American Journal of Biochemistry and Biotechnology

Original Research Paper

An Observational Study on the Prevalence of Sexually Transmitted Infections in Cheonan from 2017 to 2021

[1]Sun Jung Lee, [2]Tae Su Jang and [1]Jae Kyung Kim

[1]Department of Biomedical Laboratory Science, College of Health and Welfare, Dankook University, Cheonan, Republic of Korea
[2]Department of Health Administration, College of Health and Welfare, Dankook University, Cheonan, Republic of Korea

Article history
Received: 26-07-2023
Revised: 13-10-2023
Accepted: 01-11-2023

Corresponding Author:
Jae Kyung Kim
Department of Biomedical Laboratory Science, College of Health and Welfare, Dankook University, Cheonan, Republic of Korea
Email: nerowolf2@dankook.ac.kr

Abstract: Although the global incidence of sexually transmitted infections is increasing annually, there are few studies in Cheonan that have analyzed the frequency of infection by individual bacterial species by age since 2017. Therefore, in this observational study, we investigated trends in sexually transmitted infections in Cheonan, South Korea, since 2017. From January 2017 to November 2021, 3,297 specimens were obtained from patients who visited the Dankook University Hospital (Cheonan, South Korea) for STI screening. All collected data (obtained from men and women aged 0-93 years) were used. This study used diagnostic test data from medical institutions and did not use patients' personal information, so the requirement for prior consent was waived. Multiplex polymerase chain reaction, the most efficient diagnostic method with high sensitivity and specificity for the detection of bacteria, was performed using an MJ Research PTC-200 Thermal Cycler (Marshall Scientific, Richmond, VA, USA) and the Seeplex STD Detection Kit (Seegene, Seoul, South Korea). Using molecular diagnostics, sexually transmitted pathogens were detected in 1,017 samples. When the positivity rate was classified according to age, STIs were found to be more common among younger women (56%). When the positivity rate for each pathogen was classified according to sex, the patterns seen in male and female patients were different. Additionally, the prevalence of STIs has increased overall, from 27% in 2017 to 34% in 2021. This is consistent with the global trend of increasing incidence of STIs every year and the results of our study conducted in Cheonan and emphasized the importance of early and regular STI screening. It also highlights the importance of proactive measures such as education, prevention efforts, and improved access to healthcare to effectively respond to the increasing STI prevalence pattern in Cheonan.

Keywords: Cheonan, Multiplex Polymerase Chain Reaction, Public Health Education, Sexually Transmitted Infection, South Korea

Introduction

Commonly, Sexually Transmitted Infections (STIs) are caused transmitted via sexual contact by bacteria, viruses, or parasites (NIH, 2023). Asymptomatic and untreated STIs not only lead to long-term health problems, such as infertility, but can also affect in infants' morbidity and mortality (CINII, 2008). Approximately 374 million new infections occur annually, including syphilis and the STIs examined in this study (WHO, 2021).

The major common causative pathogens detected through STI testing are *Chlamydia Trachomatis* (CT), *Mycoplasma Genitalium* (MG), *Mycoplasma Hominis* (MH), *Neisseria Gonorrhoeae* (NG), *Trichomonas Vaginalis* (TV), and *Ureaplasma Urealyticum* (UU) (Park *et al*., 2018). The kit used in this study also extracted six major common causative pathogens. An American study found that CT is a bacterial STI that is the most common cause in all sex, men, and women (CDCP, 2023). Moreover, MG, MH, and UU are known to cause nongonococcal urethritis in men. MG is also a cause of pelvic inflammatory infections and cervicitis (Paira *et al*., 2021; Martin and Geisler, 2021). Generally, mucosal infections that appear in the lower reproductive tract of women are gonorrhea (Park *et al*., 2018), and trichomoniasis is more common in women (CDCP, 2022).

In general, various diagnostic methods for detecting

sexually transmitted pathogens, such as culture or serological tests, are used for each causative pathogen. However, at the same time, numerous pathogens are difficult to identify using the existing methods (Chung and Lee, 2017). There has been a recent interest in molecular diagnostic methods for detecting sexually transmitted pathogens. For example, Polymerase Chain Reaction (PCR) is a nucleic acid amplification technique used to identify pathogenic microorganisms and is widely used. (Chung and Lee, 2017). PCR is the most efficient diagnostic method for the detection of bacteria, as it has a shorter testing duration than other methods (Chung and Lee, 2017; Rezaei *et al*., 2022). Therefore, the molecular diagnostic method used to identify various pathogens in a short period of time is PCR.

The prevalence of STIs is a serious public health problem in both developing and developed countries (Mariani *et al*., 2021). STIs have high morbidity rates in both men and women and have an incidence of 150 million new cases annually (Cho, 2010). Despite the global annual trend of increased STI rates, there are few studies in Cheonan that have analyzed the frequency of infection by individual bacterial species according to age among sexually transmitted infection cases since 2017. There is a need for comprehensive research in Cheonan that includes all age groups, from young to old. This study analyzed each of the six major pathogens. Individuals with knowledge on STIs can recognize the possible transmission methods and complications; therefore, proper education is necessary for the prevention of these conditions (Kassie *et al*., 2019). Therefore, this study examined trends in STIs from 2017-2021 in Cheonan region of South Korea and highlighted the importance of preventing STIs through early and regular screening, improved access to healthcare, and preventing infection through early treatment. This data can also be used to design educational materials and public health strategies about STIs or related topics, such as treatments and vaccines.

Materials and Methods

Materials

From January 2017 to November 2021, 3,297 specimens were obtained from patients who visited the Dankook University Hospital (Cheonan, South Korea) for STI testing. All collected STI data (obtained from men (n = 754) and women (n = 2,543) aged 0-93 years) were used.

Methods

DNA Extraction

For multiplex PCR (mPCR), collected clinical specimens were stored at -70°C until DNA isolation. Swab samples were suspended in Phosphate-Buffered Saline (PBS). Centrifugation was performed at 13,000× g for 10 min, after which the supernatant was discarded, and the remaining sample was resuspended in PBS. For mPCR analysis, DNA (ng/µL) was extracted using the QIAamp DNA Mini Kit (QIAGEN, Hilden, Germany) according to the manufacturer's instructions. The QIAamp DNA Mini Kit (QIAGEN, Hilden, Germany) can automatically purify 1-12 samples and can rapidly purify high-quality DNA. For DNA isolation, approximately 200 µL of each sample was used as starting material. Using a NanoDrop 1000 spectrophotometer (Thermo Fisher Scientific, Waltham, MA, USA), the concentration of extracted DNA samples was measured.

Multiplex PCR

mPCR for STIs was performed using an MJ Research PTC-200 Thermal Cycler (Marshall Scientific, Richmond, VA, USA) and the Seeplex STD detection kit (Seegene, Seoul, South Korea) according to the manufacturers' instructions. The MJ Research PTC-200 Thermal Cycler (Marshall Scientific, Richmond, VA, USA) has temperature homogeneity and the Seeplex STD detection kit (Seegene, Seoul, Korea) allows simultaneous multiplex PCR and has high sensitivity and specificity. This kit is used by a Korean testing consignment company and is a product certified by the Korea Centers for Disease Control and Prevention and the Korean Association for Diagnostic Testing. First, 5 µL of the DNA extract was added to a PCR tube containing 5 µL of primer and probe mixture (Seeplex STD Detection Kit). Next, 10 µL of mPCR premix was added to each of the six STI pathogens: CT, MG, MH, NG, TV, and UU. Primer combinations for each pathogen were used, and in a single mPCR assay, detection of the six pathogens was performed simultaneously. The reaction conditions were as follows: 94°C for 15 min; 40 cycles of 94°C for 30 s, 63°C for 90 s, and 72°C for 90 s; and a final extension at 72°C for 10 min to complete partial polymerization. In each cycle, standardized viral RNA extract was used as a positive control and nuclease-free water was included as a negative control. The *Arabidopsis* cellulose synthase (*CESA3*) gene was included in all samples as an internal control for amplification. An internal control was added to the PCR mixture to detect the presence of PCR inhibitors. Thereafter, the PCR products were loaded into a 2% agarose gel stained with ethidium bromide and separated by electrophoresis. Finally, the separated PCR products were visualized under ultraviolet light (Fig. 1).

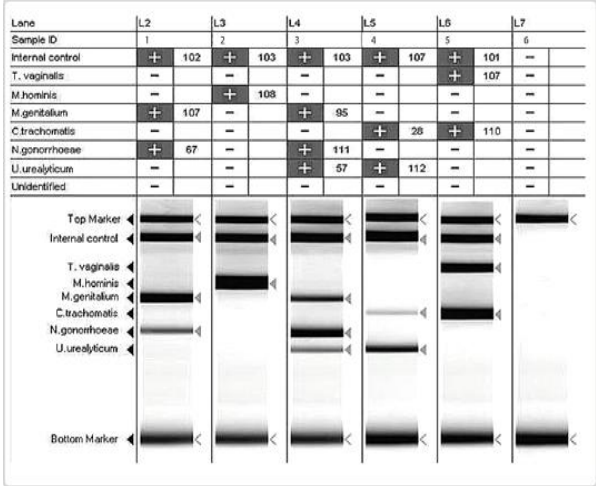

Fig. 1: Visualized data from electrophoresis for each pathogen; (https://www.seegene.co.kr/assays/seeplex_std6_ace_detection)

Statistical Analyses

For statistical processing, MedCalc ver. 11.6 (MedCalc Software, Mariakerke, Belgium) was used with multiple comparison graphs category. DNA sequences from CT, MG, MH, NG, TV, and UU detected using real-time PCR were retrospectively analyzed based on the patient's age, sex and pathogen causing STIs. A p-value <0.05 was considered statistically significant.

Results

Among the 3,297 specimens collected from Dankook University Hospital, 1,017 (30.85%) were positive for sexually transmitted pathogens (Tables 1-2). When the positivity rate was classified according to age, from 1 year old to 93 years old, STIs were found to be more common among younger women. In addition, the positivity rate for women decreased as age increased, whereas the positivity rate for men increased slightly as age increased. It can also be seen that it appears frequently in young people in their 20 and 30s (Fig. 2).

Notably, the positivity rate classified according to the causative pathogens of STIs showed different patterns across the sexes (Fig. 3). CT infections were high in young people for both men and women and gradually decreased. MG infection was more common in men than in women, whereas MH infection was found to be more common in women. Furthermore, NG infection was found to be rare in women aged >50 years old, whereas trichomoniasis was more common in older men than in younger men. Similar to MH infection, UU infection was also commonly found in women. The prevalence of UU infection was found to be high for both men and women and this was particularly high among female teenagers. In women, as age increased, the positivity rate of most bacterial STIs decreased. There was an overall increase in the prevalence of STIs (Fig. 4). Finally, in the positivity rates according to the testing month, there was no significant difference. CT ranged from 4.9-8.2% and MG ranged from 2.1-5.2%. MH ranged from 11.1% to 16.4% and UU ranged from 14.8-22.2% (Table 3).

Table 1: Number of participants categorized by age and sex

Age (years)	Men (N)	Women (N)	Total (N)
≤19	66	299	365
20	172	669	841
30	178	517	695
40	143	540	683
50	119	314	433
60	66	112	178
≥70	10	92	102

Table 2: Positivity rates for CT, MG, NG, TV, MH and UU infection by year

Year	CT %	MG %	NG %	TV %	MH %	UU %
2017	7.8	2.5	1.3	1.6	10.3	15.0
2018	6.4	3.6	0.9	1.4	11.5	15.5
2019	6.5	4.1	1.3	1.5	15.1	19.2
2020	5.3	5.5	1.8	1.4	12.6	19.5
2021	7.7	5.4	1.6	1.1	13.8	19.7

CT: *Chlamydia trachomatis*, MG: *Mycoplasma genitalium*, MH: *Mycoplasma hominis*, NG: *Neisseria gonorrhoeae*, TV: *Trichomonas vaginalis*, UU: *Ureaplasma urealyticum*

Table 3: The Positivity rates of CT, MG, MH and UU infection by testing month

Month	CT %	MG %	MH %	UU %
1	7.8	3.3	11.1	17.0
2	4.9	4.5	15.2	14.8
3	5.2	3.2	13.3	14.9
4	8.2	4.8	16.4[a]	16.1
5	6.2	2.1	13.2	18.0
6	8.0	4.3	13.3	20.2
7	6.1	5.2	16.4[a]	22.2[a]
8	5.9	3.6	8.8	19.5
9	10.0[a]	4.1	12.6	20.0
10	7.1	5.3[a]	9.3	13.5
11	6.6	5.1	9.7	14.0
12	4.8	2.4	9.7	16.9

[a]Highest rate; CT: *Chlamydia trachomatis*, MG: *Mycoplasma genitalium*, MH: *Mycoplasma hominis*, UU: *Ureaplasma urealyticum*

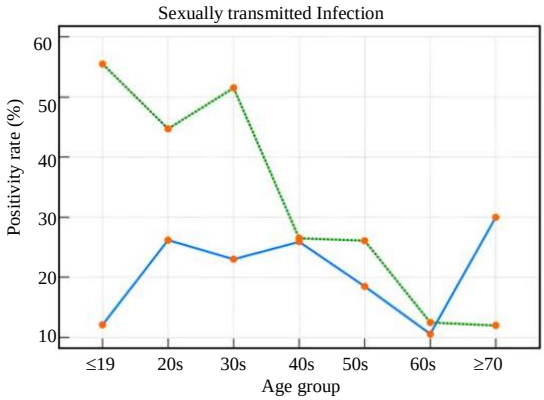

Fig. 2: Sexually transmitted infection positivity rate according to age; the blue line represents the positivity rate for men and the green line represents the positivity rate for women., for each age group

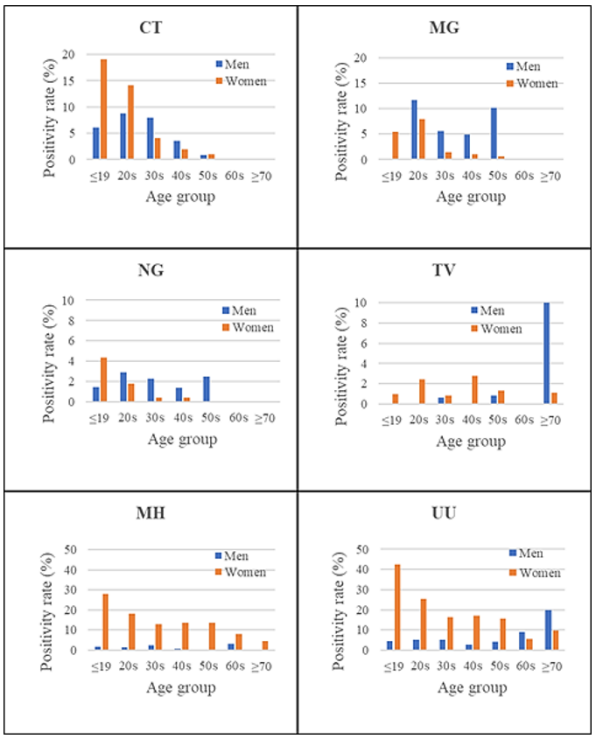

Fig. 3: Positivity rates of sexually transmitted infections by age; the blue line represents the positivity rate for men and the orange line represents the positivity rate for women, in each age group; CT: *Chlamydia Trachomatis*, MG: *Mycoplasma Genitalium*, MH: *Mycoplasma Hominis*, NG: *Neisseria Gonorrhoeae*, STI: Sexually Transmitted Infection, TV: *Trichomonas vaginalis*, UU: *Ureaplasma Urealyticum*

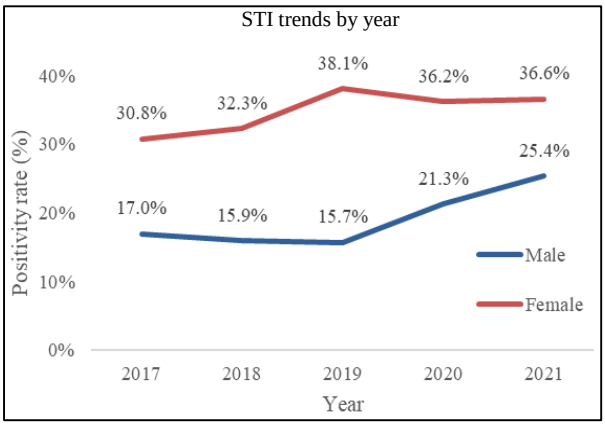

Fig. 4: The positivity rate of sexually transmitted infections trends by year; the blue and red lines represent the positivity rates for men and women, respectively, for each year

Discussion

In this study, we statistically analyzed the epidemiological trends of STIs occurring in Cheonan City from January 2017 to November 2021. Among the 3,297 specimens, 1,017 (30.85%) were positive for sexually transmitted pathogens. This is a novel study that links STIs in Cheonan with age, sex, and causative pathogens of STIs. It is worth noting that STIs occurred across all the studied age groups, resulting in varying STI positivity rates according to age, sex, and the causative pathogens involved.

According to the statistical analysis of our study, the positivity rate varied according to sex for each STI. MG infection was more common in men than in women, whereas MH infection was found to be more common in women. Furthermore, NG infection was found to be rare in women aged >50 years, whereas trichomoniasis was more common in older men than in younger men. Similar to MH infection, UU infection was also commonly found in women. The prevalence of UU infection was found to be high in both men and women, and this was particularly high among female teenagers. In a Chinese study, the NG infection prevalence was found to be higher in men (2.5%) than in women (0.8%), whereas the prevalence of UU infection was significantly higher in women (49.3%) than in men (31.5%) (Liang *et al*., 2019). A study from Canada also found higher rates of NG infection in men than in women during the 2010-2015 surveillance period (70.2 cases for men and 40.6 cases for women per 100,000 people in 2015, respectively) (Shannon and Klausner, 2018). According to another study, CT, NG, and UU infections tended to decrease in men and increase in women (Liang *et al*., 2019). The study also showed that the incidence rate of chlamydia, which continued to rise, was consistently higher in women than in men (Choudhri *et al*., 2018). In the case of transgender individuals, both CT and NG infections prevalence was higher in transgender women than in transgender men (Van Gerwen *et al*., 2020).

Our findings showed that STIs occur more often in younger women when the positivity rate is stratified by age from 1-93 years. The number of STIs worldwide is steadily increasing (Paira *et al*., 2021) and is known to vary with age and sex, with a high prevalence among young individuals (Choudhri *et al*., 2018). One study reported that CT infection and UU and MH urogenital infections are associated with sex and age and that CT infection was more common in men, whereas the more common infections in women are UU and MH (Paira *et al*., 2021). In addition, high risks of CT, UU, and NG infections were observed in all younger age groups (Choudhri *et al*., 2018; Paira *et al*., 2021). In other studies, the incidence of NG infection increases at a faster rate among older adults than among younger individuals because of natural physiological (i.e., vaginal dryness) and psychosocial changes (i.e., loss of a partner) (Choudhri *et al*., 2018). A South African study found that younger women were more than twice as likely to have treatable STIs (e.g., chlamydia, gonorrhea, and trichomoniasis) than men and older women (Francis *et al*.,

2018). In addition, the infections with the highest prevalence in young age groups are CT, NG, and UU infections, but it decreased over time irrespective of sex (Liang *et al*., 2019). In the United States, CT and NG infections were reported to be more common among adolescents than among those in other age groups (Shannon and Klausner, 2018). As individuals belonging to younger age groups have fewer opportunities to receive sex education, they are more likely to be exposed to STIs. Overall, the positivity rate decreased with age in women, whereas it slightly increased in men. However, it shows a significant increase in men aged >70 years. A study on infection with TV, which is a pathogen found in the prostatic parenchyma, urethral mucosa, and prostatic duct, have shown that the majority of infected men often remain undiagnosed or untreated because they have no symptoms (Kim *et al*., 2019).

Although the causative pathogens of STIs varied according to age and sex, no significant difference was found based on the testing month. However, the results of our study showed an overall annual increase in infection rates. Most individuals with STIs are asymptomatic and unaware of the infection; however, more than one million STIs are recorded every day worldwide (WHO, 2021). Based on statistical analysis, an urgent care center reported that the number of visits for STI examinations had almost doubled, and the number of visits made by individuals diagnosed with an STI had tripled over 4 years, from 2010-2014 (Pearson *et al*., 2017). Therefore, the STI rate, according to global estimates, remains high (WHO, 2021).

This study had some limitations. First, it was conducted exclusively in a single region of South Korea; thus, additional studies are needed in other regions for a more comprehensive understanding. Second, because this study was a retrospective study using only test results, there was no data on the clinical characteristics of individual patients.

In this study, we collected, compared, and analyzed STI data from a tertiary hospital in South Korea. The results show the need for preventive measures in each region. STIs are more common among young individuals (Folasayo *et al*., 2017). Therefore, reliable STI education (e.g., condom use and the possibility of reinfection) for younger age groups is important. The only reliable way to determine whether an individual has an STI is through proper testing (WHO, 2019). The potential risk of asymptomatic STIs should also be monitored, and regular check-ups are necessary. Untreated STIs can have serious consequences, including infertility, birth defects, and neurological problems (WHO, 2019). According to the World Health Organization, CT, NG, and TV infections can be treated with antibiotics (WHO, 2019). Therefore, it is important to prevent STIs through regular check-ups from an early age and initiate treatment at an early stage to prevent the progression of infections along with the use of antibiotics as mentioned by WHO. This highlights the need for public health policies, and it emphasizes the need for further research on STIs in regions other than Cheonan for a comprehensive understanding of regional trends and patterns.

Conclusion

In this study, we present data on the positive rate of sexually transmitted infections by age, sex, and causative pathogen through statistical analysis of STIs in the Cheonan area. STIs have been found to be more common in young women. In addition, with increasing age, the STI positivity rate in women decreased, while the positivity rate in men slightly increased with age. The positive rate classified based on the causative pathogens of STIs showed different patterns according to sex for CT, MG, MH, NG, TV, and UU. Although in positivity rates by test month, there was no significant difference, the overall prevalence of STIs increased from 27.1% in 2017 to 33.8% in 2021. Therefore, the findings of this study emphasize the importance of preventing STIs through regular screening and preventing the progression of infection by initiating early treatment.

Acknowledgment

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Funding Information

The authors have not received any financial support or funding to report.

Author's Contributions

Sun Jung Lee: Significantly contributed to the conceptualization and design of the research project. Additionally, played a pivotal role in the collection and analytical evaluation of the data.

Tae Su Jang: Instrumental in the development of the study's concept and design framework.

Jae Kyung Kim: Provided critical contributions to the data gathering process and performed a thorough analysis of the data collected.

All authors contributed greatly to the collection and analysis of STI data at Dankook University Hospital.

Ethics

The study was accepted by the Dankook University Institutional Review Board on March 24, 2022 (IRB

approval number: 2022-03-007). It adhered to the tenets of the Declaration of Helsinki. As data were analyzed retrospectively and no patient personal information was used, the Dankook University IRB withdrew the requirement to obtain informed consent. This study complied with ethical guidelines.

References

CINII. (2008). Sexually transmitted disease surveillance. *Centers for Disease Control and Prevention*. https://cir.nii.ac.jp/crid/1570572700071899392

CDCP. (2022). Trichomoniasis-CDC Basic Fact Sheet. Centers for Disease Control and Prevention. https://www.cdc.gov/std/trichomonas/stdfact-trichomoniasis.htm

CDCP. (2023). Chlamydia statistics, *Centers for Disease Control and Prevention*. https://www.cdc.gov/std/chlamydia/stats.htm

Cho, Y. H. (2010). Guideline development of Sexually Transmitted Infections (STIs) and prevalence survey of STIs in older people. https://scienceon.kisti.re.kr/srch/selectPORSrchReport.do?cn=TRKO201300000304

Choudhri, Y., Miller J., Sandhu, J. Leon A. & Aho J. (2018). *Chlamydia* in Canada. *Canada Communicable Disease Report*, *44* (2) 49-54. https://doi.org/10.14745/ccdr.v44i02a03

Chung, H. S., & Lee, M. (2017). Comparative evaluation of multiplex real-time PCR assays for six pathogens of sexually transmitted infections. *Annals of Clinical Microbiology*, *20*(1), 1-6. https://www.uptodate.com/contents/83202

Folasayo, A. T., Oluwasegun, A. J., Samsudin, S., Saudi, S. N. S., Osman, M., & Hamat, R. A. (2017). Assessing the knowledge level, attitudes, risky behaviors and preventive practices on sexually transmitted diseases among university students as future healthcare providers in the central zone of Malaysia: A cross-sectional study. *International Journal of Environmental Research and Public Health*, *14*(2), 159. https://doi.org/10.3390/ijerph14020159

Francis, S. C., Mthiyane, T. N., Baisley, K., Mchunu, S. L., Ferguson, J. B., Smit, T., ... & Shahmanesh, M. (2018). Prevalence of sexually transmitted infections among young people in South Africa: A nested survey in a health and demographic surveillance site. *PLoS Medicine*, *15*(2), e1002512. https://doi.org/10.1371/journal.pmed.1002512

Kassie, B. A., Yenus, H., Berhe, R., & Kassahun, E. A. (2019). Prevalence of sexually transmitted infections and associated factors among the University of Gondar students, Northwest Ethiopia: A cross-sectional study. Reproductive Health, 16, 1-8. https://doi.org/10.1186/s12978-019-0815-5

Kim, J. H., Moon, H. S., Kim, K. S., Hwang, H. S., Ryu, J. S., & Park, S. Y. (2019). Comparison of seropositivity to *trichomonas vaginalis* between men with prostatic tumor and normal men. *The Korean Journal of Parasitology*, *57*(1), 21. https://doi.org/10.3347/kjp.2019.57.1.21

Liang, Y. Y., Zhai, H. Y., Li, Z. J., Jin, X., Chen, Y., & Chen, S. P. (2019). Prevalence of *Ureaplasma urealyticum*, *Chlamydia trachomatis*, *Neisseria gonorrhoeae* and herpes simplex virus in Beijing, China. *Epidemiology and Infection*, *147*, e59. https://doi.org/10.1017/S0950268818003163

Mariani, A., Seweng, A., Ruseng, S. S., Moedjiono, A. I., Abdullah, T., Anshary, A., ... & Basir, M. (2021). The relationship between knowledge and personal hygiene and the occurrence of sexually transmitted diseases at the Community Health Center Talise, Palu. *Gaceta Sanitaria*, *35*, S164-S167. https://doi.org/10.1016/j.gaceta.2021.10.016

Martin, D. H., & Geisler, W. M. (2021). *Mycoplasma genitalium* infection. https://doi.org/10.5145/ACM.2017.20.1.1

NIH. (2023). Sexually transmitted diseases. *National Institute of Allergy and Infectious Diseases*. https://www.niaid.nih.gov/diseases-conditions/sexually-transmitted-diseases

Paira, D. A., Molina, G., Tissera, A. D., Olivera, C., Molina, R. I., & Motrich, R. D. (2021). Results from a large cross-sectional study *assessing Chlamydia trachomatis*, *Ureaplasma* spp. and *Mycoplasma hominis* urogenital infections in patients with primary infertility. *Scientific Reports*, *11*(1), 13655. https://doi.org/10.1038/s41598-021-93318-1

Park, J. O., Jeon, J. S., Kim, J. W., & Kim, J. K. (2018). Epidemiological trends of sexually transmitted Infections among women in Cheonan, South Korea, 2011-2017. *Microbiology and Biotechnology Letters*, *46*(1), 85-90. https://doi.org/10.4014/mbl.1801.01011

Pearson, W. S., Tao, G., Kroeger, K., & Peterman, T. A. (2017). Increase in urgent care center visits for sexually transmitted infections, United States, 2010-2014. *Emerging Infectious Diseases*, *23*(2), 367. https://doi.org/10.3201/eid2302.161707

Rezaei, K., Rajabpour Nikoo, N., Vaez, H., Rezaei Keikhaei, L., Shirazi, M., Ghaemi, M., ... & Rezaei, A. (2022). Investigating the Prevalence of *Mycoplasma genitalium* and *Mycoplasma hominis* Among Women with Vaginal Infection in Zabol in 2017. *Journal of Obstetrics, Gynecology and Cancer Research*, *4*(4), 141-145. https://doi.org/10.30699/jogcr.4.4.141

Shannon, C. L., & Klausner, J. D. (2018). The growing epidemic of sexually transmitted infections in adolescents: A neglected population. *Current Opinion in Pediatrics*, *30*(1), 137. https://doi.org/10.1097/MOP.0000000000000578

Van Gerwen, O. T., Jani, A., Long, D. M., Austin, E. L., Musgrove, K., & Muzny, C. A. (2020). Prevalence of sexually transmitted infections and human immunodeficiency virus in transgender persons: A systematic review. *Transgender Health*, *5*(2), 90-103. https://doi.org/10.1089/trgh.2019.0053

WHO. (2021). Sexually Transmitted Infections (STIs). *World Health Organization*. https://www.who.int/news-room/fact-sheets/detail/sexually-transmitted-infections-(stis)

WHO. (2019). Four curable sexually transmitted infections still affect millions worldwide. *World Health Organization*. https://www.who.int/news-room/feature-stories/detail/four-curable-sexually-transmitted-infections---all-you-need-to-know