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SOCIO-ENVIRONMENTAL DETERMINANTS OF EXPOSURE TO WATER AND SANITATION RELATED HAZARDS IN PAKISTAN

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ABSTRACT

Inadequatewater and sanitation infrastructure leads to increased health risks to the population, in particular, children. The lack of access to improved water and sanitation facilities is a major cause of diarrheal diseases.At present, access to safe drinking water, improved sanitation facilities, good personal and food hygiene and health education are the main focus of intervention strategies. The knowledge on socio-environmental determinants of exposure to water and sanitation hazards can play a pivotal role supporting and guiding preventive measures for reducing the risk of exposure to water and sanitation related hazards. The present study was carried out to identify socio-environmental determinants of exposure to water and sanitation related hazards in Pakistan by taking the incidence of diarrhoea in under five years old as an archetypical disease of lack of access to improved water and sanitation facilities. A logit model has been used to predict the determinants of diarrhoea in under fives. The results indicate that household location, household size, number of children in the family,age of the mother, education of the mother, household head's employment, drinking water sources and toilet facility are important correlates of diarrhoea in children. The findings of the study may inform to prioritize the resource mobilization in capacity building towards designing the most effective prevention intervention strategies to reduce the risk of exposure to sanitation hazards.

Keywords: Social determinants, water supply, sanitation, diarrhoea, Pakistan.

INTRODUCTION

Adequate provision of water and sanitary sanitation services along with good hygiene behaviour are crucial to health, social and economic development. Poor water supply and sanitation infrastructure leads to increased health risks to the population, in particular, children. The prevalence of diarrheal disease has been associated with lack of access to improved water and sanitation facilities (Prüss-Ustün *et al.* 2014). While there is general consensus that diarrhoeal disease is waterborne and improvement in quality water supply can greatly reduce the transmission of the disease, however, faecal-oral route of transmission is important, particularly, in the case of inadequate sanitation facilities and hygiene behaviour (Curtis*et al*. 2000). Appallingorabsence of sanitation may enhance disease transmission by contaminating water sources, increased person to person transmission via hands/food and flies (Cairncross, 2003; Ezzati *et al*. 2005). Hence focusing only on drinking water supply may not yield a reduction in diarrhoeal transmission. In fact a holistic system approach keeping in view all potential pathways of transmission (e.g. water supply, sanitation and hygiene practice) is a key to halt the transmission of diarrhoea. Historically, the improvement in water and sanitation infrastructure has shown the reduction in diarrhoeal disease (Esrey*et al*. 1985; Rahman *et al*. 1985; Victoria*et al*. 1988). According to the WHO, (2013) worldwide there are 1.7 billion cases of diarrheal diseases per annum and it is the second leading cause of deaths in children under five years old (760 000 children/year).

Globally there are, at present, 2.5 billion people without access to adequate sanitation and a large proportion of these are in Southern Asia and Sub-Saharan Africa (WHO, 2014). Pakistan is among the countries in Southern Asia where a vast fraction of population lacks access to improved sanitation. Recent estimates showed that the country has made progress in provision of drinking water and sanitation but faces significant challenges. According to the Joint Monitoring Program for Water Supply and Sanitation of the World Health Organization and UNICEF, access to an improved water source and improved sanitation facility increased from 85% to 91% and 27% to 48% over the period of 1990 to 2012, respectively (WHO/UNICEF JMP, 2014). With reference to progress towards the Millennium Development Goals (MDGs) targets for drinking water and sanitation, Pakistan is on track for drinking water; however,the country is failing to meet the target for sanitation by 2015. Pakistan is among those 46 countries

where less than halfof the population has access to improved sanitation facilities (WHO, 2014).

It is evident that though good progress has been made in drinking water supply (may not be safe drinking water) access to improved sanitation facilities isstill insufficient. Furthermore, due to a substantial growth in population, there is ever increasing risk of exposure to sanitation hazards andresultant diarrhoealdisease, especially to children under the age of five.Pakistan is the sixth most populous country in the world with estimated population of 188 million-children under 5 years of age account for about 13.37% (15.8 million) of the total population (Pakistan Economic Survey, 2013-2014). Among different causes of under 5 child mortality, prevalence of diarrhoea is a major challenge. In 2013, 11% of total deaths under 5 were due to diarrhoea (WHO, 2015).

Existing intervention strategies are centred on increasing access to safe drinking water and sanitation, capacity building to implement preventive measures (improved sanitation, source water improvements, household water treatment and safe storage), promoting personal and food hygiene (hand washing, proper food storage/heating) and health education.In recent times, the role of social determinants hasbeen increasingly recognized to support and guide the intervention strategies and preventive measures for improving public health (Marmot, 2005; Kelly *et al*. 2007; Saidu *et al*. 2014). World Health Organization Commission on Social Determinants of Health (CSDH) has highlighted that social, economic and political mechanisms play an important role in shaping the determinants of health by generating stratification and resultant socioeconomic positions in a society (Marmot*et al*. 2008). Exposure to water and sanitation related hazard is influenced by a wide range of social (e.g. income,education, occupation, social class, gender) and environmental factors (e.g. water and sanitation infrastructure). Therefore the knowledge of socio-environmental determinants of exposure to water and sanitation hazards in a region can greatly contribute to gain holistic understanding of context and severity of various pathways of disease transmission and development and implementation of sustainable intervention strategies.

The present study was carried out toexplore the socio-environmental determinants of exposure to water and sanitation related hazards in Pakistan. The diarrhoeal incidence under the age of five has been taken as an exemplary indicator of exposure outcome to water and sanitation related hazards. The findings of the study offer a holistic understanding of socio-environmental determinants of diarrhoeaunder five year olds in Pakistan and could assist in advancing and informing the prioritization of the resource mobilization in capacity building towards designing the most effective and sustainable prevention intervention strategies to reduce the risk of exposure to water and sanitation hazards in Pakistan.

MATERIALS AND METHODS

Pakistan is located in Northwest South Asia and has four provinces (Balochistan, Punjab, Sindh, Khyber Pakhtunkhwa (KPK) federal territory and federally administrated tribal areas. This research uses thedata from Pakistan Social and Living Standards Measurement Survey (PSLM) 2010-11 conducted by the Federal Bureau of Statistics, Government of Pakistan. In order to explore the association between diarrhoea incidence and socio-environmental characteristics of households in Pakistan, a categorical dependant variable model is used.

For this purpose, incidence of diarrhoea has been categorized as suffered from diarrhoea in last one month or no diarrhoea. In order to examine the socio-environmental determinants of diarrhoea, this study uses a binary logit model (Equation 1). The benefit of using this method is that it can calculate the probability of having diarrhoeaassociated with independent variables. On the basis of probabilities, the socio-environmental determinants of diarrhoea can be ranked according to their importance and influence.

The Empirical Model: Though the dependent variable for the empirical model is straight forward which consists of two categories (suffered from diarrhoea=1, no diarrhoea=0), we must decide about the potential determinants of diarrhoea. Since transmission of diarrhoea is linked with access to water and sanitation infrastructure and personal hygiene, a set of independent variables is selected in the light of the theory of public health and the literature (Mihrete *et al*. 2014; Godana and Mengistie, 2013;Aremu*et al*. 2011;Woldemicael, 2001, etc.). Table 1 shows the description of the selected independent variables.

Table 1. List of Independent Variables (with description used in the empirical model)

Location
Region of residence: urban, rural
Province of residence: Punjab, Sindh, KPK, Balochistan
Demographics
Household size: hhsize1 (1-3 members), hhsize2 (4-6 members), hhsize3 (7 or above members)
No of children in HH*: child1 (one child), child2 (2 children), child3 (3 or more children)
Mother's Age: m_age1 (30 years or less), m_age2 (31-50 years), m_age3 (above 50 years)
Human Capital
Mother's education: m_edu0 (no education), m_edu1

(primary or less), m_edu2 (10 years or less), m_edu3 (graduation or less), m_edu4 (above graduation)
Water and Sanitation Infrastructure
Water source: water1 (tap water), water2 (hand/motor pump), water3 (well), water4 (river, others) Toilet facility: toilet0 (no toilet), toilet1 (flush), toilet2 (pit, others)

* HH: Household

The binary logit model is of the following form:

$$\pi_i = \Pr(Y_i = 1|X_i = x_i) = \frac{\exp(\beta_0+\beta_1 x_i)}{1+\exp(\beta_0+\beta_1 x_i)} \quad (1)$$

Where,

$Y_i = 1$ if the child *i* had diarrhoea

$Y_i = 0$ if the child *i* NOT had diarrhoea

$X = (X_1, X_2, ..., X_k)$ is a set of explanatory variables

x_i is the observed value of the explanatory variables for child *i*

The output of the logit model is interpreted as when Y=1, the coefficients estimate the effect of a unit change in the independent variable on the log odds of the dependent variable. Since it is not very illuminating to interpret the logit coefficients in terms of log odds, this study will calculate marginal effects which are easy to interpret. The marginal effects will inform the probability of a child having diarrhoea as a result of a unit change in an independent variable by keeping all other variables fixed at their mean. The explanatory variables can also be ranked (in terms of their importance) on the basis of their probability associated with the dependent variable.

RESULTS AND DISCUSSION

Table 2 shows the distribution of diarrhoea incidence under the age of five in Pakistan. Overall, 11.49% (1.81 million) children under 5 years suffer from diarrhoea in one month; around 71% of these children live in the rural areas which lack basic needs and infrastructure. Province wise breakup of the distribution of diarrhoea sufferers indicates that though proportion of children suffering from diarrhoea in each province is high, except Punjab, the diarrhoea incidence is higher in all provinces than the children's respective population proportion in those provinces. On the other hand, though the incidence of diarrhoea seems worst in rural areas as compared to urban areas, however it is quite proportional to children's population proportion in rural and urban areas. This indicates that diarrhoea incidence is distributed according to population distribution.

Table 2. Diarrhoea incidence among children under 5 years

Region	Incidence of Diarrhoea(% of total)	Total population(%)
Pakistan	11.49	-
Punjab	52.94	58.49
Sindh	24.52	22.13
KPK	14.79	13.95
Balochistan	7.73	5.43
Urban	29.05	29.58
Rural	70.95	70.42

Table 3 gives a snapshot of diarrhoea incidence viz-a-viz different socio-environmental characteristics of the households children live in. Access to clean drinking water is another serious problem in Pakistan. Around 71% children do not have piped drinking water available in their house. The situation is worst in rural areas where around 80% children are without piped water compared to 49% children in urban areas. Most of the children suffering from diarrhoea (70.98%) live in the households without piped water. However, in rural areas 80% diarrhoea cases are found in households without piped water. In fact, less than 20% children in rural areas have access to piped water. Type of toilet facility is considered an important determinant of diarrhoea. Nearly 19% children live in households without toilet facility. The situation is severe in rural areas where nearly 26% children live without toilet as compared to 2% children in urban areas. The unhygienic living conditions no doubt contribute to the poor health of children in Pakistan. Around 70% children's mother are uneducated, only 12% mother has education between 5 to 10 years of schooling. Mother's education appears to be quite rare in rural areas where 78% mothersare without education as compared to 50% in urban areas. Majority of children (57.84%) live in large households with 7 or more members.

The results of logit estimation are presented in table 4 which show the probability (dy/dx) of a child having diarrhoea associated with each independent variable. It appears that majority of the independent variables are significantly contributing to the likelihood of a child having diarrhoea.

Interestingly, from a diarrhoea point of view, there appears no difference between urban or rural location. This result is consistent with Chen*et al.*, (1992).It appears that province of residence of a child is a significant factor. If a child lives in Balochistan or KPK, they have 4.4% and 2.0%more chance of having diarrhoea respectively as compared to a child living in Punjab. On the other hand, there appears no difference between Sindh and Punjab in terms of place of residence. The explanation for incoherence of diarrhoea pattern

across provinces may be due to different socio-environmental conditions in each province.

The water source appears to be positively associated with the diarrhoeal incidence. The results show that children in household using water from unprotected sources like well and river/streams are 3.0% and 3.1% more likely to suffer from diarrhoea as compared to a child having access to piped water. Toilet facility appears to be a significant factor associated with diarrhoea. The results indicate that children having access to flush toilet have 2% less chances to catch diarrhoea as compared to children without the toilet facility.The model suggests that children of mature mothers have significantly less chances of having diarrhoea as compared to children of young mothers. This is maybe due to the fact that older mothers are more experienced in maintaining the hygiene standards in child care. In terms of demographics of the households, the model estimates that a child living in bigger household i.e. 4-6 persons and above, has lower chances of having diarrhoea as compared to a child living in a 3 peoplehousehold which suggests that as household size grows, there are less chances of a child having diarrhoea. Although this finding looks odd but table 4 indicates that incidence of diarrhoea appears more than proportional in small households as compared to larger households. However, this needs a further investigation which will need examining the profile of such households, an agenda left for further research.

Table3.Distribution of socio-environmental factors and their corresponding diarrhoeaincidence in children under the age of 5 years

	Pakistan		Urban		Rural	
	% of Total Diarrhoea Cases	% of Total Population	% of Urban Diarrhoea Cases	% of Urban Population	% of Rural Diarrhoea Cases	% of Rural Population
Water1	26.52	29.02	51.42	50.80	16.19	19.87
Water2	55.66	57.45	43.50	42.29	60.64	63.81
Water3	6.16	4.99	0.60	0.60	8.44	6.83
Water4	11.66	8.55	4.16	6.31	14.73	9.49
Toilet0	22.01	18.88	2.58	2.01	29.97	25.96
Toilet1	57.50	64.42	93.76	94.05	42.65	51.98
Toilet2	20.49	16.7	3.66	3.94	27.38	22.06
m_edu0	72.69	70.22	47.95	50.30	82.82	78.59
m_edu1	9.28	11.93	10.49	13.75	8.79	11.17
m_edu2	12.60	12.19	26.94	22.94	6.73	7.67
m_edu3	2.73	2.45	8.10	5.61	0.53	1.13
m_edu4	2.51	2.88	6.44	7.02	0.00	1.15
hhsize1	5.69	3.43	4.92	3.49	6.01	3.41
hhsize2	36.46	34.95	42.21	39.22	34.11	33.15
hhsize3	57.84	61.62	52.88	57.29	59.88	63.44

Table 4.Marginal Effects estimated from Logit Regression-Probability of diarrhoea incidence (dependent variable) due to socio-environmental factors (independent variables)

Variable	dy/dx	Std. Err.	95% Confidence Interval	
urban	0.0113	0.0081	-0.0045	0.0270
Sindh	0.0127	0.0099	-0.0068	0.0321
KPK**	0.0204	0.0114	-0.0019	0.0427
Baloch*	0.0448	0.0161	0.0133	0.0762
hhsize2*	-0.0385	0.0134	-0.0647	-0.0122
hhsize3*	-0.0463	0.0202	-0.0858	-0.0066
child2	-0.0110	0.0077	-0.0262	0.0041
child3**	-0.0166	0.0089	-0.0341	0.0010
m_age2*	-0.0163	0.0077	-0.0313	-0.0012
m_age3*	-0.0395	0.0087	-0.0566	-0.0224
m_edu1*	-0.0284	0.0096	-0.0471	-0.0096
m_edu2	-0.0016	0.0109	-0.0229	0.0197

m_edu3	-0.0069	0.0241	-0.0542	0.0403
m_edu4	-0.0031	0.0341	-0.0699	0.0636
water2	0.0106	0.0084	-0.0058	0.0269
water3**	0.0298	0.0192	0.0190	0.0850
water4*	0.0313	0.0126	0.0065	0.0559
toilet1*	-0.0205	0.0104	-0.0408	-0.0000
toilet2	-0.0042	0.0116	-0.0269	0.0186

* Significant at 5% level of significance. ** Significant at 10% level of significance. Number of obs=13103; Wald Chi^2 (19)=112.18; Prob> Chi^2=0.0000

Conclusions: The aim of this study was to investigate the socio-environmental determinants of diarrhoea in children under 5 years of age in Pakistan.For this purpose, a binary logit model was estimated. The estimates show that province of residence, household size, number of children in household, mother's education, access to clean drinking water, and availability of toilet are the important factors associated with diarrhoea in children in Pakistan.

Children with mothers having primary education seem to have less chances of diarrhoea as compared to children with mothers without education. This result is consistent with Shrestha *et al*., (2013). This might indicate that education would have increased the awareness in mothers. The study found that almost 70% children do not have access to tap piped drinking water. On the other hand, around 19% children are living in households without toilet whereas only 58% children have access to flush toilet. This situation reveals that sources of drinking water and toilet facilities are key determinants of diarrhoea in children.

It must be acknowledged that the PSLM data have some limitations. The output of the logit model should be interpreted carefully. The results do not indicate causal relationship, instead they exhibit broad indicative patterns. The results of the model can help to inform policy and develop feasible and sustainable intervention policies and plans to reduce the vulnerability against water and sanitation hazards in Pakistan.Since social, economic, and environmental conditions are constantly changing, these may affect the individual's behaviour and household conditions. In order to examine the patter of such changes, different rounds of PSLM would be needed. This is left for future research.

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