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The use of Health Belief Model (HBM) to explain factors underlying people to take the COVID-19 vaccine in Indonesia

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ABSTRACT

Background: SARS-COV-2 (COVID-19) has severely impacted people's health worldwide. Vaccines are one of the health measures taken to reduce the impact of COVID-19, but recent reports have revealed that some people are reluctant to be vaccinated against COVID-19. Understanding the factors underlying an individual's decision to take the COVID-19 vaccine is critical to designing an immunisation programme. This study examines factors that influence the intention to take a COVID-19 vaccine using the modified Health Belief Model (HBM) framework and analysing demographic factors.

Method: A cross-sectional online survey was conducted from 10 January to 20 January 2021. Five hundred thirty-seven respondents above 17 years old and residing in Indonesia voluntarily completed an online survey. Survey questions addressed sociodemographic factors; perception of susceptibility, severity, benefits and barriers; cues to action; and intention to take the COVID-19 vaccine. A Structural Equation Modelling (SEM) approach with SmartPLS software was used to analyse the measurements and model construct.

Findings: The results showed that the perception of susceptibility, severity, benefits and barriers, as well as cues to action, predicted people's intention to take a COVID-19 vaccine. Model structure explained a large proportion of variance in people's intention to be vaccinated against COVID-19 (R^2 = 66.8 %). Some demographic factors affected the key variables of the HBM. People with low and middle income negatively influence feeling severity, beneficial and barrier in intending to take vaccine. Other demographic factors such as sex, age, marriage and living areas did not affect the components of the HBM, except for females influencing severity and people living in urban areas associated with benefits variable. These findings imply that COVID-19 vaccination programmes should focus on providing accurate information about the severity of COVID-19 and the benefits of taking the vaccine. Building people's confidence in their ability to eliminate barriers to taking the vaccine and involving family members and community and religious leaders will increase COVID-19 vaccine uptake.

Conclusion: Despite limitations to the study, such as respondent demographics that are unrepresentative of the wider Indonesian population, inadequate survey timing and an exclusive focus on vaccine intention as the outcome variable, the present study contributes to explaining individuals' intentions to take a COVID-19 vaccine in a Eastern country context. This study is valuable to providing public health policy recommendations that focus on effectively designing immunisation programme interventions.

Introduction

People worldwide have been experiencing the severe impact of SARS-COV-2 (COVID-19) since the outbreak began in Wuhan, China at the end of 2019. Although governments have taken health measures to reduce the impact of COVID-19 such as mandating social distancing, masking and handwashing, the most effective way to end the COVID-19 outbreak is a pharmaceutical intervention such as the COVID-19 vaccine [65]. Past studies have shown that vaccines save millions of lives [1]. Research has found that the mRNA-1273 vaccine has been 94.1 % effective in preventing

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COVID-19 infection [11]. Although COVID-19 vaccines have been available since the end of 2020, providing new hope to reduce spreading the COVID-19, some people reject the vaccine for various reasons [22]. Recent reports have revealed that 25 % of citizens in France, Germany, and the United States [43] and 20 % of citizens in Canada were reluctant to take COVID–19 vaccination [55].

Since the availability of the COVID-19 vaccine, some studies have been conducted to assess the acceptance of such a vaccine including in Indonesia. Most of them trying to identify factor determinants in influencing acceptance of a COVID-19 vaccine such as the effectiveness of the vaccine [29], cognitive reflection, trust in social leaders, and personality traits [64], and basic components of the Health Belief Model (HBM) [24]. Since Indonesia is a diverse community in terms of social economic, race, religion, and culture it is necessary to conduct a comprehensive study on vaccine acceptance. To the author's knowledge, no study has been conducted on COVID-19 vaccine acceptance using demographic integrated with the HBM model in Indonesia.

Indonesia is one of the countries hardest hit by COVID-19. As of 24 February 2022, there were 5,350,902 total cases, 4,632,355 recovered cases and 147,025 deaths because of COVID-19 in Indonesia [49]. As the vaccine became available in early January 2021, the Government of Indonesia provided a free COVID-19 vaccine to all members of the population meeting certain health requirements [59]. Vaccination was prioritised for frontline health workers, essential workers, older adults and public officers before it was offered to the general public.

Arifin and Anas [9] reported that in preparing for the implementation of the vaccine program, the government of Indonesia has used massively public and private places as well as door-to-door strategies to attract the public in accessing the vaccination program. Even, the government institution, the state-owned enterprises, police and army institutions as well as private sectors have supported the Indonesian government to facilitate the national vaccine program. Governments have made efforts to promote the benefits of taking a COVID-19 vaccine, yet some people have refused vaccination. The opposed people, often influenced by conspiracy theories, believe that COVID-19 vaccines have not been tested properly, negatively impact health or do not comply with religious teachings, amongst other reasons [13]. In addition, some communities raised doubt about the effectiveness of vaccines from China [53].

Although the COVID-19 vaccine acceptance rate in Indonesia was reported high, with 93 % of adults intending to receive the vaccine, vaccine refusal leads to difficulties in achieving herd immunity [55]. It is therefore critical to investigate the factors that influence people to be voluntarily vaccinated against COVID-19 and to understand the root problems of vaccine refusal using the HBM framework. The HBM has been confirmed as a strong model for establishing effective interventions in research toward health-related behavior [8]. Previous studies found that using the HBM model on COVID-19 resulted in predicting COVID-19 vaccine acceptance [34,45]. A systematic review concluded that 87.5 % of the studies involving HBM can predict a better factor in influencing COVID-19-related-behavior [66]. Another advantage of using HBM is that there is no strict standard on how to develop variables in predicting behavior [41].

The HBM has been largely used to predict health behaviour in a variety of specific contexts [18]. Previous studies have employed the HBM to successfully explain health behaviours relating to specific populations or activities such as female sex workers [67], Korean medical tourism [12], women screening for breast cancer [21], self-care with diabetes [10], meningitis [57], cardiovascular disease prevention, dietary patterns [7], and driving safety [19].

A group of psychologists in the U.S. Public Health Service developed the HBM framework to identify why people partake in healthy behaviour [52]. The HBM is a psychological model that explains and predicts specific health behaviours. The model describes that before taking certain behavior, people will evaluate the advantages and disadvantages of such behavior [27]. For example, if they perceive that taking the vaccine is more beneficial, they will make effort to do it. In contrast, if people think that taking a vaccine is not useful, they may be reluctant to do that. The HBM model consists of two variables that reflect the evaluation of barriers and benefit in taking behavior. The HBM predicts that people's behaviour is determined by their perceived susceptibility to risk, severity of risk, benefits to action, and barriers to action [17]. Later, other factors were added to the HBM, including cues to action [50], efficacy [31], confidence [32] and health motivation [20]. One of the standard models is depicted in Fig. 1 [47].

The goal of the HBM is to predict future health-related behaviour of individuals. Several studies have found that application intention can significantly foster the performance of the actual health behaviour [47]. The perceived susceptibility refers to an individual's perception of the threat posed by a disease or illness, and the perceived severity refers to their perception of the seriousness of the disease. The perceived benefit is an individual's belief that a certain health behaviour will likely reduce the harmful impact of the illness. Similarly, the perceived barrier is an individual's perception of being able to take action to reduce the threat of illness [47].

Cues to action refer to the motivations that trigger an individual to partake in health-related behaviour. This concept is similar to the concept of the subjective norm, which is a component of the Theory of Planned Behaviour (TPB) [2]. The subjective norm in the TPB refers to "persons' beliefs that specific individual or group think we should or should not take a certain behavior" [27]. Specific individuals or groups can be a wife, a husband, sons, parents, community or religious leaders, government officers, and others. While cues action of this study focused on social pressures from family, religious leaders, media, and government officers (Kim & Kim, [66]; Salazar, [67]). Social acceptance and the history of local outbreaks' variables are sometimes included in the HMB model, yet this study did not include them. Cues can be internal or external factors that encourage or discourage people to partake in healthy behaviour [36]. In the social context, people's behaviour is influenced by parents, religious leaders, community leaders, government officers and doctors [58]. The public acceptance of a COVID-19 vaccine may be affected by the social context [16].

The HBM components are affected by demographic factors [28]. Previous studies using the HBM model have reported that socioeconomic status and age are related to vaccination intention [38]; men older than 55 years have a greater willingness to be vaccinated, but younger men refused vaccination [42]. Another study has revealed that vaccine properties such as national origin, side effects, and effectiveness influence people to take vaccines [39].

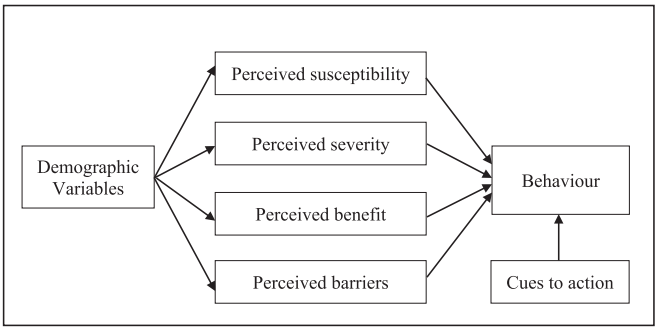

Fig 1. The Health Belief Model (HBM).

Other predictors of COVID-19 vaccine uptake include the presence of conspiracy beliefs [15]and trust in the government [48].

Most applications of the HBM to disaster risk and public health have been conducted in Western countries [23]. Because Eastern countries such as Indonesia have different cultural characteristics than Western countries, it is valuable to use the HBM framework to investigate the willingness of Indonesians to take the COVID-19 vaccine. Cultural identity influences the psychological and social aspects of individual attributes during a crisis of health [3]. One of the cultural theories differentiates between individualism and collectivism characteristics. Individualism represents western societies while collectivism is regarded in Eastern societies including Indonesia. In a collectivist society, individual motives and attitudes are considered other members of society [54]. For most people living in Indonesia, as a postcolonial state, the personal and societal members ties are stronger than in Western countries [14]. We argue that the roles of family members and informal leaders which is similar to cues to action, one of the HBM components, play important factors in determining vaccine acceptance in Indonesia.

This study hypothesises that sex, age, marriage, income, and living area factors influence perceived susceptibility, severity, benefits and barriers. In turn, these four components of the HBM, in addition to cues to action, predict people's intention to take the COVID-19 vaccine. This research is critical, as some people are reluctant to accept vaccination despite that it is an effective way to combat COVID-19. By revealing the factors underlying people's decisions to take a COVID-19 vaccine, this study contributes valuable information to public health policy interventions and immunisation programmes designed to support herd immunity.

Methods

Participants and survey design

An online questionnaire made with Google Forms was used to gather the data from 10 to 20 January 2021. The first vaccine-COVID-19 program has been started on January 13, 2021, when President Joko Widodo received a shot of Coronavac imported from China. Therefore, the intention of people to take the vaccine in this study means taking the first time for the vaccine. The questionnaire was distributed through social media, including WhatsApp, email, Facebook and other platforms. Only people living in Indonesia and at least 17 years old could participate in the survey. Under Indonesia's law, an adult is categorized as 17 years old and older. On the first page of the questionnaire, general information was provided, such as the purpose of the survey, anonymity and protection of personal data, voluntary participation, withdrawal from the survey before analysis and authors' names. Before filling out the questionnaire, participants were asked to complete the consent form by clicking 'agree' or 'not agree' to participate in the survey. Five hundred eighty-nine participants responded to the questionnaire, and the responses of 537 participants were analysed. Fourteen participants did 'not agree' to participate, and another 38 participants were excluded due to either incomplete or invalid responses. Invalid response means respondents have not completed the information or missing the answers particularly-one or more items constructed components of the HBM variables. The questionnaire consisted of questions relating to demographics and the HBM variables. Demographic data included sex (male or female), ages ($\leq$45 or greater than 45 years old), rural–urban classification (rural or urban), education (graduate degree or high school), marital status (married or single/divorced), and income (low income, middle income and high income). The extended HBM variables items were perceived susceptibility, severity, benefits and barriers; cues to action; and intention to take a COVID-19 vaccine.

Variables and measurements

The HBM variable item measurements were adapted from the modified HBM [17]. Participants responded using a scale which varied from 1 (strongly disagree) to 4 (strongly agree), which was adapted from the Health Assessment Questionnaire [40]. Demographic variables were measured using categorical data, which were treated as dummy variables. As education data samples being inequality, only sex, marital status, income, and living areas were included in the model analysis.

Four survey items measured the intention: (1) 'I plan to take COVID-19 vaccine', (2) 'I am willing to take the COVID-19 vaccine', (3) 'I will take the vaccine even if it is difficult to do', and (4) 'I will try to take the COVID-19 vaccine even if I have to pay for it'.

Four items measured the perceived susceptibility: (1) 'There is a possibility I will be infected by COVID-19′, (2) 'I am more likely than other people to be infected with COVID-19′, (3) 'If there were no vaccine, the spread of COVID-19 would worsen', and (4) 'If the spread of COVID-19 is not brought under control, within the next 6 months I might become infected'.

There are four items measured in the perceived severity: (1) 'If I contaminated COVID-19, it would cause my family to get disturbed', (2) 'The increasing number of infected COVID-19 make me worried', (3) 'If I contaminated COVID-19, it would disrupt my economic and social life', and (4) 'If I do not take vaccine of COVID-19 and I infected COVID-19, my life become worse'.

Four items measured the perceived benefits: (1) 'Vaccination can lead to immunity against COVID-19′, (2) 'If I take a COVID-19 vaccine, I will be less likely to be infected by COVID-19′, (3) 'Taking the vaccine can protect and save my family', and (4) 'COVID-19 vaccination can reduce my worries'.

Three items measured perceived barriers: (1) 'I do not believe that the COVID-19 vaccine can protect against COVID-19′, (2) 'The COVID-19 vaccine is NOT in accordance with my religious values or beliefs', and (3) 'Because the vaccine is made in China, I do not trust it'. In analysing the data, the negative measurements of the perceived barriers were reverse to the positive measurements.

Four items measured cues to action: (1) 'My family members (children/husband/wife/parents) agree that I should take the vaccine', (2) 'Religious leaders (ulama/priests/monks) agree that I should take the vaccine', (3) 'The government advises that I take a vaccine against COVID-19′.

Statistical methods

Before analysis, data cleaning was conducted using an Excel spreadsheet. Calculating descriptive statistics such as frequency, mean, and standard deviation and defining dummy variables were performed using the IBM SPSS Statistics 23.0 software package (IBM Corp., Armonk, NY, USA). This study used a Partial Least Squares Structural Equation Modelling (PLS-SEM) approach. PLS-SEM are increasingly used to analyse data with small sample sizes, non-normal data, and latent variables and allow predictions involving many independent variables [45,50]. Data were processed using SmartPLS 3.3.2 (SmartPLS GmbH, Boenningstedt, Germany) as this application is easier for beginners and available for a free [44].

Before testing the structural model, the construct reliability and validity of the measurement model were verified [45]. Outer loadings were set to above 0.7 (K. K.-K. [61]. Generally, a Cronbach's alpha (CA) score above 6 and composite reliability (CR) score above 0.7 indicates good reliability [25]. The convergent validity (CV) was examined by observing the average variance extracted (AVE) value.

The criterion for CV is that the AVE should be greater than 0.5 [44]. Discriminant validity (DV) is another test that was used to verify the validity of the measurements. According to Wong [61] the criterion for DC is that 'the square root of AVE of each latent variable should be greater than the correlations among the latent variables'.

The SmartPLS bootstrapping procedure was run with 5000 iterations and 500 subsamples. The hypotheses were tested using a *p*-value significance level of 0.05. The adjusted R-squared (R^2) quantify the portion of the structural model that explains and predicts the dependent variables [44]. Cohen [68], cited by Ringle et al. [44], explained that an R^2 of approximately 2 % is categorised as a small effect, an R^2 of about 13 % as a medium effect, and an R^2 of more than about 26 % as a large effect.

Results

Respondent profile

The responses of 537 participants were analysed (Table 1). There was a greater proportion of females (58.5 %) than males (41.5 %). The sample was thus slightly over-representative of women compared to the general Indonesian population, which is 50.2 % males and 49.8 % females (Indonesia [30]. In terms of age, participants 45 years old and under made up 66.5 % of the sample, and participants over 45 years old made up 33.5 %. The proportions of rural and urban respondents were 36.9 % and 63.1 %, respectively. More participants were married (67.8 %) than single or divorced (32.2 %). The majority of the respondents (84.5 %) had completed undergraduate or graduate programme degrees, and only 15.5 % had secondary or primary school as their highest level of education. Most participants (42.3 %) had a monthly income of Rp 7 million (1 USD = Rp 15,000) or greater, followed by Rp 1 million or below (31.1 %), and between Rp 3–4 million (26.6 %).

The mean, standard deviation (SD), CA and CR, as well as the AVE value of the variables and items tested have been assessed (Table 2). As demographic variables were categorical, their factor loadings, CA, CR and AVE were 1. All the HBM variables and cues to action variables had a factor loading of more than 0.7. The values of CA and CR were also more than 0.7. AVE also met the criteria that all variables of HBM and cues to action variables were greater than 0.5. The DV test resulted that for all variables the square root of AVE was greater than the correlation among latent variables (Table 3). Overall, data measurements had good reliability and validity, as required by the structural model.

Table 1
Characteristic of Respondents.

Varibles/Items	Frequency	%
Sex (537)		
Female	314	58.5 %
Male	223	41.5 %
Age (537)		
45 and below	357	66.5 %
46 and above	180	33.5 %
Education (537)		
High School and below	83	15.5 %
Graduate and above	454	84.5 %
Living Area (537)		
Rural	198	36.9 %
Urban	339	63.1 %
Marital Status (537)		
Single	173	32.2 %
Married	364	67.8 %
Income (537)		
Rp3 million & below	167	31.1 %
Rp.3–7 million	143	26.6 %
Rp.7 miliion & above	227	42.3 %

The results of the structural model explained 66.8 % of the variance in intention to take COVID-19 vaccine (Adjusted R^2 = 0.668) (Fig. 2). The perceived susceptibility had an R^2 of 0.049, the perceived severity had an R^2 of 0.061, the perceived benefit had an R^2 of 0.039 and the perceived barriers had an R^2 of 0.073. The results of the structural model explained the association among the variables tested, the path coefficients (β), the *t*-statistics and the *p*-values (Table 4). Among 29 associations between variables, there were 14 variables pairs that were significant and supported the hypotheses.

All four components of the HBM and cues to action variables had significant effects on the intention to take a COVID-19 vaccine. Perceived susceptibility (β = 0.132, *t* = 3.448, *p* < 0.001), severity (β = 0.076, *t* = 2.000, *p* = 0.046), benefits (β = 0.248, *t* = 5.629, *p* < 0.000) and barriers (β = 0.272, *t* = 8.763, *p* < 0.000), as well as cues to action (β = 0.319, *t* = 8.029, *p* < 0.000), predicted the intention to take the COVID-19 vaccine.

Demographic factors such as sex, age, marriage, and living areas did not affect the components of the HBM, except for sex influenced severity (b = 0.143, t = 3.305, p < 0.001) and people living areas affected benefit variables (b = -0.092, t = 2.161, p < 0.031). Low and middle income had significant effect on all variables of the HBM except for the middle income had not significant on susceptibility. The effect of low income on perceived susceptibility was β = -0.187, *t* = 3.413, *p* = 0.001, severity (β = -0.208, *t* = 3.576, *p* < 0.001), benefits (β = -0.188, *t* = 3.280, *p* = 0.001) and barriers (β = -0.359, *t* = 6.279, *p* < 0.000). The effect of middle income on perceived severity (β = -0.089, *t* = 1.977, *p* < 0.049), benefits (β = -0.093, *t* = 2.048, *p* = 0.041) and barriers (β = -0.133, *t* = 3.060, *p* < 0.002).

Discussion

The present study assesses factors determining an individual's decision to be vaccinated against COVID-19 vaccine using a modified HBM constructs, including demographic and cues to action variables. All components of the HBM and cues to action had a significant effect on the intention to take the COVID-19 vaccine. The more that people believed they could contact COVID-19, become severely ill when infected, benefit from taking the COVID-19 vaccine or overcome barriers to taking a COVID-19 vaccine and the more they perceived that their social network approved of the vaccine, the more likely they were to intend to be vaccinated. These findings demonstrate the usefulness of the HBM constructs in understanding COVID-19 vaccine uptake. The result of present study was not supported by the previous findings that not all of the key components of the HBM and cues to action factors predicted the intention to prevent against COVID-19 [5,65,21]. These results indicated that a high intention to take the COVID-19 vaccine fitting to the HBM models is advantageous for a massive immunization to the general population. Public health campaigns need to focus on the five components of the HBM including perceived susceptibility, severity, benefit, barriers, and involvement of the family and social groups.

This structural model accounts for a larger proportion of variance in intention to take a COVID-19 vaccine (66.8 %) [44]than a previous related study (28 %) [8]. This finding suggests that the modified HBM framework is useful for identifying the root factors that drive vaccine decision-making and designing intervention programmes to increase the uptake of COVID-19 vaccines in this population [18]. To address the susceptibility and severity factors, the design of intervention programmes should focus on increasing awareness of the transmissibility of COVID-19 and its severe health impacts. The public should be provided with accurate information concerning the elevated risk of spreading the COVID-19 virus and

Table 2
Mean, SD, Factor Loading, Cronbach's Alpha, Composite Reliability and AVE.

Variable and Items	Mean (1–4)	SD	Factor Loading	VIF	Cronbach's α	CR	AVE
Demographic (dummy)							
Sex (female)	–	0.493	1.000	1.000	1.000	1.000	1.000
Age (45 and below)	–	0.494	1.000	1.000	1.000	1.000	1.000
Marriage (Not married)	–	0.468	1.000	1.000	1.000	1.000	1.000
Living (Urban)	–	0.483	1.000	1.000	1.000	1.000	1.000
L-Income (under Rp3 million)	–	0.463	1.000	1.000	1.000	1.000	1.000
H-Income (Rp3-7 million)	–	0.442	1.000	1.000	1.000	1.000	1.000
Susceptibility					**0.789**	**0.861**	**0.607**
I have chance to be infected	3.1229	0.73795	0.742	1.582			
Likely to be infected than others	2.4655	0.74012	0.748	1.691			
If no vaccine it will worse	3.1248	0.82931	0.836	1.877			
No vaccine it will uncontrollable	2.8101	0.82930	0.788	1.453			
Severity					**0.837**	**0.890**	**0.669**
Family will be disturbed	3.5438	0.63660	0.801	1.873			
Feeling worried	3.3110	0.71114	0.834	2.018			
Disrupting my life	3.4488	0.67310	0.826	2.006			
My life become worse	3.0354	0.80614	0.812	1.575			
Benefit					**0.922**	**0.944**	**0.809**
Vaccine can reduce COVID-19	3.0726	0.70203	0.891	3.061			
Vaccine reduce infection	2.8547	0.73387	0.864	2.628			
Vaccine will protect me	3.1322	0.72226	0.933	4.402			
Vaccine can reduce worries	3.1676	0.72908	0.909	3.530			
Barrier					**0.783**	**0.873**	**0.697**
Vaccine is not effective	2.1657	0.82887	0.846	1.651			
Vaccine against my religion	2.9851	0.74046	0.798	1.515			
I don't trust vaccine from China	2.5252	0.93156	0.859	1.864			
Cues					**0.855**	**0.900**	**0.693**
My family agree with vaccine	3.0354	0.77787	0.831	1.713			
Religious leaders agree with vaccine	2.9106	0.79611	0.828	1.973			
Government facilitate vaccine	3.1825	0.73570	0.826	2.494			
Mass media provides information	3.0670	0.75507	0.844	2.652			
Intention					**0.944**	**0.960**	**0.857**
I plan to take vaccine	3.0037	0.78701	0.953	8.356			
I will be ready to take vaccine	3.0186	0.79153	0.945	7.701			
I push to get vaccine	2.8417	0.81674	0.939	4.839			
I would pay vaccine if necessary	2.6778	0.88654	0.862	2.778			

Note: SD: Standard Deviation, VIF: Variance Inflation Factor, CR: Composite Reliability, AVE: Average Variance Extracted, Measurement: Demographic variables used dummy variables and Modified HBM variables used 1–4 scales. Demographic Variables: male (sex), 46 and above (Age), married (Marriage), rural (Living area), High-income (Rp7 million and above) are as a reference for variables dummy.

Table 3
Discriminant validity tests results.

VARIABLES	SEX	AGE	LIVING	MARRIAGE	L-INCOME	M−INCOME	SUSCEP	SEVER	BENEF	BARR	CUES	INT
SEX	**1.000**											
AGE	0.190	**1.000**										
LIVING	0.057	−0.109	**1.000**									
MARRIAGE	0.252	0.363	−0.134	**1.000**								
L-INCOME	0.193	0.375	−0.195	−0.613	**1.000**							
M−INCOME	**0.039***	−0.164	**0.006***	−0.172	−0.405	**1.000**						
SUSCEP	−0.079	**−0.044***	**0.029***	−0.173	−0.192	**0.022****	0.779					
SEVER	0.079	**−0.059****	**0.026***	−0.156	−0.186	**0.018****	0.589	0.818				
BENEF	**0.019****	−0.069	**−0.045****	−0.115	−0.147	**−0.007****	0.581	0.652	0.900			
BARR	**0.024****	−0.053	**0.036***	−0.091	−0.227	**0.004****	0.276	0.302	0.408	0.835		
CUES	**0.024***	−0.103	**0.027***	−0.139	−0.175	**0.049***	0.562	0.568	0.636	0.395	0.832	
INT	**−0.047***	−0.088	**0.058****	−0.162	−0.279	**0.009****	0.577	0.579	0.689	0.559	0.702	0.926

Note: L-INCOME: Lower Income, M−INCOME: Middle Income, SUSCEP: Susceptibility, SEVER: Severity, BENEF: Benefit, BARR: Barrier, CUES: Cues to Action and INT: Intention. Significance level: * $p < 0.001$, ** $p < 0.05$. Demographic variables used dummy variables and Modified HBM variables used 1–4 scales. Demographic Variables: male (sex), 46 and above (Age), married (Marriage), rural (Living area), High-income (Rp7 million and above) are as a reference for variables dummy.

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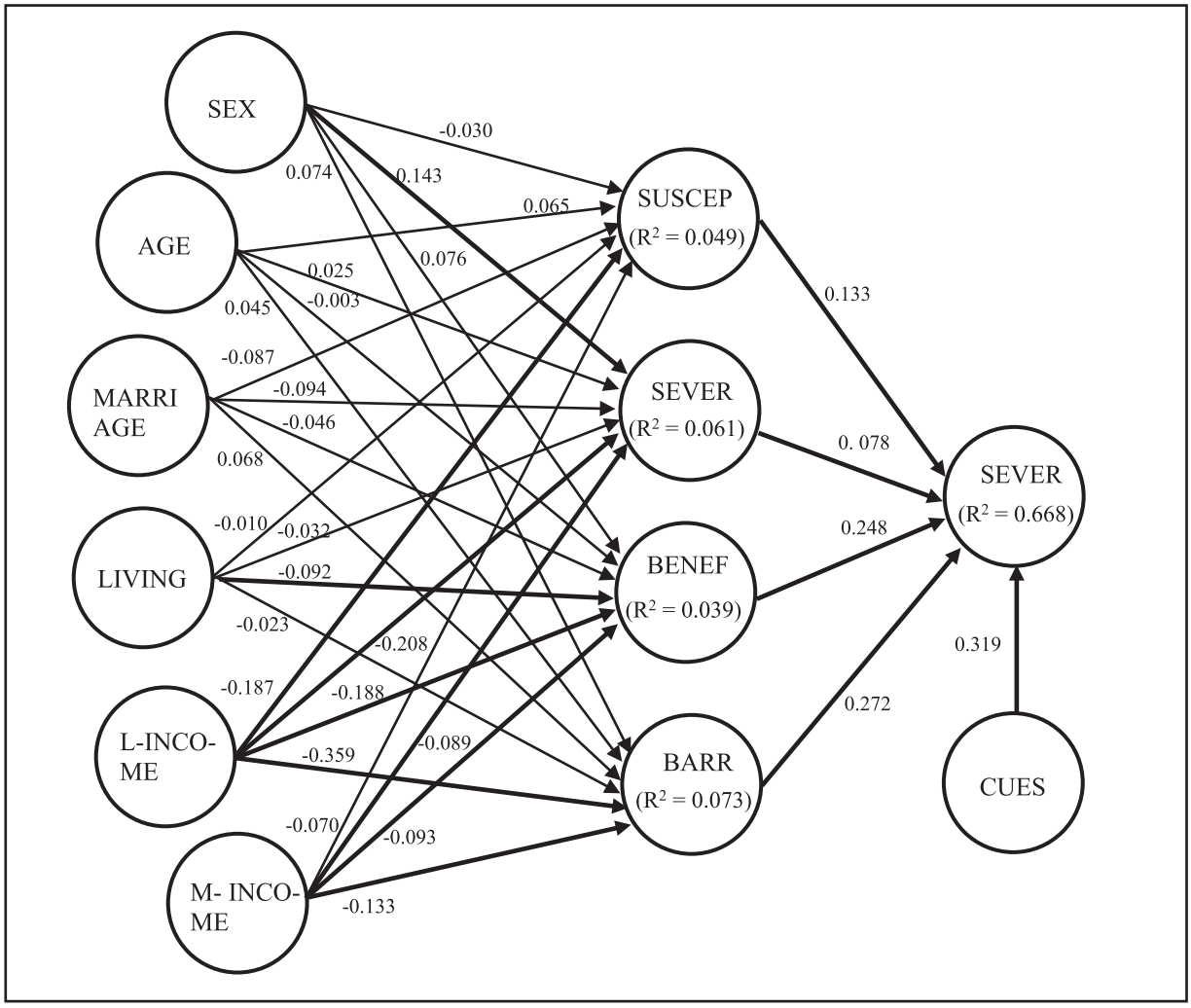

Fig 2. Structural Model ResultsNote: Thin lines = no significant and **thick lines** = significant.

experiencing severe illness for unvaccinated individuals. A previous study found that individuals who received misinformation were more likely to reject COVID-19 vaccination [38].

Perceived susceptibility and severity are predictors of the intention to be vaccinated COVID-19. This finding contrasts with past studies that concluded the perception of susceptibility and severity had no link to the intention to vaccinate against COVID-19 or the willingness to pay for vaccination [35] (M. C. S. [62]. As information technology advances, the internet and social media contribute to the spread of the COVID-19 pandemic globally and results in worldwide public concern [4]. This feeling of anxiety motivates the public to be aware of the consequence of COVID-19 for themselves and their family members. The rapid and massive information regarding COVID-19 amplifies people's perceiving the danger and severe impact of COVID-19. The more people perceive their vulnerability and the severity of the illness, the more they will decide to take precautions [56].

The present study also reveals that perceived benefits and barriers are other predictors of the intention to get vaccinated against COVID-19. These findings support previous findings that perceived benefits and obstacles to vaccination were important predictors of the intention to seek COVID-19 vaccination [35] and mammography [20]. Research indicates that vaccination campaign messages should address and decrease barriers to vaccination. These findings imply that intervention programmes can address negative perceptions of the vaccine by counterbalancing conspiracies and perceptions such as the vaccine being ineffective or contrary to religious teachings. As COVID-19 has spread, conspiracy theory issues have become widespread, influencing people to reject preventive behaviour, including vaccination [15].

Cues to action are effective predictors of the intention to take a COVID-19 vaccine. The current study supports previous findings that the more influential people accept the COVID-19 vaccine, the more others are convinced to be vaccinated [60]. Influential or trusted people can include family members, religious leaders, community leaders and government officers. In developing countries such as Indonesia, social-cultural factors may play an important role in determining individuals' behaviour [33]. As we hypothesize that Indonesian represents collectivistic people, the roles of family member and social groups are critical factors for people to take COVID-19 vaccines [54]. The present findings suggest the importance of involving key family members and other influential people in designing campaigns for vaccination programmes. It is also recommended that governments provide publicly-funded vaccines and facilitate easy access to vaccination.

Demographic variables have a partly significant effect on key components of the HBM model. In the present works, perceived susceptibility, severity, benefits, and barriers mediated the low-income group's diminished intention to take the COVID-19 vaccine compared to the high income group. Middle income status had also

Table 4
Structural Model Results.

Hypotheses	Path Coefficient (β)	*t*-statistic	p-value	Results
SEX → SUSCEP	−0.030	0.462	0.521	Not Supported
SEX → SEVER	0.143	3.305	**0.001***	**Supported**
SEX → BENEF	0.076	1.570	0.117	Not Supported
SEX → BARR	0.074	1.749	0.081	Not Supported
AGE → SUSCEP	0.065	1.396	0.163	Not Supported
AGE → SEVER	0.025	0.574	0.566	Not Supported
AGE → BENEF	−0.003	0.068	0.946	Not Supported
AGE → BARR	0.045	1.048	0.295	Not Supported
MARRIAGE → SUSCEPT	−0.087	1.626	0.105	Not Supported
MARRIAGE → SEVER	−0.094	1.631	0.103	Not Supported
MARRIAGE → BENEF	−0.046	0.783	0.434	Not Supported
MARRIAGE → BARR	0.068	1.224	0.222	Not Supported
LIVING → SUSCEPT	−0.010	0.222	0.825	Not Supported
LIVING → SEVER	−0.032	0.749	0.454	Not Supported
LIVING → BENEF	−0.092	2.161	**0.031****	**Supported**
LIVING → BARR	−0.023	0.504	0.615	Not Supported
L-INCOME → SUSCEP	−0.187	3.313	**0.001***	**Supported**
L-INCOME → SEVER	−0.208	3.576	**0.000***	**Supported**
L-INCOME → BENEF	−0.188	3.280	**0.001***	**Supported**
L-INCOME → BARR	−0.359	6.279	**0.000***	**Supported**
M−INCOME → SUSCEP	−0.070	1.534	0.126	Not Supported
M−INCOME → SEVER	−0.089	1.977	**0.049****	**Supported**
M−INCOME → BENEF	−0.093	2.048	**0.041****	**Supported**
M−INCOME → BARR	−0.133	3.060	**0.002****	**Supported**
SUSCEPT → INT	0.133	3.448	**0.001***	**Supported**
SEVER → INT	0.076	2.000	**0.046****	**Supported**
BENEF → INT	0.248	5.629	**0.000***	**Supported**
BARR → INT	0.272	8.763	**0.000***	**Supported**
CUES → INT	0.319	8.029	**0.000***	**Supported**

Note: L-INCOME: Lower Income, M−INCOME: Middle Income, SUSCEP: Susceptibility, SEVER: Severity, BENEF: Benefit, BARR: Barrier, CUES: Cues to Action and INT: Intention. Significance level: * $p < 0.001$, ** $p < 0.05$. Demographic variables used dummy variables and Modified HBM variables used 1–4 scales. Demographic Variables: male (sex), 46 and above (Age), married (Marriage), rural (Living area), High-income (Rp7 million and above) are as a reference for variables dummy.

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less perceived severity, benefits, and barriers in intending to take the vaccine. This finding supports previous studies that found that people of lower income take fewer protective measures in handling hospital wastes in Bangladesh [6]. These findings are concerning because people with lower incomes cannot easily access the COVID-19 vaccine compared to people with higher incomes. Our findings emphasise the importance of increasing the perception of susceptibility, severity, benefits and the ability to overcome barriers among the lower and middle-income populations.

The non-significant of the major demographic factors such as sex, age, marriage and living areas in the models were critical findings. These results of the study contrast with previous studies that intention to take vaccine were influenced by sex, age, marital status and living areas [26,34]. Females perceived lower severity compared the man. People living in urban did not perceive the benefit of taking vaccines. The findings suggest that vaccination campaign programs should focus on females and people in urban particularly on informing them about their risk of infection with COVID-19, perceived severity, and perceived benefits.

Limitations of the study

This study assessing individuals' intentions to take the COVID-19 vaccine has some limitations. The unrepresentative demographic variables such as respondent's education were not included in the analyses that might lead to different findings. The disproportion of males and females implies that the results might not be generalizable to all Indonesian populations. Another limitation is that because the data collection took place over only two weeks, it could not capture changes in respondents' attitudes and behaviours as the vaccination campaign progressed. As intention does not always translate into real behaviour, future work is needed to investigate whether people follow through in their intentions regarding the COVID-19 vaccine. To overcome these limitations, future studies should focus on observing the real COVID-19 vaccination behaviour in a representative and balanced demographic sample. Information plays an important role in influencing people's health-related attitudes and behaviours, so it is suggested that future studies consider the role of information in determining the factors driving people's decisions to take the COVID-19 vaccine.

Conclusion

This study confirms that the perception of susceptibility, severity, benefits and barriers, as well as cues to action, predict an individual's intention to take a COVID-19 vaccine. Model structure explains a large proportion of variance in the intention to be vaccinated against COVID-19 (66.8 %). Based on the present findings indicate that the HBM model is useful to predict people to take the COVID-19 vaccine in the collectivist society. Not all demographic variables influenced variables of the HBM model including sex, age, marital status, and living areas. Factors such as susceptibility, severity, benefits, and barriers mediated the low-income intention to take the COVID-19 vaccine. Middle income influenced lower severity, benefits, and ability to eliminate barriers to COVID-19 vaccine uptake. Males were more perceived severity compared to females and people living in rural areas were more feeling benefit in taking vaccines. This finding implies that vaccination programmes should focus on providing accurate information about the health impacts of COVID-19 and the benefits of taking the vaccine. Building individuals' confidence in their ability to eliminate barriers to vaccination and involving family and social or religious leaders will increase the proportion of the population accepting

COVID-19 vaccination. The present study explains and predicts individuals' intentions to take the COVID-19 vaccine in developing countries. Regardless of its limitations, this study provides valuable public health policy recommendations to design vaccination programmes effectively.

Declarations

Ethics approval and consent to participate

The Research Centre of Brawijaya University has determined that the study would not have required ethics approval. This study was conducted in accordance with (1) Indonesia Laws No. 18 Year 2002 on National System of Research, Development and Application of Natural Science, (2) Indonesia Government Regulation No. 48 of 2009 on Permission for Conducting Activities, Developing and the Implementation of the Science and Technology with the High Risk and Dangerous, and (3) Indonesia Government Regulation No. 39 of 1995 on Health Research and Development. This study is not categorized as high-risk and dangerous, so it is not necessary to obtain permission from the ethical committee. All study participants were informed about the purpose of the study, voluntary participation, anonymity, confidentiality of the information, age above 17 years old, and Indonesian citizen living in Indonesia territory. As this was an online survey, informed consent was provided in the introduction of the questionnaires survey, only participants who consent and agree were participating in the study.

Consent for publication

Not applicable.

Availability of data and materials

The data used in this study are available from the corresponding author upon reasonable request.

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Authors' Contributions

WA conducted the research design, theoretical framework writing, and data analysis. WI was responsible for data analyses and data collection. MON contributed to writing an introduction, analyzing, and collecting data, BN had roles in data management and analysis as well as data collection. FA was responsible to write a proposal, results part, and data collection. All authors read and approved the final manuscript.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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