Prevalence of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* in women of the Czech Republic armed forces

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ABSTRACT

Background: Sexually transmitted infections (STIs) are a serious health problem with global impact, more prominently in women. Their prevalence is increasing, and the preventive measure options are not being sufficiently innovated.
The military environment is historically characterized by a higher incidence of STIs. A prospective cross-sectional study was conducted in order to analyze prevalence of common STIs in women of the Czech Republic armed forces.
Material and methods: *Chlamydia trachomatis (C. trachomatis)* and *Neisseria gonorrhoeae* (*N. gonorrhoeae*) detection was performed in 231 women between August 2020 and December 2023. Participants were divided into three groups according to their military status. Group A – recruits (n = 84), Group B – active soldiers (n = 43) and Group C – control civilian group (n = 104).
Cervical smears were used to diagnose pathogens and data evaluating medical history and the occurrence of risk factors in women were obtained using a detailed questionnaire.
Results: *Ch. trachomatis* prevalence was 6.0% (5/84) in group A, 2.3% (1/43) in group B and 2.9% (3/104) in group C. There was no statistically significant difference between the groups (p = 0.601). No case of *N. gonorrhoeae* was recorded across the study (0/231). Regarding known STI factors, the groups differed significantly in age. The median age in group A was 26 years while it was 29 years in groups B and C similarly (p < 0.001). There was also significant in-between-groups difference in age of coitarche 16.0 vs. 16.0 vs. 17.0 years (p = 0,015). Women from group A reported more frequent absence from regular pap-smear attendance compared to other groups (12.0% vs. 16.3% vs. 3.9%) (p = 0.032).
Conclusion: This study did not show any significant difference in prevalence of *C. trachomatis* and *N. gonorrhoeae* in females of the Czech Republic Armed Forces compared to civilian women. Higher prevalence of selected STIs' risk factors were reported in recruits and active soldiers compared to civilian women.
Although not conclusively, shown findings should be considered a reason to foster the research on STIs in the military environment and to enhance preventive measures among women in the armed forces to limit impact of known STIs' risk factors.

KEYWORDS
sexually transmitted infection – *Chlamydia trachomatis* – *Neisseria gonorrhoeae* – military – army

SOUHRN

Karásek L., Svobodová P., Kiss I., Nejedlá D., Smetana J.: Prevalence *Chlamydia trachomatis* a *Neisseria gonorrhoeae* u žen vojákyň Armády České republiky

Úvod: Sexuálně přenosné infekce (STI) jsou závažným zdravotním problémem s globálním dopadem. Častěji jsou diagnostikovány u žen. Prevalence STI v současnosti opět roste a možnosti preventivních opatření jsou omezené. Vojenské prostředí se historicky vyznačovalo častějším výskytem STI. S cílem analyzovat prevalenci běžných STI u žen v ozbrojených silách České republiky byla provedena prospektivní průřezová studie.
Materiál a metody: V době od srpna 2020 do prosince 2023 byly u 231 žen provedeny odběry k detekci *Chlamydia trachomatis (Ch. trachomatis)* a *Neisseria gonorrhoeae (N. gonorrhoeae)*. Účastnice studie byly rozděleny do tří skupin dle vztahu k Armádě České republiky. Skupina A – žadatelky o vstup do armády (n = 84), skupina B – vojákyně z povolání (n = 43) a skupina C – kontrolní civilní skupina (n = 104). K detekci patogenů byly využity stěry z hrdla děložního. Pro získání anamnézy a dat hodnotících výskyt rizikových faktorů STI byla provedena dotazníková studie.
Výsledky: Prevalence *Ch. trachomatis* byla ve skupině A 6,0 % (5/84), ve skupině B 2,3 % (1/43) a ve skupině C 2,9 % (3/104) (p = 0,601). Během studie nebyl zaznamenán žádný případ *N. gonorrhoeae* (0/231). V rámci hodnocených známých rizikových faktorů STI se skupiny významně lišily věkem. Medián věku ve skupině A byl 26 let, zatímco ve skupinách B a C to bylo 29 let (p < 0,001). Dále byl mezi skupinami A, B a C zjištěn významný rozdíl ve věku koitarche: 16,0 vs. 16,0 vs. 17,0 let (p = 0,015). Ženy ve skupinách A a B v porovnání se skupinou C častěji vynechávaly preventivní cytologii (12,0 % vs. 16,3 % vs. 3,9 %) (p = 0,032).

Závěr: Tato studie neprokázala významný rozdíl v prevalenci *Ch. trachomatis* a *N. gonorrhoeae* u žen vojákyň Armády České republiky v porovnání se ženami v civilním prostředí. U žadatelek o službu v armádě a u vojákyň z povolání však byla v porovnání s civilní skupinou prokázána vyšší prevalence vybraných rizikových faktorů STI. Získaná data by měla být vnímána jako podnět k pokračování monitorování STI ve vojenském prostředí a k posilování preventivních opatření s cílem omezit negativní důsledky STI u žen vojákyň.

KLÍČOVÁ SLOVA
sexuálně přenosné infekce – *Chlamydia trachomatis* – *Neisseria gonorrhoeae* – armáda – vojáci z povolání

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BACKGROUND

Sexually transmitted infections (STIs) are a serious health issue affecting both women and men worldwide. Their incidence has an increasing tendency. The most common bacterial pathogens include *Chlamydia trachomatis (Ch. trachomatis)* and *Neisseria gonorrhoeae (N. gonorrhoeae)*. The WHO estimates that there were 128.5 million new cases of *Ch. trachomatis* worldwide in 2020 with a prevalence of 4.0% in women and 2.5% in men aged 15–49 years. There were 82.4 million estimated new cases worldwide in 2020 in the case of *N. gonorrhoeae* [1].

Even though these diseases are preventable and treatable, their effect on health can be devastating. The infection is often asymptomatic and affects women more than men [2]. The disease can lead to damage of reproductive organs and risk of deterioration of the individual's fertility. Complicated infections may even result in life-threatening conditions such as tubo-ovarian abscess in women.

The military environment has historically been associated with a higher prevalence of STIs. Specific army factors, stress, community composition and availability of medical care may play a role [3, 4]. Available data on the incidence of *Ch. trachomatis* and *N. gonorrhoeae* in the military are acquired mainly from large United States (US) army registries [5]. Studies on European military units are usually limited to their extent. The range of reported rates of STIs incidence in published manuscripts is wide ranging from 3.1% to 8.2% in case of *Ch. trachomatis* and from 0.1% to 1.3% for *N. gonorrhoeae* [6, 7]. However, most of the studies assess the STIs in soldiers without gender stratification or in men only. Data on female soldiers'STIs epidemiology are scarce. For these reasons we decided to conduct a study that aimed to evaluate the epidemiology of STIs in women of the Czech Armed Forces. The pilot phase of our study did not show significant difference in prevalence of *Ch. trachomatis* and *N. gonorrhoeae* between recruits and active soldiers of the Czech Armed Forces compared to civilian women [8]. In this recent study we publish complete epidemiological data together with STIs risk factors evaluation.

MATERIAL AND METHODS

This was a prospective cross-sectional study conducted between August 2020 and December 2023 in a tertiary health care facility. The study protocol was kept same as presented in our pilot study [8]. The participants were informed about the study protocol including vaginal examination, and a written consent was obtained prior inclusion. The study was approved by respective institutional Ethics Committee, reference number of the decision 108/13-84/2029.

Inclusion criteria were stated as age of 18–45 years and consent with gynecological exam and participation in the study in general. Exclusion criteria applied were recent (one year or less) known STI infection and dysplastic or neoplastic gynecological conditions of vulva, vagina and cervix or body of uterus. History of hysterectomy or trachelectomy was also considered as exclusion criteria.

Enrolled women were divided into three groups according to their status. Recruits entering the army at the time of study comprised Group A. Active soldiers comprised Group B and civilian women were assigned in control Group C.

The study protocol consisted of a standard gynecological examination with a cervical smear for *Ch. trachomatis* and *N. gonorrhoeae* detection. Mini tip brush in kit with liquid amies preservation medium eSwab (Copan, Brescia, Italy) was used. Examinations were performed by one of two similarly skilled gynecologists. Laboratory detection of *Ch. trachomatis* and *N. gonorrhoeae* consisted of DNA isolation using an automated nucleic acid extracting device, Nextractor NX-48 system (Genolution, Seoul, Korea) and detection performed by real-time PCR using GeneProof Chlamydia trachomatis and Neisseria gonorrhoeae PCR Kit (Geneproof, Brno, Czech Republic).

Detailed questionnaire was used to assess demographic data and known STI risk factors including age, regular pap-smears, history of STI or cervical disease, age of coitarche, number of lifetime and recent sexual partners, usage of condom and other contraceptive methods, addictive substances usage and marital status.

Obtained data were numerically pseudo anonymized. In women who were tested positive for STIs, a medical follow-up was provided with an antibiotic therapy prescribed.

Statistical analysis was performed in SPSS Statistics v.21. The Fisher exact test and standard chi-square test were used to determine difference in the STIs prevalence between the groups. Kruskal-Wallis test or chi-square/Fisher exact test were used to evaluate if the groups differed in exposure to risk factors for STIs. For statistically significant results the post hoc test or Bonferroni correction were applied. The level of statistical significance was $p < 0.05$.

RESULTS

Prevalence of *Chlamydia Trachomatis* and *Neisseria Gonorrhoeae*

A total of 231 women was enrolled in the study. Recruits in group A (n = 84), active soldiers in Group B (n = 43) and civilian women in control Group C (n = 104). Answers from 229 (99.1%) women who completed the questionnaire were collected.

Ch. trachomatis was detected in 5/84 (6.0%) women in group A, 1/43 (2.3%) in group B and 3/104 (2.9%) in group C. There was no statistically significant difference in *Ch. trachomatis* prevalence between the groups (p = 0.601).

No case of *N. gonorrhoeae* was recorded across the study (0/231).

Demographic Data and STIs Risk Factors

Regarding known STI risk factors, the groups differed significantly in age. The median age in group A was 26 years while it was 29 years in groups B and C, similarly ($p < 0.001$).

The recorded median age of coitarche was 16 years in group A, 16 years in group B and 17 years in group C. This in-between-groups difference was statistically significant with lowest age of coitarche reported in group A participants (p = 0,015). Groups did not differ significantly either in number of lifetime sexual partners or number of sexual partners last year (p = 0.415; p = 0.053) (Table 1).

Regular Pap-smear attendance reported 73/83 (88.0%) women from group A, 36/43 (83.7%) women from group B and 99/103 (96.1%) women from group C (p = 0.032). Significantly more women from civilian group underwent Pap-smear regularly compared to recruits and active soldiers. The study did not show any significant in-between-group difference in personal history of STI (p = 0.107), cervical disease (p = 0.075), usage of condom or other contraceptive methods (p = 0.875), addictive substances usage (p = 0.830), smoking (p = 0.054) or marital status (p = 0.197) (Table 2).

Table 1. Analysis of ordinal STIs risk factors in groups

Group		Age (years)	Age of coitarche (years)	Number of lifetime sexual partners	Number of sexual partners in last year
A	Median	26.0	16.0	8.0	1.0
	Average	26.1	16.4	9.7	1.7
	SD	5.7	1.8	8.6	1.6
	N	84	79	78	79
B	Median	29.0	17.0	7.0	1.0
	Average	28.7	17.1	9.3	1.8
	SD	5.7	1.9	7.0	3.0
	N	43	43	41	43
C	Median	29.0	17.0	6.0	1.0
	Average	28.9	17.3	9.2	1.4
	SD	4.6	2.4	8.4	1.4
	N	103	102	99	101
Kruskal-Wallis a post hoc tests	χ^2	17.8	8.4	1.8	5.9
	Degrees of freedom	2	2	2	2
	p-value	**<0.001**	**0.015**	0.415	0.053
	A-B	**0.021**	0.132	X	X
	A-C	0.000	**0.017**	X	X
	B-C	1.000	1.000	X	X

Explanations:
Bold: statistically significant results; N – number of subjects; SD – standard deviation; χ^2 – test statistics; A – Group A, military recruits; B – Group B, active soldiers; C – Group C; civilian women; X – not calculated

Table 2. Analysis of nominal STIs risk factors in groups

STIs risk factors	Category	Group A N	Group B N	Group C N	Test statistics	Degrees of freedom	p-value
Pap-smear in last 2 years	0	10	7	4	6.9	2	**0.032**
	1	73	36	99			
History of STI	0	76	36	83	4.5	2	0.107
	1	7	7	20			
History of cervical disease	0	69	37	69	5.2	2	0.075
	1	13	6	13			
Contraception usage	0	60	30	62	5.8	X	0.875
	Oral contraceptive pill	14	8	20			
	Intrauterine device	3	3	8			
	Vaginal ring	2	0	3			
	Condom	3	2	7			
	Sterilization	0	0	1			
Smoking	0	51	35	79	7.8	X	0.054
	1	26	7	18			
Drug abuse	0	76	42	95	0.8	X	0.830
	1	2	0	2			
Marital status	Single	63	31	72	7.7	X	0.197
	Married	12	7	23			
	Divorced	2	4	2			

Explanations:
Bold: statistically significant results; N – number of subjects; Category 0 – negative answer; Category 1 – positive answer; X – not calculated

DISCUSSION

The main aim of this study was to determine prevalence of *Ch. trachomatis* and *N. gonorrhoeae* in women of the Czech armed forces. Observed prevalence of *Ch. trachomatis* was higher, although not significantly, in recruits compared to active female soldiers and civilian controls. This is in line with high prevalence of *Ch. trachomatis* in military recruits shown by Gaydos et al. and Boyer et al. respectively [9, 10]. High seroprevalence of STIs in recruits compared to civilians was also shown by Agan et al., even though in men only and for HPV [11].

Higher *Ch. trachomatis* prevalence in military personnel was reported in several studies during last decades. Duron et al. published a study on French military service members with *Ch. trachomatis* prevalence 8.2% and 3.0% in females and males respectively [7]. Data from US military also showed increased *Ch. trachomatis* prevalence in soldiers [4, 12]. However, our study did not show any significant increase of *Ch. trachomatis* prevalence in active female soldiers. This is consistent with an Austrian study which reported *Ch. trachomatis* in 3.2% of male soldiers and none female soldiers, although only 15 women were included in the study [13]. Similar prevalence (3.1%) of *Ch. trachomatis* was shown by a study on German paratroopers and marines (155 males and 5 females) or by large Israeli study on female soldiers (3.3%) [6, 14]. These data show that different military settings vary in prevalence of *Ch. trachomatis* and cannot simply be perceived as risky and problematic altogether.

Population data on *Ch. trachomatis* epidemiology in the Czech Republic are limited. Study performed on pregnant asymptomatic women reported prevalence rate of 2.2% [15]. Another study from Central Europe region showed *Ch. trachomatis* prevalence 2.3% in German 18–24 years old women [16]. There were 1810 new cases of *Ch. Trachomatis* infection reported in the Czech republic during the 2023 year [17].

No case of *N. gonorrhoeae* was detected in our study. Low prevalence of *N. gonorrhoeae* is in accordance with German cross-sectional study which reported prevalence of 1.3% in soldiers [16]. Previously mentioned large Israeli study showed detection of *N. gonorrhoeae* in 1.1% of female soldiers [14]. Study on French service members discovered only 1 case in 925 participants (0.1%) [7].

Prevalence of *N. gonorrhoeae* in the study on population of the Czech pregnant women was 0.0% [15]. However, a slow increase in rates of *N. gonorrhoeae* is

documented across Europe and this trend will surely reach also the military environment [18]. Preliminary data for Czech population reveal 2562 new cases of *N. gonorrhoeae* in 2023 [17].

Groups in our study differed significantly in median age of participants with youngest in the Group A. We consider this a main limitation of the study. The difference could prove crucial as it is well established that STIs' prevalence is age-dependent with maximum peak in age groups < 25 years old [19, 20]. Age standardization was not applied due to limited number of positive detections. However, considering the character of in-between-group age difference, the disparity in STIs prevalence between the groups would be even smaller if standardization was applied.

Military recruits were shown to be at higher risk in two of evaluated STIs risk factors. Group A recorded the lowest age of coitarche and together with active soldiers also lower rate of regular preventive PAP-smears. The low age of coitarche in recruits could be explained by high-risk behavior in military service-women shown by Goyal et al. [21]. Simultaneously, early coitarche is often associated with risky sexual behavior, a higher number of sexual partners, substance use, and less frequent use of barrier contraception [22]. A Swedish study investigating risk factors associated with coital initiation showed that earlier onset of menstruation and a higher perceived social age may lead to earlier initiation of sexual activity. Women with earlier coitarche are also more likely to be victims of sexual violence [23].

The second main limitation of this study is the sample size and group distribution. The power of statistical analysis was limited with the smallest number (n = 43) of participants in the active soldiers group. Authors consider this to be caused partly by concerns of active soldiers regarding the results of STIs detection in relation to the employment and partly by unavailability of active soldiers due to their deployment across the units out of the health care facility region.

Authors believe that strong point of this study is its focus on female soldiers'STIs epidemiology separately from males. This is important as women are generally more affected by STIs and most of the studies refer to male soldiers or combined cohorts without clear gender distribution.

CONCLUSION

This was the first study to analyze the epidemiology of *Ch. trachomatis* and *N. gonorrhoeae* in women of the Czech Republic Armed Forces. It did not demonstrate significant differences in the prevalence of the pathogens compared to civilian women, but it did emphasize a possibly increased STIs risks in the context of military service. The results should therefore serve as an incentive for further research and consideration of preventive measures to minimize the risks of military service for female soldiers' fertility health.

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Ethics approval and consent to participate
The study was approved by the Ethics Committee of the Military University Hospital Prague, reference number of the decision 108/13-84/2029.
The participants were informed about the study protocol a written consent was obtained prior inclusion.

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Conflicts of interest
The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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