ORIGINAL ARTICLE

Exploring the Nexus of Water Contamination, Health Hazards and Households' Knowledge: A Pilot Study in Rawalpindi, Pakistan

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ABSTRACT

Objective: To examines factors affecting households' knowledge regarding water contamination and identify health issues related to drinking contaminated water.

Study Design: Cross-sectional study.

Place and Duration of Study: The information was collected from the households living in the surroundings of the Lai sewer of Rawalpindi city, from August 2019 to December 2019.

Materials and Methods: One hundred and sixty-two (162) households were randomly selected and interviewed using a well-structured questionnaire for pre-testing. The Ordered Logit model was used to analyze the data and identify determinants affecting households' knowledge regarding water contamination.

Results: The education level of households, income, proximity to the Lai sewer, health issue, and access to health advice had significant positive effects on their knowledge regarding water contamination. The study showed that vomiting (51.67%), abdominal pain (48.19%), and diarrhea (42.68) were the main health issues reported by the households.

Conclusion: Effective community awareness programs regarding hazards of water contamination are important to prevent adverse health outcomes.

Key Words: *Environment, Ground Water, Health Hazards, Knowledge, Pakistan*.

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Introduction

Equitable access to safe drinking water is considered one of the biggest challenges the world is facing from the last few decades.[1] According to the World Health Organization (WHO) fact sheet on water issues, around 780 million of the world's population lacks access to clean and safe drinking water, while at least 2 billion people consuming water contaminated with feces, pathogens, and other toxic metals.[2] Though United Nations and other development organizations have been putting in many efforts to provide safe drinking water, yet millions of people suffer with lack of access to safe water facilities, even when many countries pledged implementation of Millennium Development Goals (MDGs).[3] One of the main purpose of MDGs was to provide adequate access to safe water to half of the world's population till the end of 2015,[3] but regrettably, it could not be achieved. The agenda of Sustainable Development Goals (SDGs) also focused to "ensure availability of clean water for all".[4]

Like other low-income countries, Pakistan is facing acute water shortages, and the available water resources in the country are loaded with toxic metals and other sorts of contaminations including microbiological.[5] The availability of supplied water in the country, is through few water filtration plants which are installed in some megacities, and they are supplying water in specific areas with undetected microorganisms. As a result, a greater majority of the population in the country is deprived of safe water supply. The study by Amin et al. (2012)[6] noted that around 70 percent of the rural population and 40-60 percent of the urban population in Pakistan are

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deprived of safe water. In another report, published by the Pakistan Council of Research in Water Resources (PCRWR), around 85 percent of the water sources in Pakistan are below the recommended quality standards prescribed by the WHO.[7] Pakistan - Strategic country environmental assessment (PAK-SECA) report indicates that 20-40 percent of hospital beds in Pakistan are occupied by patients suffering from waterborne diseases, while around 30 percent of all deaths in the country occur because of water contamination related diseases.[8]

A greater percentage of the population in Pakistan is living in informal settings and has inadequate information about water contamination and hygiene. This gap regarding knowledge about water contamination is linked with several factors including socio-economic, socio-psychological, and cultural factors,[9,10] which are seldom taken into account. The previous literature (Kazi et al., 2009; Marlow et al., 2013; Tang et al., 2013; Ahmed and Shafiq 2019; among others)[11,1,12,13] has shown that the first step towards sustainable water management and consumption is to create knowledge and awareness among the citizenries. Indeed, knowledge is a central model of environmental literacy and water-related issues.[14,9,15] Davies and Simon (2012)[16] claimed that greater knowledge allows an individual to solve the environmental problem by making better decisions.[5] The authors understand that analyzing the factors affecting households' knowledge are substantial, considering several reasons such as increasing knowledge may improve the households' positive attitudes and guide to adopt the safety measures. Considering the paramount importance, the aim of this study was to analyze the factors affecting households' knowledge of water contamination and identify deleterious health risks associated with the use of contaminated water. We hypothesize that health impact and access to health advice increases households' knowledge related to water contamination.

The study was conducted in the surroundings of the Lai sewer of Rawalpindi city. The Lai sewer is a natural rain-fed stream originating from the Margallah Hills of Islamabad. It has a catchment area of around 240 kilometers which brings water domestic sewage, industrial wastewater, and rainwater runoff from twin cities spreading environmental pollution and deteriorating groundwater resources. Haq et al. (2008)[17] conducted a study on water testing of tube wells and reported that out of 240 tube wells in the vicinity of the Lai sewer, 72 tube wells were biologically and chemically contaminated and the main reason for this contamination was the recharge mechanism of the Lai sewer and Korang River.[17]

Materials and Methods

This is a pilot study of a detailed research project aiming to analyze cross-sectional data collected from the households residing near the Lai Sewer of Rawalpindi City from August 2019 to December 2019. Our focus in this study is on health hazards and water contamination. A total of 162 respondents were selected randomly from three different areas of Lai sewer. A well-structured and pre-tested questionnaire was used to collect the desired information on socioeconomic characteristics, water quality, availability and diseases associated with water pollution, etc.

The dependent variable shows households' knowledge of water contamination using a five-point Likert scale (1= strongly disagree; 5=strongly agree). The dependent variable was ordinal, therefore, the Ordered Logit model was considered to analyze the effect of other factors on households' knowledge of water contamination. Following the method used by Mehmood et al. (2020)[18] the probability that household i takes on the value (Yi) when household i faces the j^{th} ordered category for j = 1, ⋯, M, where M is considered as different ordinal responses of the household as mentioned earlier. The Ordered Logit model is given as under:

$$\mathrm{P}(\mathrm{Y_i} > j) = f(\mathrm{X_i}\beta) = \frac{\exp(\alpha_j + \mathrm{X_i}\beta)}{1 + \exp(\alpha_j + \mathrm{X_i}\beta)} \quad for\ j = 1, \ldots\ldots, M-1$$

where P (·) in equation (1) is considered as the probability, while f (·) represents the probability density function, Xi is a vector of independent variables for households, where I α and β and in the equation represent cut-off and slope parameters, respectively. The Ordered Logit model supposes that cut-off parameters (aj) change over j = 1, ⋯, M − 1 different alternative compared with the slope parameters (β) that do not vary. It has been generally argued that parallel line assumptions are generally violated while empirical applications of the ordered logit model. Therefore, to relax the parallel-lines

assumption, Williams (2006)[19] introduced the generalized Ordered Logit model, which is given as under:

$$P(Y_i > j) = f(X_i\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + \exp(\alpha_j + X_i\beta_j)} \quad for\ j = 1, \ldots\ldots, M-1$$

The dependent variable in the generalized ordered logit model allows the slope parameters βj to vary over each category. The probabilities in this model are express as:

$$P(Y_i = 1) = 1 - F(X_i\beta_1)$$

$$P(Y_i = j) = F(X_i\beta_{j-1}) - F(X_i\beta_j) \text{ for } j = 2, \ldots, M-1$$

$$P(Y_i = M) = F(X_i\beta_{M-1})$$

where F (·) in equation (3) is considered as the aggregate density function of the normal logistic distribution. Positive parameters in the equation show that the value of the independent factor increases the probability that the households considered water contamination as highly risky for health. On the contrary, negative parameters show that the value of the independent factors decreases the probability that the household is considered as not risky for health.

The dependent variable is considered as binary variable i.e., one for those households knowing water contamination and zero for else. Eight explanatory variables include the age of the household's head (years), family size (numbers), the education level (formal years of education in years), income (calculated in the US dollar.), proximity to the Lai sewer (meters), residence period near Lai sewer (years), access to advice (1 for the households receive information from the community about water contamination in the area, otherwise 0), and health impacts (1 for the households suffered any adverse health effect, otherwise 0). It is hypothesized that having adverse health impacts will increase the household's knowledge of water contamination.

Results

The empirical estimates of the households' knowledge of water contamination are shown in Table 1. The results of the ordered logistic model show that households' education, income, proximity to the Lai sewer, access to advice, and health impact are significantly related to the households' knowledge of water contamination. The significant relationship between the households' knowledge and the variables are represented through the values of coefficients: educational level (β = 0.071), income (β = 0.002), proximity to the Lai Sewer (β = -0.007), access to advice (β = 0.229), and health impact (β = 0.818). The results further explain that the variable of education, proximity to the Lai sewer, access to advice were significant at a 5% level of significance, respectively, while the income of the households' head was at 10% ($p < 0.10$) level of significance. The results of this study are supported by the empirical evidence of Ahmed and Shafiq (2019). The goodness of fit of the ordered logit model can be observed through the value of Pseudo's R2 measures (0.091) the log-likelihood statistics (-225), and LR x2 (45.63).

Table 1: Estimated results of the households' knowledge of water contamination

	Coefficient	Std. Error	*P*-value		Lower bound	Upper bound
Age of the respondent	0.015	0.011	0.163		-0.006	0.038
Family size	0.100	0.038	0.791		-0.064	0.084
Education level	0.071	0.031	0.021	**	0.011	0.132
Income	0.002	0.001	0.072	*	-0.000	0.005
Proximity to the Lai sewer	-0.006	0.002	0.008	**	-0.008	-0.001
Residence period	0.002	0.009	0.782		-0.016	0.021
Access to advice	0.229	0.114	0.045	**	-0.004	0.453
Health impact	0.818	0.321	0.011	**	0.118	1.448

Note: *P< 0.10 and **P< 0.05.

The questionnaire contains information about various waterborne related symptoms and diseases (Table 2), including abdominal pain (48.19%), vomiting (51.67%), constipation (22.33%), diarrhea (42.68), renal problems (20.53), and hepatitis (35.33). Some of the respondents and their family members suffered more than one waterborne related symptoms and disease.

Discussion

Understanding the factors affecting households'

Table 2: Symptoms and diseases suffered by the households due to water contamination (%)

Health Impacts	Total (83)
Abdominal pain	48.19
Vomiting	51.67
Constipation	22.33
Diarrhea	42.68
Renal problem	20.53
Hepatitis	35.33
Others	15.21

Note: Some households and their family members suffered more than one health issue

knowledge about water contamination is significantly important for designing policy and adopting precautionary measures for its execution. Our pilot study shows that education is an important factor to understand health and environmental issues. The study by Lee and Zhang (2008)[20] and empirical evidence provided by Feng and Reisner (2011)[21] noted that education makes a person more knowledgeable and helps aware of a complex environmental phenomenon. This has been empirically analyzed in existing studies.[22,23] For households in Rawalpindi city, a similar study by Ahemd and Shafiq (2018)[11] analyzed a positive and significant relationship between education and households' knowledge. The coefficient of income was also found significant at a 10% level of significance. The study by Bjornlund et al. (2019)[24] noted that a higher level of household income improves households' knowledge, awareness, and allows them to take better decisions. The price of bottled water in the area is much higher and it is difficult for those households who have a low level of income to afford it.

The positive effect of access to advice is significant because an increasing number of households spare a substantial proportion of their time in social gatherings and receive information about water contamination and health hazards. The majority of the surveyed households had no information about water contamination and its effect on health. The coefficient of proximity to the Lai sewer was significant at a 5% level of significance. This signifies that households residing near the Lai sewer had more knowledge of water contamination. Venables et al. (2012)[25] reported a significant and positive relationship between the household's knowledge and proximity to the pollution sources. The variable of health impact had a significant positive relationship with household knowledge. The results suggest that adverse health effect due to waterborne diseases are chronic in the affected communities near the Lai sewer which is in line with the studies by Kazi et al. (2009); Vorosmarty et al. (2010).[11,22] Ahemd and Shafiq (2018)[1] reported that consumption of water contaminated with heavy metals and the pathogen harm blood circulation, heart, kidneys, and nervous system.

Moreover, the major diseases reported by the households in the area surveyed were vomiting (51.67%), abdominal pain (48.19%), and diarrhoea (42.68) (including dehydration and chronic diarrhoea). The present study did not explore the reasons for using contaminated groundwater. Further, the health costs of the households using groundwater were not estimated. Having this information would provide interesting results.

Conclusion

The assessment of the households' knowledge of water contamination is necessary for the consumption of safe drinking water. Indeed, the lack of households' knowledge makes them consume contaminated water, which increases the risk of adverse health impacts. The results of the Ordered Logit model indicate that education of the households, income, proximity to the Lai sewer, access to advice, and health impact significantly contribute to the households' knowledge of water contamination in the area surveyed.

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