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Effect of psychological factors on COVID-19 vaccine hesitancy

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ABSTRACT

Background Vaccine hesitancy can prevent full immunization against coronavirus infectious disease-19 (COVID-19). We hypothesized that multiple factors, including an individual's personality and psychological factors, are associated with vaccine hesitancy.

Methods A total of 275 non-vaccinated individuals were recruited for this study. Participants completed a self-report questionnaire including sociodemographic factors, health status, COVID-19 literacy and psychological factors (depressive symptoms, generalized anxiety, somatization, illness anxiety, temperament and character). In a hierarchical logistic regression analysis, a discrete set of hierarchical variables with vaccine acceptance or hesitancy as the dependent variable was added to the demographic factors for Model 1; Model 1 + health status for Model 2; Model 2 + COVID-19 literacy for Model 3 and Model 3 + psychological factors for Model 4.

Results Models 3 and 4 could predict vaccine hesitancy. High scores on the Generalized Anxiety Disorder-7 and the Illness Attitude Scale, low confidence, low collective responsibility and low reward dependence were risk factors for vaccine hesitancy.

Conclusions The present study demonstrates that psychological factors play critical roles in vaccine hesitancy. In addition to conventional policies that emphasize COVID-19 vaccines' safety and efficacy and the collective benefits of vaccination, a more individualized approach that considers an individual's emotions and personality is necessary.

Keywords COVID-19, psychological determinants, vaccination

Introduction

Since December 2019,[1] coronavirus infectious disease-19 (COVID-19) began spreading throughout the world, with the World Health Organization (WHO) declaring the COVID-19 pandemic in March 2020.[2] The pandemic has caused enormous morbidity, mortality, social and economic impacts worldwide.[3,4] High vaccination rates are vital in alleviating the COVID-19 pandemic.[5,6] Nevertheless, vaccine hesitancy remains a barrier.[6] Vaccine hesitancy is defined as a delay in accepting or refusing vaccines despite the availability of vaccine services. Even before the spread of COVID-19, vaccine hesitancy was becoming an increasing concern worldwide[7] and has resulted in a resurgence of vaccine-preventable diseases, such as measles and pertussis, and avoidable deaths.[8,9] The WHO considered vaccine hesitancy as one of the top 10 global health threats in 2019.[6] Given the high burden of the COVID-19 pandemic and the potential risks of vaccine hesitancy, COVID-19 vaccine hesitancy needs to be better understood. This study aims to determine the factors affecting vaccine hesitancy and to identify a highly hesitant group.

COVID-19 vaccine hesitancy is a multifaceted phenomenon associated with sociodemographic, health-related and psychological factors.[10–12] Sociodemographic factors such as being female, being a younger age, having lower education and income, not being single or widowed and not being employed full-time have all been related to vaccine hesitancy.[11–14] Additionally, in studies conducted during the period without available vaccines or right after the development of the COVID-19 vaccine, having no chronic illnesses, having a history of COVID-19 infection in themselves or their family members and reporting poor self-rated health were associated with vaccine hesitancy.[4,15,16] High perceived sensitivity to medication, an indicator of personal concern about how one's body might respond to medication, was

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strongly correlated with negative vaccination attitudes.[17] However, some results regarding sociodemographic and health-related factors are mixed. For example, Chen et al. reported that higher income was related to vaccine hesitancy,[16] while Martin et al. reported that the education level and self-rated health were not.[17]

A systematic review and large-scale studies[10,12,15] showed that cognitive factors including the mistrust of government; conspirational, religious and paranoid beliefs about coronavirus and vaccines; and low adherence to social distancing policies were related to COVID-19 vaccine hesitancy. Perceived risks versus benefits and the lack of knowledge were the most common reasons for general vaccine hesitancy,[10] which can also be applied to the COVID-19 vaccines.[18] Altruism and collective responsibility negatively correlated with vaccine hesitancy.[12,19] The 5C model is a theoretical model to explain psychological (more cognitive than emotional) antecedents of vaccination, in which low confidence and collective responsibility and high complacency, constraints and calculation are associated with vaccine hesitancy.[8] However, the weights vary depending on the disease, vaccine, target group and country.[8]

Decision-making regarding vaccination is also influenced by emotional factors and personality traits.[11,20–22] It has been reported that patients with depression or anxiety have the highest rates of vaccine hesitancy.[22] Depression and anxiety are related to poor adherence to medical treatments, and treating them can help adherence to medical treatments such as the COVID-19 vaccination.[22] Conversely, COVID-19-related anxiety and health-related fears were related to vaccine acceptance.[21] Hence, illness anxiety, which is anxiety about having or developing a serious illness,[23] might affect COVID-19 vaccine hesitancy differently than non-specific or generalized anxiety. Somatization—a tendency to experience and communicate psychological distress in the form of somatic symptoms—may be also associated with COVID-19 hesitancy since patients with severe depression and generalized anxiety were more susceptible to normal bodily sensations, mediated by COVID-19 fear and hypochondriasis.[24,25] Increased susceptibility to normal bodily sensations, known as somatosensory amplification, is the core feature of somatic symptom disorder or somatization.[26]

Personality factors such as low agreeableness and conscientiousness and high levels of neuroticism were associated with COVID-19 vaccine hesitancy.[11] In addition, a study reported that vaccination willingness was significantly associated with personality traits such as extraversion, novelty seeking, self-directedness and cooperativeness.[27]

Overall, there have been far fewer studies analyzing the role of emotional and personality factors in vaccine hesitancy than studies on cognitive factors.[28] Therefore, integrated considerations that include emotional and personality factors are required to better understand and predict COVID-19 vaccine-hesitant individuals.

In this study, we hypothesize that vaccination intentions are associated with certain cognitive beliefs, personality and emotional states, which can help public health officials develop policies to enhance vaccination rates.

Methods

This study was conducted in August 2021 when the priority vaccinations for medical personnel and the elderly had been completed, and large-scale vaccinations for anyone over the age of 18 years had begun. The study participants were recruited through the online survey company Embrain in Seoul, South Korea. The inclusion criteria were as follows: (1) at least 18 years of age; (2) no COVID-19 vaccination; and (3) no current psychiatric disorders diagnosed. Of the 297 enrolled study subjects, 275 completed the self-report paper questionnaires. The Institutional Review Board of Chung-Ang University approved this study (approval number: 1041078–202107-HRSB-198-01), and written informed consent was obtained from each participant. The participants each received USD 20 upon the completion of the survey.

Demographic data, including age, sex, education, marital status, income and occupation, were collected from all participants. Regarding individuals' health-related factors, any chronic medical illness diagnosed, self-rated health (SRH), perceived sensitivity to medicine (PSM) and the history of COVID-19 infection in themselves or their family members were assessed. SRH was evaluated with a single question: 'In general, would you say your physical health is poor, fair, good, very good, or excellent?' Responses ranged from excellent (1) to bad (5).[29] PSM assesses the perception of susceptibility to potential adverse effects of medication with five items on a 5-point scale.[30] Both SRH and PSM have good validity and reliability.[29–31]

A short version of the 5C scale for COVID-19 vaccines and a questionnaire regarding COVID-19 literacy were administered to each participant. Since there is no established literacy scale for COVID-19, the research team created a seven-item questionnaire, referring to the US Centers for Disease Control and Prevention website. The 5C scale, a validated measure based on 'the 5C model of the antecedents of vaccine hesitancy', assesses five main determinants of vaccine hesitancy: confidence, complacency, constraints, calculation and collective responsibility. The short version of the 5C scale

is suited for field settings and regular global monitoring of the antecedents of vaccination.[8]

The psychological and personality traits of the participants were assessed through the Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder-7 (GAD-7), Somatic Symptom Amplification Scale (SSAS), Illness Attitude Scale (IAS) and Temperament and Character Inventory-Revised-Short Version (TCI-RS). The PHQ-9 is a 4-point scale consisting of nine Diagnostic and Statistical Manual of Mental Disorders-IV depressive episode criteria.[32] PHQ-9 is a valid and reliable measure to screen for the presence and severity of depression.[32] The GAD-7 is a 4-point scale consisting of seven items used for screening and assessing the symptom severity of generalized anxiety disorder,[33] and it has good reliability and validity.[33] The SSAS is a 5-point Likert scale consisting of 10 items that assess the level of somatosensory amplification, i.e. the tendency to experience bodily sensations as intense, noxious and/or disturbing.[34,35] The SSAS has good internal consistency and validity.[34,36] The IAS is a 29-item instrument used to evaluate fears, attitudes and beliefs associated with hypochondriacal concerns and behaviors.[37,38] Twenty-seven of the items are answered on a 5-point scale, with the remaining two items answered differently.[39]

The TCI-RS is a 140-item self-report questionnaire, based on Cloninger's temperament and character model, which is one of the more popular models in current psychiatric practice and research.[40,41] Cloninger's model is considered to more effectively represent maladaptive features of behavior, compared to another popular five-factor model that usually describes the normal range of individual differences.[40] Cloninger's model posits that personality consists of temperament and character.[42,43] Temperament is individual differences in preconceptual emotional reactions, which manifests during the early developmental stages and remains relatively stable throughout their lifespan.[44] In contrast, character is individual differences in higher cognitive processes (e.g. life goals and values) and includes responses to different aspects of one's identity or self-experiences.[43] An individual's character is formed later in life through environmental interactions.[45] An individual's temperament comprises four traits: novelty seeking (NS), harm avoidance (HA), reward dependence (RD) and persistence (P). In addition, there are three character traits: self-directedness (SD), cooperation (CO) and self-transcendence (ST).[46] The Korean version of TCI-RS is psychometrically reliable and valid.[47]

Vaccination intention was evaluated using a single question: 'Would you take a COVID-19 vaccine if it is recommended and provided free of charge?' Responses included 'Definitely not = 1', 'Probably not = 2', 'I may or may not = 3', 'Probably = 4' and 'Definitely = 5.' Before analysis, participants were sorted into vaccine-acceptant (having a positive intention to get vaccinated) and hesitant groups (having either a negative or neutral intention to get vaccinated). Those who answered 'Definitely not' were excluded from the study since antivaccination attitudes are distinct from vaccine hesitancy.

The sociodemographic, health-related and COVID-19-related factors and the personalities and psychological states of the participants were analyzed using t-tests and χ^2 tests. The T-scores of the TCI-RS were used for analysis. The Bonferroni post-hoc test, with a significance level of <0.05, was used. In a multiple hierarchical regression analysis, a discrete set of hierarchical variables with vaccine hesitancy as the dependent variable was added as follows: demographic factors for Model 1; Model 1 + health-related factors for Model 2; Model 2 + COVID-19-related factors for Model 3; and Model 3 + personality and psychological factors for Model 4.

Results

Vaccination intention

The majority of participants (85.8%) answered that they were either 'definitely' or 'probably' going to get vaccinated and were sorted into the vaccine acceptance group. The majority of the remainder (13.5%) answered either 'I may or may not' or 'probably not' and were sorted into the vaccine hesitancy group. Two participants (0.7%) answered that they were 'definitely not' willing to get vaccinated and were excluded from the analysis (Supplementary Table S1).

Demographic, health and COVID-19-related factors

There were no significant differences between the vaccine acceptance and hesitancy groups in terms of age, marital status, income, occupation, education, religion, chronic illness, self-rated health, the history of COVID-19 infection, 5C calculation and vaccine knowledge. The vaccine hesitancy group had a higher percentage of women, higher perceived sensitivity to medicine, lower confidence and collective responsibility and higher 5C complacency and constraints compared with the vaccine acceptance group (Table 1).

Personality and psychological states

There were no significant differences between the two groups regarding PHQ-9, NS, P, SD, CO or ST scores. However, the vaccine hesitancy group displayed significantly higher GAD-7, SSAS, IAS and HA scores as well as lower RD scores than the vaccine acceptance group (Table 2).

Table 1 Demographic characteristics

	Vaccine acceptance	*Vaccine hesitancy*	*Statistics*
Age	32.62 ± 9.34	30.73 ± 9.03	$t = -1.15$, $P = 0.25$, $d = -0.21$
Sex (male/female)	107/129	10/27	$\chi^2 = 4.38$, $P = 0.04$*, $v = 0.03$
Marital status (solo/paired)	79/157	11/26	$\chi^2 = 0.20$, $P = 0.65$, $v = 0.03$
Income ($/month)	68	16	$\chi^2 = 3.31$, $P = 0.19$, $v = 0.03$
<2000	97	11	
2000–4000	71	10	
>4000			
Occupation	88	20	$\chi^2 = 3.76$, $P = 0.05$, $v = 0.03$
None/Part time	148	17	
Full time			
Education	28	9	$\chi^2 = 4.19$, $P = 0.12$, $v = 0.03$
High school	141	19	
University	66	9	
Graduate school			
Religion (yes/no)	102/134	16/21	$\chi^2 = 0.00$, $P = 1.00$, $d = 0.01$
Chronic illness (yes/no)	38/198	5/32	$\chi^2 = 0.16$, $P = 0.69$, $d = 0.03$
SRH	2.41 ± 0.81	2.54 ± 0.96	$t = 0.88$, $P = 0.38$, $d = 0.16$
PSM	8.45 ± 4.32	10.03 ± 4.29	$t = 2.06$, $P = 0.04$*, $d = 0.36$
COVID-19 Hx. (yes/no)	23/213	4/33	$\chi^2 = 0.04$, $P = 0.84$, $v = 0.03$
Vaccine knowledge	5.61 ± 1.10	5.68 ± 0.94	$t = 0.32$, $P = 0.75$, $d = 0.06$
5C_Confidence	3.00 ± 1.00	2.16 ± 1.12	$t = -4.67$, $P < 0.01$**, $d = -0.82$
5C_Complacency	1.78 ± 0.94	2.35 ± 1.01	$t = 3.40$, $P < 0.01$*, $d = -0.60$
5C_Constraints	1.64 ± 0.92	2.19 ± 1.13	$t = 2.80$, $P < 0.01$**, $d = 0.49$
5C_Calculation	3.97 ± 0.96	4.11 ± 0.97	$t = 0.81$, $P = 0.42$, $d = 0.14$
5C_Collective responsibility	4.10 ± 1.06	3.16 ± 1.21	$t = -4.90$, $P < 0.01$**, $d = 0.86$

*:$p < 0.05$; **:$p < 0.01$

Table 2 Comparison of personality and psychological factors between vaccine acceptance and hesitancy groups

	Vaccine acceptance	*Vaccine hesitancy*	*Statistics*
PHQ-9	4.81 ± 4.74	6.84 ± 6.66	$t = 1.78$, $P = 0.08$, $d = 0.31$
GAD-7	3.54 ± 4.25	7.16 ± 6.47	$t = 3.29$, $P < 0.01$**, $d = 0.58$
SSAS	10.40 ± 5.85	14.19 ± 6.46	$t = 3.61$, $P < 0.01$**, $d = 0.63$
IAS	33.87 ± 14.10	42.97 ± 15.07	$t = 3.62$, $P < 0.01$**, $d = 0.64$
TCI_NS	65.07 ± 28.05	67.67 ± 30.78	$t = 0.51$, $P = 0.61$, $d = 0.09$
HA	46.34 ± 33.09	62.92 ± 31.02	$t = 2.82$, $P < 0.01$**, $d = 0.49$
RD	54.19 ± 32.28	42.47 ± 33.70	$t = -2.02$, $P < 0.05$*, $d = 0.36$
P	50.44 ± 31.53	52.25 ± 32.88	$t = 0.32$, $P = 0.75$, $d = 0.06$
SD	55.66 ± 32.34	48.00 ± 34.39	$t = -1.31$, $P = 0.19$, $d = -0.23$
CO	50.33 ± 30.08	48.83 ± 28.78	$t = -0.28$, $P = 0.78$, $d = -0.05$
ST	39.86 ± 30.94	47.83 ± 33.70	$t = 1.42$, $P = 0.16$, $d = 0.25$

*:$p < 0.05$; **:$p < 0.01$

Hierarchical logistic regression analysis

Models 3 and 4 were both significantly associated with vaccine hesitancy.

In Model 3, the model χ^2 (44.480, $P = 0.001$) and Nagelkerke's R^2 (0.279, explaining 27.9% of the variance in vaccine hesitancy) indicated that the model was adequate for predicting vaccine hesitancy. When the practical usefulness of the model was examined based on classification accuracy, 17 variables in Model 3 enhanced the prediction accuracy to 87.8%.

In Model 4, model χ^2 (83.540, $P < 0.001$) and Nagelkerke's R^2 (0.489, explaining 48.9% of the variance in vaccine hesitancy) indicated that Model 4 best predicted vaccine hesitancy, with an accuracy of 88.5%.

Wald statistics were used to confirm whether each variable had a significant relationship with vaccine hesitancy. Among all the independent variables, high GAD-7 and IAS scores, low confidence, collective responsibility and the RD score were significant predictors of vaccine hesitancy (Table 3).

Discussion

Main finding of this study

In this study, COVID-19-related, psychological and personality factors were shown to significantly affect vaccine hesitancy. Additionally, low confidence, collective responsibility, high generalized anxiety, illness anxiety and low RD were risk factors for vaccine hesitancy. To the best of our knowledge, this is one of the first studies to use well-established clinical scales to examine the influence of psychological and personality factors on vaccine hesitancy.

What is already known on this topic?

This study's results align with previous studies, which demonstrate that confidence and collective responsibility are essential for COVID-19 vaccination.[48,49] Confidence is defined as trust in the effectiveness and safety of vaccines and the system that delivers them.[8] Individuals who lack confidence retain more negative viewpoints on vaccination and are often swayed by misinformation, conspiratorial beliefs and inflated perceptions of vaccine-related risks.[8] Collective responsibility is an individual's willingness to protect others by getting vaccinated,[8] and it correlates positively with empathy, collectivism and communal orientation and correlates negatively with individualism.[50,51] Individuals with low collective responsibility tend not to care about herd immunity or to get vaccinated for the benefit of others.[8]

As discussed in previous studies, and corroborated by this study, public campaigns that emphasize vaccine safety and efficacy and address concerns about newly developed vaccines are essential for building confidence.[6,52] Eliciting positive emotions about helping the community and restoring health and well-being through vaccination can also assist in overcoming vaccine hesitancy.[53]

What this study adds

The present study showed that, except for confidence and collective responsibility, the other 5C subscales were not associated with COVID-19 hesitancy. However, there have been discrepancies regarding other components of 5C, namely, complacency (perceived risk and perceived level of threat of vaccine-preventable diseases), constraints (practical barriers such as geographical accessibility, comprehension and affordability) and calculation (an individual's engagement with extensive information searching).[8,54–56] Kwok et al. reported that weaker complacency is associated with COVID-19 vaccination intention.[56] Al-Sanafi et al. reported that lower constraints predict COVID-19 vaccine acceptance.[54] We suggest that this discrepancy is caused by the characteristics of COVID-19 vaccines, such as the speed of development, the innovativeness of the technology used, uncertainty regarding their effectiveness and potential side effects.[48] Kwok et al. asserted that because people cannot obtain sufficient information about COVID-19 vaccines or evaluate the possible barriers to the new vaccine in the early phase of the epidemic, calculation and constraints are not significant predictors of vaccination intention.[6] The future validation work of vaccine hesitancy models on COVID-19 is necessary since the 5C model's validity would increase as more information regarding the COVID-19 vaccines is obtained.[6]

This study reveals that both generalized anxiety and illness anxiety affect vaccination intention, whereas depression does not. However, previous studies reported that non-specific anxiety and depression were not associated with vaccine hesitancy.[21,57] The inconsistent results for generalized anxiety might be because of the different types of risk that people prioritize: people with generalized anxiety are typically risk-averse, but their anxiety is not predetermined.[58,59] The vaccine does carry the risk of side effects, but not being vaccinated increases the risk of COVID-19 infection.[59,60] The risks people with generalized anxiety prioritize might depend on the type of vaccine, diseases or study period. Previous research on infectious diseases other than COVID-19 reported that people with generalized anxiety prioritize avoiding the risks associated with infection rather than those associated with the vaccine.[61–63] However, research on COVID-19 shows that people with significant generalized anxiety prioritize avoiding the risks associated with vaccination over being infected with COVID-19.[59] Moreover, although it has been suggested that low levels of health anxiety are related to less preventive behavior, including vaccination,[64] our results indicate that for those with illness anxiety, the risk of COVID-19 vaccination is probably more significant to them than that of COVID-19 infection. Notably, concerns about vaccine safety, adverse effects and rapid development lead to concerns about quality control and are associated with negative vaccination intent.[4,52,65]

Therefore, in addition to national campaigns to address general concerns about COVID-19 vaccination, policies to

Table 3 Hierarchical logistic regression

Independent variables		*Model 1*			*Model 2*			*Model 3*			*Model 4*		
		B	*Wald*	*OR*	*B*	*Wald*	*OR*	*B*	*Wald*	*OR*	*B*	*Wald*	*OR*
Demographic factors	Sex	0.767	3.435	2.153	0.784	3.377	2.191	0.749	2.232	2.115	1.058	3.142	2.879
	Age	−0.025	0.586	0.975	−0.030	0.814	0.970	−0.023	0.318	0.977	−0.047	0.821	0.954
	Marital status	−0.134	0.069	0.875	−0.093	0.032	0.911	0.077	0.018	1.080	0.505	0.444	1.657
	Income		1.251			1.500			0.862			3.443	
		0.003	0.000	1.004	0.121	0.040	1.128	0.100	0.023	1.105	−0.783	0.910	0.457
		0.568	0.682	1.765	0.721	1.052	2.056	0.597	0.605	1.816	0.591	0.378	1.805
	Occupation	−0.441	0.752	0.643	−0.377	0.529	0.686	−0.581	1.054	0.560	0.227	0.104	1.255
	Education		1.608			2.085			2.186			2.111	
		−0.693	1.587	0.500	−0.793	1.987	0.452	−0.910	2.178	0.403	−0.736	0.968	0.479
		−0.662	0.978	0.516	−0.826	1.481	0.438	−0.684	0.893	0.505	0.072	0.006	1.075
	Religion	0.092	0.058	1.096	0.139	0.128	1.149	0.102	0.055	1.107	0.306	0.321	1.358
Health status	Chronic illness				0.217	0.149	1.243	0.010	0.000	1.010	1.316	2.499	3.730
	SRH				0.149	0.370	1.161	0.363	1.751	1.437	0.011	0.001	1.011
	PSM				0.086	4.697	1.090*	−0.012	0.052	0.988	−0.077	1.509	0.925
COVID-19-related factors	COVID-19 Hx.							−0.675	0.939	0.509	−1.152	2.009	0.316
	Vaccine knowledge							0.221	0.945	1.247	0.230	0.724	1.259
	Confidence							−0.477	4.349	0.620*	−0.757	6.450	0.469*
	Complacency							0.099	0.161	1.104	−0.081	0.074	0.922
	Constraints							0.345	1.723	1.412	0.351	1.325	1.420
	Calculation							0.182	0.536	1.200	−0.108	0.121	0.897
	Collective responsibility							−0.508	5.811	0.602*	−0.926	12.562	0.396**
Psychological status	PHQ-9										−0.005	0.003	0.995
	GAD-7										0.194	3.843	1.214*
	SSAS										−0.079	1.638	0.924
	IAS										0.080	11.357	1.083**
	TCI_NS										0.014	1.834	1.014
	HA										0.014	0.894	1.014
	RD										−0.025	6.674	0.975**
	P										0.004	0.104	1.004
	SD										0.021	1.943	1.021
	CO										0.012	1.195	1.012
	ST										0.000	0.000	1.000
Indices	Model 0	Model 1			Model 2			Model 3			Model 4		
−2LL	N/A	201.585			196.029			167.565			128.504		
Model $\chi^2/p/v$	N/A	10.459/0.315/0.399			16.015/0.191/0.499			44.480/0.001**/0.882			83.540/<0.001**/1.33		
Nag R^2	N/A	0.070			0.106			0.279			0.489		
Class accur	86.7	86.7			87.0			87.8			88.5		

*:$p < 0.05$; **:$p < 0.01$

screen and intervene for those who are anxious about getting vaccinated, particularly those with generalized anxiety and illness anxiety, are needed to enhance vaccination intention. Since people with mental health problems are at a higher risk of COVID-19 infection and are more likely to suffer a more severe course of illness,[66] addressing their reluctance to be vaccinated is important from a public health perspective.

Temperament and Character Inventory (TCI) analysis demonstrated that HA and RD differed significantly between the vaccine-acceptant and hesitant groups and that low RD predicted vaccine hesitancy. HA is the tendency toward behavioral inhibition when faced with danger[42] and is characterized by anticipatory worry and the fear of uncertainty.[67] Since HA refers to an anxiety-prone temperament,[67] HA scores were higher in the vaccine hesitancy group than in the acceptance group, as were the GAD-7 and IAS scores. However, the HA did not predict vaccine hesitancy, unlike GAD-7 or IAS. This is probably because HA is a broad concept encompassing various types of fear and anxiety.[67] As aforementioned, there are two risks surrounding vaccination: adverse effects from the COVID-19 vaccine and being infected with COVID-19.[59] Thus, people with high HA probably failed to make a unified choice in a dilemma associated with the COVID-19 vaccination. RD is the tendency to maintain previously rewarded behavior, particularly concerning social signals.[42] People with low RD are generally independent, non-conformist, practical and insensitive to social cues.[68] Thus, it is not surprising that the vaccine hesitancy group had lower RD scores and that low RD predicted vaccine hesitancy. People with low RD are likely to decide whether or not to be vaccinated based on their practical judgment, rather than being bound by social pressure or trends. Hence, policies targeting them should be developed to provide more realistic and practical benefits.

Limitations of this study

This study had several limitations. First, the results are not generalizable because of the small sample size, the high proportion of women, the high educational level and the relative youthfulness of the subjects. The under-representation of the elderly population was because the priority vaccination program for the elderly had been completed before the study period. Second, the short data selection period also limits generalizability. Vaccination willingness depends on time and context.[21] Lastly, the present study did not investigate the effect of interventions based on our findings. Further studies are needed to evaluate the efficacy of targeted interventions at both individual and national levels.

Conclusion

This study suggests that the 5C model, emotions and personality all significantly affect COVID-19 vaccine hesitancy. High GAD-7, IAS and low RD scores as well as low confidence and collective responsibility predicted COVID-19 vaccine hesitancy. Policies encouraging vaccination should be tailored to an individual's psychological traits rather than be adopted as a one-size-fits-all approach.

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Supplementary Data

Supplementary data are available at the *Journal of Public Health* online.

Author contributions

HJK and EK conceived the idea for the study and collected the data. DHH conducted the statistical analysis and interpreted the results. HJK wrote the manuscript, and EK and DHH critically revised the manuscript. All authors read and approved the final version of the manuscript.

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Conflict of interest

The authors declare that they have no conflict of interest.

Data availability

The data in this study are not publicly available. Requests for data access will be considered on application to the corresponding author Doug Hyun Han.

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