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Willingness to pay for an annual vaccine in an endemic COVID-19 scenario: a contingent valuation study in Metro Manila, Philippines

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Abstract

Using the Contingent Valuation Method, this paper estimated willingness to pay (WTP) for annual COVID-19 booster vaccines for the endemic phase of the disease. The study found that, on the average, Metro Manila households would be WTP PhP2,199.71–2,410.50 (US$42.71–46.81) for a one-dose vaccine with 90% efficacy for one year. This WTP estimate is a measure of the perceived benefits from preventing COVID-19 infection, suggesting the potential for private markets to cater to those who prefer to obtain the annual booster COVID-19 vaccine privately, while a public vaccination program that subsidizes partially or fully the cost of the vaccine for those with lower capacity to pay is likely to pass a social cost–benefit assessment. Consistent with economic theory, WTP was found to significantly decrease with vaccine price and increase with income. Further, the study found general acceptance (measured in terms of the Health Benefit Model constructs) of COVID-19 vaccines among Metro Manila households despite the dengue vaccine controversy in the country immediately prior to the COVID-19 pandemic.

Keywords Endemic COVID-19, Vaccine, Willingness to pay, Contingent valuation method, Health benefit model

1 Introduction

Starting in 2019 in Wuhan, China, the COVID-19 viral infection rapidly spread across the globe and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020. By February 17, 2022, worldwide cumulative COVID-19 cases totaled 416.6 million, resulting in 5.8 million deaths (WHO, 2022). In the Philippines, the first few confirmed COVID-19 cases with one death were reported in the first week of March 2020. Confirmed daily cases fluctuated widely, peaking in August 2020 (30,000 daily cases), April 2021 (70,000), September 2021 (100,000), and January 2022 (200,000) while bottoming in November 2020 (10,000), May 2021 (40,000), and December 2021 (less than 1,000). As of February 17, 2022, there were more than 3.6 million cumulative cases and 55,223 deaths in the Philippines (DOH, 2022a). As a global health crisis, the COVID-19 pandemic has caused unprecedented socioeconomic devastation. Health system disruptions—disrupted vaccination schedules for other infectious diseases and excessive demand for health services vis-a-vis supply—have led to recurrence of diseases and lost lives beyond those caused by the COVID-19 virus (Ioannidis, 2020). Nation-wide and city lockdowns caused massive unemployment and income losses (Pley et al., 2021). In the case of the Philippines, it has been reported that during the first year of the pandemic in 2020, the economy contracted by 9.6%, 10.1% of firms reported temporary closure while 0.4% permanently closed, and unemployment rate reached 17.6% (Chua, 2021). It is estimated that it will take about ten years for the Philippine economy to converge to its pre-pandemic growth path (Chua, 2021).

With vaccination considered to be the most favorable and viable option to deal with the health and economic

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difficulties brought about by the COVID-19 virus (Fadda et al., 2020), numerous efforts to develop COVID-19 vaccines immediately ensued. By November 2020, 49 candidate vaccines were undergoing clinical trials and 164 others were in preclinical evaluation (WHO, 2020). The first mass vaccination program started in early December 2020 with the United States government issuing Emergency Use Authorizations for both Pfizer and Moderna vaccines (CDC, 2022). In the Philippines, vaccination commenced in March 2021, and by mid-February 2022, about 130 million doses of COVID-19 vaccines were administered, 61 million people were fully vaccinated (56% coverage), and about 8 million booster shots had been administered (DOH, 2022b). Most infectious diseases specialists think that the COVID-19 virus will become endemic and will continue to circulate in different areas around the world. For societies to be able to tolerate the seasonal deaths and illnesses without the restrictive and economically devastating lockdowns and social distancing, regular vaccination may be necessary. Just like the flu vaccine, the COVID-19 vaccine may have to be updated every year as new variants of the virus emerge and are able to escape immunity from previous vaccination (Phillips, 2021). In December 2021, the Director of the Socioeconomic Planning Department of the Philippine government unraveled plans for yearly COVID-19 vaccine boosters to "prevent any more major disruptions to economic activity, with the government shouldering the cost in 2022 and then sharing the expense with the private sector starting 2023" (Philippine Daily Inquirer Editorial, 2021). This plan raises a host of policy questions. Should the vaccine be provided privately or publicly? If the annual COVID-19 booster vaccine is sold privately, will there be sufficient demand? Up to what extent can the costs be assumed privately? Is there scope for cross-subsidization to ensure vaccine coverage that can prevent major outbreaks? Alternatively, if there should be a need for a full or partial annual COVID-19 public vaccination program, estimates of the benefits from preventing the infection would be required in evaluating the program.

Using the Contingent Valuation Method (CVM), this study estimated willingness to pay (WTP) for annual COVID-19 vaccine boosters in Metro Manila (MM) as a measure of the benefits that could be derived from preventing the disease. A few estimates of CVM-based WTP for the initial COVID-19 vaccine uptake exist. Catma and Varol (2021) arrived at a mean WTP of US$236.85 for a one-year COVID-19 vaccine with 50% efficacy in the USA and found that WTP increased with income and perceived threat of the virus. Sarasty et al. (2020) estimated the mean WTP for a one-year COVID-19 vaccine in Ecuador to be USD147.61 and found that income, employment status and the probability of being hospitalized were positively related with WTP. For Chile, Garcia and Cerda (2020) came up with a mean WTP of USD184.72, noting that WTP depended not only on economic factors (employment status and income) but also on health-related factors such as preexistence of chronic disease, exposure and knowledge about COVID-19, and other factors such as perception of government performance. WTP estimates for less developed countries were lower. Harapan et al. (2020) estimated mean WTP of US$ 57.20 for Indonesia and found that high income and high perceived risk of infection were associated with higher WTP. Wong et al. (2020) found that WTP in Malaysia averaged US$30.66 and that WTP was influenced by affordability barriers and socioeconomic factors, namely higher education levels, professional and managerial occupations, and higher incomes. For Vietnam, Vo et al. (2021) estimated mean WTP to be US$85.92 (one-year, 95% efficacy) and found sex, living area, monthly income, and the level of self-rated risk of COVID-19 as significant determinants of WTP. Karam et al. (2022) concluded that Lebanese' mean WTP for the COVID-19 vaccine was approximately $60 (one year, 99% efficacy) and that their WTP was associated with the severity of COVID-19, the education level, and family income.[1]

Unlike these existing WTP for COVID-19 vaccines studies, this paper looked at vaccine demand during the endemic phase of the COVID-19 infection, rather than the demand for initial vaccine uptake during the pandemic phase. At the time of this study, public vaccination (one or two doses of the COVID-19 vaccine provided free for everyone eligible following priority rules set by the government) was on-going in the Philippines. There could be substantial differences between the initial uptake vaccine scenario and the annual COVID-19 vaccine scenario of this study. While the risks of infection and of severe complications including death might have decreased and the value and composition of the costs of illness might have changed, there could also be some evolution in people's understanding of the COVID-19 virus and of vaccine safety, efficacy and their role in avoiding the huge socioeconomic costs of the disease.

Apart from estimating the mean WTP for a COVID-19 vaccine in Metro Manila during the endemic phase, this study also looked at factors that affect demand for the

[1] Caple et al. (2022) conducted a survey on COVID-19 vaccine acceptance and WTP for the initial COVID-19 vaccine uptake scenario in the Philippines. Their study was descriptive, rather than a quantitative economic analysis of WTP. This paper goes beyond a descriptive approach by using the CVM framework and regression analysis to arrive at mean WTP for an annual COVID-19 booster vaccine with a specified 90% efficacy in an endemic COVID-19 scenario.

vaccine, such as income, demographic and other socioeconomic variables (age, sex, education, work and marital status of respondent, household composition), health condition, COVID-19 exposure and knowledge, and vaccine awareness and acceptance measured in terms of the Health Benefit Model.

A limitation of this study is that it only presented and estimated WTP for a vaccine with 90% efficacy, a plausible scenario at the time of survey.[2]

2 Methodology

2.1 Contingent valuation survey

In economics, WTP is a measure of the benefits that an individual perceives to derive from a good. WTP is the price that the individual pays for the good if the good is traded in a market. In the case of goods that have no markets or are not yet available commercially, economists resort to non-market valuation techniques. One of these techniques is Contingent Valuation Method (CVM), a stated preference (survey-based) approach that has been extensively employed in the fields of health and environmental economics. Readers may refer to Boyle (2003), Bateman et al. (2002), and Mitchell and Carson (1989) for a full and thorough discussion of the theoretical and empirical foundations of CVM, and to Carson (2011) for the history of CVM studies. Literature on CVM-based health intervention benefits assessments includes Calsson and Johansson-Stenman (2000), Hammar and Johansson-Stenman (2004), Johanneson and Johansson (1997), and Krupnick et al (2002). For examples of studies that utilized CVM specifically for estimating demand and WTP for vaccines, please see Liu et al. 2005 (Severe Acute Respiratory Syndrome); Cropper et al., 2004 (malaria); Do et al., 2006 (typhoid fever); Palanca-Tan, 2008 and 2014 (dengue); Islam et al., 2008 (cholera); Yeo & Shaffie, 2018 (dengue); and Harapan et al., 2019 (Zika). The WTP for a vaccine derived from a CVM study is a measure of the perceived benefits from preventing the consequences of the disease.

The final form of the survey instrument used for this study was the result of a series of key informant interviews (KII), and focus group discussions (FGD) and questionnaire pre-tests with different types of respondents from low- to high-income groups. These pre-survey activities provided important inputs in the formulation of the valuation scenario, range of bid levels, and phrasing of questions. The KII and FGD revealed that the 90% vaccine efficacy for one year would be a realistic valuation scenario for the target respondents and that comparing the annual COVID-19 vaccine with the annual flu vaccine would make the endemic scenario more understandable. From the pre-test results, the minimum bid level was set at PhP500, and the maximum bid level at PhP5,000. FGD participants were consulted most particularly in the phrasing of awareness and opinion questions to ensure that they are clear to respondents from diverse backgrounds.

The questionnaire included a brief introduction on the purpose of the study, demographic and socioeconomic questions about the respondent and his/her household (age, sex, marital status, education, income), questions about the current health conditions (i.e., self-assessed over-all health status and existing chronic diseases) and health consciousness of the respondent, COVID-19 exposure, awareness and opinions about vaccines, and preferences for COVID-19 vaccines.

Indicators for COVID-19 vaccine acceptance were derived following the framework of the Health Benefit Model (HBM). The HBM, used extensively to assess and predict people's acceptance and adoption of a particular health-related behavior such as vaccine uptake (see, for instance, Becker et al., 1977; Nexoe et al., 1999; Shahrabani & Benzion, 2010; Coe et al., 2012; Tsutsui et al., 2012; Lin et al., 2020), categorizes motivations or factors influencing health behavior into six constructs—(1) perceived susceptibility, (2) perceived severity, (3) perceived benefits, (4) perceived barriers, (5) cues to action, and (6) self-efficacy to engage in a behavior (Janz et al., 2002). Perceived susceptibility refers to the individual's beliefs regarding his/her risk of acquiring a health condition such as getting infected by COVID-19. Perceived severity refers to the person's beliefs about the seriousness of a condition or illness and its negative effects. Perceived benefits refer to the favorable outcomes of the behavior or intervention (particularly in terms of reducing susceptibility and severity of an illness), while perceived barriers relate to the individual's concerns or negative beliefs about a health behavior or intervention. Cues to action are strategies or information sources (such as people and events) that promote adoption of a behavior. Self-efficacy measures the individual's ability or confidence to adopt a behavior. In this study, survey respondents were asked to agree or disagree with statements relating to four HBM constructs—perceived susceptibility, perceived severity, perceived benefits, and perceived barriers.

[2] The 90% vaccine efficacy (VE) presented in the CV scenario is within the range of actual VE rates of the most preferred vaccine brands in the Philippines—Pfizer-BioNTech BNT162b2 (95% CI 90.3 to 97.6%) and Moderna mRNA-1273 (95% CI 89.3 to 96.8%), and of the less popular brand Gamaleya Sputnik V (95% CI 85.6 to 95.2%); is closer to the upper bound of the rather wide VE interval estimate for the most used vaccine brand during the early months of the Philippine government's vaccination program—Sinovac Coronavac (65 to 91%); but is higher than the VE rates of AstraZeneca (95% CI 54.8 to 80.6%), Janssen (95% CI 59.0 to 73.4%), and Bharat BioTech: 80.6% (95% CI 78.1 to 82.7%). VE rates cited here are the rates disseminated by the Philippine Department of Health in their website https://doh.gov.ph/vaccines/.

The valuation scenario presented a COVID-19 vaccine that has a 90% efficacy[3] for a period of one year. The WTP question was framed using the dichotomous choice format as follows:

> *According to health experts, even those who are fully vaccinated would need booster shots after 6–12 months. Just like the flu vaccine, it may be necessary to have annual COVID-19 vaccine to ensure continuing protection from the different variants of the virus. Suppose a single-dose COVID-19 vaccine is already available for sale for everyone in clinics and hospitals. Suppose that this vaccine has already undergone all necessary tests and has been proven to be 90% effective against the COVID-19 virus for one year. If the price of the vaccine for one person is PhP XXX, will you buy the COVID-19 vaccine?*

Five bid levels—PhP 500 (US$ 9.71), PhP 1,000 (US$ 19.42), PhP 2,000 (US$ 38.83), PhP 3,000 (US$58.25) and PhP 5,000 (US$97.09)—were assigned randomly to the respondents. After the WTP question, "yes" respondents were asked to state the number of vaccines that would be purchased for household members, and to identify the most important reason for their decision to purchase the vaccine. Respondents not WTP the specified price of the vaccine, on the other hand, were asked for the reasons why they would not buy the vaccine.

The survey was conducted in Metro Manila (MM) in December 2021. MM, the political, economic, social and cultural center of the Philippines, is one of the more modern metropolises in Southeast Asia and is among the world's 30 most populous metropolitan areas. Covering an area of only 620 km^2, MM is the smallest of the country's 17 regions. It is, however, the second most populous region (13.5 million in 2020, 12.4% of the entire Philippine population) and the most densely populated—21,749 per km^2 in 2020 (PSA, 2021). MM is the epicenter of the COVID-19 infection in the Philippines accounting for almost a fifth (19%) of both total cases and deaths in the country, as well as the focus of the government's vaccination efforts. At the time of the survey, more than three-quarters of MM population had been fully vaccinated vis a vis the 25% vaccination coverage nationwide.[4]

[3] The implication on the estimated WTP of any difference between the 90% efficacy specified in the CVM scenario and the efficacy of the vaccines that become available in the endemic phase is discussed in the Results section.

[4] COVID-19 cases and vaccination data used in the calculation of the proportions were obtained from the Philippine Department of Health's COVID-19 Dashboard and National COVID-19 Vaccination Dashboard (DOH, 2022a and 2022b).

The study employed multi-staged stratified sampling procedure. The four districts of MM (Capitol, Eastern Manila, Northern Manila, and Southern Manila) comprised the first-stage stratification of the population. Each district was then stratified into its cities (second-stage strata). For each district, a representative city was selected from which the district sample was drawn: Manila (the sole city in the district) for the Capitol, Quezon City for the Eastern District, Caloocan City for the Northern District, and Makati City for the Southern District. All four cities are the principal cities in their respective districts, with mixed of residential, commercial and industrial areas. Quezon City, Manila and Caloocan are the three largest cities in MM, in terms of both population and area. The number of respondents in each of the four cities was set proportional to the share of the respective districts in the region's population. For each city, a predominantly residential *barangay* (the smallest government administrative unit in the country), with residents belonging to all social classes, was randomly selected. Permission and assistance to conduct the survey were secured from the barangay captain's offices, as well as community and home-owner associations. Prior to the start of the survey, written informed consent was obtained from each respondent after the nature, objectives and possible consequences of the study were fully explained. The survey took an average of 15 min to complete. A total of 508 respondents were generated for the study.

2.2 Analytical framework

The "yes–no" response to the dichotomous choice WTP question was analyzed using the framework developed by (Hanemann, 1984) based on the random utility model. Indirect utility, u, depends on h (which takes on the value 1 if the respondent is willing to pay for the vaccine, 0 if otherwise), household income y, a vector of respondent and his/her household's characteristics $\boldsymbol{z}$, and a component of preferences that are known only to the respondent and not to the researcher ε_h. This utility function is specified as additively separable in deterministic (v) and stochastic preferences (ε):

$$u(h, y, \boldsymbol{z}, \varepsilon_h) = v\big(h, y, \mathbf{z}\big) + \varepsilon_h \tag{1}$$

As the random part of preference is unknown, only probability statements about "yes" and "no" responses can be made. The probability that a price p for the vaccine is accepted, Pr (yes), is the probability that the utility with the vaccine purchase where $h=1$, and income y is diminished by the price of the vaccine p ($y-p$) is greater than the utility without the vaccine ($h=0$ and income is intact at y):

Table 1 Socioeconomic and health profile of respondents

Variable name	Definition/unit	Mean	SD
Socio-demographic			
Age	Respondent's age, no of years	42.60	13.11
Sex	= 1 if respondent is male = 1, 0 if otherwise	0.28	0.45
Married	= 1 if respondent is currently with a partner, = 0 if otherwise	0.58	0.49
WithChildren	With children = 1, Otherwise = 0	0.67	0.47
Education	Respondent's education		
College	= 1 if with some college years	0.60	0.49
PostCollege	= 1 if with some post-college years	0.26	0.44
Working	= 1 if respondent is currently working, 0 if otherwise	0.78	0.41
HHSize	No of household number	5.21	2.86
HHIncome	Monthly household income, PhP	56,446.85	43,245.13
Health-related variables			
Comorbidities	= 1 if respondent is with comorbidities/specified comorbidity, = 0 otherwise	0.35	0.48
Cardiovascular		0.02	0.14
Diabetes		0.09	0.29
Asthma		0.09	0.29
Hypertension		0.21	0.41
Self-assessedHealth	Very poor = 1, Poor = 2, Fair = 3, Good = 4, Very good = 5	4.15	0.69
Smoking	= 1 if respondent is smoking, = 0 if otherwise	0.08	0.27
FluVaccine	= 1 if someone in the household has received flu vaccine in the last three years, = 0 if otherwise	0.49	0.50

$$\begin{aligned} Pr(yes) &= Pr\left[v(1, y-p, \mathbf{z}) + \varepsilon_1 \geq v(0, y, \mathbf{z}) + \varepsilon_0\right] \\ &= Pr[v(1, y-p, \mathbf{z}) - v(0, y, \mathbf{z}) \geq \varepsilon_0 - \varepsilon_1] \end{aligned} \tag{2}$$

Assuming a linear indirect utility function and a stochastic term ε that is independently and identically distributed following a normal distribution with a mean of *0* and standard deviation of σ, the binary logit regression procedure can be used to evaluate Eq. 2. The parameter estimates from the regression were used to calculate mean willingness to pay, $E(p)$, using the formula:

$$E(p) = -(\beta/\sigma)\mathbf{X}/(\beta_{\mathrm{p}}/\sigma) = -\beta\mathbf{X}/\beta_{\mathrm{p}} \tag{3}$$

β is the vector of the estimated coefficients of all explanatory variables (vector $\boldsymbol{X}$) except price, and β_p is the estimated price coefficient.

The nonparametric mean WTP for the COVID-19 vaccine was calculated using the lower-bound Turnbull formula (Haab & McConnell, 2002):

$$E_{LB}(p) = \sum_{j=0}^{M} p_j(F_{j+1} - F_j) \tag{4}$$

M is the number of bids/vaccine price levels, p_j is the bid level, F_j is the proportion of "no" responses to bid price p_j, $F_0 = 0$, and $F_{M+1} = 1$.

3 Results

3.1 Socioeconomic and health profile of respondents

The socioeconomic profile of the respondents and their households is given in Table 1. The average respondent was 43 years old. Twenty-eight percent of the respondent were male, 58% were married, and 67% reported to have children. Sixty percent of respondents had reached college level, while 26% had some post-college education. The proportion of respondents working at the time of the survey was 78%. The average household in our sample had five members and a monthly income of PhP56,447 (US$1,096).

More than a third (35%) of respondents had comorbidities, 21% were hypertensive, 9% were asthmatic, 9% were diabetic, and 2% had cardiovascular problems. On the average, the respondents assessed their general health as "good". Only 8% of respondents were smoking, while a substantial 49% had household member/s received the flu vaccine in the last three years—reflecting some degree of health consciousness among the respondents.

3.2 COVID-19 exposure and vaccination

The first two panels of Table 2 indicate respondents' COVID-19 exposure in terms of known cases within their circles. About a third of respondents (170 out of 508) had household members infected by COVID-19.

Table 2 COVID-19 exposure, vaccination and brand preference

	Proportion (%) of all respondents
Covid case/s in the family	33.46
Covid death/s in the family	3.54
Covid case/s among relatives and friends	74.02
Covid death/s among relatives and friends	38.39
Preferred vaccine brand	
Pfizer	48.62
Moderna	15.55
Johnson&Johnson	6.50
Sinovac	6.10
Astra Zeneca	5.71
Sputnik	0.59
Sinopharm	0.20
No preference	16.73
Vaccinated respondent	96.26
Vaccine provider, $n=489$	
Government	88.14
Non-government	11.86
Vaccine brand	
Sinovac	45.40
Astra Zeneca	23.31
Pfizer	16.77
Moderna	11.04
Johnson&Johnson	2.05
Sputnik	1.43

Of these 170, 18 (11%) or 4% of all respondents had household members died of the infection. In the bigger circle of relatives and friends, there was a much larger number of respondents (376) reporting known COVID-19 cases, 52% of which reported death cases. Thus, 195 respondents (38% of all respondents) had friends and/or relatives who had died of COVID-19.

A very large percentage of the respondents (96%) had already received the vaccine. Although vaccination was not mandatory, people in MM were generally willing to take the vaccine, as revealed by the long queues at vaccination sites, likely due to fear of infection and possible death from infection as well as some temporary disincentives (e.g., "no public ride" and "no in-person work" for unvaccinated people) and incentives (e.g., relief packages from some local governments, and promotional goods and services from some commercial establishments). This high proportion of vaccinated respondents also reflects the wide availability of vaccine in MM, 88% of which was provided by the government for free. Non-government vaccine providers were mostly private companies providing free or subsidized vaccines to employees and their families.

However, survey results reveal that there was a significant mismatch between the supply and the preference of the respondents in terms of vaccine brand (third and fourth panels of Table 2). Although the largest proportions of respondents preferred Pfizer (49%) and Moderna (16%), the largest proportions of vaccine received were Sinovac (45%) and AstraZeneca (23%). This may imply a big perceived need for the vaccine that people were generally willing to take any vaccine brand that was immediately available.

3.3 Health belief model (HBM)

Table 3 summarizes the responses to the HBM statements. While just a little short of majority of respondents believed there is a high chance that they will get COVID-19 (43%) and will develop severe complications from the infection (49%), almost all (86%) were worried about contracting the disease. A substantial 73% of the respondents believed that the vaccine could reduce his/her chance of contracting the COVID-19 virus, and although less, still a majority (51%) felt less anxious about getting infected because of the vaccine. The highest proportion (91%) of agreement was obtained for the statement that vaccines are needed to end the pandemic. A small minority of respondents thought vaccines could create more problems than solutions (6%) and could cause deaths (17%). Only very few (5% of respondents) felt that their practice of precautionary measures such as handwashing, social distancing and wearing masks would be sufficient to prevent infection. Overall, the responses reflect widespread acceptance and recognition of the need for COVID-19 vaccines among MM households.

3.4 Willingness to pay for a yearly COVID-19 vaccine

Figure 1 gives the proportion of respondents who were willing to pay for a COVID-19 vaccine that was specified to have 90% efficacy for a period of one year. For a vaccine price of PhP500, the substantial 80% of respondents indicated they would purchase the vaccine. Generally, the proportion of "yes" respondents was lower the higher the price of the vaccine. At vaccine prices of PhP3,000 and PhP5,000, the proportion of respondents who would be buying the vaccine was lower than 50%.

Logit regression results presented in Table 4 reveal that the likelihood of buying the vaccine was higher when the price of the vaccine was lower and household income was higher, consistent with economic theory. For the demographic variables, only sex and household size turned out to be statistically significant determinants of WTP. Respondents who were male and who had a smaller household were more likely to purchase the COVID-19 vaccine at the stated price. Age, education, marital status

Table 3 Health belief model

Statement	Proportion (%) of all respondents				
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Perceived susceptibility					
1. There is a high chance that I can be infected by the COVID-19 virus	9.84	12.20	38.84	26.97	16.14
2. I am afraid that I can get infected by the COVID-19 virus	1.57	3.94	8.66	30.31	55.51
Perceived severity					
1. It is likely that I will develop severe complications if I get infected by the COVID-19 virus	6.11	15.58	29.59	31.56	17.16
Perceived benefits					
1. The chance that I will contract COVID-19 is lower with the vaccine	1.97	5.71	19.29	38.98	34.06
2. Because there are already COVID-19 vaccines, I am not so worried anymore about contracting COVID-19	5.12	13.58	29.72	33.66	17.91
3. Vaccines are needed to end the pandemic	0.39	1.18	7.48	27.76	63.19
Perceived barriers					
1. Vaccines can create more problems than solutions	26.18	37.80	29.53	3.74	2.76
2. Vaccines can cause death to people	14.60	28.40	39.84	13.41	3.75
3. I do not need the vaccine because I take all precautionary measures to prevent infection such as wearing face masks and shields, social distancing, frequent hand-washing, etc.	32.28	39.57	23.23	3.54	1.38

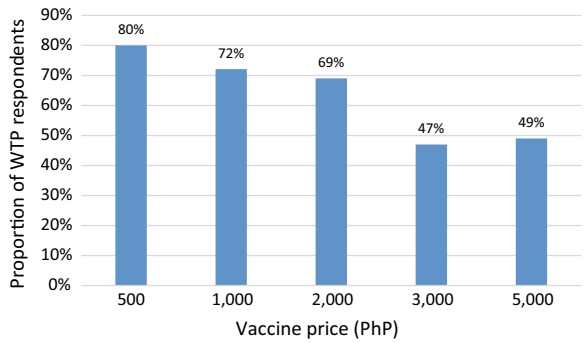

Fig. 1 Bid function

(being married or not) and work status (currently working or not) did not significantly influence WTP.

Respondents' exposure to COVID-19 cases, measured in terms of whether or not household members, relatives and friends had been infected with COVID-19 or had died from the infection, did not affect WTP. However, past flu vaccination experience turned out to be a statistically significant determinant. Respondents with household member/s who received flu vaccine/s in the last three years were more likely to buy the COVID-19 vaccine.

The HBM appears to capture COVID-19 vaccine demand quite well. Three HBM variables turned out to have statistically significant coefficients. Respondents who perceived a high chance of contracting the COVID-19 virus (Susceptibility1) and who thought that this chance of infection would be reduced by the vaccine

Table 4 Binary logit regression results

Explanatory variable	Coefficient	
	Run 1	Run 2
Bid (vaccine price)	−0.0003720***	−0.0003935***
HHIncome	0.0000235***	0.0000184***
Age		0.0123544
Sex		0.436759*
Married		−0.2714412
College		0.1433236
PostCollege		0.1428794
Working		0.1160557
Smoking		−0.5016545
CoMorbidities		0.1048999
HHSize		−0.0801663*
FluVaccine		0.6190891***
CovidDeathFamily		0.3889361
CovidDeathRelativesFriends		−0.2082763
Susceptibility1		0.1779377*
Severity		0.0984865
Benefits1		0.1920978*
Barrier2		0.0748801
Barrier3		−0.3896657***
GovtTrust		−0.0328129
Constant		−0.4880911
Number of observations	508	505
Log likelihood	−277.1935	−255.43
LR chi2(20)	112.99	151.58***
Pseudo R2	0.1693	0.2288

Asterisks after coefficients denote level of significance: * for 0.10, ** for 0.05, and *** for 0.01

(Benefits1) were more likely to buy the vaccine, while those who thought they do not need the vaccine as they are undertaking other precautionary measures (Barrier3) were less likely to be WTP. On the other hand, perceiving a high chance of developing complications (Severity) and believing that vaccines could cause death (Barrier2) did not significantly affect the likelihood of buying the vaccine.

Using the estimated coefficients of the base model, mean parametric WTP for an annual COVID-19 vaccine with 90% efficacy was calculated to be PhP3,565.86 (US$69.24) for the sample of 508 respondents with an average household income of PhP56,446.85. Adjusting for actual average household income in Metro Manila in 2021 of PhP34,821, mean WTP for the annual COVID-19 booster vaccine would be PhP2,199.71 (US$42.71). Nonparametric mean WTP using the Turnbull formula was estimated to be PhP2,410.50 (US$46.81). Hence, on the average, Metro Manila households would be willing to pay about PhP2,199.71–2,410.50 (US$42.71–46.81) for an annual booster vaccine dose with 90% efficacy. If the proportionality assumption relating to the scope sensitivity of WTP holds, WTP for a vaccine with 50% and 30% efficacy rates would be PhP1,223.04–1,340.24 (US$23.75–26.03) and PhP732.50–802.70 (US$14.22–15.59), respectively.[5]

The WTP for a COVID-19 vaccine derived in this study for the Philippines is within the range of values derived for other countries: close to estimates for developing countries—US$57.20 for Indonesia (Harapan et al., 2020), US$60 for Lebanon (Karam et al., 2022), US$30.66 for Malaysia (Wong et al., 2020), and US$85.92 for Vietnam (Vo et al., 2021), but much lower than estimated WTP of US$147.61 for Ecuador (Saratsy et al., 2020), US$184.72 for Chile (Garcia & Cerda, 2020), and US$236.85 for the USA (Catma & Varol, 2021).

Mean WTP varies widely across income groups, as revealed in Table 5. On the average, the lowest income group with monthly income below PhP10,000 would be willing to pay only PhP316 (US$6.14). Households in the second income group with monthly income of PhP10,000–19,999 would be willing to pay PhP948 on the average, while households with monthly income of Php20,000–29,999 would be willing to pay PHP1,579. Up to the income group PhP30,000–39,999), the amount of money a household is willing to pay for a COVID-19 booster vaccine dose, on the average, is below the prices of the preferred vaccines, Pfizer (PhP2,379) and Moderna (PhP3,904–4,504).[6] Nonetheless, mean WTP increases quite steeply with income, reaching PhP7,897 (US$153.34) for the highest income group with monthly income of above PhP100,000. The average WTP of households with monthly income of at least PhP80,000 already exceeds Pfizer and Moderna vaccine prices. This finding suggests some scope for cross-subsidization.

Table 5 Mean WTP, by income group

Income group	Mean WTP (PhP)
Below PhP10,000	316
PhP10,000–19,999	948
PhP20,000–29,000	1,579
PhP30,000–39,999	2,211
PhP40,000–59,999	3,159
PhP60,000–79,999	4,422
PhP80,000–99,999	5,685
Above PhP100,000	7,897

4 Discussion

4.1 Vaccine acceptance

The high initial COVID-19 vaccine uptake among respondents and the answers to the HBM statements reflect pervasive vaccine acceptance in MM, Philippines. In general, respondents believed that precautionary measures such as wearing masks, social distancing, handwashing and building resistance are not sufficient and that vaccination is necessary to end the COVID-19 pandemic. Survey results also indicate a prevailing confidence in the efficacy of vaccines to reduce the risk of COVID-19 infection and the risk of death in case of infection. This is consistent with the previous findings of Palanca-Tan (2014) regarding the widespread acceptance of vaccination in the Philippine metropolis. Confidence in vaccines among MM residents appears to have not permanently waned despite the highly politicized Dengvaxia (dengue vaccine) controversy in 2018–2019 just before the COVID-19 outbreak. More than four decades of the government's Expanded Immunization Program (DOH, 2022c) for children had developed widespread vaccine acceptance in the country. However, the Dengvaxia controversy resulted in vaccine hesitancy at that

[5] A difference between the efficacy of the vaccines that become available in the endemic phase and the 90% efficacy specified in the CVM scenario of the survey will have implications on the estimated WTP. Specifically, an actual vaccine efficacy rate that is lower/higher than 90% may lead to an over-estimated/under-estimated WTP. The mean WTP estimate derived in this study may be scaled down/up proportionally if the proportionality assumption relating to the scope sensitivity of WTP (that is, WTP increases proportionally with the amount of the good or service) holds.

[6] These vaccine prices are based on the list released by a Philippine senator. According to the Philippine Department of Health, these are indicative market prices based on the rates published by manufacturers, not the government negotiated prices (Montemayor, 2021).

Table 6 Household members' vaccination

Age group	Number of household members	Vaccinated		For whom vaccines will be purchased	
		Number	% of members	Number	% of members
0–4 years old	0.3	0.0	0%	0.2	67%
5–11 years old	0.5	0.0	0%	0.4	80%
12–17 years old	0.6	0.5	83%	0.5	83%
18–65 years old	3.3	3.1	94%	3.0	91%
Above 65 years old	0.5	0.4	80%	0.5	100%
All household members	5.2	4.0	77%	4.6	88%

Table 7 Most important reason for being WTP for the COVID-19 vaccine

Reason	Proportion (%) of "yes" respondents, $n = 322$
To lower our chance of getting COVID-19	24.46
To avoid severe complications and death in case of COVID-19 infection	55.73
Medical and other expenses that can be incurred due to COVID-19 infection are far greater than the cost of the vaccine	19.81

time—Filipinos' trust in vaccine safety plummeted to 21% from a high of 82% in 2015, contributing to the spike in polio and measles cases in the country (Skopeliti, 2020). It thus appears that Filipinos' acceptance of and faith in vaccines immediately resumed during the COVID-19 pandemic.

The number of vaccinated household members by age group, presented in the third column of Table 6, reflects the extent of the government vaccination drive in MM at the time of the survey. At that time, vaccination for the age groups below 12 years old had not yet started (0% coverage for age groups 0–11 years old). Among the vaccinated age groups, the highest coverage was for the working age group 18–65 years old (94%), followed by the age group 12–17 years old and age group above 65 years old. Overall, 77% of respondents' household members had been vaccinated, reasonably close to official data.

The number of vaccines to be purchased for each age group (columns 5 and 6 of Table 5) reflects the high potential demand for annual COVID-19 vaccines even for children, further supporting the earlier observation that vaccine hesitancy, particularly for children, created by the Dengvaxia controversy was short-lived.

Majority of the "yes" respondents (56%) cited avoidance of severe complications and death as the most important reason for buying the COVID-19 vaccine (Table 7). Remarkably, the fear of death, which sparked vaccine hesitancy in 2016–2018, was also the reason that brought back vaccine confidence during the COVID-19 pandemic.

4.2 Financial constraints to vaccine uptake

While Filipinos confidence in vaccines has returned, financial considerations appear to constrain demand for an annual COVID-19 vaccine, as reflected by the reasons cited by "no" respondents. Table 8 indicates that, together with the belief that the government should continue to provide the COVID-19 vaccines for free, lack of financial capacity and the high price of the vaccine were the major reasons for not buying the vaccine at the stated price.

Figure 2 shows the proportion of households who were not willing to buy and pay for the booster vaccine (orange plot) and the proportion of those who cited financial constraints as reasons for not being willing to pay (blue plot), by income groups.[7] The plots further illustrate the financial hurdle to booster vaccine uptake. Majority of respondents in the three lowest income groups were not willing to pay for the booster vaccine and most of those "no" respondents cited financial constraints as their

[7] In a CVM survey, bid levels are assigned randomly to respondents. In every survey area for this study, enumerators were given questionnaires with different bid levels (vaccine prices). Enumerators were instructed to randomly draw one questionnaire from the supply of questionnaires (of different bid levels) at the start of each interview. With this random assignment of the five bid levels to respondents, no systematic difference in the average vaccine price asked to different income groups is expected, as is reflected in the following average bid level per income group:

Income Group.	Below 10,000.	10,000–19,999.	P20,000–29,000.	30,000–39,999.	40,000–59,999.	60,000–79,999.	80,000–99,999.	Above 100,000.
Ave Bid.	PhP2,273.	PhP2,508.	PhP2,492.	PhP2,032.	PhP2,037.	PhP2,400.	PhP3,242.	PhP2,140.

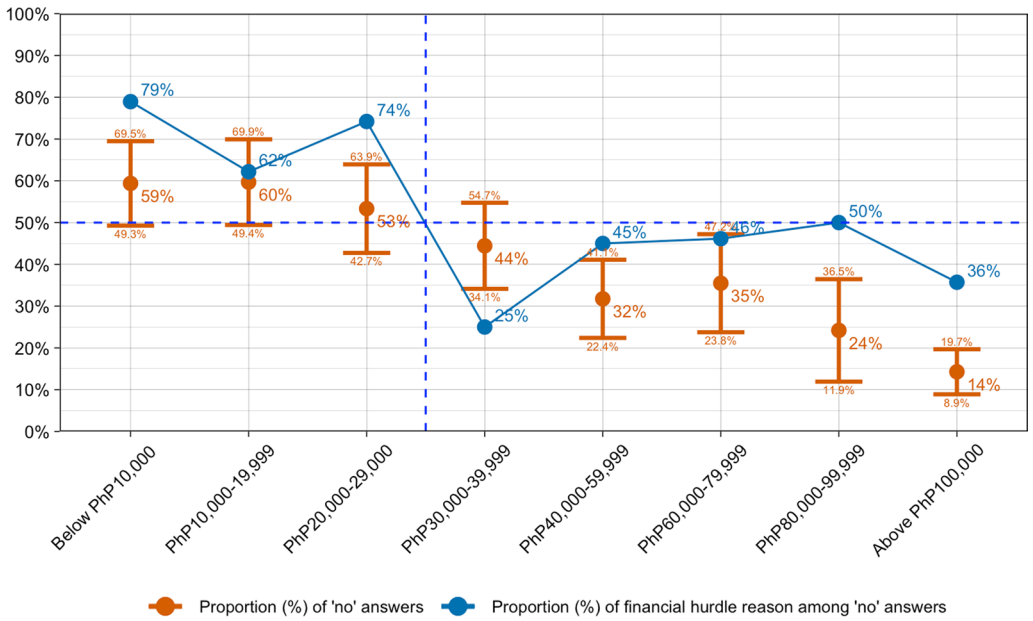

Fig. 2 Financial hurdle, by income group

Table 8 Reasons for not being WTP (multiple answers allowed)

Reason	Proportion (%) of "no" respondents, $n = 186$
Financial constraints: I do not have sufficient money to buy the vaccines, and/or the price of the vaccine is too high	56.76
I think it is government's responsibility to provide free vaccine to all	70.81
There are other means to avoid COVID-19 infection	14.67
I am afraid of the bad side effects of the vaccine	6.99
I do not believe in vaccines	1.61
Religious reasons	0.00

reasons for not buying. However, starting from income group PhP30,000–39,999, "no" respondents represent the minority, with the proportion declining sharply to only 14% (90% confidence interval of 9–20%) for the highest income group. Likewise, the financial constraints reason for not buying the vaccine also becomes the answer of the minority of "no" respondents with monthly household income of at least PhP30,000. These observations, together with estimates of mean WTPs by income group presented earlier in Table 5, reveal that WTP for the COVID-19 booster vaccine is constrained by income, and hence, there may be a need to subsidize, partially or fully, COVID-19 vaccine costs for the lower-income groups. On the other hand, commercial markets may be allowed to cater to higher-income groups who prefer to obtain the vaccines privately. This is similar with the ongoing Expanded Immunization Program for Children of the Philippine Department of Health (DOH, 2022c).

5 Conclusion

Using the CVM, this study estimated Metro Manila households' mean WTP for a dose of COVID-19 booster vaccine to be about PhP2,199.71–2,410.50 (US$42.71–46.81). This is higher than the composite price of COVID-19 vaccines administered by the Philippine government during the pandemic phase; yet may be lower than the likely commercial prices of the most preferred vaccine brands. During the pandemic phase in 2021, the average composite cost of COVID-19 vaccines administered by the Philippine government was estimated at PhP1,300 per person (DOH, 2021).[8] Vaccine prices in the beginning were set at low levels most particularly for lower-income countries as many drugmakers (e.g., Pfizer, Johnson & Johnson, and AstraZeneca) pledged to sell their vaccines on a not-for-profit basis during the pandemic phase, considering the urgent global health need of ensuring widespread vaccination for all

[8] According to the Philippine Department of Health, the following indicative market prices of COVID-19 vaccines: Moderna—PHP3,904—PHP4,504, Sinovac—PHP3,629.50, Pfizer—PHP2,379, Gamaleya—PHP1,220, COVAX Facility—PHP854, AstraZeneca—PHP610, and Novavax—PHP366, were used in estimating the proposed budget for the Philippine government's vaccination program. The vaccine prices were based on rates published by manufacturers, not the negotiated prices with the government (Montemayor, 2021).

countries. Further, COVID-19 vaccine manufacturers followed a tiered pricing approach that enabled poorer countries to pay less (Sagonowsky, 2021). Nonetheless, recent news indicates that major COVID-19 vaccine manufacturers are inclined to charge much higher commercial prices during the endemic phase of the infection. Both Pfizer and Moderna, for instance, have announced that their prices would likely be three to four times higher than the pandemic booster price (Kates et al, 2022).[9] If similar commercial price adjustments apply to the Philippines, market prices of COVID-19 booster vaccines in the country can be in the range PhP3,900–5,200. At the lower bound of this price range, only households with monthly income of PhP40,000 or more would be likely to buy and pay for the vaccine, while only households with monthly income of PhP80,000 or more would be likely to pay for the higher bound of the price range. The findings, nonetheless, suggest a potential for selling the annual booster vaccine in private markets for certain income groups in Metro Manila.

With mean WTP increasing steeply from PhP316 for the lowest income group with monthly income below PhP10,000 to PhP7,897 for households with monthly income above PhP100.000, there is scope for cross-subsidization. A public vaccination program in which part or all of the financial costs are subsidized will be needed for the lower-income groups. Measuring the benefits of a public vaccination program in terms of Metro Manila households' mean WTP, it is likely that the program will pass a social cost–benefit analysis.

Further, the multivariate analyses suggest that promotional campaigns for the COVID-19 vaccines must be directed to female household heads who were found to be less inclined to purchase the vaccine. Policy makers must also consider giving vaccine subsidies according to household size, not just household income (subsidies for larger households regardless of income such as free vaccines from the *n*th member in the family). There is also need for a continuing education and awareness campaign on virus and vaccine developments so as to keep people adequately informed and properly guided in their vaccination decisions.

Abbreviations

COI	Cost of illness
CVM	Contingent valuation method
DOH	Department of Health
HBM	Health Benefit Model
MM	Metro Manila
WHO	World Health Organization
WTP	Willingness to pay

[9] It is estimated that the average commercial price per dose of Pfizer and Moderna's COVID-19 booster vaccine in the USA would range from US$96 to US$115, three to four times higher than the weighted average price per dose (US$28.90) paid by the federal government for Moderna and Pfizer bivalent doses (Kates et al, 2022).

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RPT did conception and design of the work; acquisition, analysis, and interpretation of data; writing and revision of manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests
The author declares that she has no competing interests.

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