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# Awareness and the Demand of Safe Drinking Water Practices

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**ABSTRACT**

The demand for environmental goods is often low in developing countries. The major causes are awareness regarding the contamination of water and poverty, but less attention has been paid to the former reason. We use a household survey from Hyderabad city and estimate the contribution of awareness and income on households' water purification behaviour. The study finds out that measures of awareness such as different level of schooling of decision-makers and household heads and their exposure to mass media have statistically significant effects on home purification methods for drinking water, while other members of households can effect this behaviour only when they get higher levels of schooling.

*JEL classification:* D12, D13, D31, Q21, Q25, Q51, R21

*Keywords:* Demand, Awareness, Safe Drinking Water, Logit Model and Probit Model

## I. INTRODUCTION

The demand for environmental goods like safe food, clean air and safe drinking water is often low in developing countries. It is believed one of the major causes of low demand is the poverty, which reflects choices made by individuals in their own best interests. However, decision-makers often having lack of necessary information about their health and environmental hazards in order to make good decisions about their health and other health related issues of their daily lives. Furthermore, when state fails to provide quality of environmental goods and households can afford to take private measures to improve them, even then they may not make the best choice because of the lack of awareness about the health risks associated with inferior environmental quality.

Poor quality of drinking water is a major health hazard in developing countries and most of the fatal diseases are associated with it especially among the children. The World Health Organisation (WHO) (2004) estimates that 1.8 million people die every year from diarrhea including cholera and 90 percent of them are children under the age of five years. These children mostly belong to developing countries. It is also estimated that 88 percent of the cases of diarrhoeal disease are attributed to unsafe water supply, inadequate sanitation and hygiene. In Pakistan, the access to safe drinking water is estimated to be available to 23.5 percent of population in rural areas and 30 percent of population in urban areas, while every year 200,000 children die due to diarrheoal disease [Nils (2005)].

Measures for improving the quality of drinking through piped water supply to households can minimise health risks. According to WHO (2004), if improved water supply were achieved worldwide then 6 to 25 percent diarrhea morbidity could be reduced annually. Furthermore, it estimates that intervention in drinking water quality through household water treatment such as chlorination at point of use can lead to a reduction of diarrhea episodes by 35 to 39 percent annually. Now the question is why households have not been adopted low-grade technologies for safe drinking water? Poverty is an important factor but it cannot explain this question. The answer certainly is that people are not aware of health risks associated with contaminated water. This concludes that awareness is also a determinant of the demand for safe drinking water. This study estimates and

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analyses the magnitude of awareness for safe drinking water among households in Hyderabad district, Sindh, Pakistan.

The study is based on a survey of 514 households that consists of 3796 household members of Hyderabad city. To measure effects of households' awareness on their water purification behaviour, the indicators used are formal and informal schooling and occurrence of diarrhoeal disease among 0-5 year's old children. For the separate effects of different purification methods in a sophisticated fashion, we have used bivariate probit and multinomial logit models. The estimated results shows that the newspaper habit of decision-makers and household heads has most significant effect in determining home purification at their homes, while education of female decision-maker compared to male decision-maker has more significant effect in using any or even more expensive method of purification.

The paper is organised as follows: Section II reviews the literature. Section III presents methodology. Section IV describes the data and construction of the variables. Section V discusses the estimated results and Section VI concludes the paper.

## II. REVIEW OF LITERATURE

In Pakistan no published work has been found on examining the effects of awareness on drinking water purification behaviour. Although on other aspects of drinking water, governments' agencies, non-governmental organisations (NGOs) and private drinking water companies, do have reports, but they fail to conduct a research-based study that could then be published. In other developing countries such studies are found but in a very small number. Dasgupta (2001) uses the data of Delhi city and estimates that education of household members is statistically significant for the household's decision to purify drinking water at homes. Another similar study by McConnell and Rosado (2000) use the data from Brazil and finds the similar results that higher educational level of household members significantly affects water purification behaviour. Jyotsna, Somanathan, and Choudhuri (2003) estimate the effects of awareness on the demand and willingness to pay for safe drinking water. The study takes the educational levels of male and female members of household and their media exposures of radio, television and newspaper. The study uses the National Family Health Survey of India for Delhi city. This study adopts the multinomial logit technique and finds that wealth has a dominated effect on household water purification behaviour, or higher probability coefficients belong to higher wealth quartiles. Further, wealth appears as a more important factor affecting water purification behaviour as compared to the factors like education and media exposure. However, the study also finds that the willingness to pay for safe drinking water is highest for the highest educational level of female household member.

Bruce and Gnedenko (1998) investigate the types and amount of avoidance measures that are used by households in Moscow to adjust drinking water quality. The study is based on the survey of 615 households of Moscow and explains that water quality at the tap creates some level of health risks in water, but before consuming tap water; households can undertake various measures to improve the quality of water. These measures are called avoidance measures or averting actions, while expenditures incurred on such measures are called defensive expenditures. The study finds that if avoidance measures are inexpensive, widely available and widely used then actual health risks from water consumption may be statistically different from apparent risks at the tap. In such cases residents may prefer to continue to make their own avoidance rather than paying higher user charges. By using logit regression, the study relates the avoidance decisions to income, opinions of water quality and location in the city and finds that medium and high-income levels significantly affect households' decisions to adopt avoidance measures.

Richard and Mitchell (2000) estimate that chlorinated water containing trihalomethanes (THMs) can kill 2 to 100 people per year in the United States, largely through increased incident of urinary tract cancer. THMs in chlorinated water present a very low level of risk to drinking water consumers. The risk from not chlorinated water is dramatically higher and much more immediate since the chlorine kills biological contaminants. The study further relates these risks to the willingness to pay and estimates that the first risk indicates insensitivity to willingness to pay, while the second risk shows some sensitivity to the willingness to pay.

The existing literature on the demand for safe drinking water do not incorporate the educational levels and other important characteristics of different household members in the decision to adopt the safety measures for drinking water at the point of use. This may be due to non-availability data for such variables in published data. This paper incorporates such shortcomings and examines the different levels of education not only of household members but also household heads and decision-makers regarding water purification method at their homes. Furthermore, this paper also incorporates the sex and occupation of both decision-makers and household heads.

## III. METHODOLOGY

The households' preferences regarding their day-to-day budget allocation decisions have been the central issue in economics theory and literature. The traditional demand functions, besides income and consumption pattern are also depending on the several other factors capturing preference structure of households like demographic composition, educational levels, profession and residential status of households [see Deaton and Muellbauer (1980)]. This chapter elaborates theoretical consideration of consumers' preferences and the methodology we have used to estimate demand of safe drinking water practices as function of awareness and wealth of the households.

**Theoretical Considerations**

The traditional Marshallian demand function for a particular household for any good is a function of its own price, income and other characteristics of the households representing their preference structure. In our context the budget allocation decision-making of households is best described as a multi-stage budget process. At the first stage, a typical household will allocate the budget among board consumption categories like food, clothing, housing and health etc. This decision is made in the light of the given budget, price indices of board consumption categories and household preference structure. At the second stage, the expenditure allocated to each category at the first stage is distributed among various sub-categories. At this stage the allocation will depend on the price of sub-category and budget allocated to broader category. Likewise, we can have third and even higher stages of budget allocation.

In our context the budget will first be allocated to food, health and other categories. Then at the second stage the food expenditure will be allocated to clean drinking water and on other items, while health expenditure will be allocated to curing of 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 matters. 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 that of necessities tends to decline. This observation, known as Engel law, implies that rich households are more likely to allocate a larger share of their budget to more expensive water purification devices. In the allocation process for the quality of drinking water, here we assumed that households have the four available choices namely boiling, use chlorine tablets, ordinary filter and electric filter. If the households are fully aware of adverse health effects of using contaminated drinking water then boiling and use of chlorine tablets are necessities, while electric filter is a luxury good. It is expected that richer households are more likely to use electric filter than the poor households and they would spend a larger budget share on it. The household expenditure on different goods or their consumption allocation patterns for different commodities have different economics implications. Similarly, the demand for safe drinking water practices and income allocation patterns for such practices have not only serious implications on households' economic behaviour but also serious health productivity shocks on the aggregate country level.

Since the preference structure of a household depends crucially on the level of information that the household have regarding the utility producing attributes of various goods, the variables that represent the information of household also matter. These variables will typically include educational level of household heads, decision-makers and other members of household; and the practices of collecting information through newspaper, radio and television.

In the cross-sectional data, households face the identical prices as no genuine variation in the prices can be observed at a point of time, so here we cannot use the price of water purification method in the demand estimation. So the homogeneity of demand functions has no such role in this analysis, but adding up property of demand function is important in determining the expenditure elasticities. Whenever, prices are absorbed into the functional form, then the functional form is referred to as an Engel equation, which classifies the goods into luxuries, necessities and inferior goods. Luxury goods take up a larger share of the budget of richer household and vice versa for necessities.

The econometrics specification of such models is usually semi-logarithmic and/or double logarithmic, while method of estimation is Ordinary Least Square (OLS) unless some econometric problems like autocorrelation, heteroscedasticity etc. arise. For the estimation of demand function for water purification methods as function of awareness and wealth, we could not use such traditional methods, because purification device is durable good and usually purchased in a single unit. So we will use the variable of quantity demanded for the purification methods as categorical variable and our econometrics specification then will be bi-variate or multi-variate and method of estimation will be maximum likelihood. The data on the income of household cannot be obtained directly and accurately, so we have used wealth index as proxy for income in the specification.

**Econometric Specification**

To measure the effects of different characteristics of households on the methods of purification used by them at their homes, we develop an econometric model to separate out the effects of each variable.

***Bivariate Probit Model***

We will use a bivariate probit model to estimate the effects of different explanatory variables on the adoption of home purification method by households at their homes. The variables required for this estimation will be; one binary dependent variable and set of explanatory variables. The binary dependant variable takes the value equal to one if a household uses some water purification method and zero if the household does not use any water purification method. The explanatory variables include media exposure variables like radio, television and newspaper habits; educational variables like the highest educational attainment by household members and number of educated members in a house; and others variables namely wealth index, sex of the decision-maker, sex of the household head and binary variables representing occupations of decision-maker and household head. (1 for medical professional and 0 for non-medical professional). To estimate the effects of these variables on the dependent variable, we develop three sub models; one each to capture the effects of various characteristics of decision-makers, household heads and other members of households.

Our econometric specifications are as follows.

$$y = \beta_1 x_1 + \varepsilon_1, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$y = \beta_2 x_2 + \varepsilon_2 \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$y = \beta_3 x_3 + \varepsilon_3, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

The binary variable $y$ is the same for all equations, that is whether a household adopts any purification method no not, $\varepsilon_i$'*s* are residuals and $x_i$'s are explanatory variables.

It is expected that household's purification behaviour could be affected by its past experience of diarrhoeal disease and vice-versa. This may cause the problem of endogeneity. To allow for this, we will begin by estimating a bivariate probit model as system of equations then our econometric specification will be

$$y_1 = \beta_1 x_1 + \varepsilon_1,$$
$$y_2 = \beta_2 x_2 + \varepsilon_2,$$
$$E(\varepsilon_1) = E(\varepsilon_2) = 0$$
$$Var(\varepsilon_1) = Var(\varepsilon_2) = \sigma^2$$
$$Cov(\varepsilon_1, \varepsilon_2) = \rho$$

The binary variables $y_1$ and $y_2$ will be dependent variables; where former is whether a household adopts any home purification method or not while later is whether a child aged 0–5 years in the household experience diarrhea or not. To check the significance level of correlation coefficient between the errors of two equations denoted by $\rho$, we will use likelihood ratio test by setting

$$H_0 = \rho = 0$$
$$H_1 = \rho \neq 0$$

On the basis of $p$-value of the test we can decide whether the two dependent variables are jointly determined or not.

The estimated coefficients from these models will not be directly interpretable. For this, we will calculate marginal effects of each variable that is the effects of one unit changes in explanatory variables on the estimated probability of adopting a purification method.

***Multinomial Logit Model***

On the basis of likelihood values from the previous models we will select one model having the largest likelihood value extension to multinomial logit specification. For the selected model dependent variables will be methods of purification at home having five different choices: no purification, boiling, use of chlorine/alum tables, ordinary (candle) water filter and ultra radiation/electric filter.

The model specification is as follows

$$y_{ij} = \beta_j x_i + \varepsilon_{ij}$$

Where $j$ = 0, 1, 2, 3, 4 representing the five categories of water purification practices, $x_i$ is a set of explanatory variables (already describe) and $\varepsilon_{ij}$ is a residual. It is assumed that household chooses only one method of purification. In case a household adopts two methods simultaneously, here we will consider the best method. Finally, if the correlation coefficient of the error term of two equations (rho) from the previous model would statistically be significant then estimating the simultaneous equations in multinomial model will computationally be very difficult. To solve this problem, we will use a two-stage procedure. In the first stage a logit model of the probability of getting diarrhea as a function of explanatory variables from the previous selected models would be estimated. In the second stage a multinomial logit model will be estimated in which the predicted probability of getting diarrhea from the logit model will be included as a regressor in addition to the explanatory variables from the previous model.

The estimated coefficients from the multinomial logit model are also difficult to interpret. We need to calculate the marginal effects of each variable. The analytical expressions for the marginal effects on the probability of particular method of purification $m$ = 1,2,3,4, are

$$\frac{\Delta P(Y = m / x)}{\Delta x_k} = P(Y = m / x, x_k = 1).\{\beta_{mk} - \sum_{j=0}^{4} \beta_{jk} P(Y = j / x, x_k = 0)\}$$

These probabilities are given by

$$P(Y = m) = \frac{e^{\beta mx}}{1 + \sum_{j=1}^{4} e^{\beta mx}}$$

$$P(Y = 0) = \frac{1}{1 + \sum_{j=1}^{4} e^{\beta mx}}$$

## IV. DATA AND CONSTRUCTION OF VARIABLES

The data used in this study are collected by researchers from Hyderabad city in the year 2006. The sample size is 514 households, which consists of 3796 household members. The stratified sampling technique was used. The strata were selected on the basis of administrative division of the city, while the total number of households from a particular stratum was selected according to the population of stratum.

The Hyderabad city is administratively divided in four parts, i.e., three *Tehsils* (Hyderabad city, Latifabad and Qasimabad) under district government and one cantonment. The total population of the city according to census-1998 is 1.47 Million (city 0.518 Million, Latifabad 0.556 Million and Qasimabad 0.114 Million and remaining parts 0.285 Million). The distribution of the 514 sample is divided on the basis of population of the *Tehsils* and cantonment (200 from city, 183 from Latifabad, 102 Qasimabad 102 and the remaining 29 from cantonment). Geologically, the city is a plat-topped with subtropical, semi desert type. The main source of drinking water of city is surface water, which is served by five water supply systems. Since long the quality of drinking water of Hyderabad has been poor, this resulted in one of the highest casualties from drinking water since last two years in Pakistan. Mukesh and Zeenat (2001) estimated the content of metals in drinking water of Hyderabad city by taking 18 water samples from different locations. The results of the study finds the quality of drinking water, households received in Hyderabad, is very poor and the only choice households have to treat water at their homes.

This study estimates how different sources of awareness effect the household decision of water purification. For this, we have developed a questionnaire. The survey questions were asked according to design methodology. Among the household who treat their drinking water, four different methods are used (1) boiling (2) using chlorine/alum tablets (3) using an ordinary filter (4) using an electric filter. In the sample 64.98 percent households are using some water purification device with 23.68 percent are using the boiling technique, 5.64 percent chlorine tablets, 11.87 percent ordinary filter and 14.78 percent electric filter. Table 1 reports purification adoption rates for households. Despite the high exposure of diarrhea diseases (65 percent), a significant 35 percent household continues to consume water without using any type of water purification method. There is no direct information about how informed a household is regarding the health risks arising from drinking contaminated water. Our hypothesis is that if the decision-makers, household heads and adult member of a household are educated then it is likely that they will be aware of health risks associated with drinking contaminated water. For estimation we will, therefore, use education as a proxy for health awareness of households. We have made five categories of education: no education, 1–8 years of education, 9–12 years of education, 13–15 years of education and 16 years of education or above. These categories will be used for the decision-makers regarding the purification of water, household heads, and the highest number of educational years among male and female household members. Table 1 shows that the proportion of households who do not purify their drinking water is smaller for the households with higher education levels. This proportion reduces to 5.56 percent where female household members with 16 and above years of schooling.

The second indicator of awareness is taken as mass media exposures, we collected the information in the questionnaire as to whether a member of household who read a newspaper, watches television, or listens radio. Furthermore, we will incorporate media exposures of household heads, decision-makers and number of male and female in our analysis. Table 2 shows that 51 percentage out of decision-makers who do not read newspaper, do not treat their water at homes, while a 31 percent drink boiled water and only 6.7 percent use expensive techniques like electric filter. On the other hand, 26 percent decision-makers, who read newspaper at least once a week, do not purify drinking water in their homes, while 34 percent boil drinking water and 19 percent use electric filter to purify water. Similarly, 31 percent of out decision-makers who watch television at least once a week do not use any purification technique, while 34 percent boil the water and 16 percent use expensive technique to filter the drinking water. Rest of the Table 2 shows the media exposures of male and female household members, in which for simplicity (only for this table) we have made three categories, namely no members having a particular media exposure, 1 to 5 members having media exposure and more than five members having media exposure. Almost similar trends seem in these categories as in households and decision-makers.

The correct information on consumption, income, or wealth of households cannot be collected accurately. However, the survey collects information on household's ownership of various assets (car, motorcycle, refrigerator, telephone, air conditioner and computer, etc.) and characteristics of household dwelling (house type, number of rooms, source of fuel etc.). We calculate a wealth index from the given information by using first principle component. Appendix A provides the formula for the wealth index. For the ease of interpretation, we create and use wealth quartile from the wealth index rather than actual wealth index in our analysis. Households of the least wealth quartile correspond to the poorer units of the sample. The wealth index acts as a proxy for unobserved wealth. Here we created two indices; one is based on all given assets and second after excluding those assets that have less than 10 percent variation or more than 90 percent variation. Spearman's rank correlation coefficient ($r$=0.8876) between two indices shows that ranking of the household changes very little between two indices. Hence we use the first index for our analysis.

Table 1

*Distribution of Purification Adoption Rates by Education Level*

| | No Purification | | Purification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Boiling | | Chlorine Tablets | | Candle Filter | | Electric Filter | | Total |
| | Total | % | Total | % | Total | % | Total | % | Total | % | |
| **Education Level of Decision-maker** | | | | | | | | | | | |
| No Education | 46 | 70.77 | 11 | 16.92 | 5 | 7.69 | 2 | 3.08 | 1 | 1.54 | 65 |
| 1-8 Years | 32 | 54.24 | 19 | 32.20 | 5 | 8.47 | 1 | 1.69 | 2 | 3.39 | 59 |
| 9-12 Years | 55 | 34.81 | 66 | 41.77 | 10 | 6.33 | 14 | 8.86 | 13 | 8.23 | 158 |
| 13-15 Years | 28 | 26.17 | 33 | 30.84 | 4 | 3.74 | 19 | 17.76 | 23 | 21.50 | 107 |
| 16 or above Years | 19 | 15.20 | 39 | 31.20 | 5 | 4.00 | 25 | 20.00 | 37 | 29.60 | 125 |
| **Highest Education Level Among Female Household Members** | | | | | | | | | | | |
| No Education | 54 | 64.29 | 13 | 15.48 | 9 | 10.71 | 2 | 2.38 | 6 | 7.14 | 84 |
| 1-8 Years | 14 | 60.87 | 7 | 30.43 | 2 | 8.70 | 0 | 0.00 | 0 | 0.00 | 23 |
| 9-12 Years | 75 | 44.91 | 53 | 31.74 | 10 | 5.99 | 19 | 11.38 | 10 | 5.99 | 167 |
| 13-15 Years | 27 | 19.71 | 59 | 43.07 | 5 | 3.65 | 18 | 13.14 | 28 | 20.44 | 137 |
| 16 or above Years | 10 | 9.71 | 36 | 34.95 | 3 | 2.91 | 22 | 21.36 | 32 | 31.07 | 103 |
| **Highest Education Level Among Male Household Members** | | | | | | | | | | | |
| No Education | 13 | 86.67 | 1 | 6.67 | 1 | 6.67 | 0 | 0.00 | 0 | 0.00 | 15 |
| 1-8 Years | 20 | 83.33 | 2 | 8.33 | 2 | 8.33 | 0 | 0.00 | 0 | 0.00 | 24 |
| 9-12 Years | 76 | 52.05 | 41 | 28.08 | 10 | 6.85 | 15 | 10.27 | 4 | 2.74 | 146 |
| 13-15 Years | 44 | 31.65 | 48 | 34.53 | 10 | 7.19 | 15 | 10.79 | 22 | 15.83 | 139 |
| 16 or above Years | 27 | 14.21 | 76 | 40.00 | 6 | 3.16 | 31 | 16.32 | 50 | 26.32 | 190 |
| All Households | 180 | 35.019 | 168 | 32.68 | 29 | 5.64 | 61 | 11.87 | 76 | 14.79 | 514 |

Table 2

*Distribution of Purification Adoption Rates by Media Exposures*

| | | No Purification | | Purification | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Boiling | | Chlorine Tablets | | Candle Filter | | Electric Filter | | |
| | | Total | % | Total | % | Total | % | Total | % | Total | % | Total |
| **Media Exposures of Decision-maker** | | | | | | | | | | | | |
| Radio habit | Almost Never | 120 | 34.29 | 119 | 34.00 | 23 | 6.57 | 38 | 10.86 | 50 | 14.29 | 350 |
| | At least once a week | 60 | 36.59 | 49 | 29.88 | 6 | 3.66 | 23 | 14.02 | 26 | 15.85 | 164 |
| TV Habit | Almost Never | 33 | 73.33 | 8 | 17.78 | 0 | 0.00 | 2 | 4.44 | 2 | 4.44 | 45 |
| | At least once a week | 147 | 31.34 | 160 | 34.12 | 29 | 6.18 | 59 | 12.58 | 74 | 15.78 | 469 |
| Newspaper | Almost Never | 92 | 51.40 | 55 | 30.73 | 11 | 6.15 | 9 | 5.03 | 12 | 6.70 | 179 |
| Habit | At least once a week | 88 | 26.27 | 113 | 33.73 | 18 | 5.37 | 52 | 15.52 | 64 | 19.10 | 335 |
| **Numbers of Female Members of Household** | | | | | | | | | | | | |
| Listen Radio | 0 members | 136 | 38.10 | 112 | 31.37 | 22 | 6.16 | 38 | 10.64 | 49 | 13.73 | 357 |
| | 1-5 members | 40 | 26.49 | 55 | 36.42 | 7 | 4.64 | 22 | 14.57 | 27 | 17.88 | 151 |
| | 5+ members | 4 | 66.67 | 1 | 16.67 | 0 | 0.00 | 1 | 16.67 | 0 | 0.00 | 6 |
| Watch TV | 0 members | 26 | 63.41 | 8 | 19.51 | 1 | 2.44 | 1 | 2.44 | 5 | 12.20 | 41 |
| | 1-5 members | 149 | 32.46 | 155 | 33.77 | 28 | 6.10 | 59 | 12.85 | 68 | 14.81 | 459 |
| | 5+ members | 5 | 35.71 | 5 | 35.71 | 0 | 0.00 | 1 | 7.14 | 3 | 21.43 | 14 |
| Read Newspaper | 0 members | 127 | 51.21 | 68 | 27.42 | 16 | 6.45 | 16 | 6.45 | 21 | 8.47 | 248 |
| | 1-5 members | 52 | 19.85 | 99 | 37.79 | 13 | 4.96 | 44 | 16.79 | 54 | 20.61 | 262 |
| | 5+ members | 1 | 25.00 | 1 | 25.00 | 0 | 0.00 | 1 | 25.00 | 1 | 25.00 | 4 |
| **Numbers of Male Members of Household** | | | | | | | | | | | | |
| Listen Radio | 0 members | 104 | 35.62 | 99 | 33.90 | 18 | 6.16 | 33 | 11.30 | 38 | 13.01 | 292 |
| | 1-5 members | 71 | 33.33 | 67 | 31.46 | 9 | 4.23 | 28 | 13.15 | 38 | 17.84 | 213 |
| | 5+ members | 5 | 55.56 | 2 | 22.22 | 2 | 22.22 | 0 | 0.00 | 0 | 0.00 | 9 |
| Watch TV | 0 members | 18 | 78.26 | 3 | 13.04 | 0 | 0.00 | 1 | 4.35 | 1 | 4.35 | 23 |
| | 1-5 members | 142 | 31.63 | 152 | 33.85 | 26 | 5.79 | 59 | 13.14 | 70 | 15.59 | 449 |
| | 5+ members | 20 | 47.62 | 13 | 30.95 | 3 | 7.14 | 1 | 2.38 | 5 | 11.90 | 42 |
| Read Newspaper | 0 members | 64 | 59.26 | 32 | 29.63 | 6 | 5.56 | 3 | 2.78 | 3 | 2.78 | 108 |
| | 1-5 members | 110 | 27.99 | 133 | 33.84 | 21 | 5.34 | 57 | 14.50 | 72 | 18.32 | 393 |
| | 5+ members | 6 | 46.15 | 3 | 23.08 | 2 | 15.38 | 1 | 7.69 | 1 | 7.69 | 13 |
| All Households | | 180 | 35.019 | 168 | 32.68 | 29 | 5.64 | 61 | 11.87 | 76 | 14.79 | 514 |

Table 3 shows the relationship of wealth and other characteristic of household with water purification practices. Quite a few households belonging to top wealth quartile are found to using costly purification method namely electric filter. In particular 36.84 percent of total electric filter is being used by top wealth quartile households, this proportion is reduces to less than half (15.79 percent) in the lowest wealth quartile. However, households belongs to the lowest wealth quartile are using inexpensive technology, like boiling, 31 percent of total households who use boiling technique belongs to the lowest wealth quartile. This proportion reduces to 9.52 percent for the households belonging to top wealth quartile.

The sample is highly exposed to diarrhoeal disease. Out of all 63.33 households who children suffered from diarrhea are not using any method of water purification. It is unexpected that a household's perception about health risks from drinking unsafe water is not influence by health "shock" in the past. That is, if households learn from bad health experiences then their willingness to adopt safe drinking water practices will increase, but according to the statistics shown in Table 3 our data does not support this proposition.

Other variables are sex of decision-makers and household heads. It is expected that female decision-makers may have more willingness to adopt safe drinking water practices than male decision-makers may. The data show that among the household who do not purify water, 81 percent are represented by male decision-makers. Another way of looking at the matter is to note that among the male decision-makers 47 percent households who do not purify drinking water, 23 percent boil the water and 15 percent use electric filter to purify drinking water at their homes. Among water purification methods, boiling is an inexpensive method that is boiled at homes mostly by female members. Among female decision-makers 47.29 percent boil water at their homes and 14.29 percent use electric filter, while only 16.75 percent do not use any of the purification methods. The last variable is occupation of decision-makers and household heads. Only 2.22 percent households out of the total households, who do not use any method of water purification, belong to the medical professionals. Among the medical profession 44 percent households use electric filter for water purification at their homes. This shows that households belong to medical profession have more awareness than non-medical professions regarding the purification of drinking water.

Descriptive results are reported in this chapter suggest a strong unconditional correlations between households demand for improved quality of drinking water and different awareness indicators. However, many of these variables are correlated with each other. Thus, we have to develop econometric models, wherein we are able to separate out the effect of each variable from the effects of other variables. In the next chapter we will discuss the results obtain on the basis of econometric analysis.

Table 3

*Distribution of Purification Adoption Rates by Wealth and Other Household Characteristics.*

| | No Purification | | Purification | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Boiling | | Chlorine Tablets | | Candle Filter | | Electric Filter | | |
| | Total | % | Total | % | Total | % | Total | % | Total | % | |
| **Household Wealth** | | | | | | | | | | | |
| Least Wealth Quartile | 43 | 33.33 | 52 | 40.31 | 7 | 5.43 | 15 | 11.63 | 12 | 9.30 | 129 |
| Lower Middle Wealth Quartile | 31 | 24.03 | 55 | 42.64 | 11 | 8.53 | 22 | 17.05 | 10 | 7.75 | 129 |
| Upper Middle Wealth Quartile | 41 | 31.54 | 45 | 34.62 | 5 | 3.85 | 13 | 10.00 | 26 | 20.00 | 130 |
| Top Wealth Quartile | 65 | 51.59 | 16 | 12.70 | 6 | 4.76 | 11 | 8.73 | 28 | 22.22 | 126 |
| **Children Aged 0–5 Years Suffered from Diarrhea** | | | | | | | | | | | |
| No | 66 | 35.87 | 51 | 27.72 | 8 | 4.35 | 21 | 11.41 | 38 | 20.65 | 184 |
| Yes | 114 | 34.55 | 117 | 35.45 | 21 | 6.36 | 40 | 12.12 | 38 | 11.52 | 330 |
| **Sex of Decision-maker** | | | | | | | | | | | |
| Male | 146 | 46.95 | 72 | 23.15 | 18 | 5.79 | 28 | 9.00 | 47 | 15.11 | 311 |
| Female | 34 | 16.75 | 96 | 47.29 | 11 | 5.42 | 33 | 16.26 | 29 | 14.29 | 203 |
| **Occupation of Decision-maker** | | | | | | | | | | | |
| Non-medical Professional | 176 | 36.51 | 160 | 33.20 | 29 | 6.02 | 55 | 11.41 | 62 | 12.86 | 482 |
| Medical Professional | 4 | 12.50 | 8 | 25.00 | 0 | 0.00 | 6 | 18.75 | 14 | 43.75 | 32 |
| All Households | 180 | 35.019 | 168 | 32.68 | 29 | 5.64 | 61 | 11.87 | 76 | 14.79 | 514 |

## V. RESULTS AND DISCUSSION

For the empirical results of various econometric models specified in Section III, first we checked the endogeniety of the given probit equations by Seemingly Unrelated Bivariate Probit Model, where both the independent variables were binary i.e., whether or not a household adopts any home purification method of water and whether or not a 0-5 years old in the household has been suffered from diarrhea during the past one month. We have estimated this model using maximum likelihood technique. To check the correlation coefficient between the error of two equations we set $H_0$: ρ = 0 against $H_1$: ρ ? 0 that gave the *p*-values of likelihood ratio test as; 0.106, 0.200 and 0.125 for Equations 1, 2, and 3 respectively. These values show that endogeniety is not statistically significant in all equations, or other way we are accepting the null hypothesis that two independent variables are not jointly determined. then we estimated these equations by bivariate probit model in which diarrhea variable are included directly. These models are also estimated by same technique. The results of these models are reported in Table 4. The education variables in all three models seem plausible since the coeffic ients of all the dummy variables representing various education levels decision-makers and household heads are statistically significant at 5 percent level of significance except household heads' educational level of 1-8 years, which is significant at 10 percent level of significant. The lower levels of education of both the male and female household members are statistically insignificant, while their higher levels of education are significant at 5 percent level of significance. We can therefore conclude that all education levels of both decision-makers and household heads influence the water purification behaviour of the house, but other members, can only influence this behaviour only if they have obtained higher levels of education. For instance households in which the decision-maker's education level is 1-8 years of schooling the probability of purification is 19 percentage points higher then in the households in which decision-makers are illiterate. This increment in probability goes to 21, 28, and 34 percentage points if decision-makers have 9-12, 13-15, and 16 years or above education respectively. Almost the same probability coefficients are obtained from household head's educational variables. The results in the table also show that education of male household member have more influence on water purification behaviour then the education of female member.

The media exposure variables are only significant for decision-makers and household heads. Among them radio listening habit of both decision-makers and household heads are statistically insignificant, while watching television and reading newspaper are significant for both at 5 percent level of significance except newspaper habit of household head that is significant at 10 percent level of significance. These statistics show that on average if the decision-makers have a habit of watching television and reading newspaper then the probability

Table 4

*Marginal Effects in Bivariate Probit Regression Equations*

| | Probability of Purification | | |
|---|---|---|---|
| Explanatory Variables | Model 1 | Model 2 | Model 3 |
| Education of Decision-maker; 1-8 Years | 0.188* | | |
| | (0.013) | | |
| Education of Decision-maker; 9-12 Years | 0.210* | | |
| | (0.003) | | |
| Education of Decision-maker; 13-15 Years | 0.282* | | |
| | (0.000) | | |
| Education of Decision-maker; 16 Years or above | 0.337* | | |
| | (0.000) | | |
| Education of Household Head; 1-8 Years | | 0.150** | |
| | | (0.055) | |
| Education of Household Head; 9-12 Years | | 0.204* | |
| | | (0.004) | |
| Education of Household Head; 13-15 Years | | 0.277* | |
| | | (0.000) | |
| Education of Household Head; 16 Years or above | | 0.368* | |
| | | (0.000) | |
| Highest Education of Female Member of House; 1-8 Years | | | –0.037 |
| | | | (0.743) |
| Highest Education of Female Member of House; 9-12 Years | | | 0.030 |
| | | | (0.678) |
| Highest Education of Female Member of House; 13-15 Years | | | 0.212* |
| | | | (0.005) |
| Highest Education of Female Member of House; 16 Years or above | | | 0.288* |
| | | | (0.001) |
| Highest Education of Male: Member of House; 1-8 Years | | | 0.077 |
| | | | (0.645) |
| Highest Education of Male Member of House; 9-12 Years | | | 0.241** |
| | | | (0.083) |
| Highest Education of Male Member of House; 13-15 Years | | | 0.294* |
| | | | (0.034) |
| Highest Education of Male Member of House; 16 Years or above | | | 0.426* |
| | | | (0.003) |
| Radio Habit of Decision-maker | 0.014 | | |
| | (0.771) | | |

*Continued—*

Table 4—(*Continued*)

| Explanatory Variables | Probability of Purification Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| Television Habit of Decision-maker | 0.178* | | |
| | (0.045) | | |
| Newspaper Habit of Decision-maker | 0.194* | | |
| | (0.002) | | |
| Radio Habit of Household Head | | –0.004 | |
| | | (0.933) | |
| Television Habit of Household Head | | 0.172* | |
| | | (0.025) | |
| Newspaper Habit of Household Head | | 0.094** | |
| | | (0.098) | |
| Radio Habit of Female Member in House | | | 0.024 |
| | | | (0.292) |
| Television Habit of Female Member in House | | | –0.027 |
| | | | (0.157) |
| Newspaper Habit of Female Member in House | | | 0.015 |
| | | | (0.500) |
| Radio Habit of Male Member in House | | | –0.020 |
| | | | (0.339) |
| Television Habit of Male Member in House | | | –0.007 |
| | | | (0.676) |
| Newspaper Habit of Male Member in House | | | –0.003 |
| | | | (0.866) |
| Second Wealth Quartile | 0.087 | 0.075 | 0.111 |
| | (0.142) | (0.213) | (0.065)** |
| 3rd Wealth Quartile | 0.100 | 0.089 | 0.085 |
| | (0.104) | (0.148) | (0.159) |
| Top Wealth Quartile | –0.016 | –0.082 | –0.083 |
| | (0.798) | (0.201) | (0.221) |
| Diarrhea | 0.078 | 0.061 | 0.078 |
| | (0.104) | (0.193) | (0.104) |
| Sex of Decision-maker | 0.414* | | |
| | (0.000) | | |
| Sex of Household Head | | 0.238 | |
| | | (0.114) | |
| Occupation of Decision-maker | 0.083 | | |
| | (0.446) | | |
| Occupation of Household Head | | 0.094 | |
| | | (0.475) | |
| Log Likelihood | –242.718 | –272.107 | –254.660 |

Probability of critical values are reported in parentheses.
*Indicates significance at 5 percent level.
**Indicates significance at 10 percent level.

that they will use purified drinking water will be 18 and 19 percentage points higher respectively. The same will be the effects if household heads watch television, but if households head have a habit of reading newspaper then the probability of water purification increase by just nine percentage points.

The effects of wealth quartiles on water purification behaviour are also shown in the same table. All the wealth effects are statistically insignificant except second wealth quartile that is significant at 10 percent level of significance in Equation 3. It is also noted that the top wealth quartile in all the equations is not only insignificant but its probability coefficients are also negative. This shows that as one becomes richer then his probability of using any method of purification at home will become less. This may indicate that the households belonging to the top wealth quartile prefer to drink bottled water rather than using any method of purification at their homes.

The other variables of the equations are sex, occurrence of diarrhea among 0-5 years old household member and occupation of the household heads and decision-makers. The diarrhea is a statistically insignificant variable, that shows household's experience of past health shock does not influence their purification behaviour. Occupation of household heads and decision-maker are not statistically significant but sex of decision-maker is highly significant. Its probability coefficient states that, if the decision-maker regarding purification method is female, the probability that the household using water purification device will on average be 41 percentage points higher than the household in which the decision-makers are male.

These results show that awareness has the most significant effect on adopting any method of purification and wealth has no significant effect. Based on the data set we may say that poverty is not a cause of lower quality of environmental goods; what is more important is how informed are households regarding the importance of those good in their lives.

The log likelihood values of the models are –242.718, –272.107, and –254.66 for Equations 1, 2, and 3 respectively. The Equation 1 has the highest value among them, and we choose this model for multinomial logit model. The dependent variable in multinomial logit model has five categories i.e., no purification, boiling, use of chlorine/alum tablets, ordinary filter and electric filter. The no purification method is taken as the base category. The results of multinomial logit model are reported in Table 5. The table shows that the estimated marginal effects of different variables on the different water treatments are almost similar to the bivariate probit models. The marginal probability coefficient of the educational level 1-8 years of decision-maker is significant only for boiling method. On average 23 percent higher will be the probability that a household purify drinking water by using boiling technique if the decision-maker is educated from 1-8 years of schooling compared to illiterate decision-maker. The marginal probability of boiling technique reduces

Table 5

*Marginal Effects of Multinomial Logit Regression*

| Explanatory Variables | Probabilities of Purification Methods | | | |
|---|---|---|---|---|
| | Boiling | Chlorine/ Alum Tablets | Candle Filter | Electric Filter |
| Education of Decision-maker; 1-8 Years | 0.230* | –0.001 | –0.085 | 0.087 |
| | (0.006) | (0.351) | (0.903) | (0.215) |
| Education of Decision-maker; 9-12 Years | 0.107* | –0.001 | 0.003 | 0.173* |
| | (0.005) | (0.725) | (0.207) | (0.046) |
| Education of Decision-maker; 13-15 Years | –0.046* | –0.002 | 0.037* | 0.369* |
| | (0.002) | (0.821) | (0.018) | (0.002) |
| Education of Decision-maker; 16 Years or above | –0.031* | –0.002 | 0.045* | 0.396* |
| | (0.000) | (0.562) | (0.007) | (0.000) |
| Radio Habit of Decision-maker | 0.009 | –0.001 | 0.036 | –0.017 |
| | (0.708) | (0.295) | (0.288) | (0.862) |
| TV Habit of Decision-maker | 0.010 | 0.012* | 0.038 | 0.074 |
| | (0.417) | (0.000) | (0.360) | (0.135) |
| Newspaper Habit of Decision-maker | 0.087** | 0.000 | 0.101* | 0.042* |
| | (0.010) | (0.163) | (0.001) | (0.030) |
| Second Wealth Quartile | 0.055 | 0.001 | 0.021 | 0.036 |
| | (0.147) | (0.220) | (0.218) | (0.234) |
| 3rd Wealth Quartile | –0.057 | 0.000 | –0.019 | 0.211* |
| | (0.366) | (0.583) | (0.551) | (0.001) |
| Top Wealth Quartile | –0.205 | –0.001 | –0.032 | 0.258* |
| | (0.175) | (0.641) | (0.631) | (0.004) |
| Diarrhea | 0.108* | 0.000 | 0.017 | –0.032 |
| | (0.047) | (0.283) | (0.229) | (0.963) |
| Sex of Decision-maker | 0.357* | –0.001* | 0.117* | 0.029* |
| | (0.000) | (0.019) | (0.000) | (0.000) |
| Occupation Decision-maker | –0.026 | –0.015 | 0.030 | 0.069 |
| | (0.854) | (0.780) | (0.568) | (0.327) |
| Log Likelihood | –596.172 | | | |
| Number of Observations | 514 | | | |

Probability of critical values are report ed in parentheses.
*Indicates significance at 5 percent level.
**Indicates significance at 10 percent level.

as decision-maker becomes more educated. The marginal probability of a better-educated households (16 or above years) turns to be 40 percentage points higher for most expensive technology (electric filter) than an illiterate household. Among the media exposure variables radio listening habit of decision-maker is statistically insignificant for water purification techniques, while television-watching habit is only significant for the use of chlorine tablet technique. The newspaper reading habit of decision-maker has significant influence on the water treatment methods. On average 8.7 percentage points, 10 percentage points and 4.2 percentage points higher will be the probability for boiling, ordinary filter and electric filter respectively, if the decision-maker reads the newspapers at least once in a week compared to those decision-makers who almost never read newspaper.

Various wealth quartiles have insignificant effect on the households' behaviour except third and fourth wealth quartiles for the most expensive technique that is electric filter. The estimated marginal probability coefficients show that on average 21 percentage points and 26 percentage points higher will be the probability of using electric filter to purify drinking water, if households belongs upper middle and top wealth quartiles respectively compared to the lowest wealth quartiles.

Other variables included in the estimation are occurrence of diarrhea among 0-5 years old member of the house, sex and occupation of decision-makers. Diarrhea is significant variable at 5 percent level only for boiling method of purification that means that if a household experiences diarrhea among the children in the past, then they are 11 percentage points more likely to use boiling method for water purification. Sex of the decision-makers is highly significant for all the methods of purification. On average female decision-makers are 36, 12 and 3 percentage points more likely to use boiling, ordinary filters and electric filters at their home respectively as compared to the male decision-makers. However, female decision-makers are slightly less likely to use chlorine tablets for water purification as compared to male decision-makers. Occupation of decision-maker is not statistically significant in all the cases of purification, which means whether or not a decision-maker belongs to medical profession has no effect on water purification behaviour.

The results of multinomial logit model lead us to conclude that besides other awareness variables, wealth influences the purification behaviour only for expensive method of treatment, while the inexpensive methods of treatment like boiling and use of chlorine tablets are highly influenced by awareness variables only.

## VI. SUMMARY AND CONCLUSION

The purpose of this study is to measure and analyse the determinants of awareness regarding the demand for safe drinking water among the households in Hyderabad district, Sindh, Pakistan.

The bivariate probit and multinomial logit econometrics models are used to estimate the unconditional effects of different households' characteristics on the decision to use purification methods. The primary data is used in this study from Hyderabad city in the year 2006. The sample size is 514 households, which consists of 3796 household members. The study estimates that there are statistically significant effects of formal education on demand for better quality of safe drinking water. The study also finds that there is a strong effect of informal education like electronic and print media on the water purification behaviour of households. The robustness of the results is against the common presumption that awareness in comparison to income has a second-order impact on the demand for environmental quality. Thus better level of awareness about health hazards regarding contaminated drinking water may prevent waterborne diseases, rather than focusing other strategies. Education appears to be strong determinant to influence the people about adverse effects of contaminated water, especially the women education. The sex of decision-makers regarding water purification is statistically significant suggesting that female decision-makers are more likely to adopt some water purification device than male decision-makers. Informal education through print media and television also has a significant effect on water purification at homes, so public awareness campaigns to educate the population about the health risks of inferior water quality may be an important policy instrument.

The study leads us to conclude that quality of drinking water is highly significant with formal education thereafter the media exposure. It means lack of awareness either through formal education or through media exposures can be regarded as the main function contributing waterborne diseases and associated health risks. The households who are aware about the associated health risks for the prevention measures to improve quality of drinking are likely to adopt water purification measures. This study empirically proved that the role of awareness besides the income constraint is the key determinants of safe drinking water.

The following policy implications are derived out of the study:

- Government and civil society can make an effective difference in lives of the people by making them aware about the methods of safe drinking water.
- Education and awareness campaigns about clean water are powerful tools for public health interventions.
- Planned awareness of safety measures especially to uneducated and rural women along with relative empowerment of women in household affairs would be the key tools of success.
- Print and electronic media can be used to play a role in sensitising and informing people about health hazards from unsafe drinking water.

## APPENDIX “A”

### The Wealth Index

The Wealth Index for the *i*th household is defined as

$$W_i = \sum_{j=1}^{22} f_j \left[ \frac{a_{ij} - m(a_j)}{S_j} \right] \quad \forall_i = 1, \ldots\ldots. n$$

where

$a_{ij}$ = 1 if *i*th household has asset $a_j$
0 otherwise

$$m(a_j) = \frac{\sum_{i=1}^{n} a_{ij}}{N}$$

$$S_j = \sqrt{\frac{\sum_{i=1}^{n} a^2_{ij}}{N} - [m(a_j)]^2}$$

And $f_i$ is the "scoring factor" for the $j$th asset, that is, ($f_1$ ……………$f_{32}$) maximises the variance of $W$ subject to the constraint $\sum_{j=1}^{22} f_j^2 = 1$.

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