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Willingness-To-Pay for Vaccines in Low- and Middle-Income Countries: A Systematic Review

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Abstract

Objective: Willingness-To-Pay (WTP) values, which provide monetary measures of community preferences for vaccines, could help policy makers set priorities for the use of health resources in low- and middle-income countries. We conducted a systematic review of published studies of WTP for vaccines.

Methods: A systematic search of MEDLINE and SCOPUS through December 2013 and selection process, following PRISMA guidelines, yielded 35 English-language studies (21 studies in low- and middle-income countries and 14 in high-income countries) that evaluated WTP for one or more vaccines, either existing vaccines or hypothetical vaccines for real diseases; studies of hypothetical vaccines for hypothetical diseases were excluded. All WTP values extracted were converted to 2012 international dollars (I$) for comparability.

Results: Although no time limit was placed on the search, all the studies were published after 2001. Reporting of methods was incomplete in many studies, with details on question wording, sampling method, response rate, and sometimes even currency year, lacking. Stated preference methods based on surveys were used for 34 studies; only one used a revealed preference method. Studies were available for 14 vaccines, but 22 studies focused on only five of those – vaccines for cholera, typhoid fever, HIV/AIDS, malaria, and influenza. WTP varied widely, from less than I$100 per capita for cholera and typhoid vaccines to more than I$1000 for a vaccine against HIV/AIDS.

Conclusion: WTP varies widely across diseases in low- and middle-income countries, with consumers willing to pay substantially more for vaccines against chronic diseases with high mortality and morbidity, such as HIV/AIDS. More complete and standardized reporting would make these estimates more informative for policy makers in these countries as they set priorities for health in the face of limited resources.

ABBREVIATIONS

WTP: Willingness-To-Pay; WTA: Willingness-To-Accept; CV: Contingent Valuation; DCE: Discrete Choice Experiments; MDGs: Millennium Development Goals

INTRODUCTION

Vaccines are an important tool for achieving the Millennium Development Goals (MDGs), a set of priorities for the world's sustainable development set by the United Nations [1]. Reaching MDG 4 in particular, "to reduce child mortality," requires accelerating the introduction of new vaccines and expanding the use of underused vaccines in the developing world, where the potential for reducing child mortality is greatest. Immunization funding has risen in recent years due to global efforts by international organizations, but new vaccines are expensive and the funding gaps to scale up coverage of new vaccines are rising as well [2]. Partly in consequence, since 2008 the GAVI Alliance,

a public-private partnership founded to accelerate introduction of new vaccines in the poorest countries, has requested that GAVI-eligible countries share the cost of vaccine purchase [3]. Accordingly, low-income countries need to prioritize new vaccine introduction, while taking into account needs for other health interventions in order to balance the potential benefits of new vaccines with financial challenges. In middle-income countries as well, policy makers face constrained resources, with little financial support from international agencies for immunization programs, and need to consider prioritization of immunizations [4].

In this context, there is increasing interest in determining the value of vaccines in low- and middle-income countries in a more comprehensive way [5-8] to help policy makers at both global and local levels establish priorities among the health interventions competing for limited resources. Willingness-To-Pay (WTP) is a monetary measure of consumers' valuation of a good or program [9-11]. It represents the amount of money a person would be willing to pay to purchase the good or to secure the program's benefits. WTP has its foundation in welfare economics and is often used in cost-benefit analysis, a type of economic evaluation, to express health benefits in monetary units [9-11]. WTP has also been used as a tool to estimate demand for public goods or services, one of the criteria that may influence priority-setting for health interventions [12].

The primary approaches to eliciting WTP are revealed preference and stated preference. Revealed preference infers consumers' valuations from the choices they make in markets when they decide to purchase a good [10,13]. Stated preference elicits consumers' values from their responses to questions about hypothetical choices rather than from observed behavior. One of the techniques for eliciting preferences using the stated preference approach, Contingent Valuation (CV), asks individuals directly through a survey the amount they are willing to pay to have the benefits of a good (WTP) or the amount they would be willing to accept in compensation for giving it up (Willingness-To-Accept [WTA]) [14,15]. CV methods can be used even in situations where there are no appropriate markets to provide information about consumers' valuations.

WTP values could be used to help set priorities by determining community preferences for vaccines. Despite the increasing number of economic evaluation studies of vaccines, however, little is known about WTP for vaccines. While there have been systematic reviews that examined WTP for other health care interventions [9,16-18], to our knowledge, only two studies have focused on vaccines [8,19]. Ozawa and colleagues identified 13 WTP studies (published in 2000-2010) for vaccines in low- and middle-income countries; they reported the WTP estimates along with selected study characteristics as part of a systematic review on the cost-effectiveness and economic benefits of vaccines [8]. Yeung and colleagues focused on reviewing the usefulness of CV for assessing the demand for childhood immunization in developing countries, but not on the actual magnitude of WTP for vaccines or how WTP values compare across different types of vaccines or different countries [19].

This paper reports a systematic review of studies that measured WTP for vaccines. It focuses on the purpose for which the values were elicited, the methods used to elicit them, and the magnitudes of the WTP values. While our primary interest is in reviewing WTP for vaccines in low- and middle-income countries, our review also includes WTP studies for vaccines in high-income countries for the purpose of comparison.

METHODS

We followed PRISMA guidelines [20] in identifying published studies on WTP for vaccines or immunization programs. We used the following key words in our systematic search of MEDLINE and SCOPUS: 'stated preference', 'revealed preference', 'contingent valuation', 'choice experiment', 'discrete choice experiment', 'conjoint analysis', 'willingness-to-pay', and 'willingness-to-accept', combined with varied forms of either 'vaccine' or 'immunization'. We supplemented the search of electronic databases by manually searching the reference lists of the retrieved studies. We restricted the language to English but did not impose any restrictions on the time period or geographical areas.

Two authors independently screened the title and abstract of the retrieved articles to remove duplicates and exclude non-relevant articles. After the screening process, the two authors reviewed the full text of each of the studies included for eligibility assessment. During the review, we included studies that valued and reported benefits of a vaccine in monetary terms (i.e., WTP values for a particular vaccine) regardless of preference elicitation method. We considered vaccines currently in use and hypothetical (or under development) vaccines against real diseases, but did not include studies that measured WTP for a hypothetical vaccine against a hypothetical disease. Studies that measured WTP for only hypothetical health states or vaccine adverse events (without reporting WTP values for vaccine per se) were identified and excluded. For multiple studies based on the same primary data, only studies that reported the originally estimated WTP values were included. Figure 1 diagrams the study selection process.

We then extracted data on study aim, intervention being valued (vaccine type and target population), WTP elicitation methods (survey method, respondents and sample size, and elicitation format), and estimated WTP values. Through the entire processes, any discrepancies in the review results or independently extracted data were resolved through discussion.

For comparability, all reported WTP values were converted to 2012 international dollars (I$) using GDP deflators and purchasing power parity conversion factors [21]. When the original currency year was not reported in a study, we used the year in which the study's survey was conducted. When neither the currency year nor the survey year was available, we followed the convention of assuming the currency year was the year before the publication year.

It is not a straightforward task to identify the elicitation methods used in different studies consistently, because terminology has evolved along with valuation methods and different disciplines use different terms [15,22-24]. Accordingly, in reporting the methodological approaches used for eliciting WTP values, we usually used the terms reported in the study itself to describe its methods. For studies reporting CV as their

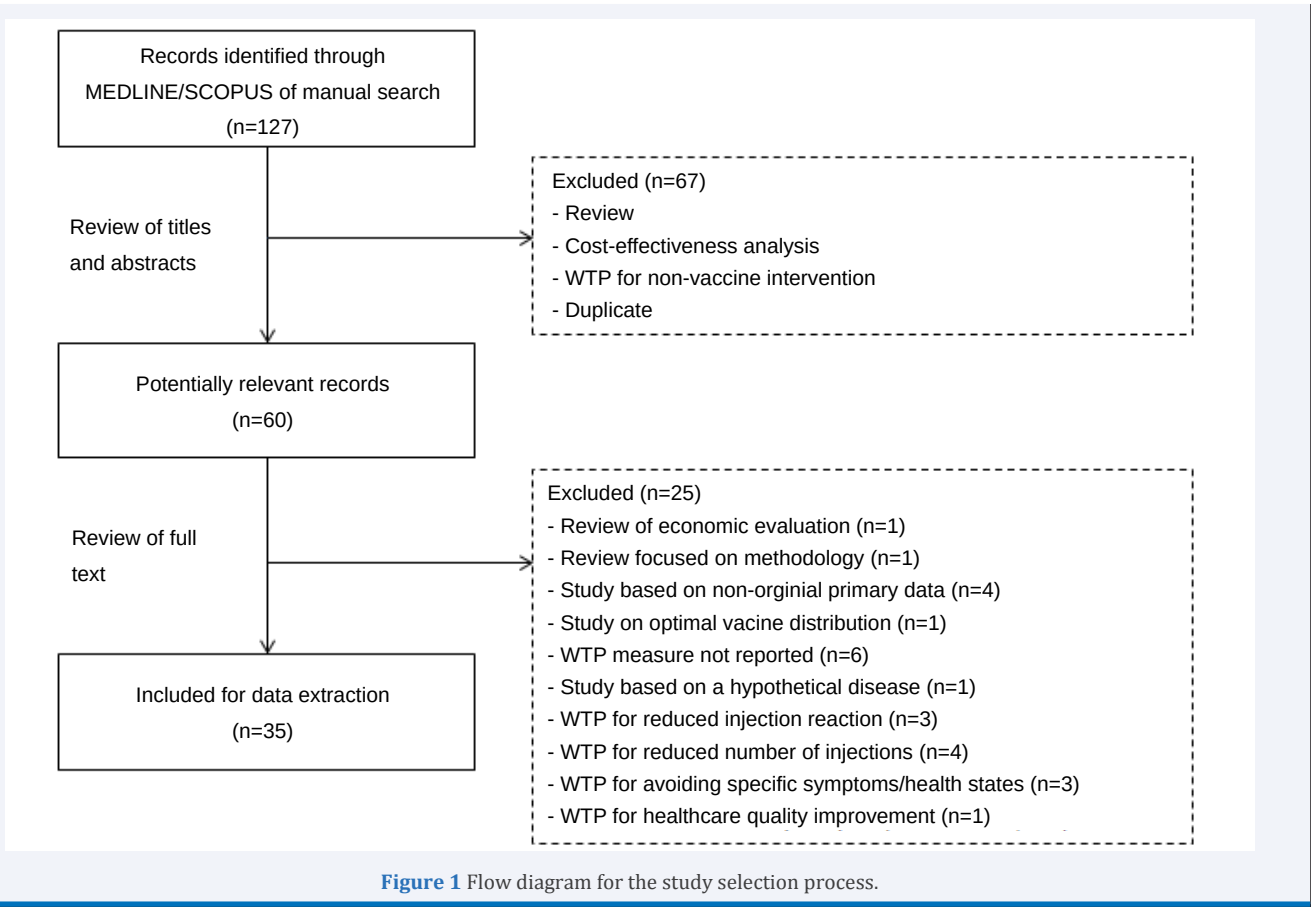


Figure 1 Flow diagram for the study selection process.

elicitation method, we recorded the method using the term CV and supplemented it with information on specific elicitation formats when provided (e.g., open-ended, payment card, bidding game, and dichotomous choice; based on our interpretations of the described details). For studies reporting their methods using terms other than CV–for example, terms associated with 'discrete choice experiments' (also known as choice experiments), which ask individuals to choose one alternative from two or more choice sets reflecting several characteristics or attributes of non-marketed goods or services [4]–we used the terms used in the study.

RESULTS

Characteristics of the WTP studies identified

A total of 127 articles were identified through the literature search. The initial review, based on titles and abstracts, excluded 67 articles as irrelevant. A full-text review of the remaining 60 articles further excluded 25 studies that did not report WTP values for particular vaccines, leaving 35 studies for data extraction (Figure 1). All of the WTP studies included in the final set were published after 2001, with 13 published in the last five years (2009-2013), reflecting the recent interest in valuing preferences for vaccines in the form of WTP. Twenty-one studies were conducted in low- and middle-income countries, 14 in high-income countries.

Table 1 summarizes some characteristics of the 35 studies, separately for low-/middle-income countries and high-income countries, using the World Bank's income categories. Fourteen different, vaccines were valued. The studies concentrated, however, on a relatively small number of vaccines, with 22 studies (63%) conducted for five vaccines: cholera (6 studies [25-30]), typhoid fever (4 studies [29-32]), HIV/AIDS (4 studies [33-36]), malaria (4 studies [37-40]), and influenza (4 studies [41-44]). The other vaccines for which WTP values were estimated included pneumococcal conjugate [45-47], rotavirus [48], Human Papillomavirus (HPV) [49-51], shigellosis [31], haemophilus influenza B (Hib) [52], varicella [53], SARS [54,55], dengue fever [56], and anti-allergy [57].

The majorities (83%) of the studies were applied studies designed to estimate preferences or forecast demand for specific vaccines, and the rest were methodological. Only one study [26] elicited WTP using a revealed reference approach, the travel cost method. The remaining studies used stated preference approaches; among those, approximately 82% claimed CV as their main elicitation method. One study [43] did not report the elicitation method clearly (Table 1).

A majority (69%) of stated preference surveys were conducted via in-person interview. The other types of survey administration included by phone (9%) or by mail (3%). The rest of the studies did not report the type of survey method. We categorized the types of respondents into four groups, slightly modifying the categories used to classify WTP studies in health care in general [16]: 1) currently diseased; 2) currently non-diseased, at future risk (general or high-risk population); 3)

Table 1: Summary of the characteristics of the WTP studies in vaccines.

	Number of studies, Sources	
	Low- and middle-income countries (N=21)	**High-income countries (N=14)**
Study type		
Methodological	3 [29,38,45]	3 [44,54,61]
Applied	18 [25-28,30-37, 39,40,49,52,56,60]	11 [41-43,46-48,50,51,53,55,57]
Vaccine type		
Allergy	0	1 [57]
Cholera	6 [25-30]	0
Dengue fever	2 [56,60]	0
Haemophilus influenzae B (Hib)	1 [52]	0
HIV/AIDS	4 [33-36]	0
Human papillomavirus (HPV)	1 [49]	2 [50,51]
Influenza	0	4 [41-44]
Malaria	4 [37-40]	0
Pneumococcal	1 [45]	3 [46,47,61]
Rotavirus	0	1 [48]
SARS (Severe Acute Respiratory Syndrome)	0	2 [54,55]
Shigellosis	1 [31]	0
Typhoid fever /Enteric fever	4 [29-32]	0
Varicella (Chickenpox)	0	1 [53]
Elicitation method		
Revealed preference	1 [26]	0
Stated preference		
o Contingent valuation (CV)	17 [25,27,28,30-32,34-40,45,52,56,60]	11 [41,42,44,46-48,51,53-55,57]
o Other methods (e.g., discrete choice experiments)	3 [33,41,49]	2 [50,61]
o No report of detailed methods	0	1 [43]
Respondent type		
Currently diseased	0	1 [57]
Currently non-diseased, at future risk		
o General population	9 [25-27,31,34-37, 40]	4 [41,44,54,55]
o High-risk population	1 [33]	1 [43]
Currently non-diseased, at no future risk		
o Parents/Household representatives	4 [45,49,52,60]	6 [42,48,50,51,53, 61]
o Healthcare providers	0	1 [46]
Combinations of the preceding categories		
o Currently non-diseased, at no future risk (parents/household representatives) plus Currently non-diseased, at future risk (general population)	7 [28-30,32,38,39, 56]	1 [47]

Abbreviations: Hib: Haemophilus Influenzae B; HPV: Human Papillomavirus; SARS: Severe Acute Respiratory Syndrome; CV: Contingent Valuation

currently non-diseased, at no future risk (parents/household representatives or healthcare providers); and 4) combinations of any of the previous categories. The numbers of studies for each category were, 1 (3%), 15 (43%), 11 (31%), and 8 (23%), respectively.

WTP measures for vaccines in low- and middle-income countries

Table 2 presents more detailed information for the 21 studies in low- and middle-income countries: country of data collection, study aim, target population of vaccination, elicitation method, respondents and sample size; and WTP values reported. Within a given study, WTP values varied depending on vaccination scenarios (i.e., vaccine effectiveness, duration of protection, adverse event rate, etc.), unit for valuation (per capita or per household) and respondent type (husband or wife). For studies reporting both mean and median WTP, the medians were often lower than the means, reflecting the right-skewed distribution typical of WTP values. Among studies conducted for the same vaccine, the magnitude of the WTP values was fairly similar across studies and countries, but, for HIV/AIDS vaccine, the values widely vary across countries.

Figure 2 shows more clearly the relative magnitude of the WTP values across different vaccines in low- and middle-income countries. The graph presents per capita WTP values for each vaccine and each study. Studies reporting per household values only were excluded from this figure. For studies reporting multiple WTP per capita values for many vaccination scenarios,

Table 2: Willingness-To-Pay (WTP) elicitation methods and estimated WTP values for vaccines in low- and middle-income countries (2012 I$).

Study	Country	Study aim	Vaccine	Target population for vaccination	Methods for measuring WTP	Respondents (N=sample size)	Estimated mean or median WTP
Islam et al., [25]	Bangladesh	To measure household WTP for cholera vaccine	Cholera vaccine	Children and adults	CV (SBDC)	Mothers (50%) and fathers (50%) of households with children less than 19 years (N=582)	Mean WTP for vaccine (2 doses, 50% effective, 3 year protection): I$5.5 per capita
Jeuland et al., [26]	Mozambique	To estimate household's private demand for cholera vaccine	Cholera vaccine	Children and adults	Revealed preference (Travel Cost Method)	Heads of households with one or more children less than 19 years (N=2486)	Mean WTP for cholera vaccine (2 doses): I$2.1 per capita, I$12.5 per household
Kim et al., [27]	Vietnam	To measure private demand for oral cholera vaccines of different levels of effectiveness and different durations	Cholera vaccine	Children and adults	CV (SBDC with follow-up)	Heads of households (or spouse) with children less than 18 years (N=800)	Median WTP for vaccine (50% effective, 3 year protection): I$22.4 per capita, I$179.2 per household
Lucas et al., [28]	Mozambique (Beira)	To measure household demand for cholera vaccine	Cholera vaccine	Children and adults	CV (using both single-bounded 5 discrete choices and a sliding scale exercise)	Heads of households (or spouse) with at least one child less than 18 years (N=991)	Mean WTP for vaccine (2 doses): I$20.4 per household; I$3.4 per capita
Cook, [29]	Vietnam	To examine the effect of giving respondents time to think about their stated choices (SC) in a survey on cholera and typhoid vaccine preferences	Cholera and Typhoid vaccine	Children and adults	Stated Choices (SC) approach	Household heads or their spouse (N=400, 200 no time to think (NTTT) sample and 200 time to think (TTT) sample)	Median WTP (assumed to be per capita based on survey questions) for a cholera vaccine assuming efficacy of 50%;70%;99%: a) with NTTT: 3 year protection=[I$8.6; I$26.5; I$59.6], 20 year protection=[I$10.2; I$29.7; I$64.5]; b) with TTT: 3 year protection=[I$-0.4; I$11.9; I$26.4], 20 year protection=[I$1.8; I$15.7; I$31.5]. Median WTP (assumed to be per capita based on survey questions) for a typhoid vaccine assuming efficacy of 50%;70%;99% : a) with NTTT: 3 year protection=[I$1.7; I$19.5; I$50.4], 20 year protection=[I$3.1; I$20.3; I$53.0]; b) with TTT: 3 year protection=[I$-2.1; I$7.8; I$20.8], 20 year protection=[I$-0.9; I$11.8; I$25.5].
Whittington et al., [30]	India (Kolkata)	To measure private demand for cholera and typhoid vaccines	Cholera and Typhoid vaccine	Children and adults	CV (SBDC and sliding scale payment card exercise)	Adults aged 64 years or less, with one or more children aged 17 years or less (N=835)	Median WTP for a household with five members 1) In middle-income neighborhood: I$84.5 for a typhoid vaccine and I$99.2 for a cholera vaccine; 2) In a low-income slum: I$51.5 for typhoid vaccine and I$55.1 for a cholera vaccine

Chen et al., [31]	China	To understand factors influencing acceptance of vaccines controlling dysentery and enteric (typhoid) fever	Unspecified shigellosis vaccine and typhoid fever Vi vaccine	General population of two rural counties in China	CV (SBDC)	Shigellosis: household heads or their spouses in a rural country (N=501); Typhoid: household heads or their spouses in a high-risk rural country (N=624)	Mean WTP (assumed to be per capita based on survey questions): I$6.1 for a dysentery vaccine; I$6.6 for an enteric (typhoid) fever vaccine
Do et al., [32]	Vietnam	To identify household demand for typhoid fever vaccine	Typhoid fever vaccine	Children and adults	CV (SBDC)	Representatives of households with children aged 0-18 years (N=1065)	Mean WTP for a single typhoid fever vaccine: I$ 10.9-22.6 per individual; I$99.1-127.4 per household
Muangchana and Bishai, [52]	Thailand	To determine the private demand for Hib vaccination in Thailand using discrete choice questions	Hib vaccination (3 doses of the vaccine)	Children	CV (assumed SBDC)	Pregnant women with at least one child (who attended ANC clinics at selected hospitals in 4 geographic regions of the country) (N=662)	Median WTP for Hib vaccine per child per vaccination: I$258.7
Heinzen and Bridges, [45]	Bangladesh	To compare 4 CV methods and test bias and validity	Pneumococcal vaccine	Children under 5 years of age	CV (randomly assigned elicitation formats: (1) open-ended, (2) dichotomous choice, (3) payment card, and (4) bidding game elicitation method, which followed up with dichotomous choice)	Parents with at least one child under 5 years (N=330 households)	Mean WTP (assumed to be per capita based on survey questions) estimates varied significantly across 4 different CV methods, ranging between I$7.2 and I$55.6
Poulos et al., [49]	Vietnam (Vinh Long Province)	To measure mothers' preferences and WTP for HPV vaccines for their daughters and to measure the tradeoffs between vaccine fees and vaccine uptake	HPV vaccine	Girls aged 9 –17 years	Conjoint Analysis (choice format)	Mothers with at least one girl aged 9-17 years (N=258)	Mean WTP (assumed to be per capita based on survey questions) for 99% effective vaccine: I$772.9 (for 2 years protection); I$847.5 (for 10 years); and I$948.8 (for lifetime)
Cameron et al., [33]	Thailand	To estimate marginal WTP for attributes of HIV vaccine (in addition to mean WTP)	HIV vaccine	Men who have sex with men (MSM), male sex workers, and transgender women	Conjoint Analysis	Individuals aged 18 or over (selected across two strata - gay entertainment venues and community-based organizations providing HIV prevention services to high-risk groups) (N=324)	Mean WTP (assumed to be per capita based on survey questions): I$2,321.2 for the most advantageous vaccine (i.e., 99% efficacy, no side effects, no VISP, 10-year duration, majority have been vaccinated, delivered at a private hospital); I$972.5 for a lower cost or less optimal vaccine (e.g., 50% efficacy, minor side effects, no VISP, 10-year duration, majority have not been vaccinated, delivered at a private hospital)

Von Keyserlingk and Rhodes, 2007 [34]	South Africa (Durban)	To measure the demand for an HIV/AIDS vaccine using a payment card approach	Hypothetical HIV/AIDS vaccine	South African students	CV (payment card approach)	University students aged 16-24 years (N=197)	Among the respondents, 71.5% would want to be vaccinated at a mean WTP of I$179.3 and median of I$55.3 (assumed to be per capita based on survey questions)
Whittington et al. [35]	Thailand	To measure household demand for an HIV vaccine and to determine whether spouses in the same household would purchase the same number of vaccines for household members and have the same demand function	Hypothetical HIV/AIDS vaccine	Individuals aged 18-20 years	CV (SBDC)	Individuals aged 18-20 years (N=1218 households)	Mean WTP: Per household -I$2137.5 at 50% effectiveness, I$2351.2 at 95% effectiveness; Per capita for household members- I$770.9 at 50% effectiveness, I$848.0 at 95% effectiveness
Whittington et al., [36]	Mexico (Guadalajara)	To measure private demand for an HIV/AIDS vaccine	Hypothetical HIV/AIDS vaccine	Adults	CV (assumed payment card)	Adults aged 18-60 years (N=234)	Mean WTP: I$1691.2; Median WTP: I$798 (assumed to be per capita based on survey questions)
Hadisoemarto and Castro, [60]	Indonesia	To identify public acceptability of a future dengue vaccine	Pediatric dengue vaccine	Children	CVM (assumed bidding game)	Heads of households (parents) (N=500)	Mean WTP (assumed to be per capita based on survey questions): I$2.9
Palanca-Tan, [56]	Philippines (Metro Manila)	To estimate WTP for a single dengue fever vaccine and the household demand function	Dengue fever vaccine	Children and adults	CV (SBDC)	Heads of households (not clearly reported, assumed based on text) (N=205)	Mean WTP (assumed to be per capita based on survey questions): For 1-year efficacy vaccine, ranged from I$69.5 (non-parametric estimate) to I$82.9 (parametric estimate); For 10-year efficacy vaccine, ranged from I$142.6 (non-parametric) to I$176.0 (parametric)
Cropper et al., [37]	Ethiopia	To measure the monetary value of preventing malaria by estimating a household demand function for a hypothetical malaria vaccine and computing the value of preventing malaria as the household's maximum WTP to provide vaccines for all family members	Malaria vaccine	General population	CV (SBDC)	Household heads or their spouses (N=569)	WTP for vaccines per household (the value of preventing malaria): I$151.7 per year
Prabhu, [38]	India (Slums of Navi-Mumbai)	To review the complexity of intra-household decision making by comparing husbands' and wives' separate and joint WTP for malaria vaccines	Malaria vaccine	Children and adults	CV (SBDC)	Husbands and wives, interviewed separately and jointly (N=422 households)	Various mean/median WTP values (assumed to be per capita based on survey questions) are reported by interview type (separate interview among husbands or wives vs joint interview), vaccine effectiveness, and unit being valued (per household vs per child). For 95% vaccine effectiveness, median WTPs per household by husbands and wives were I$46.7 and I$30.5 in a separate interview, I$35.8 and I$38.4 in a joint interview, respectively. Median WTPs per son by husband and wife in a separate interview were I$9.6 and I$7.3

Sauerborn et al., [39]	Burkina Faso	To set priorities for maternal and childhood malaria vaccines by determining community preference for these vaccines	Malaria	Women and children	CV (bidding game approach)	Adults over 20 years (N=2,326 individuals from 800 households)	Mean WTP (assumed to be per capita based on survey questions): For a vaccine against maternal malaria- I$13.0; For a vaccine against childhood malaria- I$8.9
Udezi et al., [40]	Nigeria (Benin City and Warri)	To measure the demand for malaria vaccines and to identify factors that influence people's WTP	Malaria vaccines (3 hypothetical with different levels of effectiveness and protection)	Individuals aged 18 or more	CV (payment card)	Individuals aged 18years or more (N=359)	Mean WTP (assumed to be per capita based on survey questions): For Vaccine A [75% effectiveness and 3 years of protection]: I$14.7; For Vaccine B [85% effectiveness and 6 years of protection]:I$14.5; For Vaccine C [95% effectiveness and 12 years of protection]: I$11.0

Abbreviations: WTP: Willingness-To-Pay; CV: Contingent Valuation; SBDC: Single-Bounded Dichotomous; DBDC: Double-Bounded Dichotomous; DCE: Discrete Choice Experiment.

representative values are presented, taking into account comparability with other studies. The figure shows that the values of WTP for vaccines vary widely across vaccine types. For example, the WTP values for cholera and typhoid vaccines are fairly low (approximately I$10-50 per individual, depending on the vaccination scenario) while WTP for HIV/AIDS vaccine is much higher, ranging from I$180 to I$1,690.

Comparison with the WTP values in high-income countries

Table 3 reports the detailed characteristics and WTP measures for the 14 studies in high-income countries, using the same format as Table 2. In general, the magnitudes of the WTP values in high-income countries were higher than those in low- and middle-income countries. Direct comparisons between the two settings were not available for most vaccines. WTP values have been estimated in both low-/middle- and high-income countries for only two vaccines, pneumococcal conjugate and HPV. For these two vaccines, WTP values were substantially higher in high-income countries than in low- and middle-income countries, as expected.

DISCUSSION AND CONCLUSION

WTP provides an estimate of the monetary value consumers place on a vaccine. WTP reflects demand for the vaccine and total WTP is individual consumers' WTPs summed over all the consumers whose WTP is greater than or equal to the price at which the vaccine is offered. Thus, when summed across a population, WTP contributes to the estimation of the societal value of vaccination and can be compared to the vaccine's costs to understand its net benefit [48,58]. Our review suggests that there is increasing interest in estimating preferences for vaccines in monetary terms, with WTP used as a primary metric.

Our findings show that, in low- and middle-income countries, WTP for vaccines varies widely across vaccine types and is related to disease severity. For vaccines against acute diseases with relatively short duration and low- to moderate- morbidity and mortality, such as diarrheal or enteric diseases (i.e., cholera and typhoid), WTP values were low. For vaccines against chronic diseases with higher morbidity and mortality (e.g., HIV/AIDS and HPV) WTP was substantially higher. WTP also varies with income, with low-income countries having lower WTPs than middle-income countries, and both having lower WTPs than high-income countries.

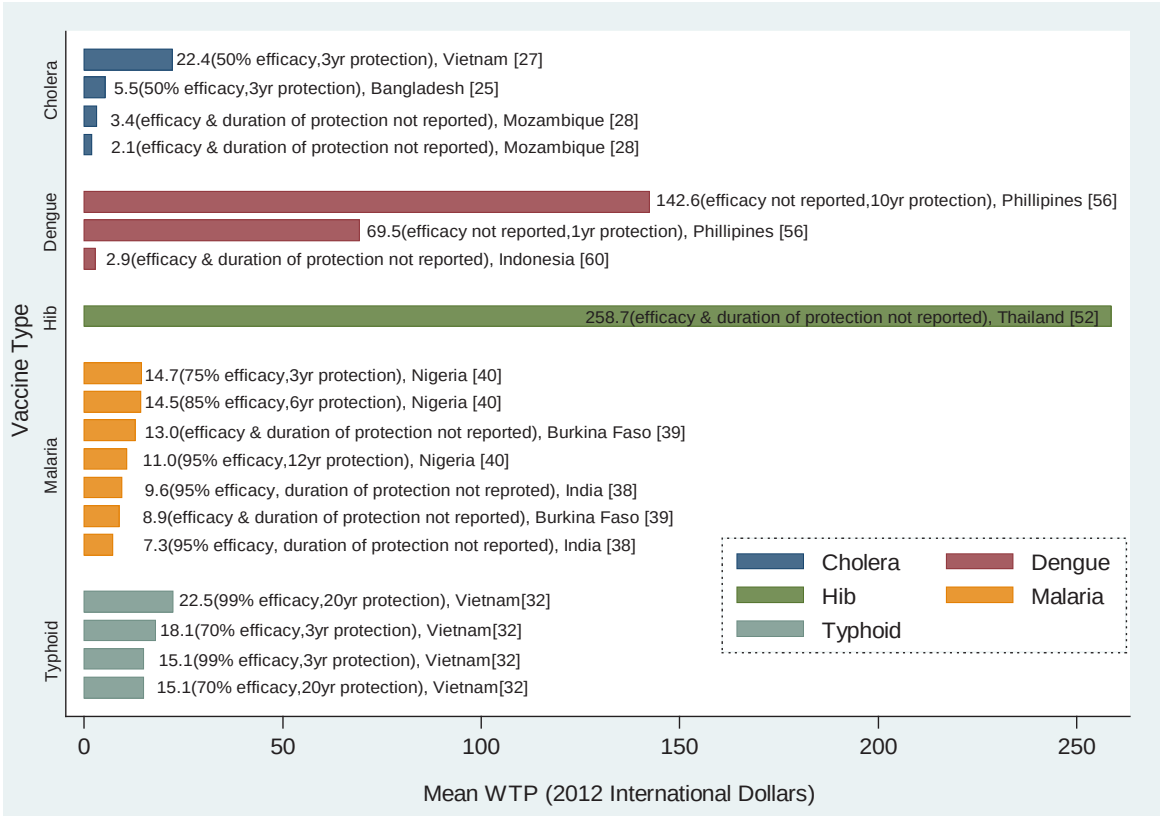
This systemic review identified several areas where methods or reporting could be improved. Because WTP will vary depending on the consumer's understanding of whether the vaccine is being offered as a public good (e.g., a government financed mass vaccination campaign) or private good (e.g., individual immunization offered in a private clinic), it is important to describe in the survey how a vaccine would be made programmatically available [59]. However, very few studies are clear on this point in their surveys. Furthermore, very few studies estimate public WTP in resource-poor settings where people can afford very little out-of-pocket expenses for health care [59].

Comparability of WTP estimates across vaccines and across countries is limited, even after converting the values into constant currency adjusting for purchasing power parity, due to the different scenarios used in survey questions (differences in terms of vaccine efficacy, duration of protection, and vaccine safety). The population unit of measurement further limits comparability. For example, some studies measured a collective WTP for the entire household, while others asked for the WTP value per individual.

Reporting of methods is often not complete. For example, details about the survey questions asked were often not provided. Sampling method, response rate, and time period for valuation were often not reported. In some studies, the currency year for the WTP values was not provided for all studies. More complete and standardized reporting would improve comparability across vaccines and across studies and would make the estimates more useful to decision makers.

Our analysis has some limitations. First, no study quality assessment was conducted in this review. Second, primarily due to the small number of studies identified and low comparability across studies, we were not able to examine the relationship between the magnitude of WTP and influential factors, such as characteristics of the disease, in a rigorous fashion.

Panel A.



Panel B.

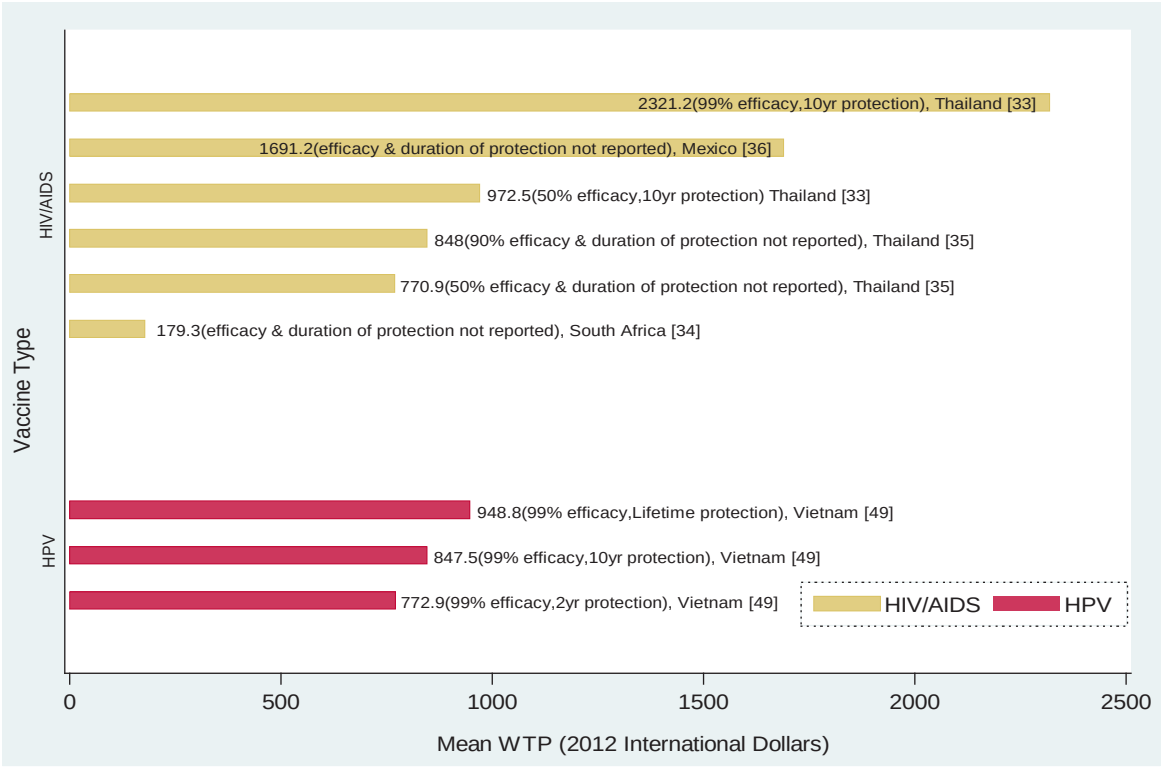


Figure 2 Willingness-to-pay (WTP) per capita for vaccine, by vaccine type. Panel A: vaccines targeting acute infections. Panel B: vaccines targeting chronic infections (HIV/AIDS, HPV).

Table 3: Willingness-to-pay (WTP) elicitation methods and estimated WTP values for vaccines in high-income countries (2012 I$)*

Study	Country	Study aim	Vaccine	Target population for vaccination	Methods for measuring WTP	Respondents (N=sample size)	Estimated mean or median WTP
Sansom et al., [48]	USA	To measure parents' WTP for two hypothetical rotavirus vaccines, with and without a risk of intussuception.	Rotavirus vaccine	Infants aged 12 months or younger	CV (payment card)	Parents (N=260)	Median WTP: For a vaccine [three doses] which halves the risk of intussusception compared to a free vaccine-I$47.2; For a risk-free vaccine -I$144.3
Lieu et al. [46]	USA (MA)	To estimate the values of pneumococcal vaccine for children, using WTP questions to pediatricians	Pneumococcal vaccine	Children	CV (Discrete Choice Experiment)	Pediatricians providing immunizations to infants (N=546)	Mean WTP for an infant pneumococcal vaccine per dose: I$71.8 for their own child, I$46.2 for the amount the government should pay on behalf of an average child
Prosser et al., [47]	USA	To measure parents' and other adults' values for PCV vaccine and health states prevented by pneumococcal conjugate vaccine	Pneumococcal conjugate vaccine (PCV)	Children	CV (DBDC with open-ended follow-up)	Parents of children who had experienced 1 or more of the outcomes described in the survey (N=101); Community members (N=109)	Median WTP for a simplified description of the 4-dose series of PCV: I$313.4 for parents; I$376.1 for community respondents
Sadique et al., [61]	UK	To review the effect of perceived risks, health impacts and costs on mothers' demand for vaccination for their children	Hypothetical vaccines for rotavirus, invasive pneumococcal, non-invasive pneumococcal)	Children below 5 years of age	Discrete Choice Experiment	Mothers (N=369)	Mean WTP: To avoid non-invasive pneumococcal disease- I$305.3. For invasive pneumococcal disease - I$1007.7
Hsu et al., [53]	Taiwan	To perform a cost-benefit analysis of routine childhood vaccination against chickenpox	Chickenpox (varicella) vaccine	Children	CV (open-ended question)	Assumed parents (N=178)	Mean WTP (2012 USD): $22.1 per vaccine per case
Asgary[41]	Canada	To assess households' WTP for an immediate pandemic influenza vaccination program	Pandemic influenza (H1N1) vaccination program	General population of Greater Toronto Area	CV (SBDC)	Heads of households living in the GTA in Ontario, Canada (N=306)	Households' WTP for immediate pandemic influenza (H1N1) vaccine: I$368.99
Prosser et al., [42]	USA (New England HMO)	To measure the values (preferences) for 4 health outcomes (influenza and injection reaction/ adverse event due to vaccination); To estimate WTPs for a child influenza vaccine with no severe allergic reaction or Guillain-Barre Syndrome	Influenza vaccine	Hypothetical child aged 1 year or 14 year of respondents' own	CV (DBCD followed by an open-ended question)	Adult members selected at random from a New England HMO (N=112)	Median/Mean for an influenza vaccine with no Guillain-Barre syndrome:I$123.5/I$421; For an influenza vaccine with no injection reaction: I$61.7/I$275.3

Steiner et al., [43]	USA (Wisconsin)	To explore WTP for influenza prevention or treatment among healthcare workers and the impact of new influenza treatments (approved weeks before the initiation of our study) on decision making these and other general decision making.	New hypothetical influenza vaccine	Healthcare workers	Detailed methods not reported (assumed stated preference method given that WTP questions were asked of vaccine recipients group, but no details of elicitation method were provided)	Healthcare workers of the University of Wisconsin Hospitals and Clinics (including both those who were vaccinated for influenza during the period of Oct. 25-Oct. 29, 1999[N=1,710] and those who were not[N=482})	Mean WTP: I$13.7
Arana and Leon, [44]	Spain (Gran Canaria island)	To evaluate health risks in the presence of altruism, using WTP for a vaccine that reduces the risk of flu in the context of altruism	A vaccine that reduces the risk of flu	Assumed general population	CV (SBDC)	Members of households (N=475)	Pooled estimated WTP per dose: Private compensating– Mean: I$6607.0 Median: I$5782.9 Social compensating- Mean: I$7540.8 Median: I$6590.4
Hong et and Collins [54]	Korea	To examine the impact of risk perception on WTP for a hypothetical SARS vaccine in Korea	SARS vaccine (hypothetical)	Adults	CV (DBDC)	Adults ranging from 20 to 75years (N=350)	Expected WTP : I$50.0
Liu et al., [55]	Taiwan	To elicit WTP for a SARS vaccine that would reduce the risk of infection and death from SARS	SARS vaccine (hypothetical)	Adults aged 20 – 65 years	CV (DBDC)	Adults aged 20-65 years (N=1,015 for Taiwan sample; 464 for Taipei sample)	Median WTP (2012 USD): ranged from $59.18 to $166.52 depending on model specifications (with different explanatory variables)
Brown et al., [50]	USA	To assess mothers' preferences and WTP for vaccinating daughters against HPV	HPV vaccine	Girls aged 13-17 years	Conjoint Analysis (with a choice-format)	Mothers (N=307)	Mean WTP:I$701.5 for Scenario A vaccine (70% cervical cancer protection, 90% genital warts protection, 10 year duration); I$592.5 for a Scenario B vaccine (80% cervical cancer protection, 0% genital warts protection, 10 year duration)
Liao et al., [51]	Taiwan	To elicit WTP using CVM and to measure VSL (value of a statistic life) for HPV vaccine	HPV vaccine	Women aged 20-55 years with at least one daughter	CV (DBDC)	Women aged 20 to 55 years with at least one daughter (N=512)	Median adjusted WTP (2012 USD) for 100% effective hypothetical HPV vaccine: $34.91 to $39.20 for daughters and $29.03 to $31.92 for mothers
Petersen et al., [57]	Denmark (Copenhagen)	To elicit WTP for allergen-specific subcutaneous injection immunotherapy in people suffering from allergic-rhinoconjunctivitis / asthma	Allergen-specific subcutaneous injection immunotherapy (SCIT)	Patients with respiratory allergy (a-RC/ asthma) aged 18-69 years	CV (discrete choice question and an open-ended question)	Patients with respiratory allergy (a-RC/ asthma) aged 18-69 years (N=317)	Mean WTP for SCIT: I$ 736.81 (median, I$295.83) by an open-ended WTP question; I$1000.52 (median, not reported) by discrete choice question

* The WTP measures for Taiwan were expressed in 2012 U.S. dollars instead of international dollars because the official purchasing power parity conversion factors were not available for the country.

Abbreviations: WTP: Willingness-to-pay; CV: Contingent valuation; SBDC: Single-bounded dichotomous; DBDC: Double-bounded dichotomous; DCE: Discrete choice experiment

Despite these limitations, our review provides a systematic and comprehensive summary of studies assessing WTP, an important measure of vaccines' economic value in low- and middle-income countries. Such assessments are valuable information for policy makers trying to maximize the health of their populations with limited resources.

REFERENCES

1. Regional Committee for the Eastern Mediterranean. Scaling up the Expanded Programme on Immunization to meet global and regional targets. World Health Organization. 2011.
2. Gordon WS, Jones A, Wecker J. Introducing multiple vaccines in low- and lower-middle-income countries: issues, opportunities and challenges. Health policy and planning. 2012; 27: ii17-26.
3. Saxenian H, Cornejo S, Thorien K, Hecht R, Schwalbe N. An analysis of how the GAVI alliance and low- and middle-income countries can share costs of new vaccines. Health Aff (Millwood). 2011; 30: 1122-1133.
4. Kaddar M, Schmitt S, Makinen M, Milstien J. Global support for new vaccine implementation in middle-income countries. Vaccine. 2013; 31: B81-96.
5. Deogaonkar R, Hutubessy R, van der Putten I, Evers S, Jit M. Systematic review of studies evaluating the broader economic impact of vaccination in low and middle income countries. BMC public health. 2012; 12: 878.
6. Ozawa S, Stack ML, Bishai DM, Mirelman A, Friberg IK, Niessen L, et al. During the 'decade of vaccines,' the lives of 6.4 million children valued at $231 billion could be saved. Health Aff (Millwood). 2011; 30: 1010-1020.
7. Stack ML, Ozawa S, Bishai DM, Mirelman A, Tam Y, Niessen L, et al. Estimated economic benefits during the 'decade of vaccines' include treatment savings, gains in labor productivity. Health affairs (Project Hope). 2011; 30: 1021-1028.
8. Ozawa S, Mirelman A, Stack ML, Walker DG, Levine OS. Cost-effectiveness and economic benefits of vaccines in low- and middle-income countries: a systematic review. Vaccine. 2012; 31: 96-108.
9. Olsen JA, Smith RD. Theory versus practice: a review of 'willingness-to-pay' in health and health care. Health Econ. 2001; 10: 39-52.
10. Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Cost-benefit analysis. Methods for the Economic Evaluation of Health Care Programmes. 3rd edn. Oxford University Press. 2005.
11. Boardman A, Greenberg D, Vining A, Weimer D. Cost-Benefit Analysis: concepts and practice. 4th edn. Prentice-Hall. 2011.
12. Musgrove P. Public spending on health care: how are different criteria related? Health Policy. 1999; 47: 207-223.
13. Clarke P. Using revealed preference methods to value health care: The travel cost approach. McIntosh E, Clarke PM, Frew EJ, Louviere JJ, editors. In: Handbooks in Health Economic Evaluation Series. United States Oxford University Press Inc. New York. 2010.
14. Arrow K, Solow R, Portney P, Leamer E, Radner R, Schuman H. Report of the NOAA panel of contingent valuation. Federal Register 1993; 10: 4601–4614.
15. A. Myrick Freeman. The Measurement of Environmental and Resource Values. 2nd edn. Washington DC: Resources for the Future. 2003.
16. Diener A, O'Brien B, Gafni A. Health care contingent valuation studies: a review and classification of the literature. Health Econ. 1998; 7: 313-326.
17. Smith RD. Construction of the contingent valuation market in health care: a critical assessment. Health Econ. 2003; 12: 609-628.
18. Sach TH, Smith RD, Whynes DK. A 'league table' of contingent valuation results for pharmaceutical interventions: a hard pill to swallow? Pharmacoeconomics. 2007; 25: 107-127.
19. Yeung RY, Smith RD. Can we use contingent valuation to assess the demand for childhood immunisation in developing countries?: a systematic review of the literature. Appl Health Econ Health Policy. 2005; 4: 165-173.
20. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. International Journal of Surgery. 2010; 8: 336-341.
21. World Bank. World Development Indicators.
22. Carson RT, Louviere JJ. A common nomenclature for stated preference elicitation approaches. Environmental and Resource Economics. 2011; 49: 539-559.
23. Ryan M, Scott DA, Reeves C, Bate A, van Teijlingen ER, Russell EM, Napper M. Eliciting public preferences for healthcare: a systematic review of techniques. Health Technol Assess. 2001; 5: 1-186.
24. McIntosh E, Clarke PM, Frew EJ, Louviere JJ. Applied Methods of Cost-Benefit Analysis in Health Care. Gray AM, Briggs A, editors. In: Handbooks in Health Economic Evaluation Series. United States Oxford University Press Inc, New York. 2010.
25. Islam Z, Maskery B, Nyamete A, Horowitz MS, Yunus M, Whittington D. Private demand for cholera vaccines in rural Matlab, Bangladesh. Health Policy. 2008; 85: 184-195.
26. Jeuland M, Lucas M, Clemens J, Whittington D. Estimating the private benefits of vaccination against cholera in Beira, Mozambique: A travel cost approach. Journal of Development Economics. 2010; 91: 310-322.
27. Kim D, Canh do G, Poulos C, Thoa le TK, Cook J, Hoa NT, et al. Private demand for cholera vaccines in Hue, Vietnam. Value Health. 2008; 11: 119-128.
28. Lucas ME, Jeuland M, Deen J, Lazaro N, MacMahon M, Nyamete A, et al. Private demand for cholera vaccines in Beira, Mozambique. Vaccine. 2007; 25: 2599-2609.
29. Cook J, Dale Whittington, Do Gia Canh, F Reed Johnson, Andrew Nyamete. Reliability of Stated Preferences for Cholera and Typhoid Vaccines with Time to Think in Hue, Vietnam. Economic Inquiry. 2008.
30. Whittington D, Sur D, Cook J, Chatterjee S, Maskery B, Lahiri M, et al. Rethinking Cholera and Typhoid Vaccination Policies for the Poor: Private Demand in Kolkata, India. World Development. 2009; 37: 399-409.
31. Chen X, Stanton B, Wang X, Nyamette A, Pach A, Kaljee L, et al. Differences in perception of dysentery and enteric fever and willingness to receive vaccines among rural residents in China. Vaccine. 2006; 24: 561-571.
32. Do GC, Whittington D, Le TK, Utomo N, Nguyen TH, Poulos C, et al. Household demand for typhoid fever vaccines in Hue, Vietnam. Health Policy Plan. 2006; 21: 241-255.
33. Cameron MP, Newman PA, Roungprakhon S, Scarpa R. The marginal willingness-to-pay for attributes of a hypothetical HIV vaccine. Vaccine. 2013; 31: 3712-3717.
34. von Keyserlingk C, Rhodes B. Using contingent valuation in hypothetical settings: estimating the WTP for an HIV/AIDS vaccine. The Journal of Interdisciplinary Economics. 2007; 18: 71-90.
35. Whittington D, Suraratdecha C, Poulos C, Ainsworth M, Prabhu V, Tangcharoensathien V. Household demand for preventive HIV/AIDS vaccines in Thailand: do husbands' and wives' preferences differ? Value in health. 2008; 11: 965-974.

36. Whittington D, Matsui-Santana O, Freiberger JJ, Van Houtven G, Pattanayak S. Private demand for a HIV/AIDS vaccine: evidence from Guadalajara, Mexico. Vaccine. 2002; 20: 2585-2591.

37. Cropper ML, Haile M, Lampietti J, Poulos C, Whittington D. The demand for a malaria vaccine: evidence from Ethiopia. Journal of Development Economics. 2004; 75: 303-318.

38. Prabhu VS. Tests of Intrahousehold Resource Allocation Using a CV Framework: A Comparison of Husbands' and Wives' Separate and Joint WTP in the Slums of Navi-Mumbai, India. World Development. 2010; 38: 606-619.

39. Sauerborn R, Gbangou A, Dong H, Przyborski JM, Lanzer M. Willingness to pay for hypothetical malaria vaccines in rural Burkina Faso. Scand J Public Health. 2005; 33: 146-150.

40. Udezi WA, Usifoh CO, Ihimekpen OO. Willingness to pay for three hypothetical malaria vaccines in Nigeria. Clin Ther. 2010; 32: 1533-1544.

41. Asgary A. Assessing households' willingness to pay for an immediate pandemic influenza vaccination programme. Scand J Public Health. 2012; 40: 412-417.

42. Prosser LA, Bridges CB, Uyeki TM, Rêgo VH, Ray GT, Meltzer MI, et al. Values for preventing influenza-related morbidity and vaccine adverse events in children. Health Qual Life Outcomes. 2005; 3: 18.

43. Steiner M, Vermeulen LC, Mullahy J, Hayney MS. Factors influencing decisions regarding influenza vaccination and treatment: a survey of healthcare workers. Infect Control Hosp Epidemiol. 2002; 23: 625-627.

44. Araña JE, León CJ. Willingness to pay for health risk reduction in the context of altruism. Health Econ. 2002; 11: 623-635.

45. Heinzen RR, Bridges JF. Comparison of four contingent valuation methods to estimate the economic value of a pneumococcal vaccine in Bangladesh. Int J Technol Assess Health Care. 2008; 24: 481-487.

46. Lieu TA, Finkelstein JA, Adams MM, Miroshnik IL, Lett SM, Palfrey S, et al. Pediatricians' views on financial barriers and values for pneumococcal vaccine for children. Ambul Pediatr. 2002; 2: 358-366.

47. Prosser LA, Ray GT, O'Brien M, Kleinman K, Santoli J, Lieu TA. Preferences and willingness to pay for health states prevented by pneumococcal conjugate vaccine. Pediatrics. 2004; 113: 283-290.

48. Sansom SL, Barker L, Corso PS, Brown C, Deuson R. Rotavirus vaccine and intussusception: how much risk will parents in the United States accept to obtain vaccine benefits? Am J Epidemiol. 2001; 154: 1077-1085.

49. Poulos C, Yang JC, Levin C, Van Minh H, Giang KB, Nguyen D. Mothers' preferences and willingness to pay for HPV vaccines in Vinh Long Province, Vietnam. Soc Sci Med. 2011; 73: 226-234.

50. Brown DS, Johnson FR, Poulos C, Messonnier ML. Mothers' preferences and willingness to pay for vaccinating daughters against human papillomavirus. Vaccine. 2010; 28: 1702-1708.

51. Liao CH, Liu JT, Pwu RF, You SL, Chow I, Tang CH. Valuation of the economic benefits of human papillomavirus vaccine in Taiwan. Value Health. 2009; 12: S74-77.

52. Muangchana C, Bishai D. The private demand for Hib vaccination in a probable low Hib disease incidence country: Thailand 2006. Southeast Asian J Trop Med Public Health. 2010; 41: 883-899.

53. Hsu HC, Lin RS, Tung TH, Chen TH. Cost-benefit analysis of routine childhood vaccination against chickenpox in Taiwan: decision from different perspectives. Vaccine. 2003; 21: 3982-3987.

54. Hong S, Collins A. Societal responses to familiar versus unfamiliar risk: comparisons of influenza and SARS in Korea. Risk Anal. 2006; 26: 1247-1257.

55. Liu JT, Hammitt JK, Wang JD, Tsou MW. Valuation of the risk of SARS in Taiwan. Health Econ. 2005; 14: 83-91.

56. Palanca-Tan R. The demand for a dengue vaccine: a contingent valuation survey in Metro Manila. Vaccine. 2008; 26: 914-923.

57. Petersen KD, Gyrd-Hansen D, Linneberg A, Dahl R, Larsen JN, Løwenstein H, et al. Willingness to pay for allergy-vaccination among Danish patients with respiratory allergy. Int J Technol Assess Health Care. 2010; 26: 20-29.

58. Cook J, Jeuland M, Maskery B, Lauria D, Sur D, Clemens J, et al. Using private demand studies to calculate socially optimal vaccine subsidies in developing countries. J Policy Anal Manage. 2009; 28: 6-28.

59. Whittington D. Improving the performance of contingent valuation studies in developing countries. Environmental and Resource Economics. 2002; 22: 323-367.

60. Hadisoemarto PF, Castro MC. Public acceptance and willingness-to-pay for a future dengue vaccine: a community-based survey in Bandung, Indonesia. PLoS Negl Trop Dis. 2013; 7: e2427.

61. Sadique MZ, Devlin N, Edmunds WJ, Parkin D. The effect of perceived risks on the demand for vaccination: results from a discrete choice experiment. PLoS One. 2013; 8: e54149.

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