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Estimating willingness to pay for improvements in drinking water quality: evidence from Peshawar, Northern Pakistan

Abstract

This study is conducted in Hayatabad Town, Peshawar, Northern Pakistan. The article is based on a survey of 150 randomly selected households. The authors use the contingent valuation method and apply the multinomial logit model to elicit the households' willingness to pay for safe drinking water as well their risk averting behavior. The study revealed that the sample households' willingness to pay for improved drinking water is significantly determined by households' awareness, levels of education, income, etc. The study concludes that the sample households are willing to pay much higher than their current monthly bills charged by City Development and Municipal Department, Peshawar.

Keywords: willingness to pay (WTP), contingent valuation method (CVM), drinking water, risk aversion, multinomial logit regression.
JEL Classification: Q21, Q25, Q50, Q51, Q53.

Introduction

Much of the world's population lacks access to adequate and safe water supplies with waterborne diseases and death continuing to be a worldwide burden in both developed and developing countries. The increase in urban population in developing countries has augmented the pressure on natural resources, specially air and water in these crowded centers. Many households in urban areas of developing countries shift significant resources into treating water for drinking consumption.

According to some estimations out of 6 billion people on earth, more than 1 billion, i.e., one-sixth lack access to safe drinking water. The Goal 7 of Millennium Development Goals (MDG) aims at reducing the proportion of people without sustainable access to safe drinking water and basic sanitation to halve by 2015 (UN, 2010). Realizing the importance of water, world water day is celebrated throughout the world on March 22nd every year.

The World Health Organization (WHO, 2004) shows that about 1.8 million people in developing countries die every year from diarrhea and cholera; out of these 90% are children under the age of 5 years. While 88% of diarrheal diseases are attributed to unsafe water supply and inadequate sanitation and hygiene.

The situation regarding the quality of drinking water is also not good in Pakistan. WHO (2008) reports that only 65% of the population has sustainable access to improved water sources and 44% have sustainable access to improved sanitation facilities. According to National Conservation Strategy, about 40% of diseases in Pakistan are water borne (IUCN, 1992).

The Khyber Pakhtunkhwa province is not different from the rest of Pakistan as the available water is not suitable for drinking, since no proper wastewater treatment facilities are available. Drinking water is contaminated due to its mix-up with sewerage water in many residential areas. The industrial estates in Hayatabad, Peshawar discharge untreated wastewater into Bara River. There is an average daily discharge of 304 cusecs from these areas, which ultimately joins river Kabul. River Kabul, which is an important source of water for drinking, irrigation and fisheries, is in danger. The mixing up of polluted water makes the water of Kabul River unsuitable for drinking and could result in reducing of fish population (IUCN, 1996).

As water is the most important component of life, it is polluted very rapidly and for the survival water resources have to be protected. The current population of Peshawar is 1.4 million and is expected to grow rapidly in next few years. This increase in population will have direct impact on the water sector for meeting the domestic, industrial, and agriculture needs. Due to overpopulation, mismanagement and low quality of drinking water in Peshawar, occurrence frequency of water borne diseases may further increase. There is, therefore, a need for thorough investigation of whether there is any awareness regarding quality of drinking water and whether the households are willing to pay for drinking water quality. No such study has been undertaking in Peshawar so this article would be an important one from that point of view. It will also help policy makers to make suitable policies regarding provision of drinking water quality.

The study investigates whether people are aware about the quality of the available drinking water and its negative effects on their health in the study area; examines if the households treat the drinking water properly so that its negative effects could be reduced; probes into the willingness of households to pay for improved drinking water in the study area; analyzes factors that determine the people's willingness to pay (WTP) for improved drinking water quality; and suggests policy recommendations as to how the quality of drinking water could be improved in the area.

1. Relevant literature

Many researchers have conducted studies on estimating WTP and risk averting behavior of households regarding safe drinking water in both the developed and less developed countries. These studies have used various estimation techniques including the contingent valuation method (CVM). The CVM is the most widely frequently used estimation method of households' WTP for non-market amenities and goods. A study by Jordan and Elnagheeb (1993) estimated people's willingness to pay (WTP) for improvements in drinking water quality and people's perceptions of potential groundwater contamination. The CVM method was used to estimate WTP using a checklist format. Jalan, Somanathan and Chowdhuri (2003) conducted a remarkable study in urban India to address a key policy question of whether increasing awareness about the adverse health effects of environmental pollution will increase demand for a cleaner environment. Their study estimated the effects of awareness and wealth on household decisions to purify home water. Average costs of various home purification techniques were used to get estimates on willingness to pay for improved drinking water quality. They found that awareness such as schooling and exposure to mass media had statistically significant effects on adoption of different home purification methods and therefore, on willingness to pay. Um, Kwak and Kim (2004) applied an averting behavior method to reconcile inconsistent public activity with objective environmental risk. The study introduced the perception averting behavior method, in which the authors added a perception measure unit to the conventional averting behavior method. The study found that the perception measure provided a valid explanation for citizens' aversion using tap water in Korea. In another study, Hensher, Shore and Train (2005) used a series of stated choice experiments and mixed logit models to establish the willingness to pay to avoid interruptions in water service and overflows of wastewater, differentiated by the frequency, timing and duration of these events. The empirical evidence is an important input into the regulatory process for establishing service levels and tariffs, as well as useful planning information for agencies charged with finding cost effective ways of delivering services at prices that customers deem to be value for money.

A study by Sattar and Ahmad (2007) is an exercise of the same kind in Hyderabad. Their study used the averting behavior approach for treating water contamination and used the multinomial logit model. Findings of the study showed that the Head of household's formal education and exposure to mass media, significantly affects their WTP for the different water purification methods and indicated that education of the HH's decision-maker is a significant determinant of their WTP as compared to their income level.

Hartono and Harahap (2007) used a hedonic price model to identify the effects of drinking water supply and home sanitation on the rent price of a house, calculate the value of marginal implicit price (marginal willingness to pay) for drinking water and sanitation, and examine factors that affects the availability of drinking water supply and sanitation. The logistic model approach revealed that households' economic and social conditions such as age, number of family members, breadwinner's education, and expenditure per capita influence the availability of drinking water facilities in the form of piped water or pumped water, sanitation facilities in the form of toilet with septic tank, and garbage handling facilities. Human capital or the level of education is very crucial in the possibilities of ownership of drinking water and sanitation facilities. A study in rural Bangladesh by Akter (2008) estimated the economic value of arsenic safe drinking water. It identified the determinants of WTP for safe drinking water. The study estimated that sample households' average WTP for safe drinking water was US$9 per year. Stated WTP amounts were found to vary significantly with respondents' levels of mass media exposure, standards of living of households, age, number of children in each household, levels of education of family members and distance of arsenic-free drinking water source. In Mexico, Vásquez et al. (2009) used a contingent valuation (CV) survey to estimate households' WTP for safe and reliable drinking water. They found that households adopted various risk averting and private investment choices. These included for example, use of bottled water, water purification, and installation of water storage facilities to adapt to the existing water supply system. Their results indicated that households were willing to pay higher than their current water bill for safe and reliable drinking water services.

The available literature shows that the CV method as well as the averting behavior approaches is suitable techniques to estimate the households' WTP safe drinking water. This study, therefore, applies the CVM method to elicit the households' WTP by using multinomial logit model for choosing various purification methods of drinking water in the study area.

2. Data and research methods

2.1. Theoretical framework[1]. Following Deaton and Muellbauer (1980) the conventional microeconomic theory shows that demand function depends upon own-price, cross-price, tastes and preferences and income of consumers. In addition, the demand functions are also affected by other factors like demographic composition, levels of educational, profession and residential status of households. The budget allocation decision-making of households is best described as a multi-stage budget process. In this context the budget will first be spent on food, health and other necessaries. Then, in the second stage the food expenditure will be consumed on clean drinking water and other items, while health expenditure will be spent on treating diarrhea and other waterborne diseases along with other items. At any stage of budget allocation, the size of given budget, prices and preference structure of household does matter. Engel has observed that the nature of preferences is such that income-consumption curves are skewed, that is, as income level (budget size) increases the budget share of luxuries tends to rise and necessities tends to decline. This implies that rich households are more likely to allocate a larger share of their budget to more expensive water purification devices. In a typical averting behavior model developed by Courant and Porter, water purification practices enter into the utility function through the production of health. For instance, utility function of health, H and all other goods Y is:

$$U = U[Y, H(v, \alpha)], \tag{1}$$

where v is the awareness regarding the contamination and α are risk averting activities, v enter through the production of health. It is assumed that households obtain utility directly through drinking safe water and indirectly through the health.

$$U = U(Xj, Z, \pi, H), \tag{2}$$

where X is the water treatment practices to make water safe, Z is the Marshallian composite good, π is the perceived risk from water contamination (however perceived risk may be different from the actual risk) and H is the health level. Further, households choose between X and Z subject to budget constraint:

$$Y = Z + PX + C,$$

where Y is income, P is the price of water alternative and C is the average cost of filter. The conditional demand for water practices can be solved as a function of wealth as proxy of income, awareness (formal and informal), i.e.

$$X^c = X^c(Y, q_i). \tag{3}$$

Substituting the conditional demand function into utility, the conditional indirect utility function is derived. The households will choose water purification alternative j, if and only if $Vj > Vk$ for all $K \neq J$, (if a household's uses two purification methods we have chosen one that is best):

$$V^c = V^c(Y, q_i, \pi). \tag{4}$$

Willingness to pay for the safe drinking water or reducing the risk π for contamination, holding other things constant, is deducted from household's income:

$$V^c = V^c(Y, q_i, \pi) = V^c = V^c(Y - WTP, q_i, \pi^*). \tag{5}$$

2.2. Econometric specification. Consequent upon the above conceptual framework, a representative household's decision to adopt improved water purification method can be interpreted as follows: a household's risk averting behavior and its willingness to pay for safe drinking water will depend on a number of factors including highest level of education of household head, income and wealth level of the household, awareness about the quality of water and water-borne diseases and exposure to media, etc. Safe drinking water practice is expected to be influenced by household characteristics such as education level of adult male and female household members, occupation of heads of households and awareness. Again, it could be expected that all these household characteristics are highly and positively correlated with household income level. Therefore, we expect household income to have a positive impact on the adoption of safe drinking water practice.

The households' decision to use a particular purification method of drinking water and the factors influencing this decision was estimated using multinomial logit model[2]. Multinomial logit regression is used because the dependent variable (y_i) in question is nominal (a set of categories which cannot be ordered in any meaningful way) and consists of more than two categories. In our study, the dependent variable has j = 0, 1, 2, 3, 4 categories, where 0 is base case with no purification and 1, 2, 3 and 4 implies four different purification techniques. The model is given as follows:

$$Pr(y_i = j) = \frac{e^{(x_i \beta_j)}}{1 + \sum_{j=1}^{J} e^{(x_i \beta_j)}}, \tag{6}$$

[1] This Section heavily draws on Sattar and Ahmad (2007).

[2] For further details see Green (2008).

$$Pr(y_i = 0) = \frac{e^{(x_i \beta_j)}}{1 + \sum_{j=1}^{J} e^{(x_i \beta_j)}}, \quad (7)$$

where for the ith household, y_i is the observed outcome and X_i is a vector of explanatory variables which include household head education, household income, age, family size, awareness, etc. e is base of natural logarithm. The unknown parameters β_j are typically estimated by maximum likelihood. $Pr\ (y_i = j)$ j = 1, 2, 3, 4, is the estimated probability of the adoption of a purification method j by i household from the multinomial model. Now from policy perspective, as discussed by Sattar and Ahmad (2007), it is very important question to ask how changes in values of regressors will influence the WTP. In order to this the WTP of households for quality of drinking water will be regressed by ordinary least square (OLS) method as follows:

$$WTP_i = \alpha + \beta_i \sum_{i=1}^{n} X_i + \varepsilon_i, \quad (8)$$

where WTP is the maximum willingness to pay for a household for safe drinking water, α and β are regression coefficients and X_i are explanatory variables as defined above and ε_i the stochastic error term.

2.3. Sample size. The study made use of primary data consisting of 150 households in Phase VI, Hayatabad, Peshawar. This area was purposively chosen for this study as majority of people living there are educated and having higher incomes compared to those living in rural areas of Peshawar. The data were collected using a pre-tested interview schedule. A two-stage stratified sampling technique was used to collect the data for this study. A CV method was used to ask respondents about their awareness and willingness to pay for safe drinking water. Questions regarding households' averting behavior were asked to know whether they were using electric filters, boiling, chlorine tablets, candle filters or no purification. We asked the respondents about their current source of drinking water and their awareness about water born diseases as well as about the socio-economic characteristics including education level, age, income and cost incurred on water purification. We specifically asked questions regarding averting behavior. One important question was: Do you use drinking water from arsenic-contaminated source? (Yes or No). If the answer was "No", then they were subsequently asked if they have do anything to have safe drinking water if they know their earlier drinking water source had a higher arsenic level than the safe level. They were further asked a number of questions regarding features of safe drinking water options, i.e., how long had the household been using safe drinking water option, who was the owner of the water option, and the cost of water collection, treatment and purification.

Regarding willingness to pay, we asked the following question: Suppose the government wants to provide safe drinking water at your door steps at cost higher than your monthly bills charged currently, would you be willing to pay higher charges (Yes/No)? If the answer is "Yes", what would be your maximum willingness to pay to have safe drinking water? Households who were willing to pay higher than their currently monthly charges were takes as those willing to pay for safe drinking water and vice versa.

3. Results and discussion

The data show that the mean monthly income of the sample households was Rs. 25,000. About 90 per cent of the households' heads were males. As many as 70 per cent were married and 30 per cent single or widowed. The average age of respondents was 42 years and the average household size was about 6. More than three-fourth (76%) of the respondents were literate. About 24 % were illiterate. Among the literates the 55% had primary level education, 11% had secondary level, 3% technical diploma holders, 5% bachelor's degree, and 2% were graduates including M. Phil and Ph.D. Almost 60% wanted improvement in drinking water and they were aware of water born diseases and they were willing to pay for safe drinking water. The results showed that about 45% of sample households were in the income group of Rs. 10,000-20,000 per month. More than one-fourth (26%) of households had a monthly income of up to Rs. 10,000. Some 29% of households have income of Rs. 20,000-50,000. Similarly the data revealed that government servants accounted for 40% of the respondents. About one-fifth (20%) were self-employed and/or were businessmen. One-third (33%) of the respondents were employed in the private sector. Doctors, engineers and lawyers together accounted for 6%. The remaining 1% were retired government servants, farmers, students, etc.

All households get water from government tube wells through pipes and drinking water is supplied by City Development and Municipal Department (CDMD), Hayatabad, Peshawar. However, the quality of drinking water in Hayatabad is reported as poor. As mentioned earlier, a study by IUCN (1996) shows that the available water is not suitable for drinking, since no proper wastewater treatment facilities are available and the drinking water is contaminated due to its mix-up with sewerage water in many residential areas including Hayatabad. The industrial estates in Hayatabad, Peshawar discharge untreated waste-water into Bara River. The Bara River constitutes the main source supporting underground water supply in the study area. The survey results showed that 40% of sample households were not treating their drinking water. Sixty percent of the households were using some kind of water purification method. About 25% of households were using boiling, 10% chlorine tablets, 15% ordinary filters and 10% electric filter as purification technique in their homes.

Findings of multinomial logit model are given in Table 1. The dependent variable has five categories: no water treatment, boiling, chlorination, cloth filter and electric filter. Category 1, i.e., no water treatment is the base category. The coefficient of marginal probability up to 10 years of education is statistically significant for boiling method only. There is a 19% higher probability that a household will boil drinking water if the head of that household haslevel of education up to 10 years compared to those with no education. As education level of household head increases, the marginal probability of boiling technique decreases. The marginal probability of highly educated households becomes to be about 40 percentage points higher for electric filter compared to uneducated household head. Regarding media exposure, listening of radio by household head is not significant for water purification methods. Watching of TV is only significant for chlorination of drinking water. Reading of the newspapers and pamphlets by the household head has statistically significant effect on almost all purification methods. Regarding the levels of household income, higher incomes have significant effect on electric filter as water purification method.

Table 1. Results from the polychotomous or multinomial logit model

Explanatory variables	Probabilities of water treatment techniques			
	Boiling	Chlorination	Cloth filter	Electric filter
Education level (years): up to 10	0.19* (0.012)	-0.05 (0.285)	-0.073 (0.83)	0.068 (0.185)
10-14 years	-0.034* (0.003)	0.019 (0.81)	0.031* (0.016)	0.343* (0.001)
15-16 and above	-0.029*(0.001)	-0.002(0.546)	0.045*(0.008)	0.396*(0.002)
Exposure to media: radio	0.012 (0.710)	-0.001 (0.287)	0.036 – (0.278)	0.017 (0.834)
TV	0.011 (0.402)	0.012* (0.001)	0.038 (0.312)	0.074 (0.128)
Newspaper, pamphlets, etc.	0.079** (0.009)	0.000 (0.137)	0.101* (0.004)	0.042* (0.032)
Income level (rs. thousand/pm): medium	0.055 (0.139)	0.001 (0.215)	0.021 (0.211)	0.036 (0.228)
High	-0.201 (0.186)	-0.001 (0.635)	-0.032 (0.619)	0.258* (0.002)
Log likelihood	-563.12			
Observations	150			

Notes: Figures in parentheses are probabilities of critical values, * and ** show significance level at 5% and 10 %, respectively.

The multiple linear regression results of the WTP by OLS are given in Table 2. As the education level increases, the WTP for improved drinking water increases. The highest level of education has the maximum WTP of Rs. 208 higher than uneducated households. The results of the study show that a highly educated household head (15-16 and above) will spend Rs. 78 higher on average than household head who has education of 10-14 years. Regarding media exposure variables, only newspaper readers, on average, will spend Rs. 80 higher than those households whose head does not read newspaper. Households with higher income have higher willingness to pay of Rs. 170 than low income households. The high income households have on average Rs. 90 higher WTP than middle income households.

The results of the study reveal that awareness through education and exposure to mass media and income of households has significant effect on the WTP of households for safe drinking water.

Table 2. Parameter estimates of the WTP equation estimated by OLS method (in Pak. rupees)

Explanatory variables	Coefficient	t-ratios
Constant	-235.5	2.45
Education level (years): up to 10	65	1.67
10-14 years	130*	2.30
15-16 and above	208*	4.15
Exposure to media: radio	25	1.85
TV	60.8*	2.47
Newspaper, pamphlets, etc.	80*	3.56
Income level (Rs. thousand/pm):medium	80*	2.31
High	170*	2.43
R-squared	0.43	
No. of observations	150	

Notes: * shows significance at 5% level or lower.

Conclusions

Demand for environmental goods including safe drinking water could be higher if income levels are high and if people have access to information and awareness regarding the health risks associated with inferior environmental quality. A key policy question is whether increasing awareness about the adverse health effects of unsafe drinking water will increase demand for clean drinking water? This study used data from a survey of 150 households in Peshawar in Northern Pakistan. It is concluded that the awareness such as education and exposure to mass media have significant influence of adoption of various water purification methods and hence on households' WTP. These findings are quite similar like income of households. The WTPs of well-informed households are higher than those which are not or less informed. Therefore, higher levels of formal and informal awareness about negative effects of contaminated drinking water on health may prevent waterborne diseases.

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