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Vaccine 20 (2002) 2585–2591

Vaccine

www.elsevier.com/locate/vaccine

Private demand for a HIV/AIDS vaccine: evidence from Guadalajara, Mexico

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Received 7 June 2001; received in revised form 19 February 2002; accepted 21 February 2002

Abstract

The private demand for a hypothetical vaccine that would provide lifetime protection against HIV/AIDS to an uninfected adult was measured in Guadalajara, Mexico, using the concept of willingness to pay (WTP). A 91-question survey instrument was administered by trained enumerators employing contingent valuation techniques to 234 adults, aged 18–60. Our estimates of private demand indicate that individuals anticipate sizable personal benefits from such a vaccine, and that they would be willing to allocate a substantial portion of their income to be protected in this way from HIV infection. A conservative estimate of the mean WTP of adults in the Guadalajara sample is 6358 pesos (US$ 669) and the median is 3000 pesos (US$ 316). A multivariate statistical analysis of the determinants of individuals' WTP shows that individuals with higher incomes, with spouses or partners, and with higher perceived risks of becoming infected with HIV are willing to pay more for the vaccine. Older respondents are willing to pay less. These results suggest that there is likely to be a potentially large private market for a HIV/AIDS vaccine in the middle-income developing countries such as Mexico. These findings have important implications both for the level of R&D effort that is devoted to a vaccine and, assuming these efforts are successful, for future policies to make the vaccine available to the public.

Keywords: Willingness to pay; HIV/AIDS vaccine; Contingent valuation method; Demand assessment

1. Introduction

This paper examines the size of the private market in Guadalajara, Mexico, for a possible vaccine against HIV/AIDS. The paper addresses the following question: "How much are uninfected individuals in a middle-income developing country willing to pay for a HIV/AIDS vaccine?" For economists, the answer to this question provides one measure of the economic benefits of such a vaccine.[1]

Although a HIV/AIDS vaccine does not currently exist, there are three related, but conceptually distinct, reasons why it is important to estimate how much uninfected individuals would be willing to pay for such protection. First, information on the structure of private demand for a potential HIV/AIDS vaccine will be necessary to design and manage public sector interventions if a vaccine is successfully developed. To make an informed choice on the trade-off between coverage and cost sharing by individuals, policy makers need to understand the amount of money different groups in the populations are willing to pay for a vaccine,

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[1] To date, estimates of the economic benefits of preventing HIV/AIDS have focused largely on the costs of illness (e.g. hospital costs) and lost productivity of those people infected. However, these costs constitute only a small portion of the economic losses associated with the HIV/AIDS epidemic because they do not include the pain and suffering that infected individuals incur. From an economist's perspective, the economic benefits of preventing HIV/AIDS are most appropriately measured by how much uninfected individuals are willing to pay to avoid the risks of contracting HIV in the future. This willingness to pay (WTP) should reflect an individual's desire not only to avoid the potential costs and lost income due to illness, but also to avoid the pain and suffering (to themselves and their families) that would result from infection. In addition, a HIV/AIDS vaccine can benefit uninfected individuals by reducing the anguish and uncertainty regarding the possibility of future infection. This should also be captured in their ex ante WTP for a vaccine. A private individual's WTP is unlikely, however, to capture the full economic benefits of a vaccine. There are positive externalities associated with an individual becoming vaccinated because such an action will reduce the risk of infection to others (see Confronting AIDS: Public Priorities in a Global Epidemic, a World Bank Policy Research report, published for the World Bank by Oxford University Press, 1997).

0264-410X/02/$ – see front matter
PII: S0264-410X(02)00152-4

as well as how alternative vaccination strategies will affect the spread of the epidemic.

Second, evidence regarding individuals' willingness to pay (WTP) for a potential vaccine may encourage more private sector research on vaccine development [1]. Third, public funding by both governments in industrialized countries and international donor organizations for the development of a HIV/AIDS vaccine is generally acknowledged to have been very low, relative to the magnitude of the problem [2]. Accurate estimates of the magnitude of the economic benefits of reducing the AIDS epidemic may help spur increased government action. Because both public and private sector financial resources are limited, health sector budgets must be allocated among competing needs [3–5]. It is thus important for policy makers to better understand individuals' perceived economic benefits of protecting themselves against HIV/AIDS relative to other global health priorities (e.g. malaria prevention).

2. Methods

The results of this study are based on a 91-question, in-person, "contingent valuation" survey of 234 adults (18–60 years of age) administered in Guadalajara, Mexico in November 1999. Surveys of this type have been used to estimate individuals' WTP for a wide variety of environmental and public health improvements, both in industrialized and developing countries. If they are carefully designed and executed, many economists believe that such contingent valuation surveys can produce meaningful, accurate estimates of individuals' WTP [6–10].

Guadalajara, Mexico was selected as the site for this research, precisely because it is not at the epicenter of the global AIDS epidemic. In Mexico, the epidemic is largely concentrated in a handful of large urban centers, one of which is Guadalajara. Guadalajara could thus be illustrative of the private demand for a HIV/AIDS vaccine in other locations in the middle-income countries where HIV is threatening to become a serious pubic health threat, but where relatively few people are actually infected with the virus.[2]

Respondents were recruited from the four main districts of Guadalajara, each of which had a distinctive socioeconomic profile. Within each district, enumerators were given gender and age quotas for the selection of respondents, based on the latest census information. Respondents were selected using an intercept approach in plazas, shopping malls, and other public places, and asked if they would be willing to participate in the survey. The majority of individuals contacted in this manner agreed to be interviewed. Although this sampling procedure did not generate a rigorous random sample, it resulted in a diverse set of respondents from throughout Guadalajara. As shown in Table 1, our sample has a slightly larger percentage of respondents in the age groups of 20–24, 25–29, 30–34, and 35–39 years than the census population estimates would indicate. Also, it is likely that our sample is slightly biased toward middle- and upper-income households, even though respondents were selected from different parts of the city. Although the results should not be extrapolated to the general population of Guadalajara, we believe that the findings are illustrative of individuals' private demand for a HIV/AIDS vaccine across a broadly diverse cross-section of the city's population.

Table 1
Comparison of the study sample with 1990 census estimates of age and gender distribution of Guadalajara

	Census		Our sample	
	Male (%)	Female (%)	Male (%)	Female (%)
20–24	10.43	11.44	9.76	15.61
25–29	8.22	9.07	8.78	4.88
30–34	6.50	7.14	8.29	7.32
35–39	5.93	7.05	7.80	6.34
40–44	5.02	6.04	4.39	7.80
45–49	4.28	4.80	3.90	5.85
50–54	3.65	4.23	1.95	0.98
55–59	3.02	3.17	2.93	3.41

All respondents were told that the interview was entirely voluntary and that the results were completely confidential (at no time during the interview did the enumerator ask for a respondent's name or address). Respondents were asked to read an advised consent form that told them to contact one of the co-authors at the University of Guadalajara School of Medicine if there were any questions about the survey or problems with its administration. Respondents were asked during the course of the interview whether they had been tested for HIV, and if so, the result of the test. If an individual indicated that they were HIV-positive, the enumerator thanked them for their participation and then informed them that the rest of the survey was designed for individuals who were not infected. The results reported here are only for individuals who were either (1) not infected, or (2) infected, but did not know it. This is because it did not make sense to ask HIV-positive individuals their WTP for a vaccine.

To determine the individuals' WTP, we asked respondents to suppose that a vaccine against HIV existed, and that it would provide 100% protection against contracting the virus over an individual's entire lifetime. We also asked them to suppose that the vaccine would not be provided free by the

[2] The 1995 population of the Guadalajara metropolitan area was 3,279,424. The State of Jalisco, of which Guadalajara is the capital, has a population of approximately 6.5 million. From 1984 to 1999, 4657 people in Jalisco have been officially listed as having AIDS (including those living and those who have died). Considering reporting inaccuracies, the true number of AIDS cases may be as high as 1.6 times the official estimate. The estimated number of individuals in Jalisco currently infected by HIV is 29,360.

Table 2
Willingness-to-pay for HIV/AIDS vaccine according to income, age, and perceived risk

Respondent sample	Number of observations	WTP-with-certainty (pesos)		Mid-point estimate of maximum WTP (pesos)	
		Mean	S.D.	Mean	S.D.
Full sample	234	6358	15416	9858	16920
Household income (pesos per month)					
<4500	51	2533	4815	5257	8606
4500–6400	58	2916	4817	7194	11242
6500–12400	58	6681	11261	11817	18240
>12400	67	11969	25261	14163	22914
Age					
18–22	48	9171	19119	13680	22033
23–29	60	7782	18932	11487	18330
29–40	68	4783	9090	9044	14824
41–60	58	4403	13651	5990	11624
Perceived risk of HIV					
Impossible	23	3504	6656	6241	11814
Very unlikely	84	5743	14609	10013	19666
Possibly/do not know	96	6265	13271	11186	16594
Most likely yes	31	10428	25311	7929	12272

In November 1999, US$1 = 9.5 pesos.

government or paid for by any health insurance or social security system.[3] We then showed the respondents a list of prices for a hypothetical HIV vaccine, ranging from very low prices to very high prices, and asked them two questions: (1) what was the highest price on the list that they were absolutely certain that they would pay for the HIV vaccine (a lower bound on their WTP that we refer to as "maximum WTP-with-certainty"); and (2) what was the lowest price that they were absolutely sure they would not pay for the vaccine (an upper bound on their WTP). The range of prices presented to respondents was selected to cover almost all prices that a respondent would conceivably consider. It ranged from 0 at the bottom to 100,000 pesos (over US$ 10,000) at the top.

In fact, it is unrealistic to expect that any HIV/AIDS vaccine available in the near or medium term would provide 100% protection for a lifetime. Our results are thus best viewed as an upper bound on individuals' private demand for an efficacious HIV/AIDS vaccine.

[3] The exact wording of the information that respondents received about the hypothetical vaccine was as follows: HIV/AIDS vaccine does not exist. But just suppose it was possible to be vaccinated against HIV/AIDS. Assume that this vaccine would be completely safe, and there would be no side effects. The vaccine would be available as an injection or as oral drops. Suppose that the two forms of the vaccine would be 100% effective. Once vaccinated, it would not be possible (there would be no risk) to get infected with the HIV virus. The vaccine would be effective for your entire lifetime. However, the vaccine would have to be taken before someone became infected with the virus; it would be totally ineffective for those who are already infected. Suppose that the vaccine was in limited supply and that those who wanted a vaccine would have to pay a fixed price for the vaccine. Everyone would pay the same price.

3. Results

The survey results are summarized in Table 2. Our results suggest that a conservative estimate of the WTP of the average uninfected adult in our sample in Guadalajara for a vaccine that would provide lifetime protection against HIV/AIDS is 6358 pesos (US$ 669). We caution, however, that this estimate of the mean individual's economic benefits is based on expressed WTP. Even if our sample was an accurate representation of the population of Guadalajara, this mean estimate of WTP should not be multiplied by the population of Guadalajara to obtain an estimate of the revenues that could be collected from the population. The total expected revenues would be less because each individual could not be required to pay an amount equal to his total (maximum) individual WTP.

We estimated the degree of certainty of individuals' responses as shown in Fig. 1. Respondents are ordered by their maximum WTP-with-certainty, from highest to lowest. There is a vertical line in Fig. 1 for each respondent; it represents their WTP range, from their maximum WTP-with-certainty (lower bound) to the minimum amount that they are certain they would not pay (upper bound). For some respondents their answers to these two questions were in fact the same, indicating that they were certain about the maximum amount they would pay for the vaccine. These individuals' answers are represented in Fig. 1 by a single point (i.e. a dot). For other respondents there was a sizable gap between the two stated values, indicating that there was a range of prices within which they were uncertain whether or not they would purchase the vaccine. One estimate of an individual's maximum WTP for the vaccine is the mid-point

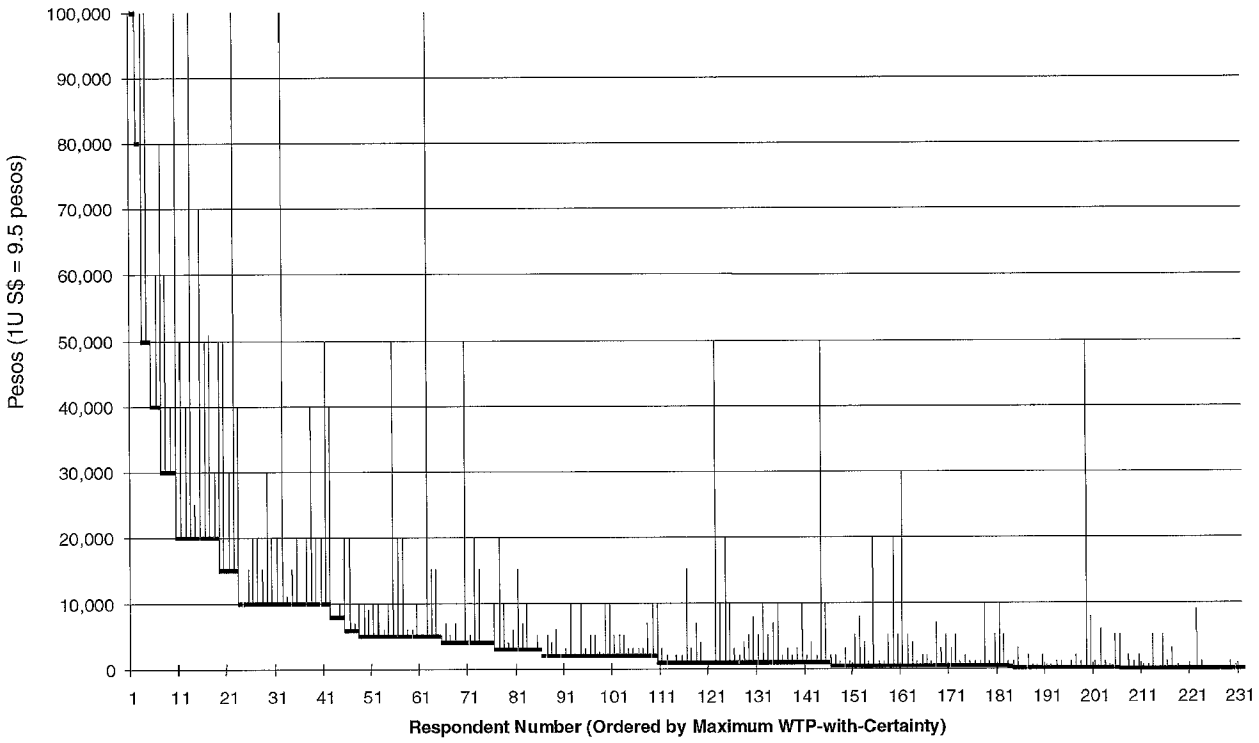

Fig. 1. Willingness-to-pay (WTP) ranges for the HIV vaccine (only includes 231 respondents, because three respondents did not state an upper bound value to the WTP questions; the upper bound responses for the first two respondents were censored at 11,000 pesos for presentation purposes).

of this range (which we refer to as the "mid-point estimate of maximum WTP").

As shown, the degree of uncertainty about WTP differs considerably across individuals. Almost 10% of the sample respondents indicated no uncertainty at all as to what they would be willing to pay. Some respondents indicated a relatively small range of uncertainty (shown by the shorter vertical lines in Fig. 1); others reveal a wide range of uncertainty. Individuals with a wider range of uncertainty tend to be those expressing a higher maximum WTP-with-certainty.

Contingent valuation can be an effective preference elicitation tool as long as respondents understand the context and content of the survey instrument. The survey results revealed that respondents in Guadalajara were very well-informed about many aspects of the AIDS epidemic, including the primary risk factors for HIV infection. Over 85% of the sample respondents identified the main ways that an individual can become infected with the HIV virus. Almost 50% claimed to have heard about anti-retroviral drugs, although few had a clear sense of the costs of these drugs in the private market (about US$1000 per month for triple drug therapy in Guadalajara). Virtually all respondents knew that AIDS was fatal and that a cure for AIDS does not currently exist. Less than half of the respondents thought it very unlikely or impossible that they could acquire HIV in their lifetime.

Many individuals' perceived probability of infection was quite high. A large portion of our sample (44%) had a friend or a family member with HIV/AIDS or who had died of AIDS. This may seem like an unusually high percentage of respondents who knew someone who had HIV/AIDS or had died of AIDS given the low prevalence rate in Guadalajara. In fact, assuming a Poisson distribution, this would imply that the average respondent needed to know about 166 people (a total that does not seem implausible in Mexican culture).

There was a great deal of variation across individuals in their stated WTP (Fig. 1), ranging from 0 in some cases to over US$1000 for approximately 10% of the respondents. This finding is consistent with recent evidence on individuals' private demand for a malaria vaccine even among a quite homogenous population [11].

An obvious question to ask about these data on individuals' stated WTP is whether they are accurate and reliable. Would respondents really purchase a vaccine if it were available at a price lower than the maximum amount they indicated they would pay? Without having an actual vaccine to test market, it is difficult to provide irrefutable evidence that the respondents in this survey would actually do what they say. However, the results in Table 2 offer some evidence of the internal consistency of respondents' answers which supports the credibility of these estimates of individuals' private demand for a HIV/AIDS vaccine. That is, to control for differences among individuals in our sample, we also asked respondents questions about their knowledge, attitudes, and perceptions of HIV/AIDS, questions about their lifestyle, and questions about their socioeconomic status.

Table 2 presents estimates of mean WTP for different groups of respondents. As one would expect, respondents with high incomes had a statistically significant higher WTP for the vaccine than respondents with relatively low incomes (this is true for both measures of WTP: (1) maximum WTP-with-certainty and (2) mid-point estimate of maximum WTP). The mean WTP-with-certainty, as a percentage of mean annual income, was about 8% (or about one month's income). Younger respondents, who are likely to be more sexually active and to face a longer period of potential future exposure to the virus, also had a higher WTP than older respondents did.

Table 2 also shows that respondents with high perceived risks of contracting HIV/AIDS generally had higher WTP-with-certainty than respondents with lower perceived risks (although the statistical significance of these results is not strong). Although results are not shown in Table 2, the survey was also separately administered to two additional sub-populations in Guadalajara who are likely to perceive themselves to be at relatively high risk of HIV/AIDS—male homosexuals (50 respondents) and health workers (50 respondents). Average WTP in these two groups was found to be significantly higher in the general population, lending additional support to the credibility of the general population results presented here.

The bivariate results shown in Table 2 are supported by multivariate statistical analysis that includes additional explanatory variables that one may hypothesize would affect individuals' WTP for a HIV/AIDS vaccine. Table 3 presents descriptions of these additional explanatory variables used in this analysis, including the gender of the respondent, respondent's education, the respondent's knowledge of HIV/AIDS and anti-retroviral treatment, self-reported health status, whether the respondent had ever been tested for HIV/AIDS, and whether the respondent lived with a spouse or partner. Table 3 also presents the direction of the hypothesized effect of these explanatory variables on individuals' WTP for a vaccine, as well as the means and standard deviations of each variable included in the model.

Table 4 presents the results of an ordinary least squares regression model that explains variations in the individuals' WTP as a function of the full set of independent variables presented in Table 3. As shown, four explanatory variables are statistically significant: (1) household income, (2) age of respondent, (3) perceived risk of becoming infected with HIV, and (4) whether the respondent lives with a spouse or partner. Household income, age, and perceived risk of becoming infected with HIV, all have the expected effect on individuals' WTP, and are highly significant. Respondents who were living with a spouse or partner were willing to pay more than respondents who were not. One might expect that respondents living with a spouse or partner would be likely to have fewer sexual partners, and thus willing to pay less for a vaccine. On the other hand, respondents living with spouses or partners may be willing to pay more for a vaccine for themselves in order to protect their spouse or partner. Both explanations are just conjecture, as we do not have data on the sexual behavior of respondents or their feelings of altruism toward their spouse or partner.

The explanatory variables for health status, whether the respondent had been tested for HIV, and whether the respondent knew about anti-retroviral treatment all had the expected signs, but were not statistically significant. The variables for respondent's education, gender, and knowledge of AIDS, were all statistically insignificant, and their expected effect on WTP was apriori unclear. For example, one might imagine that an individual with more education would be better able to learn more about HIV/AIDS, and thus be more willing to protect himself by purchasing a vaccine. Alternatively, more education might convince someone that she was not really at risk. Similar causal relationships could be posited about the variable describing respondents' knowledge of HIV/AIDS. We believe that our variable measuring perceived risk of becoming infected has a more obvious and direct relationship with WTP than education or knowledge of HIV/AIDS, and this appears to be supported by the model results.

Table 3
Variable descriptions, means and standard deviations, and expected signs

Variable description	Mean (S.D.)	Expected sign
Dependent variable: logarithm of mid-point estimate of maximum of WTP	7.7 (3.5)	N.A.
Independent (explanatory) variables		–
Logarithm of household income (pesos)	8.8 (0.7)	+
Age of respondent (years)	32.7 (11.9)	–
Gender of respondent (1 = male; 0 = otherwise)	0.5 (0.5)	?
Respondent's perceived risk of contracting HIV/AIDS (1 = totally sure; 2 = very likely; 3 = possibly yes, possibly no; 4 = very unlikely; 5 = totally impossible)	3.4 (0.8)	–
Education of respondent (number of years of school)	11.9 (4.3)	?
Whether respondent has a spouse or partner (1 = has partner or spouse; 0 = otherwise)	0.6 (0.5)	?
Respondent's self-assessment of the health status compared to others (1 = much better than average; 4 = much worse)	2.3 (0.8)	–
Knowledge of HIV/AIDS (number of correct answers to 10 questions)	7.5 (0.8)	?
Tested for HIV/AIDS (1 = respondent has been tested; 0 = otherwise)	0.2 (0.4)	+
Knowledge of anti-retroviral treatment (1 = if respondent knew about anti-retroviral treatment)	0.4 (0.5)	–

Table 4
Determinants of respondents' willingness to pay (ordinary least squares regression)

Independent variables	Estimated coefficient	S.E.	*t*-statistic	Probability > |*t*|	95% CI
Intercept	5.29	3.77	1.40	0.16	−2.1–12.72
Logarithm of household income	0.97*	0.37	2.65	0.01	0.25–1.69
Age of respondent	−0.09*	0.02	−4.43	0.00	−0.13–(−0.05)
Gender of respondent (1 = male)	0.62	0.44	1.41	0.16	−0.24–1.50
Respondent's perceived risk of contracting HIV/AIDS	−0.62**	0.27	−2.32	0.02	−1.15–(−0.09)
Education of respondent (number of years of school)	0.03	0.06	0.54	0.59	−0.90–0.16
Whether respondent has a spouse or partner (1 = has partner or spouse)	1.10**	0.46	2.38	0.02	0.19–2.01
Respondent's self-assessment of health status (1 = much better than average; 4 = much worse)	0.43	0.26	1.62	0.11	−0.09–0.94
Knowledge of HIV/AIDS (number of correct answers to 10 questions)	−0.44	0.30	−1.47	0.14	−1.03–0.15
Tested for HIV/AIDS (1 = respondent has been tested)	0.23	0.54	0.43	0.67	−0.83–1.30
Knowledge of anti-retroviral treatment (1 = if respondent knew about anti-retroviral treatment)	−0.59	0.46	−1.28	0.20	−1.50–0.32

Dependent variable: logarithm of mid-point of WTP range (i.e. mid-point estimate of maximum WTP). $N = 230$; $F(10, 219) = 5.56$; probability > $F = 0.00$; $R^2 = 0.20$; adjusted $R^2 = 0.17$.

* Indicate 1% significance levels.

** Indicate 5% significance levels.

The F-test indicates that, one can reject the null hypothesis that there is no relationship between individuals' WTP and the explanatory variables at a very high level of confidence. Although the overall explanatory power of the multivariate model presented in Table 4 [4] is not high ($R^2 = 0.20$), this is consistent with the findings of other regression models of the determinants of the WTP bids obtained from contingent valuation studies [12].

4. Discussion

These results strongly suggest that there is a potentially large private market for a HIV vaccine in the middle-income developing countries such as Mexico for a highly efficacious HIV/AIDS vaccine. Our WTP estimates indicate that the individuals in our sample anticipate sizable personal benefits from a vaccine and that they would be willing to allocate in some instances more than half of their monthly household income, at a one-time basis, to be protected in this way from HIV infection (Table 2). These findings have important implications both for the level of research and development effort that is devoted to a HIV/AIDS vaccine, and assuming these efforts are successful, for future policies to make the vaccine available to the public.

At higher prices a given percentage increase in the price of the vaccine results in a smaller percentage decrease in the quantity purchased. This is reminiscent of the present situation concerning anti-retrovirals, where cost recovery efforts have been focused on the more affluent end of the market spectrum (i.e. at high prices, where demand is price inelastic).

[4] The model in Table 4 passes the construct validity threshold test proposed by Mitchell and Carson [12] for similar contingent valuation surveys.

Responses to our survey indicate that there is considerable variation in WTP across the population. This implies that vaccination rates will depend importantly on the prices charged for the vaccine and on the degree to which these prices are subsidized. The results described in Fig. 1 show that at relatively low prices sales of the vaccine would be sensitive to the price charged. For example, at a price of about 100 pesos (US$10.87), almost 90% of the sample indicate that they are certain that they would be willing to purchase the vaccine. As the price increases, the percent of the respondents who said that they would purchase the vaccine falls off sharply. At a price of 6000 pesos (US$652), less than 25% of the population would have purchased the vaccine (based on respondents' stated WTP-with-certainty). Lowering prices should significantly increase the private demand for the vaccine and the portion of total potential economic benefits (as measured by the population's aggregated WTP for the vaccine) that are actually realized. Pricing policies will have important implications for the extent to which private and public entities are able to recover the costs of making the vaccine available to the public.

One recent proposal for increasing private sector incentives to develop a vaccine calls on governments and international agencies, such as the World Bank, to guarantee pharmaceutical companies a market for an effective vaccine by pre-committing to purchase a large volume of vaccines at a predetermined price that is affordable (provided that the vaccine met efficacy and other criteria) [13]. These vaccines could subsequently be distributed free or sold at heavily subsidized prices to individuals in the developing countries. The results of this research suggest that, at least in some middle-income countries, even less extensive subsidies may be adequate to achieve high rates of vaccination. Furthermore, our results should increase governments' confidence in their ability to recover some of the costs of guaranteed

vaccine purchases, and this should provide them with additional motivation for contributing to the development of an HIV/AIDS vaccine. In other words, incentives for vaccine development can emerge from a better understanding of private demand, such as provided by this study.

Our results from Guadalajara indicate that uninfected individuals' WTP for a HIV/AIDS vaccine is substantial, and possibly much greater than previously recognized. If these findings about the magnitude of private demand for a HIV/AIDS vaccine in Guadalajara are at all representative of individuals' WTP elsewhere in the world, they have important implications for the ongoing global policy debates on the development and distribution of a HIV/AIDS vaccine.

Acknowledgements

We would like to express our thanks to Kristin Komives, who assisted us with the development of the questionnaire, and to Jose Luis Ruvalcaba, Alberto Mercado, Rosa Ma. Vazquez, Ma Guadalupe Ramos, Marcos Figueroa, and Genoveva Rizo, who served as enumerators in this project.

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