Pakistan's Multidimensional Water, Sanitation, and Hygiene Poverty: A Disaggregated Analysis

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Abstract

Human health and well-being have become a priority after the recent pandemic. Attainment of SDGs of good health and well-being for all, availability and sustainable management of water and sanitation with hygiene by 2030, is possible in developing economies after valuation of existing situations. Current research evaluates household multidimensional water, sanitation, and hygiene poverty in Pakistan using household survey data from Pakistan Social and Living Standards Measurement Survey, 2018-2019. Dimensions for household water poverty measurement comprise resource, access, capacity, and use. Multidimensional sanitation poverty has two dimensions namely access and use. Hygiene poverty is assessed with food and personal hygiene dimensions. Multidimensional water poverty incidence is 51.2 percent, and 66.4 percent of sample households are experiencing deprivation in multiple dimensions of sanitation poverty. Multidimensional hygiene poverty incidence is 54.6 percent of the sample households in Pakistan. Results show multidimensional water poverty incidence of 4.6 percent, multidimensional sanitation poverty incidence of 61.9 percent, and multidimensional hygiene poverty incidence of 37.3 percent of the sample households in rural Pakistan. Balochistan and KP are highly water-deprived provinces, while highest multidimensional sanitation poverty incidence and multidimensional hygiene poverty incidence is in Balochistan. The study recommends assurance of policymakers towards policy implementation focusing on access to clean water and equitable hygiene and sanitation for all. Most deprived regions should get more financial and technical support for access to required facilities. Greater involvement of local communities in improvement of water, sanitation, and hygiene management can ensure long term sustainability of such efforts creating a sense of ownership.

Keywords: Multidimensional, Household, Water Poverty, Hygiene poverty, Sanitation poverty, Sustainable.

JEL Codes: L95, O13, R20, P46, Q01

Introduction

All living beings need water to function properly, and the importance of this element on earth can be observed from the fact that no life would exist without water, whether it belongs to plants, animals, or humans (Anju et al., 2017). An apt requirement to perform daily routine tasks by an individual is almost fifty liters of water (WHO, 2019). The international community emphasizes the significance of global provision of safe and clean water supply for everyone. But this resource is limited in quantity compared to its increasing demand, hence prioritized usage of this scarce natural resource is vital. Despite the allocation of waters resource based on accessibility, it should be based on equity (Sullivan, 2001; Sullivan et al., 2002). In 2010, more than 660 million individuals had zero access to clean and safe drinking water, while 159 million people consumed surface water for their needs. In 2020, 2 billion (26%) people globally lack safely managed drinking water (UN, 2021). Access to safe and clean drinking water has been recognized as a basic human right by United Nations General Assembly in 2010 (WHO, 2015; UNICEF, 2015; Komarulzaman et al., 2017).

Water poverty refers to the situation where a nation or region is unable to pay for the cost of sustainable clean water for all people at all times (Feitelson & Chenoweth, 2002). Along with the idea of shortage of water resources, water poverty contains water accessibility, capacity, use, and environmental factors (Sullivan, 2001). Sanitation is linked to individual health conditions as proper provision of facilities and services to clean human wastage is crucial. Human waste should not come in contact with human

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bodies once defecated. Millennium Development Goal (MDG) 7 was about reducing the proportion to half of people who do not have access to clean water and basic sanitation facilities by 2015 (UN, 2010). Post agenda of MDGs 2015 was carried out by Sustainable Development Goal (SDG) 6 "to ensure availability and sustainable management of water and sanitation for all" (UN, 2014; Garriga & Foguet, 2018). About half of the population i.e. 4.2 billion people are deprived of improved sanitation facilities globally (WHO, 2019). 3.6 billion (46%) people lack safely managed sanitation (UN, 2021).

In addition to improved water and sanitation facilities, better health is ensured with hygiene practices necessary to retain health and avert the extent of infections. Hygienic behavior of washing hands with soap after defecating, before eating or preparing food, and so on carries greater significance (UNICEF, 2003) and plays a vital role in public health. Globally, 2.3 billion (29%) people lack basic hygiene (UN, 2021). Hygiene SDGs goal 6.2 outline the accessibility of a handwashing facility with soap and water on the site. The availability of water and soap is the basic hygiene criterion because the accessibility of handwashing facilities devoid of soap or water is considered a limited service. The households with no facility are categorized as having no service available (WHO, 2021).

Target 6.1 under SDGs of achieving universal and equitable access to safe and affordable drinking water for all by 2030, and target 6.2 to realize access to adequate and equitable sanitation and hygiene for all and culminate open defecation, giving special consideration to the needs of women, girls and vulnerable groups (UNDP, 2021), are not achieved globally.

The global efforts to achieve the goals by 2030 need to be identified. Many underdeveloped countries are facing difficulties in providing clean drinking water, and improved sanitation and hygiene facilities in rural areas, therefore leaving them vulnerable. 129 countries are not on track to have sustainably managed water sources by 2030. Therefore, the need is to double the current rate of progress. Rural regions of most underdeveloped countries contain eight out of ten people with no basic drinking water facility. Worldwide, 92 percent of the population in rural areas practice open defecation and half of that population resides in Sub-Saharan Africa. By considering current progress, improved sanitation will be available to 67 percent of the population globally by 2030. Basic hygiene facility (with soap and water) is available to 71 percent population globally, at such rate of progress this will cover 78 percent population globally by 2030 (WHO, 2021).

More than 2 billion individuals are facing high water scarcity and approximately 4 billion individuals are experiencing severe water shortages at least a month per annum globally (UN World Water Development Report [UNWWDR], 2019). One out of four healthcare units did not have basic drinking water facilities in 2016 and in 2017, two out of five individuals in the world were deprived of a basic handwashing facility with soap and water at home (UNDP, 2019). About 673 million people (nine percent of the global population) are practicing open defecation, out of which the majority live in South Asia. Pakistan is located in Central and Southern Asia where there is a high level of water stress. About 70 percent of households are still drinking unhealthy bacterial water and 25 million people are practicing open defecation. The unavailability of proper sanitation facilities affects the health of people (UNDP, 2019).

Before the Water and Sanitation Extension Programme (WASEP), 50 percent of deaths were attributed to water-borne diseases in the local community of Gilgit-Baltistan and Chitral. In these destitute regions with no hygiene awareness, 600 villages and around 5,00,000 people suffered from poor quality and availability of water and sanitation facilities (WASEP, 2018). Forty percent of deaths and thirty percent of illness prevalence were attributed to contaminated water in Pakistan. Unclean water is the major cause that every fifth person suffers from some disease. Approximately 3 million people suffer from water-borne diseases and 1,00,000 individuals die due to contaminated water annually in Pakistan (Haydar et al., 2009).

Literature Review

Literature suggests that use of contaminated water causes diseases among the users (Aziz, 2005; Shah et al., 2012; Jallan & Ravallion, 2011) while unhygienic practices are an important cause of diarrhea among children (Cairncross et al., 2010; Ustün et al., 2014). Many studies found that water, sanitation, and

hygiene interventions play a vital role in reducing health diseases (Fewtrell et al., 2005; Waddington et al., 2009; He et al., 2018; Nanan et al., 2013) while the use of piped water in-dwelling has reduced incidence of diseases among household members (Komarulzaman et al., 2017; Jallan & Ravallion, 2011). The idea of multidimensional poverty index measure can be used on local and national levels as municipal development program and for eradication of water poverty (Jemmali, 2017; Huang et al., 2017; Anju et al., 2017; Garriga & Fouget, 2018). Different indicators were used in the indices to evaluate the water, sanitation, and hygiene conditions in a particular evaluation (Sullivan, 2001; Sullivan 2003; Sullivan & Meigh, 2007; Garriga & Foguet, 2011; Manadhar et al., 2013). Following the framework of Sullivan (2001) and Sullivan (2003); Garriga and Foguet provided a framework for WASH poverty index which comprises the Water poverty index, Sanitation poverty index, and Hygiene poverty index (Garriga & Foguet, 2013).

This study aims to estimate water, sanitation, and hygiene poverty at the household level in Pakistan. In addition, it targets to examine the incidence and intensity of water, sanitation, and hygiene poverty at the provincial and regional levels in Pakistan.

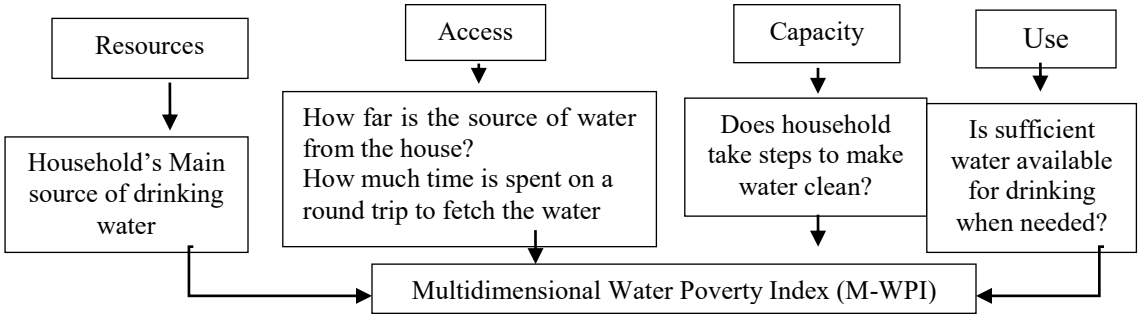
This study highlights the current situation of water, sanitation, and hygiene poverty at the household level in Pakistan and provides a baseline for policymakers to design policies for upgrading the infrastructure of water, sanitation, and hygiene facilities. Targets of Goal 6 of ensuring availability and sanitation sustainable management of water and sanitation for all can be attained by 2030 if the ground-level situation is understood. This study will help assess to what extent improvements are required at the regional and provincial levels in Pakistan. There is no such study that has evaluated water, sanitation, and hygiene poverty for all the provinces of Pakistan. Studies have been carried out in some specific regions and one or two provinces of Pakistan. Although some studies have analyzed water and sanitation conditions before 2013 hygiene conditions have been evaluated for the first time in this study. Hygiene indicator has been included in SDGs in 2015 for the first time. The results of this study will guide policymakers to devise targeted interventions to attain sustainable development goals by 2030.

Data and Methodology

The data was extracted from household survey data of Pakistan Social living and Standards Measurement (PSLM), 2018-2019 (Government of Pakistan, 2020). The 11th round of PSLM (Social and Household Integrated Economic Survey (HIES)) a is provincial level survey that includes Khyber Pakhtunkhwa (KP), Punjab, Sindh, Balochistan, Islamabad, Gilgit-Baltistan, and Azad Jammu & Kashmir (AJK), and has covered information for 24,809 households on water facilities. Data was collected from time period of August 2018 to June 2019 (Government of Pakistan, 2020).

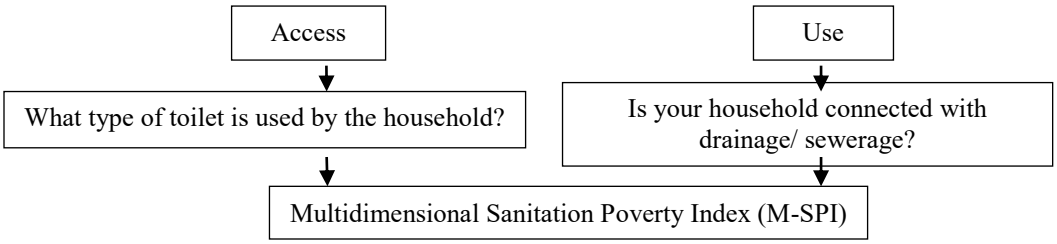
Multidimensional Water Poverty Index highlights those households which are deprived in terms of water resources, access, use, and capacity. A household is not water-poor if it has access to improved sources (Improved sources of water include; piped water, hand pump, motor pump, protected springs, boreholes, tube wells, protected dug wells, and packed bottled water) of water within 500-meter of its premises, time spent on fetching water is less than 30 minutes, and it has not spent some money/resources to clean water (see figure 1, table 1).

Figure 1. Dimensions and indicators of multidimensional household water poverty



Source: Authors' effort based on Garriga and Foguet (2013)

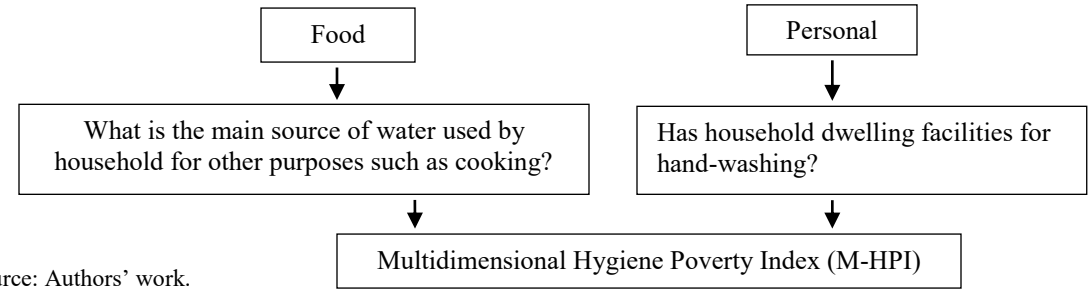
Figure 2. Dimensions and Indicators of Multidimensional Household Sanitation Poverty



Source: Authors' work.

Multidimensional Sanitation poverty index considers a household not poor in sanitation facilities if it has wet sanitation technologies (like flush and pour flush toilets connected to sewers, septic tanks and pit latrines) and dry sanitation technologies like dry pit latrines with slabs and composting toilets (UNICEF, 2017; WHO, 2017). This study used two indicators from PSLM survey 2018- 2019; i.e. What kind of toilet is used by the households? and What kind of sewerage system is connected to flush? (see table 1, figure 02). A household is not poor in hygiene facilities if it has clean water for cooking and hand washing facilities within the premises. This study used two indicators from PSLM survey 2018-19 for analyzing multidimensional hygiene poverty. A household is poor in hygiene facilities if it does not have facilities for handwashing inside the dwelling and if it uses open well, unprotected spring, pond, canal, river, stream and tanker water sources (see figure 03 and table 1).

Figure 3. Dimensions and Indicators of Multidimensional Household Hygiene Poverty



Source: Authors' work.

Water, Sanitation, and Hygiene Poverty Indices

The indices are developed in three stages, namely; selection of appropriate variables, assignment of weights and procedure to aggregate the model for subjective judgment. The quality of an index depends on the reliability of prior assumptions. For improvement in indices transparency, sensitivity analysis is used (Garriga & Fouget, 2010). Each composite index is described in table 1. The data on survey questions was available on different scales therefore prior to their analysis, it has been transformed into categorical variables, with values, zero and one. "0" is assigned to non-poor households and "1" to poor households in water, sanitation, and hygiene facilities, respectively.

Water, sanitation and hygiene poverty indices are the product of percentage of poor households in water, sanitation and hygiene facilities and an average percentage of households who were deprived in 30 percent of total water, sanitation hygiene dimensions, respectively. WPI, SPI and HPI measure household water, sanitation and hygiene poverty, respectively in different dimensions "d" across the sample households "n". $Y = [y_{ij}]$ is equal to $n \times d$ achievement matrix, where i represents households and j represents dimensions. Hence, $[y_{ij}]$ represents the achievements of '*i*' households across 'j' dimension. Each row vector $Y_i = (y_{i1}, y_{i2}, y_{i3}, \ldots\ldots y_{id})$ shows the attainment of households' information over different dimensions. Column vector $Y_j = (y_{1j}, y_{2j}, y_{3j}, \ldots\ldots y_{dj})$ $Y_i = (y_{1j}, y_{2j}, y_{3j}, \ldots\ldots y_{nj})$ represents the distribution of accomplishments in '*j*' dimensions across '*i*' households. For assigning the weight to dimensions, there is weighting vector 'w' consisting of w_j elements representing weights, where sum of the dimensions weight

equals to one as $\sum_{j=1}^{d} w_j = 1$. The assignment of weights to the dimensions and indicators is established as per their significance in literature. z_j shows the deprivation cut-off for any dimension 'j' which indicates to what extent households are deprived of a single dimension (Nussbaumer et al., 2012; Qurat-ul-Ann & Mirza, 2021; Alkire & Santos, 2010).

Let g = [g_{ij}] be a deprivation matrix, where g_{ij} element is referred as $g_{ij} = w_{ij}$, if whereas $g_{ij}=0$ when $y_{ij} < z_{ij}$. Elements should be non-numeric in the achievement matrix. Poverty cut-off represents those conditions that are necessary to meet in order to be termed as poor. If a household "*i*" is deprived in "*j*" dimension, then g_i entry in the matrix will be equal to variable weight 'w_j', while it will be equal to zero if the household is not poor. A column based on deprivation counts vector c is obtained where 'i^{th}' entry $c_i = \sum_{j=1}^{d} g_{ij}$ denotes the sum of weighted deprivations faced by household 'i' (Nussbaumer et al., 2012; Qurat-ul-Ann & Mirza, 2021; Alkire & Santos, 2010). A cut-off (k) score 0.3 is set to identify either a household is poor in water, sanitation, and hygiene facilities or not which applied on column vector 'c_i'. A household is considered poor in water, sanitation and hygiene facilities, respectively if its weighted deprivation count 'c_i' is higher than the poverty cut-off score (k=0.30) (Nussbaumer et al., 2012; Qurat-ul-Ann & Mirza, 2021).

Equation (3) represents that WPI, SPI, and HPI, respectively denoted by M_i, which is the product of headcount ratio (H) and average intensity (A) of deprivation in water, sanitation and hygiene facilities respectively measured in different dimensions. H represents headcount ratio, which is equal to ratio of deprived households (in water, sanitation, and hygiene facilities) "q" and the total sample households "n" (see equation 1).

$$H = q/n \quad (1)$$

$$A = \sum_{i=1}^{n} c_i\,(k)/q \quad (2)$$

$$M_i = H \times A \quad (3)$$

$$M_i = \frac{q}{n} \times \frac{\sum_{i=1}^{n} c_i(k)}{q} = \frac{\sum_{i=1}^{n} c_i(k)}{n} \quad (4)$$

'A' demonstrates the average intensity of multidimensional poverty in water, sanitation and hygiene facilities (equation 2) in which the element $c_i(k)$ illustrates the censored vector of deprivation counts and it is different from c because it counts zero for those households which are non-poor in multidimensional water, sanitation and hygiene facilities (Nussbaumer et al., 2012; Qurat-ul-Ann & Mirza, 2021). M_i represents multidimensional poverty in water, sanitation, and hygiene where subscript 'i' represents WPI, SPI, and HPI, respectively in equations 3 and 4.

The equal weights method is used for the measurement of multidimensional composite indices which is useful when there is minimum information available on the preferences of dimensions and indicators. In case of no prior information regarding the true weights for the indicators, decision-makers can allocate equal weights suggested by literature (Alkire & Foster 2007; Alkire & Foster 2009; Alkire & Santos, 2010; Alkire & Jahan, 2018; Alkire & Fang, 2019; Roszkowska, 2013). Equation (5) presents the procedure for equal weight distribution.

$$w_j\,(EW) = 1/N \quad (5)$$

Where 'w_j' shows weight assigned to each "j" dimension and "N" is the total number of dimensions where *j=1,2,3…., n*.

To analyze robustness of the indices, this study also used rank sum weighting criterion and Garriga and Foguet weighting method. First step in rank-sum weighting method is to individually rank the indicators and divide them by the sum of their total number of dimensions. Rank sum method assigns weights based on the importance of each dimension. This study ranked the dimensions based on their importance and used rank order weighting method to construct the dimension weights (Roszkowska, 2013; Stillwell et al., 1981) (See equation 6):

$$w_j = \frac{n - r_j + 1}{\sum_{k=1}^{n} n - r_j + 1} \quad (6)$$

Here 'w_j' shows rank-sum weight for each dimension "j", n denotes total number of dimensions and r_j is dimension's rank.

Principal component analysis based selected indicators under each dimension of water poverty index used Garriga and Foguet (2013) weighting scheme. The same weighting scheme is not used for sanitation poverty index and hygiene poverty index due to the limited range of indicators in the survey data used. The sensitivity of water poverty index, sanitation poverty index and hygiene poverty index is also assessed with changes in poverty cut-off scores along with changes in the weighting scheme in terms of each dimension in the indices (Alkire & Santos, 2010; Qurat-ul-Ann & Mirza, 2021).

Results and Discussion

Table 1 elaborates the detail of dimensions and indicators under each multidimensional poverty index (WPI, SPI, HPI), along with their individual deprivation cut-offs. The data on each indicator against each household has been evaluated based on the deprivation cut-offs and the household is categorized as poor or non-poor in each indicator. Percentage of water-poor households in each dimension and indicator is given in table 2 (from PSLM 2018-19).

Analysis of data on each dimension and indicator revealed that the percentage of sample households deprived in access and use dimension is higher. 6 percent of the sample households were deprived in water sources, 10 percent and 7 percent deprived as per access dimension in distance and time spent indicators. 7 percent of sample households used procedures to clean water and 13.6 percent of the sample households did not have availability of water to drink when required (see table 2) (Government of Pakistan, 2020).

H, A, and M_0 show incidence, intensity, and adjusted multidimensional incidence of water poverty, respectively (see table 3). The incidence of water poverty in at least one dimension is 7.6 percent of the sample households (H), 3.9 percent of the households are multidimensional water poor in 30 percent of the total dimensions (A), and adjusted multidimensional incidence (M_0) is 51.2 percent (table 3). Sensitivity analysis results depict that household multidimensional water poverty estimates change when weights and water poverty cut-off scores change (table 4).

Varying water poverty cut-off scores from 0.30 to 0.40 alters the multidimensional water poverty incidence from 7.6 percent to 5.4 percent. Incidence, intensity, and multidimensional headcount are insensitive to changes in water poverty cut-off from 0.4 to 0.5, whereas, sensitivity is observed when cut-off scores changed from 0.50 to 0.60. Sensitivity analysis based on different weights suggest that under rank-sum method, more weights are consigned to resources and access dimensions, whereas less weights are given to capacity and use dimensions, as per the significance of these dimensions. Both multidimensional water poverty incidence and intensity of multidimensional household water poverty are sensitive to changes in weights and water poverty cut-off scores (see table 4). Adjusted multidimensional water poverty incidence is less robust to changing weights at the cut-off of 0.30. Smaller variation is being observed in case of higher cut-off scores. Multidimensional household water poverty incidence and intensity under Garriga and Foguet (2013) weighting scheme decreased with increase in water poverty cut-off scores (0.3 to 0.6 percent), whereas the adjusted multidimensional incidence showed an increase after change in water poverty cut-off scores (see table 4). Higher multidimensional water poverty incidence is measured under Garriga and Foguet (2013) weighting scheme, i.e. 17.5 percent of sample households are water poor. Intensity (A) also increased compared to other weighting schemes under similar water poverty cut-off score of 0.30 (see table 4).

Table 1. Dimensions, Indicators Of Multidimensional Water, Sanitation And Hygiene Poverty Indices with Weights Under Different Weighting Schemes

				Deprivation Weighting Scheme		
	Dimensions	**Indicators**	**Deprivation Cut-off**	**EW**	**RSW**	**GFW**
WPI	Resources	Main source of drinkinThe mainter for the household	A household is water poor if it does not have access to improved sources (Improved sources of water include; piped water, hand pump, motor pump, protected springs, boreholes, tube wells, protected dug wells and packed bottle water) of water.	0.25	0.4	0.303
	Access	How far is the source of water from the house?	A household is water poor if it does not have access to improved sources of water within 500-meter of its premises	0.25	0.3	0.214
		How much time is spent on a round trip to fetch the water	Water poor if time spent on fetching water is more than 30 minutes,			
	Capacity	Is household take steps to make water clean?	Water poor if it has spent some money/resources to clean water.	0.25	0.2	0.180
	Use	Is sufficient water available for drinking when needed?	A household is water poor if it does not have water available for drinking when needed	0.25	0.1	0.303
SPI	Access	What type of toilet is used by the household?	A household is sanitation poor if it does not have toilet facility	0.5	0.67	
	Use	Is your household connected with drainage/ sewerage?	A household is sanitation poor if it does not have connection to drainage/sewerage	0.5	0.33	
HPI	Food	What is the main source of water used by household for other purposes such as cooking?	A household is hygiene poor if it does not have clean water source for cooking and other uses	0.5	0.67	
	Personal	Is household has dwelling facilities for hand-washing?	A household is hygiene poor if it does not have handwashing facility inside the dwelling	0.5	0.33	

* Weighting scheme EW represent equal weights, RSW shows rank sum weights and GFW represents Garriga and Foguet (2013) weighting schemes. Source: Authors' work based on Garriga & Foguet (2013)

Table 2. Detailed Summary And Weights For Multidimensional Household Water Poverty Index

			Weighting Schemes		
Dimensions	**Indicators**	**Percentage of deprived households**	**EW**	**RSW**	**GFW**
Resources	Water source	6.018	0.25	0.4	0.3
Access	Distance from source	10.428	0.125	0.15	0.11
	Time spent	7.445	0.125	0.15	0.11
Capacity	Steps to clean water	7.243	0.25	0.2	0.18
Use	Availability	13.552	0.25	0.1	0.3

Total number of households = 24,809

Table 3. Multidimensional Household Water Poverty in Pakistan

Incidence (H)	**Intensity (A)**	**Adjusted Multidimensional Incidence (M_0)**
0.076	0.039	0.512
(0.003) **	(0.002) **	(0.002) **
No. of households = 24,809.		

Note: As per Equal Weight method each dimension is assigned weights of 0.25 (see table 2).

Source: Authors' calculation based on PSLM (2018-19).

Table 4. Multidimensional Water Poverty Index Along With Sensitivity Analysis

Weighting Criteria		0.3	0.4	0.5	0.6
Equal Weight Method (EW)	H	***0.076***	0.054	0.054	0.018
	A	***0.039***	0.031	0.031	0.012
	M_0	***0.512***	0.568	0.568	0.710
Rank Sum Weights (RSW)	H	0.112	0.076	0.051	0.029
	A	0.054	0.042	0.032	0.021
	M_0	0.478	0.554	0.630	0.716
Weights suggested by Garriga & Foguet, 2013 (GFW)	H	0.175	0.070	0.042	0.024
	A	0.071	0.039	0.027	0.017
	M_0	0.405	0.555	0.634	0.710

WPI Dimensions (indicators): Rank 1: Resources (Water Source), Rank 2: Access (Distance from Source, Time spent to fetch water), Rank 3: Capacity (Steps to clean water), Rank 4: Use (Availability). RSW criterion and GFW criterion based weights for each indicator and dimension are also given in tables 1 and 2.

Source: Authors' calculation based on PSLM (2018-19)

Adjusted multidimensional incidence (M_0) shows that 5.5 percent of sample households in KP, 1.1 percent in Punjab, 5.2 percent in Sindh and 11.5 percent of the sample households in Balochistan are multi-dimensional water poor at the 30 percent poverty cut-off score. Table 5 also presents the share of each province (KP, Punjab, Sindh and Balochistan) in household multidimensional water poverty using different weighting schemes with 0.3 poverty cut-off score.

A higher proportion of the sample households is multidimensional water poor in KP, Balochistan and Sindh compared to Punjab where on average more households in Balochistan and Sindh are destitute in 30 percent of total water poverty dimensions (See table 5). Adjusted multidimensional water poverty incidence (M_0) shows that households in Balochistan and KP are more multidimensional water poor at the 30 percent poverty cut-off score (see table 5). 10.7 percent of the sample households are multidimensional water poor in one or more dimensions in KP, with 2.2 percent in Punjab, 10.3 percent in Sindh and 21.9 percent in Balochistan (as per equal weighting scheme). Intensity (A) shows that on average 51.4 percent of water-poor households in KP, 50 percent of sample households in Punjab, 50.4 percent in Sindh and 52.5 percent in Balochistan are poor in 30 percent of total dimensions of water poverty.

Sensitivity analysis depicts that under rank sum weighting scheme percentage of water-poor households increases more in KP and slightly in other provinces whereas a little decrease in intensity as compared to equal weighting scheme (see table 5). Garriga and Foguet (2013) suggested weighting scheme gives higher percentage of multidimensional water-poor households i.e. 35.1 percent in KP, 6.2 percent in Punjab, 21.9 percent in Sindh, and 29 percent in Balochistan. On average, 38.5 percent in KP, 37.1 percent in Punjab, 41.1 percent in Sindh, and 47.6 percent multidimensional water-poor sample households are poor in 30 percent of total water poverty dimensions. Adjusted multidimensional incidence (M_0) is sensitive to change in weighting scheme of GFW, with 13.5 percent in KP, 2.3 percent in Punjab, 9 percent in Sindh, and 13.8 percent of the sample households in Balochistan as multidimensional water-poor at the 30 percent poverty cut-off score (see table 5).

Table 5. Household Multidimensional Water Poverty Index by Province and Region(Poverty Cut-Off, 0.30)

Weighting Schemes		KP	Punjab	Sindh	Balochistan	Rural	Urban
Equal Weights (EW)	H	0.107	0.022	0.103	0.219	0.089	0.054
	A	0.514	0.50	0.504	0.525	0.517	0.463
	M_0	0.055	0.011	0.052	0.115	0.046	0.025
Rank Sum Weights (RSW)	H	0.202	0.038	0.129	0.269	0.134	0.073
	A	0.50	0.395	0.465	0.524	0.507	0.384
	M_0	0.101	0.015	0.060	0.141	0.068	0.028
Weights suggested by	H	0.351	0.062	0.219	0.290	0.201	0.128

Garriga & Foguet, 2013 (GFW)	A	0.385	0.371	0.411	0.476	0.418	0.375
	M_0	0.135	0.023	0.090	0.138	0.084	0.048

Source: Authors' calculation based on PSLM (2018-19).

Results revealed that rural areas are facing more multidimensional water poverty as compared to urban areas because most households used open well, unprotected dug well sources of water and also due to access dimension as they spent more time to fetch water when water source is outside the premises more than 500 meters. 8.9 percent of sample rural households and 5.4 percent of urban households of Pakistan were found to be multidimensional water-poor (under equal weighting scheme). On average, 51.7 percent of multidimensional water poor households are deprived in 30 percent of total dimensions in rural areas and 46.3 percent in urban areas. Adjusted multidimensional water poverty incidence is 4.6 percent among rural sample households and 2.5 percent in urban households at 0.30 poverty cut-off score. The incidence (H) and intensity (A) of multidimensional water poverty is sensitive to change in weighting schemes of rank sum and Garriga-Foguet (table 5). In addition, adjusted multidimensional water poverty incidence is less sensitive to change in dimension weights.

Table 6 shows that 77.7 percent of the sample households are multidimensional sanitation poor in one or more dimensions at the multidimensional threshold for sanitation poverty as 30 percent. Intensity shows that on average 51.6 percent of sanitation poor households are deprived in 30 percent of total dimension. The adjusted multidimensional headcount ratio (M_0) shows that 66.4 percent of the sample households are multidimensional sanitation poor at 0.30 poverty cut-off score.

Sensitivity analysis depicts that incidence of multidimensional sanitation poverty is insensitive to the changes in the weighting scheme to RSW, whereas, intensity is sensitive to this change showing that on average 43.1 percent of sanitation-poor households are destitute in 30 percent of total dimensions. M_0 is sensitive to change in weighting scheme with 55.5 percent of households are multidimensional sanitation poor at 0.30 poverty cut-off score under RSW (see table 6). Sensitivity analysis is carried out by changing the cut-off scores from 30 percent to 60 percent and using rank sum weighting method for each dimension (see table 7). Sanitation poverty estimates change when there are changes in poverty cut-off scores. Under rank sum weighting method, more weight is assigned to access dimension and less weight to use dimension, based on their importance in the literature. Multidimensional Sanitation poverty estimates are robust to variation in poverty cut-off scores from 0.40 to 0.6 (Qurat-ul-Ann & Mirza, 2021).

Table 6. Multidimensional Sanitation Poverty At The Household Level in Pakistan

	Incidence (H)	**Intensity (A)**	**Adjusted Multidimensional Incidence (M_0)**
Equal weights (EW)	0.777	0.516	0.664
	(0.003) **	(0.002) **	(0.002) **
Rank sum weights (RSW)	0.777	0.431	0.555
	(0.003) **	(0.002) **	(0.002) **
	No. of households = 24,809		

SPI Dimensions and indicators: Rank 1: Access (Toilet facility), Rank 2: Use (Sewerage)

As per Equal Weight method, both dimensions are assigned weights of 0.5, whereas, Rank sum weighting criteria determined 0.67 weight for access dimension and 0.33 weight for use dimension. 26.19 percent of the population is deprived in access dimension and 77 percent of the population is deprived in the use dimension (see table 1).

Source: Authors' calculation based on PSLM (2018-19).

Results show that 52.2 percent in KP, 49.8 percent in Punjab, 51.9 percent in Sindh and 58.8 percent of sample households are multidimensional poor in sanitation facilities at the sanitation poverty cut-off of 0.30. Sanitation poverty is very high in Balochistan, KP and Sindh as compared to Punjab (see table 8). Rural and urban estimates of household sanitation poverty at cut-off of 0.3 propose that rural

regions faced higher level of sanitation poverty i.e. 61.9 percent of sample households (equal weight method).

Table 7. Sensitivity Analysis Of Multidimensional Sanitation Poverty Index by Poverty Cut-off Scores [Weighting Method: Rank Sum]

Cut-off scores	*0.3*	*0.4*	*0.5*	*0.6*
H	0.777	0.262	0.262	0.262
A	0.431	0.260	0.260	0.260
M_0	0.555	0.991	0.991	0.991

Source: Authors' calculation based on PSLM (2018-19).

Whereas, urban areas experienced lower levels of sanitation poverty with 33.1 percent of sample households. Incidence of multidimensional sanitation poverty remained same for both rural and urban areas (see table 8).

Table 8. Household Multidimensional Sanitation Poverty Index by Province And Region (Equal Weights Method) Poverty cut-off **=0.3**

	KP	Punjab	Sindh	Balochistan	Rural	Urban
H	0.927	0.732	0.711	0.887	0.939	0.484
A	0.563	0.68	0.73	0.633	0.65	0.68
M_0	0.522	0.498	0.519	0.588	0.619	0.331

Source: Authors' work based on PSLM (2018-19)

The household hygiene poverty index measures the hygiene poverty at the household level in Pakistan covering two dimensions. Due to data limitations, other dimensions could not be included in this analysis. The households which are deprived of hygiene facilities in terms of food and personal hygiene dimensions are considered multidimensional hygiene poor. A household can be termed as hygiene poor in case of deprivation in one dimension or in both dimensions (Alkire et al., 2020). 53.2 percent of sample households are multidimensional hygiene poor in at least one dimension (table 9). On average, 29 percent of sample households who are poor in hygiene facilities are deprived in 30 percent of total dimensions (intensity). 54.6 percent (M_0) of the sample households are multi-dimensionally poor in hygiene facilities at 0.30 hygiene poverty cut-off score (Santos & Alkire, 2011) (see table 9).

Multidimensional hygiene poverty incidence in not found sensitive to different dimension weights, i.e. 53.2 percent under both weighting schemes, whereas the intensity of multidimensional hygiene poverty has been sensitive to change in weights (from 29 percent to 21.2 percent of the sample households deprived in 30 percent of the dimensions). The adjusted multidimensional incidence of hygiene poverty changed to 53.2 percent under rank sum weighting scheme. The adjusted multidimensional incidence of hygiene poverty changed to 39.9 percent of sample households under rank sum weighting scheme (see table 10).

Table 9. Household Hygiene Poverty in Pakistan- Equal Weights

Incidence (H)	Intensity (A)	Adjusted Multidimensional Incidence (M_0)
0.532	0.290	0.546
(0.003) **	(0.002) **	(0.001) **
N = 24,809		

Source: Authors' calculation based on PSLM (2018-19)

Table 10. Sensitivity Analysis of Hygiene Poverty Index (Poverty Cut-Off = 0.30)

Equal Weights (EW) Method			Rank Sum Weighting (RSW) Method		
H	**A**	**M_0**	**H**	**A**	**M_0**
0.532	0.290	0.546	0.532	0.212	0.399

HPI Dimensions and indicators: Rank 1: Food, Rank 2: Personal dimension

As per Equal Weight method both dimensions are assigned weights of 0.5, whereas, Rank sum weighting criteria determined 0.67 weight for food dimension and 0.33 weight for personal dimension. 6.01 percent

of the population is deprived in food dimension and 52.06 percent of the population is deprived in the personal dimension (also see table 1).

Source: Authors' calculation based on PSLM (2018-19) data

Provincial analysis of hygiene poverty revealed that 52.2 percent in KP, 49.8 percent in Punjab, 51.9 percent in Sindh, and 58.8 percent of sample households in Balochistan are multidimensional hygiene poor (equal weighting scheme), at 0.30 hygiene poverty cut-off score. 38.9 percent of the sample households in KP, 42.2 percent in Punjab, 45.8 percent in Sindh and 49.1 percent in Balochistan are multidimensional hygiene poor (rank sum weighting) scheme) at 0.30 poverty cut-off score. The multidimensional hygiene poverty incidence is robust for each province under different weighting schemes. Intensity of multidimensional hygiene poverty is sensitive to the change in weights. Adjusted multidimensional incidence is also sensitive to the change in weighting scheme (see table 11).

Table 11. Household Hygiene Poverty Index By Province And Region (Poverty cut-off, 0.30)

		KP	**Punjab**	**Sindh**	**Balochistan**	**Rural**	**Urban**
Equal Weights (EW)	H	0.927	0.732	0.711	0.887	0.674	0.277
	A	0.563	0.680	0.729	0.662	0.553	0.50
	M_0	0.522	0.498	0.519	0.588	0.373	0.141
Rank Sum Weights (RSW)	H	0.927	0.732	0.711	0.887	0.674	0.277
	A	0.419	0.576	0.644	0.553	0.41	0.346
	M_0	0.389	0.422	0.458	0.491	0.277	0.096

Source: Authors' own calculation based on PSLM (2018-19)

Rural regions faced higher hygiene poverty incidence of 67.4 percent at hygiene poverty cut-off score of 0.30 with equal weight method (see table 11), whereas 37.3 percent of sample households are multidimensional hygiene poor in rural areas and 14.1 percent urban households are multidimensional hygiene poor. Under rank sum weighting method 67.4 percent of sample households are deprived in hygiene facilities at 0.30 hygiene poverty cut-off score. Urban areas are experiencing hygiene poverty incidence that is 27 percent of sample households at 0.30 hygiene poverty cut-off score in rural areas. 27.7 percent of rural households are multidimensional hygiene poor and 9.6 percent of urban households are multidimensional hygiene poor (see table 11).

Conclusion and Policy Recommendations

Results indicated that the incidence of deprivation in multiple dimensions of water poverty is 7.6 percent. Intensity showed that on an average 3.9 percent of water-poor households are poor in 30 percent of the dimensions. The adjusted multidimensional headcount shows that 51.2 percent of households in Pakistan are multidimensional water-poor at 0.30 cut-off score. 77.7 percent of sample households are deprived in sanitation facilities in one or more than one dimension and on an average 51.6 percent of sanitation poor households are deprived at the poverty cut-off of 30 percent. 66.4 percent of sample households are experiencing multidimensional sanitation poverty at 0.30 poverty cut-off score. 53.2 percent of sample households are hygiene poor in one or more dimensions. On average, 29 percent of these households are poor in 30 percent of total dimensions. 54.6 percent of sample households are multidimensional sanitation poor at 0.30 poverty cut-off score. A higher percentage of households are sanitation and hygiene poor compared to being multidimensional water poor in Pakistan.

Rural households are facing higher multidimensional deprivation in water, sanitation and hygiene facilities compared to urban households of Pakistan. In rural areas, incidence of multidimensional water poverty is 4.6 percent, incidence of multidimensional sanitation poverty is 61.9 percent, and incidence of multidimensional hygiene poverty is 55.3 percent at poverty cut-off score of 0.30. Urban multidimensional water poverty incidence is 2.5 percent of the sample households. 33.1 percent of urban households are multidimensional sanitation poor and 50 percent of urban households are multidimensional hygiene poor at 0.30 poverty cut-off score.

Highest multidimensional water-poor province in Pakistan is Balochistan (11.5 percent), followed by KP (5.5 percent), Sindh (5.2 percent), and Punjab (1.1 percent). Balochistan has the highest percentage of multidimensional sanitation poor households (58.8 percent), with 51.9 percent households in Sindh, 52.2 percent households in KP and 49.8 percent households in Punjab. Balochistan has the highest (58.8 percent) multidimensional hygiene poor population, with 51.9 percent hygiene poor households in Sindh, followed by KP (52.2 percent) and Punjab (49.8 percent).

Government should focus to upgrade water, sanitation, and hygiene facilities in the country with a special focus on rural areas. Targeted policies through local and district governments, a proper infrastructure developed for evaluation of provided water, sanitation conditions, and facilities is mandatory to reduce multidimensional water, sanitation, and hygiene poverty in Pakistan. Government should build more filtration plants and increase piped water supply to reduce water poverty in Balochistan, Sindh, and KP. Identification of factors responsible for prevalence of stark water, sanitation, and hygiene poverty in rural areas and provinces of Balochistan, Sindh, and KP is imperative. It will further help and guide the policymakers to devise area-specific measures to mitigate multidimensional sanitation and hygiene poverty.

Awareness of the benefits of maintaining sanitation and hygiene among the masses is mandatory along with providing them sufficient resources to attain the sustainable development goals of child, maternal and overall health and improved standards of living. Contribution of public towards economic growth and development in future is attached to healthy minds and bodies today. In the existing era of digital media and advanced communications, multiple domains can play their role to improve hygiene behaviors along with conservation and delivery of safe drinking water facilities at the doorstep.

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