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Acceptance and Willingness-to-Pay of Vaccine for COVID-19 in Asian Countries: A Hypothetical Assessment Survey

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Abstract: Building on safety and broad acceptance of healthcare policy, we agree that human behavior is substantial because its success depends on an individual's contribution, ethnic, economic, and social status. We present three surveys testing this account for imminent hypothetical COVID-19 vaccines in Bangladesh, Indonesia, and Malaysia to study to find the acceptance and willingness-to-pay (WTP) for a vaccine in a social context. We used the contingent valuation (CV) method to estimate WTP in Bangladesh, Malaysia, and Indonesia. The statistical ANOVA estimation mode was supposed to measure the critical factors of vaccine acceptance and WTP for three vaccines and compare the associated characteristics with conventional epidemic vaccination models. The studies investigated how an individual's vaccination behavior depends on disease severity, geographical proximity, and socioeconomic similarity. Our results demonstrate that increasing vaccine uptake has a significant impact on vaccine efficacy and disease severity, while self-reported vaccine preferences were associated with factors such as lack of education and economic conditions.

Keywords: Vaccine decision making; willingness to pay; vaccine advocacy; vaccine acceptance.

1. Introduction

The protracted COVID-19 outbreak[1)] has emerged with full force in 2020 and is expected to continue; 396,866,356 coronavirus cases with 5,760,897 deaths were recorded worldwide till February (7th) 2022[2)]. More than a thousand clinical trials have been recorded in the global clinical trial registry platform, with several developments and testing stages; 57 vaccine candidates are going through clinical trials, covering 40 in Phase I-II trials and 17 in Phase II-III trials[3,4)]. The world's first COVID-19 vaccine: Moderna and Pfizer/BioNTech vaccines were commercially introduced in some countries (United Kingdom, USA, Germany, etc.) in mid-December 2020[5)] and demonstrated efficacy as high as 95%. However, mass-vaccine implementation's success is governed by many impulsive aspects, such as vaccine efficacy, hesitancy, refusal or acceptability, cost burden, socioeconomic characteristics, media effect, disease severity, and human behavior [6-9)]. Consequently, the world health organization (WHO) termed vaccine hesitancy a substantial risk to public health in 2019[10)]. Thus, public health system authorities and governments must prepare vaccine literacy through human involvement so that people will accept vaccines when a vaccine is reliable, effective, and reasonable.

To date, numerous studies have measured the acceptance of vaccination called willingness to accept (WTA) and willingness to pay (WTP) for various vaccine programs[11-18)] in countries' economic, social, and demographical situations. Earlier studies on COVID-19 vaccine acceptance and epidemic modeling approach, such as the mathematical epidemic model, intervention game model, cross-sectional survey analysis, and cognitive valuation survey aspects, have recognized many factors influencing the acceptance or uptake[19-29)]. Recent works have also demonstrated that some impact on vaccination acceptance results from vaccine hesitancy and social behavior in the context of the cultural, social, or political differences across countries in the vaccination decision-making process[30-34)].

Herd immunity is only successful when there are high acceptance and coverage rates, besides vaccine hesitancy and misinformation. All such backgrounds raise fundamental studies to understand risk perceptions about the disease, vaccine acceptance, and socioeconomic impact[35]. Vaccines are the most effective and safest way to defeat disease risk, indirectly protecting the community and unvaccinated individuals (free ride)[36, 37]. The justification for this stance is based on the social benefits of vaccines. However, the interplay between the indirect effects of immunization and the factors associated with vaccination creates a social dilemma where collective and individual interests may differ[38, 39]. Therefore, our investigation explores whether individuals perceive vaccination as a social responsibility, offering valuable insights for designing interventions that promote vaccine acceptance and mitigate disease severity.

Our study presents findings and associations derived from a survey conducted among 3,135 respondents in Bangladesh, Indonesia, and Malaysia, examining the likelihood of vaccine acceptance and willingness to pay (WTP) for three COVID-19 vaccine scenarios denoted as vaccine A (60% effectiveness), vaccine B (80% effectiveness), and vaccine C (95% effectiveness). To implement a COVID-19 vaccine in low- and middle-income countries that have yet to be well-studied, we evaluated the people's demand, hesitancy, and acceptance, considering the socio-economic-demographic perspective concerning vaccine effectiveness with cost burden. A survey based on the contingent valuation (CV) method[12], a well-established methodology to assess the individual's monetary valuation[40-44] as a form of WTP, was conducted online between July and October 2021 in Bangladesh, Indonesia, and Malaysia.

2. Method

We analyzed a survey questionnaire to assess the individuals' demand, feasibility, vaccine acceptance, prevention practices, and WTP for a hypothetical COVID-19 vaccine. A structured similar questionnaire was prepared to conduct this survey for three countries: Bangladesh, Indonesia, and Malaysia (SI Text). The first section of the study encompassed socio-economic demographic data, including factors such as age, gender, occupation, education, marital status, income, health status, and more. The second section collected data about COVID-19 prevention practices and problems during the lockdown period. Finally, section three provides a cross-sectional contingent valuation (CV) approach via a bidding game (dichotomous choice) to illustrate the WTP for three hypothetical COVID-19 vaccine scenarios of 60%, 80%, and 95% effective vaccines (figure SI2).

Study design, Data collection and participants. The survey study was covered within five months via multiple global and local online panel providers for respective country, from 22 July 2021 to 22 October 2021 (Supplementary figure SI1). The first survey was conducted in Bangladesh from 22 July to 24 August 2021. We performed the second survey in Malaysia between 7 August and 2 September 2021; Indonesia's survey was operated from 15 September to 22 October 2021. To minimize coverage bias, we considered all categories of people, including those above 17 years, for survey participants.

We considered the contingent valuation (CV) method to assess the WTA (willingness to accept) and WTP for the COVID-19 vaccine in Bangladesh, Indonesia, and Malaysia. The bidding process, conducted using the contingent valuation (CV) method as illustrated in Figure SI2 (see SI), involved a double-bounded dichotomous choice approach. Participants were asked to provide two or three bids and then respond to an open-ended question regarding their maximum willingness to pay (WTP) for each vaccine scenario. The WTP question in the CV study encompassed two components: a dichotomous choice (DC) question where individuals were asked to indicate "Yes/No" responses to purchasing vaccines at specified prices. If respondents answered "Yes," the subsequent bidding stage offered a higher price for the next choice, whereas if they answered "No," they were presented with a lower price. For example, the WTP question was structured as follows: "Would you be willing to pay US$ 40 per dose for the COVID-19 vaccine?" Respondents who were unwilling to pay any amount for the vaccine at the specified prices were asked additional questions to provide reasons for their refusal. Lastly, an open-ended question inquired about the maximum WTP amount for the respective vaccine. The survey study employed three categories of CV tests based on vaccine effectiveness (Vaccine A at 60%, B at 80%, and C at 95%). The final version of the survey questionnaire was prepared in English and translated into the local language of each respective country. This analysis did not include the pilot program and discussion period results.

Statistical analysis. We analyzed the distribution of participant responses across the entire dataset and further explored country-level differences. Statistical significance was determined using a threshold of $p<0.05$, assuming three pre-assigned vaccine effectiveness levels. The characteristics of the respondents were designated and evaluated in terms of willingness-to-accept (WTA) and willingness-to-pay (WTP) for the COVID-19 vaccine using ANOVA tests. Descriptive statistics were reported as appropriate, including percentages, means, and standard deviations. Data analysis was conducted using Python and MS Excel tools.

3. Results

A total of 3,135 participants from Bangladesh, Indonesia, and Malaysia completed the questionnaire, and their demographic characteristics and survey responses are summarized in Figure SI2 (supplementary text). Most respondents were male, had a university degree, were single, and had a monthly income of less than $300.

Vaccine attitude towards prevention practices and the problem encountered by the COVID-19

pandemic. Figure 1 displays that Malaysia's respondents gave the lowest proportion of self-protection practices as a habit (see 'Always' of the solid black line) during the epidemic. The positive attitude with the higher self-practice percentage provided by Indonesia's participants (broken black) and Bangladesh (dotted line) is more confirmed than Malaysia. As displayed in the bar chart for willingness to pay (WTP), Malaysian participants differentiated less between firmly maintained practice and non-practice groups. Respondents from Bangladesh reported an analogous tendency for estimated WTP and attained prevention practices; a higher proportion (%) of practicing prevention policy desired a vaccine with a higher price. In Indonesia, a similar trend was observed concerning paying vaccine WTP except for the first case (never). It is evident from the outcomes mentioned above mutually correlating between the prevention practices and estimated WTP reported in Bangladesh and Indonesia; there is always a positive correlation between the emergence of both interventions (vaccine and self-protection) in the population. Respondents who practice more self-protection to defend themselves from infection also want to pay higher for vaccination. However, in Malaysia, respondents offer higher WTP to get vaccines irrespective of self-protection practices (less prevention practice). Also, respondents' 'correlating' behavior somewhat confirms the effect of disease severity. For example, during the survey period (Figure SI1), respondents were not interested in following the self-practices recognized in Malaysia's mild disease. However, most individuals from Bangladesh and Indonesia had positive self-practices against infections due to higher illness (Figure SI1). Additionally, the SI Appendix, figure SI4A, and SI4B indicate that the higher the problem faced (or social-financial burden) causes, the lower prevention practices, as expected. That is an important comparison because the respondents' information about their neighbors' attitudes and difficulties during the pandemic is key to educating them.

Vaccine willingness to accept (WTA). The proportion of optimistic respondents (%) willing to accept all three countries is presented in figure 2. Respondents from Indonesia addressed the highest positive responses (vaccine A-85.98%, vaccine B-76.44%, and vaccine C-78.48%), whereas Bangladeshi respondents provided the lowest positive responses (A-40.73%, B-47.08%, and C-61.84%). The percentage of respondents from Malaysia who accepted vaccines was reported at 60.96%, 62.22%, and 64.85% for vaccines A, B, and C, respectively. Regarding vaccination preferences, Bangladeshis and Malaysians thought Vaccine C was more acceptable. That is thus followed by vaccine B and vaccine A. Factors such as risk perception, vaccine history, and effectiveness influenced vaccination acceptance among participants who accepted the vaccine significantly. The high acceptance rate and positive attitude toward Vaccine C indicate a strong demand for highly effective vaccines and increased recognition of the importance of vaccines in controlling pandemics. However, Indonesia's respondents gave the highest vaccine A and C responses. Their extreme specification in terms of quality and cost (high and low) attract people. This finding might reflect the economics concept; either cheaper with low qualities or expensive with higher-qualities products attracted people, which seems reasonable.

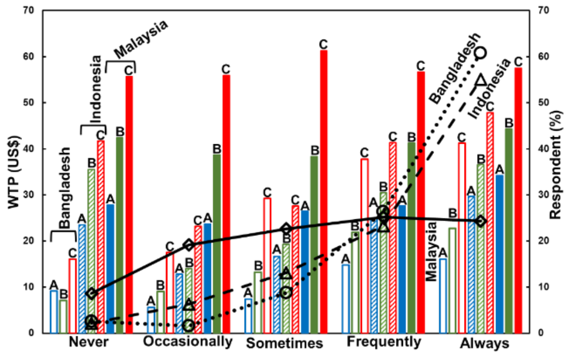

Figure 1. Estimated mean willingness to pay (WTP) (bar graph) and percent of responses (line graph) to the practice of self-protection measures (average proportion of washing hand, wearing mask, and physical distancing). The bars colored with blue, green, and red indicate the WTP values for vaccine A, Vaccine B, and vaccine C, respectively reported at Bangladesh (without filled), Indonesia (diagonal filled), and Malaysia (filled). The dotted line, broken line, and solid line represent the participants' responses as percentages for Bangladesh, Indonesia, and Malaysia. The pattern of outcomes shows that the interaction effect between respondent's self-protection behavior and WTP was comparable.

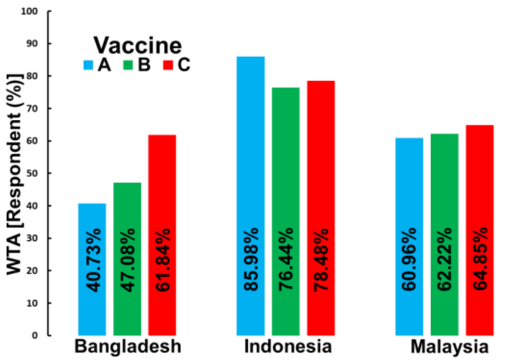

Figure 2. Bar graph showing the respondents percent of acceptance (WTA) who respondents positively to hypothetical COVID-19 vaccine by state (Bangladesh, Indonesia, and Malaysia) for three vaccines: vaccine A (blue), vaccine B (green), and vaccine C (red).

Vaccine willingness to pay (WTP). Figure 3 presents the statistical summaries of respondents' willingness to pay (mean, median, and percentiles) for three vaccines (A, B, and C) and three countries: Bangladesh, Indonesia, and Malaysia. The left axis displays WTP (US$) for all countries, whereas the right axis denotes the WTP/average income ratio for respective countries. The mean WTP for vaccines A, B, and C are 34.02 US$, 42.78 US$, and 59.77 US$ in Bangladesh, 31.84 US$, 44.22 US$, and 56.98 US$ in Indonesia and 39.93 US$, 54.98 US$ and 71.88 US$ in Malaysia, respectively. The respondents assigned the highest mean WTP value for Vaccine C for all three countries due to its high reliability. The lowest was accorded to Vaccine A, which has low effectiveness. Further, Malaysia's estimated mean WTP for all three vaccine programs (A, B, and C) is more expensive than the other two countries.

The median willingness-to-pay (WTP) is determined based on the cost at which approximately half (50%) of the population would be willing to purchase vaccines. Median estimates are typically less sensitive to unexpected responses and functional form than mean estimates. The median WTP for vaccines A, B, and C are 20 US$, 30 US$, and 36 US$ in Bangladesh, 20 US$, 30 US$, and 40 US$ in Indonesia and 40 US$, 60 US$ and 75 US$ in Malaysia, respectively. Malaysia's median WTP value is more precious than other countries. Meanwhile, the obtained median WTP estimates for Bangladesh and Indonesia fall between mean and 25th percentile values, indicating half of the responses would not afford vaccines' average price. In contrast, Malaysia's estimated median provided the opposite tendency; the median WTP is higher than the mean WTP.

To compare whether the estimated WTP depends on individuals' earnings, we weighed the normalized WTP/average income, dividing WTP by the respective country's average income (or per capita income estimated from the country's GDP by its population). Besides each income level, the fact that comparable absolute WTPs (not WTP/average income) in those three countries can imply that there would be shared with an expected worldwide retail price that indirectly refers to people's recognition of vaccines. This idea can lead to an essential absolute value to commit vaccines regardless of income, who are willing to pay as much as a worldwide price. According to the worldwide price, respondents from Bangladesh presented higher WTP values than other countries, indicating more likely to accept an immediate vaccine against the pandemic. At the same time, their income (average) may not influence their intention.

Additionally, there were notable geographic and demographic differences in COVID-19 vaccine acceptance and estimated WTP for different countries and characteristics (SI appendix; Text and figure SI6). The respondents with higher education, service holders, upper-income families, and who lived in the capital were more likely to pay higher WTP (figure SI6 (A, B, and C)). Meanwhile, women from Bangladesh (SI6 A(i)) and Indonesia (SI6 B(i)) were less likely to pay for the vaccine in general, although this tendency was not so strong. Younger (less than 40 years) people (SI 6(ii)) from all states were more likely to pay for the vaccine. Respondents who described themselves as "students" in Indonesia (SI6 B(vi)) and Malaysia (SI6 C(vi)) had quite a high WTP for any vaccines. In contrast, service holders' responses from Bangladesh (SI6 A (vi)) offered higher WTP. Finally, participants having previous COVID-19 experience (self-infected or friends/family-infected) reported higher WTP (SI6 (vii)). Hence, vaccine strategies should consider the source of information, financial capability, and education level in a subpopulation (community) and build reliable vaccine literacy to address community-based aspects directly. This attention could help policymakers and researchers view target groups to introduce vaccine programs more adequately by considering distrust, social customs, and religious or philosophical beliefs.

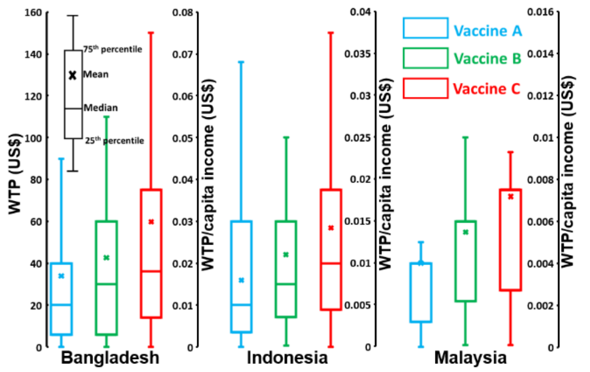

Figure 3. Statistical summaries of respondents WTP for three countries (Bangladesh, Indonesia, and Malaysia) and three vaccines (A, B, and C). The left axis, denoted as WTP (US$), presents the respondent's willingness to pay for three countries. However, the right axis, signified as WTP/capita income, shows the ratio of WTP with the respective countries' capita income. The range in the graph represents the difference between the highest and smallest values. The interquartile range given as bar chart displays the survey data range, from 25% as the lower quartile and up to 75% as the upper quartile. Further, the line and cross depicted inside the bar chart show the mean and median (middle value).

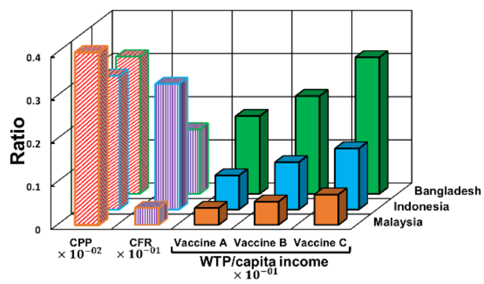

Figure 4. Comparison by confirmed cases per population (CPP) colored red, fatality per confirmed cases (CFR-case fatality ratio) colored violet, and WTP/ capita income for three vaccines (A, B, and C). The solid bar colored with green, blue, and orange represents the WTP/ capita income for Bangladesh, Indonesia, and Malaysia.

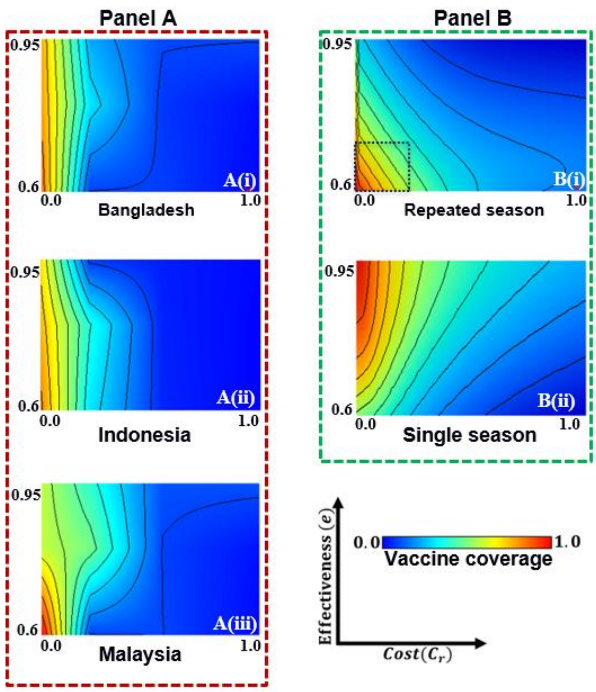

Figure 5. 2D phase diagram above present the vaccine coverage in terms of willingness to accept (frequency (%)) reproducing from survey results (Panel A) for (i) Bangladesh, (ii) Indonesia and (iii) Malaysia. Panel B displays the epidemic vaccination game model for (i) repeated season model[51)] and (ii) single season model[54)]. Here, figure A(i), A(ii), and A(iii) depict the heatmap of Bangladesh, Indonesia, and Malaysia, respectively, by vaccine effectiveness versus estimated mean WTP (cost). The evaluated mean WTP is described as the vaccine cost; normalized vaccination cost from possible maximum "cost burden" reported by Ref[48)]. On the other hand, Panel B was taken from two previously established vaccination models by Kuga et al.[51)] (B(i)) and Kabir et al.[54)] (B(ii)) in which they presumed the relative vaccination cost as the fraction of vaccination cost to the disease cost[51, 54)]. As a result, the entire heat-maps from those two models, initially ranging $0 \le e \le 1$ and $0 \le C_r \le 1$, partially focus on drawing figures B(i) and B(ii).

Surging COVID-19 pandemic does impact WTP? To look for an association between COVID-19 confirmed cases and deaths with WTP/average income for three hypothetical vaccines, we analyzed available data sets from three countries (Bangladesh, Indonesia, and Malaysia), depicted in figure 4. The picture displays the confirmed coronavirus infectious cases per population (CPP) and case-fatality ratio (CFR) in three countries relative to their total population and absolute mean WTP for three vaccines normalized by the respective country's average income, as we introduced above. A CFR expressed as a ratio of the number of deaths among confirmed cases represents disease severity. We also focus on whether there is an income effect on estimated mean WTP by presuming WTP/ average income; GDP per capita income appeared to perform as an explanatory variable as individuals' mean stated income, indicating that it is wealth in society.

The amount that Malaysian respondents were willing to pay to save themselves is comparable with CFR values; both CFR and the estimated mean WTP for three vaccines display the lowest fractions. On the other hand, Indonesia presents the highest CFR value. Although, the relationship between CFR and WTP/average income was not comparable for the Indonesian case. But, comparing the CFR value to WTA shown in figure 2, the respondent's willingness to accept was significantly consistent with the CFR value, meaning that respondents with a higher disease severity can desire more vaccines. Thus, the respondents exhibited a high positive WTP or WTA for the higher disease severity and vice versa, making intergroup aspects relevant.

Overview of cost-effective implementation to experiments and intervention game. The integration of the epidemic vaccination game model with evolutionary game theory has been widely acknowledged as a valuable approach for quantitatively assessing vaccination strategies in developing public health policies. It would be both meaningful and intriguing to establish a connection between the findings from current survey results and the predictive outcomes of intervention game models.[45-54)]. Figure 5 displays a heat map that illustrates the vaccine coverage, or frequency of vaccine acceptance, plotted on a 2D plane defined by vaccination cost (C_r) and vaccine effectiveness (e). Panel A of the heat map was redrawn from Figure SI7 (SI Appendix), considering respondents' acceptance of three effectiveness levels (0.6, 0.8, 0.95), which can be interpreted as the extent of vaccine coverage. Also, Panel B was taken from two vaccination models by Kuga et al.[51)] (Panel B(i)) and Kabir et al.[54)] (Panel B(ii)).

The first vaccination game model proposed by Kuga et al.[54)] captures the dynamics of repeated epidemic seasons, wherein individuals decide whether to receive vaccination before each season based on information acquired from the previous season. On the other hand, the second model by Kabir et al.[54)] focuses on how vaccination coverage emerges and disease spreads in one season. An individual can take the vaccine or get infected depending on the current disease breakout and vaccination coverage. Interestingly, the first model considering repeating dynamics shows larger (smaller) vaccination coverage with smaller (larger) effectiveness (see the black-dotted-line box in figure 5 B(i)). In contrast, the second one considering just one single season, shows the inverse tendency, giving smaller (larger) vaccination coverage with smaller (larger) effectiveness (see figure 5 B(ii)). One justification for this is that if the disease spreads obeys seasonal epidemics like seasonal influenza, of which perceived risk would not be time-prompt. People expect free riding on herd immunity backed by the other's contribution without paying vaccine costs when it is more reliable, resulting from a robust social dilemma. In contrast, within single-season dynamics, individuals tend to exhibit more myopic behavior, focusing on the current status of infection and vaccination rates rather than considering the possibility of free-riding. Consequently, individuals are more likely to choose vaccination when its reliability increases during a given season.

The results indicated that a decrease in vaccination coverage is observed when the cost of vaccination is fully shared, as evident in both the field survey (Panel A) and the model predictions (Panel B), as expected. Therefore, the feeling toward vaccine cost performs adequately under human conduct. On the other hand, vaccine coverage concerning effectiveness shows no significant changing tendency for Bangladesh and Indonesia (survey results). That means the collected vaccination coverage cannot exactly exhibit each of the two vaccination game models depicted in Figures 5B(i) and 5B(ii). This phenomenon can be justified by the higher disease severity and fear of being infected observed in those two countries during the survey period (see appendix). It creates a myopic impression among the people relying entirely on the present disease situation, which restricts them from trusting solely in herd immunity resulting from free riding. Therefore, the myopic characteristic shown by the respondents from respective countries primarily relies on vaccine cost and disease severity, irrespective of vaccine reliability. However, in Malaysia's case, the evaluated vaccination coverage shows a higher propensity for reasonably lower effectiveness, which is consistent with the repeated season model (figure 5B(i)). This phenomenon helps us elucidate the respondent's non-myopic characteristics associated with vaccine effectiveness. With less disease severity, people face a bigger dilemma in choosing a vaccine rather than an immediate alternative provision (self-protection), even though it gives relatively better protection.

4. Discussion

This study's findings affirm that getting vaccinated is a complex social behavior influenced by multiple factors and characterized by uncertainty. We have shown that people can be sensitive to accepting the vaccine with a likely willingness to pay for the vaccine's reliability (effectiveness). We also have recognized high heterogeneity in responses between nations. Moreover, we have argued that the higher acceptance and positive attitude toward vaccination exposed the higher demand for introducing the vaccine in controlling pandemics.

Our research suggests that by giving respondents preference regarding trading behavior between preventive self-protection and vaccination by social behavior, they perform higher prevention practices and are more likely to pay for the vaccine (higher WTP). In Malaysia, however, respondents who refused to practice self-protection measures said they would prefer to take the costly vaccine; the association of respondents' prevention practices with WTP was insignificant. These findings across three countries seem conceivable. Vaccination as a preventive measure against infection may be the primary option, as inadequate or unsafe vaccines may lead individuals to resort to self-protective measures. Additionally, adopting a combination of interventions can be perceived as a more effective approach to eradicating diseases than relying solely on one intervention.

For countries with inadequate resources and constraints, introducing a payment scheme for a newly launched vaccine program that balances cost-benefit is essential. The optimal price for the vaccine will be contingent upon the dynamics of the proportion of society willing to accept it and the amount they are willing to pay. In Malaysia, the estimated mean WTP tended to be high, justified by the individual's trust and higher-income capability. A higher median than a mean tendency towards estimated WTP in Malaysia was recognized; however, remaining countries, where the mean WTP is higher than the median with a significant gap, present less than half of responses would not afford vaccines' average price. It indicates that a governmental intervention strategy is eagerly required through a support plan to incentivize the typical individuals to attend the vaccination program.

From the standpoint of policy argument, our observed findings present that the absolute values of WTP over all three countries seem comparable (at least, being in the same digit level) irrespective of various WTP/ average income (being in different digit levels). We claim that people from different economic classes (for three countries) tend to recognize a particular vaccine cost, shared as "common sense" as a worldwide price. The COVID-19 vaccine is now promptly expected worldwide, and some may think to commit it irrespective of a gap between individuals' income level and the cost of the vaccine. We interpreted this judgment as an indicator for all individuals, regardless of nationality. Such interpretation to commit vaccines based on worldwide price could help policymakers, governments, and international organizations to target successful vaccine programs more effectively.

From a global viewpoint, when comparing the case-fatality ratio (CFR) with WTP/average income, Malaysian people fairly assess a specific acceptable cost (WTP) of vaccine that can share with worldwide trade price. Such a tendency is also true for the other two countries. This approach is, in fact, the most exciting from an epidemiological aspect because WTP/average income uses global indicators rather than local (national) and, consequently, brings more effective WTP values to introduce new vaccine programs to suppress the contagious disease.

Vaccinations are primarily intended as public health measures to attain herd immunity within the population, safeguarding everyone by preventing disease transmission. The vaccine's role in countering the disease exemplifies a typical public good scenario, where individuals may act in their short-sighted or long-term self-interest, leading to a social dilemma. From a social stance, it expresses what can be characterized as "myopic" or "non-myopic" self-interest represented in the various contact with vaccines within and between countries. Accordingly, in the case of the vaccination game aspect, when the vaccine becomes reliable and cheap, individuals have more prone to get a free ride on the herd immunity that is partially observed in Malaysia, followed by non-myopic self-interest. On the other hand, in Bangladesh and Indonesia, evidence suggests that relatively enhanced vaccination coverages were observed across both higher and lower effectiveness levels. It would be interesting to explore myopic self-interest behavior, where individuals cannot have envisioned the feasibility of the free riding on herd immunity. Our findings may influence others by possible intervention modeling efforts over behavioral intentions.

Our research has several limitations. Firstly, the information provided to respondents pertained to hypothetical COVID-19 vaccines rather than specific ones, which may affect the generalizability of the findings. The assumption of only three vaccine efficacies is also a limitation. Moreover, data collection was conducted exclusively online, potentially introducing biases related to internet accessibility. The unavailability of resources, such as time, budget, and logistical constraints, prevented us from implementing a time-to-think approach, which could have added further insights. The relatively low number of confirmed cases among participants is another limitation. Lastly, selection bias may be associated with the sampling procedure, including coverage bias due to internet accessibility and self-reported bias, as the study relied on willing respondents attracted by the survey's title "Vaccination of COVID-19".

Lastly, our statistical analyses suggest that the estimated higher WTP amount must be directed to respondents' socio-demographic characteristics and disease severity. This study examined the understanding of personal economic benefits and revealed the existence of a private market for vaccines, providing insights into individuals' perceptions. Despite the high cost of vaccines, demand persists in private markets. Our results also found that acceptance and WTP are relatively high when the vaccine has higher effectiveness. If the vaccine has lower efficacy and higher cost, the government and policymakers should consider introducing more strategies to participate in more people becoming vaccinated.

5. Conclusion

An online interview-based questionnaire survey was conducted based on the CV method with the bidding game approach. We intended to quantitively evaluate people`s preferences for sufficiently high rates and the amount of mean WTP for COVID-19 vaccines in Bangladesh, Indonesia, and Malaysia. Our statistical analyses suggest a higher WTP amount must be directed to respondents' characteristics and knowledge. Additionally, this study investigated the perception of private economic benefits and revealed the presence of a vaccine market in three countries. Finally, our findings suggest potential associations between vaccine willingness-to-accept (WTA) and epidemiological modeling and socioeconomic factors, which could shed light on novel strategies to enhance individuals' willingness-to-accept/willingness-to-pay (WTA/WTP) for the COVID-19 vaccine.

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