Professional Status of Infectious Disease Specialists in Korea: A Nationwide Cross-sectional Study

Bongyoung Kim
Hanyang University College of Medicine
Byung Wook Eun
Eulji University Eulji General Hospital
Eunjung Lee
Soonchunhyang University Seoul Hospital, Soonchunhyang University College of Medicine
Tae Hyong Kim
Soonchunhyang University Seoul Hospital, Soonchunhyang University College of Medicine
Suyeon Park
Soonchunhyang University Seoul Hospital
Se Yoon Park (sypark@schmc.ac.kr)
Soonchunhyang University Seoul Hospital, Soonchunhyang University College of Medicine

Research Article

Keywords: Infectious disease specialists, Professional development, Workforce, Adult, Pediatrics

Posted Date: September 20th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-739340/v1

Abstract

Backgrounds: Emergence of more antimicrobial-resistant pathogens and repeated occurrence of infectious disease (ID) outbreaks highlight the importance of ID specialists. This study aimed to assess the working status of ID specialists and identify problems faced by ID professionals in Korea.

Methods: This was a nationwide cross-sectional study in Korea. An online-based survey was conducted over 11 days (from December 17–27, 2020), targeting all active adult (n=281) and pediatric (n=71) ID specialists in Korea (total=352). Questions regarding the practice areas of the specialists were divided into five categories: (1) clinical practices of outpatient care, inpatient care, and consultations; (2) infection control; (3) antibiotic stewardship; (4) research; and (5) education and training. We investigated the weekly time-use patterns for these areas of practice.

Results: A total of 144/281 (51.2%) adult ID specialists and 51/71 (71.8%) pediatric ID specialists participated in the survey. Among them, 144 (73.8%) respondents were involved in all practice categories investigated. The most common practice area was outpatient service (93.8%), followed by consultation (91.3%) and inpatient service (87.7%). Specialists worked a median of 57 (interquartile range: 50–65) hours weekly: patient care, 29 (14–37) hours; research 11 (5–19) hours; infection control 4 (2–10) hours; antibiotic stewardship, 3 (1–5) hours; and education/training, 2 (2–6) hours.

Conclusions: ID specialists in Korea simultaneously undertake multiple tasks and work long hours, highlighting the need for training and employing more ID specialists.

Background

The current roles of infectious disease (ID) specialists are diverse, including diagnosis and treatment of various IDs, infection control, antibiotic stewardship, response to disease outbreaks, and vaccination. The social need for ID specialists is higher than ever because of the emergence of antimicrobial-resistant pathogens and recurrent outbreaks caused by emerging IDs. In particular, the spread of coronavirus disease (COVID-19) has affected more than 150 million people worldwide—including more than 128,000 people in Korea—since January 2020. This has created demand for ID specialists [1, 2]. Unfortunately, the number of ID specialists in several countries is suboptimal, and the number of applicants into ID training programs is insufficient [3–6].

In 2019, there were 242 active ID specialists in Korea, representing 0.42/100,000 of the population. One ID specialist in Korea was in charge of 342 beds, which was higher than that in other countries, including the US, Europe, and Brazil [3, 4, 6, 7]. The shortage of ID specialists can lead to unfavorable public health outcomes, including the emergence of more antibiotic-resistant bacteria [8, 9] and poor response to ID epidemics [10]. Additionally, the shortage can lead to long work hours and low job satisfaction among ID specialists, leading to few applicants for ID specialist courses [11, 12].

This study aimed to analyze the areas of practice and time spent in each area among ID specialists in Korea and to identify problems encountered by and propose solutions from the perspective of ID specialists.

Methods

Study design and population

A survey was conducted over 11 days, from December 17–27 2020, targeting all adult and pediatric ID specialists (N = 392) in Korea. At the time of the survey, 40 experts were either retired or had passed away and were excluded. In total, 352 ID specialists (281 adult ID physicians and 71 pediatric ID specialists) were identified as potential participants in the survey. An online-based survey link was forwarded to them via text messages and e-mails by the office of the Korean Society of Infectious Diseases and the Korean Society of Paediatric Infectious Diseases. To encourage participation, we sent a reminder on the fifth day. The responders were anonymized, and only one response from each participant was accepted. The study protocol was approved by the appropriate Institutional Review Board (IRB: No 2020-05-016). Online written informed consent was obtained from all participants.

Survey items

Survey items included baseline characteristics of respondents (age, sex, marital status, number of children, and academic degree), type of working institution, job title, and practice area. Questions regarding the practice areas of ID specialists were divided into five categories: (1) clinical practices of outpatient care, inpatient care, and consultations; (2) infection control; (3) antibiotic stewardship; (4) research; and (5) education and training. All practices, except research, were based on activities during the 1 year before the survey period (December 2019–November 2020). Activities related to research were based on the 3 years before the survey period (December 2017–November 2020). We determined that the sum of the weights for each expert's clinical and research fields was 100%. Items related to job satisfaction were surveyed using a 5-point Likert scale. To determine compensation, we investigated vacation benefits and average annual income.

Weekly patterns of time use

Respondents selected 1 week (from Monday to Sunday) between November 2, 2020 and December 6, 2020, and chose activities they performed from 6 am to midnight. One of the nine activities was entered on an hourly basis: (1) outpatient care; (2) consultation; (3) inpatient care/rounding; (4) education/training; (5) research; (6) infection control; (7) antibiotic stewardship; (8) volunteer work; and (9) participation in conferences (except infection control meetings). Additionally, start and finish times for work from Monday to Saturday were noted to investigate working hours in a week.

Statistical analysis

SPSS version 24.0 for Windows (IBM; Armonk, NY, USA) was used for statistical analysis. Chi-square or Fisher's exact tests were used to compare categorical variables. Continuous variables were compared using the Student's *t*-test or Mann–Whitney *U*-test, as appropriate. Variables with P-values < 0.05 were considered statistically significant.

Results

Demographic characteristics of respondents

Overall, 195 (55.4%) ID specialists (144 adult ID specialists and 51 pediatric ID specialists) completed the survey. Detailed baseline characteristics are shown in Table 1. Most respondents (192, 98.5%) worked in a clinical position. Most ID specialists (181, 92.8%) worked in acute-care referral hospitals, with two thirds of respondents (127, 65.1%) working in metropolitan areas (Supplementary Table S1).

Table 1
Main characteristics of infectious disease specialists

Characteristics	Total ID specialists (N = 195)	Adult ID specialists (N = 144)	Pediatric ID specialists (N = 51)	P value
Female sex	109 (55.9)	82 (56.9)	27 (52.9)	0.63
Age, median (IQR) (years)	41 (38–47)	41 (37–46)	42 (39–50)	0.08
Married	105 (79.5)	112 (77.8)	43 (84.3)	0.42
Have children	141 (72.3)	98 (68.1)	43 (84.3)	0.03
Working field				0.42
Clinical area	192 (98.5)	142 (98.6)	50 (98.0)	
Non-clinical area[1]	3 (1.5)	2 (1.4)	1 (2.0)	
Title				
Infection Control Chair	60 (30.8)	55 (38.2)	5 (9.8)	0.003
Director of ID department	68 (34.9)	59 (41.0)	9 (17.6)	< 0.001
Degree of education				0.06
Bachelor	9 (4.6)	5 (3.5)	4 (7.8)	
Master	60 (30.8)	50 (34.7)	10 (19.6)	
Doctor	126 (64.6)	89 (61.8)	37 (72.5)	
Type of hospital				0.009
Referral hospital	181 (92.8)	139 (96.5)	42 (82.4)	
Non-referral hospital	3 (1.5)	1 (0.7)	2 (3.9)	
Local clinic	5 (2.6)	1 (0.7)	4 (7.8)	

Note: Data are numbers (%) of patients, unless otherwise indicated.

ID, infectious disease; IQR, interquartile range.

[1] Non-clinical areas included pharmaceutical companies (n = 2) and a life science company (n = 1).

[2] Others included pharmaceutical companies (n = 2), life science companies (n = 1), laboratories (n = 1), and medical schools (n = 1).

Characteristics	Total ID specialists (N = 195)	Adult ID specialists (N = 144)	Pediatric ID specialists (N = 51)	P value
Long-term care hospital	1 (0.5)	1 (0.7)	0	
Others[2]	5 (2.6)	2 (1.4)	3 (5.9)	
Practice areas				
Inpatient service	171 (87.7)	129 (89.6)	42 (82.4)	0.22
Outpatient service	183 (93.8)	135 (93.8)	48 (94.1)	1.00
Consultation	178 (91.3)	135 (93.8)	43 (84.3)	0.048
Infection control	168 (86.2)	130 (90.3)	38 (74.5)	0.009
Antibiotic stewardship	168 (86.2)	130 (90.3)	38 (74.5)	0.009
Education	170 (87.2)	128 (88.9)	42 (82.4)	0.33
Research	164 (84.1)	125 (86.8)	39 (76.5)	0.12

Note: Data are numbers (%) of patients, unless otherwise indicated.

ID, infectious disease; IQR, interquartile range.

[1] Non-clinical areas included pharmaceutical companies (n = 2) and a life science company (n = 1).

[2] Others included pharmaceutical companies (n = 2), life science companies (n = 1), laboratories (n = 1), and medical schools (n = 1).

In total, 144 (73.8%) respondents were involved in all the following practices: inpatient and outpatient care, consultation, infection control, antibiotic stewardship, research, and education/training. Adult ID specialists were more involved in the practices of consultation, infection control, antibiotic stewardship, and participation in the public sector (Table 1). The major areas of specialization were bacterial/viral infections and infection control (Fig. 1A).

Clinical practices of the respondents

The most common area of clinical practice was bacterial/viral diseases, followed by fever of unknown origin, and immunocompromised infection (Fig. 1B, Table 2). HIV/AIDS, parasitic infection, immunocompromised infection, and occupational exposure were more common among adult ID specialists. In contrast, pediatric ID specialists were more often involved in vaccination/travel clinics. The majority of ID specialists had 6–10 hospitalized patients per day (48.5%); 41.9% of adult ID specialists had 6–10 hospitalized patients, while 61.9% of pediatric ID specialists had fewer than five hospitalized patients per day. The number of patients per outpatient clinic was similar between adult and pediatric ID specialists, with the majority having 11–20 patients per section. A large percentage of adult ID specialists

(29.6%) performed > 20 formal consultations per day, while the majority of pediatric ID specialists (76.7%) had < 5 formal consultations per day. The number of informal consultations per day was similar between the two groups. Consultations were conducted without assistive personnel for 73.0% of the respondents. Twenty-three percent of adult ID specialists participated in pediatric ID consultation, and 7.0% of pediatric ID specialists participated in adult ID consultation.

Table 2
Clinical practices of respondents

Characteristics	Total ID specialists (N = 192)	Adult ID specialists (N = 141)	Pediatric ID specialists (N = 51)	P value
Clinical practices, median (IQR)				
HIV/AIDS	5 (0–10)	5 (5–15)	0 (0–0)	< 0.001
Bacterial, viral diseases	40 (30–50)	40 (25–50)	40 (30–60)	0.59
Fever of unknown origin	10 (5–15)	10 (5–15)	10 (5–15)	0.81
TB/NTM	5 (5–10)	10 (5–10)	5 (3.5–10)	0.048
Viral hepatitis	0 (0–5)	0 (0–5)	1.5 (0–5)	0.21
Parasitic infection	1 (0–5)	2 (0–5)	0 (0–1)	< 0.001
Vaccination, travel clinic	10 (5–10)	5 (5–10)	15 (10–20)	< 0.001
Immunocompromised diseases	5 (0–10)	5 (0–10)	0 (0–10)	0.009
Occupational exposure to infectious diseases	5 (3–10)	5 (5–10)	1.5 (0–9.3)	< 0.001
Existence of residents in departments	137/171 (80.1)	109/129 (84.5)	28/42 (66.7)	0.01
Number of residents, median (IQR)	1.0 (0.5–2.0)	1 (0.5–2.0)	0.58 (0.50–1.38)	0.01
Number of outpatient clinic consultations per week, median (IQR)	3 (3–4)	3 (2–4)	4 (4–5)	< 0.001
Daily number of hospitalized patients				< 0.001
Less than 5	51/171 (29.8)	30/129 (23.3)	26/42 (61.9)	
6–10	83/171 (48.5)	54/129 (41.9)	11/42 (26.2)	

Note: Data are numbers (%) of patients, unless otherwise indicated.

ID, infectious disease; IQR, interquartile range; HIV, human immunodeficiency virus; AIDS, acquired immune deficiency syndrome; TB, tuberculosis; NTM, nontuberculous mycobacteria.

[1] Consultation via formal paperwork.

[2] Consultation via informal communication (e.g., telephone, text messages).

Characteristics	Total ID specialists (N = 192)	Adult ID specialists (N = 141)	Pediatric ID specialists (N = 51)	P value
11–20	46/171 (26.9)	39/129 (30.2)	5/42 (11.9)	
>20	1/171 (0.01)	5/129 (3.9	0	
Number of outpatients per clinic				0.35
Less than 10	51/183 (27.9)	34/135 (25.2)	17/48 (35.4)	
11–20	83/183 (45.4)	66/135 (48.9)	17/48 (35.4)	
21–30	36/183 (19.7)	26/135 (19.3)	10/48 (20.8)	
>30	11/183 (6.0)	7/135 (5.2)	4/48 (8.3)	
Number of formal consultations[1]				< 0.001
Less than 5	46/178 (25.8)	13/135 (9.6)	33/43 (76.7)	
6–10	32/178 (18.0)	30/135 (22.2)	2/43 (4.7)	
11–20	55/178 (30.9)	5/135 (3.7)	4/43 (9.3)	
>20	44/178 (24.7)	40/135 (29.6)	4/43 (9.3)	
Number of informal consultations[2]				0.12
Less than 5	131/178 (73.6)	97/135 (71.9)	34/43 (79.1)	
6–10	19/178 (10.7)	15/135 (11.1)	4/43 (9.3)	
11–20	10/178 (5.6)	7/135 (5.2)	3/43 (7.0)	
>20	17/178 (9.6)	15/135 (11.1)	2/43 (4.7)	
Note: Data are numbers (%) of patients, unless otherwise indicated.				
ID, infectious disease; IQR, interquartile range; HIV, human immunodeficiency virus; AIDS, acquired immune deficiency syndrome; TB, tuberculosis; NTM, nontuberculous mycobacteria.				
[1] Consultation via formal paperwork.				
[2] Consultation via informal communication (e.g., telephone, text messages).				

Among 183 respondents, 131 (71.6%) answered that their institution took care of hospitalized patients with COVID-19. Among 131 respondents, 105 (80.2%) participated in COVID-19 care (Supplementary Table S2).

Infection control and antibiotic stewardship

Participation in infection control and antibiotic stewardship activities was more common among adult ID specialists (90.3% vs 74.5%, P = 0.009) than among pediatric ID specialists (Table 1). Among 183 respondents participating in infection control activities, 96 (52.5%) had been an infection control team chair, with a median period of 5 years (interquartile range [IQR]: 2–10 years) (Table 3). The commonest infection control activities were attending infection control meetings (97.0%), responding to emerging ID (91.1%), and responding to unexpected exposure to transmissible diseases (88.7%). The most common antibiotic stewardship activities were review and approval of restricted antibiotics (81.5%), active monitoring of antibiotic prescription (51.8%), and review of surgical prophylactic antibiotics (42.8%).

Table 3
Characteristics of infection control and antibiotic stewardship activities

Characteristics	Total ID specialists (N = 195)	Adult ID specialists (N = 144)	Pediatric ID specialists (N = 51)	P value
Experience as infection control team chair	96/183 (52.5)	83/135 (61.6)	13/48 (27.1)	< 0.001
Total duration as infection control team chair, median (IQR)	5 (2–10)	5 (3–10)	1 (1–2.5)	< 0.001
Participation in infection control conference	180/183 (98.4)	134/135 (99.3)	46/48 (95.8)	0.17
Infection control activities				
Infection control rounding	121/168 (72.0)	94/130 (72.3)	27/38 (71.1)	1.00
Infection control meeting	163/168 (97.0)	128/130 (98.5)	35/38 (92.1)	0.077
Review for cases of healthcare-associated infection in ICU (KONIS)[1]	89/168 (53.0)	72/130 (55.4)	17/38 (44.7)	0.27
Response to emerging infectious diseases	153/168 (91.1)	119/130 (91.5)	34/38 (89.5)	0.74
Response to exposure to infectious diseases	149/168 (88.7)	122/130 (93.8)	27/38 (71.1)	< 0.001
Infection control campaign	124/168 (73.8)	99/130 (76.2)	25/38 (65.8)	0.21
Antibiotic stewardship activities				
Review and approval of designated antibiotics under restrictive measures	137/168 (81.5)	112/130 (86.2)	25/38 (65.8)	1.00
Review of surgical prophylactic antibiotics	72/168 (42.9)	59/130 (45.4)	13/38 (34.2)	1.00
Review of the pharmacokinetics of antibiotics	38/168 (22.6)	33/130 (25.4)	5/38 (13.2)	0.47
Review of antibiotic use in patients with specific infectious diseases	39/168 (23.2)	26/130 (20.0)	13/38 (34.2)	0.007

Note: Data are numbers (%) of patients, unless otherwise indicated.

ID, infectious disease; IQR, interquartile range; ICU, intensive care unit.

[1] KONIS (Korean Healthcare-associated Surveillance System) is a nationwide surveillance network for healthcare-associated infection using standard methods.

Characteristics	Total ID specialists (N = 195)	Adult ID specialists (N = 144)	Pediatric ID specialists (N = 51)	P value
Review of antibiotic use in specific departments	47/168 (28.0)	33/130 (25.4)	14/38 (36.8)	0.01
Review of antibiotic use in patients with isolation of pathogens from specific samples	67/168 (39.9)	52/130 (40.0)	15/38 (39.5)	0.28
Monitoring of antibiotic prescription	87/168 (51.8)	68/130 (52.3)	19/38 (50.0)	0.19
Note: Data are numbers (%) of patients, unless otherwise indicated.				
ID, infectious disease; IQR, interquartile range; ICU, intensive care unit.				
[1] KONIS (Korean Healthcare-associated Surveillance System) is a nationwide surveillance network for healthcare-associated infection using standard methods.				

Research

Overall, 164 (84.1%) respondents were involved in research, including clinical research (88.4%), basic research (19.2%), and research in public health/epidemiology (18.0%) (Supplementary Table S3). The main research interests of adult ID specialists were bacterial/viral infections (78.5%), infection control (40.8%), and antibiotic stewardship (27.7%), while those of pediatric ID specialists were bacterial/viral infections (85.7%), vaccination (59.5%), and immunocompromised patients (23.8%). Most respondents (90.2%) had experience of publication in Science Citation Index/Expanded (SCI/E) journals, and the median number of publications as the first or corresponding author to SCI/E journals within 3 years was three (IQR: 2–6). Of the ID specialists involved in research, 59.8% had acquired research funds. Detailed response results according to position (professor, clinician, or non-clinical position) are shown in Supplementary Table S4.

Education and training

Overall, 153 respondents (78.5%) were involved in education and training. The contents of education/training included ID (93.5%), antibiotics (75.9%), infection control (75.9%), and vaccination (58.2%) (Supplementary Table S5).

Weekly patterns of time use

In total, 153 (43.5%) ID specialists reported weekly patterns of time use. Detailed results are shown in Table 4. Weekly working hours were longer among adult ID specialists than among pediatric ID specialists (median: 59.0 vs 55.0 h from Monday to Friday, $P = 0.005$; median: 62.0 vs 57.5 h from Monday to Saturday, $P = 0.015$). Among activities, ID specialists spent the longest hours on patient care, especially outpatient services (median: 12 h, IQR: 7–16 h), followed by inpatient services (median: 10 h, IQR: 6–13) and consultation (median: 8 h, IQR: 4–14 h), which together resulted in a median of 29 h (IQR:

14–37 h) each week. Adult ID specialists spent more time on consultation, infection control, and antibiotic stewardship, while pediatric ID specialists spent more time on outpatient services, research, and volunteer medical services.

Table 4
Weekly patterns of time use

Characteristics	Total ID specialists (N = 153)	Adult ID specialists (N = 110)	Pediatric ID specialists (N = 43)	P value
Weekly working hours (Monday to Friday)	57 (50–65.1)	59 (52.5–67)	55 (47–60)	0.005
Weekly working hours (Monday to Saturday)	60.5 (53.5–71)	62 (55–73.5)	57.5 (49.5–66)	0.015
Activities				
Outpatient service	12 (7–16)	10 (6–15)	16 (12–19.75)	< 0.001
Inpatient service, patient care	10 (6–13)	10 (6–13)	9 (6.5–12.5)	0.15
Consultation	8 (4–14)	10 (6–15)	3 (2–6.75)	< 0.001
Research	11 (5–19)	10 (4–18)	14 (7–24.25)	0.036
Infection control	4 (2–10)	4 (3–11)	3 (1–7)	0.007
Antibiotic stewardship	3 (1–5)	3 (2–5)	2 (1–4)	0.01
Education/training	3 (2–6)	3 (2–5)	2 (4–7)	0.08
Conference	2 (3–7)	3.5 (2–8)	1.5 (3–6)	0.18
Volunteer medical service	1 (1–1)	1 (1–1)	1.5 (1–7.25)	0.03
Note: Data are median and interquartile range.				
ID, infectious disease.				

Job satisfaction and compensations

Among ID specialists, 37.4% (73) responded that they were satisfied with their current job. The percentage of respondents who answered positively to the question of whether they would select the ID major if they had to choose again was higher for the adult ID specialist group than for the pediatric ID specialist group ($P = 0.004$) (Supplementary Table S6). Most ID specialists spent 5–10 days of vacation per year (52.5%), earning 4,479–89,572 USD per year (46.2%) (Supplementary Table S7). Respondents answered that the

ideal number of hospital beds covered by one adult and pediatric ID specialist was 151–200 beds (30.8%) and 401–500 beds (30.3%), respectively (Supplementary Table S8).

Main problems and complaints

To foster ID specialty in Korea, ID specialists suggested that they should be appropriately compensated, especially for infection control or antibiotic stewardship activities (n = 91, 37.0%), wherein secure ID specialists were required (n = 61, 24.8%). Respondents also suggested that the opinions of ID specialists should be respected and reflected in government policies (n = 34, 13.8%) (Supplementary Table S9).

Discussion

In this study, we observed that ID specialists in Korea spent most of their time caring for patients with ID, although, they also participated in infection control, antibiotic stewardship, and education/training. Their weekly working hours (> 60 h) exceeded the legal limit of 52 h. Accordingly, the demands of ID specialists focused on appropriate compensation for their work and employment of more ID specialists.

Among the various roles of ID specialists, patient care is essential. Involvement of ID specialists in the care of patients with IDs results in reduced hospitalization rates, mortality, and healthcare costs [13]. Additionally, interventions conducted by ID specialists have a positive effect in reducing patient mortality and hospital stay [14–16]. According to the present study, most ID specialists were engaged in several patient care activities, including inpatient and outpatient care and consultations in the same week. Furthermore, about one fourth of adult ID specialists were engaged in pediatric ID consultations. A possible explanation for the diverse clinical responsibilities may be the low staffing numbers of ID specialists.

Following the outbreak of the Middle East respiratory syndrome in medical institutions in 2015, the medical law in Korea was revised to strengthen the legal regulations for infection control personnel [17]. Furthermore, since 2017, the Ministry of Health and Welfare has reimbursed medical institutions for infection prevention and management measures. However, for reimbursement, a hospital requires an ID doctor in charge of 300 hospital beds and for the doctors in charge of infection control to perform infection control duties for at least 20 h/week and complete 16 h of training related to infection control [17]. Consequently, infection control rounding has become a mandatory activity for ID specialists in Korean hospitals [18]. However, the pattern of weekly time use among ID specialists shows limited room for additional infection control activities. Despite this workload, the majority of ID specialists had to undertake multiple responsibilities, including being director of infection control. This results in insufficient time for infection control activities.

Participation in antibiotic stewardship mainly focused on approval for specific and restricted antibiotics [19]. Like other activities related to the ID specialty, antibiotic stewardship in Korean hospitals is mostly conducted by one or two ID specialists [19]. However, for more comprehensive ID activities, approximately 3.01 personnel are required per 1,000 beds [20]. An increase in the emergence of antimicrobial-resistant

pathogens emphasizes the importance of appropriate antibiotic use and antibiotic stewardship programs [21]. Securing ID specialists is necessary to implement and expand the antibiotic stewardship program in Korean hospitals.

According to our results, ID specialists devoted similar amounts of time to research and patient care. This may be because a large proportion of ID specialists were stationed at university-affiliated hospitals. However, they were unlikely to receive research funds and perform basic research in their early careers. Given that a rapid response to emerging infectious and re-emerging diseases will be enhanced by a strong research base [22] promoting ID research is necessary to strengthen public health control efforts. Besides expanding ID research funds, emphasizing basic research in ID training courses should be considered [23]. Promoting research in ID will most likely attract more applicants for training in ID specialties [24].

Unfortunately, the actual time that ID specialists allocated to education and training activities was 3 h per week. This time duration may be insufficient for providing adequate educational opportunities. Because of the increase in emerging IDs and IDs caused by antimicrobial-resistant pathogens, it is important to educate students/trainees and healthcare personnel on infection control. An adequately staffed ID workforce is necessary to achieve this.

ID specialists worked an average of 60.5 h per week. Given that more than half of the respondents were women and more than two thirds were married and had children, one can expect that it is difficult for ID specialists to achieve an appropriate work-life balance. In our previous survey [11], only 8.7% of ID specialists responded to having a work-life balance. In this study, working hours were based on work and leave hours. Only 2.6% answered that they did not carry work at home. It is known that long working hours can lead to health risks, including an increased risk of stroke [25].

Interestingly, this study revealed differences between adult and pediatric ID specialists. Adult ID specialists had a greater role in consultation, infection control, and antibiotic stewardship than pediatric ID specialists. Although, the satisfaction level was similar between the two types of experts, pediatric ID specialists responded more positively to reselecting the same major. It is estimated that more weekly working hours for adult ID specialists may be the cause of the reselection factor; however, further studies should be conducted in this regard.

This study had a few limitations. First, clinical microbiologists who can be classified as ID specialists were not included in the study. Second, the survey was conducted in the middle of the COVID-19 pandemic, which may have affected the operational times of ID specialists.

Conclusions

In conclusion, we identified areas of practice and patterns of time use among adult and pediatric ID specialists in Korea. Most experts were in charge of all necessary areas (including treatment, education, research, infection control, and antibiotic stewardship) in medical institutions with limited resources. It is

expected that these problems can be solved by appropriately compensating individuals and medical institutions for their invisible activities (including infection control and antibiotic stewardship) and by securing additional human resources.

Abbreviations

ID: infectious diseases;

COVID-19: coronavirus disease 2019; I

QR: interquartile range.

Declarations

Ethics approval and consent to participate

This study followed the ethical standards of the Helsinki declaration of 2008. This study was approved by the Institutional Review Board (IRB) and Ethic Committee of Soonchunhyang University Seoul Hospital (IRB No. 2020-05-016). Online written informed consent was obtained from all participants.

Consent for publication

Not applicable: this manuscript does not contain any personal data from participants.

Availability of data and materials

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Completing interest

The authors declare that they have no completing interests.

Funding

This work was supported by a National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (grant No. 2019R1G1A1099867) and Soonchunhyang University Research Fund. The funders had no role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Author's contributions

SY Park developed the study design. B Kim, BW Eun, and SY Park were responsible for data collection. B Kim, BW Eun, S Park, E Lee, TH Kim, and SY Park assisted with data interpretation. SY Park performed the literature search and wrote the first draft of the paper. SY Park obtained funding for the study. B Kim, BW Eun, S Park, E Lee, TH Kim, and SY Park have critically read and commented on draft versions of the report. All authors have read and approved the final manuscript.

Acknowledgments

We sincerely thank the infectious disease specialists for dedicating their time to make this project possible. The authors are grateful to the Korean Society of Infectious Diseases and the Korean Society of Pediatric Infectious Diseases for identifying target participants for the survey.

References

1. World Health Organization: **Coronavirus disease (COVID-19) Weekly Epidemiological Update and Weekly Operational Update**. 2020.
2. Korean Centers for Disease Control and Prevention: **Weekly Updates for Countries with Major Outbreaks**.
3. Jang Y, Park SY, Kim B, Lee E, Lee S, Son HJ, Park JW, Yu SN, Kim T, Jeon MH *et al*: **Infectious Diseases Physician Workforce in Korea**. *J Korean Med Sci* 2020, **35**(49):e428.
4. Walensky RP, McQuillen DP, Shahbazi S, Goodson JD: **Where Is the ID in COVID-19?** *Ann Intern Med* 2020, **173**(7):587–589.
5. Hussaini SMQ: **Dearth of infectious diseases physicians as the USA faces a global pandemic**. *Lancet Infect Dis* 2020, **20**(6):648–649.
6. Dickstein Y, Nir-Paz R, Pulcini C, Cookson B, Beovic B, Tacconelli E, Nathwani D, Vatcheva-Dobrevska R, Rodriguez-Bano J, Hell M *et al*: **Staffing for infectious diseases, clinical microbiology and infection control in hospitals in 2015: results of an ESCMID member survey**. *Clin Microbiol Infect* 2016, **22**(9):812 e819-812 e817.
7. Cassenote AJ, Scheffer MC, Segurado AA: **Brazilian infectious diseases specialists: who and where are they?** *Braz J Infect Dis* 2016, **20**(2):141–148.
8. Hwang H, Kim B: **Impact of an infectious diseases specialist-led antimicrobial stewardship programmes on antibiotic use and antimicrobial resistance in a large Korean hospital**. *Sci Rep* 2018, **8**(1):14757.
9. Kim YC, Kim EJ, Heo JY, Choi YH, Ahn JY, Jeong SJ, Ku NS, Choi JY, Yeom JS, Kim HY: **Impact of an Infectious Disease Specialist on an Antimicrobial Stewardship Program at a Resource-Limited, Non-Academic Community Hospital in Korea**. *J Clin Med* 2019, **8**(9).

10. Kim B, Park SY, Jung DS, Jung SI, Oh WS, Kim SW, Peck KR, Chang HH, Korean Society of Infectious D: **What should we prepare for the next coronavirus disease 2019 outbreak? A survey on the opinions of infectious diseases specialists in South Korea**. *Korean J Intern Med* 2020, **35**(6):1270–1278.
11. Park SY, Kim B, Jung DS, Jung SI, Oh WS, Kim SW, Peck KR, Chang HH, Korean Society of Infectious D: **Psychological distress among infectious disease physicians during the response to the COVID-19 outbreak in the Republic of Korea**. *BMC Public Health* 2020, **20**(1):1811.
12. Nori P, Bartash R, Cowman K, Dackis M, Pirofski LA: **Is Burnout Infectious? Understanding Drivers of Burnout and Job Satisfaction Among Academic Infectious Diseases Physicians**. *Open Forum Infect Dis* 2019, **6**(4):ofz092.
13. Brouqui P, Jouve E, Romain F, Sambuc R, Raoult D: **Are infectious disease doctors better at caring for infectious diseases than other specialists?** *Clin Infect Dis* 2014, **58**(10):1486–1487.
14. Schmitt S, McQuillen DP, Nahass R, Martinelli L, Rubin M, Schwebke K, Petrak R, Ritter JT, Chansolme D, Slama T *et al*: **Infectious diseases specialty intervention is associated with decreased mortality and lower healthcare costs**. *Clin Infect Dis* 2014, **58**(1):22–28.
15. Schmitt S, MacIntyre AT, Bleasdale SC, Ritter JT, Nelson SB, Berbari EF, Burdette SD, Hewlett A, Miles M, Robinson PA *et al*: **Early Infectious Diseases Specialty Intervention Is Associated With Shorter Hospital Stays and Lower Readmission Rates: A Retrospective Cohort Study**. *Clin Infect Dis* 2019, **68**(2):239–246.
16. Rieg S, Kupper MF: **Infectious diseases consultations can make the difference: a brief review and a plea for more infectious diseases specialists in Germany**. *Infection* 2016, **44**(2):159–166.
17. Lee J: **The Present and Future of Infection Control Policy in Korea**. *Korean J healthc assoc Infect Control Prev* 2020, **25**(2):70–78.
18. Jeong YS, Kim JH, Lee S, Lee SY, Oh SM, Lee E, Kim TH, Park SY: **Scope of a weekly infection control team rounding in an acute-care teaching hospital: a pilot study**. *Antimicrob Resist Infect Control* 2020, **9**(1):123.
19. Kim B, Lee MJ, Moon SM, Park SY, Song KH, Lee H, Park JS, Lee MS, Choi SM, Yeom JS *et al*: **Current status of antimicrobial stewardship programmes in Korean hospitals: results of a 2018 nationwide survey**. *J Hosp Infect* 2020, **104**(2):172–180.
20. Park SY, Chang HH, Kim B, Moon C, Lee MS, Kim JY, Jung DS, Kim SW, Moon SM, Kim ES *et al*: **Human resources required for antimicrobial stewardship activities for hospitalized patients in Korea**. *Infect Control Hosp Epidemiol* 2020, **41**(12):1429–1435.
21. Bartlett JG: **A call to arms: the imperative for antimicrobial stewardship**. *Clin Infect Dis* 2011, **53 Suppl 1**:S4-7.
22. Fauci AS: **New and reemerging diseases: the importance of biomedical research**. *Emerg Infect Dis* 1998, **4**(3):374–378.
23. Collins JM, Wallender EK, Woodworth MH: **Improving the Infectious Diseases Physician Scientist Workforce From the View of Junior Investigators: Vision, Transparency, and Reproducibility**. *Clin Infect Dis* 2020, **70**(1):162–168.

24. Bonura EM, Lee ES, Ramsey K, Armstrong WS: **Factors Influencing Internal Medicine Resident Choice of Infectious Diseases or Other Specialties: A National Cross-sectional Study**. *Clin Infect Dis* 2016, **63**(2):155–163.
25. Kivimaki M, Jokela M, Nyberg ST, Singh-Manoux A, Fransson EI, Alfredsson L, Bjorner JB, Borritz M, Burr H, Casini A *et al*: **Long working hours and risk of coronary heart disease and stroke: a systematic review and meta-analysis of published and unpublished data for 603,838 individuals**. *Lancet* 2015, **386**(10005):1739–1746.

Figures

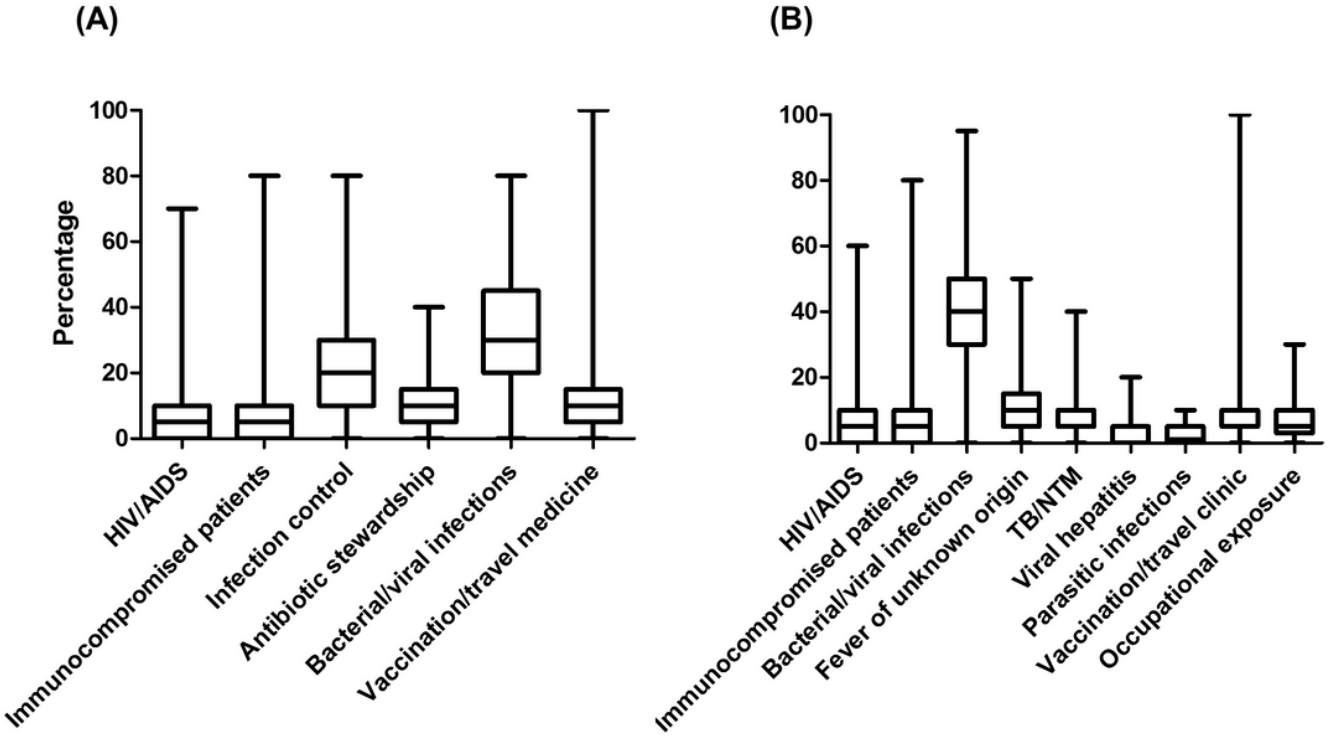

Figure 1

(A) Main specialized areas of practice and (B) clinical areas of practices among infectious disease specialists. Data are presented as the median and range. TB: tuberculosis; NTM: nontuberculous mycobacteria.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryfile20210722.docx