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Knowledge, Perceived Risk, and Precautionary Behaviours towards COVID-19: Implications on Health Crisis Policy

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Abstract

Purpose - This study examines knowledge, perceived risk, and precautionary behaviours among Malaysians during a global health crisis, which is the first health crisis experienced by most Malaysians.

Method - A self-administered online survey questionnaire was sent across Malaysia, and A total of 686 usable data was collected. A contingent valuation using double-bounded dichotomous choice was adopted to estimate the willingness to pay (WTP). A multiple regression and four logit regressions were conducted to analyse the relationship among the variables.

Findings - The study found that (1) females have higher COVID-19 knowledge and precautionary behaviours, (2) education level positively affects COVID-19 knowledge and risk perception, (3) age positively affects risk perception and precautionary behaviours, and (4) COVID-19 knowledge positively affects precautionary behaviours. In terms of willingness to get a vaccine, the study noticed that those with a higher COVID-19 knowledge, precautionary behaviours, and younger generation were more willing to get a vaccine. Based on the contingent valuation, the estimated WTP was US$ 57.50.

Originality – This study serves as a guideline for future global health crisis in emerging countries including Malaysia.

Implications - The study provides insights to the Malaysian government that the “nudge” policy should be continued by the Ministry of Health; and the vaccine cost that is accepted by Malaysians.

Keywords: COVID-19, risk perception, precautionary behaviours, vaccine, contingent valuation, willingness to pay

JEL classifications: H1, H12, H41, I1, I18

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) or in short COVID-19, is the latest emerging infectious disease that has caused and continues to cause severe threats to population health, large economic losses and also fear and dread among the population throughout the world. Malaysia has introduced the Movement Control Order (MCO) with different levels of restrictions since 18 March 2020. Daily knowledge, updates on COVID-19 and precautionary behaviours that need to be taken by the general population have been shared through phone messenger and MySejahtera phone application by the Ministry of Health Malaysia (MOH).

Past studies have investigated the impact of knowledge of COVID-19 (K) and risk perception (RP) on precautionary behaviours (PB) (Arslanca et al., 2021; Azlan et al., 2020; Cvetković et al., 2020; Fadel et al., 2021; Geana, 2020; Iorfa et al., 2020; Lu et al., 2021; Mohamed et al., 2021; Rayani et al., 2021), and COVID-19 vaccination perception (Bai et al., 2021; Caserotti et al., 2021; Fadel et al., 2021; Jiang et al., 2021; Kukreti et al., 2021; Wang et al., 2021). Mixed findings were found between different countries. In Malaysia, multiple studies have been conducted. For example, Wong and Alias (2021) found that individuals' protective behaviours and anxiety level increase with the time frame of COVID-19 pandemic. Studies also explored individuals' knowledge, attitude, and practices toward COVID-19 (Ab Malik et al., 2021; Azlan et al., 2020; Mat Dawi et al., 2021).

In addition, limited studies were found on willingness to pay (WTP) assessment. García and Cerda (2020) found that WTP for a COVID-19 vaccine for Chile was at US$ 184.72, while Harapan et al. (2020) found WTP at US$ 57.20 for Indonesia. The Malaysian government has allowed private clinics and hospitals to provide private vaccination for those who choose to opt out from the government free vaccination program. Currently, the cost per two doses paid by

Malaysians is RM338 (US$ 81.50) - RM360 (US$ 86.80), using exchange rate US$ 1 = RM 4.15.

Conceptual Framework, Literature Review and Hypothesis Development

Protection Motivation Theory

The study was designed based on the Protection Motivation Theory (PMT), which has been used to predict a variety of behaviours in the past pandemic flu disease studies (Brug et al., 2004; Cui et al., 2017; de Zwart et al., 2009; Ling et al., 2019; Miller et al., 2012; Teasdale et al., 2012; Williams et al., 2015), and also in the recent COVID-19 pandemic (Arslanca et al., 2021; Cvetković et al., 2020; Fadel et al., 2021; Kukreti et al., 2021). PMT was developed by Rogers (1975) and later revised to add in efficacy belief (Maddux and Rogers, 1983). Based on (Rogers, 1975, p100): 'people appraise the severity and likelihood of being exposed to a depicted noxious event, evaluate their ability to cope with the event, and alter their attitudes accordingly.' The theory proposes that the amount of protection motivation aroused by fear appeal and cognitive mediating processes will result in attitude change. PMT assumes that individuals' decision to participate in risk preventative behaviours is made based on their motivation to protect themselves from threats such as pandemic, natural disasters, global climate change, and nuclear explosion (Maddux and Rogers, 1983; Rogers, 1975).

Literature Review and Hypothesis Development

Knowledge, Risk Perception and Precautionary Behaviours

Arslanca et al. (2021) evaluated K, RP and PB regarding COVID-19 among 250 health care workers in Turkey. In terms of predictors for K, the only significant factor was occupation, which the medical specialists were having a significant effect than nurses, while gender, workplace, and occupation were significantly affecting PB. They also found a positive

association between K and PB. The knowledge level about COVID-19 was above 90%, but the level of PB was low, especially in males. Among the respondents, only 66.93% were willing to get a COVID-19 vaccine.

Iorfa et al. (2020), Cvetković et al. (2020) and Rayani et al. (2021) examined the relationship between K, RP and PB among Nigerians, Serbians, and Iranians, respectively. Iorfa et al. (2020) concluded that there was a strong relationship between K and PB, and this relationship was mediated by RP, especially in females, whereas Cvetković et al. (2020) found that education level was the key predictor for K, followed by age. Age and education level were the key factors affecting RP, whereas age and gender were the main predictors for PB. Rayani et al. (2021) observed that PB was associated with respondents' perceived susceptibility, perceived severity and health information seeking.

Geana (2020) conducted a quite similar study in the United States, where comparisons were made between different demographic groups. He found that most respondents have good knowledge of COVID-19 and assessed their risk of contracting COVID-19 as average. In terms of PB, over 90% of the respondents avoid touching their face, and use disinfectants to clean their hands when water and soap are not available. However, only 37% of respondents always used face masks as they doubt the effectiveness of face masks. The study found correlation between K and PB with individuals' risk assessment, and K was affected by the source of information. The study was echoed by Lu et al. (2021) and Fadel et al. (2021) where they found strong association between K and RP, higher RP of older adults in the United States led them to practice more PB.

Azlan et al. (2020) studied the knowledge level, attitudes, and practices toward COVID-19 among Malaysians during 27th March and 3rd April 2020, they found that respondents have good knowledge on COVID-19 (80.5%), willing to practice PB such as washing hands (87.8%), avoiding crowd (83.4%), and only 53.4% of respondents were willing to wear face

mask. However, the study did not explore the relationship among these variables. Based on all the above findings, we proposed Hypothesis One (H1) and Hypothesis Two (H2) to examine the relationship between K, RP and PB among Malaysians.

H1: There is a significant relationship between K and PB

H2: There is a significant relationship between RP and PB

Willingness to Get and Pay for a COVID-19 Vaccine

Fadel et al. (2021) examined factors affecting PB and WTG among residents in South Carolina, USA. The findings showed that older respondents, females, respondents with a higher level of education, more COVID-19 personal experiences, higher perceived susceptibility and perceived severity have higher PB and more willing to get a COVID-19 vaccine. Kukreti et al. (2021) evaluated the WTG among outpatient population and health care workers in Taiwan, they concluded that RP, willingness to take rapid test and PB were significant predictors for healthcare workers' WTG. Same finding was found among Italian residents, as higher level of RP increased their WTG (Caserotti et al., 2021).

Bai et al. (2021) conducted research among college students in China and found that students living in urban areas and studying health-related courses were having a positive attitude towards vaccine. Besides, those who were worried about contracting COVID-19, and believed that vaccines are safe were more willing to get a vaccine. In a study among nursing students in China, gender, academic background, visits to high-risk areas, vaccination status of family members and the side effects experienced after receiving other vaccines were significant predictors of WTG (Jiang et al., 2021). Similar research conducted in Hong Kong showed that the acceptance rate of COVID-19 vaccine is still low, Wang et al. (2021) found the willingness to accept a vaccine was getting lower from first wave to third wave, mainly contributed by concern on vaccine safety and growing compliance of personal PB. In addition, those with a

lower education level were less willing to accept a vaccine. Harapan et al. (2020) also found that being a healthcare worker, having a higher income and RP were associated with higher WTP.

In Malaysia, Mohamed et al. (2021) examined the K, WTG and perception of Malaysian adults regarding COVID-19 vaccine. Based on their findings, 62% of respondents had poor knowledge about the vaccine, and 64.5% were willing to get a vaccine. In addition, education level, income level and risk of getting severe COVID-19 were having positive relationships with knowledge of vaccine. In the WTG, those in a lower age group, have higher education levels and females were more willing to get a vaccine. However, their study did not explore the effects of K, RP, PB on WTG, and factors determining Malaysians' WTP. Thus, the following hypotheses were developed to examine these relationships. Figure 1 illustrates the conceptual framework of this study.

H3, H4, H5: There is a significant relationship between K, RP, PB and WTG, respectively.

H6, H7, H8: There is a significant relationship between K, RP, PB and WTP, respectively.

[Insert Figure 1]

Methodology

Data Collection and Sample

The information was collected through a self-administered online questionnaire, which was distributed across Malaysia through email and social media such as WhatsApp and Facebook. We adopted a mixed sampling process (snowball and convenience sampling) since our target population was people 15 years of age or older. The questionnaire was translated into three languages: Malay, Mandarin and English to ensure the variety, reliability, and validity of the data collection. The sample size was determined using G*Power 3.1.9.6, with an odds ratio of 2.25, an error probability of 0.05, and a power of 0.95, a minimum sample size of 270 was needed for this study.

The survey consisted of three sections, section one collected respondents' demographic and socio-economics information such as gender, nationality, ethnicity, age, residing state, marital status, level of education, type of employment, occupation, personal and household monthly income. Respondents were also asked whether they have any COVID-19 patient and recovered COVID-19 patient in their family. Section two collected respondents' K, RP and PB. The questionnaire of these three variables were adopted and adapted from Brug et al. (2004), and García & Vila (2020). All respondents answered these questions in a 5-point Likert scale, ranging from (1) strongly disagree to (5) strongly agree. Respondents also answered the question: "I have been practicing the following behaviours to avoid contracting COVID-19" in a 5-point Likert scale, ranging from (1) never to (5) Always. Last section collected respondents' WTG and WTP.

Double-Bounded Dichotomous Choice (DB-DC)

We adopted the DB-DC contingent valuation method (CVM), which is more efficient compared with single-bounded dichotomous choice CVM (García & Cerda, 2020; Hanemann et al., 1991). In the DB-DC CVM, respondents respond to a first dollar amount and then face a second question involving another dollar amount, higher or lower depending on the response to the first question. If the respondent selects 'yes' for the first bid, the second bid will be higher than the first bid, whereas if the respondent selects 'no' for the first bid, the second bid will be lower than the first bid. In this study, we used RM90 as the starting price of the vaccine, this price was set based on the initial price set by Pfizer and BioNTech at $19.50 per two doses. The minimum and maximum price of this study ranged from RM45 to RM360.

We then segregated the respondents into four groups, which are 'yes, yes', 'no, no', 'yes, no', 'no, yes', and created a dummy variable (WTP) with 1 = 'yes' and 0 = 'no'. Those respondents who gave the first positive response (group 'yes, yes' and 'yes, no') were

categorized as 1, and 0 otherwise (group 'no, no' and 'no, yes'). To calculate the expected WTP, we derived the following Equation (1).

$$E(WTP) = \sum[P_{yy}WTP_{yy} + P_{nn}WTP_{nn} + P_{yn}WTP_{yn} + P_{ny}WTP_{ny}] \text{ ---------Equation (1)}$$

Where $E(WTP)$ is the expected WTP for Malaysians, $P_{yy}, P_{nn}, P_{yn}, P_{ny}$ are the probability of respondents selected 'yes, yes', 'no, no', 'yes, no', 'no, yes', respectively, and $WTP_{yy}, WTP_{nn}, WTP_{yn,}WTP_{ny}$ are the average WTP for each group, respectively.

Logit Model

The STATA version 16 was used to compute the descriptive statistics and examine the relationship between the variables. First, a multiple linear regression analysis is applied to examine the relationship between K, RP and PB, and demographic factors such as gender, age, ethnicity and level of education. Then, two multiple logistic regression models are applied to examine the relationship between the dependent variables, WTG and WTP, and predictor variables such as K, RP, PB and demographic factors, given the binary nature (1 or 0) of the dependent variable (Xing, 2016). The dependent variables, WTG and WTP are categorized as '1 = yes' and '0 = no'. We used the average value of K (7 items), RP (2 items) and PB (21 items) in the data analysis.

Based on the predictor variables and dependent variables in this study, the following Equation (2) is derived as a multiple logistic regression model for WTG. We assumed that K, RP, PB, GEN, AGE, ETHNIC and EDU would affect WTG.

$$logit[\pi(\text{WTG})] = \alpha + \beta_1 K + \beta_2 RP + \beta_2 PB + \beta_3 GEN + \beta_4 AGE + \beta_5 ETHNIC + \beta_6 EDU \text{ ---------- (2)}$$

Where WTG represents the willingness to get the COVID-19 vaccine; K, RP and PB are knowledge, risk perception and precautionary behaviours towards the COVID-19,

respectively; and the demographic factors are represented by gender (GEN), age (AGE), ethnicity (ETHNIC) and level of education (EDU).

To run the multiple logistic regression model for WTP, we postulated that WTP would be affected by K, RP, PB, personal monthly income (PMI), and household monthly income (HMI). Thus, Equation (3) was developed as the econometric model in predicting WTP.

$$logit[\pi(\text{WTP})] = \alpha + \beta_1 K + \beta_2 RP + \beta_2 PB + \beta_3 PMI + \beta_4 HMI \text{----------} (3)$$

Where WTP represents the willingness to pay for COVID-19 vaccine and the demographic factors are represented by personal monthly income (PMI) and household monthly income (HMI).

Findings

Respondents' Characteristics

Table I illustrates the respondents' characteristics and their willingness to get COVID-19 vaccine by demographic factors. After data screening, total usable data was 686 (with 4% Margin of Error) after excluding 9 respondents due to duplication or missing information. Only seven respondents had COVID-19 patients in the family, and eight respondents had recovered COVID-19 patients in the family while answering the survey questionnaire. Majority of the respondents were women (64.43%), single (48.54%), university graduates (73.91%), worked in the private sector (40.53%), and belonging to ages between 25 to 40 years old (45.92%). The study also found that males (79.51%), Malay (87.74%), age group below 25 years old (86.61%), and those who were unemployed (92.11%) were the group who had the highest percentage in WTG in their respective categories.

[Insert Table I]

Knowledge, Risk Perception and Precautionary Behaviours

Table II shows the descriptive analysis of respondents' K, RP and PB against COVID-19. The mean on questionnaire about K is between 4.37 to 4.89, showing that more than 86% of respondents are having good knowledge on COVID-19. When we regress K with GEN, AGE, ETHNIC and EDU (F value = 3.26, $p<0.01$), the results show that GEN ($t = 2.38$, $p<0.05$) and EDU ($t = 3.30$, $p<0.01$) are statistically affect their K, while ETHNIC and AGE are not statistically significant. Females and those with higher levels of education tend to have more knowledge on COVID-19.

In terms of RP, the mean for R1 (the risk of me contracting COVID-19 is high) is 3.27, while the mean for R2 (the risk of me contracting and dying from COVID-19 is low) is 3.16. The findings illustrate that only 41.70% of respondents feel that the risk of them contracting COVID-19 is high, while 34.84% neither agree nor disagree. Among them, only 23.47% feel that the risk of contracting and dying from COVID-19 is high, while 39.65% neither agree nor disagree. Most respondents viewed COVID-19 as higher risk compared with influenza(flu), common cold, accident at home, food poisoning, and HIV AIDS, while lower risk as compared with cancer, heart attack, and traffic accident. When we regress RP with GEN, AGE, ETHNIC and EDU (F value = 3.91, $p<0.01$), it indicates that only AGE statistically and positively affects RP ($t = 1.96$, $p<0.05$).

A total of 93.73% of respondents agree that proper PB can avoid contracting COVID-19. Most of them have been practicing PB such as wearing a mask (98.54%), maintaining physical and social distances (96.8%), paying more attention to cleanliness (96.65%) and washing hands more often (95.77%). The least PB practiced by respondents in avoiding contracting COVID-19 are do not go to school/work from home (63.41%), avoiding eating in restaurants/cafes (64.72%), and taking vitamins and supplements (64.58%). When we regress PB with GEN, AGE, ETHNIC and EDU (F value = 8.91, $p<0.01$), we found that GEN ($t =$

5.10, $p<0.01$) and AGE ($t = 2.48$, $p<0.05$) are statistically and positively affect PB. Results exhibit that females and older people tend to practice more PB than males and younger generations.

To examine the relationship between PB, K and RP, we regress PB as a dependent variable while K and RP as independent variables. The regression model (PB (2)) shows that K significantly and positively affects PB ($t = 11.50$, $p<0.01$), while otherwise for RP ($t = 1.63$, $p>0.05$). Thus, H1 is supported and H2 is not supported. The regression results can be found under Table III.

[Insert Table II]

[Insert Table III]

Willingness to Get and Pay for the COVID-19 Vaccine

Table IV shows the descriptive analysis of WTG and WTP for COVID-19 vaccine. In general, respondents are willing to get the COVID-19 vaccine (73.76%), and 85.97% of them are willing to pay for an effective and safe vaccine. Out of those who were willing to pay for an effective and safe vaccine, almost 93.79% answered yes to the first contingent valuation (RM90), 74.76% of them would also pay for a second higher value (RM180) and 43.87% of them would pay for the highest value (RM360). Among those who said "no" to the initial price (RM90), 62.96% would pay for a second lower value (RM45) and 25.93% would pay for the lowest value (RM22.50). Based on the data collected, Equation (1) is rewritten as follows, it is estimated that the average cost accepted by Malaysians for COVID-19 vaccine is around RM238.50 (US$ 57.50), which is lower than the current cost paid by Malaysians in private clinics and hospitals.

$$E(WTP) = \sum [0.745 * RM285.39 + 0.02696 * RM47.045 + 0.2525 * RM90 + 0.0417 * RM45] = RM238.50$$

[Insert Table IV]

To perform data analysis, we run four logistic regression models. Two fitted models (Model 1 and Model 2) are constructed for the dependent variables (WTG and WTP). Model 1 includes only the three predictors (i.e., K, RP, and PB), while Model 2 includes the control variables (i.e., GEN, AGE, ETHNIC and EDU for WTG; PMI and HMI for WTP) to ensure the robustness of the tests. Table V and Table VI presents the model fit, logit coefficients, standard errors and odds ratios for the model 1 and model 2 of WTG and WTP, respectively.

Model fit refers to a likelihood ratio test comparing the full model with the intercept-only model (Peng et al., 2002; Xing, 2016). Based on Table V, the log likelihood ratio for model 1 (-390.23) and model 2 (-374.55) is higher than the log likelihood ratio for intercept-only model (-394.82 and -394.55), indicating that the two models provide a better fit than intercept-only model in predicting the logit of being in the "yes" category compared with being in the "no" category, and also Model 2 provides a better fit than Model 1. Same goes to WTP based on Table VI, the log likelihood ratio for model 1 (-97.26) and model 2 (-94.46) are better than the log likelihood ratio for intercept-only model (-101.19). Goodness-of-Fit statistics assess the fit of a logistic model against actual outcome (Peng et al., 2002).

Akaike information criteria (AIC) and the Bayesian information criteria (BIC) tests are the two statistics commonly used to measure the model error. Hence, the smaller the AIC and BIC statistics, the better the fit of the model (Xing, 2016). Based on Table V and Table VI, the AIC for model 2 is lower than model 1. Pseudo R^2 is an overall effect size measure, indicating how much variance in the dependent variable is accounted for by a set of independent variables (Xing, 2016). R^2 for model 2 of each RP is higher than model 1, indicating larger effect size and model fit. The BIC did not exhibit lower model error in model 2 compared with model 1, this could be because BIC tends to be affected by the number of independent variables, the increase of independent variables will increase the model error for BIC. Thus, based on the

overall model fit analysis, model 2 is still demonstrating a better model fit compared with model 1. Thus, we will discuss the logistic model results based on the findings in Model 2.

Based on Table V, K is the main determinant for WTG. For one unit increase in K predictor while holding other predictors constant, the odds of being in the yes category increased by 1.703. K is statistically and positively affecting WTG at 95% significance level. Thus, H3 is supported ($z = 2.30$, $p<0.05$), meaning that an increase of COVID-19 knowledge will increase respondents' WTG by 70.3%. Next important predictor is PB, odds ratios = 0.604, $p<0.10$, which is less than 1, indicating that for each unit increase in PB while holding other predictors constant, the odds of being in the yes category decreased by 0.604. Thus, H5 is negatively supported ($z = -1.67$, $p<0.10$), which means that an increase in PB will reduce respondents' WTG by 39.6%. This could be because people do not view COVID-19 as a life threatening disease. In terms of RP, for one unit increase in RP predictor while holding other variables constant, the odds of being in the yes category increased by 1.032. However, H4 is not statistically supported ($z = 0.28$, $p>0.05$).

Next, we look at the demographic factors. Results indicate that GEN and AGE are significant predictors for WTG. Based on Table V, the odds of being in the yes category for females are 0.564 times as small as the odds for males and it is statistically significant ($z = -2.83$, $p<0.01$). This means that females are 43.6% less willing to get COVID-19 vaccination compared with males. As for AGE, for one unit increase in AGE while holding other variables constant, the odds of being in yes category decreased by 0.981, indicating that older generation is 1.9% less willing to get COVID-19 vaccination compared with younger generation, and it is statistically significant at 99% significance level ($z = -2.80$, $p<0.01$). In terms of ETHNIC, we notice that Chinese, Indian and others are less willing to get COVID-19 vaccination as compared with Malay since their odds ratios are less than 1. The results are statistically significant for Chinese ($z = -3.03$, $p<0.01$) and others ($z = -3.14$, $p<0.01$), but not statistically

significant for Indians ($z = -1.32$, $p>0.05$). For EDU, there is no significant relationship found between EDU and WTG ($z = 0.60$, $p>0.05$).

[Insert Table V]

Based on Table VI, the key determinant for WTP is RP. For one unit increase in RP predictor while holding other predictors constant, the odds of being in the yes category decreased by 0.53. RP is statistically and negatively affecting WTP at 95% significance level. Thus, H7 is supported ($z = -2.52$, $p<0.05$), meaning that an increase of COVID-19 risk perception will cause respondents' 47% less willing to pay for COVID-19 vaccine. There are no significant relationships between K and PB with WTP. Thus, H6 and H8 are not supported. In terms of income level, we notice an interesting finding, where PMI significantly and positively affects WTP ($z = 2.08$, $p<0.05$) but HMI significantly and negatively affects WTP ($z = -2.09$, $p<0.05$). The results indicate that when PMI increased by one unit, respondents are 69% more willing to pay for COVID-19 vaccine, however, when HMI increased by one unit, respondents are 46.2% less willing to pay for COVID-19 vaccine. This could indicate that those who had married and with children were less willing to pay for a vaccine as they need to pay for other family and children expenses.

[Insert Table VI]

Discussions and Conclusions

We examined the relationship between knowledge, risk perception, PB and how they affect the WTG and WTP among Malaysians. Our findings show that most Malaysians have good knowledge on COVID-19, which implies that the current "nudge" policy implemented by the Malaysian government has been effective. The Malaysian government has been sending COVID-19 information to all Malaysians through phone SMS, and in MySejahtera phone application. Daily infected and recovered cases can be found in the application. Females and

those with higher education level tend to have higher knowledge on COVID-19, the finding for education level is consistent with Cvetković et al. (2020), but not for females, perhaps, culture difference could be the reason. Malaysians have moderate risk perception on COVID-19, this could be because most Malaysians believed that they could avoid contracting COVID-19 by practicing good PB. Those in the older group tend to have higher risk perception and PB, and this is consistent with past studies (Cvetković et al., 2020; Fadel et al., 2021; Lu et al., 2021), where age is the key predictor on risk perception. This makes sense because the mortality risk for COVID-19 is 600 times, 230 times, 95 times higher for those aged 85 and above, 75-84, and 65-74, respectively, with the base group as 18-29 years old (CDC, 2021). Females also found to practice more PB than males, and this finding is supported by Arslanca et al. (2021), and Cvetković et al. (2020).

In terms of the relationship between knowledge, risk perception and PB, we found a significant and positive association between knowledge and PB, when Malaysians have a higher knowledge in COVID-19, they tend to practice PB. This finding is consistent with past studies (Arslanca et al., 2021; Fadel et al., 2021; Geana, 2020; Iorfa et al., 2020; Lu et al., 2021). There is no significant relationship found between risk perception and PB, which is consistent with Arslanca et al. (2021) but inconsistent with Rayani et al. (2021) and Lu et al. (2021). This could be because both studies only looked at specific targeted groups, which were undergraduate and older adults, respectively.

In terms of WTG, knowledge, PB, gender, and ethnicity are significant predictors. Our study shows that those with higher knowledge in COVID-19, practice less PB, males, younger age group, and Malay ethnic group are more willing to get a COVID-19 vaccine. Even though females and those with higher education levels have higher knowledge, and older people has higher risk perception, these did not lead them to have higher intention to get a COVID-19 vaccine. Perhaps, this could be because they are more risk averse as the vaccines are still new

during our survey period in Malaysia. Besides, we also noticed that people who practice more PB were less willing to get a vaccine because they believed that they could avoid contracting COVID-19 by practicing good PB. There are mixed findings as compared with past studies (Bai et al., 2021; Caserotti et al., 2021; Fadel et al., 2021; Jiang et al., 2021; Kukreti et al., 2021; Wang et al., 2021). As compared with Mohamed et al. (2021), they also found those in a lower age group were more willing to get a vaccine, but our results are not consistent with them in terms of education level and gender. This could be because we conducted the survey in a different time frame, demographic factors, and adopted statistical analysis.

We found a significant relationship between risk perception, personal monthly income, household monthly income and WTP, but not for knowledge and PB. Malaysians with higher risk perception and lower personal monthly income were less willing to pay for a COVID-19 vaccine. Limited study explored the factors affecting WTP in current literature since most countries give free vaccination to their citizens. However, in Malaysia, people may opt for private vaccination as they could not wait for government appointment or want to choose the type of vaccine not in the vaccination program. Based on our findings, the WTP for COVID-19 vaccine is around RM238.50 (US$ 57.50 per two doses), which is lower than current charged vaccine cost (RM338 (US$ 81.50) - RM360 (US$ 86.80) for two doses). The finding on WTP is quite close to Indonesians at US$ 57.20 (Harapan et al., 2020).

In terms of theoretical implication, we support the PMT that individuals' perceived vulnerability and perceived severity of COVID-19 affect their WTP, while self-efficacy and response efficacy affect their WTG. In terms of practical implication, we contribute to Malaysia COVID-19 study since most current study only focused on descriptive analysis of the comparison between demographic factors (Azlan et al., 2020; Mohamed et al., 2021). The findings provide insights to the Malaysian government on the importance of COVID-19 knowledge in encouraging Malaysians to practice PB. Thus, the daily updates by MOH are

effective in cultivating these behaviours. Good knowledge will encourage more Malaysians to get a COVID-19 vaccine. Income level is the main factor affecting WTP. The effective duration of the vaccine is still unknown; thus, the Malaysian government should consider future vaccination cost in their yearly budget. The findings from this study also can provide a guideline to the Malaysian government for future global health crises, and not only COVID-19 pandemic.

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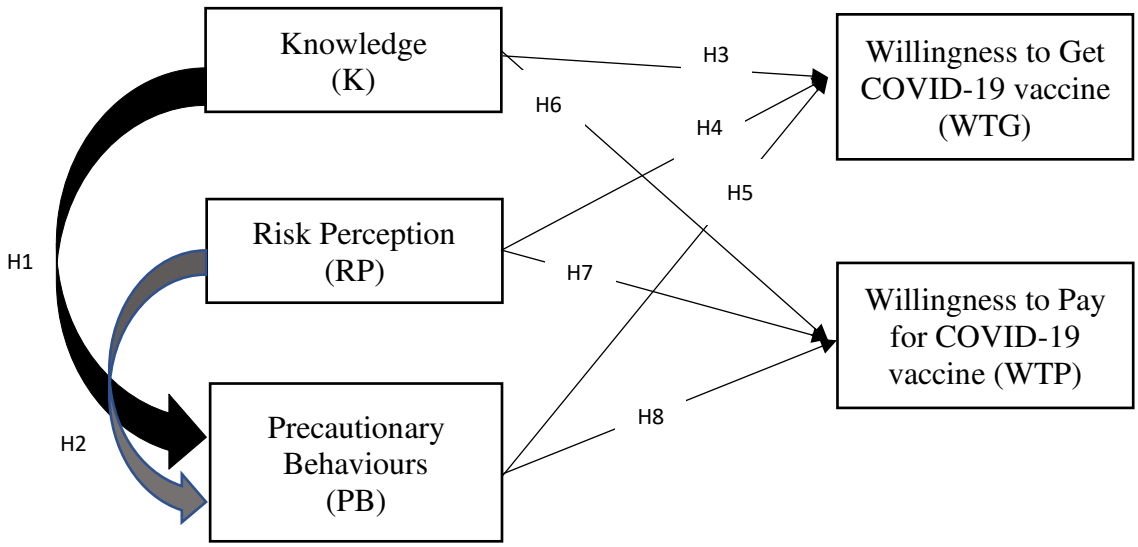

Figure 1: Research Framework

Table I. Respondents' Characteristics and Willingness to get COVID-19 Vaccine

Variable	Number	Percentage	Willingness to get vaccine (%)	Variable	Number	Percentage	Willingness to get vaccine (%)
Gender				**Education Level**			
Male	244	35.57	79.51	Higher upper education or lower	88	12.83	68.18
Female	442	64.43	70.59	Vocational and diploma	91	13.27	74.73
				Bachelor's degree and above	507	73.91	74.56
Ethnicity							
Malay	106	15.45	87.74	**Employment**			
Chinese	502	73.18	71.12	Employed (Private Sector)	278	40.53	73.38
Indian	32	4.66	78.13	Employed (Public Sector)	106	15.45	69.81
Others	46	6.71	67.39	Self-employed	83	12.10	63.86
				Retired	47	6.85	63.83
Age				Student	118	17.20	85.59
< 25	112	16.33	86.61	Unemployed	38	5.54	92.11
25 – 40	315	45.92	73.33	Others	16	2.33	56.25
41 – 56	195	28.43	69.23				
> 56	64	9.33	67.19				
Marital Status							
Single	333	48.54	79.58				
Married	329	47.96	67.17				
Others	24	3.50	83.33				

Table II Descriptive Analysis of Respondents' Knowledge, Risk Perception and Precautionary Behaviours against COVID-19

Variable (observation = 686)	**Mean**	**Percentage (agree and strongly agree; often and always)**	**Standard Deviation**	**Skewness**	**Kurtosis**	**Cronbach's Alpha**
Knowledge about COVID-19(K)						**0.8306**
K1: I have heard of COVID-19	4.89	99.27	0.382	-5.152	40.598	0.8075
K2: I know what COVID-19 is	4.80	98.84	0.461	-2.985	17.111	0.7917
K3: I know how COVID-19 spreads	4.74	98.25	0.511	-2.461	12.434	0.7827
K4: I am aware of the COVID-19 symptoms	4.63	97.09	0.592	-2.034	10.106	0.7956
K5: I know COVID-19 can have no symptoms	4.67	95.77	0.713	-3.021	13.941	0.8315
K6: I am aware of the death risk caused by COVID-19	4.74	97.82	0.528	-2.678	14.033	0.7940
K7: I am informed of the long-term health impact of COVID-19	4.37	86.30	0.887	-1.615	5.653	0.8552
Risk Perception of COVID-19 (RP)						**0.8048**
R1: the risk of me contracting COVID-19 is high	3.27	41.70	1.165	-0.211	2.340	0.8147
*R2: The risk of me contracting and dying from COVID-19 is low	3.16	36.89	1.141	-0.213	2.495	0.8259
R3: The risk of me contracting and dying from the following diseases or accidents is higher than COVID-19						
a: Influenza (flu)	2.56	20.41	1.139	0.256	2.279	0.7842
b: Common cold	2.16	12.39	1.140	0.798	2.883	0.8039
c: Accident at home	2.77	25.22	1.121	0.039	2.314	0.7761
d: Cancer	3.27	44.02	1.196	-0.307	2.324	0.7647
e: Heart attack	3.34	47.23	1.263	-0.355	2.193	0.7644
f: Traffic accident	3.37	46.36	1.159	-0.379	2.518	0.7735
g: Food poisoning	2.57	18.66	1.109	0.245	2.401	0.7761
h: HIV AIDS	2.51	24.35	1.375	0.393	1.929	0.7804
Precautionary Behaviours against COVID-19 (PB)						**0.9060**
P1: I can avoid contracting COVID-19 with proper precautious	4.46	93.73	0.671	-1.307	5.555	0.9044
P2: I have been practicing the following behaviours to avoid contracting COVID-19						
a: Avoiding travelling to COVID-19 infected areas	4.44	89.50	0.888	-1.943	6.871	0.9030
b: Making sure to get sufficient sleep	4	74.20	0.983	-0.876	3.272	0.9031
c: Wearing a mask	4.81	98.54	0.499	-3.792	23.590	0.9036

d: Maintaining physical and social distancing	4.65	96.80	0.590	-2.056	9.576	0.9020
e: Avoiding eating in food centers / hawker centers	4.03	73.76	1.047	-0.977	3.301	0.9002
f: Taking vitamins and supplements	3.74	64.58	1.222	-0.794	2.717	0.9050
g: Avoiding large gathering of people	4.57	92.13	0.799	-2.432	9.697	0.8986
h: Washing hands more often	4.64	95.77	0.628	-2.167	9.410	0.9014
i: Using disinfectants sanitizers	4.52	92.72	0.771	-2.061	8.144	0.9024
j: Paying more attention to cleanliness	4.63	96.65	0.596	-1.962	9.069	0.9013
k: Avoiding contacting people who are sick	4.59	93.73	0.713	-2.280	9.818	0.9009
l: Avoiding contracting people who are from high risk areas / red zones	4.52	91.11	0.820	-2.225	8.688	0.8987
m: Eating a balanced diet	4.22	82.22	0.893	-1.177	4.265	0.9001
n: Avoiding traveling by airplane	4.41	85.28	0.996	-1.876	5.986	0.9012
o: Do not go to school or work / working from home	3.75	63.41	1.282	-0.763	2.500	0.9070
p: Avoid shaking hands	4.56	90.96	0.839	-2.403	9.144	0.8985
q: Avoiding traveling by taxis / Grabcar	4.12	74.92	1.101	-1.146	3.460	0.9003
r: Avoiding traveling by trains, ferries or buses	4.26	81.35	1.045	-1.483	4.572	0.9000
s: Avoiding eating in restaurants/cafes	3.81	64.72	1.124	-0.720	2.751	0.8985
t: Exercising regularly	3.907	69.09	1.090	-0.857	3.070	0.9051

Note:
(1) K1 to K7, R1 – R3h: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree
(2) *R2 is reversed question
(3) P1: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree
(4) P2a – P2t: 1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always

Table III Multiple Regression Analysis for Knowledge, Risk Perception and Precautionary Behaviours

Variable	K	RP	PB(1)	PB(2)
Knowledge (K)				0.4637***
				(0.0403)
Risk Perception (RP)				0.0336
				(0.0207)
Gender (GEN)	0.0810**	0.0146	0.1960***	
	(0.0340)	(0.0665)	(0.0384)	
Age (AGE)	-0.0013	0.0085***	0.0035**	
	(0.0012)	(0.0024)	(0.0014)	
Ethnicity (ETHNIC)				
2	0.0168	-0.1550*	0.0240	
	(0.0454)	(0.0888)	(0.0513)	
3	0.0601	-0.1684	-0.0508	
	(0.0847)	(0.1657)	(0.0957)	
4	-0.0721	-0.3316**	-0.2458***	
	(0.0748)	(0.1463)	(0.0845)	
Level of Education (EDU)	0.0765***	0.0874*	0.0408	
	(0.0232)	(0.0454)	(0.0262)	
_cons	4.4792***	2.6391***	3.5173***	1.6011***
	(0.0894)	(0.1748)	(0.1010)	(0.1993)
Prob > F	0.0007***	0.0036***	0.0000***	0.0000***
Adj R-squared	0.0249	0.0194	0.0648	0.1631
Root MSE	0.41925	0.81965	0.47361	0.44802

Note: Standard errors are shown in parentheses.
** p < 0.10, ** p < 0.05, *** p < 0.01*
Stata coding is as follows:
Gender: male = 0, female = 1
Ethnicity: Malay = 1, Chinese = 2, Indian = 3, Others = 4
Level of education: higher upper education and lower = 1, vocational and diploma = 2, bachelor's degree and above = 3

Table IV Descriptive Analysis of Respondents' Willingness to Get and Pay for COVID-19 Vaccine

Variable	Obs	Yes (%)	No (%)	Standard Deviation	Skewness	Kurtosis
W1: Are you willing to get a vaccine that protects you against COVID-19?	686	73.76	26.24	0.440	-1.080	2.167
W2: If payment is required, are you willing to pay for an effective and safe vaccine?	506	85.97	14.03	0.348	-2.071	5.290
W3: Would you be willing to pay RM90?	435	93.79	6.21	0.242	-3.630	14.178
W4: Would you be willing to pay RM45?	27	62.96	37.04	0.492	-0.537	1.288
W5: Would you be willing to pay RM180?	408	74.75	25.25	0.435	-1.140	2.299
W6: Would you be willing to pay RM22.50?	10	70.00	30.00	0.483	-0.873	1.762
W7: Would you be willing to pay RM360?	305	58.69	41.31	0.493	-0.353	1.125

Table V Multiple Logistic Regression for Willingness to Get COVID-19 Vaccine

Variable	Willingness to Get COVID-19 Vaccine			
	Model 1		Model 2	
	$b(SE(b))$	OR	$b(SE(b))$	OR
knowledge (K)	0.576***	1.780***	0.532**	1.703**
	(0.219)	(0.390)	(0.231)	(0.394)
risk perception (RP)	0.0293	1.029	0.0315	1.032
	(0.106)	(0.109)	(0.111)	(0.115)
precautionary behaviours	-0.505**	0.604**	-0.362*	0.696*
(PB)	(0.207)	(0.125)	(0.216)	(0.151)
1.gender (GEN)			-0.572***	0.564***
			(0.202)	(0.114)
age (AGE)			-0.019***	0.981***
			(0.007)	(0.0068)
ethnicity (ETHNIC)				
2			-0.964***	0.382***
			(0.318)	(0.121)
3			-0.701	0.496
			(0.529)	(0.263)
4			-1.407***	0.249***
			(0.448)	(0.110)
level of education (EDU)			0.077	1.080
			(0.129)	(0.139)
-cons	0.215	1.240	1.653	5.221
	(1.022)	(1.268)	(1.177)	(6.145)
Observations	686		686	
LR (McFadden′s)R^2	0.012		0.051	
ML (Cox and Snell′s)R^2	0.013		0.057	
Nagelkerke R^2	0.019		0.084	
Log likelihood (intercept-only)	-394.82		-394.55	
Log likelihood	-390.23		-374.55	
LR χ^2 (9)	9.18		40.54	
Prob $> \chi^2$	0.027**		0.000***	
AIC	788.46		769.10	
BIC	806.58		814.41	

Note: Standard errors are shown in parentheses.

** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

Stata coding is as follows:

Willingness to get COVID-19 vaccine: no = 0, yes = 1

Gender: male = 0, female = 1

Ethnicity: Malay = 1, Chinese = 2, Indian = 3, Others = 4

Level of education: higher upper education and lower = 1, vocational and diploma = 2, bachelor's degree and above = 3

Table VI Multiple Logistic Regression for Willingness to Pay for COVID-19 Vaccine

Variable	Willingness to Pay for COVID-19 Vaccine			
	Model 1		Model 2	
	$b(SE(b))$	OR	$b(SE(b))$	OR
knowledge (K)	0.464	1.591	0.548	1.730
	(0.511)	(0.813)	(0.528)	(0.914)
risk perception (RP)	-0.505**	0.604**	-0.633**	0.531**
	(0.239)	(0.144)	(0.251)	(0.133)
precautionary behaviours (PB)	-0.886	0.412	-0.874	0.417
	(0.539)	(0.222)	(0.559)	(0.233)
Personal monthly income (PMI)			0.525**	1.690**
			(0.252)	(0.425)
Household monthly income (HMI)			-0.619**	0.538**
			(0.296)	(0.159)
-cons	6.655**	285.68**	6.237**	511.07**
	(2.497)	(713.44)	(2.580)	(1318.70)
Observations	435		435	
LR (McFadden's)R^2	0.039		0.067	
ML (Cox and Snell's)R^2	0.018		0.030	
Nagelkerke R^2	0.048		0.082	
Log likelihood (intercept-only)	-101.19		-101.19	
Log likelihood	-97.257		-94.459	
LR χ^2 (3) & (5)	7.869		13.464	
Prob $> \chi^2$	0.049**		0.019**	
AIC	202.51		200.92	
BIC	218.82		225.37	

Note: Standard errors are shown in parentheses.

** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

Stata coding is as follows:

Willingness to pay for COVID-19 vaccine: no = 0, yes = 1

Monthly income: no income = 0, RM4849 and lower = 1, RM4850 to RM10959 = 2, RM10960 and above = 4