

<p style="text-align: center;"><u>Topical Editor</u></p> <p>The literature study should not be a summary of the work of the various, but should be incorporated in the introduction, to better define the knowledge gap and the objective of the study</p> <p>The results and discussion chapter should contain a reflection on literature. What is new, what is the same as others found etc.</p>	<p>Author Responses</p> <p>As desired introduction and literature review has been merged</p> <p>As desired findings have been linked with past studies on the subject.</p>
<p style="text-align: center;"><u>Peer Review # 1</u></p> <p><u>Major Comments</u></p> <p>Please make the introduction and literature concise. Now you have 3+ pages of it. Please make it maximum 2 pages. That's possible. Delete unnecessary information. Make it concise.</p> <p>I think the citation and reference's style are not well reported. Please edit it following the journal's standard. Check the example in the website: https://www.drinking-water-engineering-and-science.net/for_authors/manuscript_preparation.html</p> <p>The conclusion is not strong enough! And the conclusion chapter is not really conclusion, but there are many repetitions from the discussion chapter.</p> <p><u>Minor Comments</u></p> <p>I think that author needs to re-write this abstract. Please consider my comments for other chapters when re-writing the abstract.</p> <p>Change water purification and other related terms to HWT. Change purifying water to treated water.</p> <p>You can add this paper as an extra citation: https://www.nature.com/articles/s41545-018-0012-z</p>	<p>Author Responses</p> <p>In the light of comments introduction and literature review has been merged and shortened.</p> <p>Citation and references has been updated according to the journal format.</p> <p>Conclusion has been updated and important policy implications along with future research directions are added.</p> <p>Numerous changes in each line and page were suggested. I incorporated all these changes.</p> <p>Abstract is updated in line with the comments</p> <p>Needful has been done.</p> <p>Paper is cited.</p>

<p>Summary of chapter 2 : authors can make this section more concise. Don't need to mention all significant variables that are found in those studies, including negative or positive correlation. You can discuss that when you relate your findings and their findings. But don't need to be detail in this chapter. See for example the paper from Daniel et al. (2019) (one of the papers that you cite) how they wrote all the factors very briefly in section 2.2 only in 1 paragraph.</p>	<p>In the light of the comments literature review is updated and made part of introduction</p>
<p>Make clear distinction between dependent and independent variable. For example, you can make different sub-title for them.</p>	<p>Dependent and independent variables have been distinguished.</p>
<p>If you write your assumption or hypothesis in several variables (age of household head and level of education), you need to make it in all variables, e.g., you don't make it for wealth of household.</p>	<p>Hypothesis have been added in all the variables.</p>
<p>Be careful of using present and past tense! Please check it. change the numbering to 3.1, 3.2, ...</p>	<p>Needful done.</p>
<p>I would say that your classification is not scientifically acceptable. For example, why don't you use the old definition of JMP, for example: improved, unimproved, surface water? But I don't want you to re-do all your analysis. So, suggest to change the name for these 6 classifications. For example, no 1: just call it "bottled water", no 3: well, no 4: unprotected well, no 5: surface water, no 6: bough water from commercial entities</p>	<p>In the light of the comments the classifications have been changed as per following details: 1bottled/filtered water" 2. Piped water 3 protected well, 4 unprotected well 5: surface water, 6: water bough from commercial entities</p>
<p>The discussion is not deep enough. Author only describe the findings one-by-one for each predictor variable and don't relate the findings to bigger context or other studies. Even there is no discussion which predictor is the most important one.</p>	<p>As desired findings have been linked with past studies on the subject.</p>
<p>Sometimes author write unnecessary words result in long sentence. Please consider to write it more concise.</p>	<p>Needful has been done.</p>
<p>It seems that author treat predictor variable as continuous in multinominal logit but then categorical in logit and this means that</p>	<p>Basically, in table 2 we have six categories of water sources (multiple categories) so the</p>

<p>the analysis is wrong. Because if the predictors are categorical, table 2 should look like table 3 (all levels in the predictor variables have their own results or they are dummy variables). Please correct me if I am wrong. if I am correct but please re-do the analysis or update the table if I am correct.</p> <p>The statistical analysis looks doubtful. Usually researcher use p value < 0.05, but author also consider p value < 0.1 as significant. Please give your reason for this in the methods section.</p>	<p>multinomial model has been adopted. A household will use water from one of these six categories. Here first category i.e. bottled/filtered water is a base category and we are comparing the coefficient (Relative risk ratios)of other variables with them. Wherein in table 3 we had only a dummy variable that either household is using water treatment method or not. So here the logit model is adopted.</p> <p>As desired in the revised draft only P value< 0.05 is used</p>
<p style="text-align: center;"><u>Peer Review # 2</u></p> <p>The author should carefully edit the paper and present the tables in a better manner before resubmission.</p> <p>Poor English at places made it difficult to understand certain arguments such as regarding the estimated effects of household size on treating household water.</p> <p>The research design in itself is not as innovative, since such studies have been conducted many times before in different contexts. The use of multinomial logit and logit model was not well motivated and its use was rather not-so-innovative as well. For example, why not probit model? Perhaps the author can bring in the assumptions that he is making when using logit models. Results obtained are also as expected. However, his use of the independent variables was well motivated by literature and challenges that Pakistani society faces in terms of access of clean drinking water. Also, use of multiple household characteristics in such a manner and its impact on use of household water treatment is perhaps new and of interest to development authorities and policy makers in Pakistan. The author should therefore make serious effort on discussing its implications for actions that policy makers can take than just focusing on</p>	<p style="text-align: center;">Author Responses</p> <p>Tables are revisited and updated</p> <p>In the light of the comments proofreading is done and tried level best to make the paper understandable.</p> <p>In the light of the comments conclusion section has been updated and important policy implications along with future research directions are added.</p>

awareness campaign.

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3 Consumption of safe drinking water in Pakistan: its dimensions 4 and determinants

5

NaeemAkram

Ministry of Economic Affairs, Islamabad, Pakistan

Email: naeem378@yahoo.com

Mobile: +92-333-5343163

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10 **Abstract**

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

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NaeemAkram

Ministry of Economic Affairs, Islamabad, Pakistan

Email: naeem378@yahoo.com

Mobile: +92-333-5343163

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31 **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 filtration plant or bottled water (safe water) and households having media exposure, education, women empowerment in household purchases and belonging to the rich segment of society are more likely to use safe drinking water source. 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 tube wells, wells, and boreholes 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), due to population growth and limited resources, in developing countries, the utilization of contaminated water is increasing. Approximately 12% of the world population lacks access to safe drinking water (World Economic Forum 2019). WHO It had been estimated that over 2 billion approximately 785 million people worldwide are drinking water from unimproved sources, do not have access to drinking water free from contamination at their homes; among them, 263-207 million people

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64 have to spend at least 30 minutes to reach water source and ~~159,144~~ million people get drinking
65 water from rivers, streams or lakes (WHO/UNICEF ~~JMP-20197~~).

66 Consequently, ~~unsafe water lead to millions of people are suffering from~~ chronic diseases like
67 typhoid, diarrhea, cholera, and parasites ~~because of drinking contaminated water~~ (Curry 2010).
68 It had estimated that due to diarrhea, around 1.3 million people die annually; among them 88%
69 are children ~~and most of these fatal diarrhea cases are associated with poor quality of water and~~
70 ~~sanitation~~ (IHME, 2015). ~~Consumption Usage~~ of safe drinking water ~~can prevent the leads to~~
71 ~~reducing the water borne diseases including fatal cases of~~ diarrhea (Fewtrell et al.2005). It is
72 supported by the fact that during 1870-1930 due to the provision of piped water in the urban
73 areas of the USA, mortality rates had declined rapidly (Cutler and Miller, 2005). However,
74 Brick et al. (2004) and Checkley et al. (2004) were of the view that ~~to health~~ achieve the
75 maximum health benefits ~~by using from~~ clean water, ~~there is need that can only be achieved if~~
76 ~~there are better~~ sanitation and hygiene conditions ~~also been improved.~~ available. ~~Bad hygiene at~~
77 ~~places of newborn babies along with unsafe water results in infectious diseases that are the major~~
78 ~~source of deaths of newborns and 25% of these deaths can be prevented by providing safe water~~
79 ~~and sanitation at the place of birth (IGME,2019).~~

80 Pakistan ranks 9th in the list of top 10 countries without access to safe drinking water. ~~i~~ In
81 Pakistan, ~~having a population of 207 million in 2018, approximately~~ 21 million ~~out of 207~~
82 ~~million (total population), people~~ do not have access to safe drinking water (Water Aid, 2018).
83 Similarly, ~~the~~ Pakistan Council of Research in Water Resources (PCRWR, 2012) concluded that
84 ~~over the years, t~~he quality of water has deteriorated over the years because of the contamination
85 of chemical pollutants and human waste. ~~It also asserts that in many areas piped water also~~
86 ~~polluted due to leakages and its closure to sewerage lines. The poor quality of water is the main~~
87 ~~cause of around 60% of infectious waterborne diseases in Pakistan (WHO, 2008).~~

88 ~~P~~The provision of clean water to the households can be achieved in two ways: by supplying
89 treated water at the ~~point of gathering~~ point of collection ~~or treating water at the point of use~~ and
90 Household Water Treatment (HWT). In the first approach, studies found that ~~e~~-significant re-
91 contamination can occur during the process of transportation and storage of the water and even
92 storage material and duration affects the water quality (Checkley et al. 2004, Brick et al. 2004).
93 Brick et al. (2004) and Fewtrell et al. (2005) ~~argued of the view t~~hat ~~treating water at the point~~

94 ~~of use~~HWT is the more effective method for the provision of safe drinking water as compared to
95 supplying treated water at the ~~point of gathering~~point of collection. Examples of HWT are
96 boiling (Even very simple methods like the use of plain cloth can clean the water to some extent
97 (Colwell et al. 2003). Mintz, (1995), chemical treatment and (Quick et al., (1999) and
98 concluded that boiling and chemical treatment can eliminate bacteria but these are relatively
99 costly methods. Chlorination (is considered one of the cheapest and effective methods for
100 household water treatment (Clasen et al, 2015). However, various studies concluded that despite
101 having positive impacts adoptability of HWT is very limited households use in house water
102 purifying methods (Brown and Clasen, 2012).

103 Consumer behavior regarding the adoption of HWT is affected by numerous factors. The past
104 studies found that income (Bruce & Gnedenko, 1998), education (Dasgupta, 2001 and Mc-
105 Connell & Rosado, 2000), education of female household members (Jyotsna et al, 2003), age of
106 household head (Mintz et al., 2001), household size (Sattar & Ahmad, 2007), level of awareness
107 (Quick et al. , 1999 and Jalan et al., 2009), cost of HWT methods (Jalan & Somanathan, 2008),
108 wealth of the household (Totoumet et al., 2012), locality of residence (Bruce & Gnedenko,
109 1998), type of water source (Daniel et al, 2019), perception about water quality and
110 usefulness of HWT (Daniel et al, 2018) are the key factors in determining the adoption of
111 household water treatment (HWT).

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

121 In Pakistan, there are numerous sources of drinking water including wells, hand pumps, piped
122 water, tube wells, ponds, rivers, bottled water, and fountains, etc. Similarly, different

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123 methodologies like boiling, use of charcoal, filters, etc has been used to treat the water at home.
124 Consumer behavior regarding the use of safe drinking water is affected by numerous factors. In
125 this regard income, education, age, household size, level of awareness, number of children and
126 gender of household head are among the key factors in determining the consumption of safe
127 drinking water in Pakistan (Sattar and Ahmad, 2007, Rauf et.al 2015, Zulifqar et.al, 2016).

128 ~~The present study is an attempt to analyze the household preferences and the impacts of~~
129 ~~different socio-economic factors on for drinking water sources in Pakistan and adoption of HWT~~
130 ~~in Pakistan and adoption of purifying methods at home. Furthermore, the impacts of different~~
131 ~~socio-economic factors on household consumption of drinking water and purifying methods will~~
132 ~~be analyzed.~~

133 **2. Literature review**

134 Numerous studies have been conducted to analyze the role of different socio-economic factors
135 on the consumer choice of drinking water; a brief overview of the selected studies is summarized
136 as under:

137 Bruce and Gnedenko (1998) find that income, locality of residence, perception about water
138 quality significantly affects the use of different water purifying methods. Abrahms, et al. (2000)
139 finds that water quality (odor, taste), perceived risk of using tap water, age and race are
140 important factors in the usage of bottled water. Whereas, perceived risk of water borne disease
141 and income determine the use of water filters.

142 Dasgupta (2001) and Mc Connell and Rosado (2000) found that the level of education positively
143 and significantly affects the household's consumption of purifying drinking water at home.
144 Similarly, according to Jyotsna et al (2003) in comparison to media exposure and education
145 wealth is a stronger factor in determining water purification behavior; furthermore, households
146 with a higher level of female education are more willing to pay for clean drinking water.

147 Quick et al. (1999), Mintz et al. (2001) Jalan and Somanathan (2008) and Jalan et al. (2009)
148 comes to the conclusion that awareness about the health hazardous associated with the use of
149 unsafe water, cost of treatment, wealth and education have significant impact on purifying
150 drinking water at home. Fotue Totouomet et al., (2012) and Daniel et al (2019) found that the

151 ~~wealth of the household, Education and facing the risk of water borne disease are the major~~
152 ~~factors in determining the adoption of in house water purifying methods. Households that are~~
153 ~~using piped water are having a higher probability of using purifying methods at home to clean~~
154 ~~the drinking water.~~

155 ~~In Pakistan, Haq, et al. (2007) are of the view that household locality (urban/rural), education~~
156 ~~and quality of available water plays a significant role in determining the demand of improved~~
157 ~~water source. Sattar and Ahmad (2007) found that the education of household head and~~
158 ~~exposures to media have a significant impact on the choice of different water purifying~~
159 ~~methodologies. It was also been found that wealthier people prefer to use expensive technologies~~
160 ~~like filters. Furthermore, the education of households has a much stronger effect as compared to~~
161 ~~the income level.~~

162 ~~Rauf et al (2015) found that family size, distance of the house from the water source and lack of~~
163 ~~transportation has a significant and negative impact on the choice of safe drinking water. The~~
164 ~~study also found that wealth, and living in urban area has a positive and significant relationship~~
165 ~~with the choice of safe drinking water. However, the study found that education and gender of~~
166 ~~the household head have an insignificant relationship with the choice of safe drinking water.~~

167 ~~Zulifqar et.al, (2016) concluded that per capita income, living in urban areas, the awareness level~~
168 ~~has a positive impact on the choice of safe drinking water. However, it has been found that the~~
169 ~~age of household head and the incidence of water borne disease to any household member have a~~
170 ~~negative relationship with the choice of safe drinking water.~~

171 ~~3-2.~~ **Methodology**

172 ~~In the present study,~~ the data of Pakistan Demographic and Health Survey (PDHS) 2017-2018
173 has been used. ~~DHS surveys are conducted in different developing countries with the funding of~~
174 ~~the United States Agency for International Development (USAID).~~ In PDHS 2017-18; 15,068
175 households were selected. ~~In the household survey, the data on we have available information~~
176 ~~regarding~~ the source of household drinking water as well as the treatment measures adopted by
177 households to clean the water were used.

178 ~~In survey 17, drinking water sources had been mentioned.~~ To examine the role of different socio-
179 economic factors in determining the water source, the Multinomial Logit (MNL) model ~~will~~
180 ~~be was~~ used. ~~The reason is that was because the -our~~ dependent variable ~~does not have any~~
181 ~~ordering and they isare~~ multi-categories. By using MNL, we ~~_will~~ examined the preference for
182 different drinking water sources by using the ~~BFilter/bottled/Filtered~~ water as the base category.
183 Similarly, Logit Model ~~was would be~~ applied to analyze whether a household applies any
184 measure to clean the water at home or not. In this regard, a binary variable ~~was is~~ created that
185 takes the value of 1 if the household adopts any water treatment method and zero for not
186 adopting any HWT otherwise. ~~The independent variables are distance to the water source,~~
187 ~~household wealth, education, exposure to media (a proxy for the level of awareness), household~~
188 ~~size, urbanization, etc.~~ Both models have been estimated by using STATA 13.0. A brief
189 ~~description overview~~ of the variables that are used in the analysis is summarized as under:

Dependent Variables:

ii.2.1 Source of Drinking water

192 In the survey, there are 17 different water sources. However, depending upon the nature of these
193 sources we had grouped them into 6 different water sources. These are 1) ~~Filtration~~
194 ~~plant/Bottled/Filtered~~ water, 2) Piped Water, 3) ~~Protected WTube well_ / borehole/ protected~~
195 ~~well,~~ 4) Unprotected well, ~~/springs~~ 5) Surface water ~~River/Dam/Lakes/ Ponds/Canals/ Streams,~~
196 6) Bought water from commercial entities ~~Tanker/ Truck/ Carats with small tank.~~

ii.2.2 Adoption of any purifying method to clean the water

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

Independent Variables:

iii.2.3 Age of household head

203 ~~The age of household head can be an important factor in determining the water source as well as~~
204 ~~the purifying method.~~ It is hypothesized expected that households headed by more aged ones are

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205 less likely to use safe drinking water and adopt modern purifying methods. It ~~was~~ categorized
206 as 15-25, 25-39, 40-59 and 60 or more years of age.

207 ~~iv~~2.4 Level of education of household head

208 ~~Numerous studies had recognized that education plays a pivotal role in choosing a safe drinking~~
209 ~~water source.~~ In the dataset, education is divided into four categories no education, primary,
210 secondary and higher education. We ~~expect~~hypothesis that education will positively affect the
211 choice of safe drinking water sources and the use of purifying methods.

212 ~~v~~2.5 Household Size

213 It is ~~hypothesized~~expected that household size will ~~reduce the chances of using bottled/filtered~~
214 ~~water hurt the choice of safe drinking water~~ as well as ~~adoption HWT~~the usage of any water
215 ~~purifying method~~. This variable is categorized as the family size of 1-5, 6-10, 11-15 and 16 ~~or~~
216 more members.

217 ~~vi~~2.6 Wealth of household

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

224 ~~vii~~2.7 Exposure to media

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

230 ~~— Value of 0 represents no media exposure, the variable takes a value of 0 if he~~
231 ~~does not use any form of media.~~

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232 **viii.2.8 Women Empowerment**

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

244 **ix.2.9 Distance to the water source**

245 ~~In the original data set, there is no direct variable available that measures the distance to the
246 water source. However, there is a variable that gives the details of the time (round trip) to get to
247 the water source. It is used because if the water source is far away then it will take more time as
248 compared to the availability of water nearby. To measure the relative distance to the water
249 source, we utilized the information of walking distance (round trip) to get to the water source.~~
250 The variable is having three options, 1) water is available at home 2) It takes up to 15 minutes to
251 reach water source 3) It takes more than 15 minutes to reach a water source. We hypothesize
252 that more distance to water will reduce the chances of using bottled/filtered water and adoption
253 of HWT.

254 **x.2.10 Locationlity**

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

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4.3. Results and Discussions

262 ~~Before conducting econometric analysis, d~~ Descriptive statistics of variables are presented in
263 Table 1. It ~~suggests shows~~ that 48% of the surveyed households were living in urban areas while
264 around 52% of the sampled households were living in rural areas.

265

266 Table 1 Descriptive statistics of explanatory variables

Variable	Proportion	Mean	Standard Deviation Dev.
Locationity		<u>0.48</u>	0.50
Urban	48.1%	--	*****
Rural	51.9%	--	*****
Water Source		<u>2.81</u>	0.99
Bottled/Filtered water Filtration plant/Bottled water,	5.5%	--	*****
Piped Water	32.0%	--	*****
Protected Tube Well / bore hole/ protected well,	46.7%	--	*****
Unprotected well/springs	10.5%	--	*****
Surface water River/Dam/Lakes/ Ponds/Cannels/ Streams,	2.3%	--	*****
Bought water from commercial entities Tanker/ Truck/ Carats with small tank,	3.0%	--	*****
Adoption of any purifying method of HWT to clean the water Locality	*****	<u>0.10</u>	0.30
No	89.8%	--	*****

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

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268 The majority of the households were drinking water from ~~Tube wells/boreholes/protected wells~~
269 (47%), followed by piped water (32%), unprotected wells (11%) and ~~water from filtration~~
270 ~~plant~~/bottled/~~filtered~~ water (6%) and other sources (4%). Similarly, 90% of households are not
271 ~~adopting any household water purifying using any method to purify the drinking water at~~
272 ~~home~~. The majority of household i.e. 76% are getting drinking water at home, 11% of the

273 household have to travel for less than fifteen minutes to reach water source and 13% of
 274 households are getting water from sources where they have to travel for fifteen minutes or more
 275 (round trip). The minimum age of the household head emerged as 15 years while the maximum
 276 age was 95 years and average age of the household head is 48 years. It is also pertinent to
 277 mention that majority of household heads belong to the age bracket of 40-59 years. The average
 278 family size is eight persons; however, the maximum family size of the surveyed households was
 279 44 persons and the minimum family size is only one family member. 50% of the households are
 280 having a family size of 6-10 persons. The table also indicates that 51% of surveyed households
 281 were uneducated and only 35% of the household are having a secondary level or higher
 282 education. In terms of wealth, 47% of the households were poor 19% are among middle and 34%
 283 were classified as rich. The table also ~~reveals~~reveals that 64 % of the surveyed households are
 284 having exposure to the media. Similarly, about 40% of the household's women have
 285 empowerment in household purchases.

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

291 **Table 2 Estimation results of Multinomial Logit (MNL) model of determinants of drinking**
 292 **water source (relative risk ratios)**

Variables	Water Sources					
	<u>Bottled/filtered water</u> Filtration plant/Bottled Water	<u>Piped Water</u> Piped Water	<u>Protected Well/Tube well/borehole/protected well</u>	<u>Unprotected well</u> Unprotected well/springs	<u>Surface water</u> River/Dam/Lakes/Ponds/Canals/Streams	<u>Bought water from commercial entities</u> Tanker/Truck/Carats
Location ity (living in rural areas)	1	1.0094*	1.1269*	1.0584*	0.6082*	0.0134

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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; **p < 0.10

The results suggest that household's location urbanization-influenced is having a significant impact on 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 are-were more likely to use water from protected wells and Tube wells as-compared to the water from other sourcesfiltration plant/bottled water for drinking, as the relative risk ratio is 1.13 significantly highest among all the alternatives, (possible reason seems to be the cost and availability of services). -Furthermore, results suggested that are also suggestive of the fact that household living in rural areas are less likely to use drinking surface water from dams/rivers/streams (relative risk ratio less than 1) but they would prefer piped water and also unprotected well/springs (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 results indicate thatthe age of household head is having a significant impact on the source of drinking water in all the five alternatives. The results suggested ed that households headed by aged ones are more likely to consume water from unprotected wells, tube wells, pipied water, rivers, streams, rivers, dams, tankers, trucks, etc (as relative risk ratios are

310 ~~significantly greater than 1~~). It reflects that aged people in Pakistan are least health-conscious
311 and they prefer to use traditional water sources ~~instead of water from filtration plants~~.

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

319 ~~It has been found that education (significant in all of the five choices) and exposure to media~~
320 ~~(significant in three out of the five choices) have a crucial role in consumption of safe~~
321 ~~drinking water~~. It has been ~~further~~ confirmed that ~~household~~ households ~~that is~~ having access
322 to media and education are more likely to use water from protected wells or bottled/filtered
323 water ~~less likely to use the water from piped water, wells, tube wells, rivers, streams, rivers,~~
324 ~~dams, tankers, trucks, etc (as relative risk ratios are significantly less than 1) rather they~~
325 ~~would prefer to use the water from filtration plants~~. It ~~may be is~~ because people have
326 information about the health hazards of unsafe water therefore they would prefer to use safe
327 drinking water sources. Abraham, et al. (2000), Haq, et al. (2007) and Zulifqar et.al. (2016)
328 also come to the similar conclusion that education and awareness about the hazards of
329 drinking unsafe water plays crucial role in determining the improved drinking water source.

330 ~~The wealth of the household emerges another significant factor in the drinking of clean~~
331 ~~water~~. ~~In line with the findings of Abraham, et al. (2000) it~~ has been found that wealthier
332 household prefers to use ~~water from filtration plants~~ bottled/filtered water in comparison to
333 other water sources. ~~and they are less likely to use drinking water from piped water, wells,~~
334 ~~tube wells, rivers, streams, rivers, dams, tankers, trucks, etc~~. The reason ~~is quite straight~~
335 ~~forward~~ may be that ~~wealthier households can afford the~~ better sources of drinking water.
336 Furthermore, rich people are more health-conscious and willing to spend more money on an
337 improved water source.

338 It has also been found that households with greater women autonomy in making household
 339 purchases prefer to use ~~water from filtration plants/~~ bottled/filtered water in comparison to
 340 other water sources. ~~and they are less likely to use drinking water from piped water, wells,~~
 341 ~~tube wells, rivers, streams, rivers, dams, tankers, etc.~~ It suggests that women are more
 342 health-conscious and if they are involved in household spending decision-making then there
 343 are more chances that they would ~~make some cuts in the budget allocated for makeup and~~
 344 ~~associated luxuries and prefer to make~~ appropriate adjustments in the expenditures to allocate
 345 ~~spend~~ more money on an for using improved water source.

346 In the next step, the household's adoption of HWT ~~use of the in-house water purifying~~
 347 ~~method~~ was analyzed. This model is tested by using the logit model. The results are
 348 summarized in Table 3.

349

350 **Table 3 Estimation results of logit model of the in-house water treatment to treat water**
 351 **(~~odd ratios~~)**

Variables	Odd Ratios	P values
Locationlity		
Urban	1	
Rural	0.8901	0.04569* *
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* *	0.0098
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		

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357 ~~more likely to adopt HWT. Hence, people living in urban areas would prefer to use water filters~~
358 ~~and adopt other water purifying methods at home.~~

359 ~~It is~~ Similar to the findings of Sattar & Ahmad (2007) it has ~~also~~ also been found that the family
360 size hurts the ~~adoption~~selection of water purifying methods as odd ratios are less than 1. Due to
361 the large family size, more water is required so it is ~~not~~ very difficult for the large families to
362 ~~adopt HWT use water purifying methods~~ rather they prefer to use water without any treatment. It
363 reveals the fact that due to larger family quality as well as quantity of essential services are
364 negatively affected.

365 Both the education and exposure to the media (the indicators for the level of awareness) ~~are~~ tends
366 to increase the likelihood of adopting HWT. ~~having significant impacts on the use of water~~
367 ~~purifying methods as odd ratios are greater than 1. However, It has been further found that~~ only
368 secondary and higher education results in increasing the chances of adoption of HWT. ~~odds of~~
369 ~~adoption of water purifying methods at home. The education up to the primary level does not~~
370 ~~have a significant impact on the adoption of water purifying methods.~~ These findings are
371 supported by various past studies including Dasgupta (2001), Mc-Connell & Rosado (2000),
372 Quick et al. (1999) and Jalan et al., (2009).

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

378 The women's empowerment is also had a significant impact on adoption of ~~water purifying~~
379 ~~method~~ HWT. Households wherein women are empowered in making household purchases are
380 more likely to use water-purifying methods ~~at home.~~ These results are supported by Jyotsna et al.
381 (2003).

382 The drinking water source is also emerged as an important and significant factor in the adoption
383 of ~~water purifying methods at home~~ HWT. The results ~~reveal~~ indicate that people might not trust
384 households using the water quality coming from the piped water (it has been supported by Daniel
385 et al. (2018)), therefore they are more likely to adopt ~~a water purifying method at home~~ HWT.

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386 Daniel et al, (2019) also comes to the similar conclusion that households using piped water are
387 more likely to adopt HWT. However, households using water from ~~tube protected well,~~
388 ~~boreholes, protected well,~~ unprotected wells and water bought from commercial sources,
389 ~~springs, tankers, truck/ carats with a small tank~~ are significantly less likely to adopt HWT. ~~water~~
390 ~~purifying methods at home.~~

391 ~~However, Present study is unable to finds-find significant impact of~~ that age of household heads
392 and distance to water sources ~~on do not have any significant impact on~~ the adoption of HWT in
393 Pakistan. ~~use of water purifying methods.~~ However past studies found that age of the household
394 head (Mintz et al., 2001) play significant role in adoption of HWT.

395 5.4. Conclusions and Policy Recommendations

396 In developing countries, poor quality of drinking water has been recognized as a major health
397 issue because many fatal diseases especially diarrhea and hepatitis are linked with the quality of
398 water. ~~In this regard, IHME (2015) had estimated that due to diarrhea around 1.3 million people~~
399 ~~die annually; among them 88% are the children. The study also estimated that these fatal diarrhea~~
400 ~~eases are mostly associated with poor quality of water and sanitation. The present was conducted~~
401 ~~to analyze the role of different socioeconomic characteristics of the households in using different~~
402 ~~water sources and adoption of HWT. Keeping in view the importance of safe drinking water for~~
403 ~~human health and economic development present study is conducted.~~ The results of the study
404 provide comprehensive insight for policymakers to tackle obstacles in the consumption of safe
405 drinking water in Pakistan and it will help them to develop adopt better policies ~~initiatives~~ that
406 would increase the availability/usage of better quality drinking water in Pakistan.

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

414 Similarly, locality of household, family size, education, exposure to the media, women
415 empowerment, source of drinking water and wealth of household are significant factors in
416 determining ~~the the household~~ adoption of ~~HWT. the water purifying method.~~ It reveals that
417 households belonging to urban areas, having a higher level of awareness (through education and
418 media), belonging to wealthy families, wherein women enjoy a higher level of empowerment
419 and households using piped water are more likely to adopt ~~water purifying methods at~~
420 ~~home~~HWT. However, households using water from ~~tube well, boreholes,~~ protected well,
421 unprotected wells, ~~water bought from commercial sources springs, tankers, truck/ carats with a~~
422 ~~small tank~~ and having higher family size are less likely to adopt water purifying methods at
423 home. However, the age of household head and distance to water sources do not have a
424 significant impact on the adoption of the water purifying method.

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

- 426 i. ~~The findings of study suggest that the government along with civil society must regularly~~
427 ~~launch awareness campaigns about different methods of safe drinking water. Similarly,~~
428 ~~better drinking water facilities must be provided in rural areas so that differences in urban~~
429 ~~and rural areas in terms of safe drinking water may be eliminated.~~
- 430 ii. ~~Furthermore, as it has been found that women empowerment in household decision~~
431 ~~making is another key factor therefore efforts would be made to empower the women in~~
432 ~~Pakistan. Study reveals that most of the Pakistani households use drinking water from~~
433 ~~wells. However excessive wells and tube wells has resulted insignificant reduction in the~~
434 ~~under the surface water levels. There is need that government may launch awareness~~
435 ~~campaigns to promote usage of drinking water from filters and piped water.~~
- 436 iii. ~~Similarly, households consider the water obtained from wells as safe and do not adopt~~
437 ~~HWT. There is dire need that a comprehensive study may be conducted to analyze the~~
438 ~~levels of pollution in the drinking water obtained from wells.~~
- 439 iv. ~~As mentioned earlier, larger families do not adopt HWT and they tried to use those water~~
440 ~~from where they can get large quantity of water without any cost. Consequently, larger~~
441 ~~families result in getting essential services at compromised quality. The policy makers~~
442 ~~must take appropriate measures to control population growth in Pakistan.~~

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- 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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