Prevalence and risk factors of genital *Chlamydia trachomatis* infection

Vesta Kučinskienė, Indrė Šutaitė, Skaidra Valiukevičienė, Žemyna Milašauskienė[1], Marius Domeika[2]

Clinic of Skin and Venereal Diseases, [1]Institute for Biomedical Research, Kaunas University of Medicine, Lithuania, [2]World Health Organization Collaborating Center for Diagnosis and Research of Chlamydial and Other Reproductive Tract Infections, Uppsala University, Uppsala, Sweden

Key words: *sexually transmitted infections; Chlamydia trachomatis infection; prevalence; incidence rate; risk factors.*

Summary. *The aim of the study was to provide a survey and generalization of literature data on the epidemiological situation of Chlamydia trachomatis infection in various countries, preventive screenings and risk factors of the infection.*

We performed a survey of articles published during 1998–2005 and selected from bibliographical medical search databases presenting data on the prevalence of Chlamydia trachomatis and the main risk factors for this sexually transmitted infection.

Chlamydial infection is the most common among sexually transmitted genital infections worldwide. It has been found that the main risk factors for Chlamydia trachomatis infection are age, irregular and/or accidental sexual relationships and change of sexual partners, failure to use or erratic use of barrier contraception during intercourse, and insufficient knowledge about sexual life and care for one's sexual health. Most countries do not have national preventive screening programs or exhaustive information about the prevalence of Chlamydia trachomatis infection.

The comparison of the prevalence and incidence of Chlamydia trachomatis infection among different countries is complicated due to the different diagnostic methods and sample selection techniques applied; however, in order to decrease the prevalence of chlamydial infection and its impact on the reproductive health of the society, significant attention should be paid to sexual education, preventive screening of people in high-risk groups, as well as to early diagnostics and timely treatment.

Introduction

The diagnostics of *Chlamydia trachomatis* infection (CI) is based on laboratory techniques. Safe, publicly acceptable, sensitive and specific diagnostic tests have been created for the detection of this pathology. Unfortunately, information about the prevalence of chlamydial infection (CI) in many countries of the world is insufficient, since population-based studies are rarely performed, preventive screenings of people attributed to high-risk groups are lacking, and thus numerous asymptomatic cases of this infection remain undetected (1-3). Asymptomatic course of CI complicates early detection and causes delayed diseases of reproductive pelvic organs, which deteriorates the reproductive health of the society and entails significant expenditures for the treatment of this pathology. It has been determined that by the amount of costs related to the treatment of CI complications, this infection is second only to HIV. In the United Kingdom, this amounts about 50 million pounds per year (4). In the US, the costs of CI diagnostics and treatment exceed 2.7 billion US dollars (5). CI and other sexually transmitted infections (STI) facilitate the transmission of human immunodeficiency virus (HIV) (6). According to the findings of the most recent studies, CI may be a risk factor for cervical cancer (7).

Methods of the study

The survey included articles that presented data on the prevalence and incidence rate of CI in different countries, preventive screening, and the risk

Correspondence to V. Kučinskienė, Clinic of Dermatological and Venereal Diseases, Kaunas University of Medicine, Eivenių 2, 50009 Kaunas, Lithuania. E-mail: kvesta@delfi.lt

factors for the infection. Articles analyzing CI diagnostic techniques and their advantages and drawbacks, as well as those analyzing CI treatment methods and complications were excluded from the survey.

We used computerized bibliographical medical databases Medline (PubMed), HINARI, EBSCO Publishing, and BioMed Central. The search for the articles was performed using the following keywords: *Chlamydia trachomatis*, epidemiological situation, prevalence, incidence rate, and risk factors. Using the aforementioned keywords, we selected articles published during 1998-2005. Additionally, we scanned through the following journals: "Medicina", "Lietuvos bendrosios praktikos gydytojas" (The Lithuanian GP), "Sexually Transmitted Infections," "European Journal of Clinical Microbiology and Infectious Diseases," "Journal of the European Academy of Dermatology and Venereology," and "World Journal of Urology." In total, over 150 articles were studied, but we tried to include only the findings of the most recent studies in the survey.

Epidemiological situation. *Etiopathogenesis. Chlamydia trachomatis* is an intercellular gram-negative microorganism that infects the columnar epithelium of male and female lower genital tract (8, 9). The infection transmitted sexually may also involve upper genital tract (10). CI causes urethritis (inflammation of the urethra), epididymitis (inflammation of the epididymis), and conjunctivitis (inflammation of the conjunctiva). Left untreated, CI in females eventually results in pelvic inflammatory disease (PID), ectopic pregnancy, and infertility and in males - chronic prostatitis (inflammation of the prostate gland) and infertility. Newborns infected during birth develop conjunctivitis or pneumonia (11).

According to literature data, more than one-half of infected males and about two-thirds of infected females may be carriers of asymptomatic CI infection for 3 months and longer (4, 6, 7).

Incidence rate. According to the WHO data, 92 million new cases of CI are diagnosed globally every year; of these, 5 million cases are diagnosed in Western Europe, and 5 million cases – in Eastern Europe and Central Asia. This is the most common bacterial STI in the world, since gonococcal infection is detected in 62 million cases, and syphilis – in 12 million cases annually (12). CI and other nongonococcal urethral inflammations are also the most common STIs in the developing countries (13).

During the last decade, the incidence rate of CI in the Nordic countries has increased significantly. In Sweden, the incidence of CI is 364 per 100 000 population, and in Norway – 386 per 100 000 population (14) (Fig. 1).

According to the data for 2004, in the United Kingdom CI is the most prevalent among young sexually active people – especially among 16–19-year-old women (1310 cases per 100 000 females detected) and 20–24-year-old men (1026 cases per 100 000 males) (15).

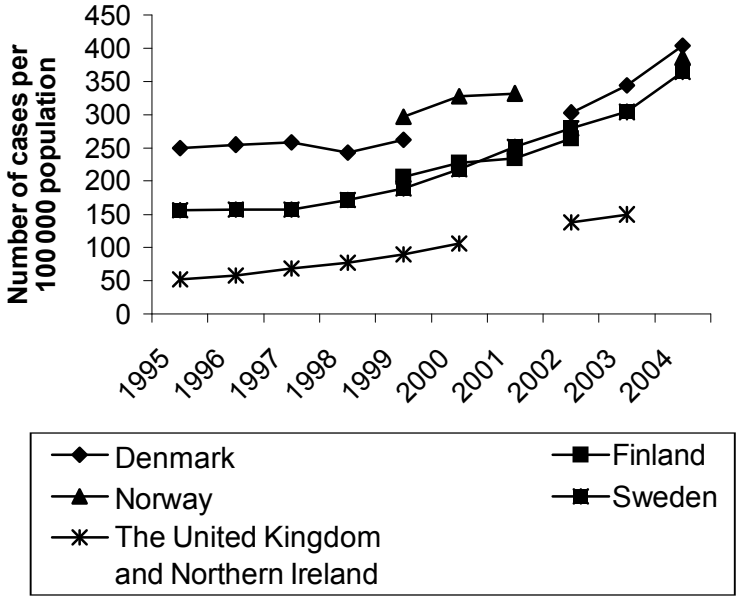

Fig. 1. **Incidence rate of genital chlamydial infection in Denmark, Finland, the United Kingdom and Northern Ireland, and in Norway during 1995-2004 (14)**

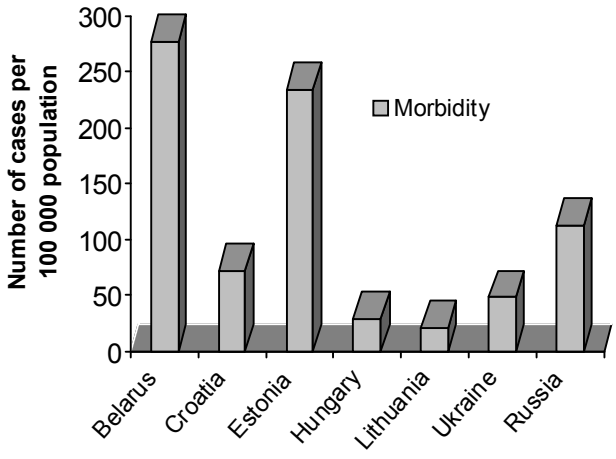

Fig. 2. **Incidence rate of genital chlamydial infection in Eastern Europe in 1999 (1)**

In an international meeting of CI Research Society in Helsinki, data on the CI epidemiological situation in 13 Eastern European countries were presented (1). The registration of incidence rate of CI in Eastern European countries was started in the last decade of the 20th century: in Estonia (1991), in Latvia (1992), in Russia (1993), in Lithuania (1994), in Slovenia (1995), and in Hungary (1998). The highest incidence rate was registered in Belarus, Estonia, and Russia (Fig. 2).

The rates of the application of various diagnostic techniques for the detection of CI infection in Eastern Europe differ. For instance, in Latvia and Estonia, CI is most frequently diagnosed using the direct immunofluorescence method (DIF) and less frequently – using nucleic acid amplification tests (ligase or polymerase chain reaction), whereas in Lithuania CI diagnosis is performed using direct immunofluorescence, nuclein acid tests, cell culture, and enzyme-linked immunoassays (1). In 2005 in Lithuania, there were 14.7 registered cases of CI per 100 000 population (16). The changes in the indices of incidence rate of CI in all three Baltic countries during the last decade are presented in Fig. 3. Although the number of newly registered cases of CI in Lithuania is lesser, compared to other Baltic countries and neighboring European countries, lower statistical indices in Lithuania may be influenced by insufficient diagnostics (17) and inaccurate registration (18). Thus, the data of the Lithuanian registry may not reflect the real epidemiological situation of CI in Lithuania (16). The comparison of received information on newly registered cases of CI in different regions of Lithuania revealed significant irregularities – the greatest number of newly diagnosed cases of CI was in Mažeikiai district (4.9/10 000 population), followed by Vilnius city (4.3/10 000 population), Vilkaviškis district (2/10 000 population), and Panevėžys city (1.4/10 000 population), whereas the number of newly diagnosed cases in the second-largest city, Kaunas, was only 1.1/10 000 population (19).

Prevalence. The prevalence of asymptomatic CI in the US is 5% among suburban adolescent females (20), 12% – among all the studied adolescent females (4), and especially high – up to 27% – among poverty-stricken pregnant urban adolescents (21) and in women's prisons (22).

According to the findings of cross-sectional studies, the prevalence of CI in Australia (23) among

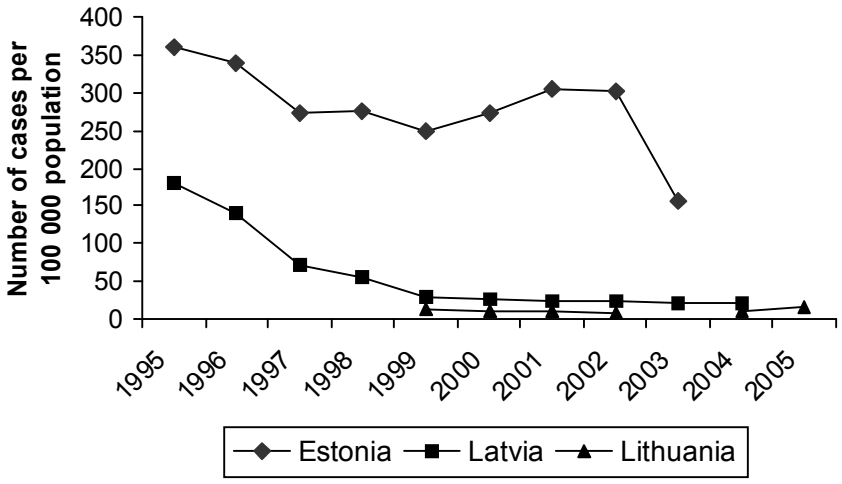

Fig. 3. **Incidence rate of genital chlamydial infection in Latvia, Lithuania, and Estonia during 1993-2005 (14, 16)**

women who apply to a gynecologist ranges between 2.8% and 5%. In Africa, the prevalence of CI among male and female students ranges between 3.78% and 6.9% (24, 25) and amounts to 38.3% among female prostitutes in Central Africa (26). In Japan, the prevalence of CI among female students and adolescents ranges between 4.6% and 13.5% (27, 28).

The prevalence of CI among women attracts significant attention of the researchers for the prevention of the reproductive health sequelae in the presence of asymptomatic CI. In Boston (US), the prevalence of CI among 16–25-year-old sexually active females who underwent prophylactic gynecological examinations and had no complaints was 22% (29).

The data on the prevalence of CI among European women in different countries are presented in Table 1.

According to the findings of the researchers, the prevalence of CI among asymptomatic females who applied for consultation about contraception varied from 4% to 17% (the highest prevalence of CI was detected in France). The prevalence of CI among those who underwent prophylactic examination for cervical cancer ranged between 1% and 12%, and the highest prevalence was found in the United Kingdom. Still, the comparison of the findings is complicated since researchers used different diagnostic techniques, and there were differences in the subjects' age, reasons for application, and the subjects' response (Table 1).

The comparison of the prevalence of CI in the Eastern European population is especially complicated. The information presented in the majority of articles on the prevalence of CI in a number of Eastern European countries was obtained during examinations of women who applied to a gynecologist (Fig. 4). The studies lack information on the applied diagnostic methods, the studied contingent, and the response rates. The prevalence of CI in Eastern Europe can relatively be distributed into three levels – low (the prevalence of CI <10%), moderate (the prevalence of CI 11–20%), and high (CI detected in more than 21% of gynecologic patients). The area of low prevalence of CI includes Slovenia, Hungary, Lithuania, Poland, and Novosibirsk, and the area of moderate prevalence – St. Petersburg region and Bulgaria (Fig. 4). The area of high prevalence of CI includes Sverdlovsk region and Ukraine. However, studies performed in these countries are poorly standardized and involve application of reagents of uncertain quality, which makes the evaluation of the real incidence of this infection impossible (34).

According to the findings of studies performed in Lithuania (35-39), the prevalence of CI ranges between 5% and 19.2%, depending on the age of the studied contingent, selection methods, examination techniques, and region (Table 2).

When evaluating the prevalence of CI among Lithuanian men and women, we found that different authors present different findings of their studies. For instance, certain authors indicated that depending on the studied contingent, the prevalence of CI among males ranged between 2.5% and 12%. CI was more frequently detected among high-risk groups of males, i.e. among those who applied to the dermatovenereologist for certain disorders or complaints (40). The prevalence of CI among Lithuanian military recruits was only 2.5% (40). The prevalence of CI among sexually active students of secondary and vocational schools in Kaunas city was also only 2.5% (41).

Peculiarities of preventive screening. A majority of countries do not have national STI prevention and control programs and do not perform preventive screening for CI. According to the WHO data, national STI prevention and control programs are operational in only one-third of European countries (12). Knowledge about the prevalence of CI in high-risk groups allows for the planning of purposive CI prevention measures.

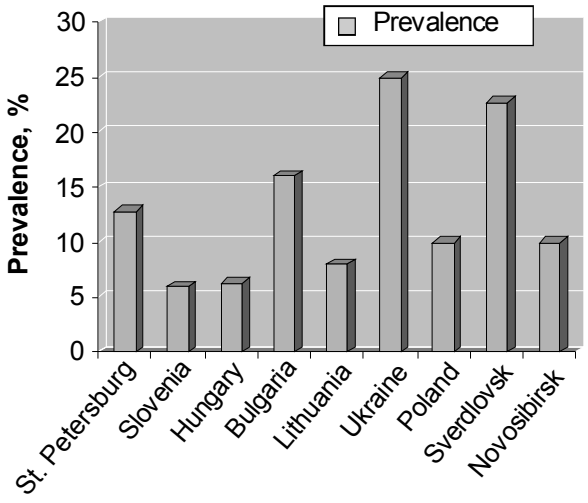

Fig. 4. **Prevalence of genital chlamydial infection in women consulting outpatient gynecological clinics in Eastern Europe (1)**

Table 1. **Prevalence of chlamydial infection among women in European countries according to J. S. Wilson et al. (7)***

Source (year)	Country	Reason for application	Age (years)	Period of study	Method of laboratory examination	Sample, n	Response rate, %	Prevalence, %
J. Paavonen and E. Vesterinen, 1982	Finland	Contraception PAP	18–40	1977–1980	Cell culture	298	Not indicated	6
D. Chi Nguyen *et al.*, 1989	France	Contraception	15–55	1987	Cell culture	306	Not indicated	17
C. J. Meijer *et al.*, 1989	Netherlands	PAP	35–55	1983–1984	DIF	2470	33	4.4
K. Persson *et al.*, 1991	Sweden	Contraception	12–25	1989–1990	Cell culture	306	77	6.0
J. R. Smith *et al.*, 1991	United Kingdom	PAP	15–58	1989–1994	Cell culture	197	Not indicated	12
L. O. Svensson *et al.*, 1994	Sweden	Preventive screening	16–20	1991–1992	EIA	751	77	2.1
Italian MEGIC Group, 1993	Italy	Contraception PAP	33	–	DIF	1321	Not indicated	3.9
C. Thompson and E. Wallace, 1994	United Kingdom	PAP	15–40	1992	DIF	287	Not indicated	1.7
J. J. Marinas *et al.*, 1997	Spain	Contraception PAP	15–35	1990–1993	Pace 2	2494	Not indicated	1
T. Nyari *et al.*, 1998	Hungary	Prenatal diagnostics	20–29	1994–1995	Pace 2	6161	Not indicated	5.9
K. Tchoudomirova *et al.*, 1998	Bulgaria	Preventive screening	16–46	1992–1995	EIA	231	Not indicated	6.1
J. Hopwood and H. Mallinson, 1999	United Kingdom	PAP	16–25	Notindicated	EIA	698	99	3.9
K. Kirkwood *et al.*, 1999	United Kingdom	Contraception	Less than 20	Not indicated	PCR	97	97	6.2
J. A. R. van den Hoek *et al.*, 1999	Netherlands	GP	15–40	1996–1997	LCR	2403	95.7	4.9
I. J. Bakken *et al.*, 2004 (30)	Norway	GP	16–24	1998–2000	Pace 2	898	Nenurodyta	2.4
I. Klavs *et al.*, 2004 (31)	Slovenia	Preventive screening	18–49	1999–2001	PCR	903	70.9	1.6
E. Filipp *et al.*, 2005 (32)	Poland	Not indicated	16–19	2002–2004	PCR	249	Nenurodyta	3.2
S. Levidiotou *et al.*, 2005 (33)	Greece	Various	18–55	1998–2004	PCR LCR	8834	Nenurodyta	2.9

*supplemented by authors. PCR – polymerase chain reaction, LCR – ligase chain reaction, EIA – enzyme immunoassay, DIF – direct immunofluorescence, PAP – oncocytological smear according to Papanicolaou, GP – general practitioner, Pace 2 – nuclein acid hybridization test.

Table 2. **Epidemiological situation of genital chlamydial infection in Lithuania**

Source	Studied contingent	Studied material	Method of laboratory studies	Sample, n	Prevalence, %
M. Domeika *et al.*, 1999 (35)	Sexually active 18–35-year-old asymptomatic (group G0) and symptomatic (group G1) women who applied to the gynecologist at Vilnius University	1. First voided urine sample 2. Sample taken from the vagina*	PCR	283 G0:160 G1:123	 G0:5 G1:13
M. Domeika *et al.*, 2000 (36)	Women who applied to the gynecologists in 6 healthcare units in Kaunas	1. Sample taken from the vagina 2. First voided urine sample 3. Sample taken from the cervix	PCR	1008	8.4
M. Domeika *et al.*, 2000 (37)	Sexually active women (mean age – 29 years) in Klaipėda	Sample taken from the cervix	PCR	147	15.6
M. Domeika *et al.*, 2000 (38)	Sexually active women (younger than 35 years of age) in Klaipėda	1. Sample taken from the vagina* 2. Sample taken from the urethra 3. Sample taken from the cervix	PCR	94	19.2
I. Basevičienė *et al.*, 2002 (39)	Sexually active 15–19-year-old girls in Kaunas, selected in schools according to the data of an anonymous inquiry	Sample taken from the vagina	PCR	24	18.2

*patient self-obtained sample. PCR – polymerase chain reaction.

In Western European countries, there are an increasing number of preventive CI studies in high-risk groups or randomly selected subjects. The aim of these studies is to determine the prevalence of CI, to evaluate the sensitivity and specificity of diagnostic tests, and to determine the preventive screening method for the diagnostics of asymptomatic CI, which would be most suitable both to the physician and to the patient. The data of the randomized population study performed in Denmark showed that best responses of the subjects were achieved by sending individual postal invitations to arrive for screening for CI and to bring self-taken vaginal or urine samples obtained using the indicated technique (42). Such methods of the study allow for performing regular check-ups in target age groups with the highest risk of infection. Early diagnostics of CI prevents the development of complications of asymptomatic CI and reduces expenditures of healthcare institutions (42). In Denmark, 270 000 tests are performed each year corresponding to 5% of the total Danish population. More than 85% of samples are obtained in general practice. CI screening is performed in women who apply for gynecological examination for any reason, in women with genital symptoms, and as part of partner notification. Despite active screening, the number of detected infections in Denmark has remained stable during the last 10 years (42). In Sweden, preventive screening is performed in sexually active 15–29-year-old women who apply for contraception or discontinuation of pregnancy. Men are screened if they had contacts with an infected partner or have symptoms of infection. In Austria, preventive screening for CI is performed in prostitutes and pregnant women (43).

Risk factors

Demographic factors. *Age.* It must be noted that age is very important for the prevalence of CI. This infection is significantly more common among young sexually active women, especially among adolescents (7).

The majority of researchers think that higher prevalence of CI among female adolescents may be due to anatomical factors. The cervix of adolescent females is not sufficiently developed and is especially susceptible to sexually transmitted infections (13).

According to the findings of the preventive screening performed in the Netherlands, examination of urine samples showed that the prevalence of CI was highest in the age group of 18–25 years (5.3%); in the age group of 26–30-year-old women, the prevalence of CI was 3.4%, and not a single case of CI was detected among women aged 31–40 years (44).

A large surveillance study performed in Germany also showed an association of the prevalence of CI with age – the highest prevalence of CI was found among 15–19-year-old females, whereas it significantly decreased after 25 years of age. According to the findings of the same study, the prevalence of CI among men also decreased with increasing age (45).

Sex. According to the findings of some studies (46, 47), the prevalence among males is lower than that among females. These findings may not be exact, since significantly fewer males are examined, compared to females. In the United Kingdom, the prevalence of CI among military recruits was found to be 9.8% (47). However, compared to the other Western European countries, the prevalence of CI among males in the United Kingdom is significantly higher, and thus preventive screening of men is as important as that of women (48).

Race. The prevalence of CI or gonococcal infection and both STIs (coinfection) among subjects of different races is different. The greatest number of cases gonorrhea and CI separately was detected among individuals of the Black Caribbean race. STI coinfection was less common among whites, compared to blacks (49).

The study of 18-29-year-old women performed in Northern California (US) showed that CI was the most common among blacks and Asians (4.2%) than among white subjects (1.4%) (50).

Occupation. Scientists did not find any significant differences in the prevalence of CI among different occupational groups. The prevalence of CI was similar among clerks and students (accordingly, 4.6% and 4.4%), among police officers and soldiers (accordingly, 3.5% and 0.4%) (51), and among female and male sex workers (accordingly, 7.4%-58.6% (52, 53) and 9.7% (54)).

Sexual behavior. According to the findings of epidemiological studies, the main risk factors for the prevalence of CI are frequent sexual relationships and failure to use or erratic use of barrier contraception during intercourse, cervical ectopy, negative attitude of adolescent females and their sexual partners to condom use, concomitant STIs, and unemployment. Studies performed in the Netherlands during different periods showed that the prevalence of CI among asymptomatic pregnant women ranged between 2.9% and 6.4% (55).

According to the findings of the study performed in the United Kingdom (49), both STIs rather than CI or gonococcal infection separately were more frequently detected in heterosexual males, compared to homosexual. This study showed that 3.8% of all subjects were infected with gonococcal infection, 8.1% – with CI, and 1.5% – with both STIs. Patients who were infected with both STIs were younger than those infected with only chlamydial or gonococcal infection (45).

According to other authors, the prevalence of CI is unrelated to either social status, the usage of contraceptives, the number of sexual partners during the last 6 months or the number of new sexual partners during the last 2 months (56).

Conclusions

1. Genital chlamydial infection is the most common bacterial sexually transmitted infection worldwide. In Europe, the prevalence of chlamydial infection among young females ranges between 4.1% and 25%, whereas among males - between 1.2% and 12%.

2. Sporadic studies on the prevalence of chlamydial infection performed in Lithuania do not allow for a precise evaluation of the situation related to this pathology or for the planning of purposive preventive measures on a national scale.

3. In various countries of the world, preventive screenings are performed in high-risk groups, and there is a lack of population-based studies aimed at the identification of cases of asymptomatic chlamydial infection.

4. The main risk factor for chlamydial infection is age. Other risk factors are irregular and/or accidental sexual relationships, frequent change of sexual partners, failure to use or erratic use of barrier contraception during intercourse, and insufficient knowledge about sexual life and care for reproductive health.

Lytinių takų *Chlamydia trachomatis* infekcijos paplitimas ir rizikos veiksniai

Vesta Kučinskienė, Indrė Šutaitė, Skaidra Valiukevičienė, Žemyna Milašauskienė[1], Marius Domeika[2]

Kauno medicinos universiteto Odos ir venerinių ligų klinika, [1]Biomedicininių tyrimų institutas [2]Upsalos universiteto Lytiškai plintančių infekcijų centras prie Pasaulio sveikatos organizacijos, Švedija

Raktažodžiai: lytiškai plintančios infekcijos, Chlamydia trachomatis infekcija, paplitimas, sergamumas, rizikos veiksniai.

Santrauka. Straipsnio tikslas. Apibendrinti literatūros duomenis apie Chlamydia trachomatis infekcijos epidemiologinę situaciją įvairiose pasaulio šalyse, atliekamus profilaktinės patikros tyrimus bei šią infekciją sąlygojančius rizikos veiksnius.

Atlikta apžvalga straipsnių, publikuotų 1998–2005 m. bei atrinktų iš bibliografinės medicinos literatūros paieškos duomenų bazių, kuriuose buvo duomenų apie Chlamydia trachomatis paplitimą bei šios lytiškai plintančios infekcijos pagrindinius rizikos veiksnius.

Visame pasaulyje tarp lytiškai plintančių infekcijų lytinių takų Chlamydia trachomatis infekcija labiausiai paplitusi. Nustatyta, kad pagrindiniai Chlamydia trachomatis infekcijos rizikos veiksniai yra amžius, nepastovūs ir (ar) atsitiktiniai lytiniai santykiai bei partnerių kaita, barjerinių kontraceptinių priemonių nenaudojimas arba nepastovus jų naudojimas, nepakankamos žinios apie lytinį gyvenimą ir rūpinimąsi reprodukcine sveikata. Daugelis šalių neturi nacionalinių profilaktinės patikros programų ir išsamios informacijos apie Chlamydia trachomatis infekcijos paplitimą.

Lyginti Chlamydia trachomatis infekcijos paplitimą bei sergamumą įvairiose pasaulio šalyse sudėtinga dėl skirtingų diagnostikos metodų ir tiriamųjų atrankos metodikos, tačiau, siekiant pristabdyti chlamidinės infekcijos plitimą bei sumažinti jos pasekmes tiek moterų, tiek vyrų reprodukcinei sveikatai, didelį dėmesį reikėtų skirti lytiniam švietimui, žmonių, priskirtinų padidėjusios rizikos grupėms, profilaktinėms patikroms, ankstyvai diagnostikai ir laiku skiriamam gydymui.

Adresas susirašinėti: V. Kučinskienė, KMU Odos ir venerinių ligų klinika, Eivenių 2, 50009 Kaunas
El. paštas: kvesta@delfi.lt

References

1. Domeika M, Hallen A, Karabanov L, Chudomirova K, Gruber F, Unzeitig V, et al. *Chlamydia trachomatis* infections in Eastern Europe: legal aspects, epidemiology, diagnosis, and treatment. Sex Transm Infect 2002;78:115-9.
2. Vuylsteke B, Vandenbruaene M, Vandenbulcke P, Van Dyck E, Laga M. *Chlamydia trachomatis* prevalence and sexual behaviour among female adolescents in Belgium. Sex Transm Infect 1999;75:152-5.
3. Aldeen T, Haghdoost A, Hay P. Urine based screening for asymptomatic/undiagnosed genital chlamydial infection in young people visiting the accident and emergency department is feasible, acceptable, and can be epidemiologically helpful. Sex Transm Infect 2003;79:229-33.
4. Laga M, Manoka A, Kivuvu M, Malele B, Tuliza M, Nzila N, et al. Non-ulcerative sexually transmitted diseases as risk factors for HIV-1 transmission in woman: results from a cohort study. AIDS 1993;7:95-102.
5. Hollblad-Fadiman K, Goldman SM. American College of Preventive Medicine practice policy statement: screening for *Chlamydia trachomatis*. Am J Prev Med 2003;24(3):287-92.
6. Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of sexually transmitted diseases to sexual transmission of HIV infection. Sex Transm Infect 1999;75:3-17.
7. Wilson JS, Honey E, Templeton A, Paavonen J, Mardh PA, Stary A, et al. A systematic review of the prevalence of *Chlamydia trachomatis* among European women. Hum Reprod Update 2002;8(4):385-94.
8. Kihlstrom E, Danielsson D. Advances in biology, management and prevention of infections caused by *Chlamydia trachomatis* and *Neisseria gonorrhoea*. Curr Opin Infect Dis 1998;7:25-33.
9. Taylor-Robinson D, Thomas BJ. The role of *Chlamydia trachomatis* in genital tract and associated diseases. J Clin Pathol 1980;33:205-33.
10. Cates W, Wasserheit N. Genital chlamydial infections: epidemiology and reproductive sequelae. Am J Obstet Gynecol 1991;164:1771-81.
11. Moss RT, editor. International handbook of *Chlamydia*. Doncaster, England; 2001.
12. World Health Organisation. Global prevalence and incidence of selected curable sexually transmitted infections. Overview and Estimates. Geneva: WHO; 2001.
13. Sedlecki K, Markovic M, Rajic G. Risk factors for Chlamydia infections of the genital organs in adolescent-females.

Srp Arh Celok Lek 2001;129(7-8):169-74.
14. Data on sexually transmitted infections (STI) from WHO Regional Office for Europe. Available from: URL: http://data. euro.who.int/cisid/?TabID=105768
15. Epidemiology main points (routine surveillance data). [Reviewed on 23 November 2005]. Available from: URL: http://www.hpa.org.uk/infections/topics_az/hiv_and_sti/chlamydia/epidemiology/htm#
16. Routine surveillance data on communicable diseases from The State Public Health Service (SPHS) under the Ministry of Health in Lithuania. 2006 Jan-Mar [cited 2006 Mar] Available from: URL: http://www.vvspt.lt/aktai/uzkreciamos/palyginamoji2006.03.xls
17. Vagoras A, Butylkina R, Jusevičiūtė V, Hallén A, Unemo M, Domeika M. Laboratory diagnosis of non-viral sexually transmitted infections in Lithuania: lack of adherence to international recommendations and availability of diagnostic services. Eurosurveillance. [In press 2006.]
18. Kligys G. Epidemiological surveillance and control system of communicable diseases: management principles of sexually transmitted infections. Conclusive Conference of the Lithuanian-Swedish Project. Improvement of the Prevention and Control of Sexually Transmitted Infections in Lithuania; 2005 May 26; Vilnius, Lithuania. Available from: URL: http://www. medsci.uu.se/klinbakt/stigup/Publications/index.htm
19. Čaplinskas S. ŽIV infekcija, AIDS ir visuomenės sveikata. (HIV infection, AIDS and public health.) Vilnius: Lietuvos AIDS centro leidykla; 2004. p. 34.
20. Biro FM, Reising SF, Doughman JA, Kollar LM, Rosenthal SH. A comparison of diagnostic methods in adolescent girls with and without symptoms of chlamydia urogenital infection. Pediatrics 1994;93:476-80.
21. Chacko M. *Chlamydia trachomatis* infection in sexually active adolescents: prevalence and risk factors. Pediatrics 1984;73: 836-40.
22. Nelson HD, Helfand M. Screening for Chlamydial infection. Am J Prev Med 2001;20(3):95-107.
23. Williams H, Tabrizi SN, Lee W, Kovacs GT, Garland S. Adolescence and other risk factors for *Chlamydia trachomatis* genitourinary infection in woman in Melbourne, Australia. Sex Transm Infect 2003;79:31-4.
24. Ngandjio A, Clerc M, Fonkoua MC, Thonnon J, Njock F, Pouillot R, et al. Screening of volunteer students in Yaounde (Cameroon, Central Africa) for *Chlamydia trachomatis* infection and genotyping of isolated *C. trachomatis* strains. J Clin Microbiol 2003;41(9):4404-7.
25. Buve A, Weiss HA, Laga M, van Dyck E, Musonda R, Zekeng L, et al. The epidemiology of gonorrhoea, chlamydial infection and syphilis in four African cities. AIDS 2001;15(4):S79-S88.
26. Kaptue L, Zekeng L, Djoumessi S, Monny-Lobe M, Nichols D, Debuysscher R. HIV and chlamydia infections among prostitutes in Yaounde, Cameroon. Genitourin Med 1991; 67(2):143-5.
27. Imai H, Shinohara H, Nakao H, Tsukino H, Hamasuna R, Katoh T. Prevalence and risk factors of asymptomatic chlamydial infection among students in Japan. Int J STD AIDS 2004; 15(6):408-14.
28. Tsukagoshi T. Epidemiological study on *Chlamydia trachomatis* infection among sexually active female adolescence. Nippon Sanka Fujinka Gakkai Zasshi1990;42(12):1655-62.
29. Shrier LA, Dean D, Klein E, Harter K, Rice PA. Limitations of screening tests for the detection of *Chlamydia trachomatis* in asymptomatic adolescent and young adult women. Am J Obstet Gynecol 2004;190(3):654-62.
30. Bakken IJ, Skjeldestad FE, Ovreness T, Nordbo SA, Storvold G. Chlamydia infections and sexual behavior among young women. Tidsskr Nor Laegeforen 2004;124(12):1633-5.
31. Klavs I, Rodrigues LC, Wellings K, Kese D, Hayes R. Prevalence of genital *Chlamydia trachomatis* infection in the general population of Slovenia: serious gaps in control. Sex Transm Infect 2004;80(2):121-3.
32. Filipp E, Raczynski P, El Midaoui A, Pawlowska A, Tarnowska-Madra U, Scholz A, et al. *Chlamydia trachomatis* infection in sexually active adolescents and young women. Med Wieku Rozwoj 2005;9(1):57-64.
33. Levidiotou S, Vrioni G, Papadogeorgaki H, Avdeliodi K, Kada H, Kaparos G, et al. *Chlamydia trachomatis* infections in Greece: first prevalence study using nucleic acid amplification tests. Eur J Clin Microbiol Infect Dis 2005;24(3):207-13.
34. Shalepo K, Savicheva A, Shipitsyna E, Unemo M, Domeika M. Diagnosis of *Chlamydia trachomatis* in Russia – in-house PCR assays may be effective but overall optimisations and quality assurance are urgent. APMIS. [In press 2006.]
35. Domeika M, Bassiri M, Butrimienė I, Venalis A, Ranceva J, Vasjanova V. Evaluation of vaginal introital sampling as an alternative approach for the detection of genital *Chlamydia trachomatis* infection in women. Acta Obstet Gynecol Scand 1999;78:131-6.
36. Domeika M, Butylkina R, Hallen A, Spukaite T, Juceviciute V, Morkunaite D, et al. Prevalence of *Chlamydia trachomatis* infections in women attending six women's healthcare units in Kaunas, Lithuania. Sex Transm Infect 2001;77(6):459-60.
37. Domeika M, Hallen A, Drulyte O. Genital *Chlamydia trachomatis* infections in Lithuanian women invited for screened via newspaper advertisement: a pilot study. Sex Transm Infect 2000; 76(3):216.
38. Domeika M, Drulyte O. Use of PCR for the detection of genital *Chlamydia trachomatis* infection on self-obtained mailed vaginal samples. Acta Obstet Gynecol Scand 2000;79(7):570-5.
39. Basevičienė I, Labanauskas L, Vyšniauskaitė N. *Chlamydia trachomatis* infekcijos ankstyvasis diagnozavimas paauglėms. (Early diagnosis of genital *Chlamydia trachomatis* infection among adolescent girls.) Medicina (Kaunas) 2003;39(2):138-43.
40. Vagoras A, Jusevičiūtė V, Šumila A, Lapinskaitė G, Marčiukaitienė I, Domeika M. Polimerazės grandininės reakcijos ir tiesioginės imunofluorescencijos metodų taikymas nustatant vyrų šlapimkanalio infekciją, sukeltą *Chlamydia trachomatis*. Konferencijos medžiaga: lytiškai plintančių infekcijų kontrolės ir profilaktikos aktualijos. (Diagnosis of male urethral *Chlamydia trachomatis* infection using direct immunofluorescence test and polymerase chain reaction. Conference material: control and prevention of sexually transmitted diseases.) 2003 rugsėjo 19–20 d.; Kaunas. Lietuvos bendrosios praktikos gydytojas 2003; 7(9):87-92.
41. Pagirskas E, Domeika M. Kauno miesto vidurinių ir profesinių technikos mokyklų jaunuolių seksualinio

gyvenimo ypatumai. Konferencijos medžiaga: lytiškai plintančių infekcijų kontrolės ir profilaktikos aktualijos. (Attitudes of sexual behaviour among male adolescents from secondary and vocational schools in Kaunas. (Conference material: control and prevention of sexually transmitted diseases.)) 2003 rugsėjo 19–20 d.; Kaunas. Lietuvos bendrosios praktikos gydytojas 2003;7(9): 94.
42. Andersen B. Screening for urogenital *Chlamydia trachomatis* infections – the Danish experience. Conference material: control and prevention of sexually transmitted infections; 2003 Sept 19–20; Kaunas. Lietuvos bendrosios praktikos gydytojas 2003;7(9):32.
43. Low N. Current status of chlamydia screening in Europe. Eurosurveillance 2004;9(10-12):68-9.
44. Morre SA, van der Brule AJ, Rozendaal L, Boeke AJ, Voorhorst FJ, de Blok S, et al. The natural course of asymptomatic *Chlamydia trachomatis* infections: 45% clearance and no development of clinical PID after one – year follow-up. The Netherlands. Int J STD AIDS 2002;13(2):12-8.
45. Wagenlehner FM, Weidner W, Naber KG. Chlamydial infections in urology. World J Urol 2006;24(1):4-12.
46. Rogstad KE, Bates SM, Partridge S, Kudesia G, Poll R, Osborne MA, et al. The prevalence of *Chlamydia trachomatis* infection in male undergraduates: a postal survey. Sex Transm Infect 2001;77(2):111-3.
47. Pierpoint T, Thomas B, Judd A, Brugha R, Taylor-Robinson D, Renton A. Prevalence of *Chlamydia trachomatis* in young men in north west London. Sex Transm Infect 2000;76(4):273-6.
48. McKay L, Clery H, Carrick-Anderson K, Hollis S, Scott G. Genital *Chlamydia trachomatis* infection in a subgroup of young men in the UK. Lancet 2003;361:1792.
49. Creighton S, Tenant-Flowers M, Taylor CB, Miller R, Low N. Co-infection with gonorrhoea and chlamydia: how much is there and what does it mean? Int J STD AIDS 2003;14:109-13.
50. Klausner JD, McFarland W, Bolan G, Hernandez MT, Molitor F, Lemp GF, et al. Knock-knock: a population-based survey of risk behavior, health care access, and *Chlamydia trachomatis* infection among low-income women in the San Francisco Bay area. J Infect Dis 2001;183(7):1087-92.
51. Spasovski MS, Simjanovska LJ, Taleski V, Petrova N, Lazetic L, Popeska Z, et al. Screening of *Chlamydia trachomatis* urogenital infections among the male and female population of the Republic of Macedonia. J Eur Acad Dermatol Venereol 2005;19(4):427-30.
52. Chen XS, Yin YP, Liang GJ, Gong XD, Li HS, Poumerol G, et al. Sexually transmitted infections among female sex workers in Yunnan, China. AIDS Patient Care STDS 2005; 19(12):853-60.
53. Mak RP, van Renterghem L, Traen A. *Chlamydia trachomatis* in female sex workers in Belgium: 1998–2003. Sex Transm Infect 2005;81(1):89-90.
54. Leuridan E, Wouters K, Stalpaert M, van Damme P. Male sex workers in Antwerp, Belgium: a descriptive study. Int J STD AIDS 2005;16(11):744-8.
55. Rours GI, Verkooyen RP, Willemse HF, van der Zwaan EA, van Belkum A, de Groot R, et al. Use of pooled urine samples and automated DNA isolation to achieve improved sensitivity and cost-effectiveness of large-scale testing for *Chlamydia trachomatis* in pregnant women. J Clin Microbiol 2005;43(9): 4684-90.
56. van Valhengoed IG, Morre SA, Meijer CJ, van der Brule AJ, Boeke AJ. Do questions on sexual behavior and the method of sample collection affect participation in screening programme for asymptomatic *Chlamydia trachomatis* infections in primary care? Int J STD AIDS 2002;13(1):36-8.

Received 11 April 2006, accepted 6 November 2006