Economy and Environment Program
for Southeast Asia
22 Cross Street
#02-55 South Bridge Court
Singapore 048421
Tel: (65) 6438 7877
Fax: (65) 6438 4844
E-mail: eepsea@idrc.org.sg
Website: www.eepsea.org

RESEARCH REPORT

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Value Of Statistical Life Estimates For Children In Metro Manila, Inferred From Parents' Willingness To Pay For Dengue Vaccines

Rosalina Palanca-Tan
Department of Economics
Ateneo de Manila University
Loyola Heights
Quezon City 1108, Philippines
Tel: 632 426 5661
Email: rtan@ateneo.edu

This study presents a 'value of life' estimate for children in Metro Manila of between US$0.70 million and US$0.80 million. It was carried out by Rosalina Palanca-Tan, from the Department of Economics at the Ateneo de Manila University in Quezon City.

Palanca-Tan's assessment is based on parents' willingness to pay for two hypothetical dengue vaccines for their children. It takes an innovative approach to the valuation challenge, one that removes much of the uncertainty surrounding similar past studies. This method involves isolating people's willingness to pay for the reduction in mortality risk that the vaccines bring. This is done by disentangling it from their willingness to pay for other related benefits that the vaccines bring (such as reducing the pain associated with illness).

The study succeeds in producing a result that can be used generally to value life in a range of scenarios and situations. As children are most vulnerable to environmental degradation such as air pollution and water pollution, this valuation will be particularly useful to environmental policy makers and campaigners looking to estimate the overall benefit of their work.

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VALUE OF STATISTICAL LIFE ESTIMATES FOR CHILDREN IN METRO MANILA, INFERRED FROM PARENTS' WILLINGNESS TO PAY FOR DENGUE VACCINES

Rosalina Palanca-Tan

June, 2008

Comments should be sent to: Rosalina Palanca-Tan, Department of Economics, Ateneo de Manila University, Loyola Heights, Quezon City 1108, Philippines.

Telefax: + 632 426 5661

Email: rtan@ateneo.edu

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I offer this work to Nelson, Matti and my Dad (Juanito P. Palanca Sr.), and most of all, to the Almighty Father from Whom all blessings come.

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EXECUTIVE SUMMARY

Based on parents' stated willingness to pay (WTP) for dengue vaccines for their children, this paper arrived at estimates of the value of statistical life (VSL) of children in Metro Manila. Unlike in previous VSL studies, respondents in this study were tasked (through a play-like activity) to isolate the value they attached to the specified mortality risk reduction from the stated WTP for the risk intervention scenario, i.e., a dengue vaccine. This was done to remove the influence of the risk context in the VSL estimate and hence improve the estimate's usefulness and applicability in a variety of environment-related project and policy assessments. The results of the two-stage estimation procedure consisting of a household vaccine demand model and a random effects probit model of the vaccine purchase decision for individual members conformed with economic intuition (household vaccine demand increased significantly increased with higher income while willingness to pay significantly increased with lower prices) and yielded value of statistical life estimates for children in Metro Manila in the range of US$0.70-0.80 million.

1.0 INTRODUCTION

One major benefit justifying environmental policies is the reduction in people's risk of death. In developing countries like the Philippines, however, this important benefit is commonly excluded or not properly imputed in environmental cost-benefit analyses and other types of environmental project assessments due to the dearth of studies on the value of mortality risk reduction and concern over the applicability of values derived in developed countries (benefit transfer). This exclusion may result in underestimated benefits that could cause the defeat of many environmental policy initiatives. This paper presents estimates of the value of statistical life (VSL) of a child in Metro Manila based on parents' willingness to pay (WTP) for dengue vaccines for (their) children[1]—the population segment most vulnerable to environmental degradation such as air pollution and water pollution.

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[1] This approach is in line with the "parental sovereignty" perspective on children's welfare which advocates parental altruism and parental guardianship or stewardship. It is an alternative to the consumer sovereignty normative perspective-based "children's sovereignty" which assumes that each individual has well-defined preferences and is the best judge of his or her own welfare. Freeman (2003, p. 340) writes: "The children's sovereignty perspective is not ethically attractive. Children are immature and lack the cognitive ability to make choices about health and safety. They may not have well-defined preferences over the full range of alternatives necessary to make reasoned choices. Also, they do not control the financial resources that are required to make trade-offs between money and health or safety."

This study used a specific intervention scenario, i.e., a dengue vaccine, to avoid the highly hypothetical nature of a general type of intervention that reduces mortality risk from different causes (see, for instance, Krupnick et al 2002; Alberini, Hunt and Markandya 2004; Mahmud 2005; Maskery et al 2007). A multi-purpose intervention can be expected to generate a high incidence of scenario rejection in the Philippine setting where the market is already flooded with health products promising remedies for all problems and the consuming public have grown highly skeptical about such products. A dengue vaccine was chosen as it offered a highly familiar risk and intervention context for the respondents of this study. Dengue outbreaks in the Philippines in the last two decades have victimized people across all income classes and increased their awareness of the risk of death from dengue, particularly among children. Vaccination is also widely accepted in the country as an effective means of preventing diseases in children, and news about positive developments in dengue vaccine research have appeared in Philippine newspapers since 2005. A dengue vaccine would also be a private good which is not likely to result in substantial "warm glow effects" as the virus is not transmitted directly from person to person.

Stated WTP for a dengue vaccine would include not only WTP for the elimination of the risk of dying from dengue, but also WTP for reduced morbidity effects (avoidance of suffering, pain, inconvenience and loss of income experienced by the sick person and his/her caregivers) and savings on other preventive measures (Cropper et al 2004). This is inherent in a specific intervention VSL scenario where respondents are inclined to consider effects other than the reduction in the risk of dying. This also relates to the issue of VSL estimates being context-specific. The non-mortality risk component of WTP for a specific intervention is expectedly context-specific. The goal of most VSL studies, however, is to come up with estimates that can be applied in the assessment of a variety of environmental projects and policies. What existing studies have done so far is to look at how WTP is affected by different risk characteristics such as degree of dread, severity, voluntariness, controllability, personal exposure and perceived immediate occurrence, and to compare VSL estimates in different contexts to arrive at some adjustment ratios (Hammitt and Liu 2004; Vassandumrongdee and Matsuoka 2005; Revesz 1999). This study undertook a strategy that had not been done in previous VSL research. We broke down the stated WTP into the different benefits that could be derived from the dengue vaccine by allocating the WTP amount into five benefits, one of which was mortality risk reduction. In a game-like manner that also served to break the monotony of the question-answer sequence of the questionnaire, respondents were given ten tokens and five containers, each labeled with one reason for buying the vaccine. The respondents were asked to think of the ten tokens as representing their WTP for the vaccine and to divide them into the five given reasons/benefits. Only the WTP for the mortality risk reduction was used in the calculation of the VSL. To our knowledge, no VSL study has isolated the WTP for mortality risk reduction from the WTP stated by the repondent before the VSL was calculated.

This study also differs from existing VSL literature in that it elicited the WTP for a dengue vaccine for each and every member of the household and used the WTP decisions for all household members in the VSL calculation. Previous VSL studies elicited the WTP for mortality risk reduction for only one household member. For example, Cropper et al (2004) elicited the household head's WTP for a malaria vaccine for himself/herself and Maskery et al (2007) elicited the survey respondent's WTP for a nutritional supplement for only the youngest child in the household. It is not difficult to see that eliciting WTP for a particular household member, say the youngest child, can result in biased estimates. We also believe that our approach better reflects the reality of household decision-making wherein the head decides to purchase an individually consumed good for one or several members after considering the needs and wants of all members in relation to the household budget. It is not always clear that this is the case when a respondent is asked to focus on just one household member.

As the study deviated from the conventional single VSL-WTP question per respondent structure, we also had to employ a different modeling procedure. This is the third unique feature of the study. We used a two-stage regression model where the household vaccine demand in proportion to household size was regressed with household income and a vector of respondent and other household characteristics in the first stage, and the "yes-no" response to the dichotomous choice WTP question for each household member was specified as a random effects probit function of the predicted household vaccine demand (derived in the first stage) and a vector of particular household member characteristics in the second stage.

The results from our two-stage regression model conformed with economic theory – vaccine demand (as a proportion of household size) specification exhibited a significant positive income effect while the individual vaccine purchase decisions exhibited a significant negative price effect. The signs of the other explanatory variables in the model were generally in accord with intuition. The VSL estimates for children in Metro Manila ranged from US$0.70-0.80 million, an order of magnitude comparable with VSL estimates in existing literature.

2.0 METHODOLOGY

2.1 Survey Instrument Development

The final form of the survey instrument was the result of a series of key informant interviews (KIIs) with doctors and medical professionals specializing in dengue, infectious diseases and pediatrics; focus group discussions (FGDs) with different types of respondents from low- to high-income households; and questionnaire pre-tests. These pre-survey activities provided important inputs in the formulation of the contingent valuation (CV) scenarios and range of bid levels as well as in coming up with appropriate visual aids and phrasing of questions.

Two CV scenarios were constructed: (1) a dengue vaccine that provided protection for one year and (2) a dengue vaccine that provided protection for ten years. During this study, potential dengue vaccines were still being developed and there were yet no clear indications of the definite forms the dengue vaccine would take. Considering the need to make the valuation task manageable for all kinds of respondents, both the one-year and ten-year duration vaccines were presented in the CV scenarios as a one-dose vaccine that could be purchased at hospitals, doctors' clinics and drug stores, and could be administered either as an injection or oral drops. Five bid levels (dengue vaccine prices) were used for both one-year and ten-year duration vaccines: US$ 2 (PhP 100), US$ 10 (PhP 500), US$ 20 (PhP 1,000), US$ 60

(PhP 3,000) and US$ 100 (PhP 5,000).[2] The target sample size of 500 respondents consisted of split samples of 50 respondents for each bid price and vaccine duration.

The survey instrument comprised four parts: A, B, C and D. Part A included a brief introduction on the purpose of the survey as well as easy-to-answer questions about the respondent and his/her household. Questions to assess the level of awareness of the respondent about dengue and preventive measures undertaken by the respondent's household were also posed. Furthermore, Part A drew cost-of-illness data from those households with experience of dengue.

Part B was a short training module on understanding mortality risk reduction. This module included information on mortality risks associated with leading causes of death in the Philippines. Apart from familiarizing respondents with the concept of mortality risk reduction, the information provided a basis of comparison for the mortality risk reduction from the dengue vaccine. Preferred over the risk scale by the less educated and lower income FGD and pre-test participants, risk grids were used as visual aids in the survey. A question to test for comprehension was asked at the end of the explanation. The enumerator was instructed to note down the number of times the explanation was repeated before the respondent was able to give the correct answer.

Part C introduced the CV scenario by presenting information details on dengue (e.g., the four dengue virus serotypes, modes of infection, incidence, medication and prevention), the difference between mortality risks from dengue of the 14 years and below age group (1/100,000) and the 15 years and above age group (1/1,000,000) likewise using risk grids as visual aids, and recent developments in dengue vaccine research. The WTP question, following the dichotomous choice formulation, was structured in the following way: the respondent was first asked how many vaccines he/she would buy for his/her household members at the stated price, after which he/she was asked who in the household would be given the vaccine. A short "cheap talk" script reminding respondents to consider their budget constraints and to answer in accordance with what they would really do if the vaccine were already available in the market was inserted in the WTP question. Part C also included two sets of debriefing questions. One set, addressed to respondents who would buy the vaccine, consisted of three items: (1) the degree of certainty of buying the vaccine, (2) the expenditure item that would be reduced most in order to buy the vaccine, and (3) the relative importance of the different reasons for buying the vaccine for each of the two age groups. Respondents not buying the vaccine, on the other hand, were first asked if they would take the vaccine for any household members if it were offered for free. A "no" response to this question was followed by a question as to the reasons why they would not want the vaccine even if it were free.

Finally, Part D solicited additional socio-economic and health information. These questions were asked last to avoid generating respondents' disinterest early on in the survey. At the end of the interview, the enumerator recorded his/her assessment of the quality of the interview.

[2] The exchange rate used was PhP 50 to US$1.

2.2 Sampling and Data Collection

The survey was conducted in Metropolitan Manila (MM). MM, one of 17 regions in the Philippines, is the National Capital Region (NCR) and the political, economic, social and cultural center of the Philippines. It is one of the more modern metropolises in Southeast Asia and is among the world's 30 most populous. Covering an area of only 636 km^2 (square kilometers), MM is the smallest of the 17 regions but it is the most populous (11.3 million in 2005, 13% of the entire Philippine population) and the most densely populated (17,751 per km^2). Three other regions in the Philippines that include metropolitan areas like the cities of MM are Central Luzon, Central Visayas and Northern Mindanao. The capital and central cities in these regions are highly urbanized as in MM. Metro Cebu, the counterpart of MM in Central Visayas, includes cities where the population density reaches 10,000 per km^2. The most densely populated cities in Central Luzon—Angeles City (4,378 per km^2), and in Northern Mindanao—Cagayan de Oro City (1,119 per km^2), on the other hand, are much less dense. In terms of the average number of reported dengue cases per year from 2000-2005, these four regions occupy the top four places: Metro Manila (3,738), Central Luzon (2,595), Central Visayas (2,070), and Northern Mindanao (2,057).

MM consists of 14 cities and three municipalities. Respondents were drawn from the five largest cities in MM namely, Quezon City (accounting for 21% of the MM population), Manila (15%), Caloocan (11%), Makati (5%), and Pasig (5%).[3] There have been a greater incidence of dengue and more cases of death from it in Quezon City compared to the other four cities. In 2000, for instance, there were 38 reported deaths from dengue in Quezon City which was equivalent to a mortality rate of 1.8 per 100,000—a figure substantially higher than MM's 1.1 and the national rate of 0.5. The mortality rates from dengue in the same year for the other four sampled cities were as follows: 1.3 for Caloocan, 1.1 for Pasig, 1.0 for Makati and 0.8 for Manila.

A sample of 100 respondents was taken from each of the five cities. For each city, a residential *barangay*[4], with residents belonging to all social classes, was randomly selected. Respondents were chosen using systematic sampling. Permission and assistance to conduct the survey were secured from the *barangay* captain's office. With maps provided by the *barangay* office, starting points were identified and enumerators were instructed to approach the 50th house from a starting point. In case of refusal to participate, the next house would be approached. Every succeeding respondent approached had to be the 50th house from the last responding household. Each respondent was randomly assigned a vaccine duration and price.

The survey was conducted through in-person interviews from the months of February to May 2007. Enumerators, recruited from a pool of applicants who were at least university students, were given a two-day training course prior to the pre-tests following the guidelines in Whittington (1996, 2002). The first day of training comprised an overview of the objectives of the study and the contingent valuation

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[3] The other nine cities and three municipalities and their populations are: Las Pinas (4.6% of the MM population), Malabon (3.8%), Mandaluyong (2.7%), Marikina (3.8%), Munitnglupa (3.7%), Navotas (2.2%), Paranaque (4.8%), Pasay (3.4%), Pateros (0.6%), San Juan (4.3%), Taguig (4.5%) and Valenzuela (4.7%). Population shares were computed based on 2000 census data.

[4] A *barangay* is the smallest political unit in the Philippines.

approach as well as information on dengue and vaccines. On the second day, enumerators were trained on the survey instrument, with the meaning and the reasons for each question and statement in the questionnaire discussed. The training included role-playing exercises.

2.3 Data Analysis

2.3.1 WTP for a dengue vaccine

A two-stage estimation procedure was undertaken to arrive at the mean willingness to pay for a dengue vaccine for young members of the household aged 14 years and below. In the first stage, household demand for dengue vaccines *d* (expressed in terms of the number of vaccines to be purchased in proportion to the number of household members) was specified as a linear function of the vectors of the respondent's characteristics ***r***, household characteristics ***z*** (excluding income), and household income *y*:

$$d = d(\mathbf{r}, \mathbf{z}, y) \qquad (1)$$

The predicted household vaccine demand derived in the first stage was then included as an explanatory variable in the vaccine purchase decisions for individual household members in the second stage. This captured the interdependence of the budget constraint in the individual vaccine purchase decisions for all household members.

In stage 2, we analyzed the "yes-no" response to the dichotomous choice CV question using the framework developed by Hanemann (1984) based on the random utility model which is briefly discussed below.

Indirect utility, *u*, depends on *h* (which takes on the value 1 if the respondent is buying the vaccine for a household member, 0 if otherwise), household income *y*, a vector of household member characteristics ***m***, a vector of respondent and his/her household's characteristics **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):

$$u(h, y, \mathbf{m}, \mathbf{z}, \varepsilon_h) = v(h, y, \mathbf{m}, \mathbf{z}) + \varepsilon_h \qquad (2)$$

As the random part of preference is unknown, only probability statements about "yes" and "no" responses can be made. The probability that a bid price *B* for the vaccine is accepted can be expressed as:

$$\begin{aligned} Pr\,(yes) &= Pr\,[v(1, y\text{-}B, m, z) + \varepsilon_1 \geq v(0, y, m, z) + \varepsilon_0] \\ &= Pr\,[v(1, y\text{-}B, m, z) - v(0, y, m, z) \geq \varepsilon_0 - \varepsilon_1] \qquad (3) \\ &= 1 - F_\varepsilon(-\Delta v) = F_\varepsilon(\Delta v) \end{aligned}$$

F_{ε} (Δv), the probability that the random variable ε will be less than Δv, represents the cumulative density function of the respondent's true maximum willingness to pay.

We assumed that the stochastic terms ε are independently and identically distributed following a normal distribution with a mean of 0 and a standard deviation of σ, and used the probit regression procedure to evaluate (3). For the indirect utility specification, we assumed a linear function such that income would disappear in the change in utility term in (3). The parameter estimates from the binary probit model were used to calculate the mean willingness to pay *E(B)* according to the following equation:

$$E(B) = - (\beta/\sigma)\mathbf{X}/(\beta_B/\sigma) = - \beta\mathbf{X}/\beta_B \quad (4)$$

β is a vector of the estimated coefficients of all explanatory variables except price (vector $\mathbf{X}$) and β_B is the estimate for the price coefficient.

Each child member of the household aged 14 years and below for whom the respondent decided to buy or not to buy a vaccine constituted one observation (one data point) in the binary choice data set. Hence, each household (that is, one filled-up questionnaire) contributed a number of data points/observations equivalent to the number of household members aged 14 years and below. Household member characteristics used as explanatory variables were age, gender and whether the household member was the respondent's own child (this last characteristic was represented by a dummy variable). As respondent and household characteristics were already incorporated in the household vaccine demand model, only the predicted vaccine demand variable in proportion to the household size was used in the individual choice decision model. Finally, the probit regression procedure was run as an unbalanced panel random effects model to capture the interdependence of the decisions to buy the vaccine for members in each household.

The non-parametric mean willingness to pay for a dengue vaccine and its variance were calculated using the lower bound Turnbull formula (Haab and McConnell 2003):

$$E_{LB}(B) = \sum_{j=0}^{M} B_j\,(F_{j+1} - F_j) \quad (5)$$

$$V(E_{LB}(B)) = \sum_{j=1}^{M} (F_j\,(1 - F_j)\,(B_j - B_{j-1})^2/\,T_j) \quad (6)$$

M is the number of bids; B is the bid level; T_j is the number of respondents offered the bid price B_j; F_j is the proportion of "no" responses to the bid price B_j; $F_0=0$ and $F_{M+1}=1$.

2.3.2 Isolating the willingness to pay for mortality risk reduction

Stated willingness to pay for a dengue vaccine includes not only the value attached to the mortality risk reduction effect of the vaccine, but also to the other benefits that can be derived from the vaccine such as avoidance of pain and suffering, savings on medical and related expenses, and avoidance of lost household income. The relative importance of a mortality risk reduction effect vis-à-vis the other effects depends on the nature of the disease or the cause of death. The willingness to pay for a reduction in the risk of death from dengue, for instance, would be different in the case of traffic accidents, cancer and other diseases with varying durations and intensites of pain and suffering. A number of studies has shown that the willingness to pay for mortality risk reduction, and hence the resulting VSL estimate, was context-specific. Hammitt and Liu (2004) found that the willingness to pay for mortality risk reduction varied according to disease type and latency, the affected body organ, environmental pathway, and payment mechanism. Jones-Lee, Hammerton and Philips (1985) arrived at a VSL estimate based on motor vehicle crashes (£23 million) that was higher than those based on heart disease (£13 million) and cancer (£7 million).

The goal of most VSL studies is to come up with estimates that can be applied in the assessment of a variety of public projects and policies (e.g., in transport, health and the environment). VSL estimates based on a particular risk context are applied to other risk contexts commonly through the use of adjustment factors. Revesz (1999), for instance, proposed to adjust the standard VSL used by the U.S. Environmental Protection Agency in a carcinogenic pollutants emission control project by a factor of two for risk characterized by involuntariness and uncontrollability, and by a factor of four in the case of risks characterized by dread. Some researchers and policy-makers, however, are skeptical about the derivation and use of such adjustment factors. For example, due to lack of empirical VSL studies in the air pollution context and reliable information to support the adjustment of the road safety-based VSL for air pollution in the United Kingdom, its Department of Health has refrained from quantifying health benefits of air pollution reduction in monetary terms (Dunn 2001).

This paper presents an alternative method of arriving at a VSL estimate with the influence of the risk context removed. This study opted to isolate the willingness to pay for the reduction in mortality risk by soliciting such information directly from the respondents. Respondents were asked to break down the amount they were willing to pay for a dengue vaccine into the different benefits that could be derived from the vaccine. Specifically, they were tasked to state the level of importance they accorded to the following five reasons for buying the dengue vaccine: (1) to prevent death, (2) to avoid the pain and suffering from being ill with dengue, (3) to avoid incurring medical expenses, (4) to avoid inconvenience and absenteeism from work or school, and (5) to avoid having to undertake and spend on other precautionary measures. Our FGDs revealed that respondents would have difficulty allocating a total weight of 100 (percent) or even 10 (point system) among the five reasons without any computation aid. So we came up with a game-like activity in which respondents were given ten tokens and five containers. The respondents were told to think of the ten tokens as representing the amount they would pay for the vaccine and to divide them into the five containers according to the importance they would give to each reason.

The average weight given to the mortality risk reduction by respondents buying the dengue vaccine, *w*, was used to isolate the willingness to pay for the mortality reduction, *WTP,* from the mean willingness to pay for the dengue vaccine, *E(B)*:

$$WTP = w\,E(B) \qquad (7)$$

2.3.3 VSL

VSL is the value an individual attaches to a reduction in mortality risk. Technically, it is the rate at which the individual would trade money for a small change in the probability of dying, Δr, during a specified time period (Hammitt and Graham 1999):

$$VSL = WTP/\Delta r \qquad (8)$$

In the case of the ten-year duration vaccine for which payment would be made only once in the first year, discounting of the mortality risk reduction, which would be realized over a period of ten years, was undertaken. Viscusi, Hakes and Carlin (1997) pointed out that insufficient accounting for discounting and time lags before the risk of death appears could overstate people's perception of risks. For this study, we used a 5% discount rate (Hammar and Johansson-Stenman 2004). This positive discount factor would effect an upward adjustment in the value of the mortality risk reduction from the ten-year duration vaccine.

3.0 RESULTS AND DISCUSSION

3.1 Respondent and Household Characteristics

3.1.1 Socio-economic profile

The first three panels of Table 1 give the household level descriptive statistics used in the vaccine demand model while the last panel presents the individual characteristics of household members aged 14 years and below that were used in the binary probit vaccine purchase decision model.

The socio-economic profile of the respondents and their households is given in the first two panels of the table. About a fifth of the respondents were male and about a third were smokers. The respondents, on average, were 34 years old. The average household in our sample had five members and a monthly income of US$492-501 (PhP 24,590-25,060). These figures compare well with household statistics in the 2003 National Demographic and Health Survey of the Philippines (NSO 2004) which reported an average household size of 4.69 persons and a mean monthly household income of PhP 22,877 in Metro Manila (NSO 2004).

Table 1. Descriptive statistics

Variable name	Variable definition	1-year efficacy vaccine		10-year efficacy vaccine	
		Mean	Std. Dev.	Mean	Std. Dev.
Respondent's characteristics					
RespondentGender	=1 if male, 0 if female	0.24	0.43	0.18	0.38
RespondentAge	Years	34.07	6.99	33.49	7.12
Respondent Smoking	=1 if smoking, 0 otherwise	.34	0.47	0.28	0.45
Household (HH) characteristics					
HHSize	Number of all household members	5.10	1.52	5.14	1.46
Income	Monthly HH income US$	501	413	492	408
	PhP	25,060	20,654	24,590	20,415
Pasig	Survey site dummy	0.20	0.40	0.20	0.40
Manila	Survey site dummy	0.20	0.40	0.20	0.40
Caloocan	Survey site dummy	0.20	0.40	0.20	0.40
Makati	Survey site dummy	0.20	0.40	0.20	0.40
Dengue-related variables					
DengueFamily	=1 if HH with dengue case/s, 0 otherwise	0.07	0.25	0.07	0.25
DengueOthers	=1 if respondent knew someone who had dengue, 0 otherwise	0.63	0.48	0.59	0.49
Correct	No. of correct answers to dengue information questions	6.17	1.14	6.01	1.24
Prevent	No. of dengue preventive methods practiced by HH	4.41	1.29	4.33	1.26
FeverFrequency	Frequency of fever in the HH =1 if frequent, 2 if not so frequent, 3 if sometimes, 4 if rarely	3.30	0.67	3.27	0.72
Individual household member characteristics (14 years old & below)					
MemberGender	=1 if male, 0 if female	0.50	0.50	0.46	0.50
MemberAge	Years	7.49	4.37	7.50	4.26
RespondentChild	=1 if member is respondent's own child, 0 otherwise	0.98	0.15	0.97	0.15

3.1.2 Dengue exposure, knowledge and preventive practices

The third panel of Table 1 summarizes the data gathered on dengue-related variables. Although the majority of the respondents personally knew someone who had been ill with dengue, only about 32 respondents reported cases of dengue in their households, 29 of which had one case while the remaining three had 2 cases.[5]

The survey results reflected a relatively high although not perfect knowledge about dengue. Of the eight dengue information questions, each respondent, on average, answered six correctly. The first panel of Table 2 indicates the respondents' knowledge about the different aspects of dengue. Almost all were aware about the particular insect (mosquito) that caused dengue, but there was less familiarity with the particular characteristics of the mosquito that carried the virus (that it bites during the daytime and lays its eggs in clean waters). Alarmingly, about half of the respondents wrongly thought that the dengue mosquito laid and bred its eggs only in dirty water. There was also some degree of misconception about the conditions (transmission and immunity) and treatment (blood transfusion) of dengue victims. The lowest proportion of correct answers was found for item 8. It appears that the majority of the respondents were yet not adequately informed of all the ways by which to prevent dengue.

In regard to dengue preventive methods, households, on average, practiced four out of the seven methods cited. The second panel of Table 2 shows particular dengue preventive methods practiced by households. Almost all households were doing the relatively easier tasks of regularly cleaning and covering (if possible) water containers. The majority of the respondents limited outside play of children during the rainy season while only about half practiced the more difficult task (especially for houses with more than one floor) of cleaning roof gutters and the more costly method of using insect repellant lotion. While 56% of the households used mosquito-killing chemicals, only 12% used bednets.

[5] The survey instrument included cost-of-illness questions for households with dengue cases. All except for three gave some rough estimates of the total medical costs (medicine, doctor's fee, laboratory and hospital fees) incurred, but as it was admittedly difficult for most respondents to recall the expenses, we had to be very cautious in using the data. The costs for five undated cases ranged from US$20 (PhP 1,000) to US$200 (PhP 10,000). The costs for the majority of the cases (14 out of 24), occurring between 2002 and 2007, ranged from US$200 (PhP 10,000) to US$400 (PhP 20,000). The costs of US$600 (PhP 30,000) for a 2004 case and US$1,000 (PhP 50,000) for a 1996 case appeared to be outliers. All cases between 2002 and 2007 averaged US$234.80 (PhP 11,740) with a standard deviation of US$137.20 (PhP 6,860). For the more recent cases in 2006 (12 cases) and 2007 (1 case), the average cost was US$195.38 (PhP 9,769) with a standard deviation of US$110.20 (PhP 5,510).

Table 2. Dengue knowledge and preventive practices

A. Questionnaire statements to test the respondents' knowledge of dengue	% who answered correctly
1. Dengue fever is caused by mosquitoes that bite during the daytime.	89
2. The dengue virus is also transmitted by cockroaches.	97
3. Children are more prone to contracting dengue fever.	87
4. Every person with dengue fever requires blood transfusion.	74
5. A surviving dengue victim acquires lifetime immunity to the dengue virus.	88
6. Dengue mosquitoes breed and lay their eggs only in dirty waters.	58
7. A person sick with dengue is contagious to other people.	89
8. Putting salt in household containers that inherently and regularly accumulate water such as ant traps and refrigerator water trays can prevent mosquito breeding.	28
B. Questionnaire statements to determine the preventive practices of the respondents	**% practicing dengue prevention**
1. We regularly clean and scrub water containers inside our house such as flower vases, ant traps, water trays of refrigerators, and bottom saucers of ornamental plants.	96
2. We regularly clean our roof gutters of debris to prevent accumulation of water.	47
3. We cover our water storage containers.	96
4. I buy insect repellant lotion for my children to prevent them from contracting dengue fever.	58
5. I don't allow my children to play outside the house during the rainy season to prevent them from contracting dengue fever.	75
6. We use bednets when sleeping.	12
7. We treat our curtains and mosquito bednets with chemicals (pyrethoids) to make them toxic resting places for mosquitoes.	56

Note: The percentage (%) figures in sections A and B of the table refer respectively to the proportions of respondents who answered the dengue information questions correctly, and who undertook dengue prevention practices. Questionnaire statements required AGREE/DISAGREE responses.

3.1.3 House ownership, sanitation and health

Table 3 summarizes the house ownership, sanitation and health conditions of the sample group. Only a fourth of the respondent households owned their houses. The other three-fourths were approximately evenly distributed into renting and living in houses owned by relatives. The majority of the households used water-sealed toilets without flush. Slightly less than half of the households used water-sealed toilets with flush. Only a few households had no toilet in their homes. About two-thirds of the households had private connection with either of the two water concessionaires in Metro Manila. The remaining one-third had shared connection.

The majority of the households reported only occasional ("sometimes") or rare incidence of fever among their members, i.e., just about 1-3 times a year. Very few had frequent occurences of fever (i.e., once a month). High blood pressure and asthma were the most common diseases in the households surveyed. Diabetes ranked third, followed by heart disease.

Table 3. House ownership, sanitation and health

Variables	Proportion (%) of households
House ownership	
Own house	25 (33,220/660,982)*
Renting	36 (75/3,730)**
Owned by relatives	39
Provided by employer	0
Type of toilet	
Water-sealed toilet with flush	45
Water-sealed toilet without flush	53
Public/communal toilet	1
Open pit	1
None	0
Main water source	
MWSS private connection	66
MWSS shared connection	25
Own well	1
Public (communal) well	5
Public communal tap	1
Water vendor	0
Others	2
Frequency of fever in the household	
Frequent (not less than once a month)	1
Not so frequent (once in 2-3 months/4-6 times a year)	11
Sometimes (once in 4-11 months/2-3 times a year)	46
Rarely (once in a year)	42
Illnesses in the household	
Heart disease	9
High blood pressure	31
Asthma	27
Diabetes	11
Liver disease	1
Cancer	2
Others	6

Notes:
* = average value of owned houses (US$/PhP)
** = average monthly rent (US$/PhP)

The survey results confirmed the widespread acceptance of vaccination and the availability of public vaccination programs in the Philippines. Almost all the respondents from low to high income classes had the children in their households given the basic vaccines as provided in the government's Expanded Program on Immunization[6] (See Table 4). The majority of the households availed themselves of the free vaccination services provided by the government and charitable institutions.

Table 4. Vaccinations for children

Vaccinations and Providers	Proportion (%) of respondents
Children vaccinated for:	
Tuberculosis (BCG)	99
Diphtheria-Pertussis-Tetanus (DPT)	99
Oral Polio Vaccine (OPV)	98
Measles	95
Hepatitis B	94
Vaccinations taken at:*	
Private clinics/hospitals	41
Public clinics/hospitals (free)	9
Free vaccination programs of charitable organizations	66

Note: * = Sum exceeds 100% as respondents were allowed to give multiple answers.

3.2 WTP and VSL

Most respondents accepted the dengue vaccine scenario. Only three of the 500 respondents rejected our description of the dengue vaccine as a safe and effective means of eliminating the chance of contracting dengue and thus of reducing mortality risks. [7] These three indicated they would not buy any vaccine and would not take the vaccine even if it were offered for free.

[6] The Expanded Program on Immunization is a priority program of the Department of Health which primarily aims to give all children the following basic vaccines before their first birthday: Bacillus Calmette Guerin (BCG) for tuberculosis, measles, three doses each of Diphtheria-Pertussis-Tetanus (DPT), and the Oral Polio Vaccine (OPV).

[7] One thought that he and his family members had a very small chance of getting ill with dengue. The second likewise believed that his household had a small chance of contracting dengue and further suspected the effectiveness of the vaccine and the side effects it might cause. The third also questioned the effectiveness, safety and side effects of the vaccine, adding that many drugs in the market were not effective.

Two hundred and seventy-one respondents indicated their willingnesss to buy one or more dengue vaccines for their household members. Table 5 shows the proportion of household members, by age group, for whom a dengue vaccine would be purchased. Two observations can be made. One, the proportion of household members for whom a vaccine would be purchased generally declined with higher vaccine price for both the 14 years and below age group and 15 years and above age group. Thus, we have a fairly well-behaved bid function for both age groups. Two, the proportion of household members for whom a vaccine would be purchased was remarkably higher for the younger group at all bid levels and for both vaccine durations. This could indicate that the respondents factored the higher mortality risk from dengue of the younger age group into their WTP decisions.

There were 34 (out of 271) who were not so sure or not sure about buying the vaccine. Figures enclosed in parenthesis in Table 5 give the proportions of household members for whom a dengue vaccine would be purchased when unsure "buy" answers were considered "not buy" answers. The two observations above, however, hold for this data set as well.

Table 5. Proportion of household members for whom a dengue vaccine would be purchased*

Vaccine price (US$)	1-year efficacy vaccine		10-year efficacy vaccine	
	14 yrs & below	15 yrs & above	14 yrs & below	15 yrs & above
2	0.625 (0.612)	0.196 (0.196)	0.689 (0.641)	0.244 (0.237)
10	0.621 (0.534)	0.112 (0.033)	0.656 (0.613)	0.094 (0.094)
20	0.304 (0.250)	0.055 (0.031)	0.505 (0.362)	0.127 (0.076)
60	0.298 (0.234)	0.015 (0.015)	0.400 (0.358)	0.078 (0.054)
100	0.231 (0.212)	0.047 (0.020)	0.234 (0.181)	0.044 (0.044)

Note: * = Figures in parenthesis correspond to the proportions when unsure "buy" answers are converted to "not buy" answers.

Buying respondents (both sure and not sure) were also asked to indicate which expenditure item they would reduce the most to free resources to buy the vaccine. The answers are summarized in Table 6. The biggest proportion of respondents selected savings, followed by clothing, and then recreation. Other items/resources specified by the respondents included vices (drinking and gambling), cosmetics, and loans.

Table 6. Expenditures to be reduced most to buy the dengue vaccine

Expenditure item	**No. of respondents**	**Proportion (%) of buying respondents**
Food	9	3.3
Clothing	91	33.6
Recreation	46	17.0
Savings	96	35.4
Others	29	10.7
Buying respondents	**271**	**100.0**

The answers to the debriefing questions indicated that generally, the respondents seriously considered their budget constraints and gave thoughtful answers. They also reflected the efforts of the enumerators to elicit honest responses from the respondents. The hypothetical CV scenario was expected to generate a number of unsure answers and this came out clearly in the survey.

3.2.1 Household vaccine demand model

Figure 1 shows the proportion of all household members for whom vaccines would be purchased. The bid function is well-behaved for both vaccine durations. The proportion of household members for whom vaccines would be purchased monotonically declined as the vaccine price increased.

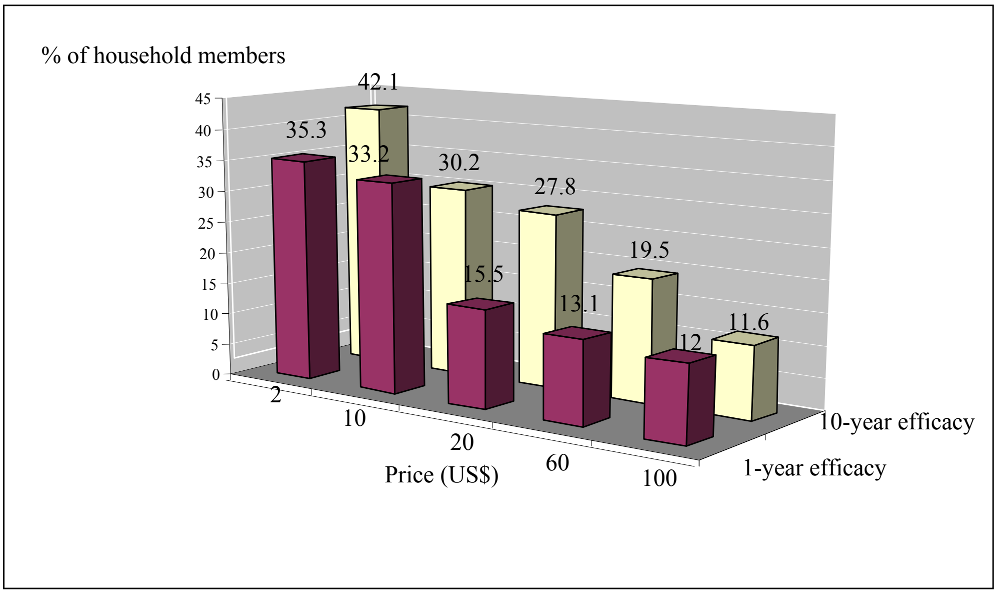

Figure 1. Vaccine demand

Household vaccine demand, expressed in terms of the number of vaccines the repondent would purchase for household members in proportion to the total number of household members, was estimated for each vaccine duration as a linear function of household income, other household characteristics, and respondent's characteristics using ordinary least squares.

The results of the regression runs are summarized in Table 7. Our household vaccine demand model revealed a significant positive income effect. Two dengue-related household profile variables, namely *DengueFamily* and *Prevent*, yielded some siginificant effects on vaccine demand which were in accord with expectations, i.e., households with a past case/s of dengue and which undertook more of the dengue preventive measures cited were likely to buy more vaccines. The respondent's characteristics (i.e., gender, age, and smoking) and knowledge about dengue did not yield any consistent nor significant influence on vaccine demand. Dummy variables for the survey sites generally had a negative sign, albeit with varying degrees of significance, indicating that the demand for dengue vaccines was higher for households in Quezon City (the omitted survey site) than in Pasig, Manila, Caloocan and Makati. This could be due to the relatively higher incidence of dengue in Quezon City.

Table 7. Household vaccine demand (as a proportion of household size), Ordinary Least Squares

Explanatory variables	**1-year efficacy vaccine**	**10-year efficacy vaccine**
Constant	0.332**	0.150
Income	0.004***	0.004***
RespondentGender	-0.046	0.049
RespondentAge	-0.004	-0.001
RespondentSmoking	0.070*	0.000
DengueFamily	0.154**	0.114
DengueOthers	0.000	-0.000
Correct	-0.006	-0.008
Prevent	0.014	0.027*
FeverFrequency	-0.020	0.000
Pasig	-0.127**	0.000
Manila	0.010	-0.047
Caloocan	-0.014	-0.104*
Makati	-0.079	-0.097
R-square	0.170	0.140
Number of observations	250	250

Notes: * = significant at $\alpha = 0.10$; ** = significant at $\alpha = 0.05$; *** = significant at $\alpha = 0.01$

3.2.2 The vaccine purchase decision for individual child household members

Table 8 presents the results of the binary probit random effects model of the respondents' stated decisions to purchase a dengue vaccine for each household member aged 14 years and below. Results for both the one-year and ten-year duration vaccines conformed with economic theory and intuition in that the vaccine price had a signifcant negative effect on the respondent's decision to purchase a vaccine for a household member while the predicted vaccine demand had a significant positive effect. The probability of the respondent buying a vaccine for a member was also significantly higher for younger members and for members who were the respondent's own children. The gender of the household member had no systematic and significant effect on the decision to buy the vaccine.

Table 8. Willingness to pay for a dengue vaccine for household members aged 14 years and below, Binary probit model with unbalanced panel random effects

Explanatory variables	1-year efficacy vaccine	10-year efficacy vaccine
Constant	-8.434*	-13.676**
Vaccine price	-0.0021***	-0.0027**
Predicted vaccine demand (in proportion to household size)	36.076***	53.363**
Member age	-0.319***	-0.579**
Member gender	0.068	-0.646
Member is respondent's child	6.648	9.862**
Random effects	0.973***	0.983***
Log-likelihood	-181.688	-159.864
Number of observations	521	479

Notes: * = significant at $\alpha = 0.10$; ** = significant at $\alpha = 0.05$; *** = significant at $\alpha = 0.01$

Using the results of the random effects probit model, the mean willingness to pay for a dengue vaccine for children 14 years old and younger was calculated to be about US$35 (PhP 1,729) for the one-year duration vaccine and US$41 (PhP 2,047) for the ten-year duration vaccine (first panel of Table 9).

The non-parametric mean willingness to pay values for the dengue vaccine calculated using the Turnbull method are shown in the second panel of Table 9. The non-parametric WTP values were slightly lower than the parametric estimates for both vaccine durations.

Table 9. Mean WTP for a dengue vaccine for children aged 14 years and below

	1-year efficacy vaccine	**10-year efficacy vaccine**
Parametric		
US$ (PhP)	34.57 (1,729)	40.95 (2,047)
Non-parametric (lower-bound estimates)		
US$ (PhP)	30.4 (1,520)	37.0 (1,852)

The mean WTP for the ten-year duration vaccine was only slightly higher than the mean WTP for the one-year duration vaccine, and the difference was much smaller than the proportionality requirement of the external scope test. Nearly all previous studies of mortality risk reduction failed the external scope test. From among 25 CVM-VSL studies reviewed by Hammitt and Graham (1999), only nine allowed for an external magnitude test and all nine studies violated the proportionality assumption.[8] More recent CVM-VSL studies employing visual aids and risk comprehension training modules were no exception (see, for instance, Hammitt and Liu 2004; Alberini, Hunt and Markandya 2004; Liu et al 2005; Maskery et al 2007).

3.2.3 VSL

Reflecting the high literacy rate in the Philippines, particularly in highly urbanized MM, respondents generally understood the concept of mortality risk. More than four-fifths of the respondents correctly answered the comprehension test question in the short module on understanding mortality risks after only one explanation. About 16% required one repetition of the explanation while the remaining 3% required two repetitions. Thus, we feel reasonably confident that respondents understood and took into consideration the mortality risk reduction that the dengue vaccine would bring about.

The results of the debriefing questions on the relative importance of the different reasons for buying the dengue vaccine for young members of the household aged 14 years and below are summarized in Table 10. On average, “yes” respondents gave the mortality risk reduction effect of the vaccine a weight of 38.7% (or a 95% confidence interval of 35.7–41.7%). This result indicates that although the mortality risk reduction was considered the most important among the five reasons given for buying the dengue vaccine, the weight attached to it was much lower (less than half) than the 100% weight implicitly assumed in VSL studies that based their estimates on the entire willingness to pay for an intervention.

[8] Three of the nine did not even satisfy the expected positive relationship between WTP and the risk reduction magnitude.

Table 10. Relative importance of reasons for buying the dengue vaccine

	Mean	Std. Deviation
1. To prevent death from dengue	3.87	1.65
2. To avoid the pain and suffering from being ill with dengue	1.91	1.12
3. To avoid incurring medical expenses	1.34	1.11
4. To avoid inconvenience and being absent from work or school	1.58	1.26
5. So that it will not be necessary for us to take and spend on other precautions (such as using anti-mosquito lotions, mosquito nets, and mosquito killers)	1.31	1.24

We used the stated weights in Table 10 to break down the willingness to pay for a dengue vaccine into the different underlying reasons and isolate the mean value attached by the respondents to a reduction in the risk of a child dying in their households. Following Hammitt and Liu (2004) and Vassanadumrongdee and Matsuoka (2005), the VSL estimates were calculated as the average of the values of the two risk reduction magnitudes. The WTP and resulting VSL estimates are shown in Table 11. The value of statistical life estimates for a child 14 years old or younger in Metro Manila ranged from US$0.70 million to US$0.80 million, about 118-133 times the annual income. Our results are fairly within the range of estimates derived in recent survey-based VSL estimates in the region. Vassanadumrongdee and Matsuoka (2005) came up with VSL estimates of US$0.7-1.5 million, about 100-170 times the annual income, in their study with scenarios on traffic accidents and air pollution in Bangkok in 2003. Meanwhile, Hammitt and Liu's (2004) liver cancer and non-cancer diseases scenarios resulted in VSL estimates of US$0.5-1.1 million, 36-80 times the annual income in Taiwan in 2001.

Compared to other VSL estimates for children, our estimates for Metro Manila are lower than previous ones in the US using revealed preference averting behavior methods (e.g.: Mount et al's (2001) estimate of US$2.6-7.7 million based on vehicle fatality rates and costs in 1997, and Jenkins, Owens and Wiggins' (2001) estimate of US$1.1-2.7 million based on bicycle helmet demand in 1997), but much higher than the recent child VSL estimate for Bangladesh of US$30-60,000 (Maskery et al 2007).

Table 11. WTP for mortality risk reduction and VSL estimates for children in Metro Manila

	Parametric	Non-parametric
WTP US$ (PhP)	14.61 (699)	13.04 (652)
VSL US$ millions (PhP millions)	0.80 (39.9)	0.70 (35.2)
VSL/Annual Income	133	118

4.0 CONCLUDING REMARKS

We arrived at estimates of the value of statistical life of a child in Metro Manila, which to our knowledge, are the first VSL estimates for the Philippines and one of the very few contingent valuation method (CVM)-based VSL estimates for children. Our estimates were derived from the willingness to pay for a hypothetical dengue vaccine—a familiar risk and intervention context for Filipinos, particularly for children.

Our study differs from existing literature in two ways. First, the WTP for a dengue vaccine was elicited for each and every household member instead of only one household member. We believe that our approach better reflects the reality of household decision-making wherein the head decides to purchase an individually consumed good for one or several household members after considering the needs and wants of all members in relation to the single household budget constraint. Likewise, a different modeling procedure was undertaken. We used a two-stage model where the household vaccine demand, in proportion to household size, was regressed with household income and a vector of respondent and other household characteristics in the first stage, and the "yes-no" response to the dichotomous choice WTP question for each household member was specified as a random effects probit function of the predicted household vaccine demand (derived from the first stage) and a vector of particular household member characteristics in the second stage.

Second, the WTP for the mortality risk reduction was isolated from the stated WTP for the specific health intervention before VSL calculation. We found out that although the mean weight for the mortality risk reduction was larger than the weights for the other reasons for buying the vaccine, it was only about a third of the total. This result suggests the extent of likely deviations of past specific intervention-based VSL estimates when applied to other risk contexts—a finding which is not inconsistent with studies recommending risk context adjustment factors of as large as two to four times for VSL estimates (Revesz 1999; Hammitt and Liu 2004).

Our models conformed with predictions of economic theory—our household vaccine demand model yielded a significant positive income effect while our random effects probit model for vaccine purchase decisions yielded a significant negative price effect. Our VSL estimates compared well with CVM-VSL estimates in existing literature—relatively lower than those derived for developed countries and falling in the lower range of estimates for slightly richer countries in the region.

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