

Screening for *Chlamydia* and Gonorrhea by Strand Displacement Amplification in Homeless Adolescents Attending Youth Shelters in Korea

We conducted the screening of sexually transmitted infections to define the prevalence of genital *Chlamydia trachomatis* and *Neisseria gonorrhoeae* infections and status of sexual risk behavior among homeless adolescents (10-19 yr old) in Korea. Adolescents who ran away from home and are under the care of youth shelters in ten cities in Korea served as the study population. Participants filled out a self-administered questionnaire related to sexuality. First-void urine was analyzed for chlamydial and gonococcal infection by strand displacement amplification (BDProbTec™ET, BD Diagnostic Systems, MD, U.S.A.). A total of 175 adolescents from 15 youth shelters took part in the study. Their median age was 16 yr, and 54.9% of them reported having sexual intercourse at least once. The prevalence of *C. trachomatis* and *N. gonorrhoeae* among homeless adolescents was 12.6% and 15.4%, respectively. Factors significantly associated with the infections were number of sexual partners during the past year and lifetime. This is the first community-based sexually transmitted infection (STI) screening among adolescent in Korea. Screening programs targeting sexually active adolescents are important for detection of STIs. They should be considered an alternative population-based surveillance system in order to control STIs nationally.

Key Words : *Chlamydia trachomatis*; *Neisseria gonorrhoeae*; Adolescent; Adolescent Health Services; Sexually Transmitted Diseases

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Received : 16 February 2004
Accepted : 25 March 2004

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*Supported by Grant from Korean Academy of Medical Sciences (2003).

INTRODUCTION

Infections with *Chlamydia trachomatis* and *Neisseria gonorrhoeae* are the most common bacterial sexually transmitted infections (STIs) and the highest age-specific rates are found in adolescents and youths in their early twenties (1). It is estimated that about half a million or 1 in 20 young people acquire a STI every day, adding up to more than 150 million new infections in a year (2). The long-term consequences of chlamydial and gonococcal infections may be severe, particularly in women and cervical infection can lead to pelvic inflammatory disease, tubal scarring, infertility, ectopic pregnancy, chronic pelvic pain, and rarely, death from tuboovarian abscesses or ruptured ectopic pregnancies (3, 4).

Since genital chlamydial and gonococcal infections cause no or few symptoms as many as 80% of infected women and 50% of infected men, many infections remain undetected (5). Especially, large proportions of young people do not seek or have special problems to access to health care services. Most cases are identified through routine screening in health care settings. Over time, screening and treatment appear to be

associated with a decrease in the prevalence of disease in areas with consistent STI control programs (6, 7). In Korea, there is currently no generalized screening policy for STIs, and prevalence data from the general population are not available. The few surveys targeted only special groups such as sex workers have been performed by the governmental health institutes (8).

Korea Youth Shelter Association (KYSA) provides comprehensive primary care for homeless teenagers and has 33 youth shelters all over the country. Many, but not all, shelters in conjunction with private reproductive health clinics offer STI and reproductive health related services. They serve homeless adolescents, predominately girls with limited financial resources, and they are used as a primary health care site for participating adolescents.

To be effective, a screening program must use the accurate and cost-effective diagnostic test available. The 'gold standard' for detection of *Chlamydia* and gonorrhea is still culture method. Culture is 100% specific, but estimates of sensitivity are as low as 50% in *Chlamydia* detection (9). The majority of laboratories have moved away from culture, as it is expensive, time-consuming and technically difficult (10). Nucleic

acid amplification techniques for diagnosing STIs are more sensitive than traditional culture or nonamplified nonculture testing techniques (10). In addition, nucleic acid amplification tests provide accurate test results using easier to collect, less invasive specimens such as voided urine. These highly sensitive and simplified diagnostic methods have now been successfully used to study STI epidemiology and to develop new screening interventions for a number of previously difficult to reach, at-risk populations such as students in school-based clinics (11). Strand displacement of amplification (SDA) is one of them and commercially available by the BDProbeTec™ET system (Becton Dickinson Microbiology System, Sparks, MD, U.S.A.). The BDProbeTec™ET system is a semi-automated system for the simultaneous detection of *C. trachomatis* and *N. gonorrhoeae* from a noninvasive urine sample (12).

Recent changes in sexual-social life of Koreans suggest the possibility of increase in STIs among the general population, so this study was done in adolescents as an initial evaluation. We evaluated the magnitude of chlamydial and gonococcal infections using SDA technology among Korean homeless adolescents. We also evaluated the status of sexual risk behavior among them to determine the risk factors associated with these infections.

MATERIALS AND METHODS

Study population

Information on the study was initially given through a letter and telephone to the KYSA. KYSA officially ask all youth shelters, distributed all over the country, to provide urine specimen for *Chlamydia* and gonorrhea testing. A total of 15 shelters decided to participate in this study. Once final approval was obtained by the headmaster of shelter, the study coordinator met with each headmaster or health care chief to coordinate and develop a campaign to maximize adolescent participation. As part of the recruitment procedure and on the consent form, all participants were provided information about the purpose of the urine test, STIs, and the consequences of untreated STIs.

Data collection and ethical clearance

An anonymous, self-administered, structured questionnaire was used to collect data on sexuality, condom use, and various psychosocial determinants of sexual behavior. A signed consent form was obtained from all subjects, who volunteered to take part in the study. The questionnaire was prepared in Korean.

Participants were asked to provide 30 mL of first-void urine in a sterile 50-mL screw-cap plastic bottle for analysis of infection by *C. trachomatis* and *N. gonorrhoeae*, after filling out the questionnaires. We assured all adolescents of confi-

dentiality. A code number linked the urine specimen and individual responses. The coded urine specimen was immediately put into a cold box and transported to the Catholic Research Institutes of Medical Science in Seoul within a day of collection.

All results were returned to participants by the headmaster of shelter. Adolescents receiving a positive test result were referred on for treatment. Infected adolescents were offered an additional STI examination with their physicians or at the reproductive health clinic.

Laboratory tests

Diagnoses were made by testing urine specimens using the BDProbeTec™ET system. Specimen processing and SDA assays were performed by two experienced technicians according to the manufacturer's instructions. Positive and negative controls for specimen processing are included in the kit along with an amplification control to monitor assay inhibition.

Statistical methods

Statistical analysis was performed using The SAS system for Windows (version 8.02; SAS Institute Inc., Cary, NC, U.S.A.). Associations between each risk factor and test result were assessed using χ^2 test for univariate analyses. Odds ratios (OR) with 95% confidence intervals (CI) were calculated. A *p* value of less than 0.05 was considered significant. Variables that showed any evidence of association with infection on univariate analysis were included in a multivariate logistic regression model.

RESULTS

Demographics and sexual behavior

A total of 175 adolescents from 15 youth shelters in ten cities were voluntarily tested. Their median age was 16 yr and the range was from 10 to 19 yr. Of 75 boys and 100 girls, 39 (52%) and 57 (57%) were sexually active, respectively, without significant difference between sexes. General and behavior characteristics of sexually active and non-sexually active adolescents are summarized in Table 1. There was a difference between sexually active adolescents and adolescents who were not sexually active as regards smoking status, regular drinking of alcohol, and presence of current genital symptoms. Table 2 shows the demographic description of sexually active adolescents according to sex. An early sexual debut (≤ 15 yr of age) was reported by 21.4% of males and 56.9% of females with significant difference. More than 60% of adolescents who had the sexual activities, had been sexually active during the past 12 months; 14.3% of males and 33.3% of females reported a single partner, whereas 64.3% and 43.1%, respectively,

Table 1. General and behavior characteristics of homeless adolescents in Korea, according to sexual activity

	No. (%) of subjects			p Value*
	All (n=175)	Sexually active (n=96)	Not-sexually active (n=79)	
Gender				0.511
Male	75 (42.9)	39 (40.6)	36 (45.6)	
Female	100 (57.1)	57 (59.4)	43 (54.4)	
Currently smoking	94 (55.0)	62 (66.7)	32 (41.0)	0.001
Drinking alcohol regularly [†]	87 (49.7)	58 (60.4)	29 (36.7)	0.002
Current genital symptoms	29 (14.3)	24 (30.4)	5 (7.8)	0.001
Prevalence <i>Chlamydia trachomatis</i>	22 (12.6)	22 (22.9)	0 (0.0)	<0.001
Prevalence <i>Neisseria gonorrhoeae</i>	27 (15.4)	27 (28.1)	0 (0.0)	<0.001
Age at first sexual intercourse (yr)				
≤15		35 (36.5)		
>15		44 (45.8)		
No. of sexual partners during the past year				
0		18 (18.8)		
1		21 (21.9)		
≥2		40 (41.7)		
No. of lifetime sexual partners				
1		23 (24.0)		
2		11 (11.5)		
≥3		45 (46.9)		
Recent new partner				
Yes		31 (32.3)		
No		48 (50.0)		
Condom use				
Always		5 (5.2)		
Most of the time		6 (6.3)		
Sometimes		13 (13.5)		
Never		55 (57.3)		
Currently smoking				
Yes		62 (64.6)		
No		31 (32.3)		
Drinking regularly				
Yes		58 (60.4)		
No		38 (39.6)		
Previous STI				
Yes		12 (12.5)		
No		67 (69.8)		
Current genital symptoms				
Yes		24 (25.0)		
No		55 (57.3)		

* χ^2 test for differences in proportion between sexually active and non-sexually active adolescents. [†]"Regularly" was defined as drinking alcohol during the weekend or several days a week.

The discordance between total number of subjects and the sum of each category was due to nonrespondents of the questionnaire.

reported two or more than two sexual partners. Only 10.7% of males and 15.7% of females used condom during sexual contact consistently, but 67.9% of males and 70.6% of females have never used it. The history of STI was reported by 17.9% of males and 13.7% of females. The majority (92.9%) of boys was free of genital symptoms at the time of screening and showed a significant difference compared to girls (56.9%).

STI prevalence and risk factors for infections

Among the 175 adolescents tested, 22 were infected with

C. trachomatis and 27 were infected with *N. gonorrhoeae*, for a prevalence rate of 12.6% and 15.4%, respectively. Prevalence of STIs among sexually active adolescents was 43.8% (42/96) with 53.8% (21/39) for males and 36.8% (21/57) for females. The rate of *C. trachomatis* positivity was 15.4% (6/39) among sexually active boys and 28.1% (16/57) among sexually active girls. Fifteen of 39 sexually active boys (38.5%) and 12 of 57 sexually active girls (21.1%) were found to have *N. gonorrhoeae* infection. Seven girls tested positive for *C. trachomatis* had dual infection with *N. gonorrhoeae*. The statistical difference of prevalence STIs between male and female sexually

Table 2. Demographic description of sexually active adolescents, according to sex

	Male		Female		p Value*
	No.	No. (%) of cases	No.	No. (%) of cases	
Prevalence STIs	39	21 (53.8)	57	21 (36.8)	0.099
Prevalence <i>Chlamydia trachomatis</i>	39	6 (15.4)	57	16 (28.1)	0.146
Prevalence <i>Neisseria gonorrhoeae</i>	39	15 (38.5)	57	12 (21.1)	0.062
Age at first sexual intercourse (yr)	28		51		0.002
≤ 15		6 (21.4)		29 (56.9)	
> 15		22 (78.6)		22 (43.1)	
No. of sexual partners during the past year	28		51		0.129
0		6 (21.4)		12 (23.5)	
1		4 (14.3)		17 (33.3)	
≥ 2		18 (64.3)		22 (43.1)	
No. of lifetime sexual partners	28		51		0.349
1		6 (21.4)		17 (33.3)	
2		3 (10.7)		8 (15.7)	
≥ 3		19 (67.9)		26 (51.0)	
Recent new partner	28		51		0.332
Yes		13 (46.4)		18 (35.3)	
No		15 (53.6)		33 (64.7)	
Condom use	28		51		0.650
Always		2 (7.1)		3 (5.9)	
Most of the time		1 (3.6)		5 (9.8)	
Sometimes		6 (21.4)		7 (13.7)	
Never		19 (67.9)		36 (70.6)	
Currently smoking	38		55		0.001
Yes		33 (86.8)		29 (52.7)	
No		5 (13.2)		26 (47.3)	
Drinking regularly [†]	39		57		0.002
Yes		31 (79.5)		27 (47.4)	
No		8 (20.5)		30 (52.6)	
Previous STI	28		51		0.625
Yes		5 (17.9)		7 (13.7)	
No		23 (82.1)		44 (86.3)	
Current genital symptoms	28		51		0.001
Yes		2 (7.1)		22 (43.1)	
No		26 (92.9)		29 (56.9)	

STI, mean sexually transmitted infection.

* χ^2 test for differences in proportion between sexually active and non-sexually active adolescents. [†]"Regularly" was defined as drinking alcohol during the weekend or several days a week.

The discordance between total number of subjects and the sum of each category was due to nonrespondents of the questionnaire.

active adolescents was not observed (Table 2). No adolescent under 13 yr old was infected with STI in this study. However, the age differences in STI acquisition are not notable in the group of adolescents aged 13 to 20 yr.

Table 3 summarizes risk factors which were significantly associated with STIs. A statistically significant correlation ($p=0.006$) was found between a positive result on the test and the number of partners in the past year (two and more partners during past year). The number of lifetime partners was found to be significant too ($p=0.004$), evidenced by a greater prevalence of positive results among adolescents who had three and more lifetime partners compared with those having less than three of partners. No statistically significant difference was found among the age at first sexual intercourse, recent partner change, condom use, and previous history of STIs.

There is no correlation with the subjective symptoms of the adolescents.

As regards of OR, there is the importance among the number of sexual partners in the preceding year (OR=1.935) and the number of lifetime sexual partners (OR=2.528) as factors that significantly increase the risk of infection. On multivariate analysis, there was no significant independent variable.

DISCUSSION

This is the first Korean epidemiologic study on STIs of adolescent population. Among the 175 study participants, 22 cases of *C. trachomatis* infection were found, giving a prevalence rate of 12.6%. Chlamydial infection among Korean

Table 3. Risk factors associated with chlamydial or gonococcal infections in sexually active adolescents

	No.	No. of cases	% positive	<i>p</i> Value	OR	95% CI
Number	96	42	43.8			
Age at first sexual intercourse (yr)						
≤15	35	16	45.7	NS	0.445	0.174-1.139
>15	44	12	27.3			
≥2 partners during past year						
Yes	40	20	50.0	0.006	1.935	1.027-3.647
No	39	8	20.5			
≥3 lifetime partners						
Yes	45	22	48.9	0.004	2.528	1.324-4.826
No	34	6	17.6			
Recent partner change						
Yes	31	15	48.4	NS	2.524	0.98-6.522
No	48	13	27.1			
Condom use always or mostly						
Yes	11	4	36.4	NS	1.048	0.278-3.943
No	68	24	35.3			
Condom use during last intercourse						
Yes	12	5	41.7	NS	1.366	0.390-4.786
No	67	23	34.3			
Previous STI						
Yes	12	6	50.0	NS	2.045	0.591-7.076
No	67	22	32.8			
Current genital symptoms						
Yes	24	8	33.3	NS	0.875	0.318-2.405
No	55	20	36.4			

homeless adolescents is considerably higher than the prevalence rate of 6.6% reported by Haley in 2002 among street youth in Montreal, Canada (13) and the 6.5% rate reported by Noell in 2001 among homeless adolescents in Oregon, U.S.A. (14). Compared to African data, the prevalence of *C. trachomatis* is also higher than the 5.6% rate recently reported by Taffa among out-of-school youth in Addis Ababa, Ethiopia (15). The STI prevalence of Korean homeless adolescents was higher than the other countries, and this might be closely related to the sexual activity, lower rate of condom use and higher rate of multiple partners. Therefore, education on proper sexual activity should be encouraged to prevent further STIs.

The prevalence rate of *N. gonorrhoea* was 15.4% among the 175 study participants. This result is much higher than the prevalence rates of gonococcal infections reported in several studies among inner-city adolescents in the U.S.A. and Canada, where infection rates of 0-5% have been documented (13, 16, 17). Generally, gonococcal infections are much less frequent than chlamydial infections. The highest incidence rates are among men aged 25-34 yr and the symptoms are more prominent than that of *Chlamydia* infections (13). However, the prevalence rate of *N. gonorrhoea* is not less than that of *C. trachomatis* in this study. This result suggests that adolescent screening for STIs in Korea should include *N. gonorrhoea*.

The risk factors that were predictive of STIs in univariate analysis were the number of partners during the past year and lifetime. The prevalence was two or three times higher among adolescents that had two and more partners during the past

year and three and more partners in their lifetime than among other adolescents. The gender differences in acquisition of chlamydial and gonococcal infections are not significant, with males being at a somewhat elevated risk compared with females. To date, research and screening for *Chlamydia* have largely centered on women, justified on the basis that such a strategy is evidence based, cost effectiveness and pragmatic (18). Despite the current proposals for *Chlamydia* screening, there is an evidence to suggest high rates of genital *Chlamydia* infection in male adolescents in Korea. The recent sexual health strategy for England suggested appropriate methods of population based screening, targeting both men and women, should be piloted (19). By including men we make them partners in the control and eradication of STIs, which is part of the solution rather than the problem.

It is important to note the limitations of this study that may have an impact on the findings. The 15 shelters where the headmasters wanted the test to be taken were picked out from 33 shelters, so there might be a selection bias. The shelters that are run by headmasters who are interested in health-care of the adolescents might have a better facilities, education, and health support. Therefore, the STI prevalence might have been measured lower from that selection bias.

In Korea, there are no national or local guidelines for the screening of STIs. Only a few surveillances have been performed among potential target groups for screening such as female sex workers (8) and gynecologic patients (20). A number of target-group screening strategies, such as service-based,

high-risk, periodic, and particular population screening, have the potential to identify disease at an early stage, prevent later morbidity and decrease transmission in the community (15). DNA amplification technology offers the greater flexibility in diagnosing STIs. Because the majority of STIs are asymptomatic and the disease can only be controlled through screening programs, urine-based screening may be the only practical way to accomplish this on a large scale.

In conclusion, the prevalence of STIs is very high in Korean homeless adolescent population. Since many cases of STIs are usually asymptomatic, these infections are undiagnosed and untreated. This is the significant health problem because this can occur predominantly among adolescents and young people. In order to prevent this problem, screening programs which target sexually active adolescents should be expanded. This type of target-group screening is feasible and acceptable and can identify a large number of asymptomatic, infected adolescents. We found that urine testing, being noninvasive, was acceptable for our adolescent population.

ACKNOWLEDGEMENTS

The study was funded by the Korean Academy of Medical Sciences and supported by Korean Association of Urogenital Tract Infection.

The authors would like to thank all study participants as well as the personnel of all youth shelters and Korea Youth Shelter Association. This study was made possible through the contributions of the Korean National Institute of Health, Becton and Dickenson Korea, and two study coordinators, Woo-In Choi and Eun-Mi Ryu.

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