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Laboratory Investigation of Sexually Transmitted Infections in the Elderly Population of South Korea

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This study analyzed the epidemiological trends of sexually transmitted infections (STIs) according to age and sex among individuals aged 50 years or older in South Korea from September 2018 to December 2020. We found that the positivity rate for *Gardnerella vaginalis* was the highest in the study group, followed by the positivity rate for *Ureaplasma parvum* (UP). Interestingly, the positivity rates for *Mycoplasma hominis* and UP were higher in female participants than in male participants. The positivity rate for *Treponema pallidum* was very low in the female participants. During the study period, the positivity rate for herpes simplex virus 2 increased in the female participants, while the positivity rate for *Candida* increased in the male participants. These results show that the STI positivity rate varies according to age and sex, and a difference was observed in the average age of positive participants according to the type of STIs. We found a clear pattern of infection in the elderly population and according to sex. Our findings are expected to be used as baseline data for future research, education, and prevention of STIs in the elderly population.

Keywords: ***Chlamydia trachomatis*, elderly, *Gardnerella vaginalis*, sexually transmitted infections**

Introduction

The aging population is a global trend due to the development of medical technology, improved standards of living, and improved health care [1], such that approximately 22% of the global population is expected to be over 60 years old in almost 40 years [2]. Population aging in South Korea is progressing faster than that in any other country, with individuals aged ≥65 years accounting for more than 14% of the total population [3]. The rapid aging of the population may be the most important and dynamic aspect of modern demographics, resulting in a substantial impact on public health [4].

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While sexual activity levels typically decrease with age after 65 years [5], large proportions of older adults desire sexual contact and engage in sexual activity [5, 6]. As an important component of the lives of the elderly, there is a need to recognize the possibility of sexual activity and sexually transmitted diseases [7]. Sexual activity is an important part of later life [8], frequently associated with better cardiovascular health [9, 10], higher self-esteem [5], and higher life enjoyment levels [11]. Improved longevity, evolving societal norms, and physiological changes may place older people at risk of human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs) [12].

STIs are some of the most frequent communicable diseases globally, representing a major social issue [13] and public health crisis worldwide including the United States [14]. There are more than 30 types of STIs caused by different pathogens including bacteria, viruses and

parasites that may differ in terms of clinical manifestations [15]. STIs are primarily a health issue prevalent in the young population, both in terms of incidence and health sequelae [12]. Since sexually transmitted diseases occur through sexual intercourse, most social interest, prevention, and academic studies on sexually transmitted diseases are focused on the young population [7]. However, several studies have reported that the elderly also have active sexual desire and their sex life is more active than expected [7]. In South Korea, there are few studies on the prevalence of sexually transmitted diseases in the elderly. In general, there is a prejudice that the elderly do not indulge in sexual activity, directly reducing the possibility of sexually transmitted diseases [7]. Regarding sex, the elderly themselves and society as a whole still view it negatively [1]. Despite the growing awareness of the sex life of the elderly, studies on sexually transmitted diseases are limited in this population of Korea and globally [7], with insufficient related medical policies. Despite the growing discussion around the recognition of sexuality and sexual activity in older age, there is limited research available on rates and patterns of sexual practices and STIs in this demographic [12]. The health burden of STIs, while primarily borne by the young population, is not trivial in the elderly population [16].

Particularly in South Korea, which is already experiencing an aging society, its importance cannot be overlooked, and social empathy and policy support are needed [17]. Therefore, the present study analyzed the epidemiological trends of STIs according to age and sex for those 50 years or older in South Korea from September 2018 to December 2020. The aim of this study was to provide information that can be used to prevent and control STIs, reduce their incidence, and improve sexual health and public health by analyzing the prevalence of STIs in the elderly over 60 years of age.

Materials and Methods

Study patients and design

From September 2018 to December 2020, the data of 59,381 specimens were collected from outpatients across primary and secondary hospitals in South Korea who requested U2Bio (Korea) for molecular biological testing for venereal disease of their samples. The data were analyzed by classifying samples into other (catheter, pus, and tissue), swab, and urine samples.

Ethical approval

The study protocol was approved by the Institutional Review Board of Dankook University (IRB No. 2021-03-056). In this study, patient consent was exempted because the statistics of tests conducted by medical institutions were used for diagnosis and the patient's personal information was not used.

Nucleic acid extraction

The collected clinical samples were stored at -70℃ until DNA isolation by multiplex polymerase chain reaction (PCR) (mPCR). DNA for the mPCR assay was extracted using the ExiPrep™ Dx Bacteria Genomic DNA Kit (Bioneer, Korea) according to the manufacturer's instructions. Concentrations of the extracted DNA samples were measured using the AccuPower® STI8B-Plex Real-Time PCR Kit (Bioneer).

Real-time PCR analysis

Real-time PCR analysis was performed using the AccuPower® STI8B-Plex Real-Time PCR Kit with the Exicycler™ 96 Real-Time Quantitative Thermal Block (Exicycler™ 96, Bioneer), according to the manufacturer's protocol. The amplification protocol comprised one cycle at 95℃ for 5 min and 45 cycles at 95℃ for 5 s and 55℃ for 5 s. The threshold cycle was determined according to the manufacturer's instructions.

Table 1. Target genes and their product sizes for RT-PCR.

Pathogen	Target gene	Product size (bp)
Candida albicans	5S rRNA	101
Chlamydia trachomatis	*ompA*	88
Gardnerella vaginalis	16s rRNA	130
Herpes simplex virus type 1	*us4*	111
Herpes simplex virus type 2	*Gg*	86
Mycoplasma genitalium	*MaPa*	131
Mycoplasma hominis	*Gap*	88
Neisseria gonorrhoeae	16s rRNA	90
Treponema pallidum	*polA*	136
Trichomonas vaginalis	beta tubulin	111
Ureaplasma parvum	*ureC*	138
Ureaplasma urealyticum	*uREc*	125

The presence of the following 12 pathogens was evaluated: *Neisseria gonorrhoeae* (NG), *Chlamydia trachomatis* (CT), *Ureaplasma urealyticum* (UU), *Mycoplasma genitalium* (MG), *Mycoplasma hominis* (MH), *Trichomonas vaginalis* (TV), *Gardnerella vaginalis* (GV), *Candida albicans*, *Ureaplasma parvum* (UP), herpes simplex virus (HSV)-1, and HSV-2.

Statistical analysis

SAS version 9.4 (SAS Institute Inc., USA) was used to perform all statistical analyses including descriptive statistical analysis and frequency analysis. MH and MG DNA detected using real-time PCR was analyzed based on the sex and age of the patients and the type of sample. A p-value of < 0.05 was considered statistically significant.

Results

Statistical analysis by sex

From August 2018 to December 2020, a total of 59,381 STI tests showed 32,312 (54.41%) positive results (Table 2).

Of the 59,381 patients included in this study, 45,833 (77.18%) were male and 23,094 male patients (50.39%) tested positive for STIs. Of the 59,381 patients included, 13,548 (22.82%) were female and 9,218 female patients (68.04%) tested positive for STIs. The test positivity rates in male patients for NG, CT, UU, MG, MH, TV, GV, *Candida*, UP, TP, HSV-1 and HSV-2 were 3.17% (n = 1,454), 8.45% (n = 3,875), 14.73% (n = 6,752), 3.81% (n = 1,746), 4.51% (n = 2,067), 0.17% (n = 78), 28.77% (n = 13,186), 0.83% (n = 381), 12.37% (n = 4,990), 0.04% (n = 19), 0.34% (n = 154) and 0.15% (n = 843), respectively.

Table 2. Age and sex distribution of positivity rates for STIs between 2018 and 2020.

	NG	CT	UU	MG	MH	TV	GV	Candida	UP	TP	HSV-1	HSV-2
Total test (*n*)	59,381	59,381	59,381	59,381	59,381	59,381	59,381	59,381	59,381	59,381	59,381	59,381
Male	45,833	45,833	45,833	45,833	45,833	45,833	45,833	45,833	45,833	45,833	45,833	45,833
Female	13,548	13,548	13,548	13,548	13,548	13,548	13,548	13,548	13,548	13,548	13,548	13,548
Positive (*n*)	1,509	4,228	8,486	1,942	3,273	170	20,718	1,941	10,660	21	174	1,255
Male	1,454	3,875	6,752	1,746	2,067	78	13,186	381	5,670	19	154	843
Female	55	353	1,734	196	1,206	92	7,532	1,560	4,990	2	20	412
Positive rate	2.54%	7.12%	14.29%	3.27%	5.51%	0.29%	34.89%	3.27%	17.95%	0.04%	0.29%	2.11%
Male	3.17%	8.45%	14.73%	3.81%	4.51%	0.17%	28.77%	0.83%	12.37%	0.04%	0.34%	1.84%
Female	0.41%	2.61%	12.80%	1.45%	8.90%	0.68%	55.59%	11.51%	36.83%	0.01%	0.15%	3.04%
Positive average Age (year)	31.1	30.7	37.5	31.8	37.9	42.0	39.1	38.3	39.0	29.0	32.5	39.6
Male	31.2	30.9	37.0	32.2	37.4	44.8	38.3	40.9	38.8	29.2	31.6	36.4
Female	27.8	28.8	39.4	28.2	38.8	39.6	40.4	37.7	39.2	27.0	39.0	46.2
The elderly (50~>70)												
Total test (*n*)	17,102	17,102	17,102	17,102	17,102	17,102	17,102	17,102	17,102	17,102	17,102	17,102
Male	11,722	11,722	11,722	11,722	11,722	11,722	11,722	11,722	11,722	11,722	11,722	11,722
Female	5,380	5,380	5,380	5,380	5,380	5,380	5,380	5,380	5,380	5,380	5,380	5,380
Positive (*n*)	90	287	1,915	110	760	62	5,302	384	2,564	1	15	347
Male	84	234	1,329	99	407	34	3,000	107	1,349	1	8	144
Female	6	53	586	11	353	28	2,302	277	1,215	0	7	203
Positive rate	0.53%	1.68%	11.20%	0.64%	4.44%	0.36%	31.00%	2.25%	14.99%	0.01%	0.09%	2.03%
Male	1.91%	5.31%	30.17%	2.25%	9.24%	0.77%	68.10%	2.43%	30.62%	0.02%	0.18%	3.27%
Female	0.22%	1.92%	21.22%	0.40%	12.78%	1.01%	83.35%	10.03%	43.99%	0.00%	0.25%	7.35%

NG, *Neisseria gonorrhoeae*; CT, *Chlamydia trachomatis*; UU, *Ureaplasma urealyticum*; MG, *Mycoplasma genitalium*; MH, *Mycoplasma hominis*; TV, *Trichomonas vaginalis*; GV, *Gardnerella vaginalis*; UP, *Ureaplasma parvum*; TP, *Treponema pallidum*; HSV, herpes simplex virus.

The positivity rates in female participants for the aforementioned pathogens were 0.41% (n = 55), 2.61% (n = 353), 12.80% (n = 1,734), 1.45% (n = 196), 8.90% (n = 1,206), 0.68% (n = 90), 55.59% (n = 7,532), 11.51% (n = 1,560), 36.83% (n = 74), 0.01% (n = 2), 7.2% (n = 20) and 3.04% (n = 412), respectively (Table 2).

Statistical analysis by the elderly. The elderly is the positivity rate of STI analyzed for the elderly over 50.

In the elderly, the test positivity rates in male participants for NG, CT, UU, MG, MH, TV, GV, *Candida*, UP, TP, HSV-1 and HSV-2 were 1.91% (n = 84), 5.31% (n = 234), 30.17% (n = 1,329), 2.25% (n = 99), 9.24% (n = 407), 0.77% (n = 34), 68.10% (n = 3,000), 2.43% (n = 107), 30.62% (n = 1,349), 0.02% (n = 1), 0.18% (n = 8) and 3.27% (n = 144), respectively. On the other hand, the positivity rates in female participants for the aforementioned pathogens were 0.22% (n = 6), 1.92% (n = 53), 21.22% (n = 586), 0.40% (n = 11), 12.78% (n = 353), 1.01% (n = 28), 83.35% (n = 2,302), 10.03% (n = 277), 43.99% (n = 1,215), 0.00% (n = 0), 0.25% (n = 7) and 7.35% (n = 203), respectively (Table 2).

Statistics by age

Of the patients who were positive for HSV-2, the average age of male participants was 36.41 years and that of female participants was 46.18 years. Among the 12 STIs, the highest average age was 44.83 years for TV in male participants and 46.18 years old for HSV-2 in female participants (Table 2).

In age-specific analysis of *Candida*, the highest positivity rate was observed at 6.42% (184/1792) in female participants aged 50–59 years and at 1.58% (27/1713) in male participants aged >70 years (Fig. 2). In age-specific analysis of HSV-1, the highest positivity rate was observed at 0.19% (3/647) in female participants aged 60–69 years and at 0.08% (3/1220) in male participants aged 60–69 years (Fig. 2). In the age-specific

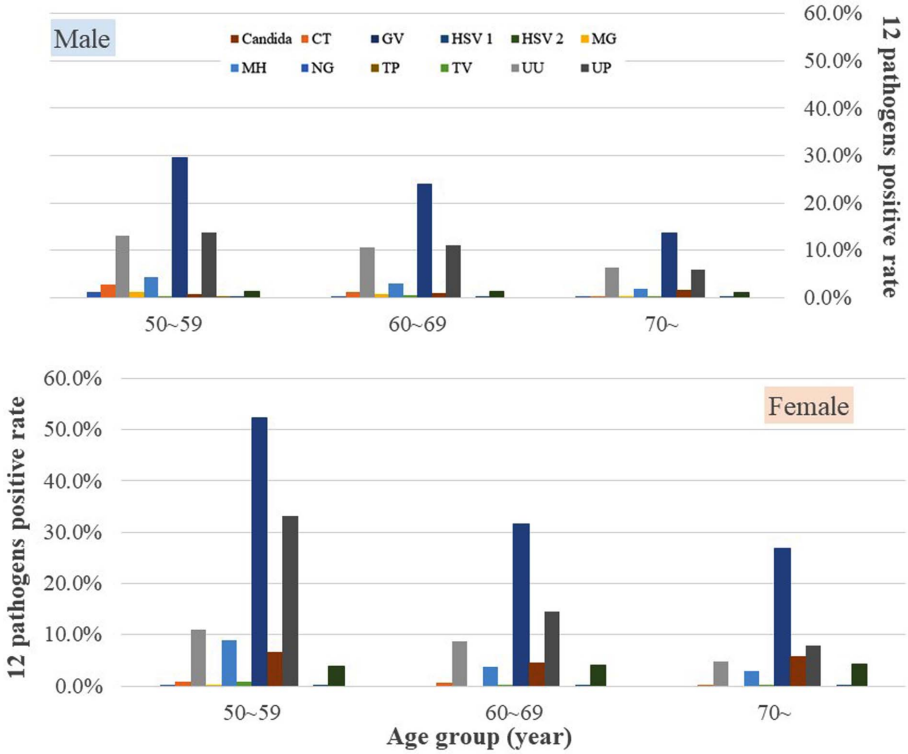

Fig. 1. Positivity rates for STIs according to age and sex in individuals aged 50 years or older. The bar represents 12 pathogens positive rates. The upper bar graph is the male positive rate and the lower bar graph is the female positive rate. Abbreviation: NG, *Neisseria gonorrhoeae*; CT, *Chlamydia trachomatis*; UU, *Ureaplasma urealyticum*; MG, *Mycoplasma genitalium*; MH, *Mycoplasma hominis*; TV, *Trichomonas vaginalis*; GV, *Gardnerella vaginalis*; UP, *Ureaplasma parvum*; TP, *Treponema pallidum*; HSV, Herpes simplex virus.

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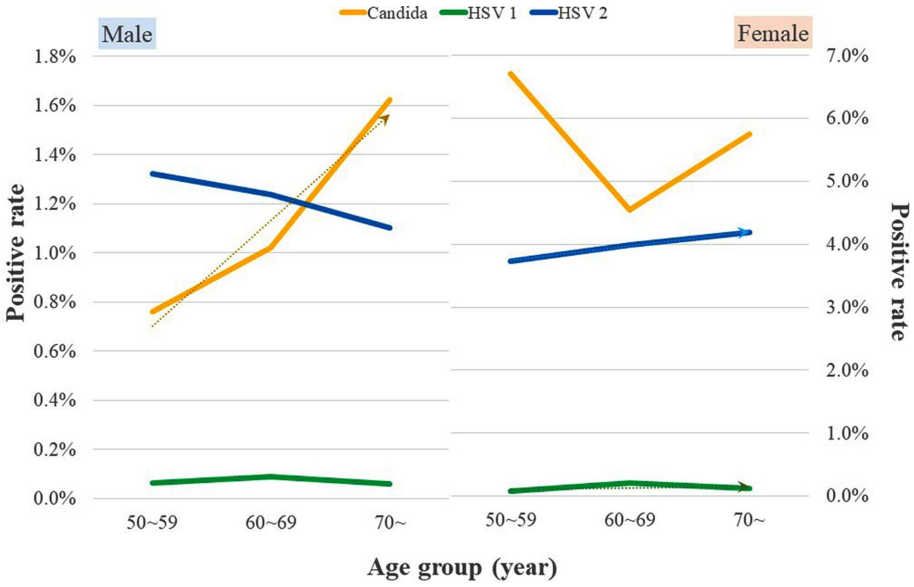

Fig. 2. Positivity rates for *Candida*, HSV-1, and HSV-2 according to age and sex in individuals aged 50 years or older. The yellow line represents Candida positivity rates. The green line represents HSV 1 positivity rates. The blue line represents HSV 2 positivity rates. Abbreviation: HSV, Herpes simplex virus.

analysis of STIs, the highest positivity rate (52.08%, 1,492/2,856) was observed for GV in female participants aged 50–59 years, followed by for UP in female participants aged 50–59 years (32.29%, 925/2,856) (Fig. 1).

In age-specific analysis of HSV-2, the highest positivity rate was observed at 4.05% (37/323) in female participants aged >70 years and at 1.27% (4/2816) in male participants aged 50–59 years (Fig. 1). A distinct infection pattern was observed in different age groups.

Elder female and male participants had higher positivity rates for HSV-2 and *Candida* than younger patients. Taken together, these data suggest trends that HSV-2 and *Candida* positivity rates are age-dependent (Fig. 2).

Statistics by year

The following results are the annual analysis results of STIs from September 2018 to December 2020. In male participants, the positivity rate for STIs was the highest at 39.82% (450/1130) in 2018 and the lowest at 36.48% (2165/5934) in 2020 (Fig. 3). In female participants, the positivity rate for STIs was the highest at 62.30% (319/

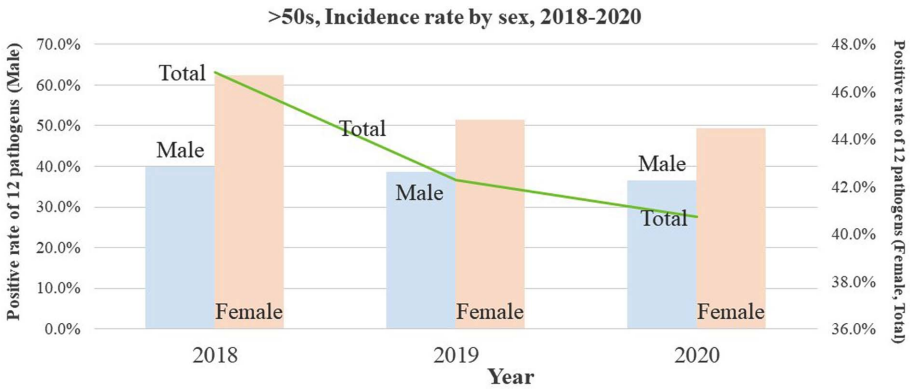

Fig. 3. Positivity rates for STIs during the period from 2018 to 2020. The light blue bar represents 12 pathogens positive rates in male. The light orange bar represents 12 pathogens positive rates in female. The green line represents 12 pathogens positive rates in total.

512) in 2018 and the lowest at 49.33% (1438/2915) in 2020 (Fig. 3). In total, the positivity rate for STIs was the highest at 46.83% (769/1642) in 2018 and the lowest at 40.72% (3603/8849) in 2020 (Fig. 3). The positivity rate for STIs in both male and female participants showed a decreasing trend during the study period.

Discussion

This study analyzed the epidemiological trends of STIs according to age and sex for those aged 50 years or older in South Korea from September 2018 to December 2020.

We found that the positivity rate was the highest for GV in the study participants, followed by that for UP. In particular, the positivity rates for MH and UP were higher in female participants than in male participants. The positivity rate for TP was very low in the female participants. During the study period, the positivity rate for HSV-2 increased in the female participants and that for *Candida* increased in the male participants. The results showed that the positivity rate for STIs varies according to age and sex, and a difference was observed in the average age of the positivity rate according to the type of STIs.

According to the U.S. Centers for Disease Control and Prevention, the incidence of STIs has more than doubled over the past decade among U.S. adults over the age of 65 years. The incidence of TP, CT, and NG infections has been reported to have increased [19]. The World Health Organization reported that the prevalence of MG infection is 1–3% in the general population with an active sex life and that of MH and UU is 20–50% and 40–80%, respectively, in asymptomatic female patients with an active sex life [20]. The Centers for Disease Control and Prevention reported CT as the most common bacterial STI in the United States, with the highest incidence in young female patients [18]. In the elderly, the incidence of gonorrhea is highest, followed by that of vaginitis, syphilis, and genital herpes [1]. According to a 2017 STI survey conducted by the Korea Centers for Disease Control and Prevention, the increase was found to have stopped [7]. Our results also showed that the STI positivity rate in both male and female participants decreased during the study period.

According to studies conducted in Western society, where signs of aging present earlier than in Korea, the incidence of venereal diseases in the elderly has increased with aging [7]. These results are related not only to a decrease in T-cell activity and immunoglobulin production with age progression [7] but also to weakening of various aging-related immune functions [7, 21], leading to aging tissue becoming more vulnerable to HIV and other STIs [7].

Nucleic Acid Amplification Test (NAAT) is a diagnostic tool that does not allow antimicrobial sensitivity evaluation [22]. However, to improve screening of resistant gonorrhea strains, a new molecular test method using PCR, single-nucleotide polymorphism, or a base sequence to identify resistance has been studied [22], and real-time PCR is currently being performed for STI detection. In this study, real-time PCR was also performed to detect STIs, and as a result of the analysis, it was observed that up to 9 STIs were present in duplicates as a result of duplicate infection.

This study has some limitations. First, it was difficult to understand the infection trend of STIs because 3 years can be considered relatively short. Second, it was difficult to obtain a history of venereal diseases from the elderly because they were reluctant to discuss information related to venereal diseases. Lastly, the sample data were anonymously processed and the patient's residence and geographic location could not be identified. Despite these restrictions, we found a clear pattern of infection in the elderly and according to sex. Our findings are expected to be used as baseline data for future research, education, and prevention of STIs in the elderly population.

In future studies, long-term research on the prevalence of STIs in the elderly and overlapping infections is needed, and continuous interest and monitoring is required due to rapid population aging.

Abbreviations

mPCR, multiplex polymerase chain reaction; PCR, polymerase chain reaction; STIs, sexually transmitted infections; NG, *Neisseria gonorrhoeae*; CT, *Chlamydia trachomatis*; UU, *Ureaplasma urealyticum*; MG, *Mycoplasma genitalium*; MH, *Mycoplasma hominis*; TV, *Trichomonas vaginalis*; GV, *Gardnerella vaginalis*; UP, *Ureaplasma parvum*; HSV-1, and HSV-2, herpes simplex virus; NAAT, Nucleic Acid Amplification Test; HIV, human immunodeficiency virus.

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Conflict of Interest

The authors have no financial conflicts of interest to declare.

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