

Impact of Clean Drinking Water and Sanitation on Water Borne Diseases in Pakistan

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Abstract

Water is an essential need of human being. Every person on this planet requires at least 20 to 50 liters of safe water in a day for drinking, cooking and other purposes. According to United Nations (UN) the basic human right is to universal access to Safe water, and an essential step towards better living standards all over the world. According to government of Pakistan Economic survey (2008) In Pakistan, it revealed that nearly 50 million people are deprived of Safe drinking water. In this research it is intended to produce trends of Sanitation and safe drinking water situation in Pakistan. This study also looks deep into the relationship of water borne diseases with the background information of the respondents. Which is itself is a contribution of my work on water borne diseases. Secondary Data from Pakistan Demographic Health Survey (PDHS) and Multiple Indicator Cluster Survey (MICS) has been used. To see the individual impact of environmental, social and demographic characteristics to influence diarrhoea separate equations were executed. Presenting the pathways of communicable diseases, has developed from two model i.e. model of Exposures and health outcomes are difficult by unified factors studied by Montgomery et al., (2007) and model of transmission pathways of fecal-oral diseases studied by Prüss et al., (2002). Results of the study conclude that Post-neonatal i.e. greater than 28 days from birth deaths have a significant proportion caused due to diarrheal morbidity. There are almost 7 postnatal deaths (per thousand) that happen due to childhood morbidity of diarrhea and almost same is for the children who are under five years old. Urban zones showed high prevalence of diarrhea among children and rural areas brought high rates of childhood diarrhea. Incidences of diarrhea are more for households with not-improved toilet facility as compared to those with improved toilet facility. Incidence of childhood diarrhea emerge more for children belonging to households with pit latrine with slab. Educated mothers are hypothesized to be beneficial for less prevalence of diarrhea. In this regard, our investigation shows that, educated mothers are highly influential. In the end Policy Recommendations has been given which are rational to be incorporated in polices for Policy Makers.

Key Words: Water, Sanitation, Diarrhoea, Communicable disease and Childhood.

Introduction

Lack of Proper sanitation & Safe drinking water has been and endures to be a source of most important issue around the globe due to high rates of mortality and morbidity associated with them. Children are most vulnerable, especially children those under the five years of age. Majority of cases of mortality and morbidity are in children.

According to UNICEF report (2008) approximately 1.8 million people die annually and 4 billion cases are associated from water-related diseases which are becoming a major root of mortality and morbidity across the globe. In developing countries, 99.8% of such deaths occur out of which 90% are children under the age of five. Moreover, 88% of this 99.8% are illnesses are directly linked with insufficient supply of water, poor water sanitation and hygiene. Due to immense uses of water for many purposes, such as agricultural and industrial activities, have hugely impacted the quality and quantity of water resources, leads to increase water related diseases and its hazardous effects.

This Scenario stands worst in third world countries. The mortality and morbidity due to poor quality drinking water and sanitation are higher among these underdeveloped and developing countries. It causes both human and economic loss for these third world countries.

The water resource issues and poor quality of drinking water are the main concerns in developing countries. Montgomery and Elimelech (2007) indicated that poor sanitation and quality of drinking water has become major cause of spreading water borne diseases including dysentery, cholera, giardiasis, and hepatitis A and E etc.

As a developing country, Pakistan also deprived of improved sanitation and Safe drinking water. In Pakistan, poor hygienic habits, improved sanitation, and Safe drinking water are associated with a number of water borne diseases among the people. Like other countries, in Pakistan children are the most affected ones from such diseases and mortality resulting from them.

As according to government of Pakistan Economic survey (2008) in Pakistan nearly 50 million individuals lack availability of Safe drinking water. Only 42% people have access to sanitation services out of which 65% are in urban areas and 30% are in rural areas. In urban areas, about 30% people live in slums. In urban areas, about 30% people live in slums, with entirely insufficient sanitation and sewage dumping facilities. Majority of the people who are living near open drains or sewers particularly affected by sever health issues. Moreover, diarrheal diseases were accounted for 14% of all expiries in children under five. In Pakistan, everyday 670,000 children missed school due to diseases and lack of proper water sanitation system. Pakistan is being hit by PKR 112 billion per annum due to hygiene related illness; it includes disease caused by unsafe water and poor sanitation.

In Pakistan, lack of water and sanitation is one of the most recurrent glitches and nearly 16 million individuals do not have access to safe water. In 2016 Dawn published that about 84% to 89% water sources do not fulfill the water quality standards for human consumption.

In rural areas, accessibility of tap water is very low, for example in Punjab it is approximately 13% as compared to 43% in urban areas. 88% of water of rural areas from the samples of 21 districts in Punjab was unsafe and similarly 79% of water of rural areas from the samples of 12 districts in Punjab was also hazardous (Daily Times, 2016). It is obvious that rate of mortality is very high due to water borne disease. Correspondingly, in 2017 Daily Times published those nearly 39,000 expiries due to Diarrheal ailments among children under five in 2015 in Pakistan, out of which 22,900 expiries were caused by poor washing habits.

Now it is a major concern for policymakers in Pakistan and international organizations working on health in Pakistan. The need for effective policy making to overcome the issue has been recognized. However, before any attempts we made, there is a need to understand the major concern and therefore studies are obligatory in this area. This study is an attempt to improve our understanding of the issue and come up with solid Policy recommendations to tackle this problem of impure sanitation system and poor drinking water in the country.

Objective

“The study will address the water quality issues with respect to water borne disease (diarrhea) and the factors associated with it, at national sub nation level. Furthermore, policy intervention required to improve water quality situation in the country”

Based on above objectives of study, the main hypotheses of the study are:

1. Variation in water and sanitation systems could affect the water borne disease among children under five.

Prevalence of childhood morbidity due to waterborne disease is a function of some background characteristics including demographic, socioeconomic and environmental factors.

Literature Review

Preclusion of waterborne disease is a big worry in the world. Waterborne illness signify burden of diseases around the globe. About 4% of illnesses are associated with sanitation, water and hygiene; similarly approximately 2.2 million persons die every single year because of diarrheal illness in the world. Drinking water is a big reason of communicable and non-communicable agents in developing countries. Waterborne medical situations represent substantial burden of illnesses worldwide. According to Rana (2009) the children who are under the age of five years are more susceptible to get infected from waterborne pathogens as compared to adults.

In 2012 Imran et al. said diarrheal disease poses morbidity and mortality hazards to children. Another perspective is the economic perspective which emphasizes on consideration and clarification of relationship and household behavior among the suitable involvements and the resources. The methodological outlook highlights the requirement to deliver households with an abundant and satisfactory safe water supply and sanitation facilities. Diarrhoea occurrence low with safe water and households are alert in their individual hygiene, and boil water. In such case, interference like water quality improvement possibly will show unsuccessful in dropping diarrhoea rates because of the behavioral issues.

Pakistan's water and sanitation challenges are increasing which illustrate the problems of rapid urbanization. Mainly in rural areas, availability of safe drinking water is also of main concern for women and children as they are also have the responsibility for fetching water from distances.

In 2005, Roseman estimated death of about 0.25 million children per annum because of diarrhea & related diseases in Pakistan. Each year about ten thousand people die in just Karachi due to renal infection caused by unsafe water.

In 2005, Aziz JA discussed that because of unsafe drinking-water, people continuously suffer from waterborne diseases. Contaminated drinking water diseases caused about 40% of all deaths and about 30% of all diseases in Pakistan. Diseases like cholera, typhoid, hepatitis and dysentery are repeatedly reported throughout Pakistan. Diarrhoea is second highest in numbers amongst 15 top infectious diseases in less than 5 years of age children. This clearly indicates the faecal contamination of drinking-water in Punjab, Pakistan.

As described by Haydar et al. (2009) in Pakistan nearly 40% expiries and 30% ailments are allied to hazardous water. Due to contaminated drinking water, every fifth individual suffers

from disease. It is projected that more than three million Pakistanis suffer from waterborne illnesses and annually 0.1 million individuals don't survive. In Pakistan, an estimated 44% population doesn't have access to safe drinking water whereas facts increase to 80% in rural areas. Nearly 1.1 billion populations are deficient to access basic drinking water and sanitation. On the other side, it is indicated that there is still 2.4 billion people who are lack of safe drinking water and improved sanitation system across the globe.

As viewed by Muhammad *et al.* (2012), diseases particularly diarrhoea is one of the leading cause of disease associated with drinking contaminated water is responsible for 2.5 million childhood deaths every year.

According to Khalil *et al* (2016) Pakistan is blessed with surface and ground resources, but with the passage of time water remains an acute resource for sustained safety of the people. Diarrhea is well-recognized water born disease caused by rotavirus among children. Water borne diseases can have a significant impact on the economy which results in increased number of deaths. Moreover, 60% of the deaths are due to diarrhoea caused by pathogens, impure drinking water or food.

In 2007 Fahim Jahangir Khan and Yaser Javed wrote about the Provision of safe drinking water & adequate sanitation in the Pakistan. The Provision of safe drinking water, adequate sanitation and personal hygiene are important to control trachoma, malaria, diarrhoea, hepatitis A & hepatitis B, morbidity, morbidity levels and the sustainable environmental condition. As reported by MICS Balochistan in 2004, about 38.5 million people of Pakistan don't have safe drinking water and 50.7 million are lacking with proper sanitation in the country. The finding of the research indicates that in Pakistan the regional and/or national targets, there are direct relationship exists between the health, nutrition, water sanitation, human well-being and natural environment. Worldwide due to water related illness every day about 14000 to 30000 individual frequently children die (IHRO, 2007) it is reported that approximately there is more than 5 million Water borne disease related mortalities per year. About 3.7% of the health problems and 3.1% of the deaths annually across the globe which is associated with unsafe drinking water, sanitation and hygiene related concerns.

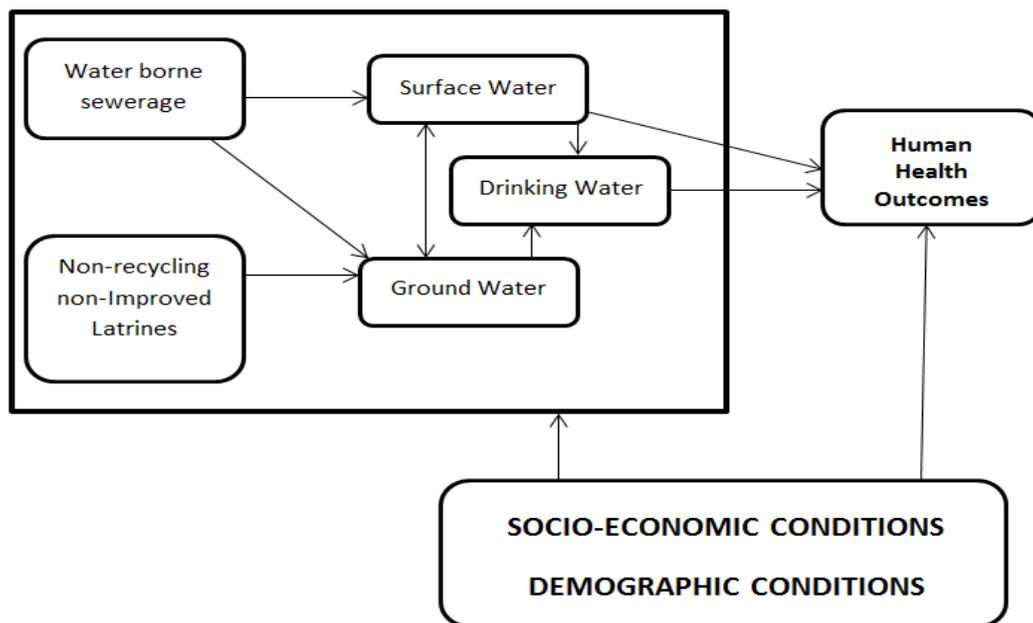
As viewed by Kemp *et al.* (2010) different progressive actions including mining, pose numerous risks to human rights for the availability of safe drinking water. Majority of universal frameworks, availability of safe drinking water is the basic human right. On the

other hand, safe water requirements can be assured through international and anti-privatization movements for access to safe drinking water.

Methodology

This study revolves around the impacts of environmental, demographic, social and economic factors on human health outcomes. Following figure, presenting the pathways of communicable diseases, has developed from two model i.e. *model of Exposures and health outcomes are complicated by interrelated factors called MEME* studied by Montgomery *et al.*, (2007) and *model of transmission pathways of fecal-oral diseases* studied by Prüss *et al.*, (2002) as discussed in literature above

Figure: 1. Model of Pathways of communicable diseases stimulated by background population characteristics and household environmental factors



Population characteristics motivate the conditions that cause diarrhoea which is considered as an outcome from poor water and sanitation conditions. Water borne sewerage and non-improves latrines (non-recycling or unpaved lines etc.) caused by human disposal of wastes majorly excreta put their impression directly to the sources of surface and ground water. However, sources of surface and ground water impress each other with their direct effects on sources of drinking water, respectively. Surface water on contamination cause communicable

diseases directly or indirectly but ground water which is interlinked with surface water indirectly brings communicable diseases by contaminating the drinking water.

Research Type & Approach

The entire research work is exploratory and is defined as the initial research into a hypothetical or theoretical idea. In exploratory research, researcher has an idea or has observed something to understand more about it. The nature of this exploratory research is to determine futuristic approach about feasibility of initial ground work. The inductive approach which is often called **bottom up** approach is used to precede this study.

This study makes use of quantitative statistical tools to evaluate objectives and test the potential hypothesis of the study. It makes use of micro data of nationally representative household surveys. To bring out the micro level evidence for mainstreaming the sub national level health policies, this study make use of national, provincial and sub provincial level data.

According to Pakistan Demographic and Health Survey (2012-13) piloted by National Institute of Population Studies (NIPS) provide comprehensive details on child health. This survey is based on two stage provincial sample design covering country districts including Islamabad, Punjab, Sindh, Balochistan, Gilgit-Baltistan and KPK. Micro Data of PDHS have selected to evaluate to impact of environmental, socioeconomic, demographic and background factors on incidence of diarrhea.

Multiple indicators Cluster Survey (MICS 2014) is well recognized micro data for analyzing the child health outcomes. It is a tool to provide the district level development indicators instrumented by UNICEF globally over last few decades. District Level Multiple Indicators Cluster Survey (MICS), published in 2014 from Punjab and Sindh Bureau of Statistics, will provide information of diarrhea prevalence in two weeks earlier the study. Both if MICS surveys provide the district level provincial estimates from Punjab and Sindh regions. Following is the samples size for MICS (2014).

Table 1. Sample Size of Multiple Indicators Cluster Survey

| Region | Sample Households | Children (0-59 months) |
|---------------|--------------------------|-------------------------------|
| Punjab | 41413 (97.6% response) | 4784 ¹ |
| Sindh | 19360 (94.4% response) | 4720 ² |

¹ MICS (2014) Punjab Report, Page 58, Table CH.5: Care-seeking during diarrhea

² MICS (2014) Sindh Report, Page 51, Table CH.5: Care-seeking during diarrhea

Limitations of Data

PDHS is based on provincial sample design. Hence it provides National and Province level estimates. MICS are limited to District level estimates for only Punjab and Sindh Districts. Last PDHS round (3) was undertaken during 2012-13 and MICS were conducted in 2014. For district level rates of diarrhea, PDHS could not comply hence MICS was selected on the bases of similarity of definition of our dependent variable and closeness of years of surveys. Schedule of data collection is totally different for both MICS and PDHS. Definitions and data dictionaries used in PDHS and MICS are similar for selected variables.

Respondents

All children ages 0-59 months are our target population. Information of diarrhea prevalence is collected from “Child Health” section of “Individual Ever Married Questionnaire”. This section provides comprehensive information of incidences diarrhea and its treatment.

Variables of Study

Childhood diarrhoea has taken as output indicators of household poor environmental conditions. Environmental conditions i.e., source of washing facility and safe drinking water affects the children health (under five years). Common viral disease spread rapidly if these conditions are not satisfactory hence hygienic. Socioeconomic status gives population subgroups that are vulnerable. Demographic characteristics gives insight into influence of population based characteristics that influence the diarrhea and household level background characteristics provide a snap shot of inherited factors that do not affect diarrhoea directly but are influencing it.

Dependent Variable

It takes the value ‘1’ if events of morbidity (diarrhea in last 14 days), due to water borne disease, are observed and ‘0’ if no such evidence is found among children under the age of five years old.

Independent Variables

There are four major groups of independent variables i.e. (toilet and drinking water facility), socioeconomic (education and working status), demographic (age of child and mother,

gender of child and size of child at birth) and background characteristics (ethnicity, household wealth status and region of residence of children).

Table 2. Domains and Variables

| Domains | Variables | Reference |
|----------------|---|---|
| Demographic | Age of Child; Age of Mother; Gender of Child | Anteneh et al 2017; Murtaza et al 2015; Imran <i>et al</i> (--); Arif and Naheed 2012; Mengistie et al 2013 |
| Socio Economic | Education of Parents; Economic Working status of mother; Wealth of Mother | Ibid |
| Background | Area of Residence; Region of Residence; Ethnicity | Ibid |
| Environmental | Water Supply; Sanitation Facility | Ibid; Fayehun, 2010; MICS 2014 Main Report |

Each component of these groups of indicators is explained below:-

Toilet Facility: It depicts the condition of sanitation at household.

Source of Drinking Water: It shows the different ways from which households are using water for drinking purpose.

Current age of child (months): Immunity of child improves as age increases.

Gender of Child: This variable is considered to show whether there is any difference in rates of diarrhea among male and female children.

Size of Child at Birth and Birth Weight: Children who are naturally healthy are least likely to get diarrhea.

Mother's Age: As soon as age of mother increases the diarrhea decreases due to increasing experience of motherhood.

Age difference B/W parents: This variable provides the communication gap among mother and father. More age difference of mothers from fathers is considered as more communication gap.

No. of Household Members: Children from larger households may sometimes get neglected. Parents and elders give more time to children in small households.

Parent's Education attainment level: Educated parents are considered more beneficial for healthcare of their children.

Mother's Working Status: Working mothers are considered to give less time as compared to those who do not work. Non-working mothers are considered as good caretaker of children.

Maternal Language: this indicator is taken to cater the traditional setups and cultural norms in society.

Wealth Possession: It gives possession of household assets that give life comfort. Households with poor cooking fuel, non-pakka household structure and other household assets are more likely to get chances of diarrhea among children as compared to those having pakka house structure, better energy sources and other household assets.

Place of Residence: Least develop area bring more disease rates as there are less nearby health facilities as compared to develop areas.

Regions: This variable gives regional variation in disease rates.

Table 3. Variable construction and Types

| Variable | Levels (categories) | Variable Types |
|------------------------------------|---------------------|---|
| Diarrhea Prevalence (dependent) | Yes | Dummy |
| | No | |
| Toilet Facility | Improved | Binary Dummy |
| | Unimproved | |
| Source of Drinking Water | Improved | -do- |
| | Unimproved | |
| Current age of child (months) | 0-5 | Categorical from continuous information of age reported in months |
| | 6-11 | |
| | 12-17 | |
| | 18-59 | |
| Gender of Child | Male | Nominal Binary |
| | Female | |
| Size of Child at Birth | Larger | Ordinal Categorical |
| | Average | |
| | Small | |
| Birth Weight | Below 2500 gm | Binary from continuous information of weight of child reported in grams |
| | ≤2500 gm and above | |
| Mother's Age | 15-19 | Categorical from continuous information of age reported in completed years |
| | 20-24 | |
| | 25-29 | |
| | 30-34 | |
| | 35-39 | |
| | 40-44 | |
| | 45-49 | |
| Age difference B/W parents | Less than 10 years | Binary from continuous information calculated from difference of mother's age to father's age |
| | 10 and above years | |
| No. of Household Members | Less than 5 | Binary form from discrete response on numbers of members living in household |
| | 5 and above | |
| Mothers Education attainment level | Uneducated | Ordinal categories developed from continuous completed years of |
| | Primary | |

| | | |
|-------------------------------------|--------------------|---|
| | Secondary | education attained |
| | Higher | |
| Father's Education attainment level | Uneducated | |
| | Primary | |
| | Secondary | |
| | Higher | |
| Mother's Working Status | Not working | Binary form |
| | Working | |
| Maternal Language | Urdu | Nominal categories |
| | Siraiki | |
| | Punjabi | |
| | Sindhi | |
| | Balochi | |
| | Pushto | |
| | Others | |
| Wealth Possession | Poor | Ordinal categories' from continuous scale |
| | Middle | |
| | Rich | |
| Place of Residence | Urban | Nominal Categories |
| | Rural | |
| Regions | Punjab | Nominal Categories |
| | Sindh | |
| | Khyber Pakhtunkhwa | |
| | Balochistan | |
| | Islamabad | |
| | Gilgit-Baltistan | |

Statistical Analysis

Descriptive statistics and regression analysis are performed on data to meet the objective of the study. Following is the brief of tools used in analysis.

Descriptive Statistics

Trends have been observed by line graphs of percentage of household with water and sanitation facilities and incidence of diarrhea in 1991, 2007 and upto 2013. These data are extracted from three rounds of PDHS (1990-91; 2006-07 and 2012-13).

Cross Tabulation

Incidence rate of diarrhea by sources of drinking water and sanitation facilities are calculated to highlight the vulnerable sources. These rates are also found for different population strata at national and sub national level. Besides these association background factors of water and sanitation facilities, demographic and socioeconomic factors is measured through chi-square test of independent association. The association is tested at 1%, 5% and 10% level of

significance for measuring the strength of association. Potential hypothesis built for this testing are provided in following table:-

Subnational level estimates of diarrhea are estimated through bivariate percentage distributions.

Regression Analysis

Multivariate Binary Logistic Regression Model (Anteneh, et al. 2017; Hosmer, *et al.* 2013) will highlight the impact of demographic, socioeconomic, background and environmental factors on prevalence of water-borne disease. This model assumes the response/dependent variable is a dummy variable in binary form. Mathematical form of the model is as under:

$$\text{logit}(P_{disease}) = \log\left(\frac{P_{disease}}{1 - P_{disease}}\right) = \beta_0 + \beta_1 X_1 + \dots + \beta_j \beta_j$$

Where;

$P_{disease}$ = is the probability that children (under five) have incidence of morbidity due to water borne diseases.

β_0 = Intercept (i.e. chances of provenance of disease)

$\beta_1, \beta_2, \dots, \beta_j$; are the effects of demographic, socioeconomic, background and environmental factors.

X_1, X_2, \dots, X_j ; are demographic, socioeconomic, background and environmental factors with levels.

To see the individual impact of set of environmental factors i.e. sources of drinking water and sanitation facility, a separate equation was executed (Equation – 1). After words, their impact is observed along with social characteristic of mother i.e. education (Equation – 2). Demographic Characteristics intervened after social factor to influence the prevalence of diarrhea (Equation – 3) and in final model background factors i.e. wealth status joined in the set of environmental, social and demographic characteristics to influence diarrhea (Equation – 4). It constitutes four sets of equations.

Estimates of logistic regression are interpreted in their transformed form of odds ratio. Positive odds are greater than 1.00 interpreted as more chances or more odds of an event to occur as compared to reference category and negative goes toward 0.00 interpreted as less chances of event of interest as compared to reference category. Odd of 1.00 are interpreted as equal chances of occurrence of an event as that of reference category. Term reference category is adopted to have benchmark based on literature or natural trends and patterns. A significant odd presents the most influential factor contributing positively or negatively to prevalence of diarrhea.

Result & Analysis

Current situation of health outcomes

Post-neonatal (greater than 28 days from birth) deaths have a prominent proportion caused by diarrheal morbidity. There are almost 7 postnatal deaths (per thousand) that happen due to childhood morbidity of diarrhea and almost same is for the children under five years of age.

Table 6. Summary of childhood diarrhea in Pakistan

| Health Outcomes | Values |
|--|--------|
| Total number of Neonatal deaths due to diarrhea | 2,909 |
| Total number of Post-Neonatal deaths due to diarrhea | 36,575 |
| Number of Under-five deaths due to diarrhea | 39,484 |
| Neonatal death rate from diarrhea (per 1000 livebirths) | 1 |
| Post neonatal death rate from diarrhea (per 1000 livebirths) | 7 |
| Under-five death rate from diarrhea (per 1000 livebirths) | 7 |
| % post-neonatal deaths due to diarrhea | 20% |
| % under-five deaths due to diarrhea | 9% |

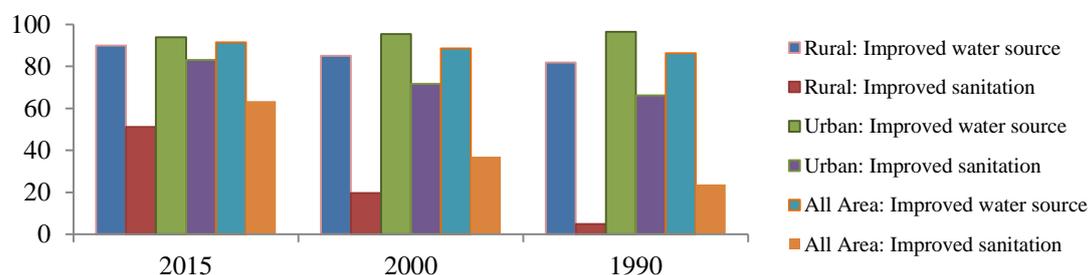
Source: WHO and Maternal and Child Epidemiology Estimation Group (MCEE) estimates 2015³

4.1. Trends

Nationally use of improved source of drinking water slightly inclined up (1990 to 2015). A significant improvement in use of improved sanitation is seen since 1990 to 2015.

An opposite trend is observed among urban and rural area with regard to availability of improved water sources at households. Urban area could not increase the use of improved water for drinking whereas rural area shows improvement in its use. Use of improved sanitation facility has increased over time in both areas (urban and Rural).

Figure 2. Trend in use of improved water and sanitation at household from 1990 to 2015.



Source: World Health Organization, 2015⁴

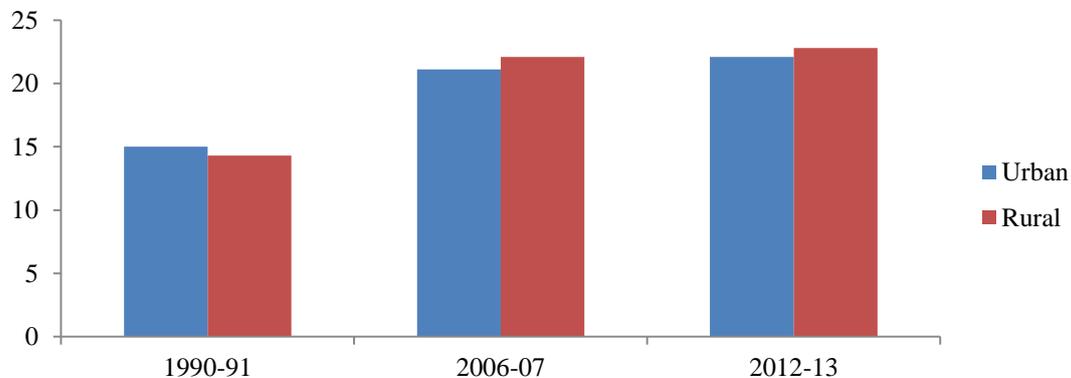
Diarrhea Morbidity

³ Go to link <<http://apps.who.int/gho/data/node.main.ChildMort?lang=en>>

⁴ World Health Organization, Global Health Observatory, <<http://apps.who.int/gho/data/node.main.46?lang=en>>

Rates of childhood diarrhea have increased over time. Rural areas show high rates as compared to urban areas.

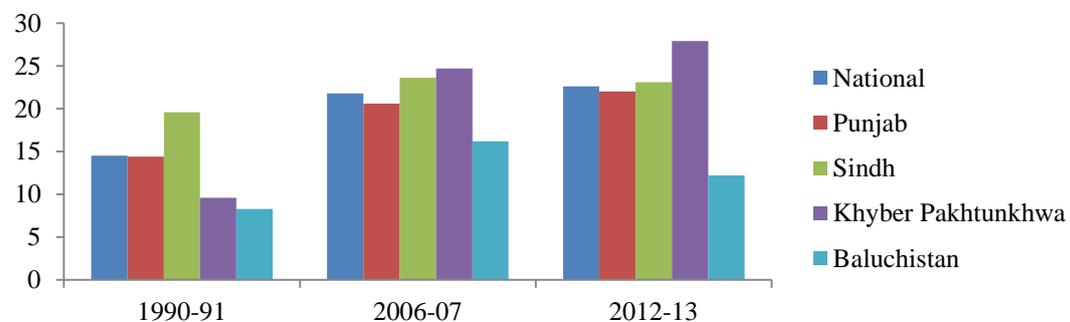
Figure 3. Trends in Rates of diarrhea among children (0-59 months) by area of residence.



Source: Pakistan Demographic and Health Surveys⁵.

Nationally rates of diarrhea have increased to almost 22% since 1991 to 2013. Khyber Pakhtunkhwa emerged as prominent in increasing rates of diarrhea over time (1991 to 2013) and Balochistan comes with improving rates especially after 2006-07 to 2012-13.

Figure 4. Trends in Rates of diarrhea among children (0-59 months) by region of residence



Source: Pakistan Demographic and Health Surveys⁶.

Variation in rates of childhood diarrhea by environmental factors

Incidences of diarrhea are more for households with not-improved toilet facility as compared to those with improved toilet facility. Incidence of childhood diarrhea emerge more for children belonging to households with pit latrine with slab.

Punjab brings high diarrhea rates from pit latrine with slab and the same is for Khyber Pakhtunkhwa region; Islamabad Capital (ICT) and Gilgit-Baltistan (GB) territories. Sindh showing poor rates from latrine with flush to septic tank.

⁵ See Chapter “Child Health” PDHS 1990-91; 2006-07 & 2012-13.

⁶ See Chapter “Child Health” PDHS 1990-91; 2006-07 & 2012-13.

Hanging toilets and pit latrines without slabs emerge as prominent sources of diarrhea in country. Hanging toilets bring poorest situation at Sindh with almost 100% incidence rate.

Same as type of toilet facility, the sources of drinking water shows that there are more incidences of diarrhea for household with not-improved source of water facilities.

Among Improved sources of drinking water facilities, the tap water/sand pipes bringing more diarrhea and it bring more diarrhea rates at Punjab region. Piped to yards supporting diarrhea more at Sindh, Rainwater spread diarrhea more prevalent at Khyber Pakhtunkhwa, most vulnerable at hand pumps at Balochistan regions and ICT/GB territories.

Unprotected springs emerge as most vulnerable for children under five in Pakistan. Unprotected wells come with high diarrhea at Punjab. Unprotected springs are prominent source of diarrhea at Khyber Pakhtunkhwa region and ICT/GB territories.

National Level Incidence Rates of Childhood Diarrhea

Age and Size at Birth of children; age of mother, age difference among parents, Household size and educational attainment of parents, working status within last 12 months and wealth status of mothers and regions from where children belong are found statistically significant subgroups of population surrounding children with diarrhea.

Following table presents that incidence of diarrhea is more children with less than 2-years age. Children born small and having low birth weight are vulnerable and pray to diarrhea disease. As soon as age of mother increases the prevalence of diarrhea decreases and higher age difference among parents showing more rates of diarrhea among children under five. Children belonging to Small households, highly educated parents and mothers who do not work have least chances of diarrhea diseases.

Children from mothers with Sindhi, Siraiki and Pashto ethnicity, living in rural areas, belonging to mothers with worse wealth status and children living at Khyber Pakhtunkhwa region are more likely to get diarrhea disease.

Sub National level Incidence Rates of Childhood Diarrhea

Except Islamabad Capital/Gilgit Baltistan territories, the rates of diarrhea are more for children from households with non-improved water and sanitation facilities. Khyber Pakhtunkhwa brings 31% diarrhea rates among children with non-improved sanitation facility where as in Balochistan the situation is better.

Children aged 12-17 months prevailing diarrheas highest especially at Sindh. Gender gap is visible at Khyber Pakhtunkhwa and Balochistan regions. Almost 33% Children born with small size are having diarrhea at Sindh.

Urdu speaking population from Punjab and ICT/GB, Sindhi speaking people from Sindh and Balochi speaking people in Khyber Pakhtunkhwa and Balochistan suffer from high prevalence of diarrhea among their children. Least prevalence of diarrhea (8%) is observable at Khyber Pakhtunkhwa, among children from highly educated mothers and almost highest rates are visible from working mothers from same region. Poor children showing high diarrhea at Punjab, Sindh and Khyber Pakhtunkhwa where as these high rates shifted to children from middle class from Balochistan and ICT/GB regions.

District level Incidence Rates of Childhood Diarrhea

Punjab

District level estimates highlights that, Sheikhpura district brings highest level of diarrhea among children from households with improved sanitation (22%) and this situation is worst for households with not improve sanitation facility (29%) at Sheikhpura. From improved drinking water facility after Hafizabad district (24% diarrhea cases), Sheikhpura is most vulnerable (23% diarrhea cases). However, for children from households with non-improved drinking water, the cases of diarrhea found highest for Rajanpur (54%), Lahore (50%) and Okara (50%) districts.

For children belonging to mothers educated higher than secondary level, the cases of diarrhea are found least at Layyah (less than 1%) then Lodhran and Chakwal with 4% respectively. Highest rates of diarrhea are found at Hafizabad (26%) for children from uneducated mothers. We have seen that as soon as age of child moves up after 23 months, the rate of diarrhea decreases. Sahiwal district appears most vulnerable (35%) for children with less than 6 months age. Gujranwala appears most vulnerable for children (6-11 months) regarding 41% prevalence of childhood diarrhea. At age of 48 to 59 months, highest rates of diarrhea are evident at Rajanpur (15%) whereas Jhang comes with least prevalence of diarrhea (2%) for same age groups. Chiniot is district where almost 33% diarrhea persists among children born small. After Chiniot, Sheikhpura is found with 28% diarrhea prevalence and then Lahore comes with 26% rate of diarrhea among small size children. Chiniot is district with least prevalence of diarrhea for children born with large size (4%) and Chakwal comes after Chiniot district where there are only 8% of large size children having diarrhea. Cases of

diarrhea are highest at Bahawalnagar (43%) for children from mothers having age 45-49 years. In younger ages of mother, Gujranwala (44%) is district that shows highest rates of diarrhea. Wealth inequality shows a higher prevalence of childhood diarrhea at Lahore (29%) then Multan (26%) and Rawalpindi (25%) in poorest households whereas, least are recorded from Vehari (5%) for richest children. Urban areas showing high prevalence of diarrhea among children from Gujranwala (26%) and least is evident at Rahimyar Khan (7%). Rural areas bringing high rates of childhood diarrhea at Rajanpur (24%) and least is at Chakwal (7%).

Sindh

Districts of Tando Allahyar and Badin are showing large proportion (41% respectively) of diarrhea among children from households with improved drinking water source. For non-improved water sources, prevalence of diarrhea raised to 50% especially at Sukkur and Karachi South districts, respectively.

Badin shows high diarrhea (43%) among children from households with improved toilet facility where the situation is worst at Karachi East (50%) and Karachi Central (almost 100%).

Poorest situation can be seen at Ghotki where almost 56% children, from middle educated mothers, have diarrhea followed by Kashmore district with 50% for same children. Children from mothers educated higher than secondary level have highest rates of 50% diarrhea prevalence at Matiari and Thatta with 40%.

It is observed that diarrhea is least for children aged 24 to 59 months and highest for children under 24-months age. Tando Allahyar is district where high rates of diarrhea (71%) emerge for children (6-11 months). At age of 48 to 59 months that better situation can be seen at Shikarpur (4%).

Prevalence of diarrhea is almost 71% for small children at Umer Kot and 50% Thatta district of Sindh. For average children the prevalence of diarrhea is recorded as 44% at Hyderabad and 43% at Tando Allahyar districts. Karachi South has almost 52% prevalence of diarrhea among children.

It is evident that 89% of children from younger mothers (15-19 years) caught by diarrhea at Hyderabad followed by 75% at Karachi South. As soon as age of mother increases the chances of diarrhea among their children also increases. Urban Areas of Nausheroferoz

providing almost 41% prevalence of diarrhea followed by 39% at Hyderabad. In rural areas, Tando Allahyar with 44% followed by Badin and Mirpur Khas with 40%. These are most vulnerable districts.

The districts of Tando Allahyar (46% diarrhea), Badin (40% diarrhea) and Umer Kot (38% diarrhea) brings high rates among poor children. Middle class are facing 41% at Hyderabad and 40% at Karachi East. Children from rich households are showing lowest rates in Larakana (6%) and Jacobabad (8%).

Determinants of Diarrhoea: Multivariate Analysis Results

Following table provides the impact of environmental (toilet and drinking water facility), socioeconomic (education and working status), demographic (age of child and mother, gender of child and size of child at birth) and background characteristics (ethnicity, household wealth status and region of residence of children) on prevalence rate of diarrhea among children under five.

Interestingly, not-Improved drinking water sources emerge as significant with less chances of diarrhea as compared to improved one. More chances of diarrhea emerge in full model where socioeconomic, demographic and background characteristics are contributing.

As soon as education of mother improves the chances of diarrhea depreciates. Expectedly, children from working mothers are almost 1.2 times more likely to get diarrhea as compared to those from non-working mothers.

Female children, children having at-least 18 months age are least likely to have diarrhea as compared to male children and those with age least than six months, respectively. Children born small have high odds of diarrheas as compared to large size children. Children belonging to mothers with Punjabi and Siraiki ethnicity are less likely to have diarrhea as compared to children belonging to urdu ethnic mothers. Children who are rich are less likely to get diarrhea as compared to poor children and those belonging to Sindh and Gilgit-Baltistan regions have least chance of childhood diarrhea as compared to children from Punjab region.

Conclusion

This study shows insightful results on the effects of availability of Safe drinking water and proper sanitation facilities on child morbidity and mortality rates across the four provinces. It also throws light on the effects of the mother's age, education, ethnicity and working status on the health and well-being of the child.

Moreover, our study highlights the incidence of childhood morbidity due to diarrhea among children from households using different type of toilet and drinking water facility. The study looks inside the correlates of diarrhea not only at National Level but also Provincial and District Level. Provincially, Sindh and Khyber Pakhtunkhwa regions found with highest rates of diarrhea. In Sindh Tando Allahyar, Matiati, Hyderabad, Badin, Karachi East and Karachi South are found most vulnerable areas where prevalence of diarrhea found non-ignorable and it is surrounded by poor households, children with mothers married in early ages, children having small size at birth and ages less than 24 months and children belonging to uneducated mothers.

Although Punjab comes with lower rates of diarrhea morbidity but in some districts like Rajanpur, Rahimyar Khan, Lahore, Gujranwala and Rawalpindi where situation is not proper due to poverty, early age marriages, small size of babies at birth etc.

It has been observed that the prevalence of most common water born disease i.e. childhood diarrhoea, in the presence of improved and non-improved sources of drinking water and type of toilet facility. These two variables are often considered as common environmental household level indicators. It was hypothesized that use of improved sources of drinking water and sanitation may support the decrease in rates of childhood diarrhoea. Regression analysis provide evidence in support of our hypothesis that, disease rate does not improve if unimproved water and sanitation prevails. Especially source of drinking water put significant impact on diarrhoea rates.

Education and working status of mother were considered to depict the socio economic factors influencing childhood diarrhea. Educated mothers are hypothesized to be beneficial for less prevalence of diarrhea. In this regard, our investigation shows that, educated mothers are highly influential. Working status of mothers shows some kind of empowerment and autonomy of women. Economically active women may contribute to support the household economic status hence contributing to child health care. In Pakistani society mother are usually less likely to work and husbands are considered as major working person to regulate

the household prosperity. Mothers who do not work are more likely to spend time better with their children as compared to working ones. Our data shows significant impact of working status on childhood diarrhea and provide evidence according to our assumptions and hypothesis.

On assumption of decrease in rates of diarrhea due to improvement in child health immunity with growing ages, a hypothesis was developed to test it and we found that current age of child is highly influential to monitor the rates of diarrhea. Size of child at birth and weight of child at birth were included to see health status of baby at the time of birth. Children with smaller body sizes are assumed to be less immune, and as body size increase it was considered that body's immunity against diseases linearly increases and child may fight better if they have better health status at the beginning of life. From analysis of data it was concluded that rates of diarrhea are lower for children who are born with bigger body size. Besides the demographics of child, the age of mother was considered in system of equation (model 3 and 4) with hypothesis that, as soon as age of mother increases, experience of caretaking for her child improves and child may less likely to suffer from morbidity. This demographic factor highlighted as highly influential for prevalence of diarrhea. As soon as age of mother increases the chance of childhood diarrhea decreases.

Ethnicity of the children was taken as a cultural factor showing cultural differences in childhood diarrheal morbidity. Sindhi are highlighted with high chances of childhood diarrhea as compared to Urdu ethnic children.

Wealth status was considered to depict the household prosperity with better possession of assets. Children from households with better wealth status are hypothesized to less likely to catch by diarrhea disease. Against the null hypothesis of increasing chances of diarrhea for poor children, we found that diarrhea is less likely for wealthy children. Regions were included with hypothesis that diarrhea is prevailing variably among regions.

The study looks inside the correlates of diarrhea not only at National Level but also Provincial and District Level. We conclude our study as, provincially, Sindh and Khyber Pakhtunkhwa regions found with highest rates of diarrhea. In Sindh Tando Allahyar, Matiati, Hyderabad, Badin, Karachi East and Karachi South are found most vulnerable districts f Sindh where prevalence of diarrhoea found non-ignorable and it is surrounded by poor

households, children with mothers married in early ages, children having small size at birth and ages less than 24 months and children belonging to uneducated mothers.

Although Punjab comes with lower rates of diarrhoea morbidity but in some districts like Rajanpur, Rahimyar Khan, Lahore, Gujranwala and Rawalpindi where situation is not up to the standard due to poverty, early age marriages, small size of babies at birth etc.

Policy Recommendations

If we are committed to improve water and sanitation, we need a coherent policy framework and investment in the Water and Sanitation sector to improve our people's health and life. National Water and Wastewater Policies documents provide a comprehensive framework of measures. Nevertheless, these policies should be followed every five years, including mid-term evaluations and independent evaluations. Water supply and management agencies should be responsible for maintaining the water quality in the water distribution system to the consumer level, which provides cooling amplifier at various pumping stations. The role of development partners and the private sector for development in the Water and Sanitation sector is very important. The government should encourage the private sector to provide Water and Sanitation services, as is the case with other social sectors, such as health and education. The Water and Sanitation service is the legal responsibility of the provinces and local authorities, so policymakers and local government officials should understand the deterioration situation and support the increase in the share of Water and Sanitation's expenditure on gross national product.

Water and Sanitation costs, as given in the PRSP, provide collective costs that do not show the proportion of water and sanitation separately. Therefore, it is not feasible to assess the impact of costs on water and sanitation separately without defaults. But in the local government system, 25 percent of the total provincial development budget is compelled to pay by the Citizens' Society Citizen Community Boards (CCBs). Creating awareness of the results of CCBs can lead to changes in the living conditions of the poor. Communities should be encouraged to spend on their interest in the Qarz al-Hasan funds. For effective awareness, educational institutions, mosques, including mass media, should be used to understand the importance of quality and quantity of water among users. Volt and the private sector support small and small schemes for income generation opportunities only. They also need to invest

in small and medium-sized loans to communities and / or households in their infrastructure. These experiments were successful in Bangladesh and India. This will ultimately improve the health and living standards.

The government should support Water and Sanitation plans at an efficient and low cost. In addition, the provision of household subsidies to households, taking into account drinking water treatment at the consumer / household level, should cost rather than costly in complex and costly designs. Waste water should be minimized and eliminate 30 to 50% of all drinking water. Awareness must be necessary in order to minimize deceptive and unsustainable activities, such as the use of stony water for washing cars or irrigation of lawns and gardens. Each of us must understand that less water usage means less wastewater production.

Water supply agencies should install meters to charge consumers based on "pay as you use." In such interventions, departments like WASA and CDA can play a major role.

There is also a need to increase the percentage of Budget to GDP for the improvement of Water and Sanitation in the country.

If immediate action is not taken to address these issues, the amount and quality of the remaining water will have a negative impact on health, education and economic sectors. The Environmental Protection Agency (EPA) must ensure, before discharging it to the mainstreams, and to improve the drainage network, ensuring higher sanitary coverage, ensuring household waste disposal, commercial and industrial units.

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