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An Examination of Factors Beyond the 5C Model in COVID-19 Vaccination Decisions

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ABSTRACT

Background: A delay in accepting or a refusal of vaccination despite the availability of vaccination services is referred to as vaccine hesitancy. Vaccine hesitancy has gained increased attention, particularly since the outbreak of the COVID-19 pandemic. The most commonly used framework in studies of vaccine hesitancy and its determinants has been the 5C model. The 5C model posits that the five individual-level determinants influencing vaccine hesitancy are confidence, complacency, constraints, calculation, and a feeling of collective responsibility. However, other factors that may also be important in influencing vaccine hesitancy, such as sociodemographic and psychological determinants, have received less attention.

Objectives: This study analyzed 1) the effectiveness of the 5C model in predicting the COVID-19 vaccination decision and 2) the association between COVID-19 vaccination decisions and the fear of being infected with COVID-19, attitude toward the media's COVID-19 vaccination information, monetary incentives, political attitudes, perception of Hong Kong's future, and attitude toward the vaccination advice of authorities (government officials and healthcare professionals).

Methods: This study used data collected in an online questionnaire distributed from May 2022 to June 2022 during the fifth wave of the Omicron variants in Hong Kong. The questionnaire had 32 items measuring the COVID-19 vaccination status, demographic characteristics, the five determinants of the 5C model, and the following six additional factors: 1) fear of being infected with COVID-19, 2) attitude toward the media's COVID-19 vaccination information, 3) monetary incentive, 4) political attitudes, 5) perception of Hong Kong's future, and 6) attitude toward the vaccination advice of authorities.

Results and Conclusions: For the 5C determinants, only confidence was significantly positively associated with COVID-19 vaccination, whereas complacency, constraints, and collective responsibility were associated when a relaxed *p*-value ($p \leq 0.25$) was used. For the six additional factors, only attitude toward the media's COVID-19 vaccination information was significantly positively correlated with vaccination status, and when a relaxed *p*-value ($p \leq 0.25$) was used, a fear of being infected with COVID-19, political attitudes, and perception of Hong Kong's future was found to be associated. There was no evidence that calculation, monetary incentives, attitude toward the vaccination advice from authorities, or demographic characteristics were associated with COVID-19 vaccination decisions. The collinearity analysis among the 5C determinants and six additional factors suggested that the six new variables are additional determinants of vaccination decisions.

Keywords: Vaccine hesitancy, Vaccine, Covid-19, 5C model

INTRODUCTION

The COVID-19 pandemic has presented numerous challenges to the global community, one of which has been the uptake of vaccines. Despite the fact that COVID-19 vaccines are safe, effective, and available, delays in accepting or refusing the vaccination have been observed. Various factors, such as a lack of trust in medical professionals and religious and ideological convictions, can contribute to vaccine hesitancy. There have also been concerns about the speed at which COVID-19 vaccines were developed and authorized, which may have contributed to worries about their efficacy and safety. Additionally, there have been instances of false/misleading information about vaccine safety and conspiracy theories spreading on social media, which have further intensified individuals' reluctance to get vaccines (Al-Sanafi and Sallam 2021, Sallam 2021, Portoghese, Siddi et al. 2023).

Most studies of the factors that influence or predict vaccine hesitancy, in general, have used the 5C model. This model proposes that five factors, namely confidence, complacency, constraints, calculation, and a feeling of collective responsibility, determine (either facilitate or hinder) individual vaccination decisions (Jarrett, Wilson et al. 2015, Betsch, Schmid et al. 2018). However, in the context of COVID-19 vaccine hesitancy, the 5C model has been shown to be less capable of fully explaining the observed vaccination behavior of citizens (Kwok, Li et al. 2021, Nath, Imtiaz et al. 2021, Kumar, Mathur et al. 2022). This raises the concern that other determinants that are important in predicting vaccination decisions are being overlooked (Xiao and Wong 2020, Machingaidze and Wiysonge 2021, Soares, Rocha et al. 2021, Ransing, Kukreti et al. 2022, Wiysonge, Ndwandwe et al. 2022). There are at least six non-5C-model factors that can influence general vaccination decisions and may also influence an individual's decision to get COVID-19 vaccines, which are described as follows.

- Fear of being infected – An individual's worry about being infected by the disease and its reported sequelae health consequences could influence their decision to receive a vaccine (Facciolà, Visalli et al. 2019, Mesch and Schwirian 2019).
- Attitude toward the media's COVID-19 vaccination information – Individuals receive a plethora of vaccination-related information from the media, which could influence their attitudes toward vaccination and thus shape vaccination decisions. Vaccine hesitancy has been linked to media misinformation that overemphasizes rare adverse events, amplifies the voices of vaccine skeptics, and undermines trust in public health authorities (Dubé, Laberge et al. 2013, Rosselli, Martini et al. 2016, Broadbent 2019).
- Monetary incentives – Monetary incentives may increase vaccination rates by encouraging individuals to get vaccinated. Exploring the impact of monetary incentives on vaccination decisions may provide insights for public health policies (Jarrett, Wilson et al. 2015, Kumar and Noor 2018).
- Political attitudes – Political ideology shapes one's beliefs and behaviors toward political issues and government. Such ideology also affects one's

trust in government officials, including healthcare professionals. People who are politically polarized and skeptical toward the government could doubt vaccine safety and efficacy and be less willing to get vaccinated (Mesch and Schwirian 2015, Giambi, Fabiani et al. 2018).

- Perception of Hong Kong's future – People with a positive perception of Hong Kong's future are often more confident in the government's decisions. Their higher level of trust in the government and healthcare system could motivate them to get vaccinated (Rosselli, Martini et al. 2016, Schmid, Rauber et al. 2017).
- Attitude toward the vaccination advice of authorities – Government officials and public health organizations have been working on public health campaigns and education to increase public trust and address concerns about vaccine safety and efficacy. Evidence from previous research has shown that government officials and healthcare professionals can provide essential information and encouragement for citizens considering vaccination (Salmon, Dudley et al. 2015, Coombes 2017).

Given that these six factors have been shown to be relevant to vaccination decisions for other diseases, they may also play an important role in shaping an individual's beliefs and behaviors in the case of COVID-19 vaccination. We thus investigated whether these six factors were associated with COVID-19 vaccination.

Through an online survey of Hong Kong residents, this study examined 1) the effectiveness of the 5C model in predicting COVID-19 vaccination and 2) the relationship between COVID-19 vaccination decisions and demographic characteristics, the fear of being infected with COVID-19, the attitude toward the media's COVID-19 vaccination information, monetary incentives, political attitudes, the perception of Hong Kong's future, and the attitude toward the vaccination advice of authorities. The findings of this study can inform decision makers and public health officials in addressing the challenges of the COVID-19 pandemic, particularly vaccination challenges and future outbreaks of infectious disease.

METHODOLOGY

Study Design

This study was based on an online questionnaire survey of a convenience sample of residents in Hong Kong who were contacted randomly between May 2022 and June 2022 during the fifth wave of the Omicron variant in Hong Kong. The online questionnaire was created using Google Form and was completed anonymously. Before a participant answered the questionnaire, their written informed consent was obtained. The questionnaire asked 32 questions about COVID-19 vaccination status, demographic characteristics, 5C model factors, the fear of being infected with COVID-19, attitude toward the media's COVID-19 vaccination information, monetary incentives, political attitudes, perceptions of Hong Kong's future, and the attitude

Table 1. Questionnaire items in the present study.

Variables	Questionnaire items
COVID-19 vaccination status	• VAC: Have you received a COVID-19 vaccine? (Yes, No)
Demographic characteristics	• DEM1: What is your age? • DEM2: What is your gender? (Male, Female) • DEM3: What is your marital status? (Married, Divorced, Separated, Widowed, Unmarried) • DEM4: What is the highest level of education that you completed? (Primary school or less, Secondary school, Higher diploma or associate degree, Bachelor's degree or higher) • DEM5: Which of the following describes your employment status right now? (Working remotely only, Working in person only, Working both remotely and in person, Not working)
CONF: Confidence (from the 5C model)	• CONF1: I am completely confident that COVID-19 vaccines are safe. (Strongly disagree (1) – Strongly agree (7)) • CONF2: COVID-19 vaccinations are effective. (Strongly disagree (1) – Strongly agree (7)) • CONF3: Regarding COVID-19 vaccines, I am confident that public authorities decide in the best interest of the citizens. (Strongly disagree (1) – Strongly agree (7))
COM: Complacency (from the 5C model)	• COM1: COVID-19 vaccination is unnecessary because the disease is not so severe as we thought. (Strongly disagree (1) – Strongly agree (7)) • COM2: My immune system is so strong it protects me against COVID-19. (Strongly disagree (1) – Strongly agree (7)) • COM3: COVID-19 is not so severe that I should get vaccinated. (Strongly disagree (1) – Strongly agree (7))
CONS: Constraints (from the 5C model)	• CONS1: Everyday stress prevents me from getting COVID-19 vaccine. (Strongly disagree (1) – Strongly agree (7)) • CONS2: For me, it is inconvenient to receive COVID-19 vaccinations. (Strongly disagree (1) – Strongly agree (7)) • CONS3: Visiting doctors makes me feel uncomfortable; this keeps me from getting COVID-19 vaccine. (Strongly disagree (1) – Strongly agree (7))
CAL: Calculation (from the 5C model)	• CAL1: When I think about getting COVID-19 vaccine, I weigh the benefits and risks to make the best decision possible. (Strongly disagree (1) – Strongly agree (7)) • CAL2: For COVID-19 vaccination, I closely consider whether it is useful for me. (Strongly disagree (1) – Strongly agree (7)) • CAL3: It is important for me to fully understand the topic of COVID-19 vaccination before I get vaccinated. (Strongly disagree (1) – Strongly agree (7))
COL: Collective responsibility (from the 5C model)	• COL1: When everyone is vaccinated, I don't have to get vaccinated, either. (Strongly disagree (1) – Strongly agree (7)) • COL2: I get the COVID-19 vaccination because I can also protect people around me with a weaker immune system. (Strongly disagree (1) – Strongly agree (7)) • COL3: COVID-19 vaccination is a collective action that prevents the spread of the disease. (Strongly disagree (1) – Strongly agree (7))
FEA: Fear of being infected with COVID-19	• FEA1: How worried are you about being infected with COVID-19? (Not worried at all (1) – Strongly worried (7)) • FEA2: How worried are you about the possible sequelae after getting COVID-19? (Not worried at all (1) – Strongly worried (7))

Table 1. Continued.

Variables	Questionnaire items
MED: Attitude toward the media's COVID-19 vaccination information	• MED1: To what extent do you think the information about COVID-19 vaccination you received from the media is positive? (Extremely negative (1) – Extremely positive (7))
MON: Monetary incentive	• MON1: To what extent do you think the Hong Kong Vaccination Lucky Draw would encourage you to get vaccinated? (Not at all (1) – Strongly encouraged (7))
POL: Political attitudes	• POL1: When it comes to most political issues, do you think of yourself as a conservative, neutral, or liberal?
PER: Perception of Hong Kong's future	• PER1: Where do you think things in Hong Kong are heading toward? (Completely on the wrong track (1) – Definitely headed in the right direction (7))
ADV: Attitude toward the vaccination advice of authorities	• ADV1: To what extent do you think the government official's advice encouraged you to get vaccinated? (Not at all (1) – Strongly encouraged (7)) • ADV2: To what extent do you think a healthcare professional's advice encouraged you to get vaccinated? (Not at all (1) – Strongly encouraged (7))

toward the vaccination advice of authorities. Table 1 presents the questionnaire items and corresponding response options in parenthesis following the item. Each item is assigned an alphanumeric code for ease of later reference.

Data Analysis

Responses for the COVID-19 vaccination status were converted into binary outcomes, with a response of Yes converted to a value of 1 and a response of No converted to a value of 0. Responses to the educational background question under demographic characteristics (DEM4) were converted into ordinal data from 1 to 4 (1: Primary school or less, 2: Secondary school, 3: Higher diploma or associate degree, 4: Bachelor's degree or higher). Responses to political attitudes (POL1) were converted into ordinal data from 1 to 3 (1: conservative, 2: neutral, 3: liberal). Univariate logistic regressions were used to identify the associations between COVID-19 vaccination status and the other questionnaire variables. The result for each variable was calculated as the mean value of all corresponding questionnaire items (Sperandei 2014). To further clarify the correlations between different variables, a correlation matrix was applied to assess collinearity. Collinearity analysis was conducted to show that the variables proposed, in addition to the 5C determinants, could provide additional information not included in the 5C model. All statistical analyses were conducted using the software R (version 4.2.0).

RESULTS

Univariate Logistic Regression

The results of the univariate logistic regression analysis, namely the regression coefficients and corresponding standard errors, odds ratios with 95% confidence intervals, and p-values for each variable, are given in Table 2. Among the variables in this study, confidence in the COVID-19 vaccination (*CONF*) and attitude toward the media's COVID-19 vaccination information

Table 2. Univariate regression results.

	Coefficient	Std. Error	OR (95% CI)	*p*-value
DEM1	0.0016	0.0341	1.00 (0.94, 1.07)	0.9621
DEM2_Male	0.6931	1.2436	2.00 (0.17, 22.89)	0.5773
DEM3_Married	-13.8049	2797.442	0.00 (0.00, inf)	0.9961
DEM3_Unmarried	-13.9825	2797.442	0.00 (0.00, inf)	0.996
DEM3_Widowed	-15.9566	2797.442	0.00 (0.00, inf)	0.9954
DEM4	-0.0114	0.5819	0.99 (0.32, 3.09)	0.9844
DEM5_In person only	-0.5232	1.4490	0.06 (0.03, 10.14)	0.718
DEM5_Not working	0.2595	1.4372	1.30 (0.08, 21.68)	0.8567
DEM5_Remote Only	15.2702	2306.1012	4283289.0 (0.00, inf)	0.9947
CONF	3.5295	1.6913	34.11 (1.24, 938.62)	0.0369*
COM	-0.4664	0.3547	0.63 (0.31, 1.26)	0.1886.
CONS	-0.6052	0.3891	0.55 (0.25, 1.17)	0.1198.
CAL	-0.2774	0.5151	0.76 (0.28, 2.08)	0.5902
COL	0.4392	0.312	1.55 (0.84, 2.86)	0.1592.
FEA	-1.4637	0.7848	0.23 (0.05, 1.08)	0.0622.
MED	2.4275	1.2229	11.33 (1.03, 124.5)	0.0471*
MON	0.7902	0.7469	2.2 (0.51, 9.53)	0.2901
POL	-1.0452	0.6589	0.35 (0.1, 1.28)	0.1127.
PER	0.959	0.5033	2.61 (0.97, 7)	0.0568.
ADV	0.1433	0.3734	1.15 (0.56, 2.4)	0.7011

*$p < 0.05$, $p \leq 0.25$

(*MED*) were both significantly positively associated with vaccination status $p \leq 0.05$. Specifically, individuals with higher confidence in COVID-19 vaccinations and those who perceived the media coverage of vaccines to be more positive were more likely to have been vaccinated. When a relaxed *p*-value ($p \leq 0.25$) was used, six variables were identified as associated with vaccination decisions: perception of Hong Kong's future (*PER*), fear of being infected with COVID-19 (*FEA*), political attitudes (*POL*), constraints (*CONS*), a feeling of collective responsibility (*COL*), and complacency (*COM*). Specifically, for PER, people with a positive perception of Hong Kong's future were more likely to be vaccinated. For FEA, vaccinated people were found to have less fear and worry about COVID-19 infection and possible sequelae. For POL, conservative people were more willing than liberal people to get vaccinated. For CONS, COL, and COM, people under more constraints and people with a higher level of complacency were less likely to get vaccinated, and people who felt more collective responsibility were more willing to get vaccinated. The univariate analysis revealed that two variables were significantly associated (when $p \leq 0.05$ was considered), and another six variables were associated (when $p \leq 0.25$ was considered) with COVID-19 vaccination.

Collinearity Analysis

To evaluate the potential for collinearity among the variables, a correlation matrix was produced (Table 3). Pearson's correlation coefficients between

Table 3. Correlation matrix (Pearson's correlation coefficients).

VAC	*DEM1*	*DEM4*	*CONF*	*COM*	*CONS*	*CAL*	*COL*	*FEA*	*MED*	*POL*	*PER*	*ADV*
VAC												
DEM1	0.01											
DEM4	0	−0.69*										
CONF	0.33*	0.16*	−0.16									
COM	−0.15	−0.09	−0.01	−0.28*								
CONS	−0.18	−0.14	0.04	−0.48*	−0.61*							
CAL	−0.06	−0.17	−0.1	0.33*	−0.23*	−0.28*						
COL	0.16	−0.23*	−0.18	0.59*	−0.44*	−0.59*	−0.53*					
FEA	−0.24*	0.12	−0.18	0.03	−0.22*	−0.09	−0.32*	−0.19				
MED	0.21	0.23*	−0.23*	0.30*	−0.11	−0.17	0.11	0.18	−0.16			
POL	−0.18	0.08	0.09	−0.11*	−0.03	0.08	0.28*	0.1	−0.26*	−0.09		
PER	0.24*	0.18	0.13	−0.30*	−0.26*	0.38*	−0.28*	−0.31*	−0.2	−0.36*	−0.05	
ADV	0.04*	0.04	0.01	−0.01*	−0.11	0.01	0.04*	0.08	0.14	0.01	0	−0.2

*$p < 0.05$

each pair of variables are shown with statistically significant ($p < 0.05$) pairs marked with *.

None of the variables were significantly correlated with the outcome variable ($|r|>0.7$), indicating that the collinearity among variables was acceptable. There were five pairs of correlated variables ($0.5<|r|\leq 0.7$), namely *DEM1* and *DEM4*, *COM* and *CONS*, *COL* and *CONF*, *COL* and *CONS*, and *COL* and *CAL*. All of the moderately correlated variable pairs consisted of 5C model variables or demographic variables, indicating that the proposed variables were not correlated with those in the 5C model.

CONCLUSION

Our examination of the 5C model determinants suggests that confidence in vaccinations was significantly associated with COVID-19 vaccination decisions. When a relaxed p-value ($p \leq 0.25$) was used, complacency, constraints, and collective responsibility were associated with vaccination decisions. However, there is no evidence that calculation was associated with COVID-19 vaccination decisions. Among the six variables introduced in this study, attitude toward the media's COVID-19 vaccination information was significantly correlated with vaccination status. When a relaxed p-value ($p \leq 0.25$) was used, the fear of being infected with COVID-19, attitude toward the media's COVID-19 vaccination information, political attitudes, and the perception of Hong Kong's future was associated with vaccination decisions. Monetary incentives, attitude toward the vaccination advice from authorities, and demographic characteristics were not associated with vaccination decisions.

Interventions that target specific factors, such as attitudes toward the media's COVID-19 vaccination information, political attitudes, and the perception of Hong Kong's future, could potentially increase vaccine uptake and address vaccine hesitancy. Strategies to control potential media misinformation and bias, such as fact-checking regulations or legal measures to combat rumors and misinformation in media, should be developed to more appropriately shape perceptions of information from the media. Tailored education about vaccination could improve limited trust in the government and address the effects of political attitudes and the perception of Hong Kong's future. However, further research is needed to explore the effectiveness of such interventions and whether these factors hold across different populations and contexts.

The collinearity test results indicate that the six selected variables were not either inter-correlated or correlated with existing 5C determinants. Therefore, these variables may serve as additional, independent determinants of vaccination decisions and provide valuable insights into explaining vaccine hesitancy. One limitation of this study was the small sample size, which affected the statistical power and generalizability of the findings, and. Thus, larger samples are needed for future studies.

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