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The use of the health belief model to assess predictors of intent to receive the COVID-19 vaccine and willingness to pay

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ABSTRACT

Background: The development of a vaccine against SARS-CoV-2 infection is on the way. To prepare for public availability, the acceptability of a hypothetical COVID-19 vaccine and willingness to pay (WTP) were assessed to provide insights into future demand forecasts and pricing considerations.
Methods: A cross-sectional survey was conducted from 3 to 12 April 2020. The health belief model (HBM) was used to assess predictors of the intent to receive the vaccine and the WTP.
Results: A total of 1,159 complete responses was received. The majority reported a definite intent to receive the vaccine (48.2%), followed by a probable intent (29.8%) and a possible intent (16.3%). Both items under the perceived benefits construct in the HBM, namely believe the vaccination decreases the chance of infection (OR = 2.51, 95% CI 1.19–5.26) and the vaccination makes them feel less worry (OR = 2.19, 95% CI 1.03–4.65), were found to have the highest significant odds of a definite intention to take the vaccine. The mean ± standard deviation (SD) for the amount that participants were willing to pay for a dose of COVID-19 vaccine was MYR$134.0 (SD±79.2) [US$30.66 ± 18.12]. Most of the participants were willing to pay an amount of MYR$100 [US$23] (28.9%) and MYR$50 [US$11.5] (27.2%) for the vaccine. The higher marginal WTP for the vaccine was influenced by no affordability barriers as well as by socio-economic factors, such as higher education levels, professional and managerial occupations and higher incomes.
Conclusions: The findings demonstrate the utility of HBM constructs in understanding COVID-19 vaccination intention and WTP.

Introduction

An outbreak of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was initially detected in Wuhan, China in December 2019.[1] In approximately 1 month, the outbreak has resulted in an epidemic throughout China. The new coronavirus rapidly spread to other countries in Asia and subsequently all around the world within a month of its onset. On 11 March 2020, the World Health Organization (WHO) declared COVID-19 a worldwide pandemic. To date, data from the COVID-19 Situation Report by the WHO recorded that the coronavirus pandemic has infected over four million people and caused thousands of fatalities across all countries worldwide.[2] Malaysia announced the first three cases of SARS-CoV-2 infection on 25 January 2020. By the end of May 2020, the confirmed cases had reached over seven thousands.[2]

Since immunization against the coronavirus is not yet available, the current best means of infection prevention is to avoid exposure. Social distancing, mass economic shutdowns and lockdowns resulted in a tremendous impairment of physical and psychosocial wellbeing, social interactions and a decline in the global economy. The catastrophic consequences associated with COVID-19 have strengthened the dire need for an effective vaccine to keep outbreaks under control. From the perspective of public health, vaccination is considered as the most effective approach against the outbreak of various infectious diseases.[3] For instance, influenza vaccination has been recognized as the most effective way to prevent seasonal influenza and its related diseases.[4] Without doubt, vaccines are among the most efficient means of preventing further COVID-19 outbreak. Development of a vaccine against SARS-CoV-2 infection is on the way. Various institutions funded by multiple governments, pharmaceutical companies and philanthropists are currently racing against time to produce a COVID-19 vaccine, with some vaccines already in clinical trials. With the development of potential vaccines for COVID-19 rapidly progressing, urgent investigation is warranted of the acceptability of a hypothetical COVID-19 vaccine in order to prepare for its public availability.

The Health Belief Model (HBM) has been one of the most widely used theories in understanding health and illness behaviors. The HBM comprises several main constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy to engage in a behavior and cues to action.[5] Perceived susceptibility refers to beliefs regarding vulnerability to infection, while perceived severity refers to beliefs regarding the negative effects of contracting

the infection. In relation to vaccination, perceived benefits are defined as an individual's beliefs about being vaccinated, and perceived barriers are described as the belief that being vaccinated is restricted due to psychosocial, physical or financial factors. Cues to action include information, people and events that guide an individual to be vaccinated.[5] The HBM constructs are recognized as an important predictor of influenza vaccination uptake that has been used in many previous studies.[6–9] Therefore, exploring significant HBM constructs that influence COVID-19 vaccination may be crucial for tailored interventions to enhance the acceptance of the vaccine.

Willingness-to-pay (WTP) is an approach to estimate the maximum amount that an individual is willing to allocate to programs, services and health technologies. The decision to vaccinate depends on the willingness of society to pay for increased health benefits.[10] Likewise, the HBM constructs have also been used to explain WTP for influenza vaccination.[11] More evidence about public acceptance and the WTP for the COVID-19 vaccine are essential to evaluate the feasibility of the implementation of vaccination programs when the vaccine is available and also to provide insights into future pricing considerations and demand forecasts. Therefore, this study aimed to 1) assess participants' perceptions of susceptibility and severity of the COVID-19 infection, benefits and barriers of the vaccine and cues to action; and 2) identify predictors of participants' intention to receive the COVID-19 vaccine and their WTP for COVID-19 vaccination. We hypothesized that the acceptance of a COVID-19 vaccine and WTP depends on the perception of susceptibility to COVID-19 infection, beliefs about the severity of the COVID-19 infection, perceived benefits of the vaccine in preventing COVID-19, and perceived barriers to accepting a vaccine. Other factors that might influence intention and WTP were also explored, such as participants' health perception, presence of chronic diseases and knowing someone in the community who has had a COVID-19 infection.

Methods

Study participants and survey design

We commenced a cross-sectional, web-based anonymous survey using an online questionnaire. The researchers used the social network platforms of Facebook, Instagram, and WhatsApp to disseminate and advertise the survey link to the public. The inclusion criteria were that the respondents were Malaysian residents who were between 18 and 70 years of age. Respondents who completed the survey received a note encouraging them to disseminate the survey link to all their contacts. The respondents were informed that their participation was voluntary and consent was implied through their completion of the questionnaire. The questionnaire was developed in English and was then translated into Bahasa Malaysia, the national language of Malaysia. Questions were presented bilingually in English and Bahasa Malaysia. Prior to the administration of the questionnaire, local experts validated the content and the questionnaire was pilot tested.

Instruments

The survey consisted of questions that assessed 1) demographic background, health status and COVID-19 experience; 2) intention to receive a COVID-19 vaccine; 3) HBM constructs; and 4) WTP.

Demographics, health status and COVID-19 experience

Personal details, including age, gender, ethnicity, religion, marital status, occupation and average monthly household income, were queried. The participants were also asked if they have existing chronic diseases and to rate their overall health status. The participants were asked to indicate whether they know of friends, neighbors or colleagues who have been infected with COVID-19.

Intention to receive a COVID-19 vaccine

The intention to accept a COVID-19 vaccine was measured using a one-item question (If a vaccine against COVID-19 infection is available in the market, would you take it?) on a five-point scale ('Definitely not' to 'Yes, definitely').

Beliefs surrounding COVID-19 and COVID-19 vaccination

HBM derived items were used to measure the participants' beliefs about COVID-19 vaccination.[12,13] The questions probed perceived susceptibility to COVID-19 infection (three items), perceived severity of COVID-19 infection (three items), perceived benefits of a COVID-19 vaccine (two items), perceived barriers to getting a vaccination against COVID-19 (five items) and cues to action (two items). Among the HBM constructs, self-efficacy is not necessary to understand simple health behavior;[7] therefore, it was not assessed in this study. A simplified option of 'agree'/'disagree' was used due to the reason that the study was in a form of self-administered web survey.

Willingness to pay (WTP)

WTP was measured using a one item question (What is the maximum amount you are willing to pay for the COVID-19 vaccine per dose?) on a six-point scale ('MYR$50/US$11.5′, 'MYR 100/US$23′, 'MYR$150/US$34.5′, 'MYR$200/US$46′, 'MYR$250/US$57.5′ and 'MYR$300/US$69′). The options range of price is based on the approximate minimum–maximum price range of current vaccines in Malaysia.

The items in the questionnaire were content validated by a panel of several experts to ensure the relevance and clarity of the questions. After minor amendments, the questionnaire was pilot tested on randomly sampled students who were not included in the main study.

Ethical considerations

This study was approved by the University of Malaya Research Ethics Committee (UMREC). Approval code: UM.TNC2/ UMREC – 847.

Statistical analysis

Frequency tables, charts and proportions were used for data summarization. The proportion and its respective 95%

confidence interval (CI) were calculated. We ran univariate analyses followed by a multivariable logistic regression analysis, including all factors showing significance ($p < .05$), to determine factors associated with the intention to take the COVID-19 vaccine. Odds ratios (OR), 95% confidence intervals (95% CI) and p-values were calculated for each independent variable. Due to the small number of responses for *probably not* and *definitely not*, the OR of a definite intention was compared with the *probable yes* and *no* intentions. The model fit of multivariable logistic regression analysis was assessed using the Hosmer–Lemeshow goodness-of-fit test.[14] The six options of WTP were categorized into three ordinally categories. A multivariable multinomial logistic regression was employed to model factors associated with marginal WTP for the COVID-19 vaccine for three categories (MYR$50/100, MYR$150/200, MYR$250/300), with the lowest WTP (MYR$50/100) as the reference. Likewise, only significant factors in the univariate analyses, with p-value of <0.05, were selected for the multinomial logistic regression analysis. All statistical analyses were performed using the Statistical Package for the Social Sciences version 20.0 (IBM Corp., Armonk, NY, USA). A p-value of less than 0.05 was considered statistically significant.

Results

Demographics

The survey link was disseminated from 3 to 12 April 2020, and a total of 1,159 complete responses were received. The study received responses from participants of diverse demographics by occupation types and income levels. As shown in Table 1, the study respondents had a higher representation of females (66.0%), university degrees (90.0%), professional and managerial occupations (55.5%) and urban localities (74.4%). In regard to health status, only a small proportion reported their health status as poor/fair (26.6%) and 10.8% reported having chronic diseases. Only 21.4% reported knowing someone infected with COVID-19.

Health beliefs

The participants had high perceptions of susceptibility. The majority view was that there was a great chance of getting COVID-19 in the next few months (59.3%); they were also worried about becoming infected (85.4%), and they believed it was possible that they would get COVID-19 (56.3%). The majority also had high perceptions of severity of the COVID-19 infection. High perceptions of benefits and perceived barriers were also reported. Under the perceived barriers construct, concern about affordability and the COVID-19 vaccine being halal (kosher) was reported by 88.5% and 52.3%, respectively. Although nearly all (98%) of the participants reported that they will only take the COVID-19 vaccine if given adequate information, 74.3%

reported that they will only take the vaccine if taken by many in the public (Figure 1).

COVID-19 vaccination intent

Figure 2 shows the proportion of responses for intention to have a COVID-19 vaccine. On the whole, a total of 1,093 (94.3%) participants responded *yes* to COVID-19 vaccine intent, while only 99 (5.7%) responded *no*. By a more specific breakdown, the majority responded *yes, definitely* (48.2%; 95% CI 45.3–51.2), followed by *yes, probably* (29.8%; 95% CI 27.-1–32.5%) and *yes, possibly* (16.3%; 95% CI 14.2–18.6). Only 2.4% (95% CI 1.6–3.5) responded *definitely not* and *probably not* (3.3%; 95% CI 2.3–4.5). The third and fourth column of Table 1 shows the demographics of the respondents who intend (*Yes, Definitely/Probably/Possibly*) and do not intend (*Definitely/Probably Not*) to take the COVID-19 vaccine.

Table 2 shows the univariate and multivariate analyses of factors associated with the *yes, definitely* response. Both items under perceived benefits in the HBM, namely the belief that vaccination decreases the chance of COVID-19 infection (OR = 2.51, 95% CI 1.19–5.26) and that vaccination makes them feel less worried about COVID-19 (OR = 2.19, 95% CI 1.03–4.65) were found to have the highest significant odds of a definite intention to take the COVID-19 vaccine. Participants who had no worries about the possible side-effects of a COVID-19 vaccination were found to have greater odds of a definite intention to take the vaccine (OR = 1.81, 95% CI 1.34–2.44). Those who disagreed that they will only take the COVID-19 vaccine if it is taken by many in the public have greater odds of a definite intention to take the COVID-19 vaccine (OR = 1.49, 95% CI 1.12–1.98). Perception of susceptibility influenced vaccination intention, whereby participants who view that they have the possibility of getting COVID-19 have greater odds of a definite intention to take the vaccine (OR = 1.36, 95% CI 1.04–1.79). Lastly, males have greater odds of a definite intention to take the COVID-19 vaccine (OR = 1.44, 95% CI 1.11–1.87) than do females.

Willingness to pay (WTP)

Figure 3 shows that most of the participants were willing to pay an amount of MYR$100 (28.9%; 95% CI 26.3–31.6) and MYR$50 (27.2%, 95% CI 24.6–29.8) for a COVID-19 vaccine. The mean ± standard deviation (SD) for the amount the overall participants were willing to pay for a dose of COVID-19 vaccine was MYR$134.0 (SD±79.2). By average household breakdown, the WTP for participants with income <MYR$2000 was MYR$98.3 (SD±60.9), and the WTP for participants with income >MYR$8000 was 162.6 (SD±80.7).

Table 3 shows the results of the multinomial logistic regression for the marginal WTP for an amount of MYR$50/MYR100, MYR150–200, MYR250–300 (MYR150–200 vs MYR$50/MYR$100 and MYR$250/300 vs MYR$50/MYR100). Participants with tertiary education had a WTP for an amount of MYR$250–300 over MYR$50/MYR100. Participants with professional and managerial occupations

Table 1. Demographics and COVID-19 intent (N = 1159).

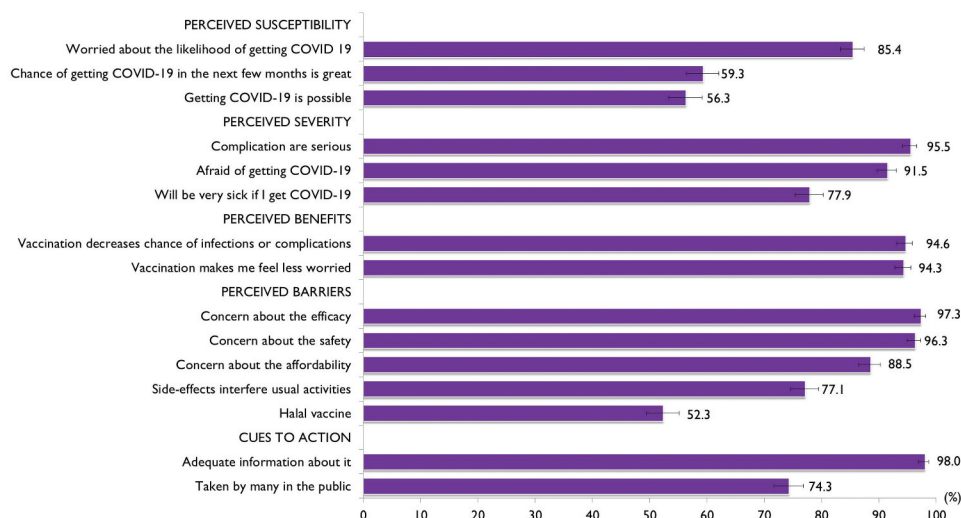|		Intention to take COVID-19 vaccine	
	Overall N(%)	Intend (Yes, Definitely/Probably/Possibly) n = 1093 n (%, 95% CI)	Do not intend (Definitely/Probably Not) n = 66 n (%, 95% CI)
Demographics			
Age group (years)			
18–30	366 (31.6)	351 (95.9)	15 (4.1)
31–40	374 (32.3)	353 (94.4)	21 (5.6)
41–50	245 (21.1)	228 (93.1)	17 (6.9)
>50	174 (15.0)	161 (92.5)	13 (7.5)
Gender			
Male	394 (34.0)	371 (94.2)	23 (5.8)
Female	765 (66.0)	722 (94.4)	43 (5.6)
Ethnicity			
Malay	546 (47.1)	510 (93.4)	36 (6.6)
Chinese	513 (44.3)	492 (95.9)	21 (4.1)
Indian	58 (5.0)	53 (91.4)	5 (8.6)
Bumiputera Sabah/Sarawak/Others	42 (3.6)	38 (90.5)	4 (9.5)
Highest education level			
Secondary and below	116 (10.0)	102 (87.9)	14 (12.1)
Tertiary	1043 (90.0)	991 (95.0)	52 (5.0)
Occupation category			
Professional and managerial	643 (55.5)	610 (94.9)	33 (5.1)
General worker	236 (20.4)	215 (91.1)	21 (8.9)
Student	99 (8.5)	94 (94.9)	5 (5.1)
Housewife/Retired/ Unemployed/Others	181 (15.6)	174 (96.1)	7 (3.9)
Average monthly household income (MYR)			
<2000	143 (12.3)	123 (93.0)	10 (7.0)
2001–4000	229 (19.8)	219 (95.6)	10 (4.4)
4001–8000	390 (33.6)	366 (93.8)	24 (6.2)
>8000	397 (34.3)	375 (94.5	22 (5.5)
Living area			
Urban	862 (74.4)	816 (94.7)	46 (5.3)
Suburban/Rural	297 (25.6)	277 (93.3)	20 (6.7)
Diagnosed with chronic diseases			
Yes	125 (10.8)	121 (96.8)	4 (3.2)
No	1034 (89.2)	972 (94.0)	62 (6.0)
Perceived overall health			
Very good	197 (17.0)	184 (93.4)	13 (6.6)
Good	654 (56.4)	617 (94.3)	37 (5.7)
Fair/Poor	308 (26.6)	292 (94.8)	16 (5.2)
Known any friends, neighbors and colleagues infected by COVID-19			
Yes	248 (21.4)	231 (93.1)	17 (6.9)
No	911 (78.6)	862 (94.6)	49 (5.4)

Figure 1. Proportion of agree responses to health belief model constructs (N = 1159).
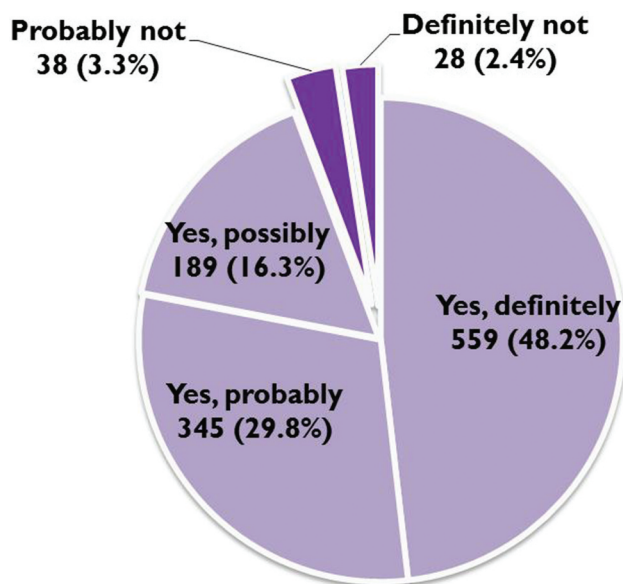
Figure 2. COVID-19 vaccination intent (N = 1159).

and a higher average household income had a WTP for an amount of MYR$150/200 and MYR$250/300 over the lower amounts. Participants who were afraid of getting COVID-19 had a WTP for an amount of MYR$250/300 over MYR$50/ MYR100. Participants who were not concerned about affordability of the vaccine and whether the vaccine is kosher had a WTP for an amount of MYR$150/200 and MYR$250/300 over the lower amounts.

Discussion

This study uses the HBM to examine the intention to take the COVID-19 vaccine and WTP, along with associated factors, among the Malaysian public. Findings with regard to health beliefs and descriptive findings of perceptions of susceptibility to COVID-19 infection showed that, despite the fact that many were worried about the likelihood of getting COVID-19, relatively few viewed themselves as at high risk of becoming infected with COVID-19. This indicates the need to increase risk perception among the public, as high-risk perception translates into preventive actions in many infectious disease outbreaks and has been found to enhance epidemic control.[15] On a positive note, most of the participants have high perceptions of severity and perceived benefits in obtaining the COVID-19 vaccine. The various perceived barriers found in this study against COVID-19 immunizations have likewise been found in other studies about the introduction of a new vaccine[16] and include worry about side effects, efficacy and safety of the vaccine. Of note, the proportion concerned about the cost of the COVID-19 vaccine was relatively lower than the proportion concerned about the efficacy and safety of the vaccine. This may imply that the public perceives the importance of the COVID-19 vaccination and emphasizes the importance of safety and effectiveness of the vaccination over

the price of the vaccine. It is equally important to note that slightly over half of the respondents were concerned about whether the COVID-19 vaccine is halal. Muslims refusing immunizations on the grounds that vaccines are non-halal (i.e., not permissible under Islam) has been a major issue in Malaysia and in many Muslim countries worldwide.[17] Considering the huge global Muslim population, the demand for halal COVID-19 vaccines is anticipated to be high, thus warranting that vaccine manufactures to also consider the production of halal COVID-19 vaccine for the Muslim market. External cues to action were found to be important, namely the provision of comprehensive information about the vaccine when it is available.

The overall acceptance of a vaccine was high, with nearly half of the participants expressing a definite intention to take the COVID-19 vaccine and 45% expressing a possible and probable intention. Of note, intervention is needed for COVID-19 vaccine refusals as well as people with possible and probable intention to ensure high actual vaccination uptake. Multivariable analysis found that HBM constructs were associated with COVID-19 vaccine acceptance, which is in concordance with many other studies.[7] In particular, the findings of this study suggest that high perception of benefits and low perceived barriers to receiving the vaccine were the two most important HBM constructs influencing a definite intention of COVID-19 vaccination. High perceived susceptibility of getting a COVID-19 infection was also associated with increased vaccination intention in the multivariate analysis. Hence, public health intervention programs that focus on increasing the perception of the benefits of vaccination and perceived susceptibility to infection, while reducing the identified barriers are warranted. Findings warrant promotional health messages framing a high risk of illness, as this has been found useful in influencing vaccine-related behavior.[18] Males were the only demographic predictor of having a definite intention of COVID-19 vaccination, which implies the need for gender-based intervention. It is important to note that in this study the price of the COVID-19 vaccine is not a significant predictor of vaccination intent.

This study revealed that most were willing to pay an amount of MYR$50 and MYR$100 for a dose of COVID-19 vaccine. The mean WTP of the overall participants was MYR $134.0 ± 79.2 (US$30.66 ± 18.12). Compared to previous studies conducted in Malaysia, the WTP for the hypothetical COVID-19 vaccine found in this study is over three-fold higher than the WTP for a hypothetical dengue vaccine (MYR39.21 [USD 9.45 USD] per dose)[19] and the hepatitis B vaccination (MYR$303 [USD 73 USD] per three-dose series).[20] To date, no studies have been conducted on the WTP of influenza vaccine in Malaysia. In Malaysia, influenza vaccination is not mandatory. Of note, the cost of influenza vaccines in Malaysia ranges as low as MYR40/MYR50 up to MYR$100, depending on the type of vaccines and whether the vaccination is through private or government hospitals. The influenza vaccination is also not in the Malaysian National Immunization program and the vaccine is not provided free for any age group in Malaysia.

Table 2. Multivariable logistic analysis of factors associated with a definite intention to take the COVID-19 vaccine (N = 1159).

		Univariate analysis			Multivariable logistic regression
	Overall	Yes, Definitely (n = 559)	Yes, probably/possibly and Definitely/probably not (n = 600)	p-value	Yes, definitely vs. Yes, probably/possibly and Definitely/probably not OR (95% CI)
Demographics					
Age group (years)				0.304	
18–30	366 (31.6)	174 (47.5)	192 (52.5)		
31–40	374 (32.3)	193 (51.6)	181 (48.4)		
41–50	245 (21.1)	117 (47.8)	128 (52.2)		
>50	174 (15.0)	75 (43.1)	99 (56.9)		
Gender				0.002	
Male	394 (34.0)	215 (54.6)	179 (45.4)		1.44 (1.11–1.87)**
Female	765 (66.0)	344 (45.0)	421 (55.0)		Reference
Ethnicity				0.029	
Malay	546 (47.1)	286 (52.4)	260 (47.6)		1.12 (0.46–2.75)
Chinese	513 (44.3)	224 (43.7)	289 (56.3)		0.83 (0.34–2.02)
Indian	58 (5.0)	26 (44.8)	32 (55.2)		0.91 (0.32–2.57)
Bumiputera Sabah/Sarawak/Others	42 (3.6)	23 (54.8)	19 (45.2)		Reference
Highest education level				0.142	
Secondary and below	116 (10.0)	48 (41.4)	68 (58.6)		
Tertiary	1043 (90.0)	511 (49.0)	532 (51.0)		
Occupation category				0.325	
Professional and managerial	643 (55.5)	321 (49.9)	322 (50.1)		
General worker	236 (20.4)	116 (49.2)	120 (50.8)		
Student	99 (8.5)	45 (45.5)	54 (54.5)		
Housewife/Retired/Unemployed/Others	181 (15.6)	77 (42.5)	104 (57.5)		
Average monthly household income (MYR)				0.217	
<2000	143 (12.3)	60 (42.0)	83 (58.0)		
2001–4000	229 (19.8)	106 (46.3)	123 (53.7)		
4001–8000	390 (33.6)	188 (48.2)	202 (51.8)		
>8000	397 (34.3)	205 (51.6)	192 (48.4)		
Location				0.178	
Urban	862 (74.4)	426 (49.4)	436 (50.6)		
Suburban/Rural	297 (25.6)	133 (44.8)	164 (55.2)		
Diagnosed with chronic diseases				0.636	
Yes	125 (10.8)	63 (50.4)	62 (49.6)		
No	1034 (89.2)	496 (48.0)	538 (52.0)		
Perceived overall health				0.126	
Very good	197 (17.0)	108 (54.8)	89 (45.2)		
Good	654 (56.4)	306 (46.8)	348 (53.2)		
Fair/Poor	308 (26.6)	145 (47.1)	163 (52.9)		
Known any friends, neighbors and colleagues infected by COVID-19				0.015	
Yes	248 (21.4)	137 (55.2)	111 (44.8)		1.25 (0.92–1.69)
No	911 (78.6)	422 (46.3)	489 (53.7)		Reference
Health belief					
Perceived susceptibility					
My chance of getting COVID-19 in the next few months is great				p < .001	
Agree	687 (59.3)	364 (53.0)	323 (47.0)		1.18 (0.90–1.56)
Disagree	472 (40.7)	195 (41.3)	277 (58.7)		Reference
I am worried about the likelihood of getting COVID-19				p < .001	
Agree	990 (85.4)	502 (50.7)	488 (49.3)		1.32 (0.88–1.99)

(Continued)

Table 2. (Continued).

	Overall	Yes, Definitely (n = 559)	Yes, probably/possibly and Definitely/probably not (n = 600)	p-value	Multivariable logistic regression — Yes, definitely vs. Yes, probably/possibly and Definitely/probably not OR (95% CI)
Disagree	169 (14.6)	57 (33.7)	112 (66.3)		Reference
Getting COVID-19 is currently a possibility for me.					
Agree	652 (56.3)	350 (53.7)	302 (46.3)	p < .001	1.36 (1.04–1.79)*
Disagree	507 (43.7)	209 (41.2)	298 (58.8)		Reference
Perceived severity					
Complications from COVID-19 are serious					
Agree	1107 (95.5)	545 (49.2)	562 (50.8)	0.001	1.63 (0.80–3.35)
Disagree	52 (4.5)	14 (26.9)	38 (73.1)		Reference
I will be very sick if I get COVID-19					
Agree	903 (77.9)	458 (50.7)	445 (49.3)	0.002	1.38 (0.99–1.90)
Disagree	256 (22.1)	101 (39.5)	155 (60.5)		Reference
I am afraid of getting COVID-19					
Agree	1060 (91.5)	527 (49.7)	533 (50.3)	0.001	1.24 (0.73–2.10)
Disagree	99 (8.5)	32 (32.3)	67 (67.7)		Reference
Perceived benefits					
Vaccination is a good idea because it makes me feel less worried about catching COVID-19					
Agree	1093 (94.3)	547 (50.0)	546 (50.0)	p < .001	2.19 (1.03–4.65)*
Disagree	66 (5.7)	12 (18.2)	54 (81.8)		Reference
Vaccination decreases my chance of getting COVID-19 or its complications					
Agree	1096 (94.6)	547 (49.9)	549 (50.1)	p < .001	2.51 (1.19–5.26)*
Disagree	63 (5.4)	12 (19.0)	51 (81.0)		Reference
Perceived barriers					
Worry the possible side-effects of COVID-19 vaccination would interfere with my usual activities					
Agree	894 (77.1)	403 (45.1)	491 (54.9)	p < .001	Reference
Disagree	265 (22.9)	156 (58.9)	109 (41.1)		1.81 (1.34–2.44)***
I am concern about the efficacy of the COVID-19 vaccination					
Agree	1128 (97.3)	543 (48.1)	585 (51.9)	0.720	
Disagree	31 (2.7)	16 (51.6)	15 (48.4)		
I am concern about the safety of the COVID-19 vaccination					
Agree	1116 (96.3)	536 (48.0)	580 (52.0)	0.535	
Disagree	43 (3.7)	23 (53.5)	20 (46.5)		
I am concern of my affordability (high cost) of getting the COVID-19 vaccination					
Agree	1026 (88.5)	488 (47.6)	538 (52.4)	0.231	
Disagree	133 (11.5)	71 (53.4)	62 (46.6)		
I am concern if the new COVID-19 vaccine is halal					
Agree	606 (52.3)	299 (49.3)	307 (50.7)	0.445	
Disagree	553 (47.7)	260 (47.0)	293 (53.0)		
Cues to action					
I will only take the COVID-19 vaccine if I was given adequate information about it					
Agree	1136 (98.0)	547 (48.2)	589 (51.8)	0.834	
Disagree	23 (2.0)	12 (52.2)	11 (47.8)		
I will only take the COVID-19 vaccine if the vaccine is taken by many in the public					
Agree	861 (74.3)	395 (45.9)	466 (54.1)	0.007	Reference
Disagree	298 (25.7)	164 (55.0)	134 (45.0)		1.49 (1.12–1.98)**

*p < 0.05** p < 0.01, ***p < 0.001.
Hosmer–Lemeshow test, chi-square: 10.761, p-value: 0.216; Nagelkerke R^2: 0.119.
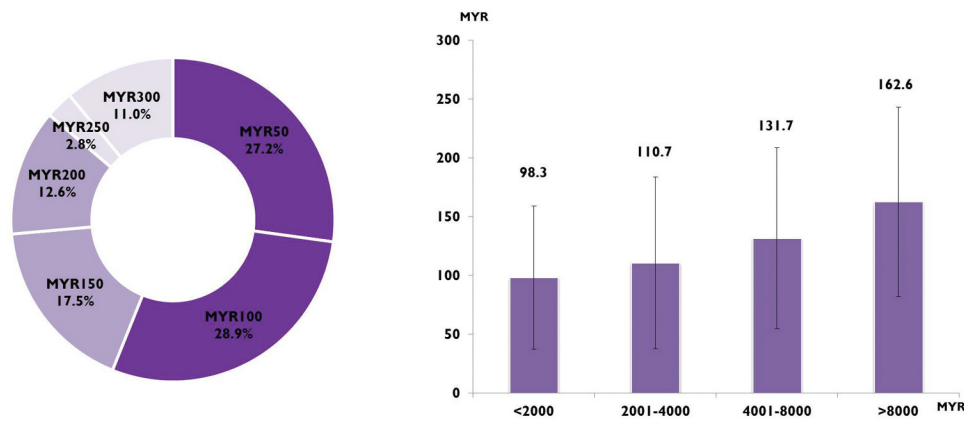
Figure 3. Overall willingness to pay (WTP) for the COVID-19 vaccine and WTP by average household income groups (N = 1159).

An important highlight of this study is that the WTP for the lowest income group (<MYR$2000) was lower than MYR$100. Of note, Malaysians are categorized into three different income groups: Top 20% (T20), Middle 40% (M40), and Bottom 40% (B40),[21] with B40 consisting of those with household incomes of less than RM4,360 per month. The B40 group consists of 2.4 million households[22] and, in reference to our results, the WTP of the B40 group is slightly over MYR$100. Should the forthcoming COVID-19 vaccine cost over MYR$100, a substantial proportion of the population in Malaysia may need financial support to obtain the COVID-19 vaccination.

Finally, the result of the multinomial logistic regression for marginal WTP revealed that no affordability barriers along with socio-economic factors, namely higher education levels, professional and managerial occupations and higher income groups, resulted in a higher WTP. A lower price barrier or higher ability to pay were associated with a higher WTP. In addition, perceived severity of the pandemic was also associated with a higher WTP. Findings imply that integration of the COVID-19 vaccine into the national immunization program would improve vaccine coverage, especially among the lower socio-economic groups. As HBM constructs significantly associated with WTP, the HBM model should be used to inform the development of interventions to promote vaccination against COVID-19 as a priority for expenditure. Shaping a person's spending priorities is important to enhance vaccine uptake if the price of the COVID-19 is higher than the price an individual is willing to pay.

As with all studies, it is worth noting a few limitations of the present study, particularly concerning the study design and data collection method. Due to various resource limitations during the disease crisis and movement restrictions in Malaysia, we resolved to use an online survey for data collection. Nonetheless, using an online web-based questionnaire via a social media platform may lead to selection bias, as reflected in the large sample of females and participants from professional and managerial groups. Thus, the sample may not be fully generalizable to the population of Malaysia as a whole. 'Secondly, we were unable to exclude the potential

bias of using a single item measurement for vaccine intention. As vaccine hesitancy is complex and multidimensional, it has been suggested that the use of diverse types of data and measurement approaches is needed to accurately identify vaccine hesitancy.[23] The use of multiple statements of immunization intent with an extension of a higher point of Likert scale has been proposed,[24] thus should be considered in future studies. Another limitation of the study is the bias associated with the use of hypothetical WTP during the vaccine development process, before the final product exists.[25] The use of WTP in real contexts would reflect consumers' actual valuation of the vaccine. Future research on WTP should be conducted when the development of the COVID-19 is successful and available in the market. Lastly, it should also be noted that the options range of vaccine price for assessment of WTP is based on the approximate minimum-maximum price range of current vaccines in Malaysia; thus, we were unable to capture responses of WTP below MYR$50. The findings of this survey should be interpreted in light of the above-mentioned limitations. Despite these limitations, we believe our findings will provide guidance to enhance COVID-19 uptake and for potential pricing.

Conclusion

The introduction of the new coronavirus vaccine is anticipated to be accompanied by a variety of challenges. Most participants intended to receive the COVID-19 vaccine. Important predictors of a definite intention to take the COVID-19 vaccine include high-perceived benefits and lower perceived barriers to receiving the vaccine, and higher perceived susceptibility to infection. Interventions targeting HBM constructs could be effective in increasing the uptake of the vaccine. This study has important implications in facilitating government authorities to design and deliver targeted intervention programs to enhance COVID-19 vaccine uptake should the vaccine be available on the market. This study revealed that the amount of WTP for the COVID-19 vaccine

Table 3. Multinomial logic regression of factors associated with marginal willingness to pay (WTP) for COVID-19 vaccine (N = 1159).

		Univariate analysis Marginal WTP				Multinomial logistic regression[†]	
	Overall	MYR50/100 N = 650	MYR150/200 N = 349	MYR250/300 N = 160		MYR150/200 OR (95% CI)	MYR250/300 OR (95% CI)
Demographics							
Age group (years)							
18–30	366 (31.6)	209 (57.1)	110 (30.1)	47 (12.8)			
31–40	374 (32.3)	202 (54.0)	109 (29.1)	63 (16.8)			
41–50	245 (21.1)	145 (59.2)	69 (28.2)	31 (12.7)			
>50	174 (15.0)	94 (54.0)	61 (35.1)	19 (10.9)	0.342		
Gender							
Male	394 (34.0)	211 (53.6)	117 (29.7)	66 (16.8)			
Female	765 (66.0)	439 (57.4)	232 (30.3)	94 (12.3)	0.107		
Ethnicity							
Malay	546 (47.1)	354 (64.8)	141 (25.8)	51 (9.3)	p < .001	1.03 (0.46–2.33)	0.98 (0.34–2.86)
Chinese	513 (44.3)	238 (46.4)	182 (35.5)	93 (18.1)		1.29 (0.57–2.89)	0.93 (0.33–2.60)
Indian	58 (5.0)	33 (56.9)	16 (27.6)	9 (15.5)		0.67 (0.24–1.83)	0.48 (0.13–1.76)
Bumiputera Sabah/Sarawak/Others	42 (3.6)	25 (59.5)	10 (23.8)	7 (16.7)		Reference	Reference
Highest education level							
Secondary and below	116 (10.0)	88 (75.9)	23 (19.8)	5 (4.3)	p < .001	0.73 (0.43–1.22)	0.35 (0.13–0.93)*
Tertiary	1043 (90.0)	562 (53.9)	326 (31.3)	155 (14.9)		Reference	Reference
Occupation category							
Professional and managerial	643 (55.5)	301 (46.8)	228 (35.5)	114 (17.7)	p < .001	1.88 (1.20–2.95)**	2.08 (1.09–3.96)*
General worker	236 (20.4)	155 (65.7)	58 (24.6)	23 (9.7)		1.34 (0.80–2.22)	1.30 (0.61–2.75)
Student	99 (8.5)	66 (66.7)	26 (26.3)	7 (7.1)		1.33 (0.72–2.46)	0.78 (0.29–2.14)
Housewife/Retired/Unemployed/Others	181 (15.6)	128 (70.7)	37 (20.4)	16 (8.8)		Reference	Reference
Average monthly household income (MYR)							
<2000	143 (12.3)	110 (76.9)	27 (18.9)	6 (4.2)	p < .001	0.31 (0.18–0.52)***	0.22 (0.09–0.57)**
2001–4000	229 (19.8)	168 (73.4)	38 (16.6)	23 (10.0)		0.25 (0.16–0.39)***	0.39 (0.22–0.69)**
4001–8000	390 (33.6)	226 (57.9)	115 (29.5)	49 (12.6)		0.47 (0.34–0.65)***	0.45 (0.29–0.70)***
>8000	397 (34.3)	146 (36.8)	169 (42.6)	82 (20.7)		Reference	Reference
Location							
Urban	862 (74.4)	464 (53.8)	270 (31.3)	128 (14.8)	0.025	0.96 (0.69–1.34)	0.95 (0.59–1.54)
Suburban/Rural	297 (25.6)	186 (62.6)	79 (26.6)	32 (10.8)		Reference	Reference
Diagnosed with chronic diseases							
Yes	125 (10.8)	76 (60.8)	33 (26.4)	16 (12.8)	0.522		
No	1034 (89.2)	574 (55.5)	316 (30.6)	144 (13.9)			
Perceived overall health							
Very good	197 (17.0)	116 (58.9)	57 (28.9)	24 (12.2)	0.124		
Good	654 (56.4)	369 (56.4)	205 (31.3)	80 (12.2)			
Fair/Poor	308 (26.6)	165 (53.6)	87 (28.2)	56 (18.2)			
Known any friends, neighbors and colleagues infected by COVID-19							
Yes	248 (21.4)	134 (54.0)	75 (30.2)	39 (15.7)	0.582		
No	911 (78.6)	516 (56.6)	274 (30.1)	121 (13.3)			
Health belief							
Perceived susceptibility							
My chance of getting COVID-19 in the next few months is great							
Agree	687 (59.3)	381 (57.0)	199 (29.0)	107 (15.6)	0.096		
Disagree	472 (40.7)	269 (57.0)	150 (31.8)	53 (11.2)			
I am worried about the likelihood of getting COVID-19							
Agree	990 (85.4)	553 (55.9)	294 (29.7)	143 (14.4)	0.292		
Disagree	169 (14.6)	97 (57.4)	55 (32.5)	17 (10.1)			
Getting COVID-19 is currently a possibility for me							
Agree	652 (56.3)	353 (54.1)	194 (29.8)	105 (16.1)	0.034	Reference	Reference

(Continued)

Table 3. (Continued).

		Univariate analysis Marginal WTP				Multinomial logistic regression[†]	
	Overall	MYR50/100 N = 650	MYR150/200 N = 349	MYR250/300 N = 160		MYR150/200 OR (95% CI)	MYR250/300 OR (95% CI)
Disagree	507 (43.7)	297 (58.6)	155 (30.6)	55 (10.8)		0.99 (0.74–1.30)	0.68 (0.46–1.01)
Perceived severity							
Complications from COVID-19 are serious							
Agree	1107 (95.5)	619 (55.9)	332 (30.0)	156 (14.1)	0.424		
Disagree	52 (4.5)	31 (59.6)	17 (32.7)	4 (7.7)			
I will be very sick if I get COVID-19							
Agree	903 (77.9)	516 (57.1)	262 (29.0)	125 (13.8)	0.292		
Disagree	256 (22.1)	134 (52.3)	87 (34.0)	35 (13.7)			
I am afraid of getting COVID-19							
Agree	1060 (91.5)	596 (56.2)	311 (29.3)	153 (14.4)	0.048	Reference	Reference
Disagree	99 (8.5)	54 (54.5)	38 (38.4)	7 (7.1)		0.92 (0.57–1.50)	0.23 (0.10–0.56)**
Perceived benefits							
Vaccination is a good idea because it makes me feel less worried about catching COVID-19							
Agree	1093 (94.3)	606 (55.4)	331 (30.3)	156 (14.3)	0.099		
Disagree	66 (5.7)	44 (66.7)	18 (27.3)	4 (6.1)			
Vaccination decreases my chance of getting COVID-19 or its complications							
Agree	1096 (94.6)	606 (55.3)	336 (30.7)	154 (14.1)	0.077		
Disagree	63 (5.4)	44 (69.8)	13 (20.6)	6 (9.5)			
Perceived barriers							
Worry the possible side-effects of COVID-19 vaccination would interfere with my usual activities							
Agree	894 (77.1)	515 (57.6)	261 (29.2)	118 (13.2)	0.153		
Disagree	265 (22.9)	135 (50.9)	88 (33.2)	42 (15.8)			
I am concern about the efficacy of the COVID-19 vaccination							
Agree	1128 (97.3)	637 (56.5)	337 (29.9)	154 (13.7)	0.269		
Disagree	31 (2.7)	13 (41.9)	12 (38.7)	6 (19.4)			
I am concern about the safety of the COVID-19 vaccination							
Agree	1116 (96.3)	627 (56.2)	335 (30.0)	154 (13.8)	0.931		
Disagree	43 (3.7)	23 (53.5)	14 (32.6)	6 (14.0)			
I am concern of my affordability (high cost) of getting the COVID-19 vaccination							
Agree	1026 (88.5)	612 (59.6)	300 (29.2)	114 (11.1)	p < .001	Reference	Reference
Disagree	133 (11.5)	38 (28.6)	49 (36.8)	46 (34.6)		2.17 (1.34–3.52)**	5.25 (3.08–8.95)***
I am concern if the new COVID-19 vaccine is halal							
Agree	606 (52.3)	411 (67.8)	153 (25.2)	42 (6.9)	p < .001	Reference	Reference
Disagree	553 (47.7)	239 (43.2)	196 (35.4)	118 (21.3)		1.64 (1.09–2.46)*	4.02 (2.24–7.23)***
Cues to action							
I will only take the COVID-19 vaccine if I was given adequate information about it							
Agree	1136 (98.0)	634 (55.8)	345 (30.4)	157 (13.8)	0.362		
Disagree	23 (2.0)	16 (69.6)	4 (17.4)	3 (13.0)			
I will only take the COVID-19 vaccine if the vaccine is taken by many in the public							
Agree	861 (74.3)	496 (57.6)	263 (30.5)	102 (11.8)	0.004	Reference	Reference
Disagree	298 (25.7)	154 (51.7)	86 (28.9)	58 (19.5)		0.89 (0.64–1.24)	1.39 (0.91–2.12)

*p < 0.05, **p < 0.01, ***p < 0.001.
†Multinomial regression; Reference group: MYR50/100.
Goodness of fit; Pearson Chi square: 993.876, Significant:0.180.

was influenced by socio-economic factors. The lower income groups may require the government to subsidize the cost of the COVID-19 vaccination.

Authors' contributions

WLP, WPF, LHY and SAB conceived the study. WLP wrote the manuscript. WLP, WPF and LHY performed data collection. WLP and HA performed data analysis.

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