

National prevalence and socioeconomic factors associated with the acceptance of COVID-19 vaccines in South Korea: a large-scale representative study in 2021

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Abstract. – OBJECTIVE: Among the global efforts toward preventing the COVID-19 pandemic, vaccines are a pivotal factor in ending the pandemic. Thus, through a large-scale population-based study, we investigated the individual-, social-, and family-associated factors affecting the acceptance of COVID-19 vaccines in South Korea.

PATIENTS AND METHODS: Data were obtained from a nationwide representative study (Korea Community Health) conducted in 2021. To determine the individual-, social-, and family-associated variables for COVID-19 vaccination acceptance, we investigated data from 225,319 individuals.

RESULTS: In the total sample (n=225,319), 184,529 COVID-19-vaccinated people and 40,790 non-vaccinated people were evaluated. The factors related to the acceptance of COVID-19 vaccination were significantly associated with the demographic factors, namely, older age group,

female sex, and a history of influenza vaccination, as well as medical conditions such as diabetes, hypertension, and depression. Socioeconomic conditions influencing the acceptance of COVID-19 vaccination were significantly associated with low-income families and blue-collar workers. Health-related risk factors were high in the obese group. However, a noteworthy negative association was found between the acceptance of vaccination and smoking habits and alcohol consumption. Conversely, a positive association was observed between academic level and vaccination acceptance.

CONCLUSIONS: Our findings suggest that old age, female sex, a history of influenza vaccination, medical conditions, such as diabetes, hypertension, and depression, low-income families, blue-collar workers, and health-related risk factors, such as obesity, were associated with the acceptance of

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COVID-19 vaccination. Additionally, a high academic level, absence of smoking habits, and non-current alcohol use were positively associated with vaccine acceptance.

Key Words:

COVID-19 vaccine, Vaccination, Influencing factors, Prevention and control strategies.

Introduction

The coronavirus infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been a global concern¹. Since 2019, the World Health Organization has designated the virus as a public health emergency². The threat of this pandemic created a health disparity in people's lives; effective measures to prevent and control the COVID-19 pandemic were urgently required³. The COVID-19 vaccination program started in 2021; however, some individuals were hesitant to get vaccinated⁴. Thus, exploring the underlying factors that may affect vaccination acceptance is vital as vaccines are the key to preventing the COVID-19 pandemic^{5,6}.

In this context, through a large-scale population-based study, we investigated the national prevalence of and the socioeconomic factors associated with the acceptance of COVID-19 vaccines in South Korea. We hypothesized that COVID-19 vaccine acceptance in South Korea is associated with socioeconomic factors. Thus, we analyzed a nationwide study⁷ of more than 200,000 Korean adults to estimate whether the prevalence and acceptance of COVID-19 vaccination are influenced by the socioeconomic factors in a general representative population.

Patients and Methods

Study Population and Data Sources

In this study, we retrieved data from the Korea Community Health Service in 2021, a survey conducted by the Korea Disease Control and Prevention Agency (KDCA) for government policies⁷. The target population comprised adults aged 19-60 years. We investigated a sample of respondents to obtain representative national data to estimate the total adult population in South Korea. An elaborate statistical analysis was conducted using weights and sample clustering to express the results appropriately and representatively. The CHS 2021 data were anonymized, and the study

protocol was approved by the KDCA and Kyung Hee University (KHUH 2022-06-042)^{8,9}. Written consent was obtained from all participants during their enrollment in the survey in 2021.

Outcomes

The Korean government has secured various COVID-19 vaccines for the Korean population. In 2021, four types of COVID-19 vaccines were used in South Korea [ChAdOx1-S (AstraZeneca) adenoviral vector, BNT162b2 (Pfizer/BioNTech) mRNA vaccine, mRNA-1273 (Moderna) mRNA vaccine, and Ad26.COV2.S (Johnson and Johnson–Janssen) adenoviral vector]. Patients who were vaccinated against COVID-19 were defined as those who received at least one dose of COVID-19 vaccination among the four types of vaccines.

Associated Factors

The variables analyzed in this study include age (continuous; individual-associated factors), sex (individual-associated factors), region (rural and urban; social-associated factors)¹⁰, body mass index (continuous; individual-associated factors), physical activity (continuous; individual-associated factors), educational level (high school or less and college or more; individual-associated factors), perceived economic status (high income, upper-middle income, lower-middle income, and low-income; socioeconomic factors), occupation (unemployed, blue-collar, and white-collar; socioeconomic factors), marital status (no and yes; family-associated factors), smoking habits (non-smoker and smoker; individual-associated factors), alcohol consumption (no, weekly, and monthly; individual-associated factors), depression (individual-associated factors), hypertension (individual-associated factors), diabetes (individual-associated factors), and the reception of influenza vaccination over the past year (individual-associated factors)¹¹. Sufficient physical activity was defined as having a metabolic equivalent task minutes score of more than 600 based on the International Physical Activity Questionnaire-short form¹².

Statistical Analysis

Qualitative data were displayed as sample numbers (percentages) or means (standard deviations). By using Fisher's exact test for categorical variables and the Student's *t*-test for continuous variables, COVID-19 vaccination acceptance-related risk factors were compared¹³. Additionally, to compare the estimates of each related risk factor for acceptance of COVID-19

vaccination, crude and adjusted odds ratios (ORs) with 95% confidence interval (CI) were expressed in multivariate and univariate regression model analysis, wherein the COVID-19 vaccination status was the dependent variable, and the associated factors were the independent variables and significantly differed in a regression model¹⁴. A two-sided p-value lower than 0.05 was regarded as statistically significant for all analyses. The survey primarily aimed to examine respondents who have received COVID-19 immunization since 2021. Descriptive statistics were used to assess the socioeconomic and demographic parameters, epidemic-related features, and COVID-19 vaccination status.

Furthermore, we analyzed the variables affecting COVID-19 vaccination acceptance since 2021. The COVID-19 vaccination status was the dependent variable for this analysis. The independent variables showed statistically significant differences in the regression model. Population-attributable risks (PARs) and 95% CIs were estimated using unconditional logistic regression^{15,16}. This method offers adjusted PAR estimates by combining the adjusted OR estimates with the observed prevalence of the risk factors among the case patients. As the logistic models were employed to estimate both OR and PAR, the measures were consistently adjusted for the same risk factors. PARs were evaluated for both the individual and combinations of risk factors.

Apart from the cases where the estimated PAR was negative, in which case the confidence bounds were obtained by adding and subtracting 1.96 times the estimated standard error of the PAR, a logit transformation¹⁷ was employed to construct 95% CIs confined to (0, 1). Statistical analyses were conducted using the IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Pie charts and error bar plots were created using MATLAB version R2021b (MathWorks, Natick, MA, USA).

Results

A total of 225,319 respondents were included in this study. Data included were retrieved from the Korea Youth Risk Behavior Web-based Survey (KYRBS)-related analysis for 2021⁷ (**Supplementary Table I**). The status of COVID-19 vaccination (received/not received) in 2021, and their acceptance-related risk factors

were analyzed. A total of 184,529 (81.9%) adults were vaccinated against COVID-19, whereas the remaining 40,790 (18.1%) adults were not.

The average age of the vaccinated population was 53.7 years, and 54.6% of women were immunized against COVID-19. Table I presents the trends in the association in comparison to the risk factor groups. Risk factors related to acceptance of COVID-19 vaccination were significantly associated with age [adjusted OR (aOR), 11.703; 95% CI, 11.209-12.219], female sex (aOR, 1.119; 95% CI, 1.079-1.160), and influenza vaccination (aOR, 3.734; 95% CI, 3.627-3.448). In terms of the medical conditions, the acceptance-related risk factors for the vaccination were significantly associated with the presence of diabetes (aOR, 1.062; 95% CI, 1.001-1.126), hypertension (aOR, 1.400; 95% CI, 1.338-1.465), and depression (aOR, 1.209; 95% CI, 1.138-1.285), and among socioeconomic conditions, these risk factors were significantly associated with low-income families 1.0 (ref) and occupation (blue-collar vs. white-collar; aOR, 1.470; 95% CI, 1.400-1.544), that are vulnerable to infectious diseases. Health-related risk factors were high in the obese group (aOR, 1.169; 95% CI, 1.135-1.203); however, smoking habits (aOR, 0.647; 95% CI, 0.625-0.670), alcohol use (aOR, 0.629; 95% CI, 0.611-0.649), and educational level (aOR, 0.389; 95% CI, 0.374-0.405) were negatively associated with vaccine acceptance.

The relative risk of vaccination rates is as follows: the PAR of non-vaccinated individuals was higher than that of those vaccinated individuals as the proportion of vaccinated individuals is higher (Figure 1). Among the non-vaccinated individuals, the prevalence of insufficient physical activity was found in 2.3% of individuals (upper 95% CI, 5.5%), suggesting an insignificant PAR value. However, non-vaccinated individuals were associated with all the eight risk-factor groups: professional workers (8.16%; upper 95% CI, 24.2%), alcohol consumption (19.3%; upper 95% CI, 31.1%), urban (12.2%; upper 95% CI, 23.8%), insufficient physical activity (2.3%; upper 95% CI, 5.8), smoking (7.8%; upper 95% CI, 35.9%), male sex (5.7%; upper 95% CI, 13.4%), age of 19-39 years (69.4%; upper 95% CI, 87.9%), and depression (1.5%; upper 95% CI, 20.4%). Risk factors for vaccinated individuals were associated with the following groups: influenza (13.7%; upper 95% CI, 21.5%), marriage (8.4%; upper 95% CI, 12.5%), high school or

Table 1. Association between the various risk factors and COVID-19 vaccination status in the Community Health Survey (total n=225,319).

	Crude model	Adjusted model
Age		
19-39 years	1.0 (ref)	1.0 (ref)
40-59 years	2.602 (2.538-2.668)	2.577 (2.496-2.661)
≥60 years	12.043 (11.645-12.454)	11.703 (11.209-12.219)
Sex		
Male	1.0 (ref)	1.0 (ref)
Female	1.128 (1.097-1.160)	1.119 (1.079-1.160)
Region		
Urban	1.0 (ref)	1.0 (ref)
Rural	0.978 (0.955-1.002)	1.001 (0.971-1.032)
BMI group, kg/m ²		
Normal	1.0 (ref)	1.0 (ref)
Obese	1.176 (1.150-1.203)	1.169 (1.135-1.203)
Sufficient physical activity		
No	1.0 (ref)	1.0 (ref)
Yes	1.035 (0.990-1.082)	1.011 (0.960-1.064)
Educational level		
High school or less	1.0 (ref)	1.0 (ref)
College or more	0.388 (0.377-0.399)	0.389 (0.374-0.405)
Economic level		
Low-income	1.0 (ref)	1.0 (ref)
High income	0.774 (0.752-0.796)	0.777 (0.748-0.807)
Occupation		
Unemployed	1.0 (ref)	1.0 (ref)
Blue-collar	1.509 (1.455-1.564)	1.470 (1.400-1.544)
White-collar	1.169 (1.136-1.203)	1.156 (1.114-1.200)
Marriage status		
No	1.0 (ref)	1.0 (ref)
Yes	1.073 (1.045-1.101)	1.146 (1.108-1.186)
Smoking status		
Non-smoker	1.0 (ref)	1.0 (ref)
Smoker	0.691 (0.668-0.714)	0.647 (0.625-0.670)
Alcohol consumption		
No	1.0 (ref)	1.0 (ref)
Yes	0.641 (0.626-0.656)	0.629 (0.611-0.649)
Depression		
No	1.0 (ref)	1.0 (ref)
Yes	1.219 (1.164-1.277)	1.209 (1.138-1.285)
Hypertension		
No	1.0 (ref)	1.0 (ref)
Yes	1.357 (1.309-1.407)	1.400 (1.338-1.465)
Diabetes		
No	1.0 (ref)	1.0 (ref)
Yes	1.098 (1.047-1.152)	1.062 (1.001-1.126)
Received influenza vaccination over the past year		
No	1.0 (ref)	1.0 (ref)
Yes	3.617 (3.536-3.700)	3.734 (3.627-3.844)

BMI, body mass index. Numbers in bold indicate significant differences (p -value<0.05).

less (13.1%; upper 95% CI, 18.9), hypertension (4.9%; upper 95% CI, 15.9%), low-income families (4.1%; upper 95% CI, 8.8%), obesity (1.9%; upper 95% CI, 3.8%), diabetes (1.5%; upper 95% CI, 12.1%), and blue-collar professionals (1.8%; upper 95% CI, 3.8%) (Figure 2).

Discussion

Key Findings

To the best of our knowledge, this is the first large-scale study conducted to estimate individual-, social-, and family-associated

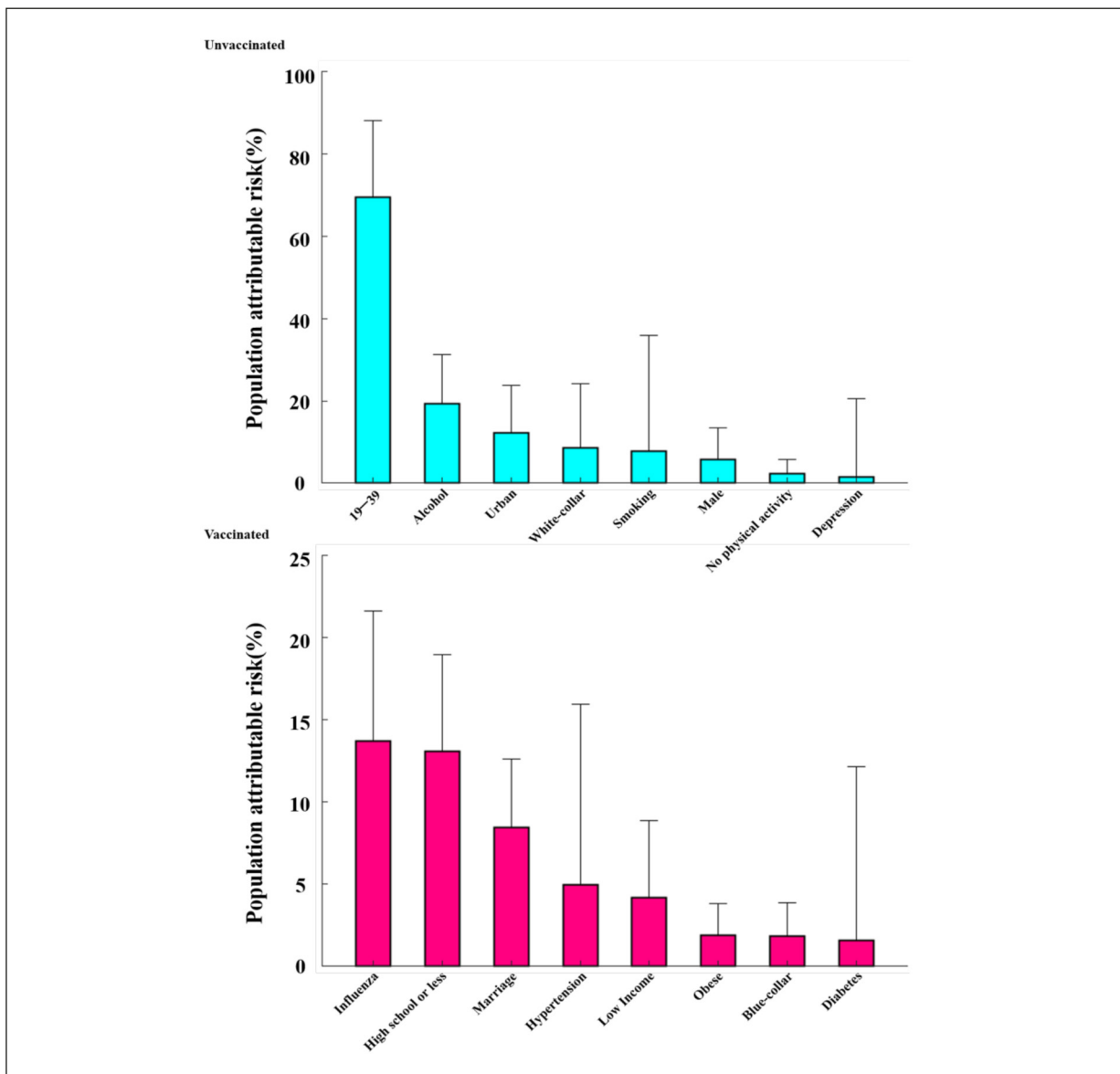


Figure 1. Population-attributable fraction of the COVID-19 vaccination status in South Korea (n=225,319). The bar indicates the upper 95% CI.

risk factors for the COVID-19 vaccine for a nationally representative South Korean population (n=229,242). This study highlighted the variations and risk factors based on an individual's vaccination status. During the survey period in 2021, after the onset of COVID-19 immunization in Korea, 81.9% of the participants in this study received the COVID-19 vaccination. The results of this study emphasize that older adults, low-income groups, and individuals with low education levels, who are vulnerable to infectious diseases, had significantly higher vaccination rates¹⁸. Older individuals with a lower education level,

belonging to both low- and high-income groups, and a high perceived risk of infection trusted the efficacy of the vaccine resulting in a higher probability of vaccination. Furthermore, a significant difference was observed in vaccination rates among the socioeconomic subgroups. Our results suggest that a precise strategy is required to ensure vaccine acceptance.

Comparison of Previous Studies

Previous studies¹⁹⁻²¹ have found that age and education level are important predictors of vaccine acceptance. Studies on vaccination acceptan-

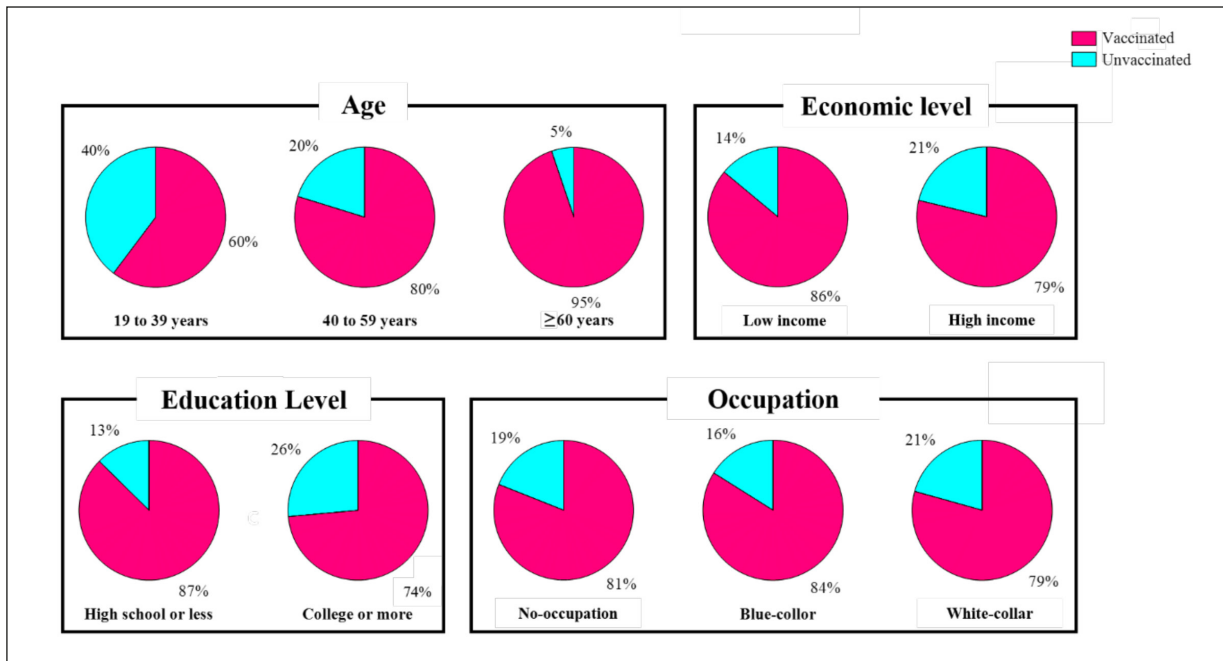


Figure 2. Study sample characteristics at baseline during the first COVID-19 lockdown with a high proportion of risk factors.

ce-related risk factors conducted in New Zealand (n=1,284)²² and the United States (n=55,000)²³ have indicated differences in income levels as significant. Similar results were found in a study conducted in Sweden (n=2,144)²⁴ that concluded that COVID-19 vaccination rates increased based on variables, such as high-income levels²². Limitations of these studies include small and heterogeneous samples, data that are not nationally representative owing to convenience sampling, compound bias, recall bias, and selection bias, all of which probably contributed to the inconsistency of our results (n=229,242).

The results of this study are not consistent with previous studies²³ conducted in the United States that found high rates of vaccination among high-income and highly educated professionals. This difference may be attributed to the survey cycle, wherein studies were conducted during different periods. The study²³ in the United States was conducted in April 2020, whereas our study was conducted in October 2021. Nonetheless, considering the limitation of fewer survey samples owing to the 2021 pandemic, the Korean survey population is larger than that of the United States. Ethnic and cultural differences also need to be considered.

Policy Implications

We interpreted that low-income families, low education levels, high body mass index (BMI),

and individuals in production occupations who rarely walked were hesitant toward receiving the vaccine. As reported in some studies, the importance of vaccination in vulnerable individuals cannot be ignored²⁵. Sustainable response, such as providing inclusive telemedicine and home-based health services for unvaccinated people, is required at the policy level²⁶. From a social perspective, the social awareness of the stability of vaccines, the overall value of immunization, individual health concerns, the effectiveness of immunization in preventing infection, and the severity of the illness are all factors that can affect vaccination acceptance²⁷. However, another study²⁸ demonstrated that multiple immunizations increase the likelihood of preventing major illnesses and promoting early recovery. Resolving vaccine hesitancy is crucial for the effective management of COVID-19. Additionally, highlighting certain advantages, and eliminating obstacles, such as erroneous information about adverse effects, can help increase the vaccination rates²⁹.

Plausible Mechanism

The above results suggest that vaccine hesitancy, driven by mistrust in vaccines, conspiracy theories, and ease of accessing information through social networks, is particularly affecting young individuals.

We believe that future vaccination drives should consider these factors to boost public trust in vaccines³⁰. For individuals who are wary of vaccinations owing to their lingering side effects, ongoing efforts are also required to develop new, more effective vaccines³¹. Additional studies that are frequently updated are required to increase vaccine coverage and address public concerns³². Targeted efforts for small non-vaccinated groups may be necessary to expand the scope of additional immunizations in Korea. As young individuals are a low-impact demographic group, we hope the additional vaccination rate will increase in this group. These insights should be considered when developing vaccines and regulations in the event of future pandemics. Our findings may serve as criteria to identify vulnerable individuals who are not vaccinated and should be considered when developing vaccine-related treatments and regulations in preparation for potential infectious disease outbreaks in the future³³.

Strengths and Limitations

Although the findings of our study revealed how sociodemographic and health-related factors are associated with the acceptance of vaccination, this study has certain limitations. First, the Korean government vaccinated older adults at the fastest rate. This may have affected our age-dependent analysis. Additionally, our study of new infectious disease strains had limited reproducibility³⁴. Second, as the survey exclusively enrolled Koreans, the results reflect the Korean sociocultural context, which may differ from worldwide trends³⁴. Third, we could not collect supplementary information, such as the family history and history of recent disease, owing to the lack of a questionnaire. Therefore, it is important to continue investigating the change in the public's perception of COVID-19. Despite these drawbacks, this study is the first thorough national investigation conducted to reveal important risk variables in South Korea. Although earlier studies used smaller samples, this study included a large number of participants (n=225,319), reflecting its dependability and representativeness. Our study provides crucial public health information that can help increase vaccine acceptance. Strategies for vaccinating vulnerable groups should be developed. Through this study, we identified the risk factors associated with vaccination acceptance and demonstrated an effective freezing vaccination method.

Conclusions

This study investigated various risk factors associated with COVID-19 vaccination acceptance in 2021. Despite significant scientific evidence supporting the safety and efficacy of vaccines, a lack of confidence in vaccines still exists among the general public. This skepticism has resulted in lower vaccination rates, increasing the morbidity and mortality of infectious diseases. However, vulnerable groups had relatively higher vaccination rates than individuals with higher incomes, education, and professional backgrounds. Thus, it is essential for scholars to first understand the underlying reasons and concerns regarding the hesitancy toward vaccination and build trust in the vaccine to address this hesitancy. Subsequently, to ensure the successful distribution and adoption of the COVID-19 vaccine, the public's trust in vaccines must be re-established. By understanding and addressing the factors examined in our study, we can help improve public health interventions and increase vaccination coverage, thereby contributing to the control and eventual end of the COVID-19 pandemic.

Conflict of Interest

The authors declare that they have no conflict of interests.

Ethics Approval

The CHS 2021 data were anonymized, and the study protocol was approved by the KDCA and Kyung Hee University (KHUH 2022-06-042).

Informed Consent

Written consent was obtained from all participants during their enrollment in the survey in 2021.

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Authors' Contributions

Dr Dong Keon Yon had full access to all the data used in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. All authors approved the final version of the manuscript before submission. Study concept and design: Hwi Yang and Dong Keon Yon; Acquisition, analysis, or interpretation of data: Hwi Yang and Dong Keon Yon; Drafting of the manuscript: Hwi Yang and Dong Keon Yon; Critical revision of the manuscript for important intellectual content: all authors; Statistical analysis: Hwi Yang and Dong Keon Yon; Study supervision: Hwi Yang, Min Seo Kim, Sang Youl Rhee, Jinseok Lee, Wonyoung Cho, Chanyang Min, Seung Won Lee, Jae Il Shin, Jiyeon Oh, Yujin Choi, Jun Hyuk Lee, Hyejun Kim, Masoud Rahmati, Seung Geun Yeo, and Dong Keon Yon. Dong Keon Yon supervised the study and is the guarantor for this study. The corresponding author attests that all listed authors meet the authorship criteria and that authors meeting the criteria have not been omitted.

Availability of Data and Materials

Data are available on reasonable request. Study protocol, statistical code: available from DKY (email: yonkkang@gmail.com). Data set: available from the Korean Centers for Disease Control and Prevention Agency (KCDA) through a data use agreement.

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