Determinants of Health Cost of Contaminated Ground Water with Arsenic: A Case Study of District Tando Allahyar

By

Abdul Sattar

PIDE2018FMPHILENV02

Supervisor

Dr. Abedullah

PIDE School of Economics

Pakistan Institute of Development Economics, Islamabad

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Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"Determinants of Health Cost of Contaminated Ground Water with Arsenic: A Case Study of District Tando Allahyar"** submitted by **Mr. Abdul Sattar** is accepted in its present form by the PIDE School of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Philosophy in Environmental Economics**.

External Examiner:

Dr. Rehana Siddiqui
Ex-Professor
PIDE
Islamabad.

Supervisor:

Dr. Abedullah
Chief of Research
PIDE, Islamabad

Head, PIDE School of Economics:

Dr. Shujaat Farooq
Assistant Professor/Head
PIDE School of Economics
PIDE, Islamabad

Author's declaration

I Abdul Sattar hereby state that my M.Phil. Thesis titled: Determinants of Health Cost of Contaminated Ground Water with Arsenic: A Case Study of District Tando Allahyar is my own work and has not been submitted previously by me for taking any degree from Pakistan Institute of Development Economics or anywhere else in the country/world.

At any time if my statement is found to be incorrect even after my Graduation the university has the right to withdraw my M.Phil. Degree.

Date: / /2022

Abdul Sattar

Dedication

I dedicate this thesis to my beloved Parents, Siblings and friends for their continued support and encouragement towards my studies

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First of all a special gratitude and special appreciation goes to Allah the almighty; without His blessings I would not be able to think of completing this work. After that, I offer my admirations and respect from the core of my heart to the Holy Prophet Muhammad (Peace be upon him) who urges his followers to “Seek knowledge from cradle to grave”. I would also like to pay my humble thank to my beloved parents, who prayed for me a lot and always encouraged me and guide me in a proper way and advise me not to lose heart.

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Abdul Sattar Laghari

Abstract

The current study evaluates the determinants of health cost due to drinking arsenic contaminated groundwater based on primary data collected from the village of Tando Allahyar. The study applies the ordinary Least Square (OLS) procedure to a primary survey of 150 households. It had 784 family members in which 385 and 389 were male and female. The minimum and maximum age of the respondents were 19 and 70 years in the sample survey. Average education of the respondents in our sample was 7 years of schooling while 32% were uneducated and 17% respondents have done graduation. Questions were asked about awareness of contaminated water with arsenic, water quality and availability of safe sources of water through questionnaires. To check the quality of water (arsenic concentration) samples were carefully analyzed from drip (Drainage and Reclamation Institute of Pakistan) Tando Jam. Laboratory report revealed that groundwater is unfit for drinking because of the high amount of arsenic in the groundwater used by Households. Around 90 percent of groundwater samples were polluted with various levels of arsenic concentration above WHO (10 ug/l or PPB) and country's (50ug/l or PPB) safe limit. Our results revealed that most of the residents are unaware about arsenic poisoning and its adverse health impacts. Due to consistent and long year's use of highly polluted groundwater with arsenic, residents are facing different kinds of health problems. About 54% respondents reported Skin diseases, 37% exposed to gastrointestinal problems and 16% are facing liver failure (Hepatitis) disease. Kidney, Lung failure, and chest diseases (Asthma and Tuberculosis) are also present in the study area. In addition to this, people also lost their lives due to high arsenic concentration in drinking water. Majority of these people were only earning hands of their families. Many households did not take any treatment because of financial constraint. This also leads to deteriorate the health among community members. OLS results show that number of visits to the doctor, water quality and interaction term of water source and arsenic concentration have significant positive relation with total health cost. Which ultimately uncovered that drinking groundwater from long years polluted with arsenic increases the direct and indirect health cost of the respondents in the study area.

Key Words: *Health cost, Arsenic, Drinking Water, Social Awareness, Policy Recommendation*

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LIST OF ABBREVIATIONS

PNDWQS	**Pakistan National Drinking Water Quality Standard**
DRIP	**Drainage and Reclamation Institute of Pakistan**
PIDE	**Pakistan Institute of Development Economics**
NGOs	**Non-Governmental Organization**
WHO	**World Health Organization**
OLS	**Ordinary Least Squares**
AS_CON	**Arsenic Concentration**
TDS	**Total Dissolved Solid**

CHAPTER 1

INTRODUCTION

1.1: Arsenic Sources and World Scenario

Water is a basic necessity of life and if this necessity becomes polluted then it can cause several hazards. There are certain minerals present in the water and some of them are very important for human body and health. Each of these minerals have specific concentration in water. If this concentration increases beyond the limits, this may lead to health problems. Arsenic is one of the mineral which is naturally present in earth's crust in the form of inorganic compounds (Ghulam murtaza Arain, 2006) further its presence intensified through anthropogenic activities like pesticide use in agriculture, industrial pollution, through combustion of fossil fuels, mining waste, sewage and smelting (Thakur, 2013) are major sources. We can neither smell, nor see if water is contaminated with arsenic (Roy, 2008)**.** Basically there are two types of arsenic, organic and inorganic, inorganic arsenic is 10 time's higher toxic than organic and it is mainly present in ground water. It enters into human body, through consumption of food, drinking of arsenic contaminated water. However its impact is greater through drinking compared to other contamination (Pointus, 2019)**.**

More than 2 billion people are using ground water sources for daily purpose (Rehman, 2018). About 200 million people, including 20 million youngsters live in part of the world where arsenic concentration in drinking water is above the world health organization (WHO) permissible limits (Rehman, 2018) and majority of them live in Bangladesh Vietnam, India and Nepal (WHO, 2014). In Bangladesh 60 districts out of 64 have arsenic contamination in ground water above (WHO, World Health Organization, 2017). 10ug/l standard for safe drinking water, and in India 30 million people are at risk (Thakur, 2013), while 86 districts of ten states of India have been reported by arsenic contamination in ground water beyond country standard level (50ug/l). World health organization WHO, warned that 35 million to 77 million people could be at the risk due to unsafe level of arsenic contaminated water (Guglielmi, 2017).

1.2: Arsenic Situation in Pakistan

Pakistan has almost the same situation like other Asian countries such as Bangladesh, India, and Nepal. About 20% of people have access to safe and 80% people are force to drink contaminated water. In Pakistan, people are facing several health problems like Diarrhea, Typhoid, Hepatitis, Skin diseases due to use of contaminated water. Studies estimate that waterborne diseases contribute around 80% in total diseases (M. K. Daud, 2017), and about 50 to 60 million people are at the risk of arsenic exposure which might use drinking water above country's safe limit (Guglielmi, 2017), which is 50ug/l (PNDWQS, 2018) Pakistan National Drinking Water quality Standard, on the other hand arsenic level is more than 300ppb in Pakistan (Majidano et al., 2011). The severity of arsenic contaminated water is greater in Punjab and Sindh as compare to other provinces. About 38% population of Sindh exposed to the arsenic contamination over 10ug/l and about 16% population is exposed to the more than 50ug/l (Murtaza et al., 2007).

1.3: Arsenic, Health and social Socio-economic Problems

According to World Health Organization the threshold level of arsenic is 10ug/l or 10ppb (parts per billion) (WHO, World Health Organization, 2017), while in Pakistan and in some other countries like India Nepal, Bangladesh and Taiwan have set 50ug/l (Karim, 2000). Arsenic related diseases are divided mainly into three stages, which are given below.

Primary Stages	In primary stages, several symptoms may develop due to arsenic poisoning such as blackening of some part or whole body (**Melanosis**), thickening and roughness of palms and soles (**Keratosis**) and redness of conjunctiva (**conjunctivitis**), inflammation of respiratory tract, and nausea and vomiting (**Gastroenteritis**)
Secondary Stages	If a patient continues to be exposed by using arsenic contaminated water with avoidance of medical care these symptoms become more visible and advanced, including white intermittent dots within blackened areas (**Leukonelanosis** or Rain Drop Syndrome), nodular growth on palms and soles (**Hyper keratosis**), swelling of feet and legs (**Non-pitting edema**), and peripheral neuropathy, disorder of liver and kidney as well.

Tertiary Stage (last Stages)	In this stage patient's health rapidly deteriorates and symptoms become irreversible, gangrene of distal organs and other parts of the body cancer of liver, skin, lung, and kidney failure developed in this stage.

Source (Khan, 2007)

These symptoms become irreversible due to medical avoidance and continuous intake of arsenic contaminated water from long period. Arsenic is a slow poison it takes 4 to 20 years to develop the disease symptoms (Khan, 2007: Alam, 2010). Many of studies show that drinking arsenic contaminated water can cause bladder, kidney, liver, lung and skin cancer (Ghulam murtaza Arain, 2006) problems in reproductive system and also effect on unborn children (karim et al., 1999). In developing countries medical expenditure to arsenic related diseases impose more pressure on already over burden (Thakur et al., 2013), some other studies found that these symptoms varies due to various factors such as general health and diet of a person, (Karim, 2000, Alam, 2010) daily intake of arsenic contaminated food and drinking water, concentration of arsenic, age and immune system of a person (Alam, 2010) and arsenic more than 50ug/l can cause significant cancer risk and may develop within 10 years of period (Ghulam murtaza Arain, 2007).

Access to safe supply of water is the most important for health, and socio-economic development (Thakur, 2013) While the problem of arsenic contamination has a major impact on socio-economic factors. Many studies shows that arsenic patients go into the situation of depression, due to social ignorance and even committed suicide. Marriages and other relationships are difficult to maintain in the areas of affected villages (Thakur, 2013), because parents are facing difficulty to find grooms for their daughters affected with arsenic (eg; Melanosis, Keratosis) because symptoms of arsenic affects the natural beauty of a female. Due to Arsenicosis, husband and wife relation is severely affected. Affected wives are sent back to their home along with their children because most of people believe arsenic related skin disease is spreadable, but large body of literature is providing empirical evidence that it is not contagious disease (Thakur, 2013). Arsenicosis affected people could not find or denied of job offers and services. On the other hand due to ignorance of people even from their beloved one they spend isolation life, and because of social exclusion sometimes they attempt to commit suicide in the end.

Roy et al., (2007), found that population of poor households are facing Melanosis and Keratosis (arsenic related skin diseases) more frequently compared to rich. He also conclude that poor people are facing more number of sick days compared to rich because rich people have better excess to preventive measures. Study also claim that women are more prone to arsenic related disease compared to men. Children and infants are more adversely affected than adults. While risk of Melanosis and Keratosis is high when there is cumulative exposure and this risk is not the same for all belonging to the same classes because richer take averting measure to avoid exposure, and women are more affected to the inflammation of respiratory tract compare to men (Khan, 2007).

1.4: Arsenic and Health Cost

The costs of arsenic contamination is large and the risks vary by socio-economic categories**.** Number of studies found the relation of arsenic exposure with economic burden. (Khan, 2007) uses primary data of 878 households. In which he uses household production method, to examine cost and health impacts of arsenic contaminated water. The total cost illness due to arsenic exposure was about Tk 557 (US$ 9) to Tk 994 (US$ 17) million per annum. Which was nearly 0.6% of individual's annual income on average, while 7 to 12 million person-days per year were lost as a result of arsenic exposure and those individuals who were sick spend between 207 (US$ 3.5) million to 369 (US$ 6.25) million taka per year for medical help.

Roy et al., (2007)**,** conducted a study in West Bengal to estimate economic cost by imposing arsenic related health issues by using household production function. Primary survey of 473 households of (Midnapore and 24 Parganas districts of West Bengal) households actions to either decrease the exposure of family members to unsafe or alleviate the health effects of consuming arsenic contaminated water. Study assess the benefits of supplying safe drinking water, by using three equation (averting actions, medical expenditures and a sickness function). Findings shows that a representative household can take benefit of 297 (7 dollars) per month by reducing arsenic concentration to safe limit of 50ug/l. because the cost of filtered water supply was 127(3 dollars) per household per month. It was feasible to invest for safe drinking water, and households were willing to pay for such investments if made aware of effective gain in welfare.

Chowdhury et al., (2015), estimated the health cost of arsenic contamination in Assam India using house hold production method, primary survey of 355 households. Three least square technique was used in which three equation were used for estimation. Study finds that 4 INR increases annual health cost per house hold if 1ug/l increases in arsenic concentration, and if arsenic contamination decreases to safe limit (50ug/l), the annual welfare gain is about INR 862 (USD 14) per household. While the annual health cost and welfare gain by reducing arsenic concentration to safe limit was about INR 0.76 million (USD 0.01 million) and INR 153 million

(USD 2.49 million). Study also find that health cost and welfare varies across arsenic concentration and across districts.

1.5: Area of the study

Tando Allahyar is one of district of Sindh with population of 836,887 (GOP, 2017). It has three tehsils, and district is facing the problem of ground water contamination with arsenic. The main source of drinking water is ground water which is highly contaminated with PH, TDS and with organic and inorganic arsenic. Arsenic posing creates serious health threats and contributing in health cost as an extra financial burden. Majidano et al. (2011) investigated the quality of ground water in the area of district Tando Allahyar. 175 groundwater samples were collected from various towns and villages throughout the district in order to assess various water quality parameters such as electrical conductivity (EC), pH, copper (Cu), cadmium (Cd), total dissolved salts (TDS), nickel (Ni), manganese (Mn), iron (Fe), and arsenic (As). The findings showed that arsenic exposure is higher through arsenic-contaminated drinking water than through food or air, and that long-term use of such water causes skin disorders, liver, kidney, and liver failure, chest problems (asthma, tuberculosis), and cancer. The table 1.1 present the arsenic concentration in different sites of the district.

Table.1.1 Arsenic concentration of water samples collected from sub-district units (talukas) of district Tando Allahyar.

Name of Taluka	Tando Allahyar	Jhando Maree	Chamber	Total
No of Samples collected	122	36	17	175
Samples with As conc. below (LOQ) limit of quantitation	32	22	13	67
Samples contaminated with arsenic	89	14	4	107
Samples with As conc. within WHO limits (0-10ppb)	55	23	14	92
Samples with As conc. Above 10ppb	66	13	3	82
Samples with As conc. 100ppb or above	56	4	0	60
No of Samples collected	122	36	17	175

Source (Majidano, 2011)

From 175 ground water samples Arsenic levels were found to be under WHO standards in 14% of the samples, and in 26% of the samples, they were within 50ppb. The acceptable limit for arsenic pollution in drinking water has been set at 50ppb by Pakistan's National drinking water quality standards (PNDWQS). As a result, 26% of ground water samples within 50ppb may likewise be considered appropriate. The arsenic level of groundwater samples from this area of the district ranged from below the limit of detection (BDL) to 300ppb. Site S1 (Taulka Tando Allahyar) was significantly contaminated with arsenic. Arsenic levels were 100ppb or higher in 46% of the water samples, and 200ppb or higher in 27% of the ground water samples. In Taulka Tando Allahyar site

09 (Village Allah bukshsh Arbab) was significantly contaminated (300ppb) with arsenic, and people were also impacted by arsenic-related ailments. This motivates me to conduct a research study in this area.

According to best of my knowledge, no study has estimated the health cost of drinking arsenic contaminated water in the province of Sindh. Present study is attempting to fill this gap in the light of above discussion following objective have been formulated.

Map of District Tando Allahyar

Figure 1.1: The Map of District Tando Allahyar

1.6: Objective of the study

- To estimate the health cost of drinking water contaminated with arsenic
- To explore the level of awareness about the presence of arsenic and its adverse health impacts in the study area.
- To suggest policy recommendations based on empirical results.

In the light of above objectives following hypothesis have been tested

1.7. Hypothesis of the Study

To achieve the objectives of the study, the following hypotheses have been developed.

- a. H0: There is no significant effect of arsenic contaminated ground water on the health of the respondents.
- H1: There is a significant effect of arsenic contaminated ground water on the health of the respondents.
- b. H0: Arsenic contaminated ground water does not increase the health cost of the respondents.
- H2: Arsenic contaminated ground water increases the health cost of the respondents.

1.8: Research question

- Is there any significant cost due to drinking ground water contaminated with arsenic?
- Are people in the study area aware about the presence of arsenic and its negative health impact?
- What should be policy implications in order to avoid the exposure?

1.9: Significance of Study

Ground water contamination is one of the major issue in Pakistan, and it has serious implication on productivity of human resources and contributing in increasing health cost. The significance of the study is to quantify the economic cost of people being affected by drinking contaminated ground water with arsenic in study area. People can shift from one source to another source but depending on the level of awareness about the risk that could arise in future due to drinking polluted water with arsenic, danger of water quality. Therefore, level of awareness about the danger of water quality has been explored. Recently 32 people have died due to water borne diseases (mainly Hepatitis, Kidney and liver failure) within three months **(Dawn, 7 fab 2020)** and 69 are diagnosed by Hepatitis B&C out of 282 people in the one of the village of District Tando Allahyar (**Health Report**). Prompting me to calculate the health costs incurred by respondents as a result of drinking arsenic-infected water in the region. Therefore, main objective of the study is to estimates the cost of illness due to drinking arsenic contaminated ground water in study area (District Tando Allahyar).

1.10: Organization of the Study

Chapter one of the study covers Arsenic sources and scenario in the world as well as in Pakistan, Arsenic related health, socio and economic issues, study area, objective, research questions, significances and organization of the study. Chapter Two covers literature relevant to the study, Chapter Three deals with qualitative data and policies over view which include National drinking water policy, its goals and objectives. Chapter four is about data description and Econometric methodology which include sampling technique, source of data and its collection, variable description. Chapter five describes the descriptive and estimated data results and their interpretation. Chapter six tells about conclusion and policy recommendations.

1.11: Research gap

- There are the lot of studies have been conducted on contamination of groundwater polluted with arsenic. Clinical studies are almost absent measuring the arsenic induced health hazards and economic cost due to drinking arsenic polluted ground water (Berg, et al., 2001; Mukherjee, et al., 2006; Farooqi et al; 2016), and second objective of the study is to investigate the awareness and knowledge about the hazardous health effects of arsenic through drinking arsenic polluted water.

- The purpose of my study is to bridge the gap between health effects and their corresponding monetary damages due to the presence of arsenic in drinking water and to check awareness about the arsenic. The present study is attempting to fill this gap.

CHAPTER 2

REVIEW OF LITRATURE

2.1: Arsenic and Health

Water is essential for human life and it contain many minerals and elements which are beneficial for human health. They are beneficial till they have certain limited amount into the water. Arsenic is one of the element which is present in water. Mainly it comes from earth crust mostly in inorganic form.(Ghulam murtaza Arain 2007), the recommended arsenic concentration into the water is 10ppb (WHO, 2019), and some countries like India, and Bangladesh recommend 50ug/l. or 50ppb (Karim, 2000). There are mainly two types of arsenic organic and inorganic, from which inorganic is more dangerous to human health, and there are different ways by which arsenic can causes many health hazards through food, air, and drinking water. while impact is greater through drinking water its impact is higher as compare to other sources (Pontius et al., 2019). Through drinking high or low arsenic contaminated water above WHO limits, can cause short and long term diseases. Short term diseases are high blood pressure heart attack, while keratosis, bladder cancer, lung cancer, kidney cancer, liver cancer and skin cancer, in long term (Ghulam murtaza Arain 2007).

The first arsenic-affected patient was discovered in West Bengal in 1993. People were exposed to arsenic when they used residential and agricultural wells to collect water from subterranean aquifers (SOES, 2007). The abuse of groundwater is the primary anthropogenic source of arsenic pollution in water. Groundwater is an important element of the region's evolving agricultural methods. It involves actions such as increasing cropping frequency, increasing land usage, and switching to low-water-use agricultural techniques, as well as conventional supplies such as surface water from rivers and ancient canals (Sarkar et al., 2009).

Pontius et al., (2019), review the literature about the health implication of arsenic in drinking water, paper define that primary exposure of arsenic is from food, air, and through drinking water. Paper express that there is certain concentration of arsenic into these sources and in food many commodities have mainly inorganic arsenic, high arsenic contaminated drinking water cause black foot disease, and in long term it can cause cancer.

Hinwood et al., (2019), conducted a study about toenail and hair exposure through high environmental arsenic concentration. Study used a cross-sectional survey of toenail and hair arsenic concentrations in residents living in rural areas with varying environmental arsenic concentrations as well as a control population. From literature it was estimated that there is strong relation between hair arsenic concentration with air, dust and soil arsenic concentrations. Result of the paper shows that high environment of arsenic concentration increases the probability of occurrence of toenail and hair arsenic.

Alam A. S et al., (2010), define the about 80% of Bangladesh and about 40 million people are at the risk of poisoning of arsenic related diseases. Literature also expresses some diseases like Melanesis, keratosis, leuco melanosis, dorsum, edema, non-petting, gangrene, and skin cancer. Arsenic compound used in pesticide of cotton desiccants, manufacture of glass, wood preservatives, ceramics, dye stuff, semi-conductors, processing of glass pigments textile, paper, metal, and ammunition. Literature in the paper express the incident of 1960 that coal mining waste leached into the spring water of Auto Fagasta Chile, many people were affected by this event mainly children through contaminated drinking water. Through surveys Study reveals that depth of 20 to 40 feet has no presence of arsenic into the water while from 70 to 200 feet have arsenic concentration above the WHO limits. On the other hand the result of the paper shows that anthropogenic sources of arsenic are not cause of the arsenic pollution and consensus is that sources of arsenic is geological, and arsenic is derived from lowering of water table which is cause by over exploitation of ground water, which is mainly cause by using ground water for agriculture purposes.

Khan et al., (2007), study evaluated that risk to Melanosis (black spots illness) and Keratosis (roughness in soles and palms) is high when there is cumulative exposure and this risk is not similar for all wealth classes, poor's are more vulnerable compare to richer. And richer are more successful to avoid the exposure of these diseases, on the other hand women are more affected by the inflammation of respiratory track to men. Which is symbol of long term exposure without option of medical help.

Thakur et al., (2015), assessed the economic costs of arsenic health concerns, which had previously been quantified by Roy (2008) and Khan (2007) in their respective works, which were centered on the economic burden imposed on households due to arsenic polluted water. These studies found that low-income families had the sickest days, implying that women and children are more vulnerable to sicknesses caused by long-term arsenic exposure.

Shankar et al., (2014), looked at cross-country data from countries such as Australia, Bangladesh, China, Cambodia, Canada, Finland, India, Pakistan, Japan, the United States of America, and Vietnam. According to the study, both natural and manmade sources have negative impacts on human health and the ecology. High arsenic concentrations have been linked to a variety of aesthetic issues. Arsenic was shown to be oxidized by these bacteria under ideal experimental circumstances, contributing to virtually 100% arsenic elimination (up to 95 percent). According to the findings of this research, arsenic-contaminated drinking water degrades the ecosystem and creates health problems by producing skin problems, black spots on the body, cuts on hand and feet and other symptoms. Study concludes that government mange waste water of industrial and agriculture activities that discharge to arsenic pollution.

According to studies, arsenic poisoning of groundwater has become a worldwide problem (India, Bangladesh, Taiwan, Cambodia, China, Nepal), but the people of Uttar Pradesh, Bihar, and West Bengal have suffered the most as a result of drinking arsenic-contaminated water. Arsenic has been found in groundwater as a result of natural weathering of arsenic-infused rocks and minerals, as well as the flow of effluents from the petroleum refining, fertilizer, pesticide, and other chemical industries. They can induce hyperkeratosis of the palms and soles, warts, leukemia, severe renal failure, and malignant rhino pharyngitis, among other things (cold infection). The effects of drinking arsenic-contaminated groundwater were investigated. The research of arsenic polluted groundwater was also aided by the human chromosomal abnormality. The respondents were asked to provide information on their behaviors, such as smoking, chewing tobacco, and chronic illnesses, and a sample was taken from them. According to this study, those who drank water with high arsenic levels had keratosis, pigmentation, and chromosomal anomalies. Arsenic levels ranged from 0.01 to 0.37 ppm (Singh et al., 2013).

In the Indian state of West Bengal, millions of people are at danger owing to excessive arsenic levels in drinking water, and thousands of them are suffering from arsenic-related illness (called arsenosis). The influence of arsenicosis on human well-being and health is multidimensional. Over the last two decades, progress has been made in understanding the reason. The scope and diversity of the arsenic problem, as well as the implementation of various corrective methods. (Abhijit Das, 2013), this research study gathers information on arsenic cleanup and societal effects from both official sources and first-hand field level personal interviews in two rural villages in the Jalagi block and Rani nagar 2 block in Murshidabad district, West Bengal. Arsenicosis has been proven to have a negative influence on key aspects of human well-being, including labour productivity, income, earning capacity lifespan, intergenerational poverty, and health. Indirectly, social exclusion increases as a result of social attitudes regarding arsenic-related health problems, resulting to social unhappiness. Any future arsenic remediation technology will require careful preparation and a thorough grasp of the problem's complexity and many obstacles in order to get societal acceptance in a social environment that has already been disrupted by live memories of non-functioning in the field (Abhijit Das 2013).

Tung Bui Huy et al., (2014), The Australian Environmental Health Risk Assessment Framework was used to analyse the health hazards associated with arsenic (As) in polluted drinking water in Hanam. Water consumption levels in 150 households were calculated based on arsenic concentrations in 300 tube-well water samples before and after filtering. A probabilistic technique was used to assess risk of skin cancer using the Cancer Slope Factor score and lifetime average daily dose. According to the water sample report Arsenic concentrations in ground water tube-well varied from 8–579 ppb (mean 301 ppb) before filtering, and existing sand filters used by the households did not meet criteria of arsenic removal. The daily intake of arsenic by 40% of individuals exceeded the Tolerable Daily Intake limit of 1 g/kg/day. If the water is not filtered, the risk of skin cancer is about 12 times higher.

2.2: Arsenic Situation in Pakistan

Atta et al., (2017), current study conducted at Tando Allahyar, district of Sindh province, the study focus was to estimate illness cause by microbial and arsenic contamination into drinking water. Water samples were collected at random from the research region, labelled, and transported safely to the Water Testing and Surveillance facility for additional investigation. Arsenic was measured using a MERCK Arsenic kit method with a detection range of 0.005mg/L to 0.5mg/L. The study's findings indicate that these pollutants are readily available. TDS concentration was also found to be over the allowed amount and arsenic in drinking water exceeded the WHO standard of 10 ppb (g/L). Overall results express that these contaminants are affecting the population of study area, and mainly the aim of the study was to create awareness.

Mehwish Bibi et al., (2015). This study was conducted in Lahore. Chung, Manga-Mandi, and Kalalanwala were chosen as low (as 4g/L in drinking water), medium (as 672g/L in drinking water), and high (as 2400g/L in drinking water) risk areas, respectively, along the Lahore-Multan road, exceeding the WHO limit of 10g/L arsenic in drinking water (Farooqi et al., 2007). Lahore Cantt was chosen as a control location since it is located far away from arsenic-contaminated regions. There were a total of 48 human subjects in this study. Adults (25-35), children (ages 10-15), and elderly individuals (ages 40-50) were chosen from each site to collect samples of urine, blood, nails, and hair from those who drank ground water, and Control samples were collected from a group of people who never drank As contaminated water and lived at a place far from As-contaminated regions of Lahore. The human participants' demographic status, source of drinking water, medical history, dietary habits, and health information were collected using a survey based on a questionnaire. Randomly chosen individuals filled out self-administered questionnaires regarding their personal characteristics, drinking water source, and eating habits. Arsenic concentration was determined from three different age groups. Estimations express that arsenic was significantly different at different sites while the presence of As contamination was not different in different age groups. Arsenic concentration in nails was high of blood sample. About 130 million people are affected by arsenic polluted drinking water in developing countries. Results also find that antioxidant enzymes have significant decrease in arsenic concentrations.

Majidano et al., (2011) conducted a study to check the quality of ground water of district Tando Allahyar, Sindh. For this purpose 175 groundwater samples collected from different towns and villages of the district, to check various water quality parameters i.e electrical conductivity (EC), pH, copper (Cu), cadmium (Cd), total dissolved salts (TDS), nickel (Ni), manganese (Mn), iron (Fe) and arsenic (As) levels. Results expressed that arsenic exposure is higher through arsenic contaminated drinking water as compare to food and air, and long term use of that water cause cancer. Paper also express about the anthropogenic sources of arsenic contamination are pesticide use in agriculture, fossil fuel combustion, treated wood, smelting and mining waste. Indus belt is mainly the natural area of arsenic. In Pakistan arsenic level is more than 300ppb.

Siddique et al., (2009), conducted study at old Kahna Lahore. Study express that in some area inorganic arsenic is significant source of exposure in drinking water, and daily intake of arsenic from beverages and food is about 20 and 300ug/d, while limited data express that 25% inorganic is present in food, sample primary data was collected tape water samples from 10 houses and tube wells randomly. Results shows that drinking water and milk contain high concentration of arsenic, and vegetables were checked those were grew by that water all samples were under safe limits. Arsenic which was much higher than safe limits can cause cancer in long term.

Karim et al., (2000), study is about arsenic pollution in ground water and health problems in Pakistan. It’s reported that arsenic is responsible for lung and skin cancer, and even it’s also effect on unborn child. While the toxicity of arsenic varies to human body, which depend upon diet, general physical health etc. arsenic slowly passes out from urine mainly and from hair finger and toenail, and from skin (keratosis). Literature define that around 52 districts and about 80% area is around contaminated with arsenic and about 40 million people of Bangladesh are at the risk. The Melanosis disease is common in people about 93.5%.

Ain et al (2017), performed research in Punjab's Rahim Yar Khan District. The focus of the research was on arsenic and fluoride. It was revealed that there is a clear link between high arsenic and fluoride concentrations and health concerns. Arsenic levels were found to be higher in regions near agricultural fields and smelting areas, indicating that fertilizer was used more often in those areas. According to the findings, arsenic causes skin pigmentation, lung cancer, and bladder cancer, while fluoride causes skeletal and dental poisoning, with extreme cases resulting in loss of movement in the human body.

Fatmi et al., (2009) in this study a representative multistage cluster survey was undertaken among 3874 people over the age of 15 to estimate the prevalence of skin lesions due to intake of arsenic, in this study. Between January and June 2006, a cross-sectional survey was undertaken in seven talukas (subdistricts) of the district Khairpur in Pakistan's province of Sindh. Cluster sampling was done in stages. In the first stage, past survey data was used (Ahmad et al., 2004). In 216 villages, a total of 3874 people (51.5 percent females) were questioned and evaluated, and 2517 samples of drinking water sources were taken for these people. Some people had various sources of drinking water, while others had a single supply that served both males and females in the household. A total of 505 urine samples were obtained, comprising 63 samples from patients with skin lesions and 432 samples from controls. Individuals with and without arsenic skin lesions had their urine arsenic levels compared. In addition, the relationship between age, BMI, and smoking status and arsenic skin lesions was investigated. Using a global positioning system, the geographical distribution of arsenic polluted wells and skin lesions in the district was determined. Using atomic absorption spectrophotometry, the total arsenic, organic and inorganic forms, in water and samples of spot-urine were measured. The prevalence of definitive cases, defined as hyperkeratosis of both soles and palms, was 3.4 per 1000 in the district, while suspected cases, defined as any symptom of arsenic skin lesions (Keratosis and/or Melanosis), was 13.0 per 1000. With cumulative exposure of arsenic (dose) in drinking water and level of arsenic in urine, the prevalence of skin lesions rises. More arsenic contaminated wells and skin lesions were found near the banks of the Indus River, implying a clear relationship between arsenic poisoning of groundwater and proximity to the river.

Mahfuzar Rahman et al., (2018), study looked at the risk of mortality of young adult as a result of high chronic arsenic exposure from years of consuming arsenic-contaminated water. Methods: A total of 58,406 people aged 4 to 18 years old were included in a prospective cohort study. All people were included in the follow-up since Matlab Health and Demographic Surveillance System (HDSS) has an ongoing surveillance system. During the analysis, age, sex, educational achievement, and SES were all corrected. All young adult fatalities were recorded by (VA) verbal autopsy using the (ICD-10) International Classification of Diseases to describe the causes in this 13-year closed-cohort research (2003–2015). Girls, on the other hand, had higher cumulative exposure of arsenic from water of tube well than males. Cancer-related mortality was found to be higher, as was death from cerebrovascular illness, cardiovascular ailment, and respiratory illness. Young individuals exposed to As > 138.7 g/L had a higher risk of mortality from all cancers than those exposed to As 1.1 g/L. Arsenic in drinking water at higher concentrations and over longer periods of time increases the risk of death in young people, regardless of gender.

Nimra Masood Baig et al., (2017), The goal of this resarch is to evaluate the level of perception among respondents in Sindh's rural areas. This was a cross-sectional survey-based study that took place between January and December 2016. The structured questionnaire based on an interview was used to collect data. Out of 241, the majority of respondents (56%) drank ground water and (27.8%) drank treated water as a drinking water source. Surface water was used by 12 %, bottled water was used by 1.3%, and boiling water was used by 2.9 %. The study discovered that diarrhoea was the most commonly reported illness (38.6%), followed by vomiting. (19.1% of the total). 15.3 % said they had kidney issues, and 5.8 % said they had hepatitis. 21.2 % said they had no water-borne illnesses over the preceding year.

Zulfiqar Bhatti et al., (2017), Current study used Arsenic Kit and atomic absorption spectrometer (AAS) were used to determine arsenic in ground water of Sindh province, Pakistan. Twenty four districts on both the left and right banks of the Indus River were investigated.According to the findings, the greatest As concentration of 200 ppb (parts per billion), which is more than the WHO limit of 10 ppb, was found in Sakrand, Shaheed Benazirabad district, followed by Matairi, Hala, Nasarpur and Tando Mohammad Khan. It was also discovered that the ground water on the left bank of the Indus River was more polluted than on the right side. Additionally, a contour map was generated using OriginPro and coordinate systems to emphasise the increased arsenic levels in the study region. Estimated Daily Intake, Cancer Risk and Target Hazard Quotient were calculated after a health risk assessment of these regions. About 45 % of all ground water samples tested positive for As in water, with the majority of these samples coming from the Indus River's left bank. These findings serve as a foundation for academics, non-governmental organisations (NGOs), and government agencies to deploy methods of arsenic treatment in those areas.

Joel E. Podgorski et al., (2017), This study generated state-of-the-art hazard and risk maps of arsenic-contaminated groundwater for thresholds of 10 and 50 mg/liter using a fresh data set of approximately 1200 groundwater quality tests collected across Pakistan. geology, Surface slope, and soil characteristics were employed as primary predictor factors in a logistic regression analysis with 1000 repetitions. The hazard model predicts that much of the Indus Plain probable to have high arsenic levels, whereas the rest of the nation is mainly safe. The process of arsenic release on the arid Indus Plain appears to be dominated by elevated-pH dissolution, unlike in other arsenic-contaminated areas of Asia. According to a research, about 50 to 60 million people in the region at danger utilise groundwater, with hotspots in Hyderabad and Lahore. This figure is dangerously high, highlighting the urgent need for all wells of drinking water in the Indus Plain to be verified and tested, followed by suitable mitigating measures.

Viqar Hussain et al., (2012), The current study is based on geochemical and microbiological investigations of groundwater in the Tando Allayar and Tando Mohammad Khan districts of the Indus deltaic plain, as well as the Tharparkar district of the Thar desert. Groundwater samples from the districts of Tando Allayar, Tando Mohammad Khan, and Tharparkar were tested for physicochemical and microbiological characteristics. Total of 40 samples of groundwater were obtained from the research area's tube wells and hand pump wells. The results suggest that water samples from shallow and deep aquifers in the Tando Allayar and Tando Mohammad Khan districts had elevated arsenic contents. The research also revealed that high arsenic affected areas are intensely cultivated and highly populated, with hotspots including

Tando Allayar and Tando Mohammad Khan, where the River Indus crossed during the Holocene period. The concentration of arsenic in Tando Mohammad Khan and Tando Allayar ranges from 10-500 parts per billion. Fluoride was also detected in all of the Tharparkar district's groundwater samples. According to the findings, the mobilisation of fluoride and arsenic in groundwater in Pakistan's Sindh province is caused by a favourable pH of groundwater and soil composition of Holocene sediments from the Indus delta and slightly earlier alluvium from the Thar desert.

The research area is the region of Tando Allahyar, Sindh Province, between 10 and 40 kilometres east northeast of Hyderabad and the Indus, according to Naseem, S. J. (2018). Groundwater was collected from various sources, depths, and locations. Microbial reduction of sedimentary iron oxyhydroxides, driven by microbial oxidation of organic matter, is the primary source of As pollution of groundwater in the alluvial aquifers of the Indus River plain, Pakistan, according to a study. Extreme ion exchange has raised pH to values >8.5 in groundwater beneath the Indus plain in some sections of Punjab, causing As pollution via alkali desorption. Although anthropogenic NO3 lowers As pollution from Fe reduction, alkalizing groundwater with RSC > 0 may be used to replace it with As pollution from alkali desorption. (Sadaf Naseem 2018).

Adnan Khan et al., (2021), The goal of this study is to see if there's a link between skin symptoms and drinking high-arsenic groundwater in the Tando Muhammad Khan district. The groundwater sample was done at the start of the dry season. A total of 212 groundwater samples were taken. These samples were chosen based on locations where clinical symptoms of consuming high arsenic water have been reported. Groundwater samples were taken from wells ranging in depth from 4.6 to 61 metres. After pumping for at least 5 to 10 minutes, water samples were taken from hand pump wells, tube wells, and digging wells to obtain representative groundwater samples. On the topographic survey sheet, the location of the wells was indicated using the (GPS)

Global Positioning System. Temperature, electrical conductivity, and pH were also measured. The concentration of arsenic in groundwater was measured at each location using a Merk field testing kit. Many cases of arsenic poisoning have been reported in Tando Muhammad Khan District, Sindh, ranging in severity from moderate to severe arsenicosis. Arsenic poisoning manifested mostly as cutaneous symptoms in the study area's rural areas. Other clinical symptoms included weakness, muscular spasms, and gastrointestinal issues such as hepatitis and stomach trouble. A total of 37 locations in the district have been recorded for the prevalence of gastroenteritis and skin disorders, with Taluka Tando Muhammad Khan being the most severely impacted by arsenicosis. High arsenic levels in drinking water were a confounder of health consequences. In the research region, there were several occurrences of hyperpigmentation and scattered melanosis. Furthermore, children are the most common group affected by stomach problems and skin irritation, followed by youngsters (20 to 25 years old). It might be because women and children have a weaker immune system as a result of their repeated exposure to arsenic-polluted water. According to a health survey conducted in the Tando Muhammad Khan region, the afflicted population has been ignorant of the long-term health consequences of drinking arsenic-contaminated water. It can be explained by the peasants' socioeconomic standing, which is impacted by poverty, illiteracy, and sanitation ignorance. The development of keratosis in the palms and soles of both adults and children was observed in clinical manifestations of exposed patients. Similarly, black foot disease was suspected in a few patients.

2.3: Economic cost of arsenic contamination

Chowdhury et al., (2015), estimated the health cost of arsenic contamination of drinking water in Assam which is area of India, the data collection of study was basically primary survey from 355 households and 3sls technique was used. The study uses the household production function model framework (Freeman, 1993) to estimate the health cost due to arsenic contamination. For this both primary and secondary data were used in this investigation. The Public Health Engineering Department (PHED) of the Government of Assam provided secondary data on arsenic concentration levels in several geographical regions in Jorhat and Nalbari district. A sample survey of households in the selected districts is used to obtain primary data. Finding shows that about 0.72 million people are being affected by this issue. It was estimated that if arsenic concentration reduced to safe limit (50ug/l) which is recommended by Indian institutions, than the annual welfare gain for a household is estimated to be INR 862 (USD 14). And the annual health cost was estimated about INR 0.76 million (USD 0.01 million), and the welfare gain from reducing the level of arsenic concentration to the safe limit is estimated to be INR 153 million (USD 2.49 million). The result also express that welfare gain and health cost vary different level of arsenic concentration across different districts.

David Maddison et al., (2005), estimated the health risk and economic cost of drinking arsenic in Bangladesh. For this purpose To calculate the annual death and morbidity cases related to arsenic pollution, epidemiological dose–response functions were coupled with survey estimates of arsenic concentrations in groundwater and the number of households in Bangladesh that rely on groundwater for drinking. There will be 6500 deadly malignancies and 2000 non-fatal cancers, according to the estimates. Using purchasing power parity exchange rates, the total willingness to pay to avoid these health consequences was estimated to be $2.7 billion per year.

Zakir et al., (2007), conducted a study primary survey of 5563 individuals of 878 households, to examine health impacts and cost of arsenic contaminated ground water. Household production function was used to calculate the willingness to pay for arsenic-safe water. Study findings shows that about 7-12 million person days per year are lost their lives due to exposure of arsenic, and those persons who are sick, spend about 207 million to 369 million tk per year for medical help. While the total cost of illness to arsenic exposure was estimated about 557tk to 994 million per annum, and on average of 0.6% of annual income of affected individual person. And there is social gain is considerable for Bangladesh government in order to provide an alternative technology to the people, which provide arsenic free safe drinking water.

2.4: Conclusion of Review of literature

From review of literature we know that the major source of arsenic is natural while the anthropogenic sources also have certain contribution in arsenic pollution. Evidences of old literature shows that there is presence of arsenic into mainly presented in deep wells. While new studies found that it is present in shallow aquifers as well. The higher probability of arsenic presence is near to the old or new Indus belt. In Sindh, province of Pakistan arsenic concentration is higher in the left bank of the Indus River as compare to the Right bank. High or low arsenic concentration can cause short and long term disease like heart disease high blood pressure, headache, in short term, while blood cancer keratosis Melanosis, skin cancer in long term. In some literature it is also proved that high arsenic pollution in drinking water is directly related to the high level of arsenic presence in toenail and in hair. Some studies also found that arsenic is one of the adverse impact on health of human and socio-economic factors, and poor are main victims of arsenic related diseases, which put extra economic burden to their back in case of medical treatment and by adopting averting expenditure to overcome arsenic related disease.

CHAPTER 3

EXISTING POLICIES OVERVIEW

3.1: Sustainable development Goals (SDGs)

3.1.1 Clean water and sanitation (SDG 6)

It is one of the 17 Sustainable Development Goals set forward by the United Nations General Assembly in 2015. This target is completely expressed as ensuring the availability, sustainability and long-term management of water and sanitation for all. The aim comprises eight objectives that must be met by 2030. Safe and affordable drinking water; end open defecation and provide access to sanitation and hygiene; improve water quality, wastewater treatment, and safe reuse; increase water-use efficiency and ensure freshwater supplies; implement IWRM; protect and restore water-related ecosystems are among the six "outcome-oriented targets. " The two "means of achieving" targets are to expand water and sanitation support to developing countries, and to support local engagement in water and sanitation management.

3.2: Pakistan Vision 2025

For a country to progress, it must have a clear vision of where it wants to go. It will be unable to design a roadmap and adopt policies that will lead it there without this. A national vision is intended to give clarity to our common and aspirational goals. Pakistan vision 2025 has many pillars from which forth pillar is energy, water and food security. Pakistan Vision 2025 understands that the availability of sufficient, reliable, clean, and cost-effective energy, water, and food – both now and in the future – is critical to ensuring long-term economic growth and development. There is a pressing need to close the vast gaps in these sectors while also addressing the growing issue of climate change. There is a renewed national consensus—as articulated in the manifestos of all major political parties—to invest significant additional resources in these sectors through public-private collaboration and to secure the production and storage capacity that are required. Simultaneously, efforts will be made to conserve, distribute, and use resources efficiently, as well as to avoid contamination and environmental deterioration. Goal of Pakistan vision 2025 for water is to increase storage capacity to 90 days, improve efficiency of usage in agriculture by 20%, and ensure access to clean drinking water for all Pakistanis.

3.4: Pakistan Environmental Protection Act (PEPA), 1997

An act to provide for environmental protection, conservation, rehabilitation, and improvement, as well as pollution prevention and control and sustainable development.

3.5: National Water Policy

National Water Policy provides the guiding principles and broad policy direction for the water sector in Pakistan and deals with some related issues such as climate change threats. Pakistan is rapidly becoming a "water scarce" country.

3.6: National Drinking Water Policy

The provision of safe drinking water is recognized by the Pakistani government as a fundamental human right. In this context, the Ministry of Environment has developed a National Drinking Water Policy to ensure that everyone has access to safe drinking water at a reasonable cost and in an equitable, efficient, and long-term manner. The Policy was developed after comprehensive consultation with line ministries, the governments of AJK, FATA, and Gilgit-Baltistan, as well as NGOs, communities, and other stakeholders.

The National Drinking Water Policy was approved on 28th September 2009, making Pakistan one of the few countries of the world having a national level Policy on the issue. The Policy emphasizes the construction of the new drinking water systems, the rehabilitation and upgrade of existing water supply systems, the long-term viability of water supply infrastructure, water conservation, water quality improvement, water treatment, and the management information system for the drinking water sector. The Policy also recommends a number of legislative actions, including the enforcement of the National Drinking Water Quality Standards, to ensure its effective implementation. It states that the various governments will develop strategies and action plans to implement the Policy.

The Policy intends to improve the people of Pakistan's quality of life by lowering the number of deaths and illnesses caused by water-borne diseases. The Policy establishes specific guidelines for increasing access to safe drinking water, protecting and conserving surface and groundwater resources, water treatment and safety, appropriate technologies and standardization, community participation, public awareness, capacity development, public-private partnerships, research and development, emergency preparedness and response, and coordinated planning and implementation.

National Standards for Drinking Water Quality

NO	Parameters	Standard values for Pakistan	WHO standards
1.	Total hardness as $CaCO_3$	<500 mg/L	-------------------------
2.	TDS	<1000 mg/L	<500 mg/L
3.	pH	6.5–8.5	6.5–8.5
4.	Aluminum (Al) mg/L	≤0.2 mg/L	0.2 mg/L
5.	Arsenic (As)	≤0.05 (P)	0.01

3.7: Goals and Objectives

The overall goal of the National Drinking Water Policy is to improve the quality of life of people of Pakistan by reducing the incidence of death and illness caused by water-borne diseases by ensuring the equitable, efficient, and long-term provision of adequate quantities of safe drinking water to the entire population at an affordable cost.

The objectives of the Policy are to:

- Provide access to safe and sustainable drinking water supply to the entire population of Pakistan by 2025 ;
- Ensure protection and conservation of water resources;
- Promote measures for treatment and safety of drinking water
- Increase public awareness about water safety, safe hygiene practices and water conservation;
- Promote cost effective and appropriate technological options for water supply systems
- Encourage community participation and empowerment in planning, implementation, monitoring and operations and maintenance of water supply systems;
- Enhance capacity of line ministries, departments, agencies and organizations at all levels in planning, implementation and monitoring of water supply programmes and sustainable operation and maintenance of water supply systems.
- Promote public-private-partnership for enhancing access of safe drinking water and sustainable operation and maintenance of water supply systems;

- Promote Inter-sectoral collaboration to maximize the impacts of water supply interventions.
- Promote research and development for enhancing access, effectiveness and sustainability of water supply interventions.

3.7: Policy Principles

The key policy principles that will be pursued for implementation of the Policy are as follows:

- Access to safe drinking water is the basic human right of every citizen and that it is the responsibility of the Government to ensure its provision to all citizens;
- Water allocation for drinking purposes will be given priority over other uses.
- In order to ensure equitable access, special attention will be given to removing the existing disparities in coverage of safe drinking and for addressing the needs of the poor and the vulnerable.
- Recognizing the fact that women are the main providers of domestic waters supply and maintainers of hygienic household environment, their participation in planning, implementation, monitoring and operation and maintenance of water supply systems will be ensured.
- Responsibilities and resources will be delegated to local authorities to enable them discharge their assigned functions with regard to provision of safe water supply in accordance with Local Bodies Legislation.

CHAPTER 4

METHODOLOGY

4.1: Data Collection Procedure

Primary data was collected through administrated questionnaire based on interview from households of selected village of study area. Total one village of the district was chosen for survey. Questions were asked about the knowledge of diseases and awareness about impacts of drinking arsenic contaminated water. How they foresee about the quality of their drinking water, further they do have any safe source of drinking water? In order to investigate the quality of drinking water in study area, various water samples was being tested from laboratory.

4.1.1: Sampling design

Purposive sampling technique was used to collect the information from households in the study area. 150 sample size was selected according to the situation of arsenic contamination. Which were being tested from laboratory.

4.2: Conceptual framework

Poor water quality has negative impact on health of an individual, which increases the economic burden of households in term of direct and indirect cost. Literature shows (Khan, 2007; Roy, 2007: Chowdhury, 2015), that arsenic has certain health cost in term of medical expenditure, and averting measures.

Health cost (Cost of illness)

Health cost has mainly two types, direct cost and indirect cost.

Direct cost: consist of incurring of diseases (Skin, liver failure, Gastrointestinal problem), Doctor Fee (per visit), traveling cost (beginning to return), Medicinal expenses, lab test fee, cost due to hospitalization.

Indirect Cost: Averting measures (collecting arsenic free water), loss of working hours, loss of time which decreases wage rate, less productivity of work due to illness, risk of losing job due to absence from work.

4.3: Arsenic Analysis in the ground water sources in the study area

Ground water samples were collected from all of the village. Water samples were carefully analyzed from laboratory soil and water analysis of drip (Drainage and Reclamation Institute of Pakistan) Tando Jam, which is one of branch of PCRWR (Pakistan council of research in water resources). About 90 percent water samples were contaminated with various level of arsenic concentration. From which 15 and 59 percent have 250ug/l and 100ug/l or ppb (parts per billion) arsenic concentration. While 15 percent have country safe limit of arsenic concentration which is 50ug/l and 2 percent have 25ug/l arsenic concentration while only 9 percent have from 0 to 5 arsenic concentration, which is below the WHO limit (10ug/l or PPB) in the samples of ground water sources in the study area. On the other hand water samples of outer side hand pumps and filtration plant were also tested from where people of village bring the water for different uses, mainly for drinking and cooking purposes.

4.4: Econometric Methodology

There are so many factors which are directly or indirectly affecting the health cost, In Pakistan average spending on health care is 33% by the public and most of the spending in Pakistan is private spending (Muhammad, Gul, Saleem, & Abrejo, 2015). Variables which have most significant share in Health cost are in the model. We will use the Ordinary Least Square (OLS) method, in which health cost (rupees) is dependent variable and the data related to health cost will also be collected through a primary survey.

4.5: Equation:

$$\mathbf{HC} = \beta0 + \beta1\mathrm{Age} + \beta2\mathrm{Edu} + \beta3\mathrm{Inc} + \beta4\mathrm{WS}\mathbf{D} + \beta5\mathrm{HHS} + \beta6\mathrm{Time} + \beta7\mathrm{Novist} + \beta8\mathbf{WQ} + \beta\mathbf{9}\ \mathbf{f_{symptom}} + \beta\mathbf{10AS_{conc}} + \beta11\mathbf{liverd1} + \beta12\mathbf{Gastrod2} + \varepsilon \quad (3.1)$$

4.6: Variable Specification:

HC: Health cost of Respondents of households due to incurring (Skin disease, liver failure, and Gastrointestinal problem) in last six month (In Rupees)

Age: Age of respondent (in Years)

Edu: Education of Respondent (Years of Education)

Inc: Total Income of Households (In rupees)

WSD: Water source (Groundwater from own=1, otherwise =0)

HHS: Household Size (Total number of family members)

Time: Total Time spent to visit for treatment from beginning to return per visit (in hours)

Novist: Number of visits to the doctor in a last month

WQ: Water quality (1=good, 2=average and 3=poor)

F_symptom: Frequency of symptoms (Skin diseases, liver failure, Gastrointestinal Problems)

Since how long years: From how long respondents are drinking water of home source

Skin disease: Skin disease taken as a base variable

Liver Failure: Taken as dummy variable (Liver failure occurs =1 otherwise =0)

Gastrointestinal problems: Dummy variable (Gastro problem = 1, otherwise =0)

AS_conc: Arsenic concentration (laboratory test) (ug/l) or (PPB parts per billion)

The expected signs for the variables used in the health cost estimation of contaminated ground water have been presented in Table 4.1 (Chowdhury, 2015), has used the same variables. These signs will provide a basis for the results of this study to carefully analyze the similarities or differences in the relationship between health cost and its affiliated variables.

Table 4.1: Expected Signs of the Variables

Variables	Variable Explanation	Expected Sign	References
HC	Health cost of respondent (Rupees) due to incurring (Skin disease, liver failure, and Gastrointestinal problem)		(Chowdhury, 2015),
Age	Age of respondent (Years)	(+)	
Edu	Education of Respondent (Years of Education)	(-)	
Total Monthly Income	Total Monthly Income of respondent (In rupees)	(-)	
HHS	Household Size (Total family members in Numbers)	(+/-)	
WSD	Water source dummy (ground water from own home =1, otherwise = 0)	(+)	
NOVIST	Number of visit to the doctor	(+)	
Water Quality	Water quality (1=good, 2=average and 3=poor)	(+)	
Frequency of symptoms	Skin problem, Liver Failure, Gastrointestinal Problem	(+)	
Since how long years	From how long respondents are drinking home water	(+)	Additional
AS_conc	Arsenic concentration	(+)	
Liverd1	Liver failure dummy	(+)	
Gastrod2	Gastrointestinal problems dummy	(+)	

4.7: Variable Description

Health Cost

It is taken into two groups i.e. direct and other is indirect costs. Direct cost includes cost of these three disease (Skin disease Liver failure, Gastrointestinal Problem), doctor fee, medicinal expenses, lab tests, and total traveling cost (from binging to return), whereas indirect costs include opportunity cost of the attendant with the patient, and economic loss of working days. It is taken in Rupees.

Age

The resistance against different diseases decreases with the increase in age, therefore, it is important to investigate the impact of age on prevalence of disease due to drinking water contaminated with arsenic. Hence, there is empirical need to investigate whether arsenic contaminated water has more severe affect in the old age, because of low immunity power. The positive and significant impact indicates that old age people are vulnerable to presence of greater quantity of arsenic in the drinking water. It is observed during the process of interviews, old age people are commonly facing diseases like skin disease, liver failure and gastrointestinal problems in the study area, which is implying that age could be potential explanatory variable in our model. Literature also reveals that different kind of diseases increases in old age because of decline in body resistance (Farooqi, 2016).

Education

Education refers to the years of schooling received by the respondents. Therefore, education of respondent have negative impact on the prevalence of diseases. Because it is taken as proxy variable of awareness.

Total Monthly Income

Income of respondent is taken in rupees per month. It relates to the quality level of medication because it indicates excess and affordability to better medical facilities, and a body of literature attempt to investigate income impact of different diseases. Among them includes, (Khan 2007: Roy 2008: Jayashree Chowdhury 2015).

Household Size

Number of total family members in a house has been considered as an explanatory variable because it is expected to affect the dependent variable. As family size increases it can affect in two ways to the probability of prevalence of diseases. It is expected to affect negatively to the probability of diseases, If numbers of children are higher in the family that can help to bring drinking water from other sources, and if number of elders are dominant in the family and they are not economically active then no one will go out bring water and also they don't sufficient resources to shift towards cleaner sources of water, implying that large family size may lead to higher probability of diseases.

Water Source (Dummy)

Water source is taken as a dummy variable i.e. (own groundwater=1, other sources/averting measures=0)

Number of visit to the doctor

These include number of visit to the doctor for disease (Skin, Liver failure, Gastrointestinal Problem) treatment, more number of visit increases the health cost of the respondent.

Water Quality

Water quality response is measured on the liker scale. The highest quality is considered 1 and 3 stands for poor quality of water, i.e. (1=good, 2=average and 3=poor). Because negative effect of poor quality of water may increase the health cost of the respondent.

Frequency of symptoms

Frequency of Symptom include Skin disease, liver failure and Gastrointestinal problems. Therefore, it is decided to define this variable i.e. absence of disease=0, prevalence of disease=1, prevalence of two diseases = 2 respectively.

Since how long years

Since how long year's people are drinking home source water, which is contaminated with arsenic, refers to the increase in number of years lead to increase the health cost of disease in order to occur symptoms or lead to increase intensity of disease.

Arsenic Concentration

Arsenic concentration is taken in μg/l or (PPB). Since it is a key variable for determination of frequency of symptoms and affiliated with health cost. (McArthur, 2018; Sthiannopkao, 2008).. WHO (World Health Organization) and Pakistan' safe standard are 10ug/l and 50ug/l respectively.

CHAPTER 5

EMPIRICAL RESULTS AND DISCUSSION

5.1 Introduction

This chapter consists of descriptive statistics and Empirical analysis based on econometric model. The health cost contains both direct and indirect costs. Direct costs consist of travel cost, doctor fee, lab tests and medicinal expenses of three diseases (Skin disease, liver failure or Gastrointestinal problems). However, indirect cost includes economic loss of working days due to illness of (Skin disease, liver failure or Gastrointestinal problems). Since all the variables are in numerical form (i.e. in Rs. unit), a simple Ordinary Least Square (OLS) approach has been adopted for this estimation. The results of each model have been discussed in detail as below.

5.1.1 Descriptive Statistics

Descriptive statistics is an important part of quantitative research. The descriptive statistics presents basic information about the data set and socioeconomic variables and helps to understand the general structure of the study area.

Descriptive statistics of the sample are reported in Table 4.1. Maximum and minimum value of each socioeconomic variable is reported in the Table. The minimum and maximum age of the respondents were 19 and 70 years, respectively. Average education of respondent was 7 years of schooling with minimum and maximum 0 and 18 years of schooling in our sample. A sample of 150 households contains 784 family members, out of which 385 and 389 were male and female, respectively. Higher income may improve the health nutrition and make easy to take precaution measures, the average income of household was 19067 rupees with minimum and maximum of 4166 and 69000 rupees per month. The average household size was 5, with minimum and maximum family size of 2 and 11, respectively. Average health cost was Rs.558 per month while the maximum cost in our sample was Rs.18500 per month. Working days lost represent a person losing their work days due to illness or serious symptoms of disease and thus not being able to do work. The average day lost was with minimum and maximum value of 0.26 days and 4 days per month. Average and maximum averting cost were around Rs.69 and Rs.183 per month. People collect water from different sources and average distance to collect safe water was 1.2 kilometers with maximum distance of 3.4 kilometers (from village to safe source) in our sample. However, the water supply line is 0.4 kilometer away from the village. The average and maximum time to fetch safe drinking water is half hour and one hour, respectively. Number of visits to the doctor due to occurrence of these three disease (Skin, liver failure, Gastrointestinal problems) indicate the severity of the disease. The minimum and maximum number of visits varies between 0 and 20 (Skin, liver failure, Gastrointestinal problems), respectively. There are many respondents which are not visiting to the doctors, mainly due to financial constraints.

Table: 5.1: Socio-Economic Characteristics of the respondents

Variable	Units	Observation	Mean	St. Dev	Min	Max
Age	Years	150	36.64	12.40	19	70
Education	Years	150	7.146	5.579	0	18
Total Income	PKR	150	19067.77	11670.64	4166	69000
House Hold Size	Numbers	150	5.22	1.98	2	11
Health Cost/M	PKR	150	558.26	1535.24	0	10800
Averting Cost	PKR	150	68.50	75.23	0	183.60
Working days lost	Numbers	150	0.26	0.70	0	4
Safe source Distance	KM	150	1.26	1.39	0	3.40
Time to bring safe water	Minutes	150	26.00	13.73	0	60
Number of Visit	Numbers	150	0.53	1.89	0	20

Awareness about ground water quality and Arsenic

Various questions were asked from respondents related to awareness of quality of their ground water, presence of arsenic and its complications. 98% respondents justified unfit quality of ground water for drinking. 71.33% respondents were not tested the quality of their ground water and only 28.67% ground water samples were tested by survey team. A large number of respondents (88.67%) were unfamiliar with health hazards of arsenic poisoning. However, only 11.3% had knowledge about the complication of arsenic. Only 9.33% respondents were familiar that their ground water is contaminated with arsenic pollution, knowledge provided by a survey team and 90% respondents were still unaware about the presence of arsenic contamination in their ground water.

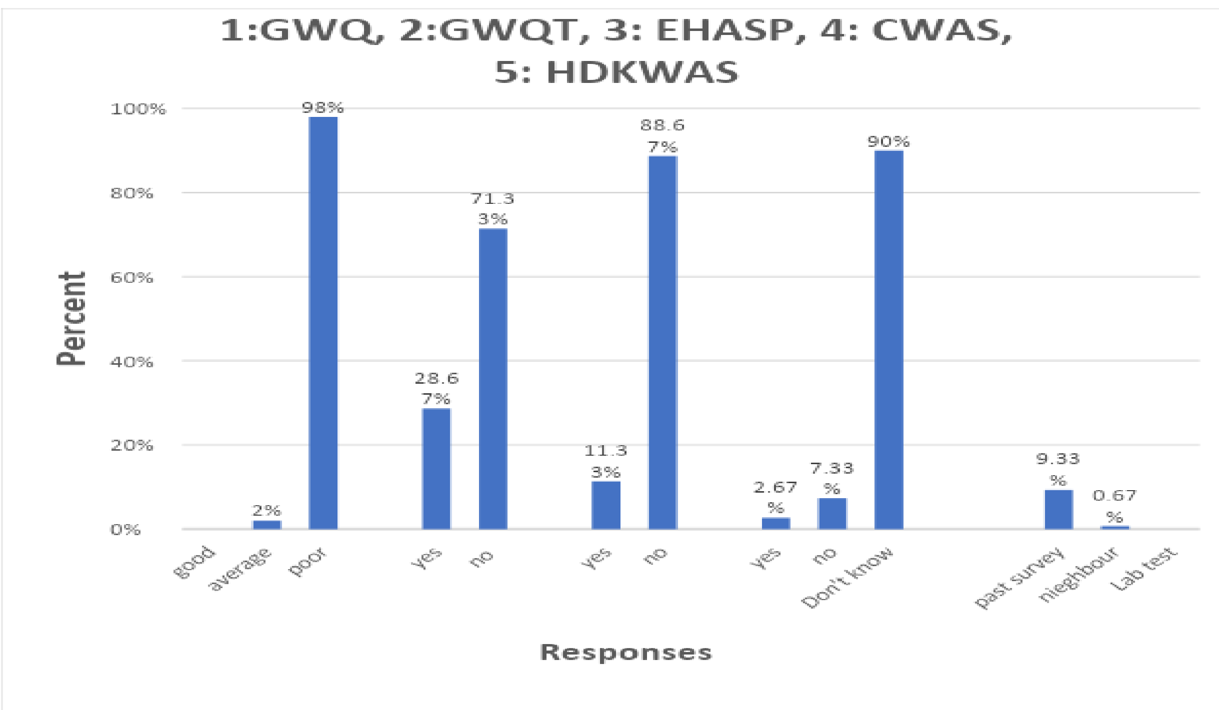

Figure: 5.1 Awareness about water quality and arsenic

GWQ= Ground water quality, **GWQT**= Ground water quality test, **EHASP** = Ever heard about arsenic poisoning, **CWAS**= Contaminated with Arsenic, **HDKWAS** = How do you know your water is contaminated with Arsenic.

Respondents foresee symptoms of diseases in village

During the survey respondents were asked to give information about diseases (Skin, liver failure, Gastrointestinal problems) due to presence of arsenic in the ground water. A large number of respondents (96%) mentioned to have various Skin problems. 93% reported to have liver dysfunction while 68% were said that people are facing gastrointestinal problems. It is also reported that 5 people have died due to these infectious illnesses, and they were earning hand of their families. Beside these arsenic related other sicknesses like chest problems (Asthma) lung failure (Tuberculosis) and kidney failure were also observed in the residents of study area.

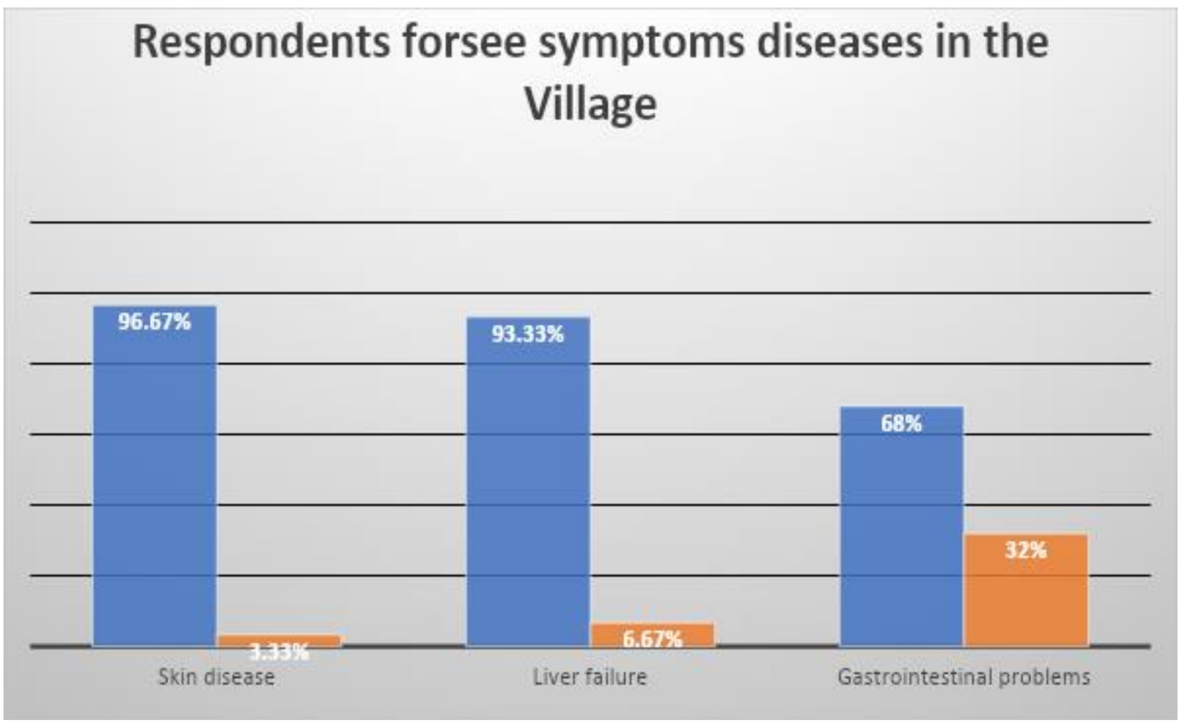

Figure: 5.2 Respondents foresee symptom of diseases in the village

Detail of Different Diseases

Survey data revealed that respondents in the village were mainly suffering from arsenic related sicknesses such as Skin diseases, liver failure and Gastrointestinal problems. Our sample results disclose that 54% respondents were facing various Skin complications, 30% have gastrointestinal problems and 16% respondents exposed to liver failure (Hepatitis).

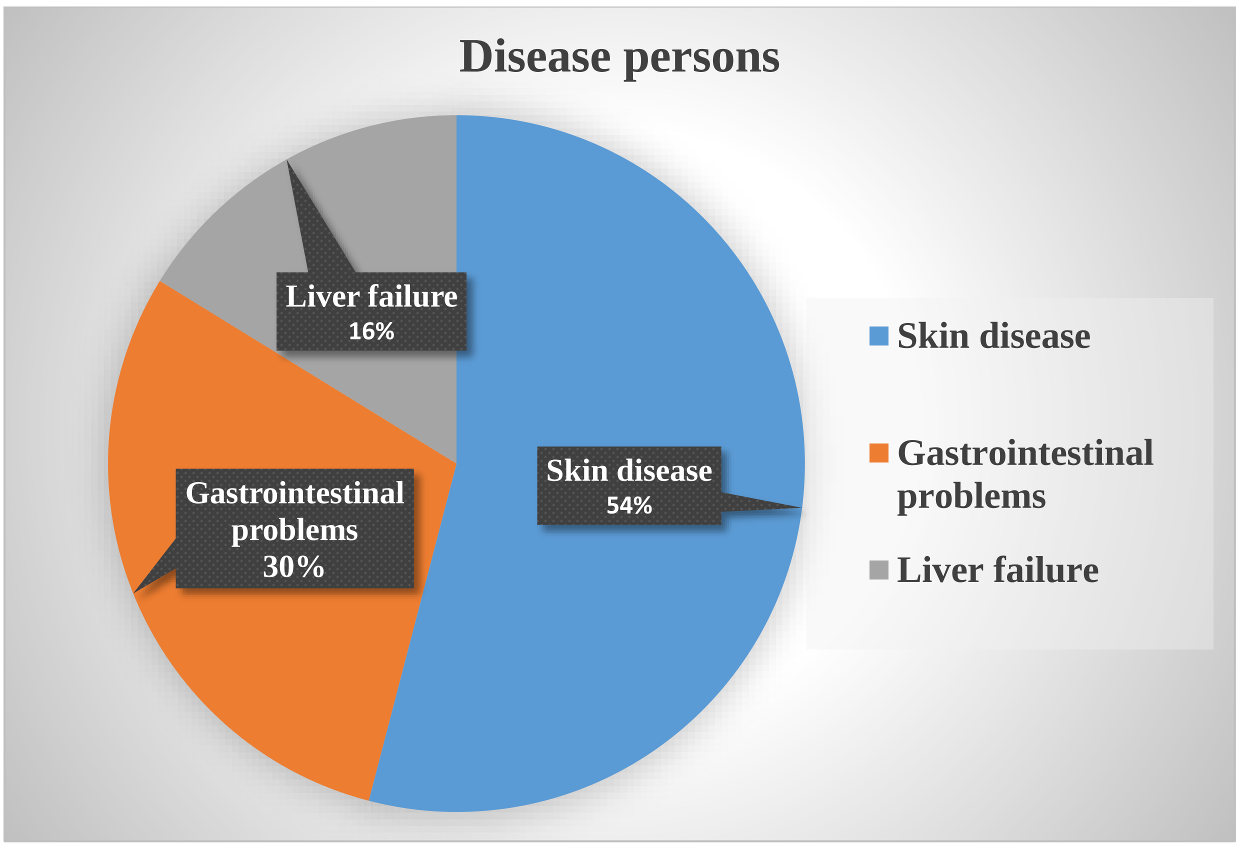

Figure: 5.3: Disease figure

5.2: Econometric Analysis of Estimation of Health Cost

In order to estimate the health cost due to arsenic related symptoms of three diseases (Skin disease, liver failure, Gastrointestinal problems), the Ordinary Least Square model was applied to the data. The dependent variable is continuous in numerical form; OLS is the appropriate model for this type of data. The dependent variable in the model is health cost due to incurring (Skin disease, liver failure, and Gastrointestinal problems) in rupees and explanatory variables include age (years), education (years of schooling), house hold size (Number of family members), time lost per visit, water source (dummy variable, 1=own groundwater, 0= other sources), frequency of symptoms (Skin disease, Liver failure and Gastrointestinal problems), arsenic concentration (μg/L) and disease dummy (liver failure, and gastrointestinal problems). All explanatory variables have been selected after careful analysis of literature and have been discussed in Chapter III in detail. When OLS model was run on primary data, heterogeneity problem was detected in those results. So, robust standard error technique was used to eliminate the heterogeneity. The results for the OLS model with robust standard error has been presented in Table 5.2:

Age shows a positive relation with health cost. The people in old age suffer more from symptoms due to lack of physical mobility, low immunity and improper nourishment. Since, old age people get sick more frequently but they are reluctant to visit doctor and to take medicines. That is why the sign of age coefficient is positive but it's insignificant.

Education is considered a proxy for awareness and increase in awareness makes people more conscious about their health, motivating them to spend more on health. Indicating that 1 year increase in education leads to decreases in health cost by Rs.8.87 per month or about Rs.53.2 per six months.

Income of the respondent shows a positive yet insignificant relation with total health cost. The increase in income provide better access to health facilities. Since, majority of respondents belongs to low income group thus the coefficient of income is positive but insignificant.

Household size variable may effect in two ways, if old members are large in numbers than it could have positive effect on health cost but if children are large in numbers in the family then it could have negative effect. Because children can fetch drinking water from the safe sources. Empirical results shows significant negative effect on health cost. By increase in household size by 1 member leads to decline in health cost by Rs.53.09 per month.

Time lost per visit to the doctor is one of the valued variable. Which shows that 1 hour per visit increases the health cost around Rs.189.84 per month. In our sample mainly respondents are working on daily wages.

Frequency of disease indicates that coefficient is insignificant and have positive relation with total health cost. This implies that if 1 unit increase in diseases (skin, liver failure, gastrointestinal problems), health cost increases by Rs.237.46 per month or Rs.1424.76 per six month.

Number of visit to the doctor has a highly significant positive relationship with health cost. By increasing 1 more visit to the doctor increases health cost Rs.507.40 per month.

Ground water quality has a significant positive relation with health cost indicating that 1 unit decrease in water quality (from good to average or average to poor) increases the health cost of the respondent by Rs.705.17 per month or Rs.4231 per six month.

Liver failure and Gastrointestinal diseases coefficients are taken as a dummy variables, while Skin disease is selected as a base. Results revealed that both dummy coefficients of diseases are highly significant and have greater health cost values compare to the base. Indicating if liver failure (hepatitis) occurs the health cost is higher Rs.1884.64 per month as compare to cost incurred on skin disease. Similarly, if gastrointestinal problems happen, it will contribute to Rs.1216.88 per month more than the cost of Skin disease. This implies that cost of liver failure and Gastrointestinal problems is higher than the cost of Skin disease and this also conclude that arsenic has greater effect of health cost through these two diseases compare to the base disease.

Interaction of water source dummy and arsenic concentration coefficient has a significant positive effect. It indicates that households using groundwater from home are facing Rs.5.65 per month or Rs.33.9 per six month additional health cost compare to those people which are bringing safe water from other sources. We took the interaction of water source dummy and since how long they are using water from this source, hence the coefficient is insignificant. This might be due to the reason that presence of arsenic, affect the body in early few years, but respondents are living there since more than 30 years. Hence there is no variation across respondent's duration making the coefficient insignificant.

Table: 5.2 OLS Model Results for Health Cost Estimation

Total cost	Coef.	Robust Std. Err.	T	P>t
Age	0.705	3.33	0.21	0.833
Education	-8.87	9.52	-0.93	0.353
Total income	0.002	0.003	0.86	0.389
Household size	-53.09	20.44	-2.60	0.010
Time lost per visit	189.84	197.18	0.96	0.337
Frequency	237.46	373.35	0.64	0.526
Number of visit	507.40	40.63	12.49	0.000
Ground water quality	705.17	250.08	2.82	0.006
Liver failure dummy	1884.64	718.29	2.62	0.010
Gastro dummy	1216.88	462.02	2.63	0.009
Wsd *Arsenic level	5.65	2.076	2.72	0.007
Wsd * Since how long	0.55	7.504	0.07	0.941
_cons	-1927.901	735.07	-2.62	0.010
Number of Observations = 150 Prob > F = 0.00 R-squared = 0.9027				

CHAPTER 6

CONCLUSION AND RECOMENDATION

This portion of the study is divided into two sections, i.e. conclusion and policy recommendation on the basis of research work.

6.1: Conclusion

About 50 to 60 million people are at the risk of arsenic exposure which might use drinking water above country's safe limit (Guglielmi, 2017), which is 50ug/l (PNDWQS, 2018).According to Pakistan National Drinking Water Quality Standard about 38% population of Sindh exposed to the arsenic contaminated water having more than 10ug/l and about 16% population is exposed to the water having more than 50ug/l(Ghulam murtaza Arain 2007).

Groundwater is the important and main source of drinking water in district Tando Allahyar. Due to high concentration of arsenic, groundwater is unfit for drinking in the sampled area. There are different reasons of pollution and among them include poor dumping of chemical waste of industries, inappropriate drainage system, excessive use of pesticides and herbicides cause poor quality of ground water through leaching process. In addition to this, extraction and excessive use of ground water for washing and agricultural practices also leads to decline the ground water level in term of quantity and quality.

The current study investigated the health impacts and health cost of drinking arsenic contaminated ground water. The study tried to explore three dimensions like presence of arsenic level, awareness regarding arsenic poisoning and its adverse health impacts and estimated the determifnants of health cost due to drinking groundwater contaminated with arsenic.

To check the arsenic concentration in the ground water of the village, water sample were tested from a laboratory of Drip (Drainage and Reclamation Institute of Pakistan) Tando Jam. Laboratory report exposed the dangerous situation of arsenic. 90% of water samples of ground water taken from respondents home were highly contaminated with arsenic and were found above the safe limit of 10 ug/l WHO (world health organization) and Pakistan (50 ug/l).

People were still using arsenic polluted water because safe water is available at 3 to 4 kilometers distance and it is difficult for families to manage the continuous supply from such a long distance.

Many socio-economic and demographic factors were responsible for cost of illness. Among these socioeconomic and demographic variables were age of the respondent, educational level, how long they are using home ground water, wage rate/ income of the respondent, distance from home to availability of safe water, and sources of drinking water respectively.

Questions were asked from respondents about three diseases Skin disease, liver failure and Gastrointestinal problems. It is observed that arsenic is present in the ground water more than a decade and people are still drinking arsenic-polluted water due to lack of knowledge about the dangerous effects of arsenic intake through water. The continuous drinking of arsenic-polluted water exacerbates the complications and symptoms become irreversible after few years. Despite the fact that number of people have died of these infectious illnesses. Many of them were the only earning hands of their families.

Previous research has shown that arsenic contamination in drinking water can lead to pregnancy disorder (Karim, 2000). But the situation in our sampled area was extremely worse because respondents reported that skin related disorders have entered in the heritage system of their families. Now children are also getting affected by these diseases.

The data from a primary survey of 150 households was used to explore the determinants of health cost faced due to drinking of polluted water with arsenic. We employed ordinary least square OLS approach. For this purpose, total health cost had been taken as dependent variable while the explanatory variables include age, education, water source, water quality, income of the respondents, arsenic concentration, total diseases (Skin disease, liver failure, Gastrointestinal problems), years since arsenic contaminated water is drinking and direct and indirect costs (number of visits to the doctor, family member with disease person) respectively.

Model results indicated that number of visits to the doctor, quality of ground water, dummy variables of liver failure, gastrointestinal problems and interaction term of water source and arsenic concentration have positive and significant relation with total health cost, indicating that these variables are responsible for health cost.

Our analysis also reveals that due to lack of awareness people are continuously drinking water affected with arsenic. As a result number of people affected with various skin, chest, and abdominal diseases and intensity of these diseases is increasing. Socio-economic and demographic factors are also responsible to intensify the symptoms and avoidance of treatment making the disease irreversible. Now Skin related diseases have entered in heritage system of families. Moreover, number of people have lost their beloved family members due long-term exposure to arsenic.

6.2: Policy Recommendation

- Our results demonstrate that level of arsenic is more than 250ug/l in the study area, which is more than the recommended level of World Health Organization 10ug/l or 10ppb (parts per billion) and country's safe limit 50ug/l or 50ppb (parts per billion). Hence study area has serious problem of the availability of safe drinking water and the concerned authorities must take immediate steps to provide safe drinking water through filtration plant.

- Our results disclose that respondents are bearing average health cost 558 rupees per month due to drinking arsenic contaminated ground water. More over average income level of respondents is very low 19067.77 rupees per month. So Government may provide relief to residents of the study area by sending the team of medical experts to treat the affected people free of cost.

- Our estimation results indicate that awareness level of respondents and villagers is very poor, for safe drinking water and health related arsenic poisoning effects. The government, NGO's, communities can play a vital role to create awareness related to groundwater contamination of arsenic poisoning, and importance of public health issues by organizing seminar in the study area.

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Appendix 1

Education

From 150 respondents 34% are uneducated, 9% have primary, matric, and intermediate, while 22 and 17 percent have middle and graduation education, respectively (Figure).

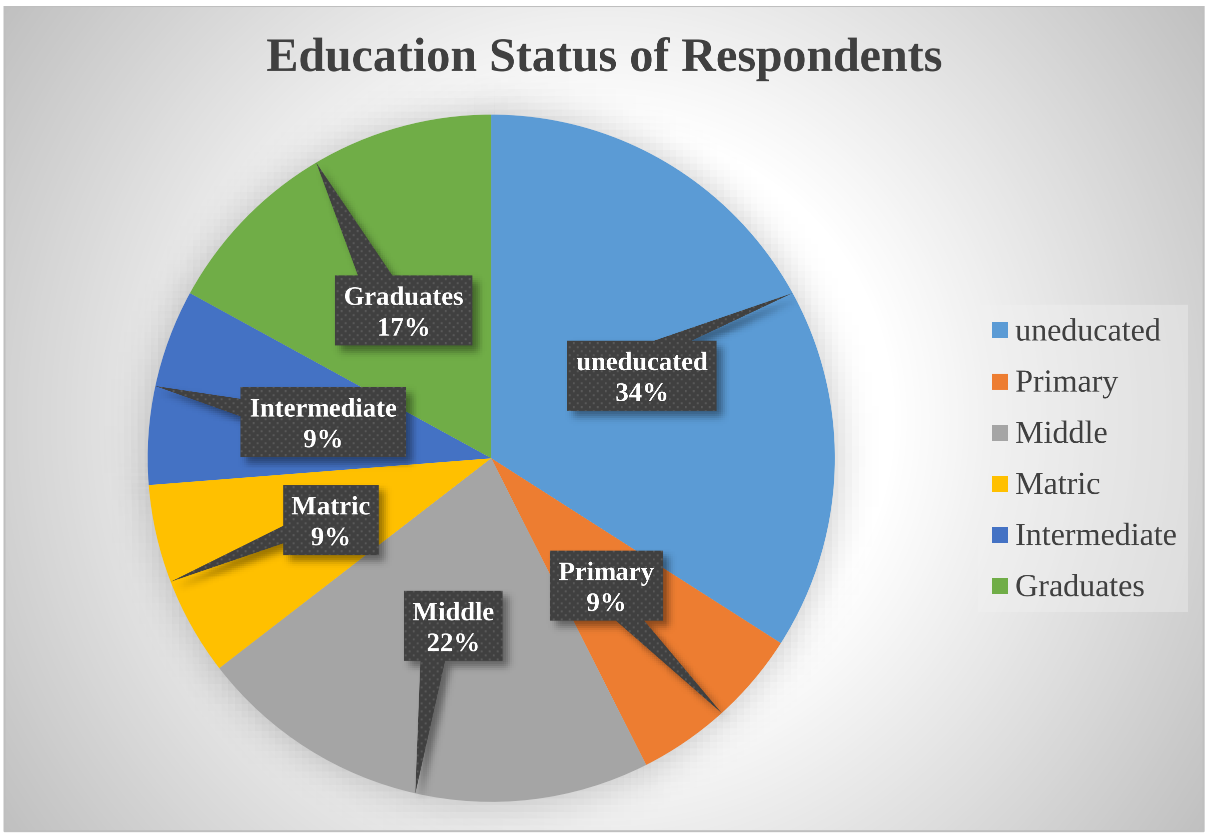

Figure: Education of Respondents

Income Frequency of Households

The total income of households varies between Rs. 4166 to Rs. 69000 per month in our sample respondents. Forty-one households lie in the income range of Rs. 5001 to Rs. 10000 per month. Forty-three households lie in the income range of Rs. 10001 to Rs. 15000 per month. Twenty-two household’s falls in the income range of Rs.15001 to Rs. 20000 per month. While the income of sixteen household are in the range of Rs. 20001 to Rs. 25000 per month and detail is given in Figure

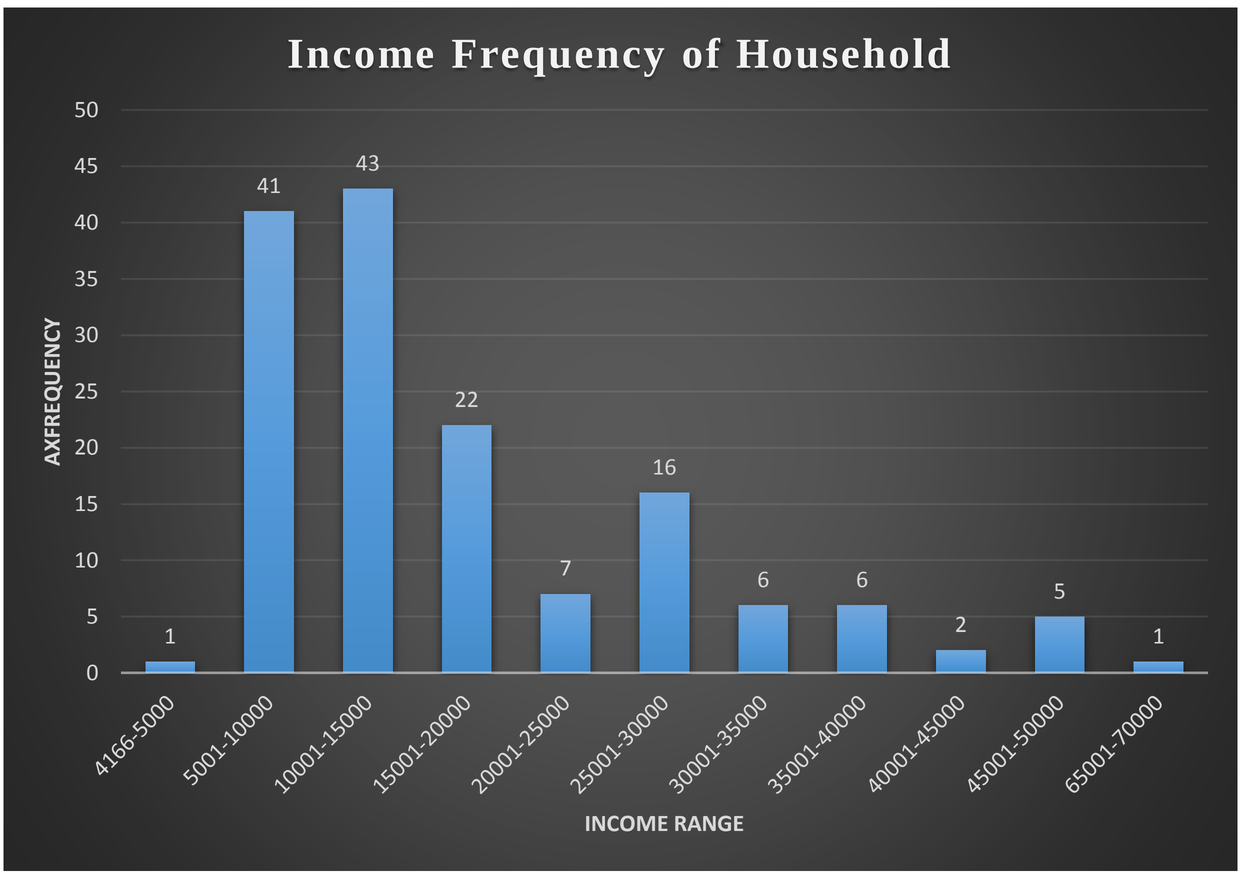

Figure: Income frequency of households

Components of Health Cost

Maximum and minimum value of each Components of health cost variable is reported in the Table.

Number of visits to the doctor due to occurrence of these three disease (Skin, liver failure, Gastrointestinal problems) indicate the severity of the disease. The minimum and maximum number of visits varies between 0 and 20 (Skin, liver failure, Gastrointestinal problems), respectively. Average doctor fee per visit was 28.13 rupees and maximum 400 rupees. Medical expenditure shows the quality of treatment the average medical cost was 877.43 with maximum 6000 rupees. Working days lost represent a person losing their work days due to illness or serious symptoms of disease (Skin, liver failure, Gastrointestinal problem) and thus not being able to do work. The average wage of respondent was 634.02 rupees with minimum and maximum of 138 and 2300 rupees per month. Time lost per visit to the doctor is also a responsible to delay or loss the work day of the patient, average and maximum time lost were 0.40 and 5 hours per visit. The average work day lost was with minimum and maximum value of 0.26 days and 4 days per month. We calculated the cost due to loss of working according to their wage rates. The average cost due to work day lost was Rs. 191.27 and maximum was Rs. 9200 which is indirect cost by incurring of these disease (Skin, liver failure, Gastrointestinal problem) which put extra economic burden on respondents.

Table: Components of Health Cost

Components	Units	Observation	Mean	St. Dev	Min	Max
Number of visits	Numbers	150	0.53	1.89	0	20
Doctor fee	Rupees	150	28.13	73.84	0	400
Medical expenditure	Rupees	150	239.33	877.43	0	6000
Traveling cost	Rupees	150	27.533	109.37	0	1000
Time lost per visit	Hours	150	0.40	0.94	0	5
Wage rate	Rupees	150	634.02	389.76	138	2300
Working days lost	Numbers	150	0.26	0.70	0	4
Cost of working days lost	Rupees	150	191.2733	852.6571	0	9200

Picture: Various skin disease symptoms in the people of study area.

Appendix 2

QUESTIONNAIRE

Name ______________________ **Address**____________________________________

Contact No/ email____

Gender _______ **Education**____________ **Age**_______________ **Occupation** __________________

Daily working hours? __________________ **Approximate monthly income?** ____________________

Monthly expenditure? _________________ **Total Household members** __________ **Male** ____ **Female** ______

Awareness questions water and arsenic:					
1. What is quality of your ground water?			Good ☐	Average ☐	Poor ☐
2. Have you or any team tests your ground water source quality?			Yes ☐	No ☐	D.Know ☐
3. Have you ever heard about arsenic poisoning?			Yes ☐	No ☐	D.Know ☐
4. Is your water contaminated with Arsenic?			Yes ☐	No ☐	D.Know ☐
5. If yes than how do you know that your water is contaminated with arsenic?			Surveys in past ☐	Neighbor/ friend ☐	Lab test ☐
6. If yes (Q.4) than are you still drinking Arsenic contaminated water?			Yes ☐	No ☐	
7. If positive then what was the result? ______ and did you take any averting measure to avoid from arsenic poisoning?			Yes ☐	No ☐	
8. If yes (**Q.7**) than what kind of averting measures are you using for arsenic poisoning?	Boiling of water ☐	Filter water ☐	Bring water from safe source ☐	Shifted to Bottled water ☐	Other ☐
9. If bring water from safe source than how much time consumes to bring the water?___________					
10. How much safe source is away from your village? _____________					
11. Do you believe that water polluted with arsenic has negative impact on health?			Yes ☐	No ☐	D.Know ☐
12. Any person died death due to arsenic?(liver, kidney failure, skin)			Yes ☐	No ☐	D.Know ☐
13. If died then in what age?__________					
14. If working at the time of death then salary?__________					
15. If yes (Q.10) than what kind of effect (diseases) you can foresee?					
A) Skin disease			Yes ☐	No ☐	D.Know ☐
B) Liver failure (Hepatitis)			Yes ☐	No ☐	D.Know ☐
C) Gastrointestinal problems			Yes ☐	No ☐	D.Know ☐
16. What kind of diseases mainly facing by your household members? (**elaborate 3 diseases**)			___________	___________	___________

17. INFORMATION ABOUT USAGE OF WATER:					
	Ground water from home	**Water from Neighbor's**	**Outer H.P/ filtration plant**	**Bottled water**	**Since how long (years)**
I. DRINKING	☐	☐	☐	☐	☐
II. COOKING	☐	☐	☐	☐	☐
III. WASHING DISHES	☐	☐	☐	☐	☐
IV. BATHING	☐	☐	☐	☐	☐

Family/Household information and Health cost in last six month																	
				Household (Disease Information)					Health cost Rupees								
SR. No	Age	Edu	Relation of responded with family member	Skin Disease Yes=1 No=0	Liver failure Hepatitis Yes=1 No=0	Gastrointestinal Problem Yes=1 No=0	Frequency of disease	Medication source Private Govt Hospital	Consulted a doctor Yes=1 No=0	No of visit to the doctor	Doct Fee	Medical exp	T.traveling cost	Time Lost for Visits	Wage rate/monthly income	Working days lost Hours	
M1																	
M2																	
M3																	
M4																	
M5																	
M6																	
M7																	
M8																	
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F10																	