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Acceptance and willingness to pay under the different COVID-19 vaccines: A contingent valuation method

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ABSTRACT

Background: The COVID-19 vaccine is recognized as a novel tool in the battle against COVID-19. Recently, there were several types of vaccines that have a different effectiveness and safety profile. Understanding the vaccine acceptance and willingness to pay (WTP) are essential to develop a strategic plan to increase the rate of COVID-19 vaccination uptake.

Objectives: To assess the acceptance and WTP for a COVID-19 Vaccine in Thailand using the contingent valuation method (CVM). Additionally, to identify the factors that affect the acceptance and the amount of WTP for a COVID-19 Vaccine.

Methods: We conducted a cross-sectional survey using a payment card approach with open-ended questions during September 2021. Three hypothetical COVID-19 vaccines (Vaccines A, B, and C) in two scenarios were employed. Data were collected from 752 people. Multivariate logistic regression was performed to assess the predictors of vaccine acceptance. Multiple linear regression was used to analyze factors associated with the maximum amount WTP for a vaccine.

Results: Of 742 respondents, the highest acceptance was vaccine C (70.71%), followed by B (17.72%) and A (11.57%). Similarly, 53.87%, 41.44%, and 36.21% of the respondents expressed WTP for vaccine C, B and A, respectively. The maximum amount WTP for vaccine C was US\$46, followed by B (US\$35) and A (US\$32). Factors affecting acceptance included monthly salary, region of residence, education, perceived risk of COVID-19 infection, knowledge and attitude about the COVID-19 vaccine. In addition, monthly salary, region of residence, education and knowledge on COVID-19 vaccine were related to maximum amount WTP.

Conclusion: Acceptance and WTP depends on vaccine characteristics. Educational campaigns should be implemented to improve people's awareness, knowledge, and attitude towards COVID-19 vaccines to increase the vaccines' acceptance. To increase the rate of vaccination, the Thai government needs to allow freedom of choice on vaccines, while considering effectiveness and safety issues.

1. Introduction

The novel coronavirus is known as Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) or COVID-19.¹ Since the start of COVID-19 to now, this contagious disease is continuing to spread over two hundred million people across the globe.² This pandemic has a substantial impact on the human life and the economics over the world.³ Stopping the spread of COVID-19 requires social distancing, hand washing, and mask wearing to reduce the COVID-19 transmission.⁴ Crucially, the COVID-19 vaccine is recognized as a novel tool in the battle against COVID-19. Scientific evidence consistently indicated the

vaccination can reduce severe illness and deaths.^{5–7} Recently, there were several types of COVID-19 vaccines that have a different effectiveness and safety profile.^{8,9} The mRNA-based vaccine was developed in the US and has an efficacy of 95% against symptomatic covid-19.¹⁰ Inactivated virus vaccine was developed in China with 50–70% efficacy¹¹ and the viral vector vaccine, have an efficacy of 70–80%.^{12,13} Acceptance of the COVID-19 vaccine is critical for achieving sufficient immunization coverage to end the COVID-19 pandemic. In high income countries showed a high demand for COVID-19 vaccination ranging from 60 to 70%.^{14–16} In contrast, the acceptance rate in low- and middle-income countries have ranged from 30% to 60%.¹⁷ Vaccine

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hesitancy in many countries have been mainly concerns over safety of the vaccine.^{18,19} Understanding the vaccine acceptance and identifying factors affecting acceptance is essential to design an effective vaccine communication and promotion program.²⁰ Furthermore, exploring willingness to pay (WTP) for the COVID-19 vaccine is also crucial because it reflects the perceived monetary values of vaccine to individuals and society.²¹ WTP for vaccine is defined as the maximum amount of money that people would consider to pay for a vaccine. The contingent valuation method (CVM) is the method to assess the WTP of individual preferences for products and services with unknown market price. This suitable method has been commonly used to set the price for several vaccines.²² According to studies in high income countries exploring WTP, the acceptable price range of the vaccine was from US \$184 to US\$236.^{22,23} Studies in middle income countries showed the amount of WTP ranged from US\$31 to US\$149. WTP information is also useful to determine pricing strategy to promote vaccination.^{24–26}

Thailand is an upper-middle income country in Southeast Asia. The country is facing a tough battle against COVID-19.²⁷ In February 2021, Thailand first received an inactivated virus vaccine then, the viral vector vaccine also became available. Both of the vaccines have been offered for free to Thai population. Since July 2021, the national vaccination programme has been provided the mix and match approach of COVID-19 vaccines. This approach administers the inactivated vaccine for the first dose and the viral vector vaccine for the second dose.^{28,29} However, the acceptance and the WTP for COVID-19 vaccines have a few studies in Thailand. This study aimed to assess the acceptance and the WTP of a COVID-19 vaccine in Thailand using the CVM. Other objectives, to identify the factors were affecting the acceptance and the maximum amount WTP for various COVID-19 vaccines. Findings from this study will provide beneficial information for the Thai government to develop a strategic plan to increase the rate of COVID-19 vaccination uptake.

2. Methods

2.1. Study design and sample size

This study was conducted a cross-sectional survey in Thai population during September 2021. Based on the conservative assumption the response rate was 80% with 4% margin of error and confidence interval of 95%, the required sample size was 752 people. The participants were selected using a stratified, multistage sampling method. Firstly, two provinces were randomly selected from four different regions in Thailand (North, Central, South, and Northeast). A list of province within these clusters was selected to get the eligible eight provinces. Each province was randomly selected two districts (one urban and one rural area). In each district, a number of participants was selected using the convenience sampling technique. Inclusion criteria include: 1) Thai citizen, aged 18–59 years old, and 2) being willing to participate in the study and providing informed consent. Participants who could not complete and answer the questionnaire were excluded.

2.2. Study instruments and collection

The questionnaire basing on an extensive literature review was developed to assess acceptance and WTP for COVID-19 vaccines. The survey was divided into four sections. The first part included questions about sociodemographic data, such as age, gender, monthly income, educational level, occupation, health insurance, perception of COVID-19 risk and the history of COVID-19 vaccination. The second part asked about the acceptability and WTP for two different hypothetical scenarios in which three COVID-19 vaccines were deployed. In the first scenario, all vaccine currently available for free of charge. For the second scenario, vaccine A and B, currently available for free of charge while vaccine C was not available (≥ 3 months) and need to pay US\$ 90. The scenarios were designed the hypothetical profiles for Vaccines A, B, and

C to reflect the efficacy and safety profiles of three real COVID-19 vaccines being currently used in Thailand: Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA BNT162b2 vaccine. Details on efficacy, safety, number and interval of required dose, and dose for each type of vaccine were shown in Table 1. To assess the acceptability of COVID-19 vaccine, participants were asked if they would get vaccinated if it was offered free of charge. If they affirmed that they would be vaccinated, their WTP was assessed by using the payment card approach. The following seven prices were set in the payment card: 200THB (US\$6), 400THB (US\$12), 800THB (US\$24), 1200THB (US\$36), 1600THB (US\$48), 2000THB (US\$60), and 2400THB (US\$72).³⁰ The prices were based on the actual prices of COVID-19 vaccines that have been registered with the Thai FDA [ranging from 125 to 1504THB (US\$3.78–45.4)].³⁰ Finally, participants were asked open-ended questions to get the maximum price of WTP for each COVID-19 vaccine. Moreover, this part also assessed the acceptability of the mixed and match Covid-19 vaccine (The inactivated vaccine for the first dose and the viral vector vaccine for the second dose). The third part included 14 questions related to knowledge on COVID-19 and vaccines. Knowledge score ranged from 0 to 14, where a higher score indicated higher knowledge. The knowledge score was grouped into 3 categories: 0–8 (low), 9–11 (moderate), and 12–14 (high).³¹ Attitude towards vaccination was measured by 13 items with a 5-point Likert scale, Strongly disagree (1 point), Disagree (2 points), Undecided (3 points), Agree (4 points), and Strongly agree (5 points). Higher scores reflected a positive vaccination attitude. Interpretation of attitude was classified into 3 groups: 1.00–2.33 (negative), 2.34–3.67 (neutral), and 3.68–5.00 (positive).³²

Questionnaire was conducted online survey via Google Forms in September 2021. The participants received a survey website link, including study information. They answered the questionnaire using their smartphones or tablets. The participants checked an “Agree” checkbox to indicate their informed consent before completing the survey. The protocol of this study was approved by The Human Research Ethics Committee of Thammasat University (Medicine) on August 3, 2021 (Project No: MTU-EC-OO-0-197/64).

Table 1

Characteristics of three hypothetical COVID-19 vaccines and the real vaccines they reflect in study of acceptance and willingness to pay of vaccines in Thailand.

Details about each vaccine	Vaccine A	Vaccine B	Vaccine C
General efficacy against infection	50–70%	70–80%	95%
Efficacy against infection by virus mutations	<20%	60%	88%
Efficacy in preventing severe disease and death	90%	92%	96%
Dosage and period of administration	2 doses, 2–4 weeks	2 doses, 4–12 weeks	2 doses, 2–3 weeks
Common side effects	Chills, headache, pain, tiredness, redness and swelling at the injection site		
Severe side effects	Muscle weakness, at 2–3 cases per million	Thrombosis, at 1–2 cases per million	Myocarditis, at 2–5 cases per million

Note: In the first scenario, all vaccines were available for free. The second scenario reflected the current situation in Thailand as of September 2021: Vaccines A and B were readily available for free. Vaccine C was not available (≥ 3 months) and required paying out of pocket (US\$ 90). (Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches, the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA, and BNT162b2 vaccine).

2.3. Data analysis

The descriptive analysis was used to analyze sociodemographic characteristics of respondents. For each type of vaccine, a multiple logistic regression was conducted to assess factors associated with acceptance. A p -value ≤ 0.05 was considered statistically significant. Among those respondents who indicated acceptance towards the vaccine, multiple linear regression was conducted to measure the association between various factors with the maximum amount WTP for three COVID-19 vaccines. Due to its non-normal distribution, the data were transformed for the maximum amount WTP for the COVID-19 vaccines into its logarithmic form. In the initial multivariable model, all explanatory variables were included. Then, all explanatory variables in which their association with the maximum amount WTP had p -values ≥ 0.20 were excluded. Statistical significance of variables in the final model was designated as having a p -value ≤ 0.05 . All analyses were carried out using STATA software version 14.1 (Stata, College Station, Texas 77845 USA).

3. Results

3.1. Sociodemographic characteristics of respondents

Of 752 respondents approached, 742 (98.67%) participated in this study. The mean age was 27.5 ± 10.5 years old. 64.7% of the respondents were female, and 54.0% of the respondents had a bachelor's degree or above. Half of them were living in the rural area (52.40%). Approximately, 37% of respondents had the universal coverage scheme. The average monthly income was US\$349.66 (SD = 567.52). The most frequent types of occupation were student and unemployed, followed by government official and state enterprise employee, agriculturist and employee. Nearly half had a high perceived risk of COVID-19 infection (45.80%) and moderate knowledge on COVID-19 and vaccines (48.38%). More than half of participants had neutral attitude toward the COVID-19 vaccine (54.58%) (Table 2).

3.2. Acceptance and WTP for COVID-19 vaccine

The first scenario was shown in Fig. 1. The highest acceptance rate was Vaccine C (70.71%), followed by B (17.72%) and A (11.57%), respectively. In the second scenario, Vaccines A and B were available for free, while Vaccine C was not available (≥ 3 months) and required payment US\$ 90. The highest percentage of participants (63.38%) preferred Vaccine C, followed by B (26.97%) and A (9.65%), respectively. The common reasons for unacceptance of COVID-19 vaccines were concerned about efficacy (75.38% and 60.62% for Vaccine A, and B, respectively) and safety concerns for Vaccine C (71.62%). Only 29.11% of respondents accepted the mix and match vaccine approach. The reason for unacceptance was safety concerns (42.40%). Fig. 2 showed that the highest percentage of the participants expressed WTP for Vaccine C (53.87%), followed by B (41.44%) and A (36.21%). The common reason for unwilling to pay, they believed that vaccine should be provided for free by government. As shown in Fig. 3, at least 70% of participants were willing to pay for vaccine at the price ranging from US \$6 to 24 per course. If the prices for a COVID-19 vaccine increased to US \$36, US\$48, US\$60, or US\$72, the number of respondents who were willing to pay decreased. The maximum price WTP for Vaccine C was the highest (US\$46), followed by B (US\$35) and A (US\$32).

3.3. Factors associated with acceptance and WTP for COVID-19 vaccine

For Vaccines A and B, acceptance were likely to be higher among those who were living in the Northeast ($OR_A = 1.81$ and $OR_B = 2.65$) and the South ($OR_A = 2.15$ and $OR_B = 1.69$), as compared to the Central region. Those who perceived moderate risk of COVID-19 infection tend to have higher acceptance rate of vaccination ($OR_A = 1.74$ and $OR_B =$

Table 2

Sociodemographic characteristics of respondents in study of acceptance and willingness to pay for three different hypothetical COVID-19 vaccines in Thailand (n = 742).

Variable	N	(%)
Age, Mean \pm SD (Range)	27.5 \pm 10.5(18-59)	
≤ 20	268	(36.10)
21-30	262	(35.30)
≥ 31	212	(28.60)
Gender		
Female	480	(64.70)
Education		
\leq Junior High School	148	(20.00)
Senior High School	193	(26.00)
\geq Bachelor's Degree	401	(54.00)
Region of Residence in Thailand		
Central	192	(25.90)
Northeast	175	(23.60)
North	175	(23.60)
South	200	(27.00)
Type of Area of Residence		
Urban	353	(47.60)
Rural	389	(52.40)
Type of health insurance		
Universal Coverage Scheme	280	(37.70)
Civil Servants Medical Benefit Scheme	77	(10.40)
State Enterprise Officer	29	(3.90)
Social Security Scheme	164	(22.10)
Out-of-Pocket	192	(25.90)
Monthly Salary (Thai Baht), Mean \pm SD (Range)	349.66 \pm 567.52 (29.50–7375.00)	
\leq US\$ 149.50	323	(43.53)
US\$149.53- US\$299	180	(24.26)
US\$299.03- US\$448.50	107	(14.42)
US\$448.53- US\$598	58	(7.82)
\geq US\$598	74	(9.97)
Occupation		
Student/Unemployed	283	(38.14)
Agriculturist/Employee	158	(21.21)
Self-employed	122	(16.44)
Government official/State enterprise employee	179	(24.12)
Perceived risk of COVID-19 infection		
Low	167	(22.51)
Moderate	235	(31.67)
High	340	(45.82)
Knowledge on COVID-19 and vaccine		
Low	206	(27.76)
Moderate	359	(48.38)
High	177	(23.85)
Attitude towards COVID-19 vaccine		
Negative	155	(20.89)
Neutral	405	(54.58)
Positive	182	(24.53)

2.21), compared to those with a low perceived risk of infection. The acceptance rate tended to be higher among those with positive ($OR_A = 2.35$ and $OR_B = 2.62$) and neutral attitude ($OR_A = 1.56$ and $OR_B = 1.60$) towards the COVID-19 vaccine, compared with those with a negative attitude. Respondents who had a low income of \leq US\$149.50 ($OR_A = 0.32$ and $OR_B = 0.42$) and US\$149.53 to US\$299 ($OR_A = 0.51$ and $OR_B = 0.52$) were less likely to agree to be vaccinated with Vaccines A and B, comparing to those with income \geq US\$598. For Vaccines B and C, the acceptance rate tended to be higher among those with higher education (high school: $OR_B = 1.67$ and $OR_C = 2.30$), (\geq Bachelor's degree : $OR_C = 2.10$). Additionally, the acceptance rate tended to be higher among those with higher knowledge on COVID-19 and vaccine (high knowledge: $OR_B = 1.82$ and $OR_C = 4.88$), (moderate knowledge: $OR_B = 1.87$ and $OR_C = 2.30$), compared to those with low knowledge. As indicated in Table 3.

The results of factors affecting the maximum amount of WTP were presented in Table 4. For Vaccine A, respondents living in the Northeast [$\beta = -0.29$], the North [$\beta = -0.20$] and the South [$\beta = -0.30$], those who had salary of US\$299.03-US\$448.50 [$\beta = -0.26$] and US\$448.53-US

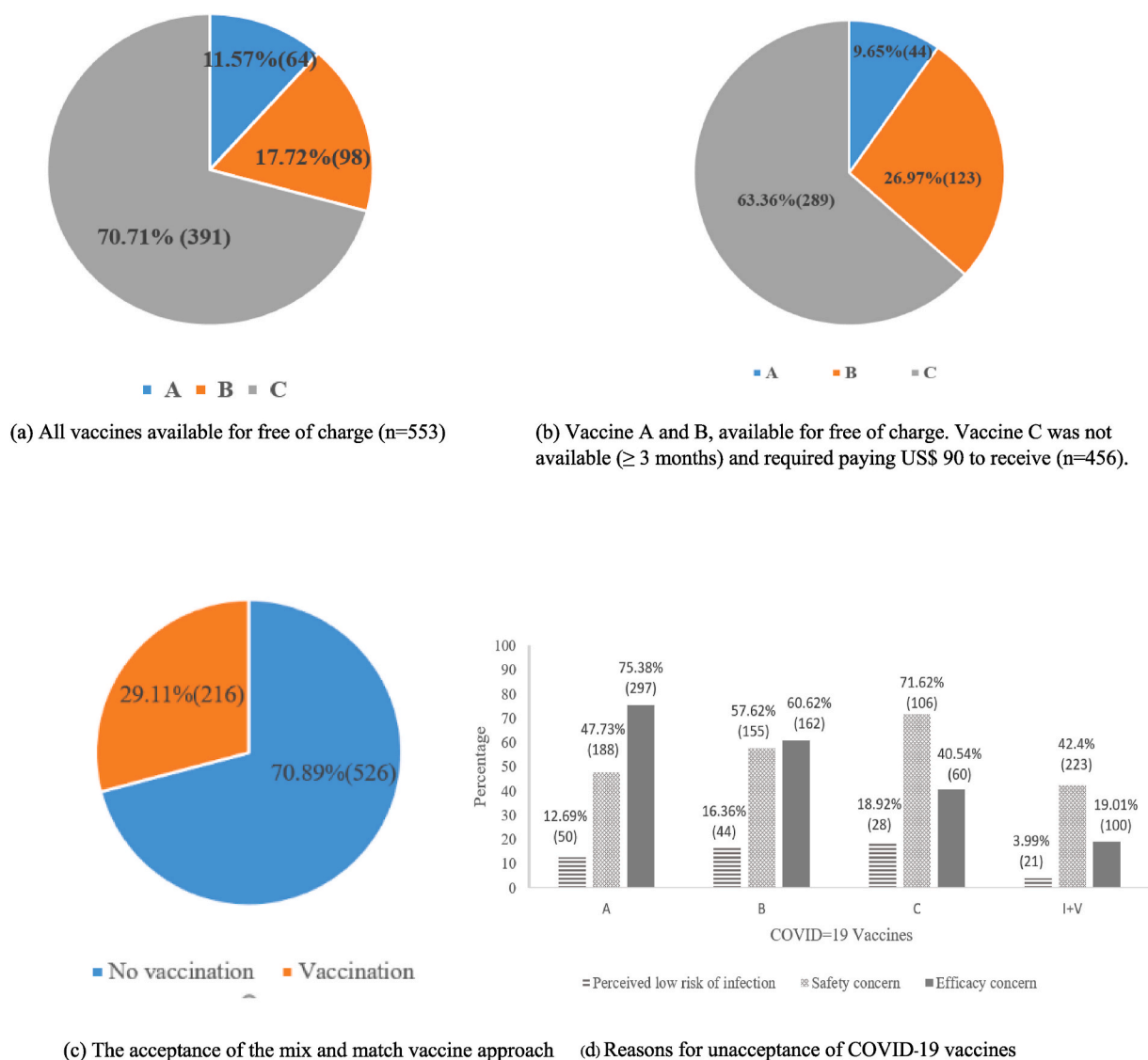


Fig. 1. The acceptance of different hypothetical COVID-19 vaccines and reasons for unacceptance of COVID-19 vaccines in Thailand (Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches, the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA, and BNT162b2 vaccine. I = Inactivated vaccine and V= Viral vector vaccine).

\$598 [$\beta = -0.22$] had a lower maximum amount WTP for a COVID-19 vaccine compared to those living in the Central region and those with salary of \geq US\$598. For Vaccine B, respondents who had a Bachelor's degree and above [$\beta = 0.29$] were willing to pay more than those who completed secondary school and below. Those who had salary of US \$299.03 - US\$448.50 [$\beta = -0.21$] were willing to pay less than people who had salary of \geq US\$598. Regarding to Vaccine C, respondents living in the South [$\beta = -0.12$], those who had salary of \leq US\$149.50 [$\beta = -0.21$] were willing to pay less than those living in the Central region, who had salary of \geq US\$598. Meanwhile, respondents who had the high [$\beta = 0.20$] and moderate [$\beta = 0.14$] knowledge on COVID-19 and vaccine were willing to pay more for Vaccine C than those with low knowledge.

4. Discussion

This study explored the acceptance and the WTP for three COVID-19 vaccines in Thailand, using payment card approach. To reflect the real COVID-19 vaccine situation in Thailand, The efficacy and safety profiles of three vaccines were similar to those of the available vaccines in the country (i.e., inactive SARS-CoV-2, ChAdOx1 nCoV-19 and BNT162b2

vaccines). In the first scenario, all vaccines were available for free, acceptance rates ranged from 11.57% to 70.71%. The highest acceptance rate was vaccine C, followed by B and A, respectively. The acceptance rates were lower than those in previous studies in Southeast Asian countries, which ranged from 64% to 97%.^{25,33,34} The lower vaccination demand was found in low-and middle-income countries compared to high-income countries.¹⁷ Many developing countries including India and South Africa confronted the Covid 19 vaccine and medicine shortage. To address this barrier, those countries requested to the World Trade Organization for a waiver of intellectual property rights to make Covid 19 vaccine and medicines affordable and accessible to all.³⁵ Moreover, the World Health Organization (WHO) introduced the WHO COVAX for the fairly and equitably global distribution to get the Covid 19 vaccine coverage.³⁶ In Europe countries invested in CureVac to produce the cheap Covid 19 vaccines and not a profit.³⁷ Nevertheless, the Covid-19 vaccine acceptance could not be directly compared across countries because each study employed different hypothetical vaccine scenarios and serious COVID-19 situations. The second scenario reflected the situation in Thailand as of September 2021, where vaccines A and B, readily available for free, while vaccine C was not available (≥ 3 months) and required payment US\$90. The findings indicated that the

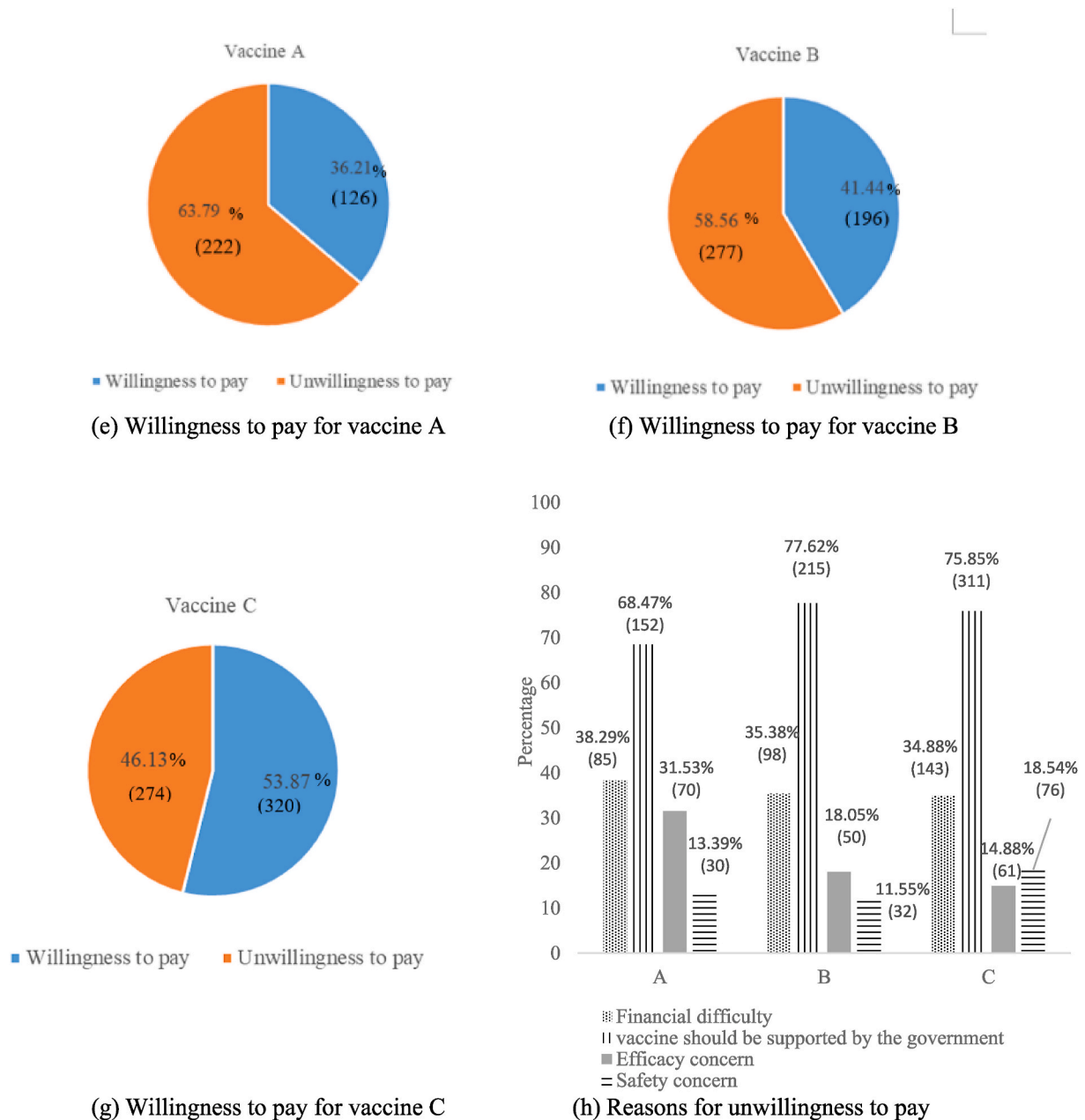


Fig. 2. Percentages of respondents willing to pay for hypothetical COVID-19 vaccines and reasons for being unwilling to pay for vaccines in Thailand (Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches, the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA, and BNT162b2 vaccine).

highest acceptance was vaccine C, followed by B and A, respectively. The acceptance rates for this scenario were within the range from 9.65 to 63.36%. More than half of respondents refused vaccine A and B because of their low effectiveness. Respondents preferred the highest efficacy vaccine even though they would have to wait three or more months and pay for the vaccine themselves. Consistently, the study in Indonesia, found that if vaccine efficacy was reduced to 50%, the acceptance for vaccination was also decreased.³³ Similar to the study in Vietnam, safety was important reason that could influence vaccine acceptance.³⁸ Therefore, to increase acceptance for vaccination, perception on efficacy and safety needed to be improved.³⁹ The government in Israel conducted exclusively with the BNT162b2 vaccine, which proved to be 95% effective. The budget of Covid 19 vaccine was paid more than the United States and some Europe countries. Israel' people accepted and agree with the efficiency data of the vaccine. Besides, the government has a deal with the Pfizer Company to continue selling doses for the country.⁴⁰

The United Kingdom has been using the BNT162b2 and ChAdOx1 nCoV-19 vaccine so the quick vaccination reached more than 30%.⁴¹ Vaccination campaigns should focus on the perceived value and benefits of vaccination. Furthermore, government should allow freedom of choice on the types of vaccine that population can get for free of charge. Thailand allowed population to receive ChAdOx1 nCoV-19 three weeks after an initial single inactive SARS-CoV-2 vaccine to improve protection against the Delta variant.³³ Evidence from western countries were available for the ChAdOx1 nCoV-19 and the BNT162b2 or mRNA-1273 vaccine.⁴² This survey was conducted in September 2021, found that the acceptance of the mix and matching vaccine was only 29.11%. As of October 2021, just 13% of Thai population had already been given a first shot of inactive SARS-CoV-2 vaccine follow by ChAdOx1 nCoV-19, which significantly boosts immunity.²⁹ The fear of getting serious adverse events from the combining two different vaccines was the major barrier of the vaccine acceptance. Thus, the Thai population should be

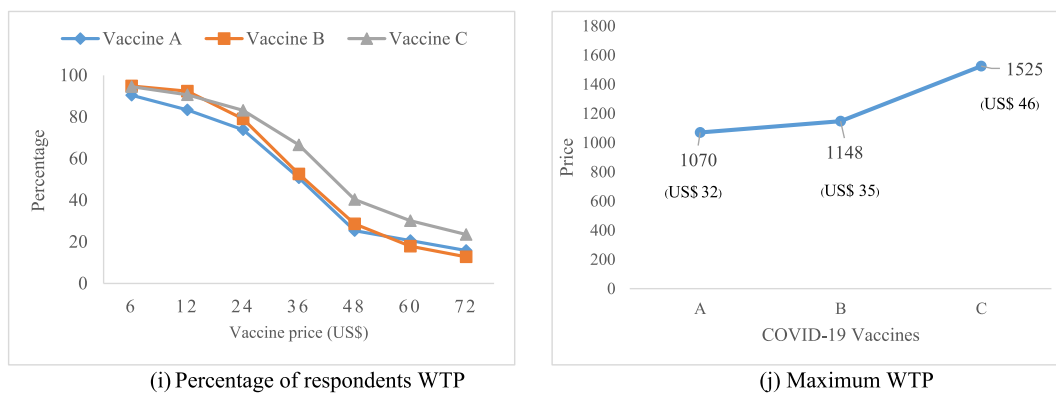


Fig. 3. Percentage of respondents WTP for three different hypothetical COVID-19 vaccines, and maximum WTP for vaccines in Thailand (Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches, the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA, and BNT162b2 vaccine).

Table 3
Factors affecting COVID-19 vaccine acceptance based on multivariate logistic regression models for three different hypothetical COVID-19 vaccines.

Variables	Vaccine A		Vaccine B		Vaccine C	
	Adjusted OR	95% CI	Adjusted OR	95% CI	Adjusted OR	95% CI
Education						
≤ Secondary school	1	–	1	–	1	–
High School	1.11	0.70–1.77	1.67*	1.03–2.71	2.30*	1.34–3.94
≥ Bachelor’s Degree	1.03	0.67–1.59	1.41	0.92–2.19	2.10*	1.29–3.42
Region of Residence in Thailand						
Central	1	–	1	–	1	–
Northeast	1.81*	1.19–3.03	2.65*	1.53–4.60	1.01	0.55–1.88
North	0.79	0.49–1.25	1.39	0.86–2.25	1.26	0.68–2.32
South	2.15*	1.33–3.49	1.69*	1.02–2.80	1.77	0.94–3.32
Monthly salary						
≥ US\$598	1	–	1	–	1	–
≤ US\$149.50	0.32*	0.17–0.59	0.42*	0.22–0.81	0.72	0.30–1.74
US\$149.53– US\$299	0.51*	0.27–0.95	0.52*	0.26–0.98	0.73	0.30–1.81
US\$299.03– US\$448.50	0.52	0.27–1.02	0.67	0.33–1.34	0.84	0.32–2.20
US\$448.53– US\$598	0.95	0.46–1.95	1.27	0.55–2.94	0.84	0.29–2.43
Perceived risk of COVID-19 infection						
Low	1	–	1	–	1	–
Moderate	1.74*	1.13–2.68	2.21*	1.40–3.48	1.22	0.71–2.11
High	1.27	0.84–1.92	1.22	0.80–1.87	0.74	0.45–1.25
Knowledge on COVID-19 and vaccine						
Low	1	–	1	–	1	–
Moderate	1.16	0.77–1.75	1.87*	1.22–2.90	2.30*	1.44–3.71
High	0.90	0.53–1.53	1.82*	1.05–3.15	4.88*	2.34–7.15
Attitude towards COVID-19 vaccine						
Negative	1	–	1	–	1	–
Neutral	1.56*	1.03–2.35	1.60*	1.06–2.42	1.01	0.62–1.63
Positive	2.35*	1.46–3.80	2.62*	1.59–4.31	1.18	0.66–2.10

*p < 0.05 for statistical significance.

CI = confidence interval.

(Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches, the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA, and BNT162b2 vaccine).

able to access useful information for helping them make more informed decision. In addition, people who get vaccinated with a mix of different vaccines should be carefully monitored.⁴³

This survey data showed that the highest WTP was vaccine C (US \$46), followed by B (US\$35) and A (US\$32), respectively. This probably due to the fact that vaccine C had greater effectiveness than other vaccines. This was similar to the previous studies, found that the maximum WTP were positively related with the vaccine efficacy.^{44,45} This study, almost all respondents were willing to pay when the vaccine’s price for two doses ranged between US\$6 to 24. However, the proportion of respondents who were willing to pay was negatively associated with the vaccine price. The maximum amount of WTP in This study was lower than the maximum amount of WTP in USA (US\$228-US\$291)⁴⁴ and China (US\$149-US\$301.36),^{26,45} but higher than in Vietnam (US\$15).³⁸ The maximum WTP depends on income,⁴⁶ the seriousness of the

COVID-19 situation,⁴⁴ and attitude towards COVID-19 vaccines, which varied across countries.⁴⁷ According to, the BRICS (Brazil, Russia, India, China, South Africa) and Emerging Markets Seven (EM7-Brazil, Russia, India, China, Mexico, Indonesia, Turkey are the nations that have a crucial role in global health funding on the demand and supply of medical goods and services including Covid-19 vaccines during the Covid-19 pandemic period.^{37,48} For Asian countries, the OECD members included Japan and the Republic of Korea, while the non-OECD nations were China, India, Indonesia, Malaysia, Pakistan, the Philippines, and Thailand. Those countries contributed to growing purchasing power and high health expenditure to increase equity of vaccination coverage for their citizens.⁴⁹ The market pharmaceutical spending has shown up to US\$400 billion in 2020 to develop new drug, pharmaceutical technology products including Covid-19 vaccine.⁵⁰ However, the availability of vaccines in the low and middle-income countries depended on the

Table 4

Factors associated with maximum amount willing to pay for three different COVID-19 vaccines based on multivariate linear regression models.

Variables	Vaccine A		Vaccine B		Vaccine C	
	β	SE	β	SE	β	SE
Education (\leq Secondary school as reference)						
High School	0.11	0.27	0.22	0.19	0.10	0.16
\geq Bachelor's Degree	0.23	0.11	0.29*	0.19	0.11	0.15
Region of residence in Thailand (Central as reference)						
Northeast	-0.29*	0.25	-0.05	0.16	-0.06	0.14
North	-0.20*	0.18	-0.05	0.13	-0.02	0.11
South	-0.30*	0.19	-0.10	0.14	-0.12*	0.13
Monthly salary (\geq US\$598 as reference)						
\leq US\$149.50	-0.08	0.25	-0.22	0.23	-0.21*	0.20
US\$149.53- US\$299	-0.08	0.24	-0.12	0.20	-0.07	0.17
US\$299.03- US\$448.50	-0.26*	0.26	-0.21*	0.20	0.02	0.16
US\$448.53- US\$598	-0.22*	0.26	-0.14	0.18	0.03	0.17
Perceived risk of COVID-19 infection (Low as reference)						
Moderate	0.20	0.20	0.19	0.15	0.05	0.11
High	0.08	0.19	0.10	0.15	0.10	0.12
Knowledge on COVID-19 and vaccine (Low as reference)						
Moderate	0.05	0.18	0.07	0.15	0.14*	0.12
High	0.11	0.22	0.11	0.16	0.20*	0.15
Attitude towards COVID-19 vaccine (Negative as reference)						
Neutral	0.21	0.23	0.12	0.14	0.02	0.11
Positive	0.16	0.24	0.15	0.16	0.05	0.12

* $p < 0.05$ for statistical significance.

(Vaccine A reflects the inactivated SARS-CoV-2 vaccine. Vaccine B matches the viral vector ChAdOx1 nCoV-19 vaccine. Vaccine C matches the mRNA, and BNT162b2 vaccine).

priority evaluation by the developed countries due to the pharmaceutical manufacturers received a financial intensive from those developed countries.³⁵ To make equality for all countries around the world, WHO that has the authority should has the policy regarding to fairly distribute vaccine to cover population in each country all over the world. The study found that acceptance of Vaccines A and B were associated with region of residence, perceiving risk of COVID-19, attitude towards the vaccine, and salary. People living in the South and the Northeast were more likely to accept the Vaccine A and B. Due to Thai government has a sandbox model in the south that allowed travelers who were fully vaccinated to enter this region. Moreover, the large scale investment for medical tourism competitiveness was adopted to be the medical hub in Thailand so people needed to have fully vaccination to increase herd immunity.⁵¹ In the Northeast, many working age adults have moved to other regions for job opportunities, while many elderly remain in the Northeast. The elderly population might perceive that they have higher threat of getting infected, thus were more likely to accept the vaccine. Moreover, Thai vaccination policy gives priority to elderly. People with low monthly income were less likely to accept the vaccines, compared to those with high monthly income. Higher education and knowledge about the COVID-19 vaccines were also positively associated with acceptance for Vaccines B and C. Most respondents had strong confidence for a vaccine to be highly effective. Similar to other studies,^{34,38,52–54} participants with higher education reported higher vaccine acceptance than those with lower education. Positive attitude towards vaccine increased the chance of vaccine acceptance.^{34,54} To increase acceptance, public health campaigns should focus on providing knowledge on the benefits of vaccination and on developing a positive attitude towards vaccine, especially in areas with a high COVID-19 infection rate.

In terms of the maximum amount WTP for a vaccine, income was the significant predictors for all vaccines. Theoretically, greater income is positively associated with the maximum amount WTP because people consider their ability to pay for optional health services.⁵⁵ A study in Chile found that having a high income increased the amount WTP for a vaccine.⁵⁶ The negative relationship of income and amount of maximum

WTP have been demonstrated previously.⁵⁷ People who had low monthly income in this study were less willing to pay for vaccination. A prior study discussed that it is advantageous for vaccines to be free for low-income people, while higher income people could pay for themselves.⁵⁸ Higher education and knowledge on COVID-19 and vaccine were associated with a higher maximum WTP for vaccines B and C. We hypothesize that those with higher health literacy and education were aware that the benefits outweighed the risks of vaccines B and C. Similarly, in several studies, people with high education and adequate health literacy were willing to pay for a vaccine with high efficacy because they can understand, and use information to choose the best vaccine.^{38,56,59}

Respondents from the Northeast, the North, and the South had a lower maximum amount WTP for Vaccine A compared to the Central region. Also, the maximum amount WTP for Vaccine C was negatively associated with residence in the South. This finding could probably explained by the fact that people living in those regions had lower income than the Central region.⁶⁰ Similarly to the study in Vietnam, the geographic region was associated with maximum amount WTP. People living in rural areas in the south of Vietnam were associated with being less likely to pay for the vaccine. In contrast, people living in the north, which included the capital of Vietnam, were more likely to pay for the vaccine.³⁸ The people in remote area and low socioeconomic status should equitable access for getting COVID-19 vaccine by utilizing universal health coverage.

There were some limitations of this study. Firstly, respondents were selected with convenience sampling, so generalizability of this findings could be made with caution. In addition, by using online platform, the outcome might miss out on the opinions of older and those who did not have access to internet. Finally, some participants (34.91%) were already vaccinated before the survey. Their responses might not be similar to those who had never been vaccinated.

5. Conclusion

Acceptance, WTP, and the maximum amount WTP for COVID-19 vaccine varied depending on vaccine's characteristics. The efficacy and safety of COVID-19 vaccines play crucial roles in acceptance and WTP. Factors affecting vaccine acceptance included salary, region, education, perceived risk of COVID-19 infection, knowledge and attitude on COVID-19 Vaccine.

In addition, salary, region, education and knowledge on COVID-19 vaccine were associated with the maximum amount WTP for each vaccine. To increase the vaccination rate, educational campaigns or counseling services should be implemented to improve people's awareness, their knowledge, and attitude about the COVID-19 vaccine. Moreover, the Thai government needs to allow personal freedom of choice on vaccines that people receive, while considering effectiveness and safety issues.

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Declaration of competing interest

None.

CRedit authorship contribution statement

Vanida Prasert: Conceptualization, Methodology, Investigation, Writing – original draft, Methodology, Writing – review & editing. **Montarat Thavorncharoensap:** Conceptualization, Methodology, Editing, Supervision. **Pasitpon Vatcharavongvan:** Editing, Supervision.

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