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Exploring the important determinants of access to safe drinking water and improved sanitation in Punjab, Pakistan

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ABSTRACT

Access to safe drinking water and improved sanitation is a fundamental human right and basic ingredient of public health. However, one of the major problems faced by developing countries in the twenty-first century is the lack of access to these facilities. Punjab, the most populous province of Pakistan with more than 50% of the country's population, is no exception. Keeping in view its importance, the current study is an effort to investigate important determinants of access to safe drinking water and improved sanitation in Punjab to ensure the provision of these services to the masses. Multiple Indicator Cluster Survey Household data from 2017 to 2018 has been used for analysis. The results of a logistic regression model revealed that household media exposure, education level of household head, household wealth status, and ethnic background of the household head are some of the important determinants of household access to safe drinking water. For household access to improved sanitation, along with these factors, the role of social norms and place of residence are also important. Particularly, the role of social norms is very profound. Findings from the study suggest that efforts should be made to provide readily available media access, household education level needs to be enhanced, policies should be made to raise the living standard of the poorest households, and the social norm for the use of improved sanitation needs to be promoted.

Key words: Education, Improved sanitation, Public health, Safe water, Wealth status

HIGHLIGHTS

- In the wake of COVID-19, the importance of water, sanitation, and hygiene has been increased manifold.
- There is dire need to understand the important factors that contribute to access to safe water and improved sanitation.
- Currently, there are hardly any studies in Punjab (Pakistan) on this matter, so the current study is an effort to fill this gap.

1. INTRODUCTION

The United Nations in 2010 acknowledged access to improved sanitation and safe drinking water as a basic human right (UN General Assembly, 2010). The shortage of sanitation amenities and safe drinking water are the major problems faced by underdeveloped countries in the twenty-first century. About one-third of the planet's population do not have access to safe drinking water, whereas 55% of the global population do not have access to safely managed sanitation facilities. Around 8.92% of the world population defecate in the open, whereas around 3 billion lack basic handwashing facilities (UN Water, 2019).

The availability of better sanitation and safe drinking water was the greatest concern of the Millennium Development Goals (MDGs), and currently Sustainable Development Goals (SDGs) address discrepancies and focus

on equal access in acquiring water and sanitation. Goal 6.1 is to ensure the equitable and universal opportunity to affordable and safe drinking water by 2030. Goal 6.2 talks about sanitation in terms of giving distinctive care to womenfolk, vulnerable, persons with disabilities, and elderly groups by 2030 (UN General Assembly, 2015).

The lack of access to safe drinking water and improved sanitation is the world's second largest cause of child deaths (Watkins, 2006). Improved sanitation and safe drinking water access significantly reduce water-borne infections (Armah, 2014; Pullan *et al.*, 2014). The significance of various interventions relating to water and sanitation can be shown in this way that their benefits are not just limited to maintaining the health of the people. To collect water from long-distance sources is a very time-consuming activity; it causes various problems for poor people, especially women and children, and to overcome this issue will require reforms in installation (WHO & UNICEF, 2010). Furthermore, apart from health the improved facilities also afforded other benefits including privacy and convenience. The recent literature describes that the deficiency in 'privacy and convenience' may lead to various kinds of violence against women such as sexual, physical, or psychological. Shared and public sanitation is less desirable for women in comparison to men due to the various dangers mentioned above (Biran *et al.*, 2011). These benefits offer sufficient economic justification for investment in water and sanitation services.

During COVID-19, the importance of water, sanitation, and hygiene (WASH) has been increased manifold. The experience of the coronavirus pandemic has demonstrated that the lack of water and sanitation services for marginalized segments of society can cause a humanitarian tragedy (Heller *et al.*, 2020). The studies on previous Severe Acute Respiratory Syndrome coronavirus (SARS-CoV-2) proved the possibility of spread of the virus through polluted liquid droplets. Casanova *et al.* (2009) studied the probable risks from this channel and found that coronavirus remains infective for a long period in water and sterilized stable sewage as a possible risk for humans if aerosols are produced. Emerging studies within the context of COVID-19 do not provide sufficient evidence of the spread of this novel coronavirus through sewage; however, the authors are of the view that there is a potential threat of the spread of the virus through the oral-fecal tract as a respiratory alternative (sneezing and coughing) and interaction diffusion (Ong *et al.*, 2020; Wu *et al.*, 2020). Zhang *et al.* (2020) found that the patients of COVID-19 have live viruses in stool specimens which is a new finding regarding the transmission of COVID-19.

Pakistan is a country with more than 207[1] million inhabitants with an area of 881,913 km^2. It shares borders with India, China, Iran, and Afghanistan. Given the importance of WASH for human life and its dignity, the Government of Pakistan realizes the acquisition of safe drinking water and sanitation services as a fundamental right as implicit from Article 9, Pakistan Constitution 1973 which states that 'no person shall be deprived of life or liberty save under law'. Therefore, the Government of Pakistan has placed provisions for safe drinking water, improved sanitation, and hygiene as its priority agenda in Vision 2025 (Planning Commission, Govt. of Pakistan, Pakistan Vision 2025), National plans, and National Water Policy 2018 to fulfill international commitments and constitutional obligations.

In Pakistan, the most populous province is Punjab which accounts for more than 50% of the country's population. The commitment of the Government of Punjab in the provision of universal access to sanitation and safe drinking water is embedded in Punjab Water Policy 2018, Punjab Water Act 2019, Punjab Growth Strategy 2019–2023 (Planning and Development Department, Govt. of Punjab 2019), the Government of Punjab's framework 'Response Investment for Social Protection and Economic Stimulus (RISE-2020)' (Planning and Development Department, Govt. of Punjab 2020), Punjab WASH Sector Development Plan 2014–2024 (Planning and Development Department, Govt. of Punjab 2015), and the Punjab Spatial Strategy 2047. Whereas the draft Punjab Water and Sanitation policy-2020 is in the final stages of approval from the cabinet.

[1] As per Pakistan population and housing census 2017.

As per Multi-Indicator Cluster Survey (MICS), in 2018, of the total population, 91.4% of people have sufficient drinking water quantity when demanded, 74.2% of the have water availability on-premises, and 63.8% have drinking water without *E. coli* pollution. Overall, 43.7% of the households have access to safe drinking water. In Punjab, around 70.4% of the population have improved sanitation facilities. About 40.7% of households reported on-site safe removal of human excreta that is 50.5% in villages and 23.4% in cities. Nonetheless, many problems still exist for effective fecal muck managing regarding the utilization or construction of sewer lines and septic tanks.

1.1. Significance of the study

In order to make any policy intervention to increase the level of access to safe drinking water and improved sanitation, it is imperative to be familiar with the determinants of access to safe drinking water and improved sanitation. Therefore, there is an urgent need to understand the important factors that contribute to access to safe water and improved sanitation. However, currently, there is hardly any study in Punjab that identifies the important factors that contribute to access to safe drinking water and improved sanitation. To fill this gap, the current study investigates the important factors which can increase the access to safe drinking water and improved sanitation facilities, so it is very important from the policy perspective.

2. LITERATURE REVIEW

Public health emerged as an area of public policy in professional disciplines and is synonymous with improving 'sanitary conditions' following the ingenious studies of Chadwick (1842), Snow (1855), and Farr (1866) in the nineteenth century. The significance of WASH has consistently been concerned with the health of the general public, young children, and infants (Jones, 1923). Different studies have highlighted determinants of water and sanitation services across the world.

Larson *et al.* (2006) demonstrated a significant association between education and water use given that wealthier people have higher education levels and better access to water consumption. In 2010, De Albuquerque presented a structure of Human Rights Council 'for assessing good practices (for providing clean water and sanitation) from a human rights perspective, using five normative criteria (availability, quality/safety, acceptability, accessibility, and affordability) and five cross-cutting criteria (nondiscrimination, participation, accountability, impact, and sustainability)'.

To end the practice of open defecation, social networks play an important role as has been established in studies in peri-urban areas in Africa (Tukahirwa *et al.*, 2011). The information is raised through the mixture of income, education, and exposure which affect household choices for in-house sanitation (Akpabio & Brown, 2012). Tiwari & Nayak (2013) discovered that literacy rate and education are important determinants of water and sanitation access. The socioeconomic, cultural, and spiritual beliefs in Africa are the main obstacles to sanitation and pure water supply (Akpabio & Brown, 2012; Akpabio & Takara, 2014). Practices and norms such as non-economic indicators also affect sanitation due to the collective behavior of society (McGranahan, 2015). In line with Ahmed *et al.* (2015), sanitation may include women, gender, and girls issues which can cover a variety of unseen problems in accessing better sanitation.

Adams *et al.* (2016) searched the demographic and socio-economic indicators connected with better sanitation and water facilities in Ghana. They discovered that education, income, and family size are major factors of better sanitation and water sources. Wasonga *et al.* (2016) studied WASH issues in rural Kenya and thought of them as social and cultural. Water storage is affected by traditions, while sanitation and hygiene issues are ritualized and bound by taboos.

Tiwari & Nayak (2017) found that caste, education, and income are the most important factors behind better toilet facilities in India. They looked for the effect of household size on sanitation behavior and the situation of

community and housing infrastructure like water availability. Luo *et al.* (2018) used a model of regression to explore the indicators of sanitation facilities in China. The result of this investigation showed that some socio-economic variables, like Gross Domestic Product (GDP) per capita or illiteracy, are associated with access to cleanliness. De (2018) focused on the non-economic factors, including education, region, religion, caste, household size, and occupation. The analysis disclosed that income had a low impact, but the non-economic elements such as age, sex and education have a higher impact when it comes to using latrines.

Gomez *et al.* (2019) concluded that gross national income (GNI), females' primary education rate, agriculture, rural population growth, governance factors, political constancy, and corruption control are variables associated with water availability. Simelane *et al.* (2020) studied the causal factors of access to ameliorate potable sources in Eswatini in 2010 and 2014. They found that household access to improved drinkable sources, age, and gender of the head, family members, wealth index of the head, and locality are the main determinants to scrub drinking water.

A study was conducted by Hailu *et al.* (2020) to evaluate the attitude, knowledge, and practices of rural inhabitants on sanitation, water, and hygiene in Tigray, Ethiopia. They found that a poor unfavorable attitude, knowledge, and poor WASH practices were common among the rural residents in Tigray, and the government should take steps to reinforce the interventional steps to enhance the attitude, knowledge, and practices on WASH. Zahid (2018) investigated the impact of unavailability of clean drinking water and the lack of improved sanitation facilities on water-borne diseases in Pakistan. The study found that the unavailability of clean drinking water and the lack of improved sanitation facilities resulted in increased diarrheal disease in children. The effect of some other factors on water-borne diseases was also analyzed. The role of the mother's education was found to be significant in controlling the diarrheal disease in children. Daud *et al.* (2017) reviewed the various sources of contamination of drinking water, drinking water quality, sanitation services, and the effect of contaminated drinking water on human health. The sewerage discharged into drinking water supplies was found to be the basic source of drinking water contamination. The contaminated drinking water leads to around 80% of the diseases and 33% of the total mortality in Pakistan.

After going through the literature, we came to understand that there is a role of various socio-economic factors in access to safe drinking water and improved sanitation facilities. The access to safe drinking water and improved sanitation facilities needs special focus, keeping in view the fact that there is an urgent need to explore the important determinants of access to safe drinking water and improved sanitation facilities. However, in case of Pakistan in general, and Punjab in particular, there is hardly any study that has explored the determinants of access to safe drinking water and improved sanitation facilities.

3. MATERIALS AND METHOD

The study explored the indicators of safe potable and improved sanitation in Punjab (Pakistan). We used household data from the Multi-Indicator Cluster Survey 2018 by the United Nations International Children's Emergency Fund (UNICEF). The sample from MICS Punjab, 2018 was outlined to supply an estimate of indicators of households in the Punjab province. Based upon the household data census 2017, the sample of households was picked in two stages. At the primary stage, Primary Sampling Units (PSUs) and enumeration blocks were chosen, and at the second stage, 20 households were nominated through systematic sampling with random initiate from each PSU.

3.1. Theoretical foundation

In developing countries, the role of households is very important to reduce the water-borne health risks. This is due to the fact that water supply is generally household based. Decisions are needed at the household level to purchase or build safe water supply and improved sanitation facilities. However, it is often observed that health mitigation

behavior regarding safe water consumption and use of improved sanitation facilities is often ignored due to the lack of awareness. Behavior change is necessary for any health mitigation strategy (Cairncross & Shordt, 2004). This fact has led to the proposal of various theories that suggested various key determinants of health behaviors. These theories include health belief model, social learning theory, social-cognitive theory, theory of reasoned action, theory of planned behavior, etc. Social-cognitive behavior theories explained that theory-based interventions are more likely to be successful for behavior change effects. Social behavior can be best understood as a function of people's perceptions of reality, rather than as a function of an objective description of the stimulus environment (Norman & Conner, 2005). If any intervention is able to alter these determinants, it will lead to greater behavior change effects (Norman & Conner, 2005; Mosler, 2012). In this regard, it is important to identify the important determinants which can explain the target behavior. These determinants can be identified on the basis of various social-cognitive behavior theories. The existing literature identified various factors that influence the adoption of WASH technologies and the continuation of improved practices. These factors include attitudes, norms, self-regulation, etc. The determinants used in this study are based upon these theories.

The variable description of independent and dependent variables is given in Table 1.

The dependent variables are household access to safe drinkable and improved sanitation, which are binary, having a value of 1 if the family has access to safe drinking water or improved sanitation and 0 otherwise. When a dependent variable is categorical and binary, the acceptable technique for estimation is binomial logistic regression.

Logistic regression analysis studies the association between a categorical dependent variable and a set of independent (explanatory) variables.

Let

$$p_i = pr\left(y = \frac{1}{x = x_i}\right) \tag{1}$$

p_i is the probability of access to safe water and improved sanitation, the model can be written as

$$\log\left(\frac{p}{1-pi}\right) = \text{logit}(p_i) = \beta_0 + \beta_i x_i \tag{2}$$

The above pattern is a simple representation with one independent variable. Here, p_i is the chance of acquiring safe water and improved sanitation, and for example, if we consider x_i is the educated[2] household head. When $x_i = 1$ educated household head, $\beta 1$ demonstrates the log of odds of obtaining safe water and improved sanitation in the case of the uneducated household. We can write the pattern in terms of odds as:

$$\frac{p_i}{(1-p_i)} = \exp(\beta_0 + \beta_i x_i) \tag{3}$$

Or in terms of the chance of the outcome (e.g. access to safe water and improved sanitation) occurring as:

$$p_i = \exp(\beta_0 + \beta_i x_i)/(1 + \exp(\beta_0 + \beta_i x_i)) \tag{4}$$

[2] By educated we mean who ever attended school.

Table 1. | Description of variables.

Variable	Description
Sex of household head	The head of household categorized into two distinct categories, i.e. male and female.
Place of residence	The current residence status of the respondent has been categorized into urban and rural.
Education level of household head	The level of education attained by the household head is a categorical five mutually exclusive levels: illiterate, primary, middle, secondary, and higher.
Ethnic background of the household head	The ethnic background of the household head is represented by the mother language and the households are categorized as Urdu, Punjabi/Potohari, Saraiki, and others.
Family income	A composite index of household possessions, assets, and amenities, grouped as poorest or beggarly, poor, middle, rich, and richest.
Household media exposure	The feedback of the respondent has been classified into Yes and No. The response is noted as 'Yes' if respondents use any of the three sources of media: reading newspaper; watching TV or listening to the radio (at least once a week or more), 'No' otherwise.
Age of household head	The age of the household head is a continuous variable.
Number of household members	The number of the household members is a continuous variable and contains the whole number of household members.
Age of household head	The age of the household head is taken in years and it is a continuous variable.
Social norm of sanitation	For social norms in the society regarding sanitation, the average use of latrine at the community level has been used. If the use of latrine is preferred over open defecation in a community, the average score will increase, and it will indicate that in the community, there is a social norm against open defecation. For creating these variables, individual households' feedbacks were piled up and averaged to the PSU level.
Household access to safe drinking water source	The access to drinking water is considered safe and labeled as 'Yes' if it is from an improved source and (i) located on-premises, (ii) available when required, (iii) and free of fecal and priority chemical contamination, 'No' otherwise.
Household access to improved sanitation	If the household has a sanitation facility in any of the following: flush/pour flush: flush to piped sewerage, flush to the septic tank, flush to pit latrine; pit latrine: ventilated improved pit latrine, pit latrine with slab has been treated as improving and labeled as 'Yes' and 'No' otherwise.

Conversely, the chance of the outcome not occurring (e.g. no access to safe water and improved sanitation) is

$$1 - p_i = \frac{1}{1 + \exp(\beta_0 + \beta_i x_i)} \tag{5}$$

The point to be noticed is that we have so far not inserted a residual term in the models and have instead expressed the model in terms of population probabilities. So it may be written as:

$$P_i = p_i + f_i = \exp(\beta_0 + \beta_i x_i)/(1 + \exp(\beta_0 + \beta_i x_i)) + f_i \tag{6}$$

It may be important to know that f_i is not normally distributed, and it is supposed that it was linear regression.

All categorical variables are tested for association with access to safe water and improved sanitation and are chosen for analysis based on statistical and theoretical grounds. The variables included in the estimation of the logistic regression model are listed in Table 1 along with their description of the construction of data.

3.2. Results and analysis

The analysis has been done with the help of descriptive statistics of the respondents of the study, association tests, and logistic regression. The results are as given below.

3.3. Descriptive statistic analysis

The descriptive statistics of the respondents to the access to safe drinking water and sanitation are given in Tables 2 and 3, respectively. In MICS 2017–18, approximately 15% of the sampled household were selected for water quality tests, so access to safe drinking water can be assessed only for a small number of households. The data of 3756 households have been used in the access to safe drinking water analysis.

It is evident that the percentage of female-headed households is only 9.11%, while the percentage of males as household heads is 90.89%. About 40.7% of households are illiterate, while the percentage of households with a higher level of education is 9.29%. The majority (63.34%) of households belong to the Punjabi/Potohari speaking

Table 2. | Descriptive statistics of the respondents of the access to safe drinking water.

Variable	Classification		Response (%)	
Gender of household head	Male		90.89	
	Female		9.11	
Education level of family head	Illiterate		40.73	
	Primary		18.85	
	Middle		13.34	
	Secondary		17.78	
	Higher		9.29	
Ethnicity of household head	Urdu		2.93	
	Punjabi/Potohari		63.34	
	Saraiki		29.13	
	Others		4.61	
Household place of residence	Urban		20.39	
	Rural		79.61	
Household wealth status	Poorest		25.96	
	Second		25.03	
	Middle		22.36	
	Fourth		15.60	
	Richest		11.05	
Media exposure	Yes		62.57	
	No		37.43	
Household access to safe drinking water	Yes		66.27	
	No		33.73	
	Mean	**Standard deviation**	**Minimum**	**Maximum**
Age of household head	48.05	13.77	18	98
Number of household members	6.8	3.13	1	37

Table 3. | Descriptive statistics of the respondents with access to improved sanitation.

Variable	Classification		Response (%)	
Gender of household head	Male		90.02	
	Female		9.98	
Education level of household head	Illiterate		37.72	
	Primary		18.09	
	Middle		13.85	
	Secondary		18.82	
	Higher		11.52	
Ethnicity of household head	Urdu		3.93	
	Punjabi/Potohari		70.52	
	Saraiki		20.98	
	Others		4.56	
Household place of residence	Urban		29.32	
	Rural		70.68	
Household wealth status	Poorest		21.31	
	Second		21.38	
	Middle		20.88	
	Fourth		19.37	
	Richest		17.06	
Media exposure	Yes		78.39	
	No		21.61	
Household access to improved sanitation	Yes		78.39	
	No		21.61	
	Mean	**Standard deviation**	**Minimum**	**Maximum**
Age of household head	48.09	13.56	15	98
Number of household members	6.62	2.99	1	45
Improve sanitation as social norm	0.78	0.24	0	1

population. Around 20% of the households live in urban areas. 25.96% of households belong to the poorest categories, while the percentage of riches households is around 11%. Approximately 62.5% of households have media exposure. The average household size is 6.87, with 1 minimum household member and 37 maximum number of household members. The average age of the household head is around 48 years with 18 years as a minimum and 98 years as a maximum.

It is clear from the descriptive statistics that around 66% of households added in the study have access to safe drinking water and around 34% do not have access to safe drinking water.

The descriptive statistics of the respondents of the access to improved sanitation analysis are given in Table 3. The total number of households with access to improved sanitation analysis is 47,554. The percentage of female-headed households is only 9.98%, while the percentage of males as a household head is 90.02%. 37.72% of household heads are illiterate, while the percentage of household heads with a higher level of education is 11.52%. The majority (70.52%) of households belong to the Punjabi/Potohari speaking population. 29.32% of the households belong to an urban area. The 21.31% of households belong to the poorest category, while the percentage of the richest households is 17.6%. The 66.27% of households have media exposure. The average household size is 6.62, with 1 minimum household member and 45 maximum number of household members. The average age of the

household head is around 48 years with 15 years as a minimum and 98 years as a maximum. The average presence of social norms regarding sanitation is 0.78, with 0 as a minimum and 1 as a maximum.

It is evident from Table 3 that around 78% of households included in the study have access to better sanitation and around 22% do not have access to improved sanitation.

3.4. Analysis of association

In this section, the association tests for a household have been given to examining the safe potable and improved sanitation. The analysis of the association between household access to safe drinking water and its determinants is given in Table 4. It is evident from the table that the education level of the household head, ethnicity of the household head, household wealth status, and media exposure have a significant association with access to safe drinking water. The gender of household head and household place of residence have an insignificant association with household access to safe drinking water.

Table 5 indicates the results of the association between access to improved sanitation and its determinants. The results reveal that the gender of household head, education level of household head, the ethnicity of household head, place of residence, wealth status, and media exposure have a significant relation to household access to improved sanitation.

Table 4. | Analysis of association (access to safe drinking water model).

	Access to improved drinking water		
	χ^2	*p*-value	Significance
Gender of household head	0.08	0.777	
Education level of household head	23.99	0.000	***
Ethnicity of household head	8.04	0.045	***
Household place of residence	0.14	0.707	
Household wealth status	32.92	0.000	***
Media exposure	10.17	0.001	***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 5. | Analysis of association (access to improved sanitation model).

	Access to improved sanitation		
	χ^2	*p*-value	Significance
Gender of household head	46.60	0.000	***
Education level of household head	2,831	0.000	***
Ethnicity of household head	2,121	0.000	***
Household place of residence	2,241	0.000	***
Household status of wealth	15,486	0.000	***
Media exposure	3,009	0.000	***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

3.5. Regression analysis

The results of Table 6 indicate that logistic regression is given for household access to safe drinking water. The first determinant of access to safe drinking water is the gender of the household head. The sex of the head does not make any difference to access to safe drinking water.

The next variable is the education level of the household head. The base level is that households have no education overall or have merely preschool level. It is evident from the results that as the level of education accelerates from none to higher, the associated odds ratio increases. The odds ratio is highest (1.75) for the

Table 6. | Logistic regression (dependent variable = access to safe drinking water).

	Odds ratio	Standard error	*t*-value	*p*-value	Significance
Gender of household head					
Male (Base Category)	1.000	.	.	.	
Female	1.112	0.140	0.84	0.398	
Education level of household head					
Illiterate (Base Category)	1.000	.	.	.	
Primary	1.131	0.112	1.24	0.214	
Middle	1.202	0.139	1.69	0.091	*
Secondary	1.272	0.139	2.21	0.027	**
Higher	1.755	0.264	3.75	0.000	***
Ethnicity					
Saraiki (Base Category)	1.000	.	.	.	
Urdu speaking	0.818	0.188	− 0.88	0.382	
Punjabi/Potohari	0.746	0.064	− 3.40	0.001	***
Others	0.570	0.098	− 3.28	0.001	***
Place of residence					
Rural (Base Category)	1.000	.	.	.	
Urban	1.066	0.106	0.64	0.521	
Household wealth status					
Poorest (Base Category)	1.000	.	.	.	
Second	1.135	0.115	1.25	0.211	
Middle	1.644	0.191	4.28	0.000	***
Fourth	1.455	0.198	2.76	0.006	***
Richest	1.188	0.193	1.06	0.289	
Media exposure					
No (Base Category)	1.000	.	.	.	
Yes	1.134	0.087	1.65	0.100	*
Age of household head	1.004	0.003	1.29	0.197	
Number of household members	1.00	0.012	0.28	0.780	
Constant	1.268	0.226	1.33	0.183	

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

higher education level of the household head. This may be because, as the level of education of the household head increases, they become more aware of the benefits of safe drinking water and harms associated (water-borne diseases) with unsafe drinking water. Therefore, the household makes efforts to have access to safe drinking water. Resultantly, the educated household head appears to have greater access to safe drinking water. The odds ratio associated with a higher level of household head education is 1.75, which means that a household head with a higher level of education is 1.75 times more likely to obtain safe drinking water in contrast to an illiterate household head.

The ethnicity of the household head matters significantly in access to safe drinking water as depicted by results. The base category of the ethnic background of the household head is Saraiki-speaking households. This is clear from the results that, as compared with Saraiki-speaking households, the households of other ethnic backgrounds (Punjabi, Urdu, and others) are less likely to have access to safe drinking water. The place of residence and the number of households have no statistically significant effect on access to safe drinking water in the current analysis.

The household wealth status is the next determinant of access to safe drinking water. The base category is the poorest households. It is evident from the results that the odds ratios associated with higher household status (second, middle, fourth, and richest) are higher than the odds ratio of the base category (1). This indicates that the households with better wealth status compared with the poorest households are more likely to have access to safe drinking water. However, the highest odds ratio (1.64) is associated with middle-class households, which indicates that middle-class households have more likelihood of access to safe drinking water.

The next independent variable is media exposure of the household which has been used as a proxy of awareness of the household to the benefits or harms of safe drinking water. The odds ratio associated with household media exposure is 1.13 and it is statistically significant as well. This indicates that the household that has media exposure is 1.13 times more likely to have access to safe drinking water as compared with those who do not have media exposure.

The age of the household head is statistically insignificant which indicates that younger and older household heads have a similar likelihood of obtaining safe drinking water. Similarly, the sex of the household head also makes no difference in access to safe drinking water.

In Table 7, the results of logistic regression are given for household access to improved sanitation. The first variable is the sex of the household head. The gender of the household head makes no difference in accessing improved sanitation as the variable is statistically insignificant. The upcoming variable is the education level of the household head. The ground category is that households have no education (illiterate). It is witnessed from the consequences that as the level of education increases from none to higher, the associated odds ratio increases. The odds ratio is highest (1.82) for the higher education level of the family head. The reason for this may be that, as the education level of the household head increases, they become more familiar with the benefits of improved sanitation and harms associated (contagious diseases) with unimproved sanitation, so the household makes efforts to have access to improved sanitation. Resultantly, the educated household head appears to have access to improved sanitation. The odds ratio corresponding with a higher level of household head education is 1.82, which means that the household head with a higher level of education is 1.82 times more likely to examine the improved sanitation as compared with the uneducated household head.

The ethnicity of the household head has a significant impact on access to improved sanitation as depicted by results. The base category of the ethnic background of the household head is Saraiki-speaking households. It is clear from the results that as compared with Saraiki-speaking households, the households of other ethnic backgrounds (Punjabi, Urdu, and others) are less likely to have access to improved sanitation. The place of residence also has a statistically significant effect on access to improved sanitation and households residing in urban areas

Table 7. | Logistic regression (dependent variable = access to improved sanitation).

	Odds ratio	Standard error	*t*-value	*p*-value	Significance
Gender of the household head					
Male (Base Category)	1.000	.	.	.	
Female	1.041	0.057	0.74	0.462	
The education level of the household head					
Illiterate (Base Category)	1.000	.	.	.	
Primary	1.241	0.051	5.23	0.000	***
Middle	1.364	0.068	6.19	0.000	***
Secondary	1.563	0.079	8.87	0.000	***
Higher	1.823	0.134	8.17	0.000	***
Ethnicity					
Saraiki (Base Category)	1.000	.	.	.	
Urdu speaking	0.573	0.064	− 4.97	0.000	***
Punjabi/Potohari	0.548	0.020	− 16.53	0.000	***
Others	0.558	0.042	− 7.70	0.000	***
Place of residence					
Rural (Base Category)	1.000	.	.	.	
Urban	1.522	0.073	8.80	0.000	***
Household wealth status					
Poorest (Base Category)	1.000	.	.	.	
Second	4.837	0.187	40.85	0.000	***
Middle	9.830	0.497	45.16	0.000	***
Fourth	13.013	0.840	39.74	0.000	***
Richest	21.591	2.014	32.94	0.000	***
Media exposure					
No (Base Category)	1.000	.	.	.	
Yes	1.111	0.034	3.35	0.001	***
Social norm of sanitation	180.316	12.781	73.29	0.000	***
Age of household head	1.008	0.001	6.78	0.000	***
Number of household members	1.033	0.006	5.97	0.000	***
Constant	0.011	0.001	− 47.34	0.000	***

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

are 1.52 times more likely to have access to improved sanitation. This may be because it is very difficult to find places for open defecation in urban areas, so by default they have to build latrines.

The household wealth status is the next determinant of access to improved sanitation. The base category is the poorest households. It is evident from the results that the odds ratios associated with higher household status (second, middle, fourth, and richest) are higher than the odds ratio of the base category (1). Furthermore, the odds increase as household wealth status increases. This may be due to the reason that wealthy households

have more resources and face no financial constraints to build latrines. The odds ratio is highest (21.5) for the richest households. It indicates that the richest households compared with the poorest households are 21.5 times more probably have access to improved sanitation.

The next independent variable is media exposure of the household, which has been used as a proxy of awareness of the household of the benefits of improved sanitation and harms associated with unimproved sanitation. The odds ratio associated with household media exposure is 1.11 and it is statistically significant as well. This indicates that the household that has media exposure is 1.11 times more likely to obtain better sanitation in comparison to those which do not possess media exposure.

The next is social norms regarding the use of improved sanitation or open defecation. In some societies, open defecation is considered against the household dignity and the use of improved sanitation (latrine) is preferred. In some societies, open defecation is considered a normal practice and culturally it is accepted. So, the role of social norms is very important when it comes to access to improved sanitation. In the current study, the first argument of the social norm has been used. The results confirm the importance of social norms as the odds ratio associated with the social norm is extraordinarily high (around 180). This indicates that if the social norm of the community is that open defecation is against human dignity, the individual household will be the higher follower of the community social norm and 180 times more likely to have access to improved sanitation.

The age of the head of household is statistically significant; however, the associated odds ratio is 1.00, which indicates that younger and older household heads have a similar likelihood of access to improved sanitation. Similarly, the number of household members is statistically significant; however, the associated odds ratio is 1.00, which indicates that with the increase in household members, the likelihood of access to improved sanitation remains almost the same.

4. CONCLUSION AND RECOMMENDATIONS

Access to safe drinking water and improved sanitation is a fundamental human right. However, developing countries like Pakistan are facing problems with providing these facilities to the masses. Punjab, the most populous province of Pakistan accounting for more than 50% population of the country, is no exception. There is a serious need to address the issue, which calls for an appropriate understanding of the significant determinants to obtain safe drinking water and improved sanitation. By taking into account this fact, the current research is an attempt to explore this contrivance. Multiple Indicator Cluster Survey data of 2017–18 has been used for analysis. The results of the logistic regression model revealed that household media exposure, education level of household head, household wealth status, and ethnic background of the household head are some of the important determinants of household access to safe drinking water. For household access to improved sanitation, along with these factors, the role of social norms and place of residence are also important; the role of social norms is particularly profound. Keeping in view these findings, the current study suggests that efforts should be made to provide readily available media access to the households, household education level needs to be enhanced which will require increased public spending on education, there is an urgent need to raise the living standard of the poorest households by creating earning opportunities for them, and social norm for the use of improved sanitation needs to be propagated. The importance of safe drinking water and improved sanitation services need to be made part of the school curriculum. The government should focus on the provision of water and sanitation in schools, Basic Health Units, Rural Health Centers, and public places like bus stops, railway stations, and public parks.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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