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RESEARCH PAPER

Identifying the Determinants of Multidimensional Inequalities of WASH Services in Pakistan

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ABSTRACT

An economy's most basic need is water accessibility. Water inequality is a major challenge facing developing countries like Pakistan today. UNICEF and WHO have developed a joint monitoring program. The WASH index is created using ten indicators that measure 6.1 and 6.2 (equal distribution of WASH services). By applying regression to the sample size 49510, this study examines factors contributing to WASH spatial disparities. Several factors influence WASH services (household head gender, household head age, household head marital status, household head education, household income, household size, family size, occupancy status, and residence place). Water, Sanitation, and Hygiene (WASH) services are more accessible to female-headed households than male-headed households. The age of the household head is positively correlated with access to WASH (Water, Sanitation, and Hygiene) services. Household heads who are unmarried or separated have less access to WASH facilities. WASH services are positively correlated with household income. Despite this, house size (number of rooms) has a significant positive impact on access to WASH services. Rural areas have fewer WASH facilities. To address these issues, gender-sensitive policies should be developed. Multi-sectoral approaches are required for implementation. Hygiene education campaigns could also enhance equitable access to WASH.

Keywords: Determinants of WASH, Hygiene, OLS Regression, Sanitation, WASH Index, Water

Introduction:

In addition to well-being, safe WASH is crucial for economic development. WASH infrastructure can generate substantial economic returns. An investment of one dollar in improved water supply and sanitation infrastructure has the potential to yield a return from three to thirty-four dollars, depending on the specific circumstances. This economic benefit comes from reduced healthcare costs, increased productivity, and improved educational outcomes (DAR, 2023).

A high growth rate can be achieved with equal distribution of water, which is a key input factor and basic raw material for production sectors. Sectors with a lot of water have more jobs, large production scales, and high growth rates. It is also possible for the unequal distribution of water resources to adversely affect economic development. In the absence of adequate water supplies, growth rates are low, and development is limited (He et al., 2019). Currently, things aren't going well. Around 144 million people use hazardous drinking water due to disparities in the availability of water and sanitation services. Nearly a tenth of the global population lacks access to these services. Two billion rural people live in developing countries without basic sanitary facilities. About one-third of the world's population lives in rural areas, without access to basic sanitary facilities. There are still 673 million people living in 23 countries who practice open defecation (DAR, 2023).

Almost 39 countries have increased open defecation. In developing economies, three-quarters of the total population lacks access to basic handwash facilities. The majority of people live in Sub-Saharan Africa. Uneven distribution of water and sanitation spreads different health risks, e.g. 297,000 children under five die from inadequate water and sanitation. Besides economic and health risks, unequal access to water also raises ethical and social issues. Women spend a lot of time fetching water from outside resources, wasting their productivity. The worst situation is in India where almost 30% of sexual spanks occur when girls defecate outside. Global administrations have paid considerable consideration to the provision of water because of the current situation and its importance to every sector of the economy. The top 17 goals include equal access to water and sanitation for all by 2030.

In Pakistan, WASH challenges have adversely affected health and well-being, as well as development. Inadequate infrastructure, rapid population growth, urbanization, and natural disasters contribute to WASH problems in the country. Securing access to safe and clean drinking water is a major challenge for Pakistan's citizens. Worldwide, waterborne diseases have spread rapidly due to unsafe water sources. Rural areas lack sanitation facilities due to lack of infrastructure. There are not enough toilets and sewerage systems, leading to open defecation, which poses health risks and pollutes water sources (Haider, 2019). Water and sanitation-related diseases (diarrhea) still kill 53000 children under 5 in Pakistan every year. Over 70% of households still consume contaminated water (UNICEF, 2021). Regarding water stress, Pakistan is ranked third by the IMF (International Monetary Fund). It is estimated that only 20% of the population in Pakistan has access to safe drinking water, while the remaining 80 percent are dependent upon hazardous water sources (IMF, 2021). The most populated province of Pakistan, Punjab, has adequate access to sanitation facilities for 70.4% of its population (MICS, 2018).

By the end of 2018, the Punjab government of Pakistan intends to provide sewerage and better water to 25 million people. Providing sanitation services to everyone requires comprehensive measures. To ensure water and sanitation are developed within the state by 2024, Punjab passed the Water and Sanitation Act of 2019 (ELAHI, 2015). Several factors make it particularly difficult for women and girls in Pakistan to access clean and safe water. Women are often forced to collect water, which exposes them to safety risks and negatively impacts their education and economic prospects. The lack of gender-sensitive sanitation facilities exacerbates gender disparities within communities (The Sustainable Impact of Affordable Housing, 2021). Pakistan has been ranked as the ninth most deficient nation globally in terms of access to fundamental sanitary amenities, with a staggering one-third of schools lacking basic toilet facilities. The empirical evidence indicates that education is linked to sanitation facilities as follows; a school with a toilet space is connected with an increased number of girls enrolling in the schools that do not have toilet facilities (Gillani, 2021).

An improved source of water is defined as a source that has been protected from solid wastes, outside contamination, and fiscal constraints. These sources include piped water systems connected to the house, public taps, hand pumps, motor pumps, tube wells, boreholes, closed wells, protected springs, public taps, and standpipes. The other sources are considered unimproved; unprotected wells, springs, rivers, dams, lakes, bottled water (could not fulfill the requirement of household) water provided by tankers. Moreover, these services must be fetched within 30 minutes and the distance of the source should not be more than 0.5 km. WHO (2023) enhanced sanitation services encompass the provision of facilities that effectively and hygienically manage the disposal of human feces, urine, and other forms of human waste. The facilities encompass a range of sanitation options, such as flush toilets connected to a public sewage system, septic tanks, pit latrines, and composite latrines. On the other side public-use sanitation facilities are known to be unimproved, also toilets without slabs or open pits and hanging toilets and open defecation are unimproved. Hygiene, as defined by the WHO, is a set of situations and practices aimed at mitigating the

transmission of diseases. Cleanliness and sanitation are primarily the focus of hygiene practices. Personal hygiene includes washing your hands, bathing properly, brushing your teeth, wearing clean clothes, and grooming yourself. Food hygiene involves handling, preparing, and storing food correctly in order to prevent contamination, viruses, and parasites that can cause foodborne illness. (WHO, 2023).

Literature Review

According to Sen; poverty is multidimensional. The researchers Sullivan (2002) in the UK Sullivan and Meigh (2003) in South Africa, Sri Lanka, and Tanzania, Mara and Evans (2018) in Sub Sahara Africa, Western Asia, and North Africa, and Jemmali and Sullivan (2014) in the Gulf States and MENA (Middle East and North Africa) region has proved that water poverty exists. Water poverty is a great hurdle to achieving good health, high productivity, and economic growth. And they have also defined the multidimensional characteristic of water poverty. They introduced the water poverty dimensions as; water, sanitation, and hygiene. They all together define the WASH index. The WASH index contains all the basic water services which are the basic requirement of households. All water-related issues have equal importance in maintaining equality in access to WASH (Behera & Sethi, 2020).

The Sen's capability approach has provided the base to conceptualize a multidimensional WASH index. Water poverty cannot be measured only on the availability of water but also the water, sanitation, and hygiene (Calderón-Villarreal et al., 2022). Before analyzing the inequality of water, all dimensions of water should be considered. As in the current study, all basic water-related services are included. These dimensions are; water resource, water access (time to fetch water and distance from a water source) water capacity, and water use. Sanitation services include a toilet facility and sewerage system connected to the house. Hygiene is known as the water available for cooking, water for hand washing, proper place for hand wash, and availability of soap for hand wash.

Increasing population has resulted in an increase in water consumption. This resulted in more tensely on the rivers, lakes, and aquifers that provide water. The areas in which population growth is fast there would be water scarcity. The water supply particularly in these areas is already under water stress. Population density increases, which leads to a reduction in freshwater resources per person (Biswas, 2008). The water infrastructure (pipelines, sewerage system, etc) needs great attention along with the increase in population. It calls for the fair distribution, protection, and sustainable use of water resources (Rockström et al., 2017).

Qurat-ul-Ann and Bibi (2022) analyzed the WPI to determine the level of poverty in the country. The current study aims to investigate comprehensive knowledge about the access of WASH services in Pakistani Moreover, (Adil et al., 2021) have conducted extensive research on many issues within the context of Pakistan. There is no study available to determine the factors of household head age, gender, marital status, education, household income, family size, occupation status, household size, and region, nor is there a study available to determine the factors of WASH services in Pakistan. In this article, a new model will be presented that will contribute significantly to the literature.

The effectiveness of the development policies is dependent upon comprehensive knowledge that is possible through the comprehensive index. So, for strong policies, Chopra and Ramachandran (2021) developed WPI in India. Over time, the index gained more comprehensive information and dimensions. Behera and Sethi (2020) analyzed some social and economic factors in their study. They introduced more specific and relevant determinants to water and introduced the WASH index (water, sanitation, and hygiene). Moreover, these WASH services play a significant role in economic development. The importance of these services was analyzed by Tsesmelis et al. (2020) who introduced a

WASH composite index. When the importance of WASH services became part of the discussion over the world Calderón-Villarreal et al. (2022) studied comprehensive WASH index. Water services were added to the literature. WASH index should include basic hygiene facilities, waste disposal facilities, menstrual hygiene materials, bathing, and improved sanitation and water facilities. In order to highlight the value of hygiene services, they studied almost 5632 households in Bangladesh, Kenya, South Africa, Uganda, and Zimbabwe. Using PCA and multivariate analysis, the WASH services index was developed. As a result of the study, disparities in access to water, sanitation, and hygiene (WASH) facilities were further discussed

Cronin et al. (2017) conducted a study in various locations in Indonesia to assess the availability of improved water resources inside households. This assessment encompassed improved drinking water, improved sanitation, open defecation practices, hand wash facilities, and safe disposal of kids' faces. The research findings also indicate that the availability of enhanced sanitation facilities is notably limited in rural regions. Along with geological disparities, demographics were also affected like residential area rural-urban, household size, education of family head, and wealth status of the family head. The relation between these demographics and access to WASH services was investigated using multivariate regression analysis. The results suggest that poor people often use E.Coli contaminated water.

A study by Nadeem et al. (2018) analyzed the factors such as household head, distance, waste disposal, household swage, and climate change that are responsible for creating Water Poverty in households. Water poverty is a multi-dimensional phenomenon, which means that it is determined by a wide range of factors outside the household. It has been found by Nadeem et al. (2018) that as a result of these determinants (disposal of wastewater from households, climate change, and household sewage), there are more people in need of water at the household level, which can be evaluated using the WPI. The study by Ohwo (2019) revealed that there are disparities in WASH services across Sub-Saharan Africa. These existing inequalities may threaten the WASH SDGs by 2030. WASH services must be provided and managed sustainably for all countries to avoid repeating the MDG failures where water and sanitation targets were missed.

In addition to demographic characteristics, Mactaggart et al. (2018) added that disability is also a barrier to accessing water and sanitation in Bangladesh, India, and Malawi. To estimate the relationship between water, sanitation, and time to fetch water and the age of the household head, sex of the family head, social income class, and disability type, the multivariate logistics regression model is used. According to the findings, people with disabilities do not have difficulty accessing services, but their quality does.

In their study, Agbadi et al. (2019) conducted an estimation of the many elements that serve as barriers to the accessibility of improved or unimproved sources of water and toilet facilities in Ghana. Data were collected from 12831 households in 2014, and GVIF, DF, and multivariate robust Poisson regression models were used for analysis Improved toilet facilities are included if the household has a flush/pour piped sewerage system, septic tanks, pit latrine with slabs and unimproved water sources including flush/pour not connected to the sewerage system, septic tank, pit latrine, or open pit hanging toilet. The accessibility to these services is influenced by various factors, including gender, age, educational attainment, marital status, wealth status of the household head, household size, and place of residence. The findings of the study indicate that there is a favorable correlation between education, age, marital status, and the likelihood of families using water and sanitation facilities.

Adzawla et al. (2020) estimated the effect of household characteristics on toilet choices in Ghana. The researcher analyzed the impact of age, education, marital status of the household head, family size, and place of residence on toilet choice. This analysis involved

the use of multinomial logit regression on a dataset consisting of 14,159 households. The results showed those males, the young, the less educated, and those in the first quintile of income did more open defecation. Simelane et al. (2020) delineate a set of determinants that influence a household's ability to access clean drinking water. These determinants encompass the age of the family head, the gender of the household head, the educational attainment of the household head, the size of the household, the household's wealth index, the location of the household's residence, as well as additional variables such as the time required to obtain clean water. To estimate the relationship of these determinants with water poverty the data collected from Multiple Indicator Cluster Surveys (EMICSs), a sample of 4819, 4843 households respectively from 2010, and 2014, Univariate analysis and bivariate Multivariate techniques are used.

Dorea et al. (2020) conducted a study in Korea to examine the components associated with the provision of drinking water services that meet safety standards. They found that the lack of infrastructure was a major contributing factor to the disparity between urban and rural households, with rural households having much higher levels of contamination than urban households. Water services are categorized as basic services, limited services, unimproved services, and surface water. The elements of safely managed water are the household region, province, and wealth index of the household. The study concluded that investing in infrastructure and services can improve the quality of life for rural households. As reported by Ahmed et al. (2022) the WASH services in primary schools in Sindh, Pakistan have been identified. There was an overall lack of access to WASH services in schools, according to the study. As a result, primary schools in Pakistan need to invest more in WASH services. In this study, data were collected from 425 schools and analyzed using structural equation modeling. Similarly, WASH services are categorized into four categories: advanced, basic, restricted, and no services at all. A study analyzed the effect of limited services on schools; enrollment, dropout rate, and absenteeism in schools as a result of limited services.

Among the elements that contribute to easy access to drinking water resources and sanitary facilities in Ethiopia, Andualem et al. (2021) evaluated them. This study examines a sample of 16,650 homes to investigate the impact of demographic factors, such as gender, age, education level, marriage status, and wealth status of household heads, on their access to drinking water sources and toilet facilities. As well as the time needed to get water, and the size of the family, the regional differences were also analyzed by the researcher to identify that people who live in rural areas are less likely to have access to improved sources of water. There are two types of water sources, those that have been improved and those that have not. Using multivariate binary logistic regression. The findings of the study indicated that individuals residing in rural regions exhibited comparatively reduced accessibility to enhanced water sources in comparison to their urban counterparts

Pandey (2022) conducted logistic regression analysis on households in the Indian state of Bihar. The results revealed that access to basic water and combined water, sanitation, and hygiene facilities was significantly associated with household socioeconomic characteristics such as household wealth, education level, caste, and religion. The data from 16,650 households were used for the analysis. As a result of the study, female heads of households have greater access to hygiene facilities than households dominated by males. The data also showed that the literacy levels of the household head are significant in determining access to WASH facilities. The study revealed that families led by literate females had notably greater accessibility to WASH facilities in comparison to those led by illiterate males.

There are several factors that contribute to psycho-emotional distress, including unequal access to clean water as one of them. Looking at the relationship between gender, employment, education, marital status, as well as the state of the water source and psycho-emotional distress (Achore & Bisung, 2022). According to Girmay et al. (2022) empirical

evidence has been presented for Ethiopia. The research finds that the country has made significant progress in terms of economic growth, poverty reduction, and social development. The provision of WASH services has witnessed a significant enhancement, which may be attributed to various characteristics like education, gender, age, marital status, occupation, income status of the household head, place of living, and family size. In the adjusted odd ratio analysis, a relationship was discovered between demographic characteristics and the ability to access WASH services, indicating a causal relationship. In an analysis of data from 5350 households, it was found that household heads' age, income, and education were major determinants of the use of safe water by their households.

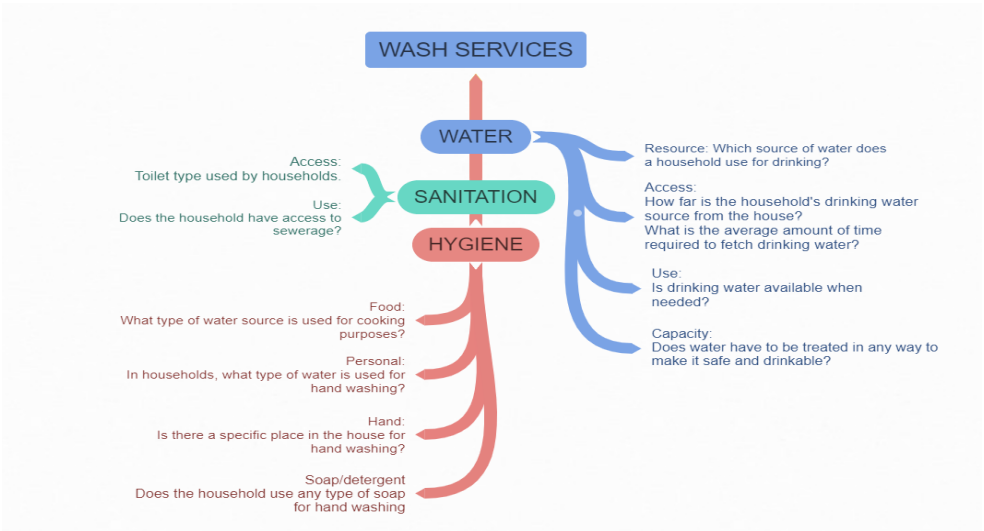
Furthermore, Alfonso et al. (2022) conducted research on the social status and water access inequality in the Philippines, in order to discover if there is a relationship between both. In the study, income status and water accessibility were positively correlated. The study concluded that the higher the household income, the better their access to water. Furthermore, the study highlighted the need to address the issue of water access inequality in the Philippines.

Methodology:

This study was conducted using a secondary data set to investigate the factors that contribute to multidimensional spatial inequalities in WASH services in Pakistan. The data for 2019-2020 available on Pakistan Social and Living Standards Measurement (PSLM) (Qurat-ul-Ann & Bibi, 2022).

The present study employed the WASH index as the dependent variable. The WASH index is multidimensional as water, sanitation, and hygiene (Qurat-ul-Ann & Bibi, 2022). For generating the WASH index, the data is converted into binary form so that it can be analyzed. The study counts only improved water services as having or not having them in a household. The indicators in each dimension are shown in the figure 1.

Figure 1 Indicators of WASH index



Literature suggests that when there are only a few indicators are available. The equal weightage method is used to assign weight to create a WASH index that only has three dimensions and 10 indicators. (Alkire & Jahan, 2018; Alkire & Santos, 2010; Roszkowska, 2013) Following the equation used; $\boldsymbol{W_j}\ (\boldsymbol{EW}) = \frac{\mathbf{1}}{\boldsymbol{N}}$

There are several factors that contribute to the spatial inequality of the WASH services, including the demographic characteristics of household heads, such as gender (HHG), age (HHA), education (HHEDU), marital status (HHMS) as well as the characteristics of households, such as income (HY), ownership status (OS), and family size (FS). These demographic factors can have a direct impact on access to WASH services, as they are often linked to decisions around the affordability and accessibility of WASH services (Adzawla et al., 2020; Cronin et al., 2017; Rauf et al., 2015; Simelane et al., 2020). Furthermore, geographic locations (rural, urban) and provinces (Punjab, Khyber-Pakhtun-Khan, Sindh, and Baluchistan) are counted in the data in order to measure spatial inequalities in Wash services across the country.

The household head is asked for the data by the data collector. The household head is usually the main source of information for the data collector.

Regression Analysis

The ordinary least square regression model will be used in this study to estimate the effects of socio-economic determinants on WASH services (Adil et al., 2021; Cronin et al., 2017; Mactaggart et al., 2018). This equation will be used to illustrate how WASH services are influenced by household determinants to express the dependency:

$$WASH = f\,(HH\ gender, HH\ age, HH\ education, HH\ marital\ status, H\ income,$$

$$H\ size\ of\ the\ family, occupancy\ status, HH\ size\ of\ the\ house, region).$$ As part of the third objective of the study, regression-based models were used to complete the analysis (Agbadi et al., 2019; Simelane et al., 2020).

$$\boldsymbol{Y = \beta_1 + \beta_2 X_1 + \beta_3 X_2 + \beta_4 X_3 + \beta_5 X_4 + \beta_6 X_5 + \beta_7 X_6 + \beta_8 X_7 + \beta_9 X_8 + \beta_{10} X_9 + \varepsilon_i} \textbf{ ....(i)}$$

Results and discussion Let's begin by looking at descriptive statistics of the data Tabe 1. As the data is recoded and categorized into different classes, so that the frequencies of the data are displayed in Table 2 (appendix), we are able to gain a deeper understanding of the data as a whole.

Table 1
Descriptive Statistics

Variables	N	Minimum	Maximum	Mean	Std. Deviation
WASH index	49836	.00	10.00	6.5770	1.95827
household head gender	49836	.00	1.00	.9233	.26610
Household head Age	49836	1.00	5.00	3.0191	1.25779
Household head education	49510	1.00	7.00	2.2022	1.30768
Household head Marital status	49836	1.00	3.00	2.0472	.29124
Household Annual Income	49836	1.00	6.00	1.3618	.82022
Present occupancy status	49836	1.00	2.00	1.8112	.39135
Family size	49836	1.00	4.00	2.1271	.80619
household size	49836	1.00	4.00	1.4291	.63297
place of residence	49836	.00	1.00	.3430	.47471
Valid N (list wise)	49510				

Based on the standard deviation of 1.96, a WASH Index value of 6.57 indicates an average level of WASH services within the sample. With a standard deviation of 6.57, the WASH Index values within the sample show moderate variability.

Table2
Frequency Distribution

Variable	Classes (codes)	Frequency	Percentage

Wash index	0	6	0
	1	365	0.7
	2	1377	2.8
	3	2842	5.7
	4	3682	7.4
	5	5099	10.2
	6	7161	14.4
	7	9986	20.0
	8	11434	22.9
	9	7278	14.6
	10	606	1.2
Total		49836	100
Household head gender	Female (0)	3822	7.7
	Male (1)	46014	92.3
Total		49836	
Household head age	<30 (1)	5956	11.9
	31-40 (2)	1295	26.0
	41-50 (3)	13256	26.6
	51-60 (4)	9534	19.1
	60< (5)	8139	16.3
Total		49836	100
Household head education	No schooling (1)	22246	44.6
	Primary (2)	6453	12.9
	Secondary (3)	13675	27.4
	Higher secondary (4)	3072	6.2
	Graduation (5)	3899	7.8
	Master/PhD (6)	82	0.2
	Others (7)	83	0.2
Missing		326	0.7
Total		49836	100
Household income	<500000 (1)	37929	76.1
	500001-1000000 (2)	8685	17.4
	1000001-1500000 (3)	1746	3.5
	1500001- 2000000 (4)	612	1.2
	2000001- 2500000 (5)	303	0.6
	2500001> (6)	561	1.1
Total		4983	100
Total		198336	100

Source: authors own work

It appears that approximately 92% of household heads are males based on the variable "Household Head Gender". According to the standard deviation of 0.2666, gender proportions are very stable. Therefore, the population in question is heavily skewed in favor of male household heads. Based on the small standard deviation, the results are consistent across households. "Household Head Age" has a mean of 3.1, indicating an average age of household heads within the third bracket. Within this range, the household head's average age shows moderate variability. Household heads have an average educational attainment of 2.20 years. Household head marital status has a mean value of 2.04, which is moderate. According to the standard deviation of 0.82 for "Household annual Income", these groups are moderately variable. It indicates a wide range of household income levels.

It indicates that 81% of homes have occupied rooms as the mean value for occupancy is 0.81. With a standard deviation of 0.39, occupancy rates in the sample appear moderately different. For the "Family Size" variable, we determined a mean value of 2.12 for

each sample household. Room number variation is moderate, with a standard deviation of 0.63. According to the observed standard deviation of 0.475, the proportion of urban residents exhibits moderate variability. Within the sample, urban and rural areas are distributed moderately.

Determinants of WASH: Based on the presented regression findings, let's evaluate the estimated coefficients, standard errors, p-values, and confidence ranges for each independent variable. Table 3, shows the regression results;

Table 3
Results of Regression analysis

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig
	B	Std. Error	Beta		
(Constant)	5.906	0.093		63.511	0
Household head Age	0.134	0.007	0.086	19.343	0
Household head gender	-0.475	0.033	-0.064	-14.322	0
Household head education	0.079	0.006	0.053	12.664	0
Household head Marital status	-0.139	0.031	-0.021	-4.44	0
Household Annual Income	0.219	0.01	0.092	21.812	0
Occupancy status	-0.035	0.021	-0.007	-1.667	0.096
Family size	-0.077	0.01	-0.032	-7.677	0
Household size	0.208	0.013	0.067	15.555	0
Region	1.331	0.018	0.324	74.133	0
R Square	0.409				
Adjusted R square	0.167				
F	1103.906				
N	49510				

Male household heads are associated with a drop in the WASH Index by -0.475. Male-headed households typically have a lower WASH Index than female-headed households due to this negative coefficient. The findings are similar to the study by (Pandey, 2022). It is expected that the p-value will be quite low since there is no 0 in the confidence interval, and all values are negative. The standard error of the coefficient is 0.033. The coefficient of -0.064 is moderate. There is some association between male-headed households and the WASH Index, but it is not overwhelming. These associations were also captured by (Adil et al., 2021; Simelane et al., 2020).

WASH Index and household head age are correlated, as shown by the coefficient of 0.134. There is a general tendency for the WASH Index to increase along with the household head's age based on the positive correlation between the two as analyzed by (Mactaggart et al., 2018). Statistics show a significant coefficient. There is a tendency for older household heads to score higher on the WASH Index. This may be due to greater access to resources, financial stability, and hygiene knowledge. The following tendency was also analyzed by (Simelane et al., 2020). An increase in the WASH Index is associated with a higher level of education acquired by the household head, as indicated by the coefficient of 0.080. literature supports the results as education may improve WASH outcomes (Andualem et al., 2021; Pandey, 2022). Due to being unmarried, the WASH Index drops by -0.139, which is attributed to the unmarried status. These results are also found in the study by (Andualem et al., 2021). As a result, single households have a lower WASH Index than married households. The confidence interval ranges from -0.200 to -0.078. Marriage and unmarried households have significant differences in the WASH Index, but the magnitude of the differences is unclear. WASH Index is lower for unmarried individuals when the coefficient is -0.139.

A correlation of 0.219 revealed that households with a higher annual household income had a higher WASH Index. This relation is also found by (Agbadi et al., 2019). WASH Indexes are higher for households with higher incomes on average because of this positive coefficient. The coefficient is statistically significant (Adil et al., 2021; Adzawla et al., 2020;

Mactaggart et al., 2018; Rauf et al., 2015). WASH Index and the ownership status of homes have an inverse correlation of -0.035. Nevertheless, the coefficient's confidence interval encompasses -0.007, indicating its statistical significance (Rauf et al., 2015). The WASH Index shows a significant correlation with family size, with a coefficient of -0.077. In general, households with more family members have a lower WASH Index. WASH facilities are less likely to be available in larger households (Adzawla et al., 2020; Simelane et al., 2020). It could be because larger households require more resources and have difficulty affording them, or because larger households tend to live in less developed areas with fewer services (Adil et al., 2021; Aleixo et al., 2019). However, this interpretation is limited by the lack of information regarding the p-value or confidence interval.

Access to WASH is positively correlated with household size (number of rooms). WASH access is easier for households with more rooms, according to the coefficient of 0.208. WASH services are more accessible to larger households (Adil et al., 2021; Rauf et al., 2015). A city's WASH Index is much higher than one in a rural area, based on a coefficient of 1.331. Positive coefficients indicate that households in cities have higher WASH Indexes than those in rural areas (Behera & Sethi, 2020). Based on the standard error (SE) of 0.018, the coefficient is statistically significant (Ohwo, 2019). WASH services are much more accessible to urban households than to rural ones (Jemmali & Sullivan, 2014).

An R-squared, modified R-squared, and F-statistic can be used to determine a regression model's fit and significance. This model explains a significant portion of the variation in the WASH Index with an R-squared of 0.40. This model's explanatory power is significantly lower when degrees of freedom and model complexity are taken into account. According to the R-squared and modified R-squared values, the model is useful for predicting WASH (Ozili, 2023). Statistically significant F-statistics and a low p-value demonstrate the regression model's importance. The low p-value shows that the results are valid and statistically significant.

Conclusion

WASH Index drops when a male household head is in charge, even when all other variables remain constant (Agbadi et al., 2019; Rauf et al., 2015). As elderly people age, WASH services may need to be enhanced and made more accessible to them. It is essential to implement targeted policies and initiatives that meet the unique requirements of elderly families in terms of clean water, sanitation, and hygiene. Public education and literacy can improve WASH results (Andualem et al., 2021; Girmay et al., 2022). Promoting awareness, understanding, and behavioral changes in hygiene practices can play a crucial role in improving access to and utilization of WASH services, especially for the poor (Cronin et al., 2017; Rani et al., 2020).

Recommendations

Households with higher incomes have better access to WASH services. Statistical significance indicates reliability. WASH access can be improved by reducing income gaps). Households living in poverty can benefit from income assistance, livelihood opportunities, and poverty reduction. It is also important to invest in infrastructure to support WASH programs. WASH services may need to be tailored to the needs of larger households. Providing appropriate sanitation and greater access to water can help improve WASH results in larger households. Households may be given more resources, such as free or subsidized access to services, or offered incentives to install and maintain sanitation facilities. WASH services for larger households can also be promoted through public campaigns.

Generally, urban areas have more resources and are better equipped to provide WASH services. Increase rural people's access to clean water, sanitation facilities, and

hygiene practices. By eliminating the rural-urban divide, we can reduce the rural-urban divide. As a result, rural communities will have access to WASH services. Health outcomes will be improved, and society will be more equitable.

Limitation and future research directions: Due to data limitations, it is not possible to include indicators for evaluating WASH services, such as environment. Water accessibility is only discussed in the study. Quality of water is not discussed and better quality of water is very important for better health. Statistically, home ownership may negatively affect WASH access, but other factors may be more important. Homeownership-related WASH services may be studied and analyzed in the future.

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