# Consumption of safe drinking water in Pakistan: its dimensions and determinants

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**Abstract**

Safe drinking water is one of the basic human needs. Poor quality of drinking water is directly associated with various waterborne diseases. The present study has attempted to analyze the household preferences for drinking water sources and the adoption of household water treatment (HWT) in Pakistan by using the household data of Pakistan Demographic and Health Survey 2017-2018. This study found that people living in rural areas, headed by aged ones and having a large family sizes are significantly less likely to use water from bottled or filtered water and households having media exposure, education, women empowerment in household purchases and belong to the rich segment of society are more likely to use bottled or filtered water. Similarly, households belonging to urban areas, having a higher level of awareness (through education and media), belonging to wealthy families, women enjoying a higher level of empowerment and using piped water are more likely to adopt household water treatment (HWT). However, households using water from wells and having higher family sizes are less likely to adopt water purifying methods at home.

**Key Words**: Drinking Water**,** Education, Filtration, Health

**JEL Classification:** D31, I26, J31

# 1. Introduction

Access to clean and safe drinking water is a basic human right. However utilization of contaminated water is increasing (particularly in developing countries), approximately 12% of the world population lacks access to safe drinking water (World Economic Forum 2019). It had been estimated that approximately 785 million people worldwide are drinking water from unimproved sources, 207 million people have to spend at least 30 minutes to reach water source and 144 million people get drinking water from rivers, streams or lakes (WHO/UNICEF 2019).

Consequently, unsafe water lead to chronic diseases like typhoid, diarrhea, cholera, and parasites (Curry 2010). It had estimated that due to diarrhea, around 1.3 million people die annually among them 88% are children (IHME, 2015). Consumption of safe drinking water can prevent the fatal cases of diarrhea (Fewtrell et al.2005). It is supported by the fact that during 1870-1930 due to the provision of piped water in the urban areas of the USA, mortality rates had declined rapidly (Cutler and Miller, 2005). However, Brick et al. (2004) and Checkley et al. (2004) were of the view that to achieve the maximum health benefits by using clean water, there is need that sanitation and hygiene conditions also been improved.

Pakistan ranks 9$^{th}$ in the list of top 10 countries without access to safe drinking water. In Pakistan, having a population of 207 million in 2018, 21 million people do not have access to safe drinking water (Water Aid, 2018). Similarly, Pakistan Council of Research in Water Resources (PCRWR, 2012) concluded that the quality of water has deteriorated over the years because of the contamination of chemical pollutants and human waste.

Provision of clean water to the households can be achieved in two ways: by supplying treated water at the point of collection and Household Water Treatment (HWT) . In the first approach, studies found that significant re-contamination can occur during the process of transportation and storage of the water and even storage material and duration affects the water quality (Checkley et al. 2004, Brick et al. 2004). Brick et al. (2004) and Fewtrell et al. (2005) argued that HWT is the more effective method for the provision of safe drinking water as compared to supplying treated water at the point of collection. Examples of HWT are boiling (Mintz, 1995), chemical treatment (Quick et al.,1999) and Chlorination (Clasen et al, 2015). However, various studies concluded

that despite having positive impacts adoptability of HWT is very limited (Brown and Clasen, 2012).

Consumer behavior regarding the adoption of HWT is affected by numerous factors. The past studies found that income (Bruce & Gnedenko, 1998), education (Dasgupta, 2001 and Mc-Connell & Rosado, 2000 ), education of female household members (Jyotsna et al, 2003), age of household head (Mintz et al., 2001), household size (Sattar & Ahmad, 2007), level of awareness (Quick et al. , 1999 and Jalan et al., 2009), cost of HWT methods (Jalan & Somanathan, 2008), wealth of the household (Totouomet et al., 2012), locality of residence (Bruce & Gnedenko, 1998), type of water source (Daniel et al, 2019), perception about water quality and usefulness of HWT (Daniel et al, 2018) are the key factors in determining the adoption of household water treatment (HWT).

Very limited studies are being conducted on determinants of household's preference for drinking water sources. In this regard, Abraham, et al. (2000) found that perceived risk of using tap water, age, income and race are important factors in the usage of bottled water. Haq, et al. (2007) found that education of household head, and quality of available water play significant role in determining the demand of improved water source in Pakistan. Rauf et al (2015) found that family size, distance of the house from the water source have negative impact consumption of safe drinking water source. Zulifqar et.al, (2016) concluded that living in urban areas has a positive while age of household head and the incidence of water-borne disease to any household member have a negative impact on use of drinking water from improved source.

The present study is an attempt to analyze the household preferences and the impacts of different socio-economic factors on drinking water sources and adoption of HWT in Pakistan.

## 2. Methodology

The data of Pakistan Demographic and Health Survey (PDHS) 2017-2018 has been used. In PDHS 2017-18; 15,068 households were selected. The data on the source of household drinking water as well as the treatment measures adopted by households to clean the water were used.

To examine the role of different socio-economic factors in determining the water source, the Multinomial Logit (MNL) model was used. That was because the dependent variable is multi-

categories. By using MNL, we examined the preference for different drinking water sources by using the Bottled/Filtered water as the base category. Similarly, Logit Model was applied to analyze whether a household applies any measure to clean the water at home or not. In this regard, a binary variable was created that takes the value of 1 if the household adopts any water treatment method and zero for not adopting any HWT. Both models have been estimated by using STATA 13.0. A brief description of the variables that are used in the analysis is summarized as under:

**Dependent Variables:**

### 2.1 Source of Drinking water

In the survey, there are 17 different water sources. However, depending upon the nature of these sources we had grouped them into 6 different water sources. These are 1) Bottled/Filtered water, 2) Piped Water, 3)Protected Well, 4)Unprotected well, 5) Surface water, 6)Bought water from commercial entities .

### 2.2 Adoption of any purifying method to clean the water

We had created a binary variable to represent purifying methods used by the households. It takes the value of 1 if the household adopts any type of purifying method at home and 0 if the household does not adopt any purifying method.

**Independent Variables:**

### 2.3 Age of household head

It is hypothesized that households headed by more aged ones are less likely to use safe drinking water and adopt modern purifying methods. It was categorized as15-25, 25-39, 40-59 and 60 or more years of age.

### 2.4 Level of education of household head

In the dataset, education is divided into four categories no education, primary, secondary and higher education. We hypothesis that education will positively affect the choice of safe drinking water sources and the use of purifying methods.

### 2.5 Household Size

It is hypothesized that household size will reduce the chances of using bottled/filtered water as well as adoption HWT. This variable is categorized as the family size of 1-5, 6-10, 11-15 and 16 or more members.

### 2.6 Wealth of household

The wealth index had been used to describe the wealth of the household. The wealth index is calculated in PDHS by using the principal component analysis of around 40 different asset variables including the housing facilities, consumer and other material. The wealth index can take value from 1-5 where 1 indicates the poorest and 5 as the richest household. It is hypothesized that wealth will increase the chances of using bottled/filtered water and adoption of HWT.

### 2.7 Exposure to media

We constructed a binary variable named exposure of media (reading newspaper, watching TV or listening to the radio). It takes the value of 1 if a household either reads the newspaper, watches TV or listens to the radio, indicating that the household has exposure to media. Study hypothesize that media exposure will increase the likelihood of using bottled/filtered water and adoption of HWT.

### 2.8 Women Empowerment

There are several aspects of women empowerment. These include control over resources, involvement in household decision-making, and economic contribution in the household, freedom of movement, sense of self-worth, appreciation in the household, time use, knowledge, division in household work etc (Akram, 2018). Keeping in view the nature of the present study, we had used only her autonomy in household purchases as an indicator of empowerment. In the dataset, the question has five responses 1) respondent alone 2) respondent and husband/partner 3) husband/partner alone 4) family elders and 5) others. To make binary variables in the study, the first two responses are assigned the value of 1 describing that woman has autonomy and 0 for the rest of three options indicating that she had no autonomy. It is hypothesized that women empowerment will increase the likelihood of using bottled/filtered water and adoption of HWT.

### 2.9 Distance to the water source

To measure the relative distance to the water source, we utilized the information of walking distance (round trip) to get to the water source. The variable is having three options, 1) water is available at home 2) It takes up to 15 minutes to reach water source 3) It takes more than 15 minutes to reach a water source. We hypothesize that more distance to water will reduce the chances of using bottled/filtered water and adoption of HWT.

### 2.10 Location

Rural and Urban areas are two bifurcations of the location. In this regard, a binary variable has been constructed assigning a value of 1 for rural households and 0 for urban households. It is hypothesized that households belonging to urban areas are more likely to use bottled/filtered water and adopt HWT.

## 3. Results and Discussions

Descriptive statistics of variables are presented in Table 1. It shows that 48% of the surveyed households were living in urban areas while around 52% of the sampled households were living in rural areas.

**Table 1 Descriptive statistics of explanatory variables**

| Variable | Proportion | Mean | Standard Deviation |
|---|---|---|---|
| **Location** | | 0.48 | 0.50 |
| Urban | 48.1% | -- | -- |
| Rural | 51.9% | -- | -- |
| **Water Source** | | 2.81 | 0.99 |
| **Bottled/Filtered water** | 5.5% | -- | -- |
| Piped Water | 32.0% | -- | -- |
| Protected Well | 46.7% | -- | -- |
| Unprotected well | 10.5% | -- | -- |
| **Surface water** | 2.3% | -- | -- |
| **Bought water** | 3.0% | -- | -- |

| | | | |
|---|---|---|---|
| **from commercial entities** | | | |
| **Adoption of HWT** | -- | 0.10 | 0.30 |
| No | 89.8% | -- | -- |
| Yes | 10.2% | -- | -- |
| **Distance to Water Source** | | 0.37 | 0.70 |
| At home | 76.2% | -- | -- |
| Up to 15 minutes | 10.8% | -- | -- |
| Above 15 minutes | 13.0% | -- | -- |
| **Age of Household Head** | | 47.78 | 14.02 |
| 15-25 | 2.4% | -- | -- |
| 25-39 | 28.5% | -- | -- |
| 40-59 | 46.3% | -- | -- |
| 60+ | 22.8% | -- | -- |
| **Household Size** | | 8.43 | 4.61 |
| 1-5 | 26.4% | -- | -- |
| 6-10 | 50.0% | -- | -- |
| 11-15 | 16.5% | -- | -- |
| 16+ | 7.1% | -- | -- |
| **Education** | | 0.99 | 1.14 |
| No Education | 50.6% | -- | -- |
| Primary Education | 14.0% | -- | -- |
| Secondary Education | 20.8% | -- | -- |
| Higher Education | 14.6% | -- | -- |
| **Wealth** | | 2.79 | 1.43 |
| Poorest | 25.3% | -- | -- |
| Poorer | 21.4% | -- | -- |
| Middle | 19.0% | -- | -- |
| Richer | 17.1% | -- | -- |
| Richest | 17.2% | -- | -- |
| **Media Exposure** | | 0.64 | 0.48 |
| No | 35.7% | -- | -- |
| Yes | 64.3% | -- | -- |
| **Women Empowerment in Household purchases** | | 0.40 | 0.49 |
| No | 60.1% | -- | -- |
| Yes | 39.9% | -- | -- |

The majority of the households were drinking water from protected wells (47%), followed by piped water (32%), unprotected wells (11%) and bottled/filtered water (6%) and other sources (4%). Similarly, 90% of households are not adopting any household water purifying method . The majority of household i.e. 76% are getting drinking water at home, 11% of the household have to travel for less than fifteen minutes to reach water source and 13% of households are getting water from sources where they have to travel for fifteen minutes or more (round trip). The minimum age of the household head emerged as 15 years while the maximum age was 95 years and average age of the household head is 48 years. It is also pertinent to mention that majority of household heads belong to the age bracket of 40-59 years. The average family size is eight persons; however, the maximum family size of the surveyed households was 44 persons and the minimum family size is only one family member. 50% of the households are having a family size of 6-10 persons. The table also indicates that 51% of surveyed households were uneducated and only 35% of the household are having a secondary level or higher education. In terms of wealth, 47% of the households were poor 19% are among middle and 34% were classified as rich. The table also reveals that 64 % of the surveyed households are having exposure to the media. Similarly, about 40% of the household's women have empowerment in household purchases.

The study is focused on the determinants of household drinking water sources. For estimation Multinomial Logit (MNL) model has been applied. In the MNL model, we had used the bottled/filtered water as the base category. The results are summarized in Table 2 below.

**Table 2 Estimation results of Multinomial Logit (MNL) model of determinants of drinking water source**

| Variables | Water Sources | | | | | |
|---|---|---|---|---|---|---|
| | Bottled/ filtered water | Piped Water | Protected Well | Unprotected well | Surface water | Bought water from commercial entities |
| Location (living in | 1 | 1.0094* | 1.1269* | 1.0584* | 0.6082* | 0.0134 |

| | | | | | | |
|---|---|---|---|---|---|---|
| rural areas) | | | | | | |
| Age of Household Head | 1 | 1.2826* | 1.1197* | 1.4915* | 1.0676* | 1.1768 |
| Household Size | 1 | 1.5281* | 1.5405* | 1.3387* | 1.8129* | 1.9999* |
| Media Exposure | 1 | 0.9893* | 1.0989 | 0.7319* | 0.8713 | 0.6348* |
| Education | 1 | 0.8325* | 0.7136* | 0.6479* | 0.3625* | 0.8397* |
| Women Empowerment in Household purchases | 1 | 0.6489* | 0.7705* | 0.6130* | 0.5478* | 0.3766* |
| Wealth | 1 | 0.4325* | 0.4625* | 0.2505* | 0.3936* | 0.2192* |
| **Constant** | 1 | 110.0963* | 283.4138* | 200.7871* | 10.0194* | 112.5794* |
| **LR Chi-Square** | | | 3651.62 | | | |
| **P-value of Chi-Square** | | | 0.0000 | | | |
| **Pseudo R Square** | | | 0.1021 | | | |

*p < 0.05

The results suggest that household's location influenced the choice of drinking water in four out of five alternatives. Zulifqar et.al, (2016) also come to the similar conclusion that living in urban or rural area play significant role in determining the households water source. The results suggest that people living in rural areas were more likely to use water from protected wells and Tube wells compared to the water from other sources(possible reason seems to be the cost and availability of services). Furthermore, results suggested that household living in rural areas are less likely to use drinking surface water (relative risk ratio less than 1) but they would prefer piped water and also unprotected well (relative risk ratio greater than 1).

Similar to the findings of Abraham, et al. (2000) and Zulifqar et.al, (2016) it has been found that the age of household head is having a significant impact on the source of drinking water in all the five alternatives. The results suggested that households headed by aged ones are more likely to consume water from unprotected wells. It reflects that aged people in Pakistan are least health-conscious and they prefer to use traditional water sources.

Household size is having a very strong impact, as the results are significant in all the five alternatives. The results are also been supported by the findings of Rauf et al (2015). The households having larger family size prefers to use other water sources in comparison to the bottled/filtered water as in all the alternatives relative risk ratio is significantly greater than 1. Because with increase in family size, water consumption increased so families prefer to use water from those sources where they can get more water easily.

It has been confirmed that households having access to media and education are more likely to use water from protected wells or bottled/filtered water. It may be because people have information about the health hazards of unsafe water therefore they would prefer to use safe drinking water sources. Abraham, et al. (2000), Haq, et al. (2007) and Zulifqar et.al, (2016) also come to the similar conclusion that education and awareness about the hazards of drinking unsafe water plays crucial role in determining the improved drinking water source.

In line with the findings of Abraham, et al. (2000) it has been found that wealthier household prefers to use bottled/filtered water in comparison to other water sources. The reason may be that wealthier households can afford better sources of drinking water. Furthermore, rich people are more health-conscious and willing to spend more money on an improved water source.

It has also been found that households with greater women autonomy in making household purchases prefer to use bottled/filtered water in comparison to other water sources. It suggests that women are more health-conscious and if they are involved in household spending decision-making then there are more chances that they would make appropriate adjustments in the expenditures to allocate more money for using improved water source.

In the next step, the household's adoption of HWT was analyzed. This model is tested by using the logit model. The results are summarized in Table 3.

**Table 3 Estimation results of logit model of the in-house water treatment to treat water**

| Variables | Odd Ratios | P values |
|---|---|---|

| | | |
|---|---|---|
| **Location** | | |
| Urban | 1 | |
| Rural | 0.8901 | 0.0469* |
| **Age of Household Head** | | |
| 15-25 | 1 | |
| 25-39 | 0.8677 | 0.459 |
| 40-59 | 0.8805 | 0.505 |
| 60+ | 0.8846 | 0.536 |
| **Household Size** | | |
| 1-5 | 1 | |
| 6-10 | 0.9519* | 0.047 |
| 11-15 | 0.8922* | 0.008 |
| 16+ | 0.8672* | 0.000 |
| **Education** | | |
| No Education | 1 | |
| Primary Education | 1.0702 | 0.447 |
| Secondary Education | 1.1308* | 0.041 |
| Higher Education | 1.8081* | 0.000 |
| **Wealth** | | |
| Poorest | 1 | |
| Poorer | 0.9991 | 0.992 |
| Middle | 0.9005 | 0.266 |
| Richer | 1.0675* | 0.063 |
| Richest | 1.0844* | 0.032 |
| **Media Exposure** | | |
| No | 1 | |
| Yes | 1.1904* | 0.017 |
| **Distance to Water Source** | | |
| At home | 1 | |
| Up to 15 minutes | 1.1270 | 0.253 |
| Above 15 minutes | 0.9610 | 0.722 |
| **Women Empowerment in Household purchases** | | |
| No | 1 | |
| Yes | 1.2291* | 0.001 |
| **Water Source** | | |
| Bottled water | 1 | |
| Piped Water | 1.0991* | 0.000 |
| Well | 0.5752* | 0.000 |
| Unprotected well | 0.9641* | 0.000 |
| Surface water | 0.9984 | 0.994 |
| Bought water from commercial entities | 0.5640* | 0.017 |
| **Constant** | 0.1608 | 0.000 |

| | |
|---|---|
| **LR Chi-Square (36)** | 118.72 |
| **P-value of Chi-Square** | 0.000 |
| **Pseudo R Square** | 0.1360 |

*p < 0.05

The results from table 3 indicate that locality of the household plays a significant role in adoption of in-house water purifying treatment and people who live in urban areas are more likely to adopt HWT (odd ratio for rural households are significantly below 1). These findings are also been supported by Bruce & Gnedenko (1998) that urban households are more likely to adopt HWT.

Similar to the findings of Sattar & Ahmad (2007) it has also been found that the family size hurts the adoption of water purifying methods as odd ratios are less than 1. Due to the large family size, more water is required so it is very difficult for the large families to adopt HWT rather they prefer to use water without any treatment. It reveals the fact that due to larger family quality as well as quantity of essential services are negatively affected.

Both the education and exposure to the media (the indicators for the level of awareness) tends to increase the likelihood of adopting HWT. However, only secondary and higher education results in increasing the chances of adoption of HWT. These findings are supported by various past studies including Dasgupta ( 2001), Mc-Connell & Rosado (2000), Quick et al. (1999) and Jalan et al., (2009).

In line with the findings of Bruce & Gnedenko (1998) and Totouomet et al.(2012), it has been found that the wealth of households has a significant impact on the adoption of the water purifying method. There are significantly higher odds of the wealthier household to adopt HWT in comparison to a poor or middle-income household.

The women's empowerment is also had a significant impact on adoption of HWT. Households wherein women are empowered in making household purchases are more likely to use water-purifying methods. These results are supported by Jyotsna et al. (2003).

The drinking water source is also emerged as an important and significant factor in the adoption of HWT. The results indicate that people might not trust the water quality coming from the piped water (it has been supported by Daniel et al, (2018)), therefore they are more likely to

adopt HWT . Daniel et al, (2019) also comes to the similar conclusion that households using piped water are more likely to adopt HWT. However, households using water from protected well, unprotected wells and water bought from commercial sources are significantly less likely to adopt HWT.

Present study is unable to find significant impact of age of household head and distance to water sources on the adoption of HWT in Pakistan. However past studies found that age of the household head (Mintz et al., 2001) play significant role in adoption of HWT.

## 4. Conclusions and Policy Recommendations

In developing countries, poor quality of drinking water has been recognized as a major health issue because many fatal diseases especially diarrhea and hepatitis are linked with the quality of water. The present was conducted to analyze the role of different socioeconomic characteristics of the households in using different water sources and adoption of HWT. The results of the study provide insight for policymakers to tackle obstacles in the consumption of safe drinking water in Pakistan and it will help them to develop adopt better policies that would increase the availability/usage of better quality drinking water in Pakistan.

It has been found that locality of household, family size, age of household head, wealth of household, level of awareness (education and exposure to media), and women empowerment are significant factors in determining the household consumption of drinking water sources. People living in rural areas, headed by aged ones, having large family sizes are significantly less likely to use improved drinking water sources. However, households having media exposure, education, women empowerment in household purchases and belonging to the rich segment of society are more likely to use a safe drinking water source.

Similarly, locality of household, family size, education, exposure to the media, women empowerment, source of drinking water and wealth of household are significant factors in determining the adoption of HWT. It reveals that households belonging to urban areas, having a higher level of awareness (through education and media), belonging to wealthy families, wherein women enjoy a higher level of empowerment and households using piped water are more likely to adopt HWT. However, households using water from protected well, unprotected wells, water bought from commercial sources and having higher family size are less likely to adopt water

purifying methods at home. However, the age of household head and distance to water sources do not have a significant impact on the adoption of the water purifying method.

On the basis of the findings of the present study it is recommended that:

i. Better drinking water facilities must be provided in rural areas so that differences in urban and rural areas in terms of safe drinking water may be eliminated.
ii. Study reveals that most of the Pakistani households use drinking water from wells. However excessive wells and tube wells has resulted insignificant reduction in the under the surface water levels. There is need that government may launch awareness campaigns to promote usage of drinking water from filters and piped water.
iii. Similarly, households consider the water obtained from wells as safe and do not adopt HWT. There is dire need that a comprehensive study may be conducted to analyze the levels of pollution in the drinking water obtained from wells.
iv. As mentioned earlier, larger families do not adopt HWT and they tried to use those water from where they can get large quantity of water without any cost. Consequently, larger families result in getting essential services at compromised quality. The policy makers must take appropriate measures to control population growth in Pakistan.
v. It is also recommended that policy makers in Pakistan must take appropriate actions to empower women. Women empowerment will not only uplift the conditions of women in Pakistan but it will also have positive impacts on other social dictators including consumption of safe drinking water.
vi. Study also found that awareness created by media and education play significant role in determining the consumption of safe drinking water in Pakistan. Therefore, it is suggested that government along with different NGOs working on social sector must launch awareness campaigns regarding hazards of consuming unsafe water and adoption of HWT. In this regard it is also recommended that issues associated with safe drinking water must be included in curriculum of public as well as private schools.

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