Research

Coronavirus Disease 2019 and Influenza Vaccination Rates: A Study Based on 2022 Korea Community Health Survey Data

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Abstract

Objectives: This study aims to analyze the differences in vaccination rates according to population size by comparing COVID-19 and influenza vaccination rates across different regions. Through this analysis, it seeks to provide essential data for formulating vaccination policies.

Methods: Using data from the 2022 Community Health Survey in South Korea, the COVID-19 and influenza vaccination statuses were compared according to population size. Regions were categorized as Seoul, metropolitan cities, large cities, medium-to-small cities, and counties.

Results: Using data from the 2022 Community Health Survey in South Korea, the COVID-19 and influenza vaccination statuses were compared according to population size. Regions were categorized as Seoul, metropolitan cities, large cities, medium-to-small cities, and counties.

Conclusion: In South Korea, although accessibility to healthcare facilities improves with increasing population and region sizes, this does not necessarily lead to a higher vaccination rate. However, regional differences in age distribution may have influenced vaccination rates. Vaccination rates were higher in areas with small populations. Urban areas with high population densities have a greater potential for the spread of communicable diseases compared with less-populated areas, necessitating management at the national level.

keywords: *COVID-19, influenza, vaccination, Korea Community Health Survey*

Introduction

Coronavirus disease 2019 (COVID-19), first reported in Wuhan, China at the end of 2019, rapidly spread worldwide, establishing a pandemic [1]. COVID-19 is a respiratory disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [2], with symptoms such as fever, persistent cough, difficulty breathing, muscle and joint pain, and pneumonia. Many cases are asymptomatic or mild, but there can be serious symptoms accompanied by damage to multiple organs [2,3]. Because of its high transmissibility, COVID-19 has led to millions of deaths globally, significantly impacting healthcare systems, economic development, and social cohesion [4].

Scientists and public health experts undertook extensive research to halt the spread of COVID-19 [3]. The spread of SARS-CoV-2 infection has required a variety of response strategies such as social distancing, wearing masks, and the development of vaccines. The development of vaccines to prevent the spread of COVID-19 proceeded at an unprecedented pace [5,6]. Beginning in late 2020, numerous research institutions and pharmaceutical companies developed and clinically tested candidate vaccines against COVID-19, several of which were approved internationally and used in mass-vaccination programs [6]. These vaccines have controlled the spread of COVID-19, however, discussions about the effectiveness of vaccines continue as a result of the emergence of variant strains [7].

Influenza is an important respiratory infection that has caused pandemics, and its annual seasonal

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outbreaks result in millions of deaths worldwide [8]. Efforts are made annually to prevent the spread of influenza by vaccination, aiming to reduce the rates of illness and mortality. Like COVID-19, most patients with influenza recover without serious symptoms, however, prevention efforts are necessary because older adults, very young children, pregnant individuals, and individuals with chronic diseases can develop severe conditions [9]. In South Korea, influenza vaccination is offered free of charge for children aged 6 months to 13 years, pregnant women, and persons ≥65 years of age, and the country has several policies to promote vaccination [10]. In 2019, before the emergence of COVID-19, South Korea's influenza vaccination rate was 43.5%. Following the COVID-19 pandemic, the overall influenza vaccination rate has increased due to emphasis on the importance of receiving the influenza vaccine to prevent symptoms similar to COVID-19 [11]. Previous studies have reported that influenza vaccination rates can be influenced by factors such as the elderly and children, women, rural residence, low education level, and high income [10-12].

Vaccination rates tend to be higher in urban areas with better access to healthcare services. According to a study by the CDC on COVID-19 vaccination rates in the United States, the vaccination rate for the first dose was lower in rural counties (58.5%) compared to urban counties (75.4%) [13]. These regional differences in vaccination rates can also affect disease incidence and mortality rates [14]. Therefore, it is essential to consider these differences when planning vaccination programs and to work towards increasing vaccination rates uniformly.

Effective vaccination programs are crucial for preventing outbreaks and protecting public health. Therefore, this study aims to assist in the development of more efficient vaccination policies by segmenting regions in South Korea based on population size and comparing vaccination rates.

Methods

This study used data from the 2022 Korea Community Health Survey (KCHS). The KCHS is a community-level health survey conducted to produce regional health statistics used to establish and evaluate local healthcare plans [15]. It is conducted in 1-, 2-, or 4-year cycles depending on the survey items, with a total cycle of 4 years [15]. The 2022 KCHS was conducted from August 16 to October 31, 2022, targeting adults ≥ 19 years of age. The survey data was downloaded from the Korea Disease Control and Prevention Agency (KDCA) website (https://chs.kdca.go.kr/chs/index.do). Out of the 231,785 participants, those who responded with "refused to answer" or "don't know" to the question about COVID-19 and influenza vaccination were excluded from the study. As a result, the analysis of COVID-19 vaccination status included data from 231,748 individuals, the analysis of influenza vaccination status included data from 231,506 individuals, and the analysis of both COVID-19 and influenza vaccination status included data from 231,471 individuals.

The 2022 KCHS is composed of 19 domains encompassing 138 items. We analyzed the items related to the COVID-19 vaccination experience in the COVID-19 domain and the annual influenza vaccination status in the vaccination and screening domains, by region. The criteria for dividing the regions were based on the 2022 demographic statistics of the Ministry of the Interior and Safety of South Korea (https://jumin.mois.go.kr/), and the names used for reginal classification were referenced from the 'Toponymic Guidelines for Map and Other Editors For International Use, Republic of Korea' [16]. Excluding Seoul and metropolitan cities (Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), areas corresponding to cities and counties were divided into large cities (16 areas), small-to-medium cities (62 areas), and counties (77 areas) based on population size (Table 1). Processing and analysis of the survey data were conducted using R (version 4.3.0; R Development Core Team, Vienna, Austria).

Results

COVID-19 vaccination status according to population size

In response to a question about COVID-19 vaccination, 7,823 participants (3.4%) responded that they had not been vaccinated, 1759 (0.8%) had received one dose, 36,597 (15.8%) had received two doses, 124,286 (53.6%) had received three doses, and 61,283 participants (26.4%) had received four or more doses. Overall, the rate of vaccination with at least one dose of a COVID-19 vaccine was high (96.6%), likely due to promotion of COVID-19 vaccination at the national level. Regarding COVID-19 vaccination by region, in all areas, more participants had been vaccinated at least once than not vaccinated (Table 2). Furthermore, in a subgroup analysis according to number of doses by region, the proportion of participants who had received only one dose was lowest in all regions, whereas the proportion of those who had received three doses was highest. There were regional differences in the rates of receiving two or four or more vaccine doses. In regions C1, C2, and C3, more participants had received only two doses than four or more doses. In the other regions, the rate of receiving four or more

Table 1. Classification of the study regions

	Population	Classification	Regions	n=231,748
Special city		A	Seoul	22,938
Metropolitan cities		B	Busan, Daegu, Incheon, Gwangju, Daejeon, Ulsan	44,514
Large cities	>1 million	C1	Suwon, Goyang, Yongin, Changwon	11,827
	700,000 to 1 million	C2	Seongnam, Hwaseong, Cheongju, Bucheon, Namyangju	13,605
	500,000 to 700,000	C3	Ansan, Anyang, Pyeongtaek, Siheung, Cheonan, Jeonju, Gimhae	10,003
Small and medium-sized cities	300,000 to 500,000	D1	Uijeongbu, Paju, Gimpo, Pohang, Gumi, Jeju, Sejong, Hanam, Gwangju, Wonju, Asan, Jinju, Yangsan	15,188
	100,000 to 300,000	D2	Gwangmyeong, Osan, Gunpo, Icheon, Yangju, Chuncheon, Gangneung, Chungju, Gunsan, Iksan, Mokpo, Yeosu, Suncheon, Gyeongju, Gyeongsan, Geoje, Guri, Uiwang, Anseong, Pocheon, Yeoju, Jecheon, Gongju, Seosan, Nonsan, Dangjin, Jeongeup, Naju, Gwangyang, Andong, Yeongcheon, Yeongju, Gimcheon, Tongyeong, Sacheon, Milyang, Seogwipo	34,936
	<100,000	D3	Dongducheon, Gwacheon, Donghae, Sokcho, Samcheok, Taebaek, Boryeong, Gyeryong, Namwon, Gimje, Sangju, Mungyeong	10,698
Counties	>100,000	E1	Yangpyeong, Chilgok	1,799
	50,000 to 100,000	E2	Gapyeong, Hongcheon, Jincheon, Eumseong, Geumsan, Buyeo, Hongseong, Yesan, Taean, Wanju, Gochang, Buan, Goheung, Hwasun, Haenam, Yeongam, Muan, Yeonggwang, Uiseong, Yecheon, Haman, Changnyeong, Goseong, Geochang	21,409
	<50,000	E3	Yeoncheon, Hoengseong, Yeongwol, Pyeongchang, Jeongseon, Cheorwon, Hwacheon, Yanggu, Inje, Goseong (in Gangwon), Yangyang, Boeun, Okcheon, Yeongdong, Jeungpyeong, Goesan, Danyang, Seocheon, Cheongyang, Jinan, Muju, Jangsu, Imsil, Sunchang, Damyang, Gokseong, Gurve, Boseong, Jangheung, Gangjin, Hampyeong, Jangseong, Wando, Jindo, Sinan, Gunwi, Cheongsong, Yeongyang, Yeongdeok, Cheongdo, Goryeong, Seongju, Bonghwa, Uljin, Ulleung, Uiryeong, Namhae, Hadong, Sancheong, Hamyang, Hapcheon	44,831

doses was higher than that of receiving only two doses. The difference was larger in regions D2, D3, E1, E2, and E3, which are small-to-medium cities or counties with populations of < 300,000. Additionally, the rate of receiving up to four doses increased with decreasing population size in metropolitan cities, small-to-medium cities, and counties and increased in the order of regions C, D, and E.

Table 2. COVID-19 vaccination status according to population size

Classification		No n(%)	Yes n(%)	p-value	First n(%)	Second n(%)	Third n(%)	Fourth or higher n(%)	p-value
Special city	A	816 (3.56)	22122 (96.44)	<0.001	224 (1.01)	4621 (20.89)	12551 (56.74)	4726 (21.36)	<0.001
Metropolitan cities	B	1714 (3.85)	42800 (96.15)		351 (0.82)	8180 (19.11)	24502 (57.25)	9767 (22.82)	
Large cities	C1	422 (3.57)	11405 (96.43)		92 (0.81)	2533 (22.21)	6824 (59.83)	1956 (17.15)	
	C2	464 (3.41)	13141 (96.59)		127 (0.97)	2741 (20.86)	7889 (60.03)	2384 (18.14)	
	C3	364 (3.64)	9639 (96.36)		89 (0.92)	1960 (20.34)	5745 (59.60)	1845 (19.14)	
Small and medium-sized cities	D1	587 (3.86)	14601 (96.14)		139 (0.95)	2950 (20.20)	8506 (58.26)	3006 (20.59)	
	D2	1199 (3.43)	33737 (96.57)		294 (0.87)	5388 (15.97)	19060 (56.50)	8995 (26.66)	
	D3	367 (3.43)	10331 (96.57)		79 (0.76)	1472 (14.25)	5820 (56.34)	2960 (28.65)	
Counties	E1	80 (4.45)	1719 (95.55)		12 (0.70)	291 (16.93)	982 (57.12)	434 (25.25)	
	E2	506 (2.36)	20903 (97.64)		125 (0.60)	2250 (10.76)	10675 (51.07)	7853 (37.57)	
	E3	1304 (2.91)	43527 (97.09)		227 (0.52)	4211 (9.67)	21732 (49.93)	17357 (39.88)	

Influenza vaccination status according to population size

Among the 231,748 participants who answered questions about COVID-19 vaccination, a regional analysis was conducted on the 231,506 participants who responded “no” or “yes” to influenza vaccination. Regarding having received the influenza vaccine in the past year, 130,013 (56.1%) and 101,493 (43.8%) participants reported that they had and had not been vaccinated, respectively. According to the 2018 KCHS data, before the emergence of COVID-19, 53.6% of participants had received the influenza vaccine, and this rate increased to 56.0% in 2019, 58.1% in 2020, and 59.4% in 2021 [17-20]. However, there was a decreasing trend in the influenza vaccination rate in 2022, when the spread of COVID-19 had slowed. In most regions, more participants reported being vaccinated against influenza compared with those who did not (Table 3). However, the proportion of participants who reported not having been vaccinated against influenza was highest in large cities with a population of > 1 million (C1 region). In large cities with populations of 500,000–700,000 (C3 region) and medium cities with populations of 300,000–500,000 (D1 region), the proportion of participants who had not been vaccinated for influenza was slightly larger than that of those who had been vaccinated. In small-to-medium cities and in counties, the proportion of participants who reported having received the influenza vaccine increased with decreasing population size.

Relationship of covid-19 and influenza vaccination status by population size

To investigate the relationship between population size and the rates of COVID-19 and influenza vaccinations, groups were categorized based on their experience with COVID-19 vaccination, and the rates of influenza vaccination among these groups were compared (Table 4). Among those who did not receive the COVID-19 vaccine, the proportion of individuals not vaccinated against influenza was higher compared to those who were vaccinated for influenza, but the rates according to population size did not show a statistically significant difference. In contrast, among those who received the COVID-19 vaccine, the comparison between those who did and did not receive the influenza vaccine revealed a distribution similar to that observed in the survey of influenza vaccination experiences over the past year (Table 3). This outcome is thought to have occurred due to the high overall vaccination rate for COVID-19. Regarding the number of COVID-19 vaccine doses, among the participants who received one dose of COVID-19 vaccine, the rate of not being vaccinated against influenza was higher than that of being vaccinated in all regions (Table 4). Also, the number of participants vaccinated against influenza increased with decreasing population size in metropolitan cities, small-to-medium cities, and counties.

Among the participants who had received a second dose of a COVID-19 vaccine, the proportion of those not vaccinated against influenza was higher in all regions. In small-to-medium cities and counties, the number of participants vaccinated against influenza increased with decreasing population size. Among participants who had received a third dose of a COVID-19 vaccine, similar proportions had versus had not received the influenza vaccine. In regions B, C1, C2, C3, D1, and E1, non-vaccinated participants were slightly more prevalent, whereas in regions A, D2, D3, E2, and E3, vaccinated participants were slightly more prevalent. Additionally, in small-to-medium cities and counties, the influenza vaccination rate increased with decreasing population size. Among participants who had received four or more doses of

Table 3. Influenza vaccination status according to population size

Classification		No	Yes	p-value
		n(%)	n(%)	
Special city	A	10664 (46.51)	12262 (53.49)	<0.001
Metropolitan cities	B	21369 (48.03)	23120 (51.97)	
Large cities	C1	6386 (54.06)	5426 (45.94)	
	C2	6718 (49.40)	6882 (50.60)	
	C3	5115 (51.23)	4869 (48.77)	
Small and medium-sized cities	D1	7655 (50.47)	7512 (49.53)	
	D2	7655 (50.47)	19312 (55.34)	
	D3	4415 (41.29)	6278 (58.71)	
Counties	E1	4415 (41.29)	924 (51.36)	
	E2	7598 (35.56)	13767 (64.44)	
	E3	15112 (33.75)	29661 (66.25)	

Table 4. Experience with influenza vaccination according to COVID-19 vaccination by population size

Vaccination		Special city		Metropolitan cities	Large cities			Small and medium-sized cities			Counties		p
		A	B	C1	C2	C3	D1	D2	D3	E1	E2	E3	
COVID-19	Influenza												
No	No	600 (73.53)	1303 (76.02)	333 (78.91)	353 (76.24)	277 (76.10)	444 (75.64)	916 (76.52)	281 (76.51)	65 (81.25)	370 (73.41)	947 (72.90)	0.225
	Yes	216 (26.47)	411 (23.98)	89 (21.09)	110 (23.76)	87 (23.90)	143 (24.36)	281 (23.48)	86 (23.43)	15 (18.75)	134 (26.59)	352 (27.10)	
Yes	No	10063 (45.52)	20066 (46.91)	6053 (53.14)	6364 (48.45)	4838 (50.29)	7211 (49.46)	14668 (43.53)	4134 (40.03)	810 (47.12)	7226 (34.65)	14160 (32.58)	<0.001
	Yes	12042 (54.48)	22708 (53.09)	5337 (46.86)	6770 (51.55)	4782 (49.71)	7368 (50.54)	19029 (56.47)	6192 (59.97)	909 (52.88)	13629 (65.35)	29299 (67.42)	
First	No	160 (71.43)	234 (66.86)	66 (71.75)	89 (70.08)	57 (64.04)	93 (67.39)	192 (65.31)	43 (54.43)	9 (75.00)	72 (58.06)	120 (52.86)	<0.001
	Yes	64 (28.57)	116 (33.14)	26 (28.26)	38 (29.92)	32 (35.96)	45 (32.61)	120 (52.86)	36 (45.57)	3 (25.00)	52 (41.94)	107 (47.14)	
Second	No	3168 (68.65)	5779 (70.70)	1805 (71.40)	1877 (68.55)	1357 (69.48)	2110 (71.72)	3801 (70.73)	962 (65.44)	222 (76.29)	1521 (67.87)	2772 (66.03)	<0.001
	Yes	1447 (31.35)	2395 (29.30)	723 (28.60)	861 (31.45)	596 (30.52)	832 (28.28)	1573 (29.27)	508 (34.56)	69 (23.71)	720 (32.13)	1426 (33.97)	
Third	No	6064 (48.34)	12286 (50.18)	3757 (55.12)	4011 (50.86)	3063 (53.43)	4423 (52.08)	9200 (48.33)	2701 (46.42)	496 (50.51)	4636 (43.53)	8975 (41.37)	<0.001
	Yes	6480 (51.66)	12199 (49.82)	3059 (44.88)	3875 (49.14)	2670 (46.57)	4070 (47.92)	9835 (51.67)	3117 (53.58)	486 (49.49)	6014 (56.47)	12722 (58.63)	
Fourth or higher	No	671 (14.21)	1767 (18.10)	425 (21.75)	387 (16.24)	361 (19.57)	585 (19.46)	1475 (16.40)	428 (14.46)	83 (19.12)	997 (12.72)	2293 (13.23)	<0.001
	Yes	4051 (85.79)	7998 (81.90)	1529 (78.25)	1996 (83.76)	1484 (80.43)	2421 (80.54)	7519 (83.60)	2531 (85.54)	351 (80.88)	6843 (87.28)	15044 (86.77)	

a COVID-19 vaccine, a significantly higher proportion had than had not been vaccinated against influenza. Overall, after excluding participants who had received only one dose of a COVID-19 vaccine, as the number of doses increased, the proportion of participants vaccinated against influenza increased gradually.

Discussion

As the population increases, the size of the region also expands, leading to a greater number of healthcare facilities and, consequently, enhanced access to healthcare services. Since improved access to healthcare facilities can increase vaccination rates [21], we analyzed regional COVID-19 and influenza vaccination statuses based on population size using data from the 2022 KCHS to determine if similar results are observed in South Korea and to support the development of effective vaccination policies.

The analysis confirmed that vaccination rates are higher in regions with smaller populations compared to large cities. The rate of receiving four or more doses of a COVID-19 vaccine was higher in areas with smaller populations than in those with larger populations. Additionally, in large cities, small-to-medium cities, and counties, the rate of receiving up to four doses increased as the population size decreased. Among participants who responded about COVID-19 vaccination, the proportion who reported not having been vaccinated for influenza was higher in large cities with a population of over 1 million compared to other regions. Furthermore, the influenza vaccination rate increased as the population size decreased in large cities, small-to-medium cities, and counties among participants who had received only one dose of a COVID-19 vaccine. This trend continued for participants who received two, three, or four or more doses of a COVID-19 vaccine in small-to-medium cities and counties. Generally, access to healthcare facilities improves with increasing population size, and areas with better access to healthcare facilities tend to have higher vaccination rates. However, vaccination rates do not necessarily follow the same trend in the analysis of the 2022 KCHS data. The finding that vaccination rates for COVID-19 and influenza are higher in regions with smaller populations underscores the importance of targeted public health interventions. Various factors can affect vaccination rates in urban and rural populations, including access to healthcare facilities, socioeconomic status, and cultural beliefs [22]. Smaller communities, due to their high sense of belonging and trust within the community, are able to share information quickly and have higher levels of trust in local healthcare providers [22, 23]. Given that the population density is higher in large urban areas compared to rural areas, leading to a greater potential for the spread of infectious diseases, it is necessary to conduct an in-depth analysis of the factors that contributed to the high vaccination rates in less populated areas. This analysis would help implement more effective vaccination campaigns to improve vaccination rates in large urban areas.

However, the age distribution varied by region, which may have influenced the vaccination rates [21, 24, 25]. We compared the average ages of participants in the 2022 KCHS by region, finding that the average ages were 52.18 years in region A, 53.52 years in region B, 50.11 years in region C1, 49.99 years in region C2, 50.06 years in region C3, 51.89 years in region D1, 55.35 years in region D2, 57.58 years in region D3, 56.42 years in region E1, 60.83 years in region E2, and 62.96 years in region E3. While the average age in large cities was similar, the average age in small-to-medium cities and counties was higher in regions with smaller populations. Therefore, the older average age in areas with smaller populations likely contributed to a higher vaccination rate compared with areas with younger populations. Age is an important factor influencing vaccination rates, as older adults are more likely to experience severe symptoms from infectious diseases, leading them to be more proactive in getting vaccinated compared to younger adults [26]. Additionally, in the case of the influenza vaccine, older adults can receive the vaccine for free, and because promotional efforts for free vaccination programs are relatively well-targeted, areas with a higher proportion of older adults eligible for free vaccination are likely to have higher overall vaccination rates.

The study’s results indicate that accessibility to healthcare facilities alone does not guarantee higher vaccination rates. Despite better access to healthcare in large cities, the lower vaccination rates observed highlight the need for enhanced public health education and community engagement efforts. This is particularly important in younger, urban populations, where vaccine hesitancy and complacency may be more prevalent. Tailored communication strategies and community-based interventions can help maintain balanced vaccination rates across all age groups.

Conclusion

Vaccination not only reduces the incidence and mortality rates of communicable diseases but also can bring socioeconomic benefits by preventing their spread [10]. Mass vaccination protects not only the vaccinated but also indirectly protects those who cannot be vaccinated or who do not mount an adequate immune response to the vaccine [10,11]. Because vaccination is the most effective means of combating communicable diseases, the government should provide support to ensure that vaccinations are conducted irrespective of disease risk [11]. In this study, vaccination rates were higher in areas with smaller populations. Because urban areas with large populations have greater potential for the spread of communicable diseases than do those with smaller populations, management of this issue at the national level is required [27]. The COVID-19 vaccines were developed and produced very rapidly, leading to hesitation to be vaccinated as a result of fears of side effects [10]. Therefore, to increase vaccination rates, education about the necessity of vaccination is important, as are efforts to ensure the trustworthiness of vaccines. This study compared COVID-19 and annual influenza vaccination statuses across regions according to population size. Our findings will assist the formulation of policies to prevent diseases by promoting vaccination.

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