients were infected with more than one agent.
[b]Two days for gonorrhoea.

## DISCUSSION

### Summary of main findings

At the primary examination, the prevalence of genital chlamydia was 8.4%, *Mycoplasma genitalium* 6.4%, and gonorrhoea 0.6%. In addition, the prevalence of bacterial STI possibly from the assault diagnosed at follow-up was 3.0% in total; 2.5 % for *Mycoplasma genitalium,* 1.4% for genital chlamydia, and 0.2% for gonorrhoea. Not recommending azithromycin prophylaxis did not increase the prevalence of STI.

### STI prevalence

The prevalence of genital chlamydia and gonorrhoea among our patients were higher than in the general Norwegian population of similar age, 8.4% vs. 2.4% and 0.6% vs. 0.1%, respectively,[24] in line with previous studies.[11, 12, 14] Compared to other SAC studies, our findings are in the same range as a previous Norwegian study from Trondheim in 2003–2010 reporting genital chlamydia in 6% and no cases of gonorrhoea;[11] as well as UK, Belgian, and Dutch studies reporting genital chlamydia in 6–10% and gonorrhoea in 1–2%;[7-10, 13] though lower than a French study reporting genital chlamydia in 15% and gonorrhoea in 5%.[12] Few SAC studies report *Mycoplasma genitalium* prevalence. In comparison to the 6.4% in our study, 2% was reported in the Trondheim study,[11] and 8% in a Korean study from 2010–2019.[14]

### Antimicrobial prophylaxis

As most bacterial STIs were diagnosed at the primary examination (Table 4), their prevalence would not be affected by prophylactic treatment. Hence, the recommended azithromycin was as much an empiric treatment of pre-existing infection as a prophylactic, yet still resulting in overtreatment. Not recommending azithromycin treatment did not increase the prevalence of

assault related bacterial STI. This supports a strategy of treating STI only when diagnosed, in countries with well-developed health services. Still, the FIGO and the CDC recommend empiric prophylactic antimicrobial treatment,[15, 20] arguing that many patients do not return for follow-up consultations, making it difficult to base treatment on results from the initial screening. In our study population 77.1% presented to at least one follow-up consultation, compared to the 30–60% more commonly reported.[6, 7, 25-27] The Oslo SAC keeps an active outreach approach if patients do not show up. Patients may also seek help elsewhere. Testing and treatment for STI are easily available and free of charge in Norway, and widely accepted by adolescents and young adults.

Targeted prophylactic empiric antibiotic treatment might be considered for patients especially at risk of not presenting at follow-up (in our study sex work, substance abuse, and previous contact with child welfare services). These patients often are particularly vulnerable.[26]

In 2013, when *Mycoplasma genitalium* was included in the Oslo SAC screening program, azithromycin was an effective treatment. As macrolide resistance increased, moxifloxacin was introduced. The clinical significance of detecting *Mycoplasma genitalium* was increasingly questioned, and the Oslo SAC stopped screening asymptomatic patients for *Mycoplasma genitalium* in April 2019 in line with changing international and national guidelines.[21, 22] This development highlights that the risk and harm of antimicrobial resistance and overtreatment must be considered when deciding on prophylactic empiric antibiotic treatment after sexual assault. Reduced antibiotic use may also be beneficial to the individual patients by avoiding potential side effects.

We found no new cases of hepatitis B or HIV. This mainly reflects low prevalence in the population, but also suggests that the vaccination and post-exposure prophylaxis are sufficiently extensive.

**Medico-legal aspects**

Consequences of STI may be serious, especially in countries with less available health services. Bacterial infections, often conceived as less serious diseases in high income countries, are becoming more difficult to treat as antimicrobial resistance is increasing. The sexual crime legislation in Norway explicitly states that transmission of an STI is an aggravating circumstance, carrying stricter custodial penalties. While it may be impossible to ascertain the exact time for STI transmission, and thus difficult to conclude with certainty in medical terms whether the STI resulted from the assault, the Courts may still find this information pertinent to their proceedings. This supports the case for addressing possibly assault related STI in medicolegal reports.

**Strengths and limitations**

Comparing with annual reports from the Oslo SAC,[28] our study population is similar concerning age, sex, and relation to the assailant. While we expected vulnerable patients to be less likely to consent to participation, 62% of the patients in our study reported at least one vulnerability factor, compared to 56–59% in previous Norwegian studies.[29, 30] Migrants are probably underrepresented, as the information/consent form was available only in Norwegian and English. Otherwise, our study population seems representative for the Oslo SAC population. However, as it is estimated that only 10% of sexual assault victims attend an SAC,[4, 29] it is uncertain to what extent our results are representative for sexual assault victims in general.

Estimating the risk of assault related STI is complicated. A strength of our study is that we have samples both from the primary examination and from follow-up consultations, as re-testing often is necessary to establish whether an infection has been transmitted. Prophylactic antibiotic treatment may hinder development of infection, consequently obscuring the risk. An STI might stem from other sexual contacts than the assault, information we did not gather. Some of the STI diagnosed at the primary examination may be assault related, but probably a minority. Among early examined patients, samples may catch newly deposited infected body fluids,[18] but not all assailants are STI-carriers, and not all sexual contacts will transfer an infection. We consider definition D our best estimate of assault related STI, though probably on the lower side.

As the study sample size was calculated for comparisons with the general population, the study may be underpowered for identifying risk factors. Hence, there is a possibility of type II errors, and risk factors may go undetected, as may a possible protective effect of recommending azithromycin prophylaxis.

**Conclusion**

About 3% of patients attending the Oslo SAC had an STI possibly from the assault, mainly genital chlamydia and *Mycoplasma genitalium.* There was no increase in STI when azithromycin prophylaxis was no longer recommended, supporting a strategy of treating only diagnosed infections, thus avoiding overtreatment. However, as the most vulnerable patients seem most at risk of not presenting to follow-up, targeting prophylactic empiric treatment to them may be a reasonable strategy.

## ACKNOWLEDGMENTS

We thank the patients for participating in the study, the nurses and doctors at the Oslo SAC for including patients in the study, and the staff at the Department of Microbiology at Oslo University Hospital for their work with the microbiological analyses.

This work was performed on the TSD (Tjeneste for sensitive data) facilities, owned by the University of Oslo, operated and developed by the TSD service group at the University of Oslo IT Department (USIT) (tsd-drift@usit.uio.no).

## CONTRIBUTORS

KS, HN, MB, and OMV conceived the study. All authors contributed to the design. KS, HN, and OMV collected the data. KS, HN, IM, and OMV analysed the data. KS and OMV drafted the manuscript. All authors contributed substantially to revising the manuscript and approved the final version.

## COMPETING INTERESTS

None declared.

## FUNDING

KS received funding from the Norwegian Committee on Research in General Practice (a committee of the Norwegian College of General Practitioners) (grant number N/A), and from the Rolf Geir Gjertsens minnefond (UNIFOR) (grant number N/A). The sponsors had no involvement in the conduct of the research or the preparation of the article.

## DATA SHARING STATEMENT

The dataset cannot be made openly available due to conditions set by the Regional Committee South-East A for Medical and Health Research Ethics prior to collecting the data. Inquiries about the data and conditions for access can be made to the corresponding author.

## ETHICS APPROVAL

The study was approved by the Regional Committee South-East A for Medical and Health Research Ethics (REK no. 2016/2279). Patients were included after informed written consent. Patients were approached for inclusion only if considered in an appropriate state of mind.



## REFERENCES

1. García-Moreno C, Pallitto C, Devries K, et al. Global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence. Geneva, Switzerland: World Health Organisation 2013.
2. Jina R, Thomas LS. Health consequences of sexual violence against women. *Best Pract Res Clin Obstet Gynaecol* 2013;27:15-26.
3. Holmberg S, Lewenhagen L. Reported and cleared rapes in Europe: difficulties of international comparisons. Stockholm, Sweden: The Swedish National Council for Crime Prevention [Brottsförebyggande rådet (Brå)] 2020.
4. Thoresen S, Hjemdal OK, (eds.). Vold og voldtekt i Norge: en nasjonal forekomststudie av vold i et livsløpsperspektiv. Oslo, Norway: Nasjonalt kunnskapssenter om vold og traumatisk stress 2014.

5. Lamba H, Murphy SM. Sexual assault and sexually transmitted infections: an updated review. *Int J STD AIDS* 2000;11:487-91.
6. Reynolds MW, Peipert JF, Collins B. Epidemiologic issues of sexually transmitted diseases in sexual assault victims. *Obstet Gynecol Surv* 2000;55:51-7.
7. Kerr E, Cottee C, Chowdhury R, et al. The Haven: a pilot referral centre in London for cases of serious sexual assault. *BJOG* 2003;110:267-71.
8. Thompson C. Review of 212 individuals attending a city centre genitourinary medicine clinic following acute sexual assault. *J Clin Forensic Med* 2006;13:186-8.
9. Forbes KM, Day M, Vaze U, et al. Management of survivors of sexual assault within genitourinary medicine. *Int J STD AIDS* 2008;19:482-3.
10. Gilles C, Van Loo C, Rozenberg S. Audit on the management of complainants of sexual assault at an emergency department. *Eur J Obstet Gynecol Reprod Biol* 2010;151:185-9.
11. Hagemann CT, Nordbo SA, Myhre AK, et al. Sexually transmitted infections among women attending a Norwegian sexual assault centre. *Sex Transm Infect* 2014;90:283-9.
12. Jaureguy F, Chariot P, Vessieres A, et al. Prevalence of Chlamydia trachomatis and Neisseria gonorrhoeae infections detected by real-time PCR among individuals reporting sexual assaults in the Paris, France area. *Forensic Sci Int* 2016;266:130-3.
13. van Rooijen MS, Schim van der Loeff MF, van Kempen L, et al. Sexually transmitted infection positivity rate and treatment uptake among female and male sexual assault victims attending the Amsterdam STI Clinic between 2005 and 2016. *Sex Transm Dis* 2018;45:534-41.
14. Park JH, Kim N, Shin S, et al. Prevalence and correlated factors of sexually transmitted infections among women attending a Korean sexual assault center. *J Forensic Leg Med* 2020;71:101935.

15. Jina R, Jewkes R, Munjanja SP, et al. Report of the FIGO Working Group on Sexual Violence/HIV: guidelines for the management of female survivors of sexual assault. *Int J Gynaecol Obstet* 2010;109:85-92.
16. Welch J, Mason F. Rape and sexual assault. *BMJ* 2007;334:1154-8.
17. Linden JA. Clinical practice: care of the adult patient after sexual assault. *N Engl J Med* 2011;365:834-41.
18. Sena AC, Hsu KK, Kellogg N, et al. Sexual assault and sexually transmitted infections in adults, adolescents, and children. *Clin Infect Dis* 2015;61(Suppl 8):S856-64.
19. Australian STI management guidelines for use in primary care. Australasian Sexual Health Alliance 2017. http://www.sti.guidelines.org.au/ (accessed 23 May 2020).
20. Sexually Transmitted Infections Treatment Guidelines 2021. US Departement of Health & Human Services 2021. https://www.cdc.gov/std/treatment-guidelines/ (accessed 11 Feb 2022).
21. Hagemann C, Schei B, Nesvold H, et al. Mottak av ungdom/voksne pasienter etter seksuelle overgrep. Norsk gynekologisk forening, 2021 https://www.legeforeningen.no/foreningsledd/fagmed/norsk-gynekologisk-forening/veiledere/veileder-i-gynekologi/mottak-av-pasienter-etter-seksuelle-overgrep/ (accessed 28 Mar 2022).
22. Horner PJ, Blee K, Falk L, et al. 2016 European guideline on the management of non-gonococcal urethritis. *Int J STD AIDS* 2016;27:928-37.
23. Casey DG, Domijan K, MacNeill S, et al. The persistence of sperm and the development of time since intercourse (TSI) guidelines in sexual assault cases at Forensic Science Ireland, Dublin, Ireland. *J Forensic Sci* 2017;62:585-92.
24. MSIS-statistikk. Folkehelseinstituttet [The Norwegian Institute of Public Health] 2022. www.msis.no (accessed 18 Feb 2022).

25. Gibb AM, McManus T, Forster GE. Should we offer antibiotic prophylaxis post sexual assault? *Int J STD AIDS* 2003;14:99-102.

26. Ackerman DR, Sugar NF, Fine DN, et al. Sexual assault victims: factors associated with follow-up care. *Am J Obstet Gynecol* 2006;194:1653-9.

27. Holmes MM, Resnick HS, Frampton D. Follow-up of sexual assault victims. *Am J Obstet Gynecol* 1998;179:336-42.

28. Waitz HM, Abel V, Johannessen CO, et al. Overgrepsmottaket: nøkkeltall 2018. Oslo, Norway: Oslo kommune Helseetaten 2019.

29. Nesvold H, Friis S, Ormstad K. Sexual assault centers: attendance rates, and differences between early and late presenting cases. *Acta Obstet Gynecol Scand* 2008;87:707-15.

30. Vik BF, Nottestad JA, Schei B, et al. Psychosocial vulnerability among patients contacting a Norwegian sexual assault center. *J Interpers Violence* 2019;34:2138-57.

**Supplementary table 1. Factors associated with not presenting at follow-up consultations at a sexual assault centre in Oslo, Norway**

| | Did not present at any follow-up consultation n (%) | Presented at one or more follow-up consultations n (%) | Total n (%) | Relative risk (95% CI) |
|---|---|---|---|---|
| **Previous contact with child welfare service** | 17 (11.5) | 29 (5.8) | 46 (7.1) | 2.0 (1.1–3.5) |
| **Substance abuse** | 24 (16.2) | 50 (10.1) | 74 (11.5) | 1.7 (1.1–2.7) |
| **Sex work** | 6 (4.1) | 6 (1.2) | 12 (1.9) | 3.6 (1.2–11.0) |
| **Crime scene assailant's residence** | 34 (23.0) | 171 (34.4) | 205 (31.8) | 0.72 (0.52–0.98) |
| **Penetration in vagina** | 92 (62.2) | 369 (74.2) | 461 (71.5) | 0.84 (0.73–0.96) |
| **Penetration in anus** | 19 (12.8) | 100 (20.1) | 119 (18.4) | 0.68 (0.44–1.1) |
| **Anal injury** | 5 (3.4) | 47 (9.5) | 52 (8,1) | 0.36 (0.14–0.88) |
| **Oral injury** | 13 (8.8) | 23 (4.6) | 36 (5.6) | 2.0 (1.1–3.9) |
| **Total** | 148 (100) | 497 (100) | 645 (100) | |

Variables not associated with presenting or not at follow-up consultations: age, sex, previous contact with child/adolescent psychiatry service, previous contact with adult psychiatric outpatient services, previously admitted psychiatric hospital, previous contact with addiction outpatient services, psychiatric disorder, previous trauma, physical disability, mental disability, resident at institution, crime scene patient's residence, crime scene other person's residence, crime scene public place indoors, crime scene outdoors, crime scene in vehicle, penetration in mouth, assailant relation, genital injury.

**Supplementary table 2. Treatment for sexually transmitted infections among patients attending a sexual assault centre in Oslo, Norway**

| | First treatment | | Test after initial treatment | Second treatment | | Test after second treatment |
|---|---|---|---|---|---|---|
| **Chlamydia trachomatis** | | | | | | |
| 58 | Azithromycin | 25 | Negative 6 | | | |
| | | | Positive 7 | Doxycycline | 7 | Negative 3 |
| | Doxycycline | 23 | Negative 14 | | | |
| | | | Positive 2 | Doxycycline | 1 | |
| | | | | Azithromycin | 1 | Positive 1 |
| | Moxifloxacin | 1[a] | Positive 1 | Doxycycline | 1 | Negative 1 |
| | Unspecified[b] | 7 | Negative 4 | | | |
| | No information | 2 | | | | |
| **Mycoplasma genitalium** | | | | | | |
| 24 | Azithromycin | 13 | Negative 8 | | | |
| | Moxifloxacin | 1 | Negative 1 | | | |
| | Doxycycline | 3 | Positive 2 | Azithromycin | 1 | |
| | | | Negative 1 | | | |
| | Unspecified[b] | 4 | Negative 3 | | | |
| | No information | 3 | Negative 2 | | | |
| **Mycoplasma genitalium macrolide resistant** | | | | | | |
| 21 | Azithromycin | 4 | | Moxifloxacin | 1 | Negative 1 |
| | | | | Unspecified[b] | 1 | |
| | Moxifloxacin | 10 | Negative 9 | | | |
| | Unspecified[b] | 2 | Negative 2 | | | |
| | No information | 5 | Negative 2 | | | |
| **Neisseria gonorrhoeae** | | | | | | |
| 5 | Treated at specialist venereal clinic[b] | 4 | | | | |
| | No information | 1 | | | | |

Total numbers at the primary examination and during follow-up: genital *Chlamydia trachomatis* in 58 patients, amongst whom 25 (43.1%) had symptoms; *Mycoplasma genitalium* in 45 patients, amongst whom 19 (42.2%) had symptoms; and *Neisseria gonorrhoeae* in 5 patients, amongst whom 2 (40.0%) had symptoms.
Missing data not shown for second treatment and tests after treatment.
[a]Co-infection with macrolide resistant Mycoplasma genitalium.
[b]Antibiotic treatment, drug not specified.
Among patients with no information about treatment, several may have received treatment elsewhere.

BMJ Open

# Sexually transmitted infections among patients attending a sexual assault centre: a cohort study from Oslo, Norway

| | |
|---|---|
| Journal: | *BMJ Open* |
| Manuscript ID | bmjopen-2022-064934.R1 |
| Article Type: | Original research |
| Date Submitted by the Author: | 30-Sep-2022 |
| Complete List of Authors: | Skjælaaen, Katarina; University of Oslo, Department of General Practice; City of Oslo Health Agency, Oslo Sexual Assault Centre<br>Nesvold, Helle; City of Oslo Health Agency, Oslo Sexual Assault Centre<br>Brekke, Mette; University of Oslo, Department of General Practice<br>Sare, Miriam; Oslo University Hospital, Department of Microbiology<br>Landaas, Elisabeth Toverud; Oslo University Hospital, Department of Microbiology; University of Oslo, Institute of Clinical Medicine<br>Mdala, Ibrahimu; University of Oslo, Department of General Practice<br>Olsen, Anne Olaug; University of Oslo, Department of Community Medicine and Global Health; Norwegian Institute of Public Health, Department of Infection Control and Vaccine<br>Vallersnes, Odd Martin; University of Oslo, Department of General Practice; City of Oslo Health Agency, Oslo Accident and Emergency Outpatient Clinic |
| Primary Subject Heading: | Infectious diseases |
| Secondary Subject Heading: | Legal and forensic medicine, Obstetrics and gynaecology, Sexual health, Urology |
| Keywords: | FORENSIC MEDICINE, GENITOURINARY MEDICINE, Epidemiology < INFECTIOUS DISEASES, MICROBIOLOGY, SEXUAL MEDICINE |
| | |

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# Sexually transmitted infections among patients attending a sexual assault centre: a cohort study from Oslo, Norway

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Word count: 3,167

## ABSTRACT

**Objectives**: We estimate the prevalence of sexually transmitted infection (STI) among patients after sexual assault, assess the possible value of azithromycin prophylaxis, and identify risk factors for assault related STI and for not presenting at follow-up.

**Design**: Prospective observational cohort study.

**Setting**: Sexual assault centre in Oslo, Norway.

**Participants**: 645 patients, 602 (93.3%) females and 43 (6.7%) males, attending the centre from May 2017 to July 2019.

**Outcome measures**: Microbiological testing at the primary examination and at follow-up consultations after 2, 5, and 12 weeks. Estimated relative risk for assault related STI and for not presenting at follow-up.

**Results**: At primary examination the prevalence of genital chlamydia was 8.4%, *Mycoplasma genitalium* 6.4%, and gonorrhoea 0.6%. In addition, the prevalence of bacterial STI diagnosed at follow-up and possibly from the assault was 3.0% in total; 2.5% for *Mycoplasma genitalium,* 1.4% for genital chlamydia, and 0.2% for gonorrhoea. This prevalence did not change when azithromycin was no longer recommended from January 2018. There were no new cases of hepatitis B, hepatitis C, HIV, or syphilis. We found no specific risk factors for assault related STI. Patients with previous contact with child welfare service less often presented to follow-up, relative risk (RR) 2.0 (95% confidence interval 1.1–3.5), as did patients with a history of sex work, RR 3.6 (1.2–11.0), or substance abuse, RR 1.7 (1.1–2.7).

**Conclusions**: Most bacterial STIs were diagnosed at the primary examination, hence not influenced by prophylaxis. There was no increase in bacterial STI diagnosed at follow-up when azithromycin prophylaxis was not routinely recommended, supporting a strategy of starting treatment only when infection is diagnosed or when the patient is considered at high

risk. Sex work, substance abuse, and previous contact with child welfare services were associated with not presenting to follow-up.

**Trial registration:** ClinicalTrials.gov ID: NCT03132389

## STRENGTHS AND LIMITATIONS

- Microbiological samples were taken both at the primary examination and at follow-up consultations.
- The study population is representative for patients attending the Oslo Sexual Assault Centre, apart from migrants probably being underrepresented.
- As only about 10% of sexual assault victims attend a sexual assault centre, the results may not be representative for sexual assault victims in general.
- A sexually transmitted infection might stem from other sexual contacts than the assault, information we did not gather.
- The study may be underpowered for identifying risk factors.

**Keywords:** Sexual assault, sexually transmitted infection, chlamydia, *Mycoplasma genitalium,* gonorrhoeae, azithromycin

## INTRODUCTION

Sexual violence is a fundamental violation of human rights and a global public health problem.[1, 2] A broad range of physical and psychological health consequences after sexual assault may have significant and long-lasting effects on an individual's well-being and functioning.[1, 2] In a European survey, 3–14% of women reported having been raped, varying between countries.[3] In a Norwegian survey, 9% of women and 1% of men reported having been raped (sexual assault with penetration), and 34% of women and 11% of men reported having been sexually assaulted or abused.[4]

After a sexual assault, the risk of sexually transmitted infection (STI) often causes great concern to the individual. The World Health Organization (WHO) describes a 50–80% increased risk of STI among women exposed to sexual violence.[1] Reviews from 2000 report STI prevalence in the range of 0–56% after sexual assault, probably reflecting variations in local population prevalence and study inclusion criteria.[5, 6] More recent European studies report prevalences of *Chlamydia trachomatis* after sexual assault at 6–15%, *Mycoplasma genitalium* at 2%, and *Neisseria gonorrhoeae* at 0–5%.[7-13] The prevalence of STI is higher among patients at sexual assault centres than in the general population,[11, 12, 14] though similar to or lower than among patients tested for STI for other clinical reasons.[11, 13]

Screening for and managing STI are well established procedures after sexual assault.[5, 6, 15-21] Over the last century, the main concern has shifted from syphilis and gonorrhoea to HIV and hepatitis and the increase in multi-resistant bacteria. Accordingly, recommendations for screening and prophylaxis need to be reconsidered from time to time. Since the prevalence of STI varies between geographical areas, recommendations should be adapted to the local STI panorama and medical services.[6] Hence, there is a continuous need for updated studies from

different areas. Current Norwegian guidelines recommend screening for chlamydia, gonorrhoea, syphilis, HIV, hepatitis B and C, and other infections if indicated.[21]

The International Federation of Gynecology and Obstetrics (FIGO) and the US Centers for Disease Control and Prevention (CDC) recommend empiric prophylactic treatment with antibiotics against chlamydia, gonorrhoea, and trichomoniasis after a sexual assault.[15, 20] At the Oslo Sexual Assault Centre (SAC), a single dose of azithromycin for chlamydia was routinely recommended, in line with Norwegian guidelines. Increasing macrolide resistance in *Mycoplasma genitalium* led to the end of this procedure in January 2018,[22] giving us the opportunity to evaluate any concurrent change in the prevalence of STI.

### Objectives

Our main objective was to estimate the prevalence of STI after sexual assault in the Oslo area in Norway. Our secondary objectives were to identify risk factors for assault related STI and for not presenting at follow-up consultations, and to evaluate the change in azithromycin prophylaxis policy. We also describe patient and assault characteristics.

## METHODS

### Design

Prospective observational cohort study among patients attending a sexual assault centre from May 2017 to July 2019.

### Setting

The Oslo SAC sees about 600 patients per year and serves a population of about 1.2 million. It is integrated in a large primary care emergency clinic. The SAC services are available for

persons alleging sexual assault, free of charge and independent of police reporting. Patients younger than 14 years are examined at paediatric hospital departments.

At the primary examination, the patient's history is systematically obtained, including details of the assault and the assailant(s), medical history, and vulnerability factors. Medical and medicolegal examinations include microbiological testing, pregnancy test, forensic swabs, and injury documentation. Necessary treatment is provided, including emergency contraception. Psychosocial counselling includes 1–6 follow-up consultations with a nurse or social worker.

In addition to the primary examination, the Oslo SAC offers three medical follow-up consultations, at 2, 5, and 12 weeks. Both medical and psychosocial issues are addressed, including relevant microbiological sampling and necessary treatment.

Until 20 January 2018, azithromycin 1000 mg was routinely recommended as chlamydia prophylaxis to patients presenting within a week of the assault. Since then, chlamydia prophylaxis has not been generally recommended. Hepatitis B vaccination is offered at the primary examination and repeated twice during follow-up. HIV post-exposure prophylaxis (four weeks of emtricitabine, tenofovir, and raltegravir) is recommended based on individual risk in patients presenting within 72 hours of the assault.[21]

**Participants**

Patients 14 years of age and older presenting at the Oslo SAC were eligible for inclusion in the study. Based on an estimated prevalence of STI of 7% among SAC patients, we calculated that a sample size of 625 participants was needed to make comparisons with the general

population. Patients were recruited by SAC nurses and doctors, at the primary examination or at follow-up. During the recruitment period, 1374 patients presented at the Oslo SAC, amongst whom 645 (46.9%) consented to participate.

**Data collection and classification**

Data were collected from the patients' electronic medical records and archived paper files. We registered age at primary examination, sex, time since assault, previous contact with health and social services, vulnerability factors (as reported by the patient or from the medical records), type of crime scene, assault characteristics, number of assailants, assailant's relation to victim, oral/genital/anal injuries, symptoms of STI, microbiological tests, prophylaxis/treatment given at primary examination and/or follow-up consultations, and whether the patient presented at follow-up consultations.

**Microbiological sample collection**

At the primary examination, samples were obtained using genital swabs (preferably collected from the cervix and vagina, otherwise in urine or by vaginal self-testing, and in urine or from the urethra for men). Oropharyngeal swabs were routinely taken for *Neisseria gonorrhoeae* only. Anorectal swabs were taken in cases with anal penetration or suspected anal penetration, or when the circumstances were unclear. Samples were collected using Sigma Transwab Liquid Amies. Furthermore, blood samples were collected for serological testing for hepatitis B, hepatitis C, HIV, and syphilis. Other STIs were tested for if clinically indicated.

During follow-up, samples were repeated; at 5 weeks if azithromycin had been given, at 2 weeks if not. At 12 weeks follow-up, serology was taken for hepatitis B, hepatitis C, and

syphilis. HIV serology was repeated at all follow-up consultations. If a patient did not present to follow-up, repeated active out-reach was tried, and testing offered at a later consultation.

**Microbiological diagnostic tests**

Microbiological analyses were performed at the Department of Microbiology at Oslo University Hospital. Polymerase chain reaction (PCR) was used for the detection of *Chlamydia trachomatis, Mycoplasma genitalium* (until 10 April 2019), and *Neisseria gonorrhoeae* (AmpliSens® Chlamydia trachomatis-FRT for the former, in-house real-time PCR assays for the latter two, and in some cases Fast-track diagnostics for confirmation of *Neisseria gonorrhoeae*). For *Neisseria gonorrhoea*e, swabs were also cultured, independent of the PCR result. Lymphogranuloma venereum PCR was performed on anorectal samples positive for *Chlamydia trachomatis*, and *Mycoplasma genitalium* positive specimens were examined with PCR for macrolide resistance (both in-house real-time PCR assays).

Blood samples were examined for serologic markers for HIV (HIV antigen/antibody combined), hepatitis B (hepatitis B surface antigen and antibody and core antibody), hepatitis C (hepatitis C antibody), syphilis (*Treponema pallidum* antibody) (all using Abbott Architect assays). Positive results were confirmed with alternative tests (available upon request).

**Outcome measures**

We calculated the prevalence of STI at the primary examination as the rate of detected infections among the patients tested for each specific agent.

To estimate the prevalence of bacterial STI possibly from the assault and assess the azithromycin prophylaxis policy, we defined prevalence within different time frames from assault to primary examination, and prevalence at follow-up:

A. Within two days: Positive tests possibly representing infections transmitted before the assault. However, due to the high sensitivity of PCR testing, an early positive test might also represent infected body fluids deposited at the assault.[18, 23] Newly deposited agents can be detected for a period, then enter an undetectable incubation phase before becoming manifest infections. The two-day time frame was set based upon the two days when semen is likely to be retrieved.[23]
B. Day 3–7: Incubation period. Infections from the assault probably not yet detectable (except gonorrhoea). Positive tests probably representing infections transmitted before the assault.
C. Week 1–4: Positive tests possibly representing infection transmitted at assault, manifest after incubation, but possibly also pre-existing infection.
D. At follow-up, infection possibly transmitted at the assault: Positive test for genital chlamydia or *Mycoplasma genitalium* at follow-up combined with negative test at primary examination within a week of the assault. Cases negative both at primary examination and at follow-up were considered not infected. Cases negative at primary examination but not tested at follow-up were considered not infected if the primary examination was more than a week after the assault, otherwise they were excluded. The same definition was used for gonorrhoea, but with the cut-off set at two days. This definition probably misses some assault related infections as the incubation time may be longer than a week (two days for gonorrhoea).

The results in definitions A, B, and C will not be affected by prophylaxis, but these patients will need treatment. In definition D, test results at follow-up will be affected by whether azithromycin was given or not.

Definition D was used when estimating risk factors for assault related STI. Risk factors were estimated as relative risks.

Seroconversion assessment was based on serologic tests done at 12 weeks follow-up.

**Statistical analyses**

Statistical analyses were performed using SPSS 27 or an online calculator from Epitools (https://epitools.ausvet.com.au). Associations between categorical variables were established from the chi-square test, or Fisher's exact test when appropriate. Age comparisons were done using Mann-Whitney U-test. Relative risks were estimated in Stata SE 17.

**Patient and public involvement**

No patient involvement.

**RESULTS**

Among the 645 patients included, 602 (93.3%) were female, and 43 (6.7%) were male. Median age was 23 years (interquartile range 19–28) among females, and 26 years (22–32) among males (p=0.003).

In total 191 (29.6%) patients had previously been in contact with psychiatric outpatient services for adults, and 106 (16.4%) with similar services for children/adolescents (Table 1).

There was a history of mental disorder among 288 (44.7%) of patients, previous trauma (including sexual assault) among 247 (38.3%), and substance abuse among 74 (11.5%). Of the assailants, 98.9% were male (Table 2).

**Table 1. Background data and assault characteristics for patients attending a sexual assault centre in Oslo, Norway**

| | Females n (%) | Males n (%) | Total n (%) |
|---|---|---|---|
| **Vulnerability factors** | | | |
| *Mental disorder*[a] | 271 (45.0) | 17 (39.5) | 288 (44.7) |
| *Previous trauma* | 232 (38.5) | 15 (34.9) | 247 (38.3) |
| *Substance abuse* | 64 (10.6) | 10 (23.3)* | 74 (11.5) |
| *Sex work* | 12 (2.0) | - | 12 (1.9) |
| *Physical/mental disability* | 3 (0.5) | 1 (2.3) | 4 (0.6) |
| *Resident at institution* | 3 (0.5) | - | 3 (0.5) |
| *Other* | 24 (4.0) | 2 (4.7) | 26 (4.0) |
| *No vulnerability factors reported* | 229 (38.0) | 18 (41.9) | 247 (38.3) |
| **Previous contact with health/social services** | | | |
| *Adult psychiatric outpatient service* | 179 (29.7) | 12 (27.9) | 191 (29.6) |
| *Child/adolescent psychiatry service* | 105 (17.4) | 1 (2.3)* | 106 (16.4) |
| *Admitted psychiatric hospital* | 45 (7.5) | 3 (7.0) | 48 (7.4) |
| *Child welfare service* | 45 (7.5) | 1 (2.3) | 46 (7.1) |
| *Addiction outpatient service* | 35 (5.8) | 7 (16.3)* | 42 (6.5) |
| **Crime scene**[b] | | | |
| *Assailant's residence* | 195 (32.4) | 10 (23.3) | 205 (31.8) |
| *Patient's residence* | 121 (20.1) | 7 (16.3) | 128 (19.8) |
| *Other person's residence* | 98 (16.3) | 8 (18.6) | 106 (16.4) |
| *Public place indoors*[c] | 73 (12.1) | 11 (25.6)* | 84 (13.0) |
| *Outdoors* | 57 (9.5) | -* | 57 (8.8) |
| *Vehicle* | 25 (4.2) | 3 (7.0) | 28 (4.3) |
| *Other/no information* | 33 (5.5) | 4 (9.3) | 37 (5.7) |
| **Type of assault** | | | |
| *Penetration total* | 459 (76.2) | 25 (58.1)* | 484 (75.0) |
| *Penetration attempted* | 13 (2.2) | 1 (2.3) | 14 (2.2) |
| *Penetration suspected* | 121 (20.1) | 14 (32.6) | 135 (20.9) |
| *No penetration* | 9 (1.5) | 3 (7.0)* | 12 (1.9) |
| *Penetration in vagina* | 460 (76.4) | 1 (0.2)*** | 461 (71.5) |
| *Penetration in mouth* | 129 (21.4) | 18 (41.9)** | 147 (22.8) |
| *Penetration in anus* | 94 (15.6) | 26 (60.5)*** | 120 (18.6) |
| *Penetration with penis* | 438 (72.8) | 26 (60.5) | 464 (71.9) |
| *Penetration with fingers* | 169 (28.1) | 10 (23.3) | 179 (27.8) |
| *Penetration with foreign object* | 7 (1.2) | 4 (9.3)** | 11 (1.7) |
| *Penetration not further specified* | 106 (17.6) | 10 (23.3) | 116 (18.0) |
| *Patient had to penetrate other person* | 1 (0.2) | 5 (11.6)*** | 6 (0.9) |
| *Patient had to execute other sexual action* | 67 (11.1) | 15 (34.9)*** | 82 (12.7) |
| *Other kind of assault* | 26 (4.3) | 5 (11.6)* | 31 (4.8) |
| *Amnesia but strong suspicion of assault* | 154 (25.6) | 13 (30.2) | 167 (25.9) |
| **Injuries sustained**[d] | | | |
| *Genital injuries* | 140 (23.3) | -*** | 140 (21.7) |
| *Anal injuries* | 46 (7.6) | 6 (14.0) | 52 (8.1) |
| *Oral injuries* | 35 (5.8) | 1 (2.3) | 36 (5.6) |
| **Total** | 602 (100) | 43 (100) | 645 (100) |

Penetration where and with what also registered for cases with attempted or suspected penetration.
[a]Encompassing personality disorders, depression, post-traumatic stress syndrome, severe anxiety disorders, attention deficit hyperactivity disorder, and a few patients with psychotic disorders.
[b]More than one crime scene in 6 cases.
[c]Mainly hotels, bars, clubs.
[d]Mainly minor and few, e.g. superficial small tears, ecchymoses, and abrasions.
Comparisons between sexes: *p < 0.05; **p < 0.01; ***p < 0.001.

**Table 2. Assailant characteristics in sexual assaults on patients attending a sexual assault centre in Oslo, Norway**

| | Female patients n (%) | Male patients n (%) | Patients total n (%) |
|---|---|---|---|
| **Gender**[a] | | | |
| *Male* | 671 (99.3) | 44 (93.6)* | 715 (98.9) |
| *Female* | 5 (0.7) | 3 (6.4)* | 8 (1.1) |
| | | | |
| **Relation** | | | |
| *Met same day* | 188 (26.9) | 9 (16.4) | 197 (26.2) |
| *Stranger* | 161 (23.1) | 19 (34.5) | 180 (23.9) |
| *Acquaintance* | 167 (23.9) | 7 (12.7) | 174 (23.1) |
| *Friend* | 57 (8.2) | 2 (3.6) | 59 (7.8) |
| *Met via the internet* | 34 (4.9) | 8 (14.5)** | 42 (5.6) |
| *Intimate partner present/past* | 33 (4.7) | 2 (3.6) | 35 (4.6) |
| *Authority figure* | 16 (2.3) | - | 16 (2.1) |
| *Family member* | 6 (0.9) | 1 (1.8) | 7 (0.9) |
| *Other/no information* | 36 (5.2) | 7 (12.7) | 43 (5.7) |
| | | | |
| **Total**[b] | 698 (100) | 55 (100) | 753 (100) |

[a]Missing information in 30 cases; 22 among females and 8 among males.
[b]One assailant in 537 (83.3 %) cases, two in 40 (6.2 %), three or more in 23 (3.6 %), unknown in 45 (7.0 %).
Comparisons between sexes: *p < 0.05; **p < 0.01; ***p < 0.001.

Most patients, 563 (87.3%), presented to primary examination within one week of the assault, 452 (70.2%) within 48 hours, and 350 (54.3%) within 24 hours. Only 42 (6.5%) presented later than 4 weeks. In total 497 (77.1%) patients presented to at least one follow-up consultation, 270 (41.9%) presented to all three. Patients with previous contact with child welfare services less often presented to follow-up, relative risk (RR) 2.0 (95% confidence interval 1.1–3.5), as did patients with a history of sex work, RR 3.6 (1.2–11.0) or substance abuse, RR 1.7 (1.1–2.7) (Supplementary table 1).

At the primary examination *Chlamydia trachomatis* was diagnosed in 52/620 (8.4%) patients, *Mycoplasma genitalium* in 34/529 (6.4%), and *Neisseria gonorrhoeae* in 4/635 (0.6%) (Table 3). There were no new cases of hepatitis B, hepatitis C, HIV, or syphilis. Five patients had

pelvic inflammatory disease; only one of whom had STI diagnosed (positive for *Chlamydia trachomatis*, *Mycoplasma genitalium*, and *Neisseria gonorrhoeae*).

**Table 3. Sexually transmitted infections at primary examination among patients attending a sexual assault centre in Oslo, Norway**

| | Females n/N (%) | Males n/N (%) | Total n/N (%) |
|---|---|---|---|
| ***Chlamydia trachomatis*** | | | |
| *Patients total* | 50/578 (8.7) | 2/42 (4.8) | 52/620 (8.4) |
| *Cervix/vagina/urethra/urine*[a] | 49/573 (8.6) | 0/42* | 49/615 (8.0) |
| *Anus* | 12/243 (4.9) | 2/30 (6.7) | 14/273 (5.1) |
| ***Mycoplasma genitalium*** | | | |
| *Patients total* | 34/494 (6.9)[b] | 0/35 | 34/529 (6.4)[b] |
| *Cervix/vagina/urethra/urine*[a] | 28/490 (5.7)[c] | 0/34 | 28/524 (5.3)[c] |
| *Anus* | 8/212 (3.8)[d] | 0/25 | 8/237 (3.4)[d] |
| ***Neisseria gonorrhoeae*** | | | |
| *Patients total* | 4/593 (0.7) | 0/42 | 4/635 (0.6) |
| *Cervix/vagina/urethra/urine*[a] | 2/573 (0.3) | 0/41 | 2/614 (0.3%) |
| *Anus* | 1/238 (0.4) | 0/30 | 1/268 (0.4) |
| *Oropharynx* | 4/522 (0.8) | 0/36 | 4/558 (0.7) |
| **Hepatitis B** | | | |
| *Known chronic contagious infection* | 1/584 (0.2) | 1/42 (2.4) | 2/626 (0.3) |
| *Previous infection* | 10/584 (1.7) | 1/42 (2.4) | 11/626 (1.8) |
| *Previously vaccinated* | 181/584 (31.0) | 15/42 (35.7) | 196/626 (31.3) |
| *Positive vaccination status during follow-up*[e] | 360/420 (85.7) | 24/32 (75.0) | 384/452 (85.0) |
| **Hepatitis C** | | | |
| *Known previous infection* | 12/585 (2.1) | 2/42 (4.8) | 14/627 (2.2) |
| **HIV** | | | |
| *Known infection* | 1/586 (0.2) | 0/42 | 1/628 (0.2) |
| **Syphilis** | | | |
| *Known previous infection* | 1/576 (0.2) | 2/39 (5.1)* | 3/615 (0.5) |

Proportions stated as positive tests (n) per patients tested (N).
Fourteen patients were tested for lymphogranuloma venereum, all negative.
Seven patients were tested for *Trichomonas vaginalis*, all negative.
No condylomas were diagnosed (visual inspection).
[a]Females sampled from cervix and/or vagina or in urine, males sampled from urethra or in urine.
[b]Fourteen cases macrolide resistant.
[c]Twelve cases macrolide resistant.
[d]Four cases macrolide resistant.
[e]Seroconversion assessment three months after primary examination.
Comparisons between sexes: *p < 0.05; **p < 0.01; ***p < 0.001.

Azithromycin prophylaxis was given to 153/645 (23.7%) patients (131/218 (60.1%) before 20 January 2018 and 22/427 (5.2%) after), hepatitis B vaccination to 415/645 (64.3%), and HIV post-exposition prophylaxis to 144/602 (23.9%) females and 20/43 (46.5%) males. Antibiotic treatment was ascertained for all diagnosed patients except 2/58 with genital chlamydia, 8/45 with *Mycoplasma genitalium,* and 1/5 with gonorrhoea (Supplementary table 2).

Bacterial STI possibly from the assault was diagnosed at the primary examination in 55/447 (12.3%) patients using definition A and in 5/56 (8.9%) using definition C, and at follow-up in 15/495 (3.0%) patients using definition D (Table 4). Changing the azithromycin prophylaxis recommendation did not affect the prevalence. We found no specific risk factors for assault related STI.

**Table 4. Sexually transmitted infections diagnosed after assault among patients attending a sexual assault centre in Oslo, Norway**

| | Azithromycin prophylaxis recommended n/N (%) | Azithromycin prophylaxis not recommended n/N (%) | p-value | Total n/N (%) |
|---|---|---|---|---|
| **A. Positive test at primary examination within two days of assault. Infectious agents possibly deposited at assault.** | | | | |
| **Genital chlamydia** | 13/138 (9.4) | 21/297 (7.1) | 0.51 | 34/435 (7.8) |
| ***Mycoplasma genitalium*** | 8/138 (5.8) | 17/228 (7.5) | 0.69 | 25/366 (6.8) |
| **Gonorrhoea** | 0/142 | 4/304 (1.3) | 0.31 | 4/446 (0.9) |
| **Any of the above** | 19/142 (13.4)[a] | 36/305 (11.8)[a] | 0.75 | 55/447 (12.3)[a] |
| **B. Positive test at primary examination 3–7 days after assault. Incubation period – infection probably from before assault.** | | | | |
| **Genital chlamydia** | 3/39 (7.7) | 8/68 (11.8) | 0.74 | 11/107 (10.3) |
| ***Mycoplasma genitalium*** | 1/38 (2.6) | 4/55 (7.3) | 0.65 | 5/93 (5.4) |
| **Gonorrhoea** | 0/41 | 0/68 | - | 0/109 |
| **Any of the above** | 4/41 (9.8) | 10/68 (14.7)[a] | 0.65 | 14/109 (12.8)[a] |
| **C. Positive test at primary examination 1–4 weeks after assault. Infection possibly from assault, manifest after incubation.** | | | | |
| **Genital chlamydia** | 1/18 (5.6) | 3/36 (8.3) | 1.00 | 4/54 (7.4) |
| ***Mycoplasma genitalium*** | 1/17 (5.9) | 1/31 (3.2) | 1.00 | 2/48 (4.2) |
| **Gonorrhoea** | 0/19 | 0/37 | - | 0/56 |
| **Any of the above** | 2/19 (10.5) | 3/37 (8.1)[a] | 1.00 | 5/56 (8.9)[a] |
| **D. Negative test at primary examination within a week of assault[b], positive at follow-up. Infection possibly from assault.** | | | | |
| **Genital chlamydia** | 1/138 (0.7) | 5/289 (1.7) | 0.67 | 6/427 (1.4) |
| ***Mycoplasma genitalium*** | 2/139 (1.4) | 7/222 (3.2) | 0.49 | 9/361 (2.5) |
| **Gonorrhoea** | 1/162 (0.6) | 0/328 | 0.33 | 1/490 (0.2) |
| **Any of the above** | 4/162 (2.5) | 11/333 (3.3)[a] | 0.78 | 15/495 (3.0)[a] |

[a]Some patients were infected with more than one agent.
[b]Two days for gonorrhoea.

## DISCUSSION

### Summary of main findings

At the primary examination, the prevalence of genital chlamydia was 8.4%, *Mycoplasma genitalium* 6.4%, and gonorrhoea 0.6%. In addition, the prevalence of bacterial STI possibly from the assault diagnosed at follow-up was 3.0% in total; 2.5 % for *Mycoplasma genitalium,* 1.4% for genital chlamydia, and 0.2% for gonorrhoea. Not recommending azithromycin prophylaxis did not increase the prevalence of STI.

### STI prevalence

The prevalence of genital chlamydia and gonorrhoea among our patients were higher than in the general Norwegian population of similar age, 8.4% vs. 2.4% and 0.6% vs. 0.1%, respectively,[24] in line with previous studies.[11, 12, 14] Compared to other SAC studies, our findings are in the same range as a previous Norwegian study from Trondheim in 2003–2010 reporting genital chlamydia in 6% and no cases of gonorrhoea;[11] as well as UK, Belgian, and Dutch studies reporting genital chlamydia in 6–10% and gonorrhoea in 1–2%;[7-10, 13] though lower than a French study reporting genital chlamydia in 15% and gonorrhoea in 5%.[12] Few SAC studies report *Mycoplasma genitalium* prevalence. In comparison to the 6.4% in our study, 2% was reported in the Trondheim study,[11] and 8% in a Korean study from 2010–2019.[14]

No patients were diagnosed with trichomoniasis or bacterial vaginosis. This may partly result from limited testing, as these infections were only tested for when clinically suspected, in line with Norwegian recommendations.[21] However, similar findings were also done in the Trondheim study.[11] This contrasts to the high prevalence of trichomoniasis and bacterial

vaginosis reported in US studies from the 1990s,[25, 26] though the prevalence seems to have been lower in Europe.[5, 7, 9]

**Antimicrobial prophylaxis**

As most bacterial STIs were diagnosed at the primary examination (Table 4), their prevalence would not be affected by prophylactic treatment. Hence, the recommended azithromycin was as much an empiric treatment of pre-existing infection as a prophylactic, yet still resulting in overtreatment. Not recommending azithromycin treatment did not increase the prevalence of assault related bacterial STI. This supports a strategy of treating STI only when diagnosed, in countries with well-developed health services. Still, the FIGO and the CDC recommend empiric prophylactic antimicrobial treatment,[15, 20] arguing that many patients do not return for follow-up consultations, making it difficult to base treatment on results from the initial screening. In our study population 77.1% presented to at least one follow-up consultation, compared to the 30–60% more commonly reported.[6, 7, 27-29] The Oslo SAC keeps an active outreach approach if patients do not show up. Patients may also seek help elsewhere. Testing and treatment for STI are easily available and free of charge in Norway, and widely accepted by adolescents and young adults.

Targeted prophylactic empiric antibiotic treatment might be considered for patients especially at risk of not presenting at follow-up (in our study sex work, substance abuse, and previous contact with child welfare services). These patients often are particularly vulnerable.[28]

In 2013, when *Mycoplasma genitalium* was included in the Oslo SAC screening program, azithromycin was an effective treatment. As macrolide resistance increased, moxifloxacin was introduced. The clinical significance of detecting *Mycoplasma genitalium* was increasingly

questioned, and the Oslo SAC stopped screening asymptomatic patients for *Mycoplasma genitalium* in April 2019 in line with changing international and national guidelines.[21, 22] This development highlights that the risk and harm of antimicrobial resistance and overtreatment must be considered when deciding on prophylactic empiric antibiotic treatment after sexual assault. Reduced antibiotic use may also be beneficial to the individual patients by avoiding potential side effects.

We found no new cases of hepatitis B or HIV. This mainly reflects low prevalence in the population, but also suggests that the vaccination and post-exposure prophylaxis are sufficiently extensive.

**Medico-legal aspects**

Consequences of STI may be serious, especially in countries with less available health services. Bacterial infections, often conceived as less serious diseases in high income countries, are becoming more difficult to treat as antimicrobial resistance is increasing. The sexual crime legislation in Norway explicitly states that transmission of an STI is an aggravating circumstance, carrying stricter custodial penalties. While it may be impossible to ascertain the exact time for STI transmission, and thus difficult to conclude with certainty in medical terms whether the STI resulted from the assault, the Courts may still find this information pertinent to their proceedings. This supports the case for addressing possibly assault related STI in medicolegal reports.

**Strengths and limitations**

Comparing with annual reports from the Oslo SAC,[30] our study population is similar concerning age, sex, and relation to the assailant. While we expected vulnerable patients to be

less likely to consent to participation, 62% of the patients in our study reported at least one vulnerability factor, compared to 56–59% in previous Norwegian studies.[31, 32] Migrants are probably underrepresented, as the information/consent form was available only in Norwegian and English. Otherwise, our study population seems representative for the Oslo SAC population. However, as it is estimated that only 10% of sexual assault victims attend an SAC,[4, 31] it is uncertain to what extent our results are representative for sexual assault victims in general.

Estimating the risk of assault related STI is complicated. A strength of our study is that we have samples both from the primary examination and from follow-up consultations, as re-testing often is necessary to establish whether an infection has been transmitted. Prophylactic antibiotic treatment may hinder development of infection, consequently obscuring the risk. An STI might stem from other sexual contacts than the assault, information we did not gather. Some of the STI diagnosed at the primary examination may be assault related, but probably a minority. Among early examined patients, samples may catch newly deposited infected body fluids,[18] but not all assailants are STI-carriers, and not all sexual contacts will transfer an infection. We consider definition D our best estimate of assault related STI, though probably on the lower side.

Surprisingly, we found no increased risk for assault related STI among patients with genital injury or exposed to multiple assailants. However, as the study sample size was calculated for comparisons with the general population, the study may be underpowered for identifying risk factors. This would especially apply to risk factors for assault related STI, as the number of assault related STI was small. Hence, there is clearly a possibility of type II errors, and risk

factors may have gone undetected, as may a possible protective effect of recommending azithromycin prophylaxis.

Samples for microbiological testing were obtained from genital swabs performed by health personnel, from self-testing, and in urine specimens. The choice of method is based on the patient's preferences and what is most appropriate and convenient then and there, in line with the pragmatic approach at the Oslo SAC, though swabs performed by health personnel is the preferred method at the primary examination. In systematic reviews, self-swabbing and other non-invasive sampling methods have been shown to be equivalent to conventional testing by health personnel.[33, 34]

**Conclusion**

About 3% of patients attending the Oslo SAC had an STI possibly from the assault, mainly genital chlamydia and *Mycoplasma genitalium*. There was no increase in STI when azithromycin prophylaxis was no longer recommended, supporting a strategy of treating only diagnosed infections, thus avoiding overtreatment. However, as the most vulnerable patients seem most at risk of not presenting to follow-up, targeting prophylactic empiric treatment to them may be a reasonable strategy.

## ACKNOWLEDGMENTS

We thank the patients for participating in the study, the nurses and doctors at the Oslo SAC for including patients in the study, and the staff at the Department of Microbiology at Oslo University Hospital for their work with the microbiological analyses.

This work was performed on the TSD (Tjeneste for sensitive data) facilities, owned by the University of Oslo, operated and developed by the TSD service group at the University of Oslo IT Department (USIT) (tsd-drift@usit.uio.no).

## CONTRIBUTORS

KS, HN, MB, and OMV conceived the study. All authors contributed to the design. KS, HN, and OMV collected the data. KS, HN, IM, and OMV analysed the data. KS and OMV drafted the manuscript. All authors contributed substantially to revising the manuscript and approved the final version.

## COMPETING INTERESTS

None declared.

## FUNDING

KS received funding from the Norwegian Committee on Research in General Practice (a committee of the Norwegian College of General Practitioners) (grant number N/A), and from the Rolf Geir Gjertsens minnefond (UNIFOR) (grant number N/A). The sponsors had no involvement in the conduct of the research or the preparation of the article.

## DATA SHARING STATEMENT

The dataset cannot be made openly available due to conditions set by the Regional Committee South-East A for Medical and Health Research Ethics prior to collecting the data. Inquiries about the data and conditions for access can be made to the corresponding author.

## ETHICS APPROVAL

The study was approved by the Regional Committee South-East A for Medical and Health Research Ethics (REK no. 2016/2279). Patients were included after informed written consent. Patients were approached for inclusion only if considered in an appropriate state of mind.

## REFERENCES

1. García-Moreno C, Pallitto C, Devries K, et al. Global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence. Geneva, Switzerland: World Health Organisation 2013.
2. Jina R, Thomas LS. Health consequences of sexual violence against women. *Best Pract Res Clin Obstet Gynaecol* 2013;27:15-26.
3. Holmberg S, Lewenhagen L. Reported and cleared rapes in Europe: difficulties of international comparisons. Stockholm, Sweden: The Swedish National Council for Crime Prevention [Brottsförebyggande rådet (Brå)] 2020.
4. Thoresen S, Hjemdal OK, (eds.). Vold og voldtekt i Norge: en nasjonal forekomststudie av vold i et livsløpsperspektiv. Oslo, Norway: Nasjonalt kunnskapssenter om vold og traumatisk stress 2014.
5. Lamba H, Murphy SM. Sexual assault and sexually transmitted infections: an updated review. *Int J STD AIDS* 2000;11:487-91.

6. Reynolds MW, Peipert JF, Collins B. Epidemiologic issues of sexually transmitted diseases in sexual assault victims. *Obstet Gynecol Surv* 2000;55:51-7.
7. Kerr E, Cottee C, Chowdhury R, et al. The Haven: a pilot referral centre in London for cases of serious sexual assault. *BJOG* 2003;110:267-71.
8. Thompson C. Review of 212 individuals attending a city centre genitourinary medicine clinic following acute sexual assault. *J Clin Forensic Med* 2006;13:186-8.
9. Forbes KM, Day M, Vaze U, et al. Management of survivors of sexual assault within genitourinary medicine. *Int J STD AIDS* 2008;19:482-3.
10. Gilles C, Van Loo C, Rozenberg S. Audit on the management of complainants of sexual assault at an emergency department. *Eur J Obstet Gynecol Reprod Biol* 2010;151:185-9.
11. Hagemann CT, Nordbo SA, Myhre AK, et al. Sexually transmitted infections among women attending a Norwegian Sexual Assault Centre. *Sex Transm Infect* 2014;90:283-9.
12. Jaureguy F, Chariot P, Vessieres A, et al. Prevalence of Chlamydia trachomatis and Neisseria gonorrhoeae infections detected by real-time PCR among individuals reporting sexual assaults in the Paris, France area. *Forensic Sci Int* 2016;266:130-3.
13. van Rooijen MS, Schim van der Loeff MF, van Kempen L, et al. Sexually transmitted infection positivity rate and treatment uptake among female and male sexual assault victims attending the Amsterdam STI Clinic between 2005 and 2016. *Sex Transm Dis* 2018;45:534-41.
14. Park JH, Kim N, Shin S, et al. Prevalence and correlated factors of sexually transmitted infections among women attending a Korean sexual assault center. *J Forensic Leg Med* 2020;71:101935.
15. Jina R, Jewkes R, Munjanja SP, et al. Report of the FIGO Working Group on Sexual Violence/HIV: guidelines for the management of female survivors of sexual assault. *Int J Gynaecol Obstet* 2010;109:85-92.

16. Welch J, Mason F. Rape and sexual assault. *BMJ* 2007;334:1154-8.
17. Linden JA. Clinical practice: care of the adult patient after sexual assault. *N Engl J Med* 2011;365:834-41.
18. Sena AC, Hsu KK, Kellogg N, et al. Sexual assault and sexually transmitted infections in adults, adolescents, and children. *Clin Infect Dis* 2015;61(Suppl 8):S856-64.
19. Australian STI management guidelines for use in primary care. Australasian Sexual Health Alliance 2017. http://www.sti.guidelines.org.au/ (accessed 23 May 2020).
20. Sexually transmitted infections treatment guidelines 2021. U.S. Departement of Health & Human Services 2021. https://www.cdc.gov/std/treatment-guidelines/ (accessed 11 Feb 2022).
21. Hagemann C, Schei B, Nesvold H, et al. Mottak av ungdom/voksne pasienter etter seksuelle overgrep. Norsk gynekologisk forening 2021. https://www.legeforeningen.no/foreningsledd/fagmed/norsk-gynekologisk-forening/veiledere/veileder-i-gynekologi/mottak-av-pasienter-etter-seksuelle-overgrep/ (accessed 28 Mar 2022).
22. Horner PJ, Blee K, Falk L, et al. 2016 European guideline on the management of non-gonococcal urethritis. *Int J STD AIDS* 2016;27:928-37.
23. Casey DG, Domijan K, MacNeill S, et al. The persistence of sperm and the development of time since intercourse (TSI) guidelines in sexual assault cases at Forensic Science Ireland, Dublin, Ireland. *J Forensic Sci* 2017;62:585-92.
24. MSIS-statistikk: Folkehelseinstituttet [The Norwegian Institute of Public Health] 2022. www.msis.no (accessed 18 Feb 2022).
25. Jenny C, Hooton TM, Bowers A, et al. Sexually transmitted diseases in victims of rape. *N Engl J Med* 1990;322:713-6.

26. Glaser JB, Schachter J, Benes S, et al. Sexually transmitted diseases in postpubertal female rape victims. *J Infect Dis* 1991;164:726-30.
27. Gibb AM, McManus T, Forster GE. Should we offer antibiotic prophylaxis post sexual assault? *Int J STD AIDS* 2003;14:99.
28. Ackerman DR, Sugar NF, Fine DN, et al. Sexual assault victims: factors associated with follow-up care. *Am J Obstet Gynecol* 2006;194:1653-9.
29. Holmes MM, Resnick HS, Frampton D. Follow-up of sexual assault victims. *Am J Obstet Gynecol* 1998;179:336-42.
30. Waitz HM, Abel V, Johannessen CO, et al. Overgrepsmottaket: nøkkeltall 2018. Oslo, Norway: Oslo kommune Helseetaten 2019.
31. Nesvold H, Friis S, Ormstad K. Sexual assault centers: attendance rates, and differences between early and late presenting cases. *Acta Obstet Gynecol Scand* 2008;87:707-15.
32. Vik BF, Nottestad JA, Schei B, et al. Psychosocial vulnerability among patients contacting a Norwegian sexual assault center. *J Interpers Violence* 2019;34:2138-57.
33. Cook RL, Hutchison SL, Ostergaard L, et al. Systematic review: noninvasive testing for Chlamydia trachomatis and Neisseria gonorrhoeae. *Ann Intern Med* 2005;142:914-25.
34. Lunny C, Taylor D, Hoang L, et al. Self-collected versus clinician-collected sampling for chlamydia and gonorrhea screening: a systemic review and meta-analysis. *PLoS One* 2015;10:e0132776.

**Supplementary table 1. Factors associated with not presenting at follow-up consultations at a sexual assault centre in Oslo, Norway**

| | Did not present at any follow-up consultation n (%) | Presented at one or more follow-up consultations n (%) | Total n (%) | Relative risk (95% CI) |
|---|---|---|---|---|
| **Previous contact with child welfare service** | 17 (11.5) | 29 (5.8) | 46 (7.1) | 2.0 (1.1–3.5) |
| **Substance abuse** | 24 (16.2) | 50 (10.1) | 74 (11.5) | 1.7 (1.1–2.7) |
| **Sex work** | 6 (4.1) | 6 (1.2) | 12 (1.9) | 3.6 (1.2–11.0) |
| **Crime scene assailant's residence** | 34 (23.0) | 171 (34.4) | 205 (31.8) | 0.72 (0.52–0.98) |
| **Penetration in vagina** | 92 (62.2) | 369 (74.2) | 461 (71.5) | 0.84 (0.73–0.96) |
| **Penetration in anus** | 19 (12.8) | 100 (20.1) | 119 (18.4) | 0.68 (0.44–1.1) |
| **Anal injury** | 5 (3.4) | 47 (9.5) | 52 (8,1) | 0.36 (0.14–0.88) |
| **Oral injury** | 13 (8.8) | 23 (4.6) | 36 (5.6) | 2.0 (1.1–3.9) |
| **Total** | 148 (100) | 497 (100) | 645 (100) | |

Variables not associated with presenting or not at follow-up consultations: age, sex, previous contact with child/adolescent psychiatry service, previous contact with adult psychiatric outpatient services, previously admitted psychiatric hospital, previous contact with addiction outpatient services, psychiatric disorder, previous trauma, physical disability, mental disability, resident at institution, crime scene patient's residence, crime scene other person's residence, crime scene public place indoors, crime scene outdoors, crime scene in vehicle, penetration in mouth, assailant relation, genital injury.

**Supplementary table 2. Treatment for sexually transmitted infections among patients attending a sexual assault centre in Oslo, Norway**

| | First treatment | | Test after initial treatment | Second treatment | | Test after second treatment |
|---|---|---|---|---|---|---|
| **Chlamydia trachomatis** | | | | | | |
| 58 | Azithromycin | 25 | Negative 6 | | | |
| | | | Positive 7 | Doxycycline | 7 | Negative 3 |
| | Doxycycline | 23 | Negative 14 | | | |
| | | | Positive 2 | Doxycycline | 1 | |
| | | | | Azithromycin | 1 | Positive 1 |
| | Moxifloxacin | 1[a] | Positive 1 | Doxycycline | 1 | Negative 1 |
| | Unspecified[b] | 7 | Negative 4 | | | |
| | No information | 2 | | | | |
| **Mycoplasma genitalium** | | | | | | |
| 24 | Azithromycin | 13 | Negative 8 | | | |
| | Moxifloxacin | 1 | Negative 1 | | | |
| | Doxycycline | 3 | Positive 2 | Azithromycin | 1 | |
| | | | Negative 1 | | | |
| | Unspecified[b] | 4 | Negative 3 | | | |
| | No information | 3 | Negative 2 | | | |
| **Mycoplasma genitalium macrolide resistant** | | | | | | |
| 21 | Azithromycin | 4 | | Moxifloxacin | 1 | Negative 1 |
| | | | | Unspecified[b] | 1 | |
| | Moxifloxacin | 10 | Negative 9 | | | |
| | Unspecified[b] | 2 | Negative 2 | | | |
| | No information | 5 | Negative 2 | | | |
| **Neisseria gonorrhoeae** | | | | | | |
| 5 | Treated at specialist venereal clinic[b] | 4 | | | | |
| | No information | 1 | | | | |

Total numbers at the primary examination and during follow-up: genital *Chlamydia trachomatis* in 58 patients, amongst whom 25 (43.1%) had symptoms; *Mycoplasma genitalium* in 45 patients, amongst whom 19 (42.2%) had symptoms; and *Neisseria gonorrhoeae* in 5 patients, amongst whom 2 (40.0%) had symptoms.
Missing data not shown for second treatment and tests after treatment.
[a]Co-infection with macrolide resistant Mycoplasma genitalium.
[b]Antibiotic treatment, drug not specified.
Among patients with no information about treatment, several may have received treatment elsewhere.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

| | Item No | Recommendation | Reported on page # |
|---|---|---|---|
| **Title and abstract** | 1 | (*a*) Indicate the study's design with a commonly used term in the title or the abstract | 1-2 |
| | | (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found | 2-3 |
| **Introduction** | | | |
| Background/rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 4-5 |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 5 |
| **Methods** | | | |
| Study design | 4 | Present key elements of study design early in the paper | 5 |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 5-6 |
| Participants | 6 | (*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up | 6-7 |
| | | (*b*) For matched studies, give matching criteria and number of exposed and unexposed | NA |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 7-10 |
| Data sources/ measurement | 8* | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group | 7-10 |
| Bias | 9 | Describe any efforts to address potential sources of bias | 9-10 |
| Study size | 10 | Explain how the study size was arrived at | 6-7 |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why | 8-10 |
| Statistical methods | 12 | (*a*) Describe all statistical methods, including those used to control for confounding | 10 |
| | | (*b*) Describe any methods used to examine subgroups and interactions | 9-10 |
| | | (*c*) Explain how missing data were addressed | 10 |
| | | (*d*) If applicable, explain how loss to follow-up was addressed | NA |
| | | (*e*) Describe any sensitivity analyses | NA |
| **Results** | | | |
| Participants | 13* | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | 6-7 |
| | | (b) Give reasons for non-participation at each stage | 6-7 |
| | | (c) Consider use of a flow diagram | NA |
| Descriptive data | 14* | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders | 10-13 |
| | | (b) Indicate number of participants with missing data for each variable of interest | 12-16 |
| | | (c) Summarise follow-up time (eg, average and total amount) | 6 |
| Outcome data | 15* | Report numbers of outcome events or summary measures over time | 13-16 |
| Main results | 16 | (*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included | 13-16 |

| | | | |
|---|---|---|---|
| | | (*b*) Report category boundaries when continuous variables were categorized | NA |
| | | (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period | NA |
| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses | 13-16 |
| **Discussion** | | | |
| Key results | 18 | Summarise key results with reference to study objectives | 17 |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 19-21 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 17-19 & 21 |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 17-19 |
| **Other information** | | | |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 22 |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.