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Assessing willingness to pay for HIV vaccines in Vietnam: A contingent valuation method study

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ABSTRACT

Objective: HIV has infected approximately 75 million people worldwide with over half dying from AIDS-related diseases. This study aimed to determine individuals' willingness to pay (WTP) for future HIV vaccines.

Methods: A cross sectional study was conducted in December 2022 in Southern Vietnam with 1 675 face-to-face interviews. WTP was determined using the contingent valuation method with two bidding games under three vaccine efficacy scenarios (high, medium, low) for both self-vaccination and child vaccination.

Results: Among 1 655 valid respondents, 553 were willing to pay for their children's vaccination. Overall, the WTP of adults for the HIV vaccine was (4 961 264±3 793 652) VND (23 700 VND = 1 US dollar). The WTP of parents is (4 947 799±4 930 721) VND for self-vaccination and (4 865 399±4 064 567) VND for vaccinating their children. Average WTP decreased with lower vaccine efficacy and lower bid prices. Education level, marital status, occupation, and monthly income were significantly associated with WTP for all vaccination types.

Conclusions: In this study, high WTP rates and numerous individuals willing to pay for HIV vaccines were found. These findings can help decision-makers understand factors influencing WTP for future HIV vaccines and provide evidence for developing funding programs and budgeting plans for introducing such vaccines in Vietnam.

KEYWORDS: Policy making; Price setting; Universal immunization; Vaccine; Vietnam

1. Introduction

Infection from the human immunodeficiency virus (HIV) and its deadliest phase-the acquired immunodeficiency syndrome (AIDS)-are becoming significant global issues in today's modern society. By the end of 2018, around 37 million individuals all over the world had HIV[1]. In comparison to 2018 levels, there are an estimated 75 million HIV-positive individuals worldwide, among whom more than half are dying as a result of AIDS-related diseases[1].

Summary

Question: How willing are individuals in Southern Vietnam to pay for future HIV vaccines under different efficacy scenarios?

Findings: Among 1 655 respondents in this cross-sectional survey, 553 were willing to pay for child vaccination. Willingness to pay decreased with lower vaccine efficacy and lower bid prices. Education, marital status, occupation, and income significantly influenced willingness to pay across vaccination types.

Meaning: These results highlight key socioeconomic factors shaping vaccine affordability and acceptance, providing valuable evidence for policymakers to design funding strategies and budgeting plans for HIV vaccine introduction in Vietnam.

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Among Southeast Asian countries between 1980 and 2017, Vietnam registered AIDS-related deaths totaling 11 400, second only to Thailand[2]. Because of the severe impact of HIV/AIDS on society, an important task is to discover a way to reduce the spread of the virus in communities to control the illness. In 2017, Vietnam reported 19 100 new HIV infections, accounting for 20.6% of Southeast Asia's cases[2]. Adherence to antiretroviral therapy among people living with HIV in Vietnam remains suboptimal[3]. This highlights the urgent need for effective prevention measures, such as an HIV vaccine. By focusing on the regional impact, we emphasize the importance of addressing HIV in Vietnam.

Many people believe that an HIV vaccine can prevent the spread of the virus and save millions of lives[4]. The efficacy of HIV vaccinations has been investigated through numerous trials since the 1980s, and many of these have progressed to Phase Ⅲ, with the promise of improving the effectiveness of next-generation candidate vaccines to elicit adaptive immune responses against HIV[5]. However, an important consideration in drawing plans for a future HIV immunization program is understanding people's acceptance and preparedness to receive such a vaccine. This can be achieved through a survey-based, hypothetical, and direct methodology called the contingent valuation method (CVM), which is used to look into financial projections based on the market effects of health technologies[6]. Thus far, CVM has been developed with the goal of measuring the total worth of a good by directly asking customers about their willingness to pay (WTP) for such a good. WTP and acceptability are useful variables for determining the extent to which buyers value items and services, as these reveal advantages in the form of monetary values. Government or international financing may afford patients free HIV vaccinations, but under inadequate or restricted budgetary funding, evaluating patients' WTP for such a vaccine may be crucial in the development of an effective approach[7].

Previous studies on WTP for HIV vaccines lack a focus on Vietnam. Vietnam will have to make a difficult choice regarding whether to add a new vaccine to an expanded immunization program or sell the vaccine privately to those who can afford it. This choice highlights the importance of estimating the cost of HIV immunizations for both financial and community health reasons. Correspondingly, this study was carried out to calculate the WTP for future HIV vaccines using CVM and its associated parameters. Our study addresses this gap by examining the socio-economic factors influencing WTP in Southern Vietnam. This approach provides new insights specific to the Vietnamese context. The findings were expected to considerably affect the implementation of a vaccination campaign in the future. Additionally, this research was intended to help decision makers better understand the influencing factors of WTP and consider them when creating funding programs and budgeting plans for the introduction of future HIV vaccines in the context of Vietnam.

2. Methods

As previously stated, the WTP of respondents was determined using CVM[8], which was initially created for environmental benefit assessment and is a widely accepted and used approach to identifying priorities in obtaining the maximum WTP[9]. It is particularly relevant in an immunization setting, where individuals are already aware of the potential advantages of vaccination, such as disease avoidance, affordability, and the reduction of pain and suffering[10].

2.1. Study design and participants

To achieve the objectives, a cross sectional study was conducted in December 2022 involving residents of Southern Vietnam. The inclusion criteria were as follows: at least 18 years old and had resided in the region for at least a year, of Vietnamese descent, communicates well in Vietnamese, and is willing to participate. Participants who could not complete the questionnaire, had mental health issues, or were unable to participate in interviews because of morbidity-related circumstances were excluded. In addition, the study aimed to estimate positive willingness to pay (WTP) values among individuals who expressed any demand for an HIV vaccine. Therefore, only participants who were willing to pay for at least one of the three efficacy scenarios (low, medium, or high) were included in the analysis. This inclusion criterion was anticipated during the sample size calculation as follows.

This study employed convenience sampling, and sample size was estimated using the following formula[11]:

$$n = \left(\frac{\text{precision}^2}{\text{cv}^2 \times Z^2_{1-\frac{\alpha}{2}}}\right)^{-1}$$

where precision was assumed to be 0.05, Z (1.96) was the value of normal distribution at 95% confidence interval, and coefficient of variation (CV) was assumed to be 0.9. Based on the formula, the minimum sample size required was 1 245. Given that this study involved only respondents who were willing to pay for at least one scenario, we divided the minimum sample size by the rate of WTP which referred to a previous study on the WTP for a dengue vaccine in Vietnam (89.19%)[12]. We assumed that the percentage of respondents with missing values or invalid questionnaire responses would be 20%, driving us to conduct 1 675 interviews, *i.e.*:

$$\frac{1245\times100}{89.19} \times \frac{120}{100} \approx 1675$$

Using convenience sampling may introduce biases and limit the generalizability of our findings. We will discuss these limitations and suggest that future studies employ probability sampling to obtain more representative samples. This will help enhance the robustness of future research.

2.2. Survey design and data collection

A face-to-face survey was carried out by researchers and well-trained data collectors. The data collectors underwent a seven-day interview strategy class, and further training on survey introduction and administration enabled them to control shifts in the data during the interviews. A provision was established for interviewee selection to be distributed across selected provinces of Vietnam. The survey was voluntary in nature and took about 10 minutes to complete. Residents of the entire southern region of Vietnam were actively recruited to minimize constraints on data collection, but no rewards were offered to encourage participation.

2.3. Survey instrument

The research team used CVM, past experiences, and the literature to produce the original draft of the questionnaire, which was aimed at determining respondents' views on the introduction of an HIV vaccine. After the initial stage of questionnaire development, a focus group was formed to evaluate the language of the questionnaire and the ability of people in general to reply to the questions.

The study was designed to be conducted in English, but it is minimally spoken by populations with low education levels. Accordingly, the questionnaire was translated into Vietnamese, the primary language spoken in the study area and the most widely used in the country, then re-translated into English to check for consistency. Out of this process, a self-administered structured questionnaire was created based on information and was twice assessed by five experts in relevant domains, including social and administrative pharmacy, health economics, and public health. Prior to the survey, the focus group discussion was conducted one on one with 40 persons of different demographic backgrounds on the basis of COVID-19 restrictions and Haab and McConnell's[13] recommendations. After these interviews, the survey was modified to reflect the data that the respondents provided. A pilot study involving face-to-face interviews was then carried out to test the revised survey, specifically to ensure that the questionnaire was clear and to have the respondents directly reply to the open-ended question regarding their monthly WTP for the introduction of HIV vaccines. The average WTP per vaccine scenario was 3 283 345 Vietnamese Dong (VND) (approximately US$140 in December 2022; VND is used hereafter as the currency unit for WTP). Correspondingly, the initial suggested bid in the questionnaire was set to 3 million VND, then another 3 million was added to each subsequent bid, and the bidding was eventually concluded at a maximum value (9 million).

The structured questionnaire had two sections. The section on basic information (11 items) covered age, sex, sexual orientation, residency, education level, marital status, occupation, religion, monthly income, financial vulnerability, and self-evaluated risk of acquiring HIV. Financial vulnerability was assessed based on participants' self-reported ability to handle an unexpected expense. Respondents were asked: "If you faced an unexpected expense, would you be able to afford it?" Those who answered that they could afford it entirely were categorized as low vulnerability, those who might be able to afford it were medium vulnerability, and those who could not afford it at all were considered high vulnerability. This approach was adopted from Lusardi *et al*[14], which has been widely used to assess financial fragility in the absence of standardized national criteria. The second section was meant to ask respondents to imagine that a vaccine against HIV is successfully tested and distributed to local health centers/hospitals nationwide. Iterative bidding games were then conducted to determine the WTP of the respondents for self-vaccination and the vaccination of their children (if any).

The questionnaire was translated into Vietnamese and back-translated to ensure accuracy. Focus groups were conducted to ensure cultural appropriateness, and a pilot study was performed to refine the survey for better comprehension among participants.

2.4. WTP measurement

The fundamental problem with a contingent valuation survey is the selection of elicitation forms, which directly affects the estimation of the valuation functions associated with respondents' WTP. CVM-based tools include open-ended questions, discrete choice questions, iterative bidding, and payment cards[15]. The iterative bidding approach was employed in this work. A bidding game, in contrast to other CVM tools, is time-consuming but best conducted in person[16]. It provides valuable insight into a person's maximum WTP.

Before the bidding games were initiated, the respondents were informed about a fictitious HIV vaccination program with typical attributes based on vaccine features. A diagram illustrating the vaccine's potency was shown to them to ensure a full grasp of the facts given. Three types of vaccines with different characteristics were incorporated into three scenarios: vaccination with low-, medium-, and high-efficacy vaccines. On the basis of the average WTP value determined in the pilot study, a pre-assigned vaccine price of 3.0 to 9.0 million VND was set.

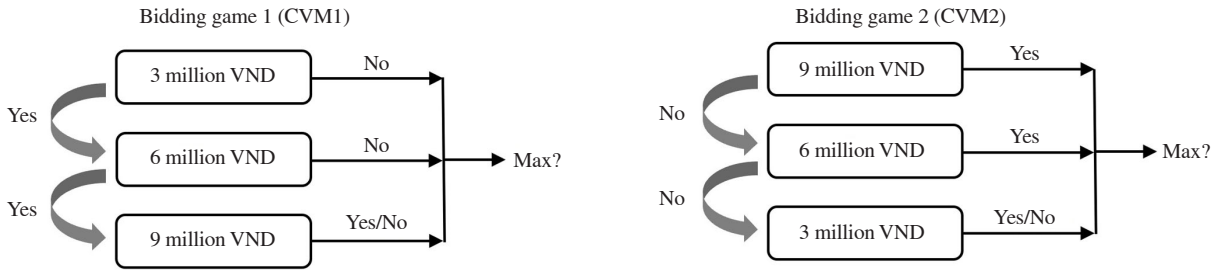
To minimize the influence of anchor bias on the average WTP, two bidding games, which were randomized among the respondents, were conducted. The random function in Microsoft Excel was used to randomize. In the first game (CVM1), the participants were offered the HIV vaccine at the lowest price/bid (3 million VND). The bid was then increased to 6 million VND for those who agreed to the initial price, and upon acceptance of this value, the bid was raised to 9 million VND. At this level, the respondents were presented with the open-ended question asking them about their maximum WTP.

The second game (CVM2) commenced with the maximum bid (9 million VND), and upon rejection, the bid was decreased to 6 million VND and then 3 million VND. After this, the bidding process for the other scenarios was conducted in a similar manner.

Iterative bidding was chosen for this study as it allows for a more precise determination of maximum WTP compared to open-ended questions or discrete choice methods. However, it may introduce anchor bias, which we attempted to mitigate by randomizing the starting bids. Figure 1 illustrates the two bidding games and three scenarios.

2.5. Statistical analyses

The data were entered into Microsoft Excel 2016 for statistical analyses, and each entry was carefully double checked and confirmed. Missing answers and outliers were rigorously checked



Variables	High scenario	Medium scenario	Low scenario
Efficacy	99%	75%	50%
Protection duration	Lifetime	10 years	5 years
Dose scheme	1	1	3

Figure 1. Iterative bidding technique used to explore WTP for HIV vaccines. Scenario: "Good morning/afternoon. I am ____. I am inviting you to participate in a study that estimates the willingness-to-pay (WTP) for HIV vaccine. After we give you some basic information about the HIV vaccine, we would like to ask whether you agree to get the vaccine, and if yes, how much you are willing to pay for each of these following types of vaccines to protect yourself (and your under 18-year-old children if you have any) based on our questions below. Please note that your budget is limited, as there is no financial support from health insurance offices or the government."

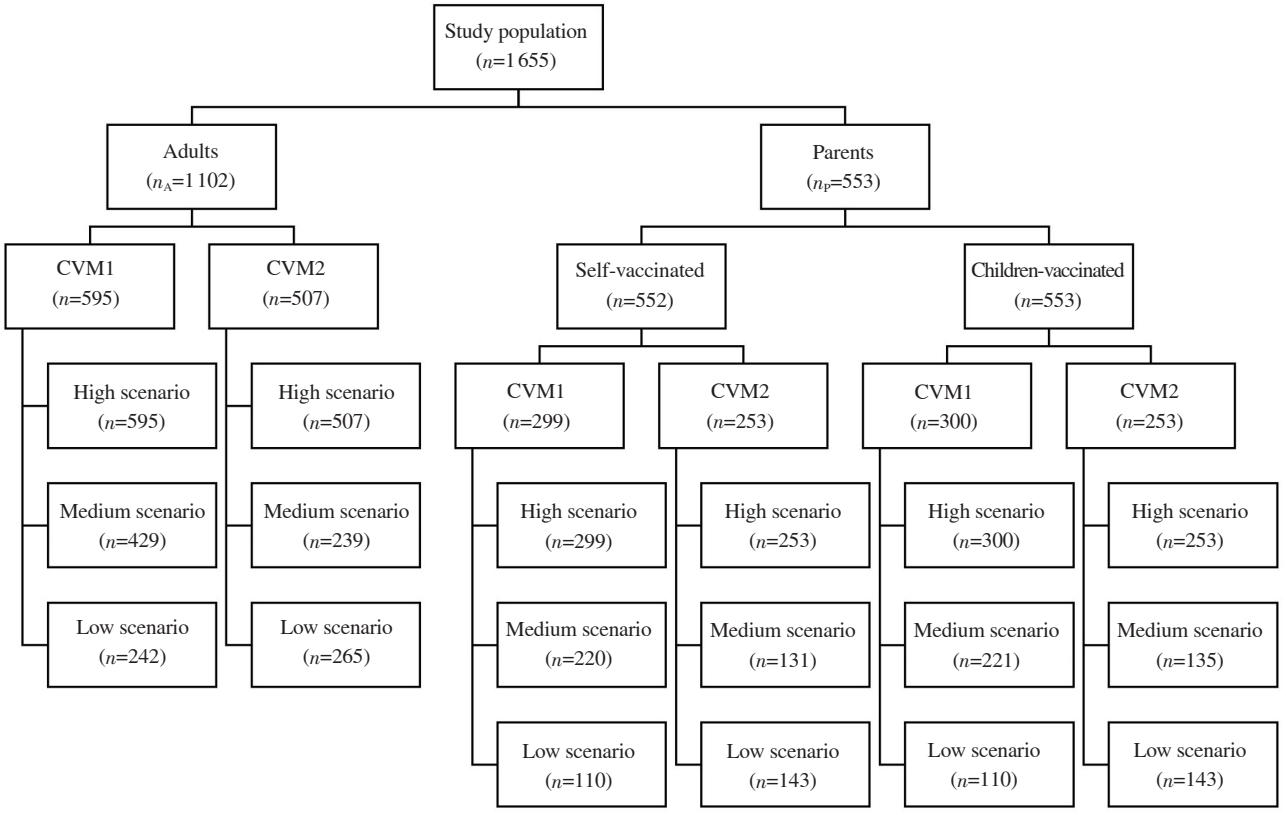


Figure 2. Number of participants who were willing to pay for HIV vaccines across three scenarios (high, medium, and low efficacy) and two bidding games (CVM1 and CVM2).

and managed before the analyses, which were performed using the Statistical Package for the Social Sciences (version 20.0). From the open-ended inquiry with pertinent instances, the median and interquartile range (IQR) of the WTP were determined, along with standard deviations (SD) and the 95% confidence interval (*CI*). Given the abnormal distribution of the data, nonparametric techniques, such as the Kruskal–Wallis and Mann–Whitney *U* tests for two variables, were conducted to compare the median values of the participant groups. A statistical significant level was set at 0.05. To evaluate the explanatory variables affecting the WTP for HIV immunization, conditional linear regression analysis was carried out. This well-known approach was used in previous studies on immunization[17–19].

Data compliance with the multivariate model's linear regression assumptions was first evaluated using diagnostic procedures. The variance inflation factor (VIF)[20], Lagrange multiplier test[21], Glejser test[22], and Kolmogorov–Smirnov test[23] were used to evaluate multicollinearity, autocorrelation, heteroscedasticity, and the presumption of normality, respectively. A VIF lower than 10 and a tolerance value (1/VIF) higher than 0.1 were used as cut-off values that reflected the absence of multicollinearity between the variables. In the Lagrange multiplier, Glejser, and Kolmogorov–Smirnov experiments, a $P>0.05$ was employed as a cut-off point to demonstrate the absence of autocorrelation, heteroscedasticity, and regular residual distribution, respectively. Because data from social surveys commonly violate heteroscedasticity and normality assumptions, a plan was formulated in anticipation of this occurrence. The truth of these statements was determined by transforming WTP values on the basis of the natural logarithm (*ln*). We examined the correlation between the explanatory factors and transformed WTP values using the current multivariate linear regression model. The first multivariate linear regression model's explanatory variables that were significant at $P<0.25$ were retained and incorporated into the final linear regression model. As mentioned earlier, the cut-off point of $P=0.25$ was employed[24,25]. To make sure that the final model contained all the necessary explanatory variables, two-step linear regression modeling was performed. Any projected *ln*WTP value in our model should follow a normal distribution on a natural log scale.

The data distribution was non-normal, which we addressed by transforming WTP values using the natural logarithm. Despite this adjustment, some limitations remain, such as the potential for residual non-normality affecting the results.

2.6. Ethical considerations

The protocol of this study was approved by the Hanoi University of Public Health (No. 445/2022/YTCC-HD3 on 2 December 2022). The explanations given to the responders included information about the study's voluntary nature and safety. Prior to initiation, informed consent, volunteering, written, and signed agreements were obtained from each participant. The information gathered from the respondents was kept anonymous, and no details allowing for the identification of a specific individual were gathered. Participant confidentiality was maintained by anonymizing responses and securely storing data. The study protocol was approved by the Hanoi University of Public Health, and informed consent was obtained from all participants.

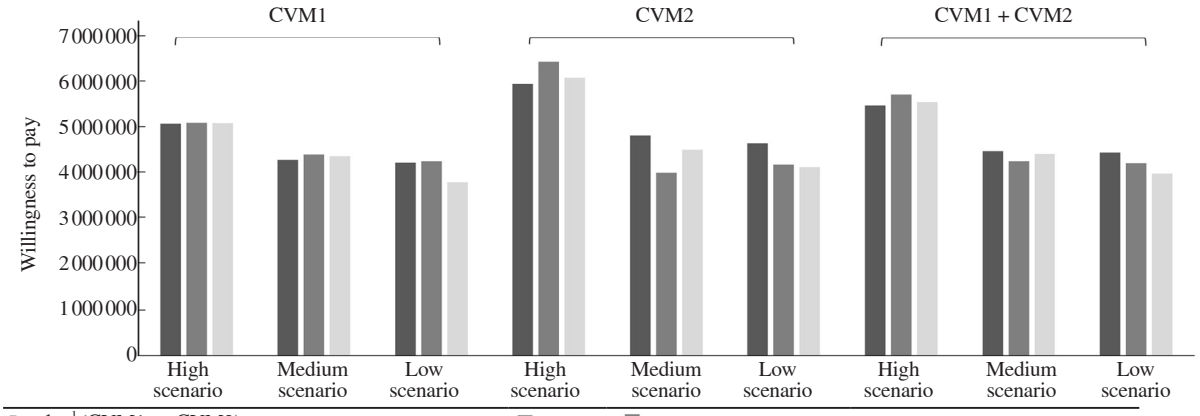
3. Results

Of the 1 675 interviews conducted, 1 655 were regarded as valid, indicating a response rate of 98.8% for at least one HIV vaccination scenario. Among the remaining respondents, 553 (33.4%) had at least one under-18 years son/daughter. In general, the number of respondents who were willing to pay decreased as vaccine efficacy diminished (high to low scenario) and as bidding progressed (CVM1 to CVM2) (Figure 2).

Table 1. Participants' characteristics.

Characteristics	Adult (*n*=1 102)	Parent (*n*=553)
Age, years		
Mean (SD)	32.3 (11.4)	32.0 (10.3)
Min-Max	18-69	18-68
Sex		
Male	535 (48.5)	273 (49.4)
Female	567 (51.5)	280 (50.6)
Sexual orientation		
Heterosexual	870 (78.9)	448 (81.0)
LGBT	232 (21.1)	105 (19.0)
Residency		
Urban	904 (82.0)	443 (80.1)
Rural	198 (18.0)	110 (19.9)
Education level		
High school	363 (32.9)	168 (30.4)
University	739 (67.1)	385 (69.6)
Occupation		
Blue collar	163 (14.8)	77 (13.9)
White collar	541 (49.1)	288 (52.1)
Students/Housewife/Retired/ Unemployed	398 (36.1)	188 (34.0)
Marital status		
Single/Widowed/Divorced	636 (57.7)	288 (52.1)
Marriage/Co-habitat	466 (42.3)	265 (47.9)
Religion		
Religious	791 (71.8)	383 (69.3)
Irreligious	311 (28.2)	170 (30.7)
Monthly income (million VND)		
< 4.5	375 (34.0)	187 (33.8)
4.5-<10.5	348 (31.6)	185 (33.5)
≥ 10.5	379 (34.4)	181 (32.7)
Financial vulnerability		
Low	145 (13.2)	89 (16.1)
Medium	627 (56.9)	290 (52.4)
High	330 (29.9)	174 (31.5)
Self-evaluated risk		
No risk	812 (73.7)	415 (75.0)
Risk	290 (26.3)	138 (25.0)

Data were expressed as *n* (%) unless otherwise specified. Adult: those who do not have any child; Parent: those who had at least one under-18 years son/daughter; 23 700 VND = 1 US dollar (Source: Vietnamese Ministry of Finance-exchange rate for foreign currencies in December 2022). LGBT: lesbian, gay, bisexual, and transgender; SD: standard deviation.



P-value[1] (CVM1 *vs.* CVM2)	Adult	Parent (self-vaccinated)	Parent (children-vaccinated)
High scenario	**0.001**	0.06	0.13
Medium scenario	**0.001**	0.75	0.88
Low scenario	**0.008**	0.74	0.43
P-value[2] (high *vs* medium *vs* low scenario, CVM1 + CVM2)	**0.001**	**0.001**	**0.001**

Figure 3. Mean willingness to pay for HIV vaccines across three scenarios (high, medium, and low efficacy) and two bidding games (CVM1 and CVM2).

Table 2. Linear regression of WTP for adult vaccination, parental self-vaccination, and child vaccination (overall model).

Variables	Adult vaccination				Parent self-vaccination				Vaccination for children			
	B	SE	Beta	*P*	B	SE	Beta	*P*	B	SE	Beta	*P*
Constant	-254 524.804	835 273.138		0.761	-507 615.267	1 498 463.486		0.735	1 929 540.300	1 221 202.639		0.114
Sex	-392 084.586	159 734.426	-0.051	0.014	-436 774.930	290 450.208	-0.044	0.133	-594 052.885	236 394.870	-0.073	0.012
Sexual Orientation	477 801.255	203 180.923	0.050	0.019	196 290.724	377 608.019	0.015	0.603	173 743.241	307 005.834	0.016	0.572
Residency	-109 961.465	204 344.479	-0.011	0.591	-373 278.154	360 850.365	-0.031	0.301	-615 411.428	294 503.619	-0.063	0.037
Education level	760 636.913	188 813.519	0.093	0.000	729 651.607	352 736.217	0.068	0.039	765 352.203	287 796.073	0.087	0.008
Marital status	-717 345.044	190 555.557	-0.092	0.000	-1 077 099.338	350 941.165	-0.109	0.002	-995 646.014	285 868.427	-0.122	0.001
Occupation	738 867.973	149 444.936	0.131	0.000	1 466 626.347	273 172.796	0.201	0.000	971 983.690	222 695.416	0.161	0.000
Religion	463 607.731	174 496.509	0.059	0.008	243 489.052	308 793.767	0.024	0.431	-9 038.527	251 117.450	-0.001	0.971
Monthly income	641 538.693	121 392.398	0.142	0.000	790 670.727	226 937.951	0.134	0.001	826 172.171	185 099.835	0.170	0.000
Financial vulnerability	637 918.866	124 106.208	0.112	0.000	433 456.114	227 296.863	0.060	0.057	455 591.775	185 165.266	0.077	0.014
Self-evaluated risk	128 816.634	186 377.625	0.015	0.490	465 766.275	349 018.638	0.039	0.182	-192 820.362	284 754.373	-0.020	0.498
Adjusted R^2	0.076				0.079				0.096			

CVM: contingent valuation method; WTP: willingness to pay, SE: standard error. Table 2 presents the overall results, which are aggregated from all three scenarios and both games (CVM1 and CVM2).

Half of the respondents were male, and approximately 20% of them identified as lesbian/gay/bisexual/transgender (LGBT) (Table 1). The average age of the participants was (32.33±11.41) years for adults and (31.99±10.34) years for parents. Most of them lived in urban areas (81.3%, 1 347/1 655) and acquired higher education degrees (67.9%, 1 124/1 655). Single and religious individuals accounted for about 55.8% and 70.9% of the sample, respectively. More than half of the respondents evaluated themselves as having moderate financial vulnerability, and only about one-fourth of them assumed that they had a potential risk of HIV acquisition (*P*=0.001).

Overall, the WTP of adults for the HIV vaccine is (4 961 264±3 793 652) VND. The WTP of parents is (4 947 799±4 930 721) VND for self-vaccination and (4 865 399±4 064 567) VND for vaccinating their children. The mean WTP of the respondents is presented in Figure 3. The lowest WTP was for the low-efficacy vaccine in CVM1, provided by parents with respect to child vaccination (about 3.8 million VND). The highest WTP was for the high-efficacy vaccine in CVM2, as indicated by parents with regard to self-vaccination (around 6.4 million VND). In general, the average WTP value decreased as vaccine efficacy diminished (from high to low scenario) and as bidding progressed (from CVM2 to CVM1). A significant difference in WTP value was found between CVM1 and CVM2 in the adult group (*P*=0.001) but not in the parent group. When the data from the two games were combined, a significant difference was found among the three scenarios (*P*=0.001).

On the grounds of all three scenarios and combined games, education level, marital status, occupation, and monthly income were the factors associated with the general WTP for adult vaccination, parental self-vaccination, and vaccination for children (Table 2). Monthly income was the most significant determinant of WTP for adult vaccination and vaccination for children, and occupation was the most significant with regard to parental self-vaccination. Marital status was negatively associated with WTP values.

Because the WTP values for adult vaccination, parental self-vaccination, and child vaccination in the high, medium, and low scenarios significantly differed, linear regression models that combined the two bidding games were established (Table 3). Marital

Table 3. Linear regression of WTP for adult vaccination, parental self-vaccination, and child vaccination (models by three scenarios).

Variables	High scenario				Medium scenario				Low scenario			
	B	SE	Beta	*P*	B	SE	Beta	*P*	B	SE	Beta	*P*
Adult vaccination												
Constant	-1 890 088.131	1 317 955.433		0.152	1 397 705.215	1 432 953.017		0.330	-834 762.370	1482050.267		0.574
Sex	-167 646.981	248 319.724	-0.020	0.500	-146 312.250	285 264.424	-0.021	0.608	-931 004.965	277485.955	-0.145	0.001
Sexual orientation	684 917.929	307 036.335	0.067	0.026	-195 790.152	388 285.989	-0.020	0.614	592 119.509	342530.888	0.075	0.084
Residency	-112 404.233	331 527.150	-0.010	0.735	-507 514.504	380 569.239	-0.054	0.183	587 174.447	318657.890	0.080	0.066
Education level	873 813.701	296 470.995	0.099	0.003	502 298.699	333 470.358	0.067	0.132	906 298.686	324471.869	0.129	0.005
Marital status	-657 706.661	288 959.094	-0.078	0.023	-740 261.502	321 933.467	-0.105	0.022	-1 154 063.282	383588.263	-0.155	0.003
Occupation	886 050.013	229 757.184	0.146	0.000	669 779.718	255 003.333	0.125	0.009	688 176.895	283273.379	0.144	0.015
Religion	599 930.115	283 453.764	0.065	0.035	520 009.011	313 519.319	0.069	0.098	746 653.691	288062.828	0.118	0.010
Monthly income	703 854.249	188 727.788	0.141	0.000	517 205.693	205 759.929	0.122	0.012	831 264.986	229085.812	0.222	0.000
Financial vulnerability	914 556.343	200 478.514	0.140	0.000	380 070.982	219 766.891	0.072	0.084	513 466.042	197520.561	0.117	0.010
Self-evaluated risk	225 463.665	282 626.847	0.024	0.425	227 547.116	320 041.512	0.029	0.477	-143 701.487	362382.801	-0.018	0.692
Adjusted R^2		0.090				0.051				0.112		
Parents self-vaccination												
Constant	-1 516 406.848	2 198 062.528		0.491	-122 139.915	3 018 657.642		0.968	-485 683.714	2 534 964.763		0.848
Sex	-723 419.036	413 464.241	-0.074	0.081	458 294.876	593 203.534	0.042	0.440	-500 466.704	505 973.608	-0.060	0.324
Sexual orientation	508 026.795	526 499.404	0.041	0.335	-393 980.068	810 507.483	-0.027	0.627	-286 174.374	650 033.850	-0.027	0.660
Residency	-15 896.939	547 731.460	-0.001	0.977	-1 268 567.238	752 183.994	-0.097	0.093	513 139.559	565 079.836	0.057	0.365
Education level	955 850.809	508 697.493	0.090	0.061	303 178.672	727 296.858	0.026	0.677	525 628.167	598 382.184	0.058	0.381
Marital status	-901 509.372	488 496.865	-0.092	0.066	-907 377.336	689 735.935	-0.085	0.189	-2 652 972.541	679 064.284	-0.305	0.000
Occupation	1 278 000.946	390 462.754	0.173	0.001	1 802 178.909	547 610.865	0.227	0.001	1 330 519.392	480 710.108	0.220	0.006
Religion	556 427.396	453 736.801	0.053	0.221	304 164.855	637 231.787	0.027	0.633	363 458.305	525 163.143	0.044	0.490
Monthly income	775 623.306	321 927.226	0.130	0.016	952 480.817	475 145.356	0.146	0.046	955 281.202	395 211.496	0.202	0.016
Financial vulnerability	995 935.861	323 916.496	0.137	0.002	-61 289.234	480 586.142	-0.008	0.899	237 377.489	384 229.821	0.041	0.537
Self-evaluated risk	184 212.019	477 255.446	0.016	0.700	263 670.725	685 854.584	0.021	0.701	1 603 852.728	734 992.330	0.133	0.030
Adjusted R^2		0.091				0.071				0.118		
Vaccination for children												
Constant	947 420.086	1976 513.957		0.632	2 042 447.062	2 085 309.373		0.328	1615 192.856	2 045 783.071		0.431
Sex	-307 783.448	371 602.568	-0.035	0.408	-386 540.086	407 611.410	-0.050	0.344	-1 092 081.840	408 333.976	-0.162	0.008
Sexual orientation	239 745.619	472 125.904	0.021	0.612	-27 876.131	557 557.056	-0.003	0.960	120 041.785	524 594.372	0.014	0.819
Residency	-767 642.370	492 567.197	-0.070	0.120	-1 051 234.770	521 860.968	-0.111	0.045	720 768.434	456 034.253	0.099	0.115
Education level	594 964.445	457 449.527	0.062	0.194	943 234.477	504 176.705	0.114	0.062	765 574.665	482 910.121	0.104	0.114
Marital status	-805 557.203	439 195.402	-0.092	0.067	-780 902.913	475 205.692	-0.102	0.101	-2 352 143.831	548 022.693	-0.332	0.000
Occupation	999 723.798	350 888.720	0.151	0.005	1 015 628.708	378 926.467	0.178	0.008	830 015.210	387 945.669	0.169	0.033
Religion	629 382.356	407 791.436	0.066	0.123	-293 923.658	438 056.747	-0.036	0.503	9 820.755	423 820.434	0.001	0.982
Monthly income	954 133.138	289 504.436	0.177	0.001	704 031.646	329 097.618	0.151	0.033	852 386.435	318 946.046	0.222	0.008
Financial vulnerability	631 320.358	290 902.818	0.097	0.030	509 224.784	332 328.193	0.092	0.126	398 100.344	310 083.547	0.084	0.200
Self-evaluated risk	-315 886.702	429 060.182	-0.031	0.462	-434 919.110	475 454.971	-0.048	0.361	401 043.974	593 158.093	0.041	0.500
Adjusted R^2		0.086				0.128				0.131		

CVM: Contingent valuation method, WTP: Willingness to pay, SE: Standard error. Table 3 presents the disaggregated results by each scenario, while the data are combined from both games (CVM1 and CVM2).

status, monthly income, and occupation were associated with adult vaccination (P<0.05), but only monthly income and occupation were linked with the WTP for parental and child vaccinations (P<0.05).

4. Discussion

Our findings showed considerable WTP for a preventive HIV/AIDS vaccine for self-vaccination and child vaccination. This WTP was sensitive to vaccine attributes (efficacy, duration of protection, and number of doses per scheme) but non-sensitive to the value of the first bid. Our findings have significant implications for healthcare financing in Vietnam, where HIV prevalence remains high. Policymakers should consider the socio-economic factors influencing WTP when designing funding strategies for HIV vaccine programs.

Compared to studies in Uganda and Thailand, our findings indicate a higher WTP for HIV vaccines in Vietnam, possibly due to different socio-economic conditions and perceptions of HIV risk[4,26]. Additionally, among the participants who viewed their risk of infection as high, the WTP for an AIDS vaccine was noticeably larger. These results suggest that individuals who are more likely to acquire HIV infection would be more eager to seek out an AIDS vaccine when it becomes available—a sort of self-targeting among those who need it the most. These are the people who stand to substantially gain from vaccination on a personal level, and it is advantageous to the rest of society, as well, if such individuals are engaging in risky conduct.

Given that both the cost of a vaccine and income level affect the WTP for an AIDS vaccine, high costs and limited financial capacity may prevent people who are most at risk from acquiring vaccination. In this situation, the government will play an essential part in ensuring that a vaccine is available to both high-risk, financially disadvantaged individuals and those who can afford it. This initiative

will achieve both equity and efficiency goals and exert a remarkable positive impact on an entire population.

The overall WTP value and the difference in such values between high- and low-efficacy vaccines may have been different in a country where the AIDS epidemic is in its infancy, AIDS awareness is low, the population knows few people with AIDS, and stigma against those infected with HIV or who exhibit high-risk behaviors may be greater. The observed WTP in this study was influenced by the public's beliefs about the repercussions of HIV infection, which differ depending on the availability of therapy. The WTP for an AIDS vaccine may decrease to the extent that improved access to therapy lengthens AIDS patients' lives and improves their health, reducing unfavorable effects.

The willingness to pay for an HIV vaccine and the factors contributing to COVID-19 vaccine hesitancy are interconnected topics that offer valuable insights into public health strategies. Understanding the economic and psychological determinants of vaccine acceptance can inform the design of effective vaccination programs. Research indicates that willingness to pay for an HIV vaccine is significantly influenced by perceived efficacy, cost, and convenience. Individuals are more inclined to invest in a vaccine that promises higher efficacy and longer protection, reflecting a prioritization of health benefits over financial constraints. This willingness is particularly relevant in low- and middle-income countries, where cost remains a substantial barrier. Conversely, COVID-19 vaccine hesitancy is influenced by factors such as misinformation, mistrust in government and pharmaceutical companies, fear of side effects, and perceived low risk of the disease. Addressing these concerns requires comprehensive educational campaigns, transparent communication, and community engagement to build trust and counteract misinformation. By integrating these insights, public health authorities can enhance vaccination strategies for both HIV and COVID-19. For HIV vaccines, ensuring affordability and highlighting efficacy can increase willingness to pay. For COVID-19, addressing hesitancy through targeted interventions can improve acceptance. Combining these approaches can lead to higher vaccination rates, crucial for controlling and eventually eradicating both diseases[27-37].

This study, as an application of CVM, considered some systematic limitations. Compliance bias is an important phenomenon to take into account. This type of bias occurs when a subject decides to exaggerate their WTP values to win over an interviewer. This research minimized this issue by giving the participants a spending cap. Finally, the WTP assertions found in this work might not correspond to actual values given the conditions implemented in the scenarios. To ascertain the efficacy of vaccines and their length of protection, the pre-assigned scenarios were created on the basis of data taken from the most recent HIV vaccine clinical trials[38,39]. Low efficacy also affects the results of contingent valuation surveys[40]. The introduction of choice model methodologies in the examination of difficulties associated with intrahousehold vaccine demand represents an alternative direction for future research. Choice modeling experiments are more effective in this regard, because they obtain far more value information from each respondent in a survey than is typically collected in contingent valuation investigations. Choice models have also been used to estimate respondent demand for typhoid and cholera vaccines, but they have not yet been applied to the evaluation of WTP for HIV vaccinations or demand by husbands and wives residing in the same home[41,42]. This study only included participants who expressed a willingness to pay for at least one scenario of HIV vaccine efficacy. As a result, individuals who were unwilling to pay under all presented scenarios were excluded. This exclusion may have introduced selection bias and potentially led to an overestimation of overall demand or average WTP. Furthermore, our contingent valuation design did not explicitly collect zero WTP values, as the research objective focused on understanding the positive monetary value that individuals assign to the vaccine.

Despite the limitations discussed above, the authors believe the study is important because it is the first multicenter survey of its kind for HIV vaccination in Southern Vietnam and because it determined the WTP under various HIV vaccination scenarios across different demographic groups. The high WTP medians compared with those in other studies serve as an essential benchmark for pricing to be adopted in Vietnam. When creating future price strategies and healthcare insurance rules, we advise the Vietnamese government, vaccine manufacturers, and business owners to examine our findings. Policymakers should consider implementing subsidy programs and public health campaigns to increase HIV vaccine accessibility. Our findings suggest that targeting educational and income-related interventions could enhance vaccine uptake.

To conclude, in this study, high WTP rates and numerous individuals willing to pay for HIV vaccines were found, favoring the introduction of such vaccines in Vietnam. Beyond policy changes, our findings highlight the importance of community engagement in HIV prevention. Future research should explore longitudinal changes in WTP as more information about HIV vaccines becomes available. Future research should include longitudinal studies to track changes in WTP over time. Additionally, investigating the impact of new HIV vaccine information on public perception and economic factors is crucial.

Conflict of interest statement

The authors declare that they have no competing interests.

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Availability of data and materials

The corresponding author can provide the datasets used in this study on reasonable request.

Authors' contributions

TNTH and LA conceived and designed the study. TNTH collected the data. NTTH and SP analyzed the data and contributed to the interpretation of the results. SS, LA and RRM provided methodological support, assisted in statistical analysis, and reviewed the manuscript. All authors contributed to the final version of the manuscript. LA supervised the project and critically revised the manuscript.

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