A STUDY ON IMPACT OF NATURAL BACKGROUND RADIATION AND PHYSICAL ENVIRONMENT ON HEALTH OF THE SLUM PEOPLE IN KHULNA CITY

M. Sc. Thesis

AMINA CHOWDHURY

DEPARTMENT OF PHYSICS
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
KHULNA-9203, BANGLADESH

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AMINA CHOWDHURY
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DEPARTMENT OF PHYSICS
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
KHULNA-9203, BANGLADESH
APRIL, 2016

DECLARATION

This is to certify that the thesis work entitled "AStudy on Impact of Natural Background Radiation and Physical Environment on Health of the Slum People in Khulna City" has been carried out by Amina Chowdhury in the department of Physics, Khulna University of Engineering & Technology, Khulna, Bangladesh. The above thesis work or any part of this work has not been submitted anywhere for the award of any degree or diploma.

Signature of Supervisor

.....
(Professor Dr.Jolly Sultana)

Signature of Candidate

.....
Amina Chowdhury

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF PHYSICS

Approval

This is to certify that the thesis work submitted by Amina Chowdhury entitled **"A Study on Impact of Natural Background Radiation and Physical Environment on Health of the Slum People in Khulna City"** has been accepted by the board of examiners for the partial fulfillment of the requirements for the degree of *Master of Science* in the Department of Physics, Khulna University of Engineering & Technology, Khulna, Bangladesh on 30 April, 2016.

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To

My Beloved Parents

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Author

ABSTRACT

In urban areas of developing countries the presence of slum is very common. Bangladesh is one of the rapidly urbanizing countries. The number of slums has significantly increased in Bangladesh over the last three decades along with the expansion of cities and towns. Basic facilities are very much unsatisfactory for the slum people. Due to lack of proper water supply and sanitation system they suffer several diseases. Natural uranium concentration is also high in tube well water which is responsible for kidney diseases. The urban population particularly poor live in a crowded, damp and highly polluted environment.Against this background the study was performed in Khulna city.The present work has been designed to investigate the life-style health, sanitation profile, the existing status of access of the slum dwellers, identify the status of water use, hygienic condition, background radiation conditions and its impact on health of the slum people of Jabdipur slum, Bagmara slum, Bastuhara slum and Muripotty slum of Khulna City in Bangladesh. The area has been selected by using purposive sampling technique and data has been collected from 339 households, which have been surveyed by using systematic random sampling technique. Data has also been collected via questionnaires, personal interview, and direct observation and focus group discussions. It has also been explored the water security and safety at the point of consumption, problems faced in getting safe drinking water, drainage facilities, solid waste disposal system, knowledge of the features of hygienic latrine, awareness about health etc. It has been found that the services to water supply, sanitation and health is hardly related to income, occupation, housing and educational status. It has also been found that housing structure and occupational pattern of the slum people are highly vulnerable situation. Income level, sanitation, solid waste disposal and drainage pattern are in greater vulnerable situation. The work may attribute to further research on water supply and sanitation study. It will guide those who will work to improve the present.

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ABBREVIATION

ABR	Advance Biomedical Reserve
BAEC	Bangladesh Atomic Energy Commission
PHE	Public Health England
CC	Cochrane Community[beta]
W NA	World Nuclear Association
GCNB	Government of Canada navigation bar
HPS	Health Physics Society
IAEA	International Atomic Energy Agency.
WHO	World Health Organization.
AIH	Australian Indigenous Health
KUB	Khulna University Bangladesh
SN	Science Nature
UPPR	Urban Partnership for Poverty Reduction
CUS	Centre for Urban Studies
BBS	Bangladesh Burau of Statistics
PRA	Participatory Rural Appraiser
KCC	Khulna City Corporation

CHAPTER I

INTRODUCTION

1.1 Introduction

Radioactive pollutions are increasingly becoming great concerns for human beings. It is directly linked to human health. Pollution is broadly categorized into two groups - one is manmade and other is natural. Arsenic, uranium, radon etc. are natural pollutants while CO_2, I^{131}, Cs^{137} etc. are the manmade pollutants which pollute the nature. We live in such a world that there is no place on earth that has no natural radioactivity. More than sixty radionuclide's can be found in the environment, which can be divided into three general categories: Primordial (which formed before the earth creation), cosmogenic (which formed as a consequence of cosmic ray interactions), and human produced (which formed due to human actions; they are minor amounts compared to natural). Radionuclides are found naturally in air, soil, water, and food. Natural radioactivity is common in the rocks and soil that constitute planet earth, in water and oceans, and in building materials and homes. Some radioactive nuclides are detectable in soil. They belong to natural radionuclides such as the members of the uranium and thorium decay series. More specifically, natural environment radioactivity and the associated external exposure due to gamma radiation depend on the geological and geographical conditions and appear at different levels in the soils of each region in the world. The specific levels of terrestrial radiation are related to the geological composition of each lithologically separated area and to the content of the rock from which the soils originated in each area in the radioactive elements of thorium (^{232}Th), uranium (^{238}U), and potassium (^{40}K).

All building materials contain various amounts of radioactivity. For example, materials derived from rock and soil contains natural radionuclides of the uranium and thorium series and the radioactive isotope of potassium. Artificial radionuclides can also be present, such as cesium (^{137}Cs), resulting from the fallout from weapons testing and the Chernobyl accident. All these can be sources of both internal and external radiation exposures. Internal exposure occurs through the inhalation of radon gas, and external exposure occurs through the emission of penetrating gamma rays

Considering that about 50% of natural exposure of people is from radon gas, it is the leading cause of cancer patients suffering from respiratory and gastrointestinal system problems, and the highest percentage of radon that enters the human body is from drinking water and breathing. Once radon in water supplies reaches consumers, it may result in human exposure via inhalation and direct digestion. Radon in water transfers into the air during the rains, flushing toilets, washing dishes, and washing clothes. The aerosols tend to deposit in the lungs, where they release radiation that has been shown to increase the likelihood of lung cancer. Radon can also reach other body tissues through ingestion, resulting in radiation exposure to the internal organs. Ingestion of radon is believed to increase the risk of stomach cancer. Besides the effect of soils in population exposure by using them as building material, they can affect the human body by taking the food containing radionuclide, which enters the food chain from deeper soil layers and also tainting the ground water. Owing to the inevitable effects of radiations and health risk from these exposures, it is necessary to investigate all reported data in the last few years.

Poverty has long been associated with the rural masses in developing countries, which have rightly been the targets of development and food assistance programs. With the growth of cities, poverty is increasingly becoming visible among city dwellers to the extent that many urban poor live in absolute poverty. UN Habitat estimates that there are currently 924 million slum dwellers in the world, making up one third of the global urban population. This number could grow to 1.5 billion by 2020 unless a significant health and infrastructure interventions and pro-poor housing and tenure policies are undertaken. The poor are the fastest growing population in urban areas. A quick look at the absolute numbers of urban poor populations living in the developing region reveals a challenge of staggering proportion. Sixty percent of the world's slums are in Asia. In absolute numbers, Asian slum dwellers outnumber those of any other region, with about 550 million people living in Asian slums. (UN Habitat 2003). Urban poverty has many facets that need to be considered such as housing as well as levels of income and consumption. Poverty is conventionally defined in terms of incomes that are inadequate to permit the purchase of necessities, including food and safe water in sufficient quantity. In such populations, Housing/shelter may be of poor quality, overcrowded or

insecure. Inadequate provision of public infrastructure (piped water, sanitation, drainage) can increase health burdens (Montgomery, 2003). The number of slum area and gathering of poor people in some important points of the city shows the large existence of urban poor in this city. As they do not have any permanent resident, they are deprived of basic utility and service facilities like-water supply, sanitation, drainage, health,educational facilities, electricity,garbage disposal etc.The lower income group people living in the slums suffer, according to an estimate, from various types of diseases like malnutrition, diarrhea, dysentery, cough, fever, skin diseases, headache,gastric, etc.

Bangladesh is one of the rapidly urbanizing countries. Rapid urbanization, caused largely by heavy influx of migrants from rural areas, has exerted sever pressure on public services in the metropolitan city of Khulna with which the expansion of infrastructure and basic urban services could not cope. This situation coupled with the destitute economic condition of poor migrants has given rise to the formation large numbers of slums, where services inadequacies have been compounded and multiplied on a massive scale, resulting in a hazardous environmental condition. The Millennium Development Goals (MDG) target of significantly improving the lives of at least 100 million slum dwellers by 2020 will depend in part on improved provision for water and sanitation, so having the proportion of people without "sustainable access to safe drinking water" and "basic" sanitation by 2015 will depend in part on urban households that are able to move to new homes with better provision or able to invest in better provision within their existing home. However, slum dwellers in Bangladesh are behind from the millennium development goals. There are about 132 slims in the Khulna city corporation area of varying sizes where the cities poor lived in about the characteristics of unmetalled and semi-metal led structures of these settlements are deprived by basic urban services. High population density combined with inadequate infrastructure and sanitation facilities creates a deplorable environmental condition in these slums. People's access to various basic essential services is very limited in urban poor areas. The populations of urban area increases but the services are not. Although located within city corporation limits, the slums and squatters facilities have limited access to the urban services. These problems are acute in Khulna city but some other large metropolitan city has faced the same. These services are basic right for every urbanite, but the slum dwellers are not able to get these services.

According to a city corporation estimate, about 1.5 million are now living in the metropolitan area.The population of urban area increases but the services are not. Although located within city corporation limits, the slums and squatters facilities have limited access to the urban services. Thesis problems are acute in Khulna city but some other large metropolitan city has faced the same. These services are basic right for every urbanite, but the slum dwellers are not able to get these services. The study tries to find out the existing status of access of the slum dwellers to some selected urban services and explore the conditions and problems of such services of the Jabdipur slum, Bagmara slum, Bastuhara slum and Muripotti slum in Khulna city. The main goal of this study is to identify the status of water use, sanitation and hygienic condition and its impact on health of the population living in this region.

1.2Background of the research

Bangladesh is one of the world's most densely populated countries with 150 million people, 49% of whom live below the national poverty line. Urban poverty in Bangladesh is evident in all the towns and cities. It is estimated that 43% of urban households live below the poverty line among which 23% are considered extreme poor. Around 35% of the populations of six major cities live in slums which cover only 4% of their land area with limited or no access to services. Khulna city is located in the southwest part of Bangladesh and the central part of the Jessore-Khulna-Mongla axis. It is the third largest city of the country with a population of more than one million. Khulna experienced the faster growth of population and industrial expansion during 1950 to 1960.

Rapid urbanization, caused largely by heavy influx of migrants from rural areas, has exerted sever pressure on public services in the Khulna city corporation area with which the expansion of infrastructure and basic urban services could not cope. The millennium Development Goals (MDG) target of significantly improving the lives of at least 100 million slum dwellers by 2020 will depend in part on improved provision for water and sanitation. However, slum dwellers in Bangladesh are behind from the Millennium Development Goals. Moreover, most of the people are living in poor status. They faced various types of financial problem. So they involved different types of income earning occupation. Most of them are involved in fish processing industry. Most of the women are involved in fish selling and thus create an

unhealthy environment in around them because at first they selling and thus create an unhealthy environment in around them because at first they process their fish in their house then sell. Not only this, but also there exists unhealthy environment which affects their health. Considering the study above, this study has been designed to investigate the life-style health and sanitation profile.. The study also tries to find out the existing status of access of the slum dwellers to some selected urban services and explore the conditions and problems of such services in slum. The main goal of this study is to identify the status of water use, sanitation, hygienic condition, natural background radioactivity in soil, water, and air and its impact on health of the slum people of Jabdipur slum, the Bastuhara slum and the Muripotty slum.

1.3 Justification of the study

Radiation has always been present and is all around us in many natural forms.Radioactivity and ionizing radiations treated as one of the severe health hazard for the human beings. Even a low level activity in the air can cause a significant damage in the body.Humans are always exposed to a background radiation spread of radioactive nuclei in the air, soil, rock, water, and building materials. The annual average effective dose from natural background radiation is 2.4 mSv worldwide. People exposed to high radon levels, cigarette smokers are much more likely to get lung cancer than non- smokers. Radiation is energy in the process of being transmitted. It may take such forms as light or tiny particles much too small to see. Visible light, the ultra-violet light we receive from the sun, and transmission signals for TV and radio communications are all forms of radiation that are common in our daily lives. These are all generally referred to as 'non-ionizing' radiation, though at least some ultra-violet radiation is considered to be ionizing. Radioisotopes such as polonium-210, carbon-14 and potassium-40 naturally occur within the human body. In our daily life, we are exposed to various types of naturally occurring radiation from cosmic rays, from radioactive substances in the earth, and from naturally occurring radiation in our bodies.During the past few decades, rapid strides in industrialization and nuclear waste generation have resulted in modifying the environmental radiation profiles. A great deal of study is under way at various levels to learn extensively about the nature and sources of human exposures to radiation and radionuclides. Radiation exposure increases incidence rate of fatal cancer to the exposed persons. It is therefore, very important to know the population exposure to this natural radiation in Khulna City.

Slum population has largely increased in Bangladesh over the last three decades along with the growth and expansion of cities and towns. The urban faculties are quite unsatisfactory for urban dwellers in Khulna city. Poverty, high density, the absence of utilities and lack of infrastructure are common features of urban slums. The environment of the slums is extremely unhygienic. The urban poor and the residents of slums have been affected most negatively by urban service deficiencies. Low income families member may suffer from malnutrition, a condition in which their body is either not getting enough healthy food or too much unhealthy environment. Then, it was impossible to fulfill their basic requirement of life. Furthermore they have very little knowledge about sanitation and hygiene, so most of them suffer from different types of diarrheal diseases.Most of the people are living in poor status. They faced various types of financial problem. So they involved different types of income earning occupation. Most of them are involved in fish processing industry. Sothe unhealthy environment also affected their health.

Considering the all above facts, this study has been designed to investigate the physical environment and the life style health. This study would be helpful to find out the problems of different types of services and facilities. This study also point out the present circumstances of services and facilities in the study areas. This research also identifies the major environment problems which affect the slum dwellers in selected studyareas. This proposed research would evaluate the activities of government and other organization's aimed improving the physical environment of the slum areas. In this respect, this as a result can provide a guideline to establish future strategies for developing physical environment of urban slums

This proposed study would be the first attempt towards the investigation of life style health and sanitation profile of this deprived group of population in Khulna City. As such it is needed to take necessary steps regarding their physical environment, which can ensure the better urban environment to safeguard the urban masses. In this context this study is very much crucial. It is expected that the results of this study will be helpful for other researcher to conduct research in this regard.

1.4 Objectives of the Research

- To assess the existing physical environment of the slum people.
- To findout the consequences of environmental factors with respect to housing, literacy, income and occupation.
- To know the natural background radiation in soil, water and air in the study area and its impact on human health.
- To investigate the life-style health, the status of water use, sanitation profile and hygienic condition and its impact on health of the population living in this region.
- To find out the existing status of access of the slum dwellers, main causes of various kinds of diseases and explore the conditions and problems of such services of those slum areas.

1.5Limitations of the study

The limitations of the study area are as follows:

- This study has been conducted only few peripheral slum in Khulna city and it seem a bit inadequate to portray the overall house hold scenario.
- Inadequate and isolated secondary information of the concerned area has been confined the study.
- Lack of instruments to detect the level of radiation in soil, water and air.
- In some cases, due to ignorance of the people the study has been confronted lake of adequate information from the people.
- Most of the respondents are illiterate. So their response regarding various issues of the study may not reflect the actual picture.
- Both the respondents and the organizational officers took a long time to understand the reason of the survey and took a loge time to answer, and all of them were not able to answer accurately.
- The time was too limited to conduct this work.

CHAPTER II

Literature Review

2.1 Background of Radioactivity

Radioactivities in the nature either from artificial sources or natural sources may cause several dangerous diseases like cancer, renal, bone and cardiovascular diseases. Radioactive pollutants from air, water and soil enter into human bodies directly or through food-chain. Natural uranium enters into human bodies mainly through drinking water or through food-chain when groundwater is used for food-production. Radon, a decay product of uranium, is the 2nd leading cause of lung cancer after cigarette-smoking. Uranium is a weak chemical poison that can seriously damage kidneys at high concentration in blood. Major health hazard of uranium in the body is renal failure. In Bangladesh, the latest statistics on kidney disease is very alarming. Every year, more than 35,000 new patients are attacked by various kidney diseases with nearly 40,000 dying. Origin of most of these diseases is linked to hypertension and diabetic but it is imperative to say that dissolved uranium in drinking water may also contribute at least a fraction to this fatal disease. Unlike other countries, people of Bangladesh have been using groundwater from millions of tube wells for their drinking purpose. In the rural areas, water supply system varies from family to family. Right now, none of the departments working on water has any facility to measure the uranium content in groundwater of Bangladesh. In a preliminary survey, British Geological Survey team detected uranium content in groundwater of Bangladesh. According to its report, the maximum uranium concentration was observed 47 μgL^{-1} in Chapainawabganj whereas the maximum acceptable concentration is 30 μgL^{-1} according to USEPA [USEPA 2000]. It is necessary to measure uranium level through a comprehensive survey in the drinking water like the survey was done for arsenic contamination.

Naturally occurring radiation is known as background radiation. There is no place on earth that has no natural radioactivity.Some radioactive nuclides are detectable in soil. All building materials contain various amounts of radioactivity. For example, materials derived from rock and soil contains natural radionuclides of the uranium and thorium series and the radioactive isotope of potassium. Artificial radionuclide's can also be present, such as cesium (^{137}Cs), resulting from the fallout from weapons testing and the Chernobyl accident. All these can be

sources of both internal and external radiation exposures. Internal exposure occurs through the inhalation of radon gas, and external exposure occurs through the emission of penetrating gamma rays. Considering that about 50% of natural exposure of people is from radon gas, it is the leading cause of cancer patients suffering from respiratory and gastrointestinal system problems, and the highest percentage of radon that enters the human body is from drinking water and breathing. Once radon in water supplies reaches consumers, it may result in human exposure via inhalation and direct digestion. Radon in water transfers into the air during the rains, flushing toilets, washing dishes, and washing clothes. The aerosols tend to deposit in the lungs, where they release radiation that has been shown to increase the likelihood of lung cancer. Radon can also reach other body tissues through ingestion, resulting in radiation exposure to the internal organs. Ingestion of radon is believed to increase the risk of stomach cancer. Besides the effect of soils in population exposure by using them as building material, they can affect the human body by taking the food containing radionuclide, which enters the food chain from deeper soil layers and also tainting the ground water.Owing to the inevitable effects of radiations and health risk from these exposures, it is necessary to investigate all natural radiations, including cosmic, terrestrial, and food radiation.

Radiation is everywhere, including in the soil. Radionuclide's in the soil can move into the water, air and even our food supply. Natural radiations in the environment, nuclear tests, accidents and possible leakages from nuclear facilitiesmayresult in serious problems for environment and human health.Naturalenvironmental radioactivity arises mainly from primordial radionuclide's from the 235U,238Uand 232Th series, followed by 40k. Gamma radiation emitted from those naturally occurring radionuclide's and from radionuclide's deposited on the ground are the main external sources of radiation exposure of the human body. Natural environmental radioactivity and associated external exposure due to gamma radiation depend primarily on the geological, geographical, altitude and mineralogical structures of soil and rocks (Ismal 2014).

Nearly eighty five per cent of the radiation dose received by humanity comes from natural radiation sources. The knowledge of primordial radionuclides is an important prerequisite for the evaluation of the rate of exposure and the absorbed dose by the population. The long-lived

naturally occurring radionuclides may get transferred to plants along with the nutrients during mineral uptake, accumulate in various parts and even reach in the edible portions. Abnormal occurrences of uranium and its decay products in rocks and soils and thorium in monazite sands have been identified in several areas of the world.

Bangladesh is operating a 3 MW nuclear research reactor, a radioisotope production facility, a high activity gamma irradiation facility as well as other radiological facilities for the benefit of the people of the country.Moreover Bangladesh is planning to establish nuclear power plants to improve its energy mix. Neighboring countries have a number of nuclear power plants in operation. Accidents may happen in nuclear installations inside the country as well as in the neighboring countries causing the spread of radioactivity and consequently, influencing the background radiation level and hence, causing the increase of exposure level to public in this region. Almost every country with nuclear facilities or facilities in neighboring country has its own background radiation mapping database to be used in time of any incident or accident in these nuclear facilities.

The radioactivity in the environmental samples is mainly due to uranium and its daughter products. Uranium is picked up by water from the rocks and soil by leaching. Radon content of water is due to the decay of radium, which is the immediate decay product of uranium, picked up from the rock and soil and dissolution of trapped radon. On the other hand radon is the only gaseous state of the U- 238 series. Uranium is a naturally occurring radioactive element that is radiologically and chemically toxic as well as a hazardous environmental pollutant. Average abundance of uranium in the earth's crust is about 2 mg per kg (range 0.1 to 20 mg per kg). Natural uranium contains three isotopes with an isotopic abundance of ^{238}U: 99.2745% ± 0.0015%; ^{235}U: 0.72% ± 0.001%; and ^{234}U: 0.0055 % ± 0.0005% (Holden, 2003). In water most of the uranium is dissolved. Although uranium is radioactive but principle health effects are from chemical toxicity. Uranium is introduced into the human body mainly through ingestion of food and water and inhalation of air. Only 2 percent to 5 percent of ingested uranium is absorbed in the gastrointestinal tract, the rest is eliminated from the body. The absorbed uranium is carried through the bloodstream and will be filtered by the kidney and excreted in the urine in 24 hours. As a result nephritis is the primary chemically induced

effect of uranium in humans. Water having uranium concentration above the proposed Maximum Acceptable Concentration (MAC) levels of Australia (15 μg L^{-1}; ADWG, 1996), U.S. (30 μg L^{-1}; U.S.EPA, 2000), Canada (20 μg L^{-1}; Health Canada, 2002), WHO (15 μg L^{-1}; WHO, 2003) is not safe for drinking purposes as it causes to harmful health effects in humans. According to British Geological Survey report (BGS, 2000) the maximum uranium concentration observed was 47 μg/L in Chapai Nawabganj in Bangladesh. As we know uranium in water is highly toxic for human health, to prevent the toxic effect of uranium at first it needs to know the source of uranium from which it could inject into the body. Usually uranium injected into the body from water. So a nationwide comprehensive survey becomes important to know the level of uranium concentration in ground water of all the tube wells of Bangladesh for the health risk assessment. In a preliminary survey, British Geological Survey team detected uranium content in groundwater of Bangladesh. According to its report, the maximum uranium concentration was observed 47 μgL^{-1} in Chapainawabganj whereas the maximum acceptable concentration is 30 μgL^{-1} according to USEPA. It is necessary to measure uranium level through a comprehensive survey in the drinking water like the survey was done for arsenic contamination.

Maximum Acceptable Concentration (MAC) levels of uranium in drinking water is of Australia (15 μg L^{-1}; ADWG 1996), U.S. (30 μg L^{-1}; U.S.EPA 2000), Canada (20 μg L^{-1}; Health Canada 2002), WHO (15 μg L^{-1}; WHO 2003). In this work it was found the range of uranium content to be 0.50±0.33 to 56.27±0.52 ppb from various of Bangladesh. So the range of uranium concentration in drinking water found in this study lie towards the low side of the ranges, reported for other locations. Table 2.1 shows that range of uranium concentration in groundwater worldwide. (Sultana 2009)

Radon is a radioactive noble gas occurring naturally in the environment. It is produced by the decay of uranium in soil and rock. The release of radon from its source matrix into groundwater, as agreed by many investigators is governed by the alpha recoil process and subsequent diffusion. The alpha recoil takes place during radon formation in the decay of its immediate parent (Ra-226).

Table 2.1 Uranium concentration in groundwater world wide

Sr. no.	Country	Range of Uranium Concentration (ppb)	References
1	Ontario, Canada	0.04-4.21 (0.4)	
2	USA	0.01-652	(Drury*et.al.*, 1981; Edgington, 1965)
3	New York, USA	0.03-0.08	(Fisenne, 1986)
4	Argentina	0.04-11.0 ppb(1.3)	(Bomben, 1996)
5	Australia	>20 ppb	(Hostetler, 1998)
6	Turkey	0.24-17.65 ppb	(Kumru, 1995)
7	India	0.08-471.27 ppb	(Taluedar, 1983)
8	Japan	(0.0009)	(Nozaki, 1970)
9	Norway	>20	(Frengstad, 2000)
10	New Mexico	>20	(Hakonson, 2002)
11	Jordan	0.04-1.400(2.4)	(Gedeon, 1994)
12	Kuwait	0.02-2.48	(Bou-Rabee, 1995)
13	South Greenland	0.5-1.0	(Brown, 1983)
14	Himalayas	0.89-63.4	(Virk, 2001)
15	Finland	2.1-2900(26)	(Kahlos, 1980)
16	Cyprus	0.005-38(086)	(Smith, 2000)
17	Pakistan	0.05-5	(Akram, 2004)
18	Sea Water	3.0-3.6	(Kaya, 1993)
19	Chapainawbabgonj, Bangladesh	<47 ppb	(BGS, 2000)
20	Bangladesh	0.99-56.10 ppb	(Sultana, 2009)

The transfer from the rock surrounding to groundwater is mostly by diffusion through crystalline lattices and through and along cracks and the crystal boundaries. However, ^{222}Rn is short-lived (half-life, $T_{1/2}$ = 3.82 days), which will limit the distance of movement from the source before decaying. It is therefore expected that radon in groundwater would be correlated with the local uranium/radium abundance in rock and soil. It may therefore be useful to convert measurement points to continuous surfaces (raster or girded format) before performing such kind of correlation analysis. The importance of generating these surfaces is that they are used as the basic information to perform further spatial analyses in environmental applications. Based on these surfaces, it is possible to carry out additional analyses to answer questions related to environmental problems, such as health effects due to radon exposure. The accuracy of subsequent analyses directly depends on the accuracy of the surfaces built in the early stage of analyses.

2.2 Radiation inside the Human body

Radiation is a part of the natural environment. This background radiation is contributed principally by three sources: terrestrial radiation, cosmic radiation, and radiation from radioactive elements in our bodies.There are basically two ways that people can be exposed to radiation: they can be exposed externally to a close source of radiation or they can be exposed internally by radioactive material that has entered the body. For external exposure, the intensity of radiation falls with distance from the radiation source, just as the brightness of light falls with distance from a light bulb. The total amount of external exposure will also depend on the length of time the person remains close to the source.

Radioactive material can be taken into the body by consuming foodstuffs and liquids with radioactivity in them, by inhaling radioactive gases or aerosol particles, or by absorption through wounds in the skin. The material taken in will internally expose the organs and tissues for as long as it remains inside the body. Radioactive gas will have a short residence time, while inhaled aerosols will take longer to clear the lungs. Ingested material will reside for some time within the gastrointestinal tract but then radioactive elements will be taken into the body and metabolized in the same way as non-radioactive forms of the same chemical

element.Table 2.2 gives average values of background radiation to which various parts of the body are exposed annually.

Inhalation

The earth's crust produces radon gas, which is present in the air we breathe. Radon has four decay products that will irradiate the lungs if inhaled. The worldwide average annual effective dose of radon radiation is approximately 1.3 mSv. A recent Health Canada survey on radon in homes reported that the radon levels in 93percent of Canadian homes are below the current Canadian guideline of 200 Bq/m^3.

Ingestion

Natural radiation from many sources penetrates our bodies through the food we eat, the air we breathe and the water we drink. Potassium-40 is the main source of internal irradiation (aside from radon decay). The average effective dose from these sources is approximately 0.3 mSv a year.

Table 2.2: Average values of background radiation of the body are exposed annually.

Source	Dose Equivalent Rate(mSv/y)			
	Bronchial Epithelium	Other Soft Tissues	Bone Surfaces	Bone Marrow
Cosmic	0.27	0.27	0.27	0.27
Cosmogenic	0.01	0.01	0.01	0.03
Terrestrial	0.28	0.28	0.28	0.28
Inhaleds	24	0	0	0
In the body	0.35	0.35	1.1	0.50
Rounded totals	25	0.9	1.7	1.1

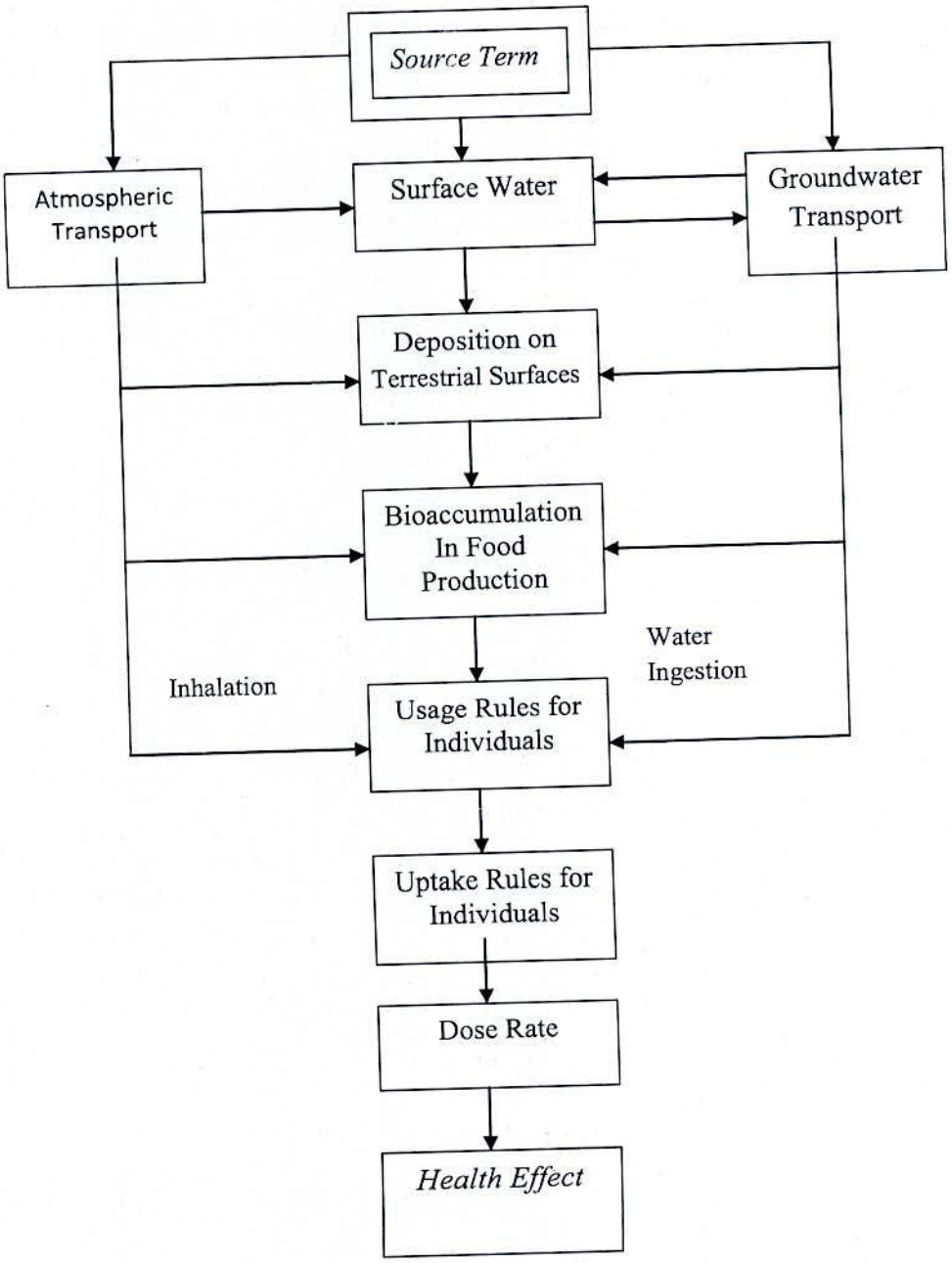


Fig. 1.1 Environmental pathways for potential human health effects for radionuclide (Orloff, 2004).

2.3 Physical Environment of Slum Area in Khulna City

Physical environment is determined based on some specific facilities and absence of these facilities means presence of different types and levels of pollution. These polluted consequences make the living environment more unhygienic and inhabitable. "The overall physical environment in an urban area is determined by some specific facilities such as housing, sanitation, sewerage, drainage, drinking water supply, gas supply, electricity, garbage disposal and waste management. There is a chronic shortage of housing, congestion in public transport, acute crisis in supply of water, gas and electricity. Increasing pressure of population upon the civic amenities has resulted in air, water, noise pollution and an increase in urban crimes. (Jahan, 2012).

Physical environment includes

- Natural environment – air, noise, water, green space
- Built environment – houses, roads, transport systems, buildings, infrastructure (Built environment includes internal environment and external environment.)
- Socio-economic and Cultural – the social and economic characteristics of the societies and communities in which we live (PHE, 2013).

There are many strategies to develop slum area and these strategies include both physical environment and infrastructure interventions. It also includes particularly water and sanitation, energy infrastructure, transport infrastructure, environmental hazard, waste management and housing improvement under the physical environment and infrastructure interventions. According to the Slum Upgrading Strategies Involving Physical Environment and Infrastructure Interventions and their Effects on Health and Socio-economic Outcomes, the potential physical environment interventions include the following (Turley, 2013).

- Water and sanitation: improved access to sanitation (e.g. private latrines), access to adequate water quality and quantity for drinking and other needs (e.g. piped water into dwelling), drainage and flood protection.
- Energy infrastructure e.g. gas or electricity supply, improved cook stoves.
- Transportation infrastructure e.g. building toad networks, emergency access roads, Public transportation, paved sidewalks and footpaths, installing street lighting.

- Mitigation of environmental hazards (flood, landslide and waste) via ground stabilization, water drainage, sewerage systems, waste disposal and collection.
- Waste management e.g. curbside waste collection.
- Housing improvements e.g. improved flooring.

Settlement in slum area

Settlements refer to place in where people live in and it is known as housing also. Housing is often regarded as one of the basic human needs. It ranks second after food and thereafter clothing. It is a pre-requisite for the survival of man (Onibokun, 1985). Omole mentioned in An Assessment of Housing Condition and Socio-Economic Life Styles of Slum Dwellers in Akure, Nigeria that housing as a unit of the environment has profound influence on the health, efficiency, social behavior, satisfaction and general welfare of the community. He also discussed about the quality of housing in the Slum area is very low due to the low quality materials used for construction and the inadequate technology as well as poor planning standards of handling the building components (Omole, 2010).

A report named Urban Slum of Bangladesh is published by The Daily Star on June 5, 2014, this report illustrated the housing quality of slum area in six cities. The majority of slum houses in the six cities were of very poor quality (weak and temporary structures or kasha units), while another were semi-pucca type. A very small proportion was dilapidated older buildings, while only 0.5 percent was good quality homes. This report also compared the quality of settlements among six cites. Such as the physical quality of slum housing was generally better in Dhaka and very poor in Khulna and Barisal.

Water supply and sanitation in slum area

Water supply and sanitation facilities are very concerning issues in our country especially in urban slum areas. People living in slum areas do not have access to safe drinking water and sanitation facilities. Only a small portion of the city dwellers have access to sewerage system. According to the Assessment of Water Supply and Sanitation Facilities for Korail Slum in Dhaka City, water supply and sanitation facilities in terms of quality and quantity are outmost necessary for assessing the living environment of the slum. In slum area, it has no proper arrangement of water supply and sanitation system that create an adverse effect on city's

environment. This study also discusses about water supply facilities and the problems in fetching water from the source. Sanitation situation is worse than water supply in the low cost areas. The commonly available sanitation facilities include pit latrines, bucket latrines and water seal latrines in slum area (Biplob, 2014).

"Slum dwellers in the city are disadvantaged in terms of their access to urban services like safe water, electricity, gas supply, toilet facilities and garbage disposal. The quality of these services has been found to be poor and the supply remains highly irregular and inadequate. Most slum dwellers have access to safe water for drinking purpose only. And most use unsafe water for washing, bathing and other purposes. A small proportion of the urban poor use sanitary latrines and the majority still use a variety of non-hygienic latrines" (Hossain, 2008).

According to Slum of Urban Bangladesh; mapping & census 2005, the major sources of drinking water in slums areas were municipal taps and tube wells. A small proportion of households collected drinking water from other sources (rivers, ponds, lakes, canals etc.). Dhaka's slum residents typically relied on municipal tap water while those in the other cities usually used tube wells. This study also discussed about the sanitary system in slum areas. Dhaka slum residents had the best access to safe latrines while those in Sylhet and Barisal had very poor access Pit latrines, a variety widely regarded as unsafe, were common in slum areas. In almost all slums, latrines were usually shared by two or more households (CUS, 2006).

In the study named Sanitation, Hygiene and Water Supply in Urban Slums, "Slum houses perch on the edges of fetid cesspools as there is inadequate sewer drainage and little access to sanitary latrines. People are not motivated to spend money on sanitation infrastructure. The use of hanging latrines, suspended over rivers and ponds, is three times as common in urban slums as in the country at large. This means that urban water sources are likely to be contaminated with raw sewage. Poor sanitation leads to an increased prevalence of diarrhea and other parasitic diseases. Hygiene awareness and knowledge of the links between poor hygiene and disease are lowest among the typically poorly-educated slum dwellers".

Waste management in slum area

UNICEF mentioned in their Sanitation, Hygiene and Water Supply in Urban Slums, "Millions of slum-dwellers in Bangladesh live stressful lives among teaming rubbish because there is no waste disposal system. In slums, the lack of solid waste management is one of the biggest factors for environmental pollution and health risks. Solid waste is responsible for 49 vector borne diseases, such as dengue, in Bangladesh" (UNICEF, 2008).

Solid waste management is one of the big challenges for the city authority or other related responsible authority. According to Solid Waste Service Delivery for Slum Areas through Strengthening Partnership between Local Government and NGOs (Chowdhury, 2007), "Solid waste service delivery is expensive. Local governments have financial and administrative limitation to meet growing demand for SWMS. The main identified problems of solid waste and disposal in slum areas are

- Lack of awareness of waste disposal and environmental sanitation at household level;
- No or very little awareness about solid waste management at community level;
- Roadside bins are insufficient and often broken;
- Scattering of waste from bins by animals and scavengers;
- Throwing of waste into drains which causes blockages and overflow into streets;
- Limited capacity of city administration to provide services for solid wastes removal.

"There is no fixed place for waste disposal in slum area. Generally wastes are disposed wherever they live like on the ground or above the water body. Therefore, scattered wastes are found visible in open place. It indicates that adequate facilities of waste disposal as well as collection are almost non-existent in slum area. Exposure to such dirty environment is very risky for children as they spend most of their time playing outside" (Akter, 2014).

The majority of slums do not have any fixed place for garbage bins. Only some have regular garbage collection system others have no garbage collection system at all. Among the six cities the frequency of garbage collection appeared to be best in Dhaka.

Table 2.3 Garbage disposals in slums by city (percentage of clusters)

Garbage Disposal	Dhaka	Chittagong	Khulna	Rajshahi	Sylhet	Barisal	All Cities
Fixed Place	54.6	33.0	42.1	16.2	43.6	12.0	44.3
No Fixed Place	45.4	67.0	57.9	83.8	56.3	88.0	55.7
Total %	100	100	100	100	100	100	100
N	4,966	1,814	520	641	756	351	9,048

Drainage system in slum area

Insufficient and unsanitary drainage condition is a major problem for drainage congestion in slum areas. Drainage system removes unwanted water from the neighborhood in a controlled as well as hygienic manner to minimize public health hazards. The construction of an. efficient drainage system is very complex.

According to Assessment of Water Supply Sanitation and Drainage Facilities of South Begunbari Slum Dhaka, Bangladesh, "The main two problems of drainage system are water logging and filthy condition of roads. The main reasons be-hind these problems are heavy rainfall during rainy sea-son and outflow of sewage line. It creates an unhealthy condition and inundation of roads for which people face difficulties to move from one place to another. To get rid of these problems the dwellers thinks that there should be one more drainage pipe for discharging the waste water, sewerage and the outlet of the pipes should be wider" (Shakil, 2013).

In the study named Slum of Urban Bangladesh: mapping & census 2005, "Bangladesh experiences moderate to heavy rainfall during the rainy season. The drainage situation is,

therefore, usually considered to be a very important aspect of the physical suitability of a prospective urban residential area. Slum settlements are often found on land which is in most cases unsuitable in this sense for proper housing. For instance, low lying areas, marshes, sewage canals, riversides, railway tracts and embankments are frequently the site of slums. These sorts of places are prone to suffer from poor drainage and hence water logging (stagnation of water) and flooding, particularly during the rainy season. The worst drainage situation was in Dhaka and Chittagong, while the best was in Barisal" (CUS, 2006).

Drainage condition differs from area to area. Drainage system develops on the basis of the area geographical and longitudinal characteristics. But in Bangladesh, except Chittagong and Sylhet, most of the area lands are plain. So it is not difficult to construct effective drainage system. Thus, all the responsibility goes to the authority. But the reality is most of the authorities have very limited concern on slum area, so it is very difficult to see better drainage system in slum area. The following table shows the percentage of drainage system according to its characteristics and it defines the drainage as well drained, moderately drained and poorly drained.

Table 2.4 Drainage condition in slum areas by city (percentage of clusters)

Drainage	Dhaka	Chittagong	Khulna	Rajshahi	Sylhet	Barisal
Well drained	11.4	2.7	10.2	1.2	6.3	59.8
Moderately drained	30.0	38.4	51.1	74.6	39.8	34.2
Poorly drained	58.7	59.0	38.6	24.2	53.8	6.0
Total %	100	100	100	100	100	100
N	4,966	1,814	520	641	756	351

Source: Slum of Urban Bangladesh: mapping &census, 2005

Energy (Electricity supply and source of cooking fuel)

For lighting the housing unit most households depend on electricity. The slum area have low assess of electricity supply. Alternatively they use kerosene lump which can be risky for them. The slum dwellers usually use straw leaves, gas etc. as fuel for cooking. Wood is still the main sources of the fuel in the slum areas. The slum dwellers do not have access to the gas supply. They use various traditional forms of fuel like wood, straw, cow dung and waste paper for cooking. Access to electricity is far from universal and sometimes access to these services is accomplished through illegal means (Jahan, 2012).

In the study named Electricity access in urban slum households of Bangladesh: A case of Dhaka, The authors discussed about the availability, accessibility affordability and continuity of usage of electricity. This study also discussed the current status of electricity access in slum area of Dhaka and identifies the barriers to electricity access from both demand and supply side (Lieu, 2014).

Slum in Khulna city

Khulna is the third largest city in Bangladesh. The 2005 population within the KCC area was estimated to be 966,837. The city has 520 slum clusters with population of 188,442. The large concentrations of slums are railway line and two industrial areas Doulatpur and khalishpur. Still another is Rupsha ghat area and Sonadanga bus stand area (CUS, 2006).

Status of water use sanitation and hygienic condition of urban slums on Rupsha Ferighat slum in Khulna, The study reveals that status and practice regarding water, sanitation and hygiene. This paper has also explored that assessment of water resource availability and quality at source point of consumption; problems faced in getting safe drinking water; and knowledge of the features of hygienic latrine; awareness about health (Rana, 2009).

A report is published by The Independent 27 April 2014 named Census on slum people begins in cities. That report was about Slum and Floating People Census-2014 which had started on April 24 to May 2 in Khulna slum area. The main aim of the census was that to determine the number of slums, number of households in the slums and assessing the socio economic condition of the slum dwellers in Khulna city. This census had another aim to collect the

information about the education, profession and the overall environment in slum areas of Khulna city

2.4 Poverty

Urban poor are increasing. Slum is now 35% of the urban population in Bangladesh and 37% in Dhaka were slum population double from 1.5 to3.4 million between 1996 and 2005. The increase of poor people in urban areas is resulting in the growth of massive numbers of slums in large cities. The latest census identified 9,448 slums in the six cities with highest concentration (54.9%) in Dhaka, followed by Chittagong (20%), Sylhet (8.3%), Rajshahi (7.1%), Khulna (5.7%) and Barisal (3.9%) (CUS, 2011). These demographic changes have impact the level of pollution, spread of communicable disease, increase in crime rates, traffic congestion and created higher demand for health care services, educational institutions, and transport and law enforcement agencies. It has also contributed to the rise in prices for essentials, both food and non-food items.

2.5 Urbanization

Urbanization is generally considered to be a natural process of economic development with large numbers of people migrating from the rural areas in search of employment opportunities. One estimate indicates that by 2020, the poor will comprise 40-60% of the urban population (Anam, 1993).Finding effective solutions to the problems contributed by the rapid growth of the urban poor population and addressing their health needs thus become a priority at the national level. According to health status indicators, the condition of the urban poor is worse than their rural counterpart. Urbanization is largely noticed in the major cities where more than half of the total urban population resides.

2.6 Meaning of Slum

Slums are defined by United Nation Organizations as "a building or group of buildings and area characterized by overcrowding, deterioration in sanitary conditions or absence of facilities and amenities, which because of these conditions or any of them endanger the health, safety or morals of its inhabitants or the community". Local condition, however, should be taken into account while defining the term 'slum'(Marimuthu,2009).

2.7 Challenges in Achieving Health Equity

The urban population of Bangladesh, particularly the poor, lives in a crowded, dump, and highly populated environment. Due to their exposure to this environment, bronchial astema and other respiratory disease are increasing. Poor sanitation and inadequate supply of drinking water result in increased incidence of communicable disease such as dysentery, shigellosis, giardiasis, gastroenteritis, etc, skin diseases and respiratory tract infections. About one-fifth of the total burden of disease in Bangladesh is associated with environmental factors. Two of top three causes of death and sickness are respiratory illness and diarrheal diseases. Both of these are strongly associated with the environment and have a significant impact on the health of children. Repertory tract infection, gastro enteritis (Diarrhea, amoebiasis, shigellosis etc.), skin diseases (mainly scabies, ringworm), pulmonary tuberculosis and fever (viral, enteric), are more frequent among the poor segment of people. Poor sanitation facilities, crowded and damp housing condition, inadequate supply of safe drinking water, unhygienic drainage system and improper disposal of excreta are common problem among the residents of slum and squatter settlements in Bangladesh. Lifestyle-related diseases, hypertension, cardiovascular diseases, peptic ulcer, and drug addiction are more frequently found among the middle and upper class people. The major causes for these diseases are an unhealthy life style, bad food habits and the lake of balance between needs and wants. According to a survey conducted by the Bangladesh Institute of Research and Rehabilitation the diabetes(BIRDEM) the existence of diabetic mellitus in rural areas is only 4% while in urban population, it is 11.4% and nationally 7% (Sayeed,2007).

2.8 Specific Intervention

To promote the importance of social capital/cohesion in urban health development and planning there is a need to measure and monitor these variables and the health impacts. There is a key role for health workers and the health sector here, in documenting health outcomes and disseminating findings to increase recognition of the value of social sector interventions. There is also room for other sectors such as water and sanitation, transport and education to recognize the role they have to play in social and health development for better health equity.

2. 9 Biological Effects of Radiation

The interaction of ionizing radiation with the human body, arising either from external sources outside the body or from internal contamination of the body by radioactive substances, leads to biological effects which may later come as clinical symptoms (Martin, 1979). The nature and severity of these symptoms and the time at which they appear depend on the amount of radiation absorbed and the rate at which it is received.

While ionizing radiation has many uses, some of great benefit to mankind, it is also true that its beneficial use must be carefully weighed against possible delirious effects. Ionizing radiation is not only potentially dangerous, but in fact lethal, if misused. The effects which occur depend on the types of cells which absorb the radiation, the total radiation dose, the length of time over which the exposure occurred, and whether the body is able to affect any repair of the damage. Differences in biological effects are the result of differences in these factors. The biological effects of radiation may be broadly classified into two categories, viz. non-stochastic (deterministic) and stochastic effect (Cember, 1989).

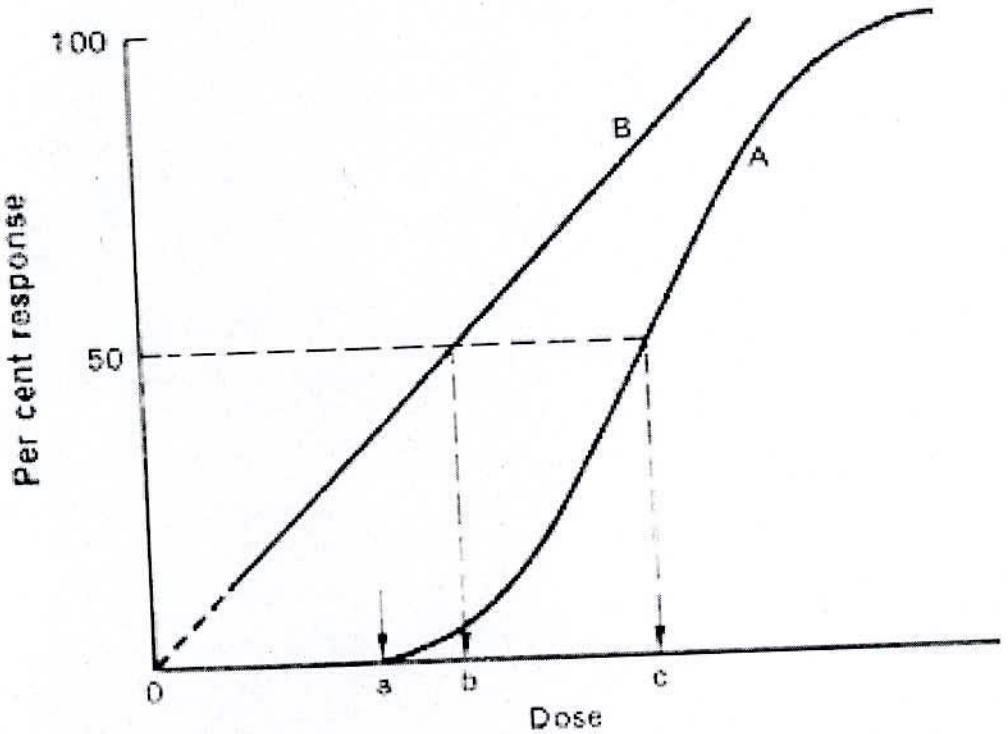
Non-stochastic Effects

Effects with a threshold dose and for which the severity of the injury increases with dose are known as non-stochastic effects. Non-stochastic effects are characterized by three quantities: First, a certain minimum dose must be exceeded before the particular effect is observed. Additionally, the magnitude of the effect increases with the increase of the dose. Furthermore, there is a clear causal relationship between dose agent and effect in a given individual. In a word, in non-stochastic effect, a certain minimum dose must be exceeded before the particular effect is observed, and the magnitude of the effect increases with the increase of the dose. For example, a person must exceed a certain amount of alcohol before he shows signs of drinking. After that, the effect of the alcohol depends on how much he drank.Because of the minimum dose that must be exceeded before an individual shows the effect, non-stochastic effects are also called threshold effects. Non-stochastic effects are also can be termed as early radiation effects. Examples: Erythema, cataract, radiation damage to the gut and the production of the temporary or permanent sterility in both males and females. When the magnitude of the effect or the proportion (percent) of individuals who respond at a given dose is plotted as a function

of dose to obtain a quantitative relationship, the dose-response curve A of Figure 2.9 is obtained. In Figure 2.9, A point 'a' represents the threshold point.

Stochastic Effects

Stochastic effects are those effects that occur by chance. They occur among unexposed people as well as among exposed individuals. Stochastic effects are therefore not clearly related to exposure. The main stochastic effects are cancer and genetic effects. The result of exposure to a carcinogen (substance that produces cancer, tobacco) increases the probability of occurrence of the effect. In this case, the increase in probability of the effect is directly proportional to the dose.



Dose-response curves for non-stochastic (A) and stochastic (B) effects.

People may develop cancer whether they are exposed to carcinogenic agents or not. However, exposure to carcinogen increases the likelihood of cancer. Lung cancer is found in a much

higher proportion of cigarette smokers than among non-smoker, and among cigarette smokers, lung cancer is seen in a greater proportion of heavy smokers than in light smokers.

In other word, as the name implies, stochastic effects occur in a statistical manner. For radiation induced effects, the probability of a stochastic effect occurring depends upon the radiation dose received, but there is no such thing as a "safe dose" i.e., no threshold dose exists below which such an effect can't occur. Two general types of stochastic effect are well recognized. The first occurs in somatic cells and may result in the induction of cancer in the exposed person; the second occurs in cells of the germinal tissue and may result in hereditary disorders in the progeny of those irradiated (Islam, 2009).

Another important point concerning such stochastic effects as mentioned earlier, is that the severity of the effect is unrelated to radiation dose. Thus, as the radiation dose increases, the probability of cancer induction increases, but the severity of the cancer does not depend upon the radiation dose which caused it.

Stochastic effects are often called linear, zero-threshold dose response effects. According to the linear, zero-threshold model, every increment of radiation, no matter how small, carries with it a corresponding increase in risk of stochastic effect (Cember, 1989).
When the frequency of occurrence or percent response of a stochastic effect is plotted against the increase of dose to obtain the quantitative relationship, a linear dose-response curve (B) of is observed.

CHAPTER III

Methodology

3.1Introduction

Methodology is a systematic way to solve the research problem. It helps to organize the experience, observation, analysis of the data and information, their logical interpretation is systematic manner for the achievement of the study objectives smoothly. So, an appropriate and systematic methodology is always necessary for the successful completion of any research work step by step analysis and supervision in each and every step is essential for conducting the whole research. A wide variety of studies have been carried out for unveiling the facts and problems of the study area. Based on the objectives of the study this chapter represents the process of the study in a sequential order.

3.2Reconnaissance survey

The preliminary field investigation to get the general view of the study area, livelihood pattern of the slum people, population characteristics and education status has been done which is called reconnaissance survey. It is conducted during the early stage of the survey. This survey helps to select sampling unit and sampling technique. It also helps to prepare a better questionnaire for the study and finalize the sampling procedure.

3.3 Study area and location

Khulna is the third largest metropolitan city of Bangladesh. It is populated by about 12 millions. It has an important river port of the country and the divisional head quarter of Khulna division. The city is emerging very rapidly as an important regional center of education, trade and commerce and cultural activities in the south-western part of the country. In fact the present city emerged as municipality in 1884. The city has experienced industrial development and growth during the early and mid-60s of the twentieth century. Very recently, the export of shrimp and establishment of Khulna University and Khulna Medical College have boosted up the overall socio-economic development activities in the city. The income level of the overwhelming part of the population of the city is below the poverty level and they are forced

to live in sub-standard conditions. On the other hand, like other third world cities of the world, the demand for municipal services and facilities by the city dwellers fall far short of expectations. The present level of the delivery of these services and facilities by different service providing agencies in the city is adequate. As result the overall built environment of the city is not order and the aerial coverage of the municipal services and facilities has not been developed in a planned manner and the city dwellers have not been adequately served so far of the urban services is concerned. This is turn affects the overall environment of the city. However, this has to be addressed through an effective management and development and establishment of urban infrastructure in planned way which will help improve the city's environment.

Location: Khulna is located in south-western Bangladesh at 22°49′0″n 89°33′0″e, on the banks of the Rupsha and Bhairab River. It covers a total area of 59.57 km², while the district itself is about 4394.46 km². It lies south of Jessore and Narail, east of Satkhira, west of Bagerhat and north of the Bay of Bengal. It is part of the largest delta in the world. In the southern part of the delta lies the Sundarban, the world's largest mangrove forest. The city of Khulna is in the northern part of the district, and is mainly an expansion of trade centers close to the Rupsha and Bhairab rivers. The Mayur river forms the western boundary of the metropolitan area.Khulna is the main city in Khulna division in Bangladesh. On the bank of Rupsha (and Bhairav) river, it is known as the industrial city and located in southern part of Bangladesh. A large part of the Sundarbans, a UNESCO world heritage is located in Khulna. It has many jute mills, the only Newsprint mill and Hardboard mill of Bangladesh, the only state-owned match factory (dada match, later Dhaka match), Oxygen Company (bol) and Ship yard. Khulna is the 3rd largest city in Bangladesh after Dhaka and Chittagong. It is a quiet, calm city inhabited by 1.5 million people.Figure3.1 indicatesthe location of Khulna City in Bangladesh Map. Figure3.2 is the slums of Khulna City **(CUS, 2006).**

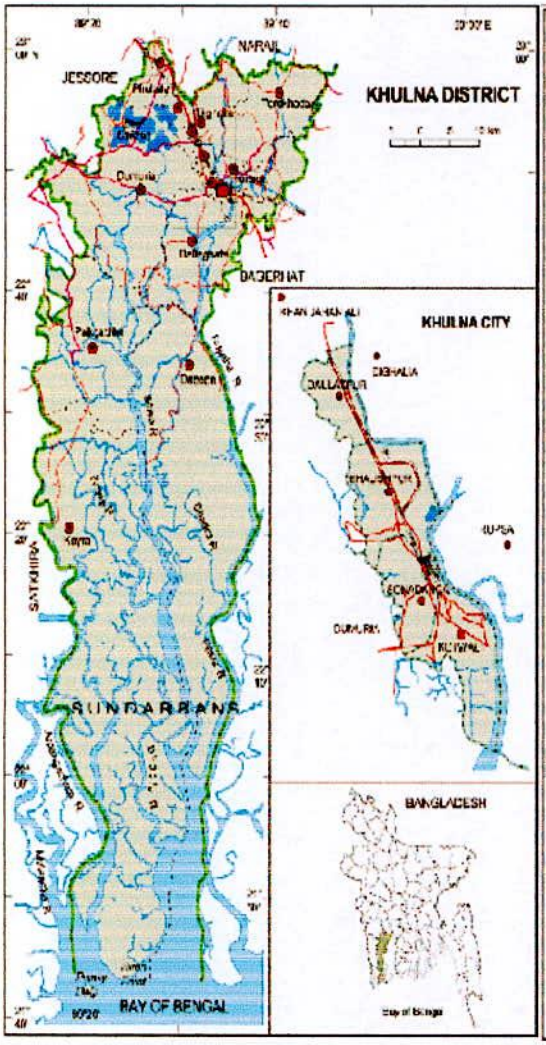


Figure3.1: Location of Khulna City in Bangladesh Map

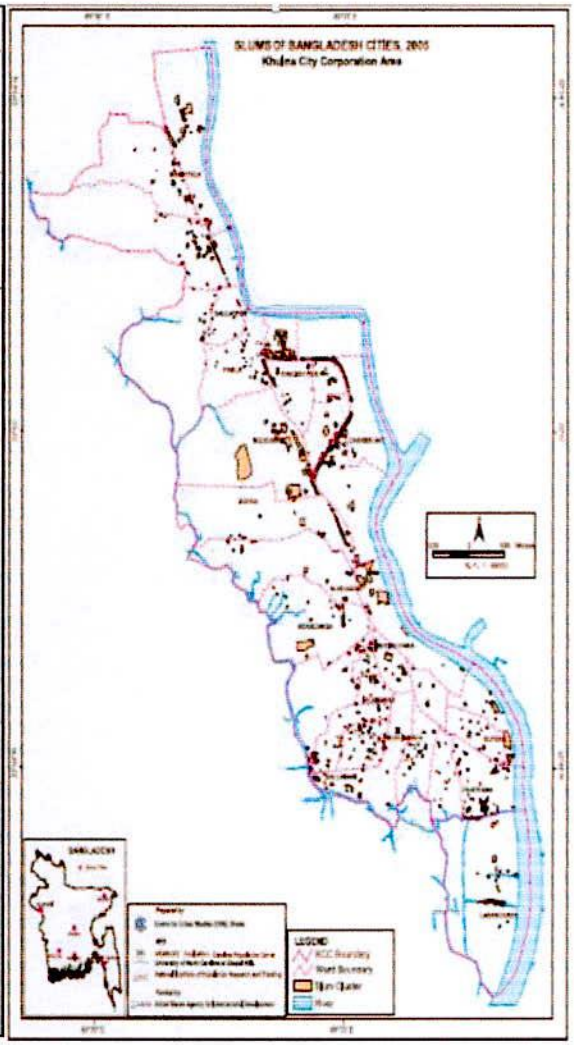


Figure3.2: Slums of Khulna city (CUS, 2006)

3.4Physical Setting

Land: Natural environment has a profound impact on acity in shaping its physical setting and its pattern of growth. Khulna city is located in the southwest region of the countrywhich has been developed and influenced by the process of siltation from a network of rivers.Because of its location in a moribund delta and tidal environment, the city has specific characteristics on land, soil, climate, hydrology, rainfall, and salinity.The land of Khulna region can be broadly characterized by the Ganges-tidal floodplain having lower relief and being criss-crossed by innumerable tidal rivers and channels. It is nearly flat and the surface is poorly drained. Some peat basin up to 3- meter thick has also been found in many parts of Khulna. These peats are formed due to the decomposition of reeds and grass having relationship with a tidal or mangrove ecosystem.The land surface of Khulna City Corporation is not perfectly level and is characterized by six major geomorphic units. These are natural levees, floodplains, old meander complex, bar, tidal marsh and back swamps. Natural levees are well developed along the Bhairab-Rupshaw banks(mostly on the west bank) and are occupied mainly by the present built-up area of the city .This part of the city is 4m above the Main Sea Level(MSL).The low-lying areas extend mainly towards fringe areas of the city characterized by swampy areas,currently used for agricultural purpose that are poorly drained and persistent water login problems. The average altitude of this area is less than 2 m above MSL.

Soil: Khulna district is formed entirely by the action of the Ganges which brought mud and lime stone from the Himalayas. The soil is to a great extent uniform in character and varies only greater or smaller admixture of sand, silt and clay. Naturally, the percentage of sand is greater along the riverside's and smaller in those areas where deltaic action has ceased. The city fingers, particularly the bee(marsh} areas,the decayed vegetation produces stratumof black soil. The load bearing capacity of this soil is very poor that incurred high cost for constructing high-rise building in particular.

River System: The Khulna city has been growing in a linear shape following the Bhairab-Rupsha course. The Bhairab, originating from the Kobadak,flows southwards and meets the Atari near Daulatpur and Atharabanki near Kotwali. At present the main city is situated on the

west bank of the Bhairab-Rupsha course. The Rupsha River flowing along the city is navigable throughout the year.It is also the main natural drainage for the city. The rivers of this area are tidal in nature and get very little fresh water from upstream, particularly during the winter. The main source of fresh water is from the Ganges through the Garai-Madhumati.

Temperature: Remarkable changes in temperature can be found with the changes of seasons in Khulna city. April is the hottest month when monthly maximum temperature is up to 35^0c. However, Khulna city shows a mild summer than of inland areas, particularly northwestern district, where summer temperature sometimes exceeds 40^0c. In June, there is sharp fall in temperature due to the outbreaks of monsoon. During the monsoon, the monthly maximum temperature is about 30^0c. The cool dry winter season begins in November, and January is the coldest month with a minimum monthly temperature of about 10^0c.

Rainfall: Khulna receives an average rainfall of about 1800mm. The main source of rainfall is the southwestern monsoon. Nearly 81 per cent of total rainfall occurs during June-October. During march-May some rainfall also occurs. Winter is the dry period with little or nearly no rainfall. However, during the months of December and January little rainfall is recorded.

Wind: Due to monsoonal variation of the climate, there are variations in wind direction in Khulna city. The southwesterly monsoon starts from about the middle of March and recedes about the end of September. The monsoon winds blow from the south with sustained force from March to October, the wind blows from the north and northeast in January. February is a calm month with foggy weather in the morning particularly.

Radiation level: Radiation is very harmful for human being. So it is needed to detect the radiation level.In a preliminary survey, British Geological Survey team detected uranium content in groundwater of Bangladesh. According to its report, the maximum uranium concentration was observed 47 μgL^{-1} in Chapainawabganj whereas the maximum acceptable concentration is 30 μgL^{-1} according to USEPA [USEPA 2000]. It is necessary to measure uranium level through a comprehensive survey in the drinking water like the survey was done for arsenic contamination in Khulna City. On the other hand the natural radionuclides (^{226}Ra, ^{232}Th and ^{40}K) were found very high in soil and sediment in different parts of Bangladesh

(Jahan 2015). So different kinds of foods are also contaminated which are grown in this soil. As a result, these foods are affected directly to the human health in the slum people. It is necessary to measure radiation level through a comprehensive survey in Khulna City.

The Surveyed Area:

In the present research area the study area has been selected on the basis of objectives of the study. The study has been carried out in slum areas of Khulna city which are selected by using purposive sampling technique. These are

1) The muripotti slum
2) Bastuhara slum
3) Jabdipur slum and
4) Bagmara slum

KCC is comprised of thirty one wards with an area of 47.52 sq.km.The city had 520 slum clusters with a population of 188,442 which is 19.5 percent of city's population in Ward No. 26 of KCC, which contains 32 slums(Jahan, 2012). Among the thirty one wards The Muripotti slum is in ward no. 23,The Bastuhara slum is in ward no.9. The Jabdipur slum is in ward no. 7 and the Bagmara slum is in ward no. 27.The enter 23 no. ward and 27 no. wards are part of Khulna City Corporation (KCC.) Khulna City Corporation consists of 31 wards. In Muripotti slum area there are 325 house household,In Bastuhara slumarea there are 300house household,In Jabdipur slumarea there are 200house household and In Bagmara slumarea there are250house household. The slum dwellers are very poor which can be ascertain by the condition of the dwellers which were built by Golpata/Tin. The main occupation of the people are Day Labour, and Rickshaw pullingwhile few numbers of women are servants. The location map of the study area is shown in Figure 3.3.

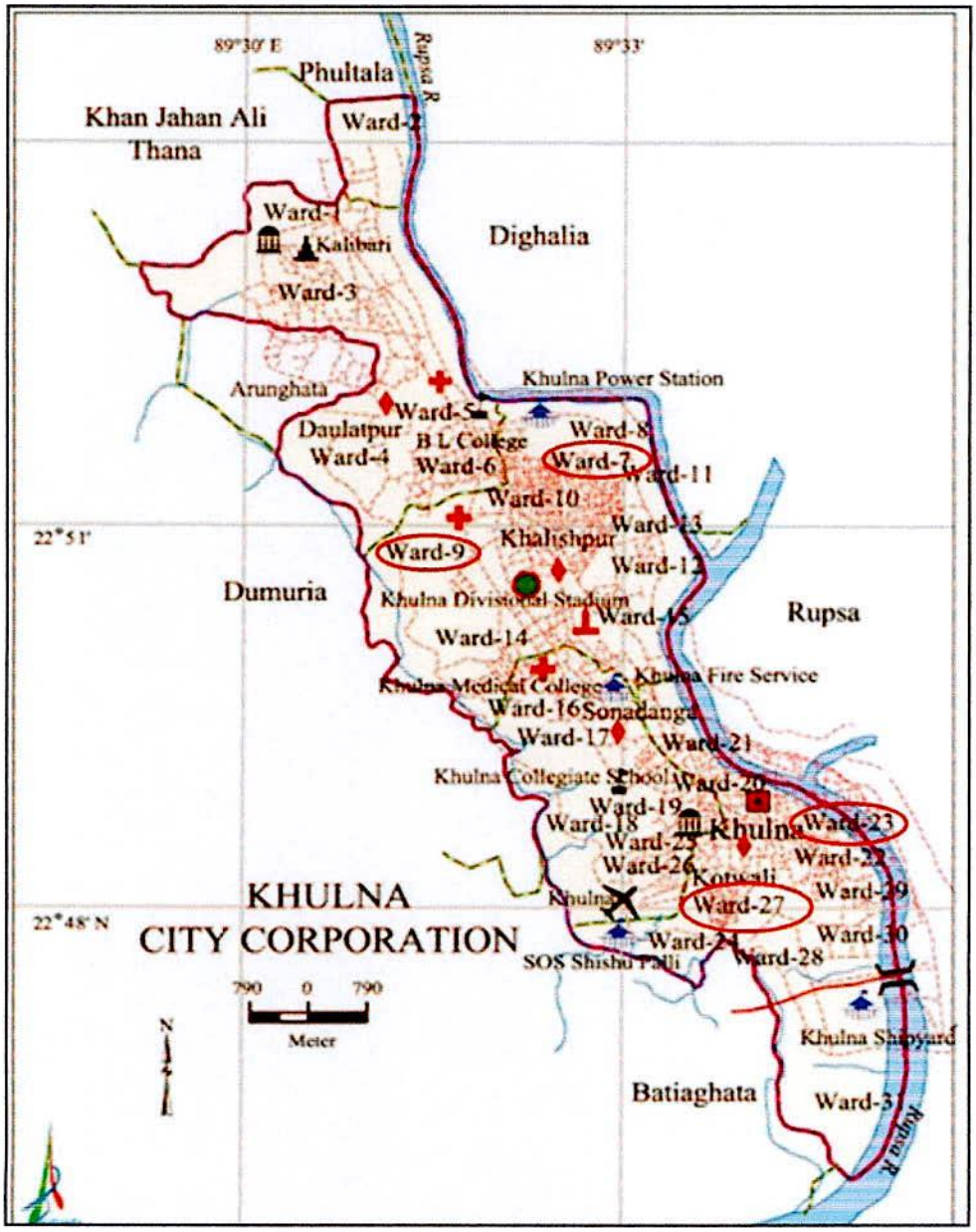


Figure 3.3: Location map of Khulna City and the detailed map of Study area

3.5 Problem Identification

Rapid urbanization, caused largely by heavy influx of migrants from rural areas, has exerted sever pressure on public services in the metropolitan city of Khulna with which the expansion of infrastructure and basic urban services could not cope. This situation coupled with the destitute economic condition of poor migrants has given rise to the formation large numbers of slums, where services inadequacies have been compounded and multiplied on a massive scale, resulting in a hazardous environmental condition. The millennium development goals (MDG) target of significantly improving the lives of at least 100 million slum dwellers by 2020 will depend in part on improved provision for water and sanitation, so having the proportion of people without "sustainable access to safe drinking water" and "basic" sanitation by 2015 will depend in part on urban households that are able to move to new homes with better provision or able to invest in better provision within their existing home. However, slum dwellers in Bangladesh are behind from the millennium development goals. There are about 132 slums in the Khulna city corporation area of varying sizes where the cities poor lived in about the characteristics of unmetalled and semi-metal led structures of these settlements are deprived by basic urban services. High population density combined with inadequate infrastructure and sanitation facilities creates a deplorable environmental condition in these slums. People's access to various basic essential services is very limited in urban poor areas. The populations of urban area increases but the services are not. Although located within city corporation limits, the slums and squatters facilities have limited access to the urban services. These problems are acute in Khulna city but some other large metropolitan city has faced the same. These services are basic right for every urbanite, but the slum dwellers are not able to get these services. The study tries to find out the existing status of access of the slum dwellers to some selected urban services and explore the conditions and problems of such services in slum. The main goal of this study is to identify the status of water use, sanitation and hygienic condition and their effect and impact of natural background radiation on health of the slum people of Muripotti slum, the Bastuhara slum the Jabdipur slum and Bagmara slum.

3.6Data collection

Both primary and secondary data were collected to complete the present study. Primary data were collected from field observation, reconnaissance survey, and questionnaire survey and pra. Secondary data were collected previous studies.

Primary data collection: The primary data was collected through observation direct communication with respondents. Which are very much necessary to perceive the real condition of different subject matter of the study area. The questions for questionnaire, pra and observations were developed with their opinion in pre-field work workshop. These were collected by following way.

- **Preliminary field investigation:** Preliminary field survey was completed in the month of July, 2015.during this period primary field in investigation were maintain carefully to identify the scope and objective requirements of the study. Public opinions were also observe to make clear idea about the livelihood of the slum people in the study area. This survey helps to select sampling unit and sampling technique. It also helps to prepare a better questionnaire for the study and finalize the sampling procedure.
- **Preparation of questionnaire:** After performing the observation survey in the study area, a clear and structured questionnaire was prepared. As the study mainly based on primary sources, questionnaire preparation was an important part of this study and special attention was given in preparation of questionnaire. At first a draft questionnaire was prepard.then the draft questionnaire was pre-tested and the performance of that questionnaire was review. Then a final questionnaire was prepared with the help of the experience of the pre-testing.
- **Sample size selection:**It is not possible to study the universe or entire population. Sampling is simply a procedure to learn about the entire population. Small groups among the universe or population are selected for the investigation which is representative of the entire population. In the present study the sample size is determine by the following stoical formula.A complete list of household in the study area was used for the determination of sample size. The total population of the slum that mean total no. Of household are given below which is complete list of household for investigation.

Table 2.1: Households of selected slum

Name of the area	Word no.	Number of household
Muripotti slum	23	1200
Bastuhara slum	9	600
Jabdipur slum	7	500
Bagmaraslum	27	800
Total=		3100

By the following equation the sample size of this three selected areas have determined (Kothari, 2006)

$$n = \frac{Z^2 pqN}{e^2(N-1)+Z^2 pq} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

n=sample size

z=1.96=the value of the standard variant at 95% confidence level

p=0.5= the target proportion. In this case, p is assuming 0.5.

(For the most conservative sample size, p is 0.5)(Kothari, c.r, 2006)

q=0.5. (p+q=1, therefore, q = 0.50)

e=10%=0.10=acceptance error

For Muripotti slum area, total household=300

ForBastuhara slum area, total household=250

ForJabdipur slum area, total household=150

For Bagmara slum area, total household=200

For Muripotti slum area the sample size is,

$$N=\frac{(1.96)^2\times.5\times.5\times1200}{(.10)^2\times(1200-1)+(1.96)^2\times.5\times.5}=88.99\approx89$$

ForBastuhara slum area,the sample size is:

$$N=\frac{(1.96)^2\times.5\times.5\times600}{(0.10)^2\times(600-1)+(1.96)^2\times.5\times.5}=82.907\approx83$$

ForJabdipur slum area,the sample size is:

$$N=\frac{(1.96)^2\times.5\times.5\times500}{(0.10)^2\times(500-1)+(1.96)^2\times.5\times.5}=80.70\approx81$$

For Bagmara slum area,the sample size is:

$$N=\frac{(1.96)^2\times.5\times.5\times800}{(0.10)^2\times(800-1)+(1.96)^2\times.5\times.5}=85.84\approx86$$

The total sample size n=89+83+81+86=339, to be drawn for a household size N=3100

- **Sampling technique:** In the case of questionnaire survey, sampling is very much important task. Determination of good sampling technique is the key fro a successful research study. For getting the most appropriate data, systematic random sampling technique has been applied as sampling procedure. By using the procedure 265 households were surveyed.
- **Questionnaire survey:** Then primary data was collected from questionnaire survey according to sample technique. Questionnaire was open-ended and enumerators collected information from direct interview.
- **Participatory rural appraiser:**For getting the more effective information, a PRA was also done among the slum people. A multi-method approach, combining of both qualities and quantitative data collection tools was applied.

Secondary data collection

For any rigorous research, it needs to collect secondary information. Present study also incorporated some secondary data from different sources. Data related to study was collected from following secondary source.

- Researchers publication,
- Internet,

- Journal,
- Seminar papers,
- Books,
- Published/Unpublished report,
- UNDP office, Khulna etc.

3. 7Data Interpretation

Collected primary and secondary data were compiled and interpreted for processing and analysis. The data from questionnaires were grouped, categorized and interpreted according to objectives as well as the indicators. Some data continued numeric and some contains narrative facts. For measurable and indicative answer data have been group in the tabular forms.

3.8Data processing and Analysis

All the collected data were analyzed using computer by prominent program (SPSS 12 and MS EXCEL 2007).Statistical methods such as frequency count, percentage, bar diagram, pie chart etc were used for analysis. After collecting the secondary data, efforts made for interpretation and processing them. After data processing the was sorted for analysis.

3.9Report writing and Submission

After analyzing all available data and information with finalization of maps, tables and charts, an outline of different chapters and sub chapters was prepared. After then a draft report was prepared and submitted to the supervisor in order to facilitate correction. After some correction as per the direction by the supervisor the final report was prepared and submitted to complete the study. The overall research framework of methodology is given in Figure: 3.4.

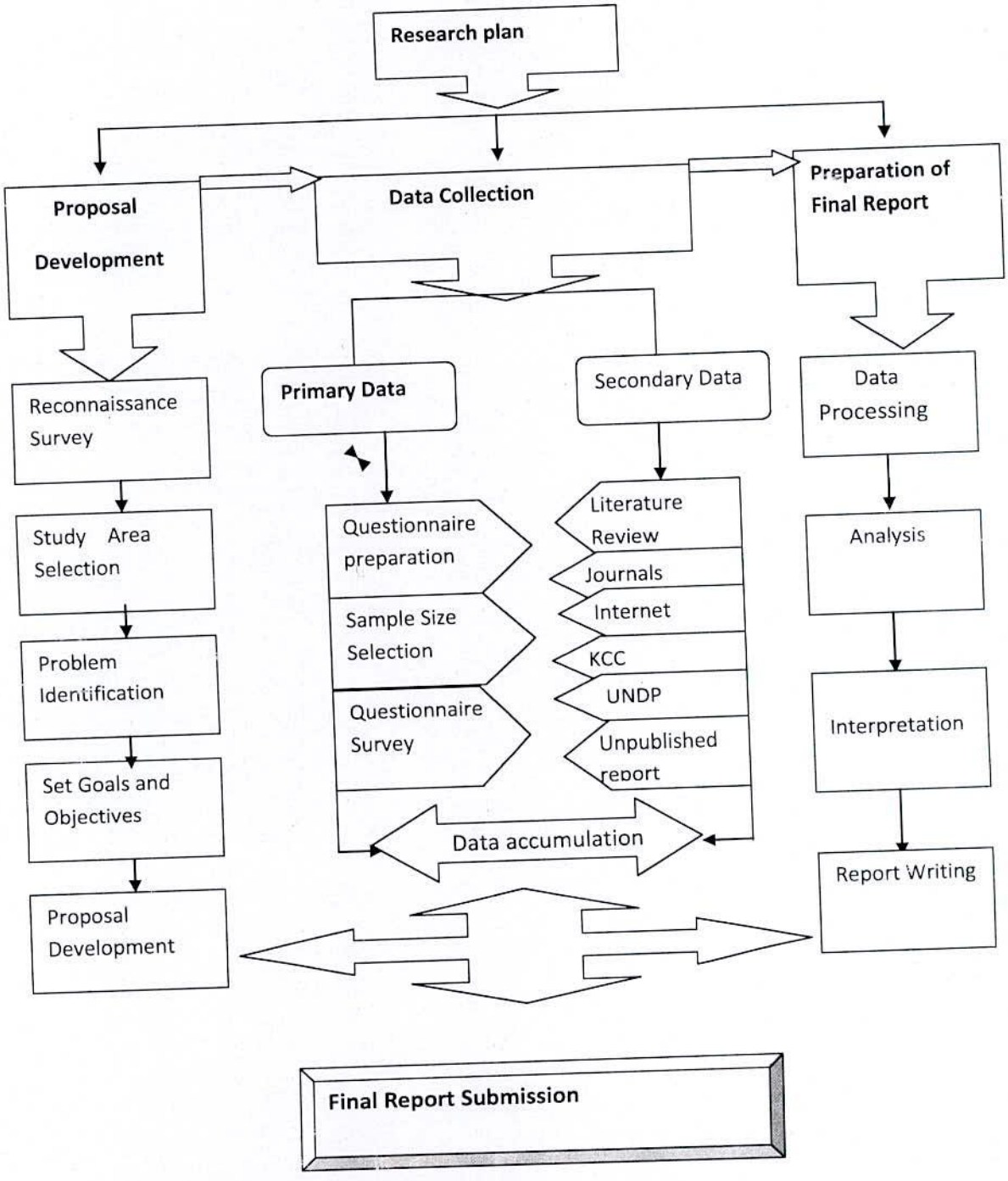


Figure3.4A Schematic Diagram of Research Plan

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is the presentation of data and information that was collected from the field survey and also their analysis. The study was conducted in four slums that under Khulna City Corporation. The following resultsare found through direct field survey, other primary and secondary information based on the objective of the study. It is observed from the questionnaire surveys that water supply situation in the study areas are not satisfactory. Moreover, the other services like sanitation, drainages and waste disposal are not adequate. These situations create an adverse impact on the health of the slum people.

4.2 Socio-Economic Profile

The socio-economic condition of the slum people in our country always remains in substandard level. The poor economic condition is responsible for that condition. The Slums are densely populated and neglected parts of cities. Housing and living conditions are very poor. Slums lack of basic services, particularly access to pure water and sanitation. Many people crowded into small living spaces.The main occupation for men is day labor and rickshaw pulling while most women are housewives. Men are the only earning members of the family. Living conditions in slums and their poor health considered as an increasing concern for governments worldwide.In the study 300 household were selected from four slums of Khulna City Corporation to fulfill the objectives of the study.

4.2.1 Household characteristics

The associated circumstances such as high population density, poor education, unavailability of urban services facilities enhance the sub-standard condition of the slums. There is a high propensity of young people to migrate to the city. Poor house condition as well as unreasonable house occupancy is existed in the Bastuhara slum. Generally a house of the slums occupies people rather than its capacity. Table 4.1 shows the household characteristics of the four slums in Khulna city. Total population of Muripotti slum, Bagmaraslum,

Bastuharaslum and Jabdipur slum are 5000, 3200, 2400 and 2000 respectively. Total household of Muripotti slum, Bagmaraslum, Bastuhara slum and Jabdipur slum are 1200,800,600 and 500 respectively.

Table 4.1:The household characteristics of the four slums

Population and household characteristics	Muripotti slum	Bagmara slum	Bastuhara slum	Jabdipur slum	Total
Population	5000	3200	2400	2000	12,600
Number of household	1200	800	600	500	3100
Number of surveyed household	89	86	83	81	339

4.2.2Ownership of Household

Proper housing is a very important factor for social and psychological development of a person. But the practical situation of all slums (Muripotti Bastuhara, Jabdipur, and Bagmara) indicates a dreadful life with poor lighting, lack of ventilation facilities, high crowding and living and cooking either close to or at the same place. Most of the rooms built by tin or wood/Straw/Golpata/Mud in squatters are made of low quality materials. Most of them hold a single room for the whole family that makes the slums very crowded. Most of the rooms have been poorly built and now have seeped out roofs and some empty wreck buildings. Maximum people are renter of house.The most distinctive feature in slum areas is the presence of substandard housing characterized by poor structure, overcrowding and inadequate floor space. Majority of slum houses are of very poor quality.Figure 4.1 shows that the study area 95% respondents are tenant of house and 5% are owner of the house.Figure 4.2 and Figure 4.3 shows the worse conditions of the house.

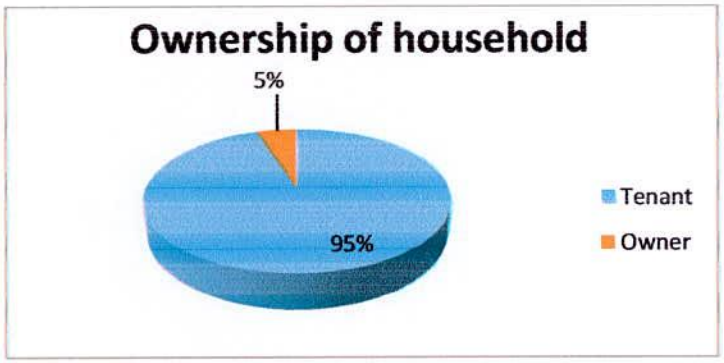


Figure 4.1: Average percentage of ownership of household

Figure 4.2Different types of wastes such as dirty papers and kitchen wastes are exist here and there.

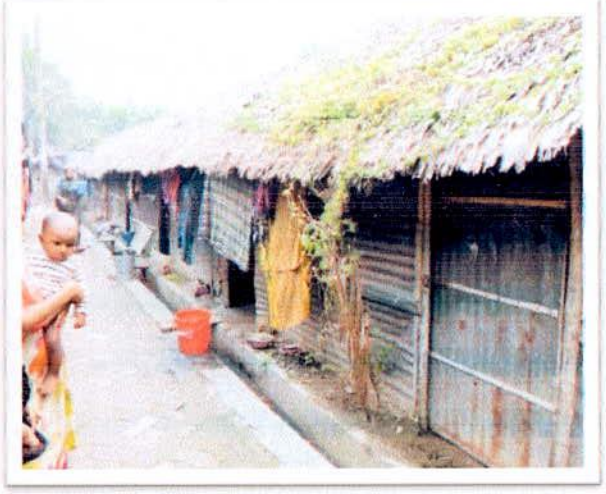


Figure 4.3: Worse condition of the house

4.2.3 Housing structure

Table 4.2shows the criteria of residence of the respondents. It shows that 11% respondent's residence is made in tin shade and mud wall, 12% respondents residence is made in straw/golpata/mud well, 28% respondent's residence are made in straw/ bamboo/ tin shade, 12% are made in tin and 24% residence is made in brick cement/tin.Only13% residence is made in brick.

Table 4.2: Distribution of the criteria of residence of the studied individuals

Type of housing	Muripotti		Jabdipur		Bastuhara		Bagmara		Total	Average
	No. of respondent	Percentage %	No. of respondent	Percentage %	No. ofrespondent	Percentage %	No. of respondent	Percentage %	No. of respondent	Percentage %
Tin/Mud	17	17	13	19	21	21	3	10	54	18
Straw/Golpata/Mud	0	0	17	24	15	15	2	7	34	11
Straw/Bamboo/Tin	10	10	16	23	29	29	13	43	68	23
Tin	17	17	8	11	20	20	0	0	45	15
Brick/tin /cement/	35	35	6	9	9	9	8	27	58	19
Brick/ cement	21	21	10	14	6	6	4	13	41	14
Total	100	100	70	100	100	100	30	100	300	100

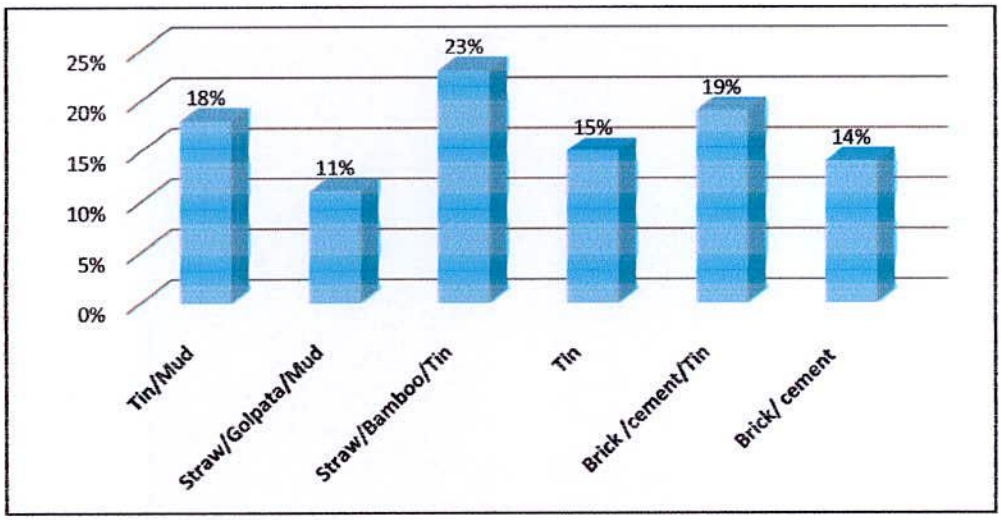


Figure 4.4: Average Distribution of the criteria of residence of the studied individuals.

The bad housing conditions are more likely to have mental health problems, such as anxiety and depression, to contract meningitis, have respiratory problems and experience long-term ill health.Figure 4.4 shows theaverage distribution of the criteria of residence of the studied individuals.

4.2.4 Educational Qualification of the respondents

Education is an important factor in any social study. It also helps us to determine the quality and characteristics of sample population. Sometimes people are unable to carry their children's education in secondary level cause of poverty. For this reason, a huge number of illiterate are exist in the slums.The education level of Muripotti, Jabdipur, and Bastuhara and Bagmara slum are shown in Figure 4.5.It indicates that the illiterate people are higher in Bastuhara slum and primary level is higher in Bastuhara slum. There is no significance variance in the educational level among these four slums. It indicates that the illiterate people are higher in Bastuhara slum. In the Figure 4.6 it is observed from Muripotti, Jabdipur, Bastuhara and Bagmara slums the average education level of respondents, there are about 15% respondents are illiterate, about 30% can read and write, 35% respondents have completed primary education, about15% have completed education secondary education, about 4% respondents have completed secondary H.S.C level of education and only 1% respondents have completed higher education (Table 1 Appendix).

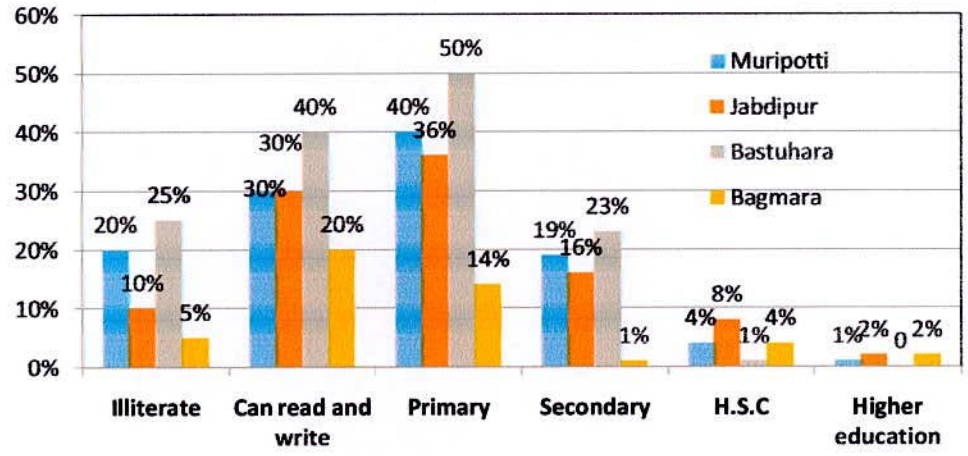


Figure 4.5: Educational level of education of four slum areas

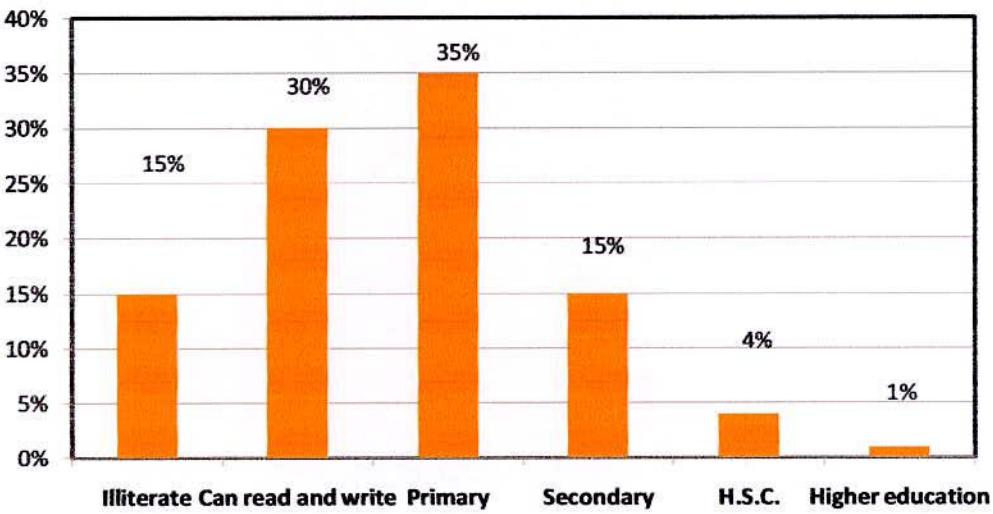


Figure 4.6: Average level of education of the slum

4.2.5 Occupational pattern of the respondents

Occupation indicates the level of income and available leisure time, which in turn influences the way of living.It gives a picture of the nature, type and distribution of the economic activities carried out in the study area. Information on occupation pattern helps in determining the trend of current economy and the prospective economic activity that may become dominant for the future development of these areas. Usually the poor people's are engaged in different types of informal activities because they are not able to get better job in anywhere as they are not educated enough. In study area different type professional peoples have been seen. The livelihood patterns depend on the income level. Income level has great influence on the physical environment in the slum areas.Table 4.3 shows that peoples occupational of four different study areas.It is observed that in Muripotti slum about 31% respondents are rickshaw puller /driver, where in Bastuhara 11 % , Jabdipur 6 %, Bagmara 15 %. It has been showed that peoples from (Muripotti, Bastuhara, Jabdipur, Bagmara) slums are different occupational pattern such as,Rickshaw puller/ Driver, Retail Shopkeeper /Tea Stall, Tailors, Servants, Hawkers/Fish seller, Day labor, Work in shop, and Service holder. Figure 4.7 shows the average level of occupational pattern of the respondents.

Table 4.3: Occupational pattern of the respondents

Occupation	Muripotti	Bastuhara	Jabdipur	Bagmara	Average
Rickshaw Puller/Driver	31%	11%	6%	15%	16%
Retail Shopkeeper /Tea Stall	8%	15%	20%	10%	13%
Tailors	4%	10%	5%	2%	5%
Servants	25%	17%	9%	8%	15%
Hawkers/Fish seller	7%	8%	8%	20%	11%
Day labour	10%	30%	13%	23%	19%
Work in shop	8%	7%	15%	12%	11%
Service holder	6%	2%	19%	10%	9%
Do not work	1%	0%	5%	0%	2%

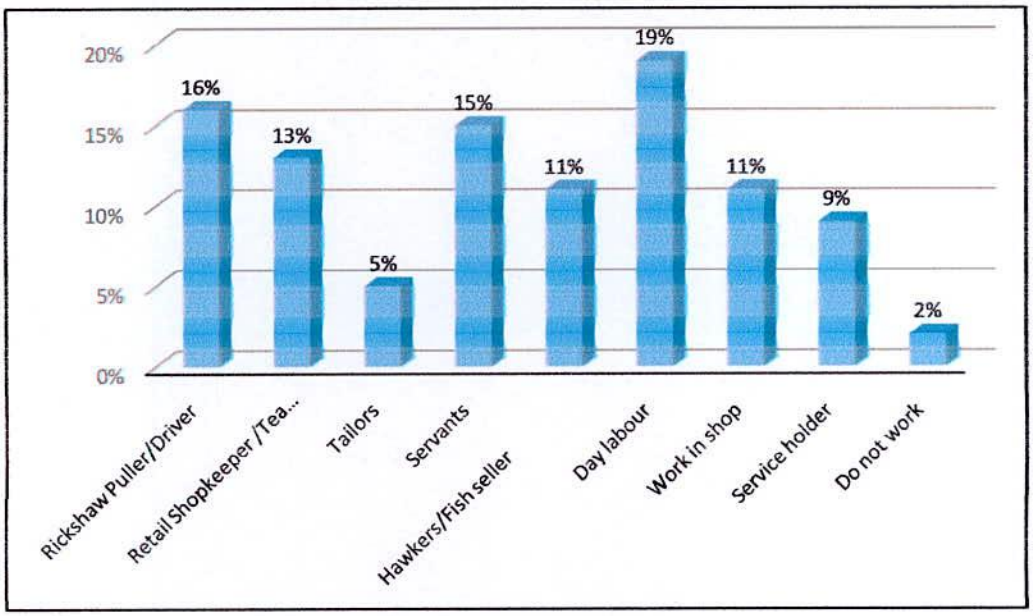


Figure 4.7 Average level of occupational pattern of the respondents

4.2.6 Economical condition of the respondents

The level of income in the primary occupation is one of the most important indicators for the realization of the true economic condition of any population. Information regarding the income of people helps in determines their demand and affordability of receiving the services and facilities to be provided in the area and also to access the expected financial returned from the people for the facilities. From Figure 4.8 ithasbeen observed to study four slums area (Muripotti, Bastuhara, Jabdipur, and Bagmara slum).Figure 4.9 shows the average level of income in the four slums area.The average monthly income level is very low. Throughout the survey 50% people are getting around TK 4000-6000 and 36% people are getting approximately TK 6001-8000 per month and 12% people are getting approximately TK 8001-10,000 per month. Only 2% respondents have the income above TK 10001(Table 3 Appendix).

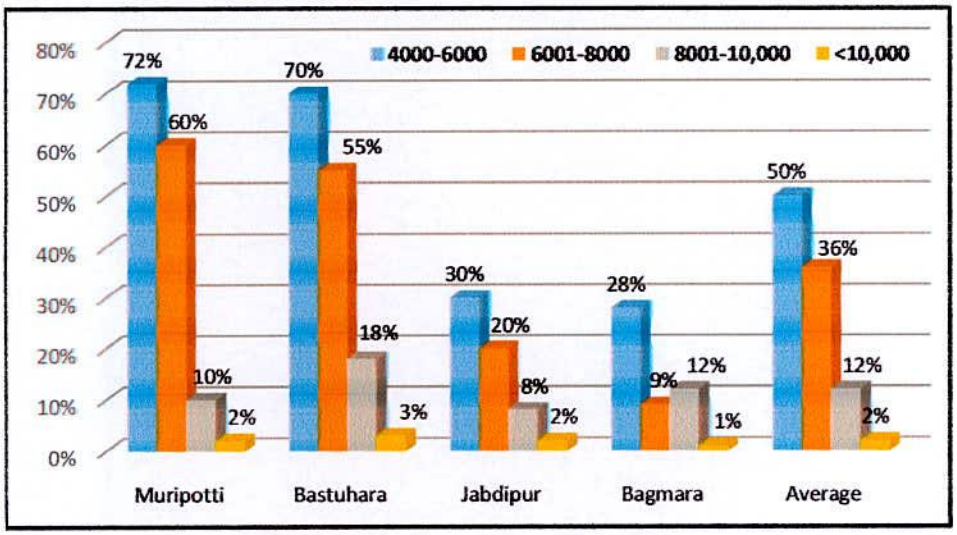


Figure 4.8: Income level in the four slum areas.

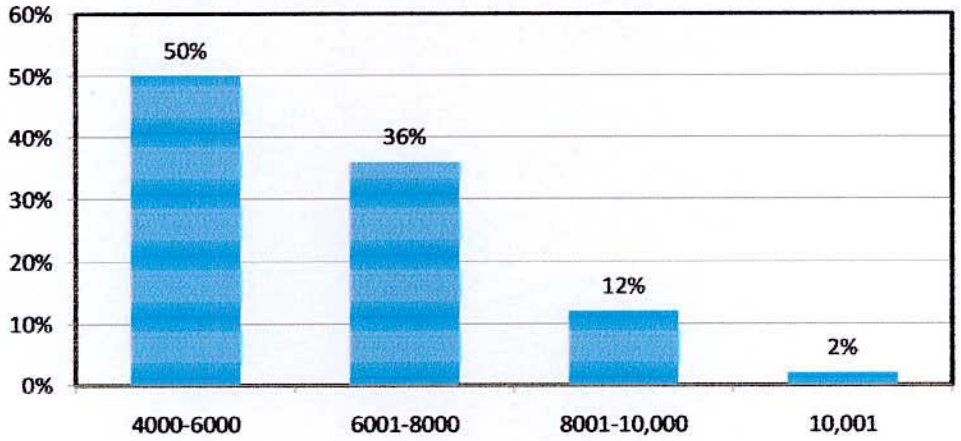


Figure 4.9: Average level of income in the four slumareas.

4.3 Condition of the Water Supply Facilities

The existing condition of water supply is inadequate for the rapidly growing urban population. Most of the diseases, which are to be found to the slum dwellers, are water born. Many of them do not get sufficient water for different purpose. On the other hand, they also waste tube well water when they get. Slum dwellers have not access to piped water supply. Some people collect water from the road side tap.Figure 4.10 showssource of drinking water and water reservoir.There is no drainagefacility to dispose used water.

Figure 4.10: Source of drinking water andwater reservoir.

4.3.1 Source of Water Supply

Khulna City Corporation is the responsible authority for water supply in the city. KCC provide piped water supply and shallow or deep tube wells in the city. Piped water is generally provided from house to house and a few roadside tapes for the common public use are available but slum dwellers have no any access to the piped water supply. They collect water from tube wells, or ponds, or rain water. Respondent's perception about the sources of water is shown in Figure 4.11 here it has been observed that the slum people also use pond in their daily works.

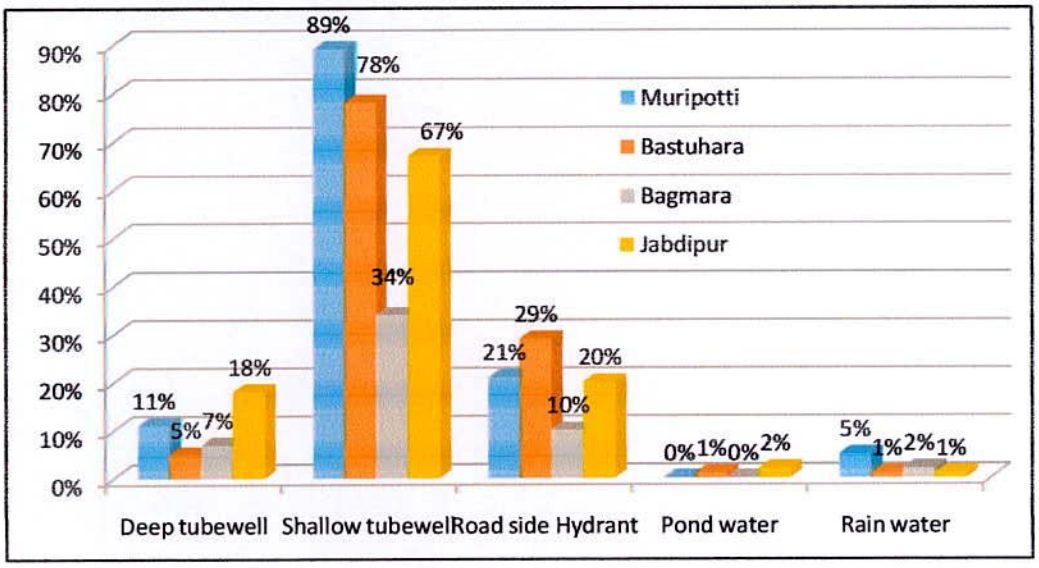


Figure 4.11: Source of water supply in four slum areas

Table 4.4 shows various uses of water from different sources in Muripotti, Bastuhara, Jabdipur, and Bagmara slum. The main source of drinking water is tube well. Around 65% respondents use tube well water for drinking. Most of the respondent'sabove 71% use shallow tube well water for cooking purpose. About 75% use shallow tube well water for washing purpose. About 65% use Shallow tube well water for bathing purpose. Slum dwellers use water from different sources (Shallow tube well, Deep tube well, Road side hydrant, Pond/Rain water) for drinking, cooking, washing, bathing purpose.Figure 4.12 indicates various uses of water from different sources.

Table: 4.4 Various uses of water from different sources

Source of water	Drinking %	Cooking %	Washing %	Bathing %
Shallow tube well	28	71	75	65
Deep tube well	65	20	19	17
Road side hydrant	16	17	3	12
Pond/Rain water	1	2	3	6

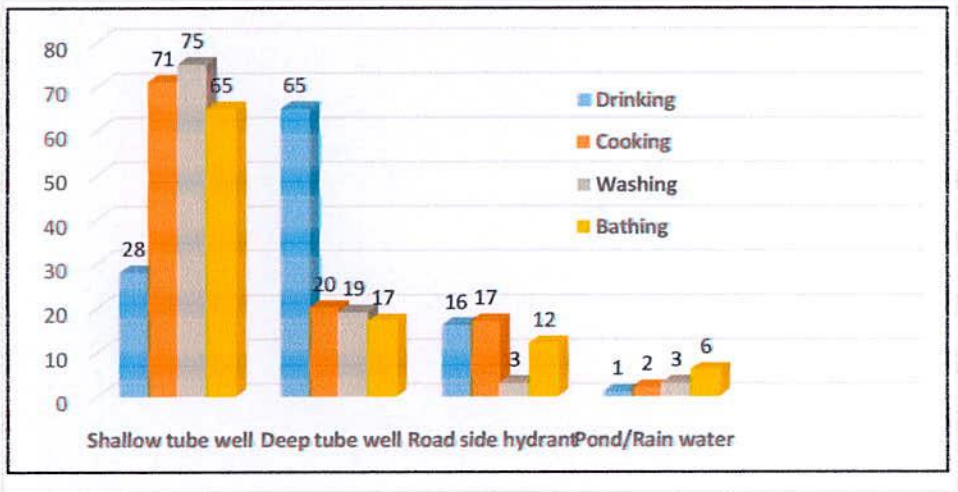


Figure 4.12: Various uses of water from different sources

Most of the slum dwellers are dependent on tube well for water. But all families do not have equal access to the tube well water. This is mainly due to the difference in the distance of the tube well from respective individual houses. Usually women slum dwellers collect water from the tube wells. As the sources are over pressured most of the time they have to wait in a long queue for a long time to collect only even a jar of water. As a result families near to the sources have better access to collect water from both tube wells and taps.

4.3.2 Quality of Drinking Water:

In the study area accessibility level of safe drinking water is very poor. The quality of drinking water is not safe. The taste of drinking water is salty and ironic.It has been observed from Figure 4.13 about 20% respondents answer is "salty" water, about 10% respondents answer is" bad smell", 40% says water is "ironic" that means it after a long time use, 12% says" water is "dusty" that means different types of suspended solids are seen in open eye and only 18% says the "water is safe".

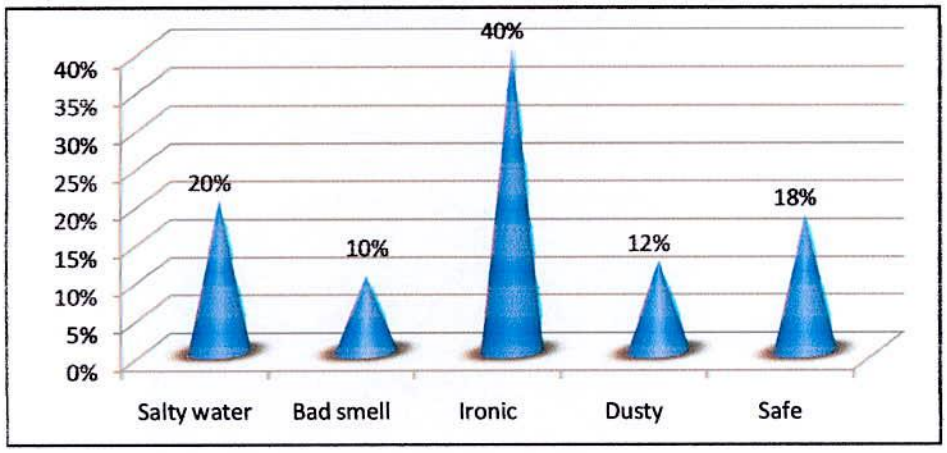


Figure 4.13: People's perception about drinking water quality

4.3.3 Water Storage Container

Different types of containers are used by the households for storing drinking water. Pitcher is the most widely used container. It has been observed from Figure 14 about 80% people use pitcher, 15% use big jar, only 5% use cooking pot and bottle. The household usually 90% kept water storage pot on the floor.

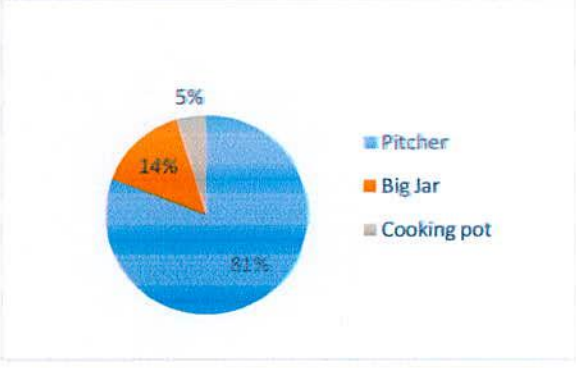


Figure 4.14: Various type of Water storage container

4.3.4 Water Purification

From the interview it is observed that most of the people are not concern of purification of drinking water. Arsenic test of the tube well water in thestudy area (Muripotti, Jabdipur, Bastuhara, Bagmara slum) has not done.From the interview it is observed that, only 2% people use filter for purification of water.Most of the people, about 56% wait for a while for the settlement of suspended solid which are exist in water,after then they use it(Figure 4.15)

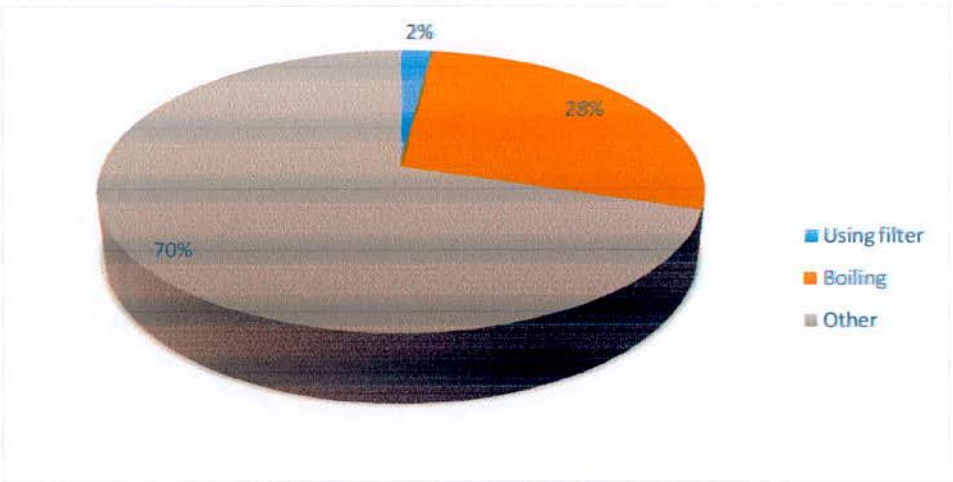


Figure4.15: Water purification measure taken by the respondents

4.3.5Problems faced in getting safe drinking water

Figure 4.16 shows that the various problems to get the safe drinking water in the study area. About 20% respondents say the water quality is very low, 40% say it takes more time to collect water. About 5% say there is far distance of water source.

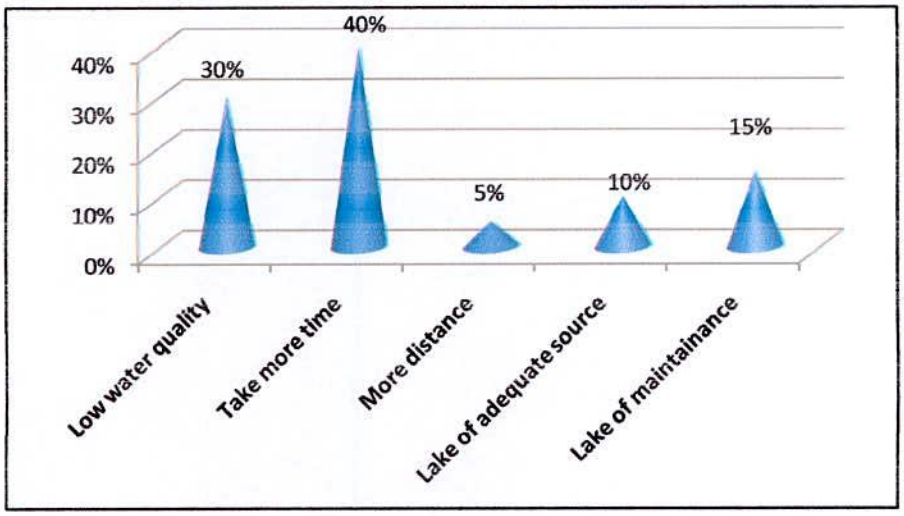


Figure 4.16: Problems faced in getting safe drinking water

Use of water and its impact on health of slum people in study area are as follows:

In the study area accessibility level of safe drinking water is very poor. A very few number of deep tube-wells are unevenly distributed around the area.

1. Piped water supply and tap water supply is absent in the study area. As a result it is not easy to collect safe water from source.
2. The less number of tube-well is present in the slum area and this tube-well is not arsenic tested. The poor families are suffering more from the Arsenic problem. Because they have no access to alternative safe drinking water sources. The first symptoms of long-term exposure to high levels of inorganic arsenic (e.g. through drinking-water) are usually observed in the skin, and include pigmentation changes, skin lesions and hard patches on the palms and soles of the feet .These occur after a minimum exposure of approximately five years and may be a sign to skin cancer. In addition to skin cancer, long-term exposure to arsenic may also cause cancers of the bladder and lungs. The presence of arsenic in tube well water is very harmful for our health. Government should take necessary steps to test the Arsenic in this tube well in study area.
3. Quality of drinking water is important for health and it is highly related with public health. Any kind of contaminated particle present means thousands of health problems.

There are two types of water, one is iron mixed water and another is sweet water. According to the respondents 40% said that they are suffer iron problem in drinking water.

4. The surrounding space of every water sources in the slum is mostly dirty and unhygienic. They get water from the sources where they also take bath, wash. Sometimes slum people dispose their kitchen waste by side of the tube-wells. As a result the water sources lost the healthy environment. The people use these source and fall into different water born diseases.
5. Uranium in water comes from different sources. The redistribution of uranium and uranium progeny to both surface water and groundwater occurs primarily from the natural erosion of rock and soil; some redistribution also comes from the mining, milling, and, to a lesser extent, conversion portions of the nuclear fuel cycle. Some of the uranium is simply suspended in water, like muddy water. Most drinking water sources have very low levels of radioactive contaminants i.e. radionuclides. Elevated concentrations of natural uranium in well water are more likely to be found in drilled wells that obtain their water from the cracks and fractures of bedrock, rather than dug wells or surface water supplies. Uranium and its salts are highly toxic. Water having uranium concentration above the proposed Maximum Acceptable Concentration (MAC) is not safe for drinking purpose as it occur lead to harmful health effects in humans.WHO provisional guideline for drinking-water quality: 15 µg of uranium per liter (WHO, 2003).The toxic dose of uranium has been also examined in animals and humans (Hursh, 1973; Lussenhop, 1958; Wrenn, 1985). Studies of occupationally exposed persons, like uranium miners, have shown that the major health effect of uranium in the body is renal toxicity (Taylor, 1989; SRC, 1990). Because uranium tends to concentrate in specific locations in the body, such as in the skeletal structure and the liver, risk of bone cancer, liver cancer and blood diseases such as leukemia also are increased The major portion of uranium in blood is excreted in the urine. So uranium concentration in ground water should be tested in each tube well.

4.4 Household and Environmental Sanitation and its impact on health

Sanitation facilities are the prime requirement for a healthy living environment. But most of the slums nuts do not incorporate sanitary facilities.The sanitation systems found in the study area are sewer system, septic tank, pit latrine, and others. Sewer system is not introduced in Khulna city.Figure 4.17 shows water source and latrine at the same place.

Figure4.17:Water source and latrine at the same place

4.4.1 Types of latrine

It is observed that Sanitation situation is worse than water supply in the Muripotti, Jabdipur, Bagmara, Bastuhara slum. The commonly available sanitation facilities include sanitary latrines, pit latrines and ring slab latrines in slum areas in KCC. Among theses, building materials of latrine are expensive and very few slum dwellers have access to the sanitary latrines. Pit latrine is cheaper than sanitary latrine and slum people can make it themselves by using a tank of soil. Sanitary and Ring slab latrine is common in all slums. Ring slab latrine is easy and cheap to make with place of bamboo and jute or cloth or plastic. In Muripotti slum there is no Pit latrine. Some slum dwellers going to open place or drain. All the latrines are not hygienic and environment friendly. No slum has separate sanitation locks for male and female users.Figure 4.18 shows various types of latrine in the study area. (Table 3 Appendix).

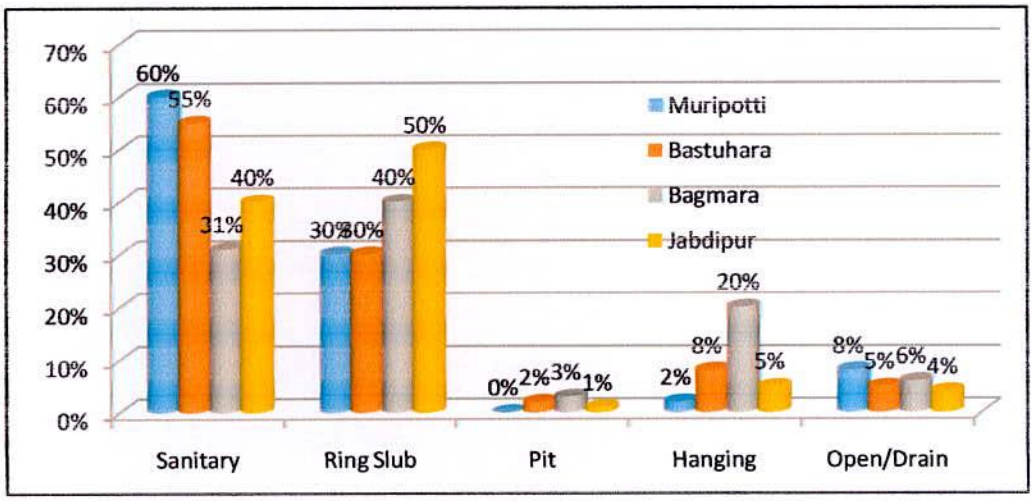


Figure 4.18: Various types of latrine in the study area

4.4.2 Ownership pattern of latrine

Out of the households using any hygienic latrine, common latrines users are higher in every slum in the study area. Table02shows Ownership pattern of latrine in Muripotti, Jabdipur, and Bagmara and Bastuhara slum (Appendix). Most of the people in slums use Community on latrine inMuripotti(69%), Bagmara (47%) and Jabdipur (41%).Only few percentage of household has owned latrine facilities.Figure 4.19 shows ownership pattern of latrine.(Table 4 Appendix).

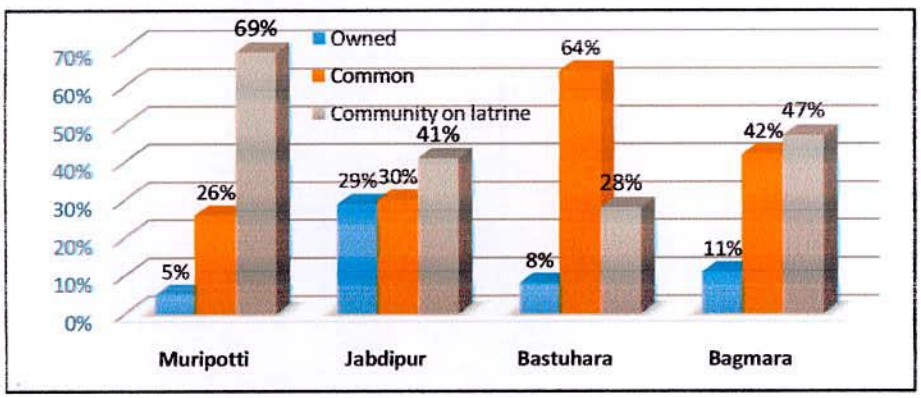


Figure 4.19:Ownership pattern of latrine in the study area.

4.4.3 Disposal of children's feces

Very few percentages of children's feces are disposed ofin the latrine,highest percentage of children's feces is are thrown to the drain, others are to ditch or garbage stack or are left at the place of defecation. Children less than 5 years do not use latrines.Figure 4.20 showsdisposal system of children's feces.

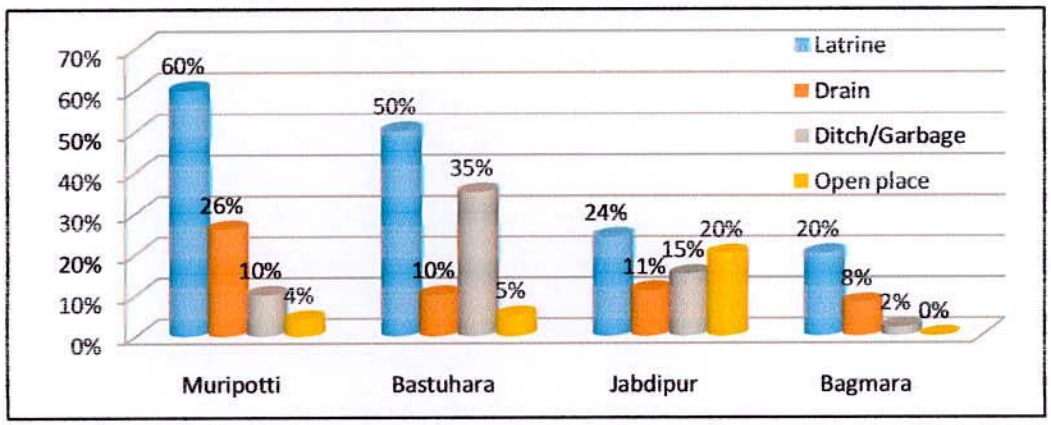


Figure 4.20: Disposal system of children's feces

Problems in access to sanitation and its impact on health:

The problems that are faced by the slum dwellers are as follows.

- The surrounding space of every sanitation latrine in the slum area is mostly dirty and unhygienic. They dispose waste attached with the sources sometime the slum people dispose their kitchen waste by the side of the latrine. As a result the sanitary latrine lost the healthy. The people use these source and fall into different water born diseases.
- It is found most of the family shares their latrines. The number of latrines is less then they need. But the number of latrines is too short to need. The number of sanitation latrine exist in the slum are not adequate in the context of the total household member.
- The slum peoples have not easy access to the sanitation facilities. So, some portion of the slum dwellers uses hanging latrines or open places for their and threats to their health.

- The location of the sanitary latrines is not in appropriate situation. As a result some slum dwellers have to face some difficulties for long distance from their house and also have to wait for the inadequate number of sanitary latrine.
- The condition of most of the latrine is unclean platforms and leakage of septic. The surrounding space of latrine in the slums area is mostly dirty and unhygienic.
- Maximum children are not use sandal during defecation and soap in washing hands returning from toilet so diseases are very common among children.
- Financial ineptitude is the main problem of the slum people to set up sanitary latrine.

4.5 Solid waste Disposal

In study slum area (Muripotti, Jabdipur, Bastuhara, Bagmara) of Khulna city there is no solid waste collection facility. Some municipal dustbins are found in slum area for solid waste disposal, but not sufficient and all have been destroyed. It was observed that waste was dumped here and there in the slum area. Few dustbins are present in Muripotti and Bagmara slum to dispose solid waste disposal. But Jabdipur, Bastuhara and slum have no facility to through solid waste disposal into the dustbin. Food waste, paper, rubbish, ashes and residue, special wastes such as street sweeping, road side litter and abandoned vehicles are the main solid waste in the study area, besides this slum dwellers have tendency to dump solid waste in the study area. Figure 4.21and Figure 4.22showsscattered disposal of wastes.

Figure 4.21: Scattered disposal of wastes Figure4.22: Waste disposed into nearby house

4.5.1 Disposal place of solid waste

Disposal of solid is a real problem for the residents of city as well as slums. In Muripotti slum area waste disposal facilities are better than Jabdipur, Bastuhara and Bagmara. In Jabdipur, Bastuhara and Bagmara slum area waste disposal facilities situation is vulnerable. There is no organization to work here. K.C.C. authority does not provide any facilities to dispose garbage. Most of the respondent is not satisfied for the solid waste management in slum area. In these slums, most of the solid wastes are disposed indiscriminately. There is house to house waste collection system by KCC authorities but it is very low in the slum area. So the solid waste disposing system of slum area isvery low and poor. As results the environmental is hazardous.

From the present study, it is observed that maximum slum dwellers dispose their solid waste near the house or open place and its percentage is Muripotti 11%, Jabdipur 65%, Bastuhara 30% and Bagmara 40%. About municipal collection its percentage is Muripotti 22%, Jabdipur 0%, Bastuhara 0% and Bagmara 0%.Slum dwellers through their waste disposal indiscriminately in percentage Muripotti 45%, Jabdipur 25%, Bastuhara50% and Bagmara 27%. About 12% in Muripotti,10% in Jabdipur,20% in Bastuhara and 22% in Bagmara dispose their waste into the road side drain. Table 03 in Appendix showsdisposal of solid waste into different places in four slum area.The percentage of households dispose their solid wastes in to different places are shown in Figure 4.23.(Table 5 Appendix).

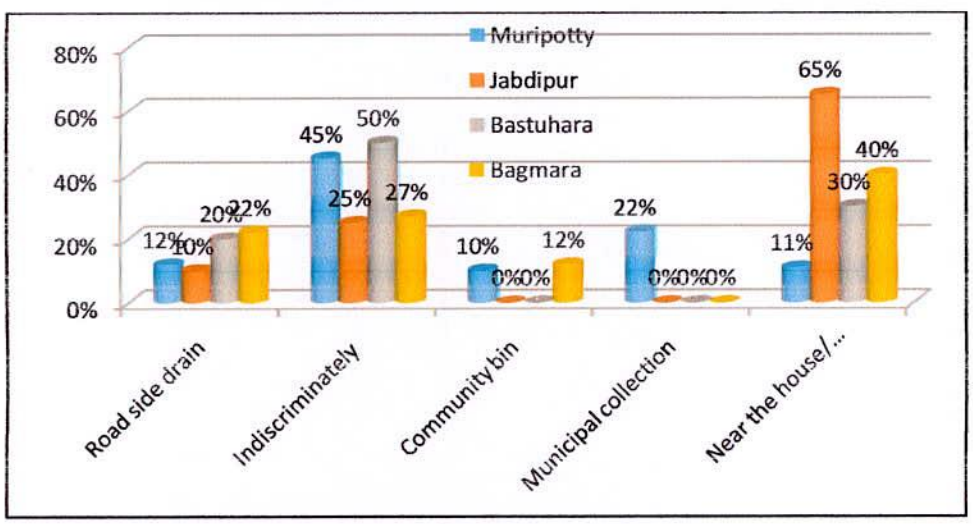


Figure 4.23: Disposal of solid waste into different places

4.5.2 Problems in access to solid waste disposal

In the Figure 4.22, Shows that financial ineptitude is the main problem in access to solid waste disposal because it needs money in the door to door collection of solid waste by the KCC. About 50% respondents say take of awareness is the another vital problem. About 30% says lake of financial ineptitude and 15%says lake of maintained. Figure 4.24shows problem in access to solid waste disposal in study area.

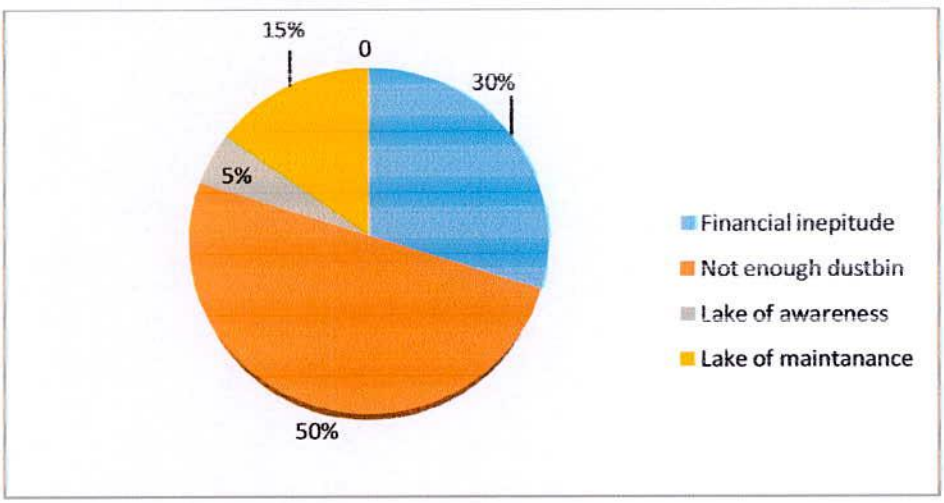


Figure 4.24: Problem in access to solid waste disposal in study area

Solid waste disposal system and its impact on health:

There are potential risks to environment and health from improper handling of solid wastes. Direct health risks concern mainly the workers in this field, who need to be protected, as far as possible, from contact with wastes. There are also specific risks in handling wastes from hospitals and clinics. For the general public, the main risks to health are indirect and arise from the breeding of disease vectors, primarily flies and rat's. Uncollected solid waste also increases risk of injury and infection.There are very few dustbins in the slum areas. But these are not clean as wells regularly.Lake of awareness is another major problem among slum dwellers about waste disposal.Due to lake of dustbins, slum dwellers through their waste near

the house or open place.It was observed that waste was dumped here and there within the slum area. Dwellers also have the tendency to dump solid waste in the ditches within the slum to increase land area, which causes an unhygienic environment and causes environmental pollution that badly effect our health.

Infections:

1. Skin and blood infections resulting from direct contact with waste, and from infected wounds.
2. Eye and respiratory infections resulting from exposure to infected dust, especially during landfill operations.
3. Different diseases that results from the bites of animals feeding on the waste.
4. Intestinal infections that are transmitted by flies feeding on the waste.

Chronic diseases: Incineration operators are at risk of chronic respiratory diseases, including cancers resulting from exposure to dust and hazardous compounds.

4. 6 Drainage system

Violation on the drainage path, inadequate drain sections, absence of outlets, indefinite drainage outlets, lack of proper maintenance of the existing drainage system and disposal of solid wastes into drains or drainage paths contribute to the backlog of drainage and water logging problems,

Only 30% short drainage facilities are exist in the study area and there is no planned drainage facility. About 32% respondents say due to the lack of drainage facilities water logging is the main problem especially in rainy season. The major portion of excreta and solid wastes are deposited into the drain and jammed it which makes a serious water logging in these slums. Worse drains system is one of the reasons of polluted environment in the study area. About 38% have no drainage facilities. The drainage facilities in Muripotti are better than Jabdipur, Bagmara and Bastuhara.Figure 4.25 showsdisposal of solid waste through into drain, Figure 4.26 showsinadequate space of drainage facility in study area and Figure 4.27 showsdrainage facility in study area. Figure 4.28 showsproblem in access to drainage facility in study area.

Figure 4.25: Disposal of solid waste through into drain

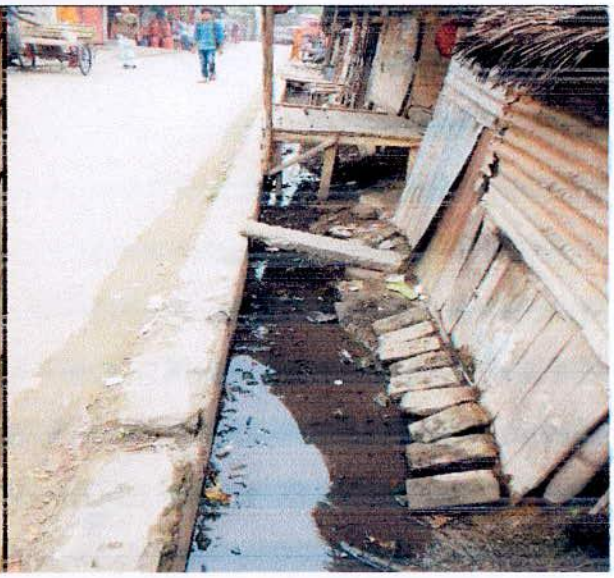


Figure 4.26: Inadequate space of drainage facility in study area

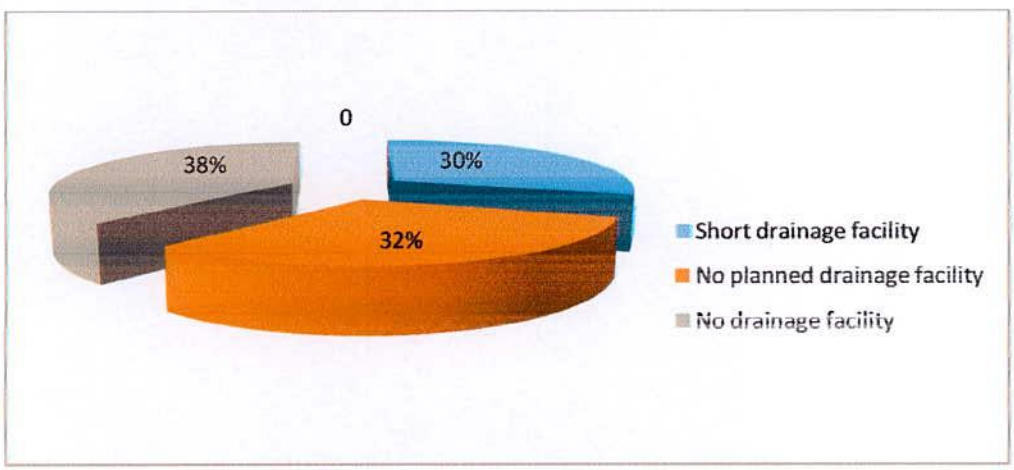


Figure 4.27: Drainage facility in study area

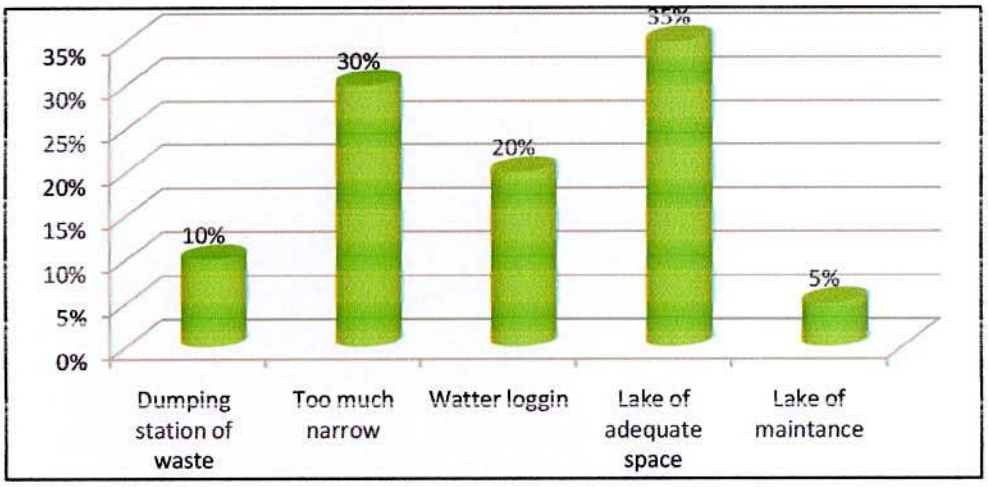


Figure 4.28: Problem in access to drainage facility in study area

Drainage system and its Impact on health:

Inadequate drainage is a common character in the slum. It makes many problems and it also involved with their health problem.

- Very often slum dwellers dispose waste in drain closed to their house. So the flow of water would be rain water or cooking/bathing purpose used water is hampered in the slum areas. The authority does not maintain the cleaning of these drains regularly or according to the need. For that water logging occur very often in the area.Especially during rainy season water logging is a common picture in and around the slums of Muripotti, Bagmara, and Bastuhara and Jabdipur slum area. Water logging inside the houses for the absence of sufficient drainage facilities. As a result excessive mosquito problem occur in this place in the present study area.
- Most of the slums have very little access to drainage facilities. Worse drainage system is one of the reasons of polluted environment in the study area.
- All narrow drains are open drains. There is no provision for the regular cleaning of the drains in the slum areas in the city. The waste disposed in the drains may over flow sometimes. It causes environmental pollution as well as the health hazard.

4.7 Hygienic knowledge and Health status

Health is one of most important basis need of the human life. The health situation of the slum dwellers is extremely poor. This is mainly due to the unhealthy and unsanitary environment of living in the slum area. The poor food intake causes malnutrition and lower disease resistance power of the slum dwellers. They are not aware about the modern health facilities for lack of appropriately knowledge. There economic condition does not support them to take the modern expensive medical treatment. As a result they suffer in several diseases through the whole year.

Their is a relation between socio economic factors including income, expenditure, education, food habit, knowledge about hygiene and physical environment and health. Socio economic factors influence the physical environment such as and health knowledge about hygiene can bring a good physical environment in the slum areas. which can less the amount of disease.

4.7.1 Homewards Environment

There is negligence amount the slum people to clean the house and yard that means surrounding environment of their living place. During survey, it is observed that only 30% of household are cleaned. Different types of wastes such as dirty papers and kitchen wastes are exist here and there. These create an unhealthy environment in the slums and aggravate different types of diseases.The study areas the presence of substandard housing characterized by poor structure. overcrowding and inadequate floor space. Majority of slum houses are of very poor quality. In study area most of the house room is one door and there is no window. This environment is unhealthy for people living in these rooms.Figure 4.29 showsinsufficient room space in the study area. Figure 4.30 shows surrounding dirty space of the house and Figure 4.31 showshomewards environment in four slum areas. About 70% slum people are lived in dirty place.

Figure 4.29: Inadequate room space in the study area

Figure 4.30: Surrounding space of the house is dirty

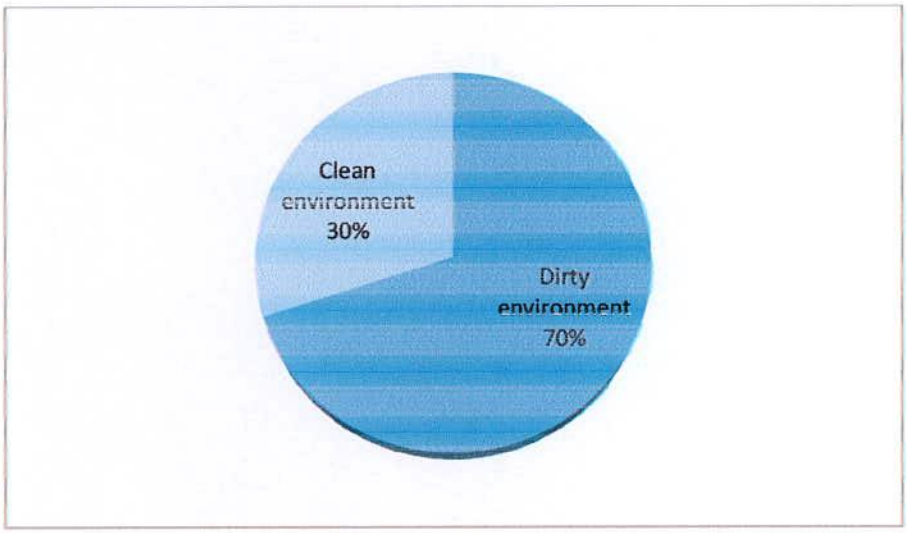


Figure 4.31: Home wards environment in four slum area

4.7.2 Occurrences and Types of Diseases

Physical environment have influence on the human health. The slum areasare not safe for health.Physical environment condition is not in a satisfaction level. This causes continuous flow of different diseases. Slum dwellers are the most unconscious group of the urban people about health. In the study area sanitation and drainage condition is very poor. As a result common infectious diseases can flourish here easily. Some diseases in the area are common called malnutrition, diarrhea, dysentery, cough, fever, skin diseases, gastric, etc.The unhygienic residential environment of the slums is the main causes of these diseases.The unhygienic residential environment of the slums is the main causes of these diseases.Figure 4.32 shows the distribution of diseases suffered by slum dwellers. This figure is completely based on field survey. Is has been found that about large portion that is 20% of the slum people suffered by malnutrition problem.

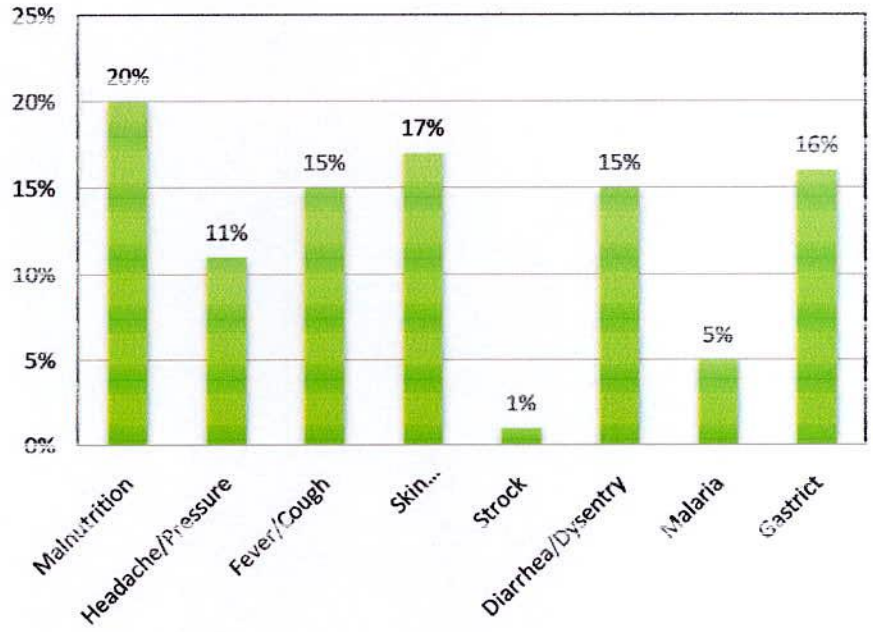


Figure 4.32: Distribution of diseases suffered by slum dwellers in study area

4.7.3 Environmental health treats in slum areas

Most urban people particularly the poor are living in a crowded and damp environment.Due to exposure to their environment bronchial asthma and other respiratory disease are on the increase.Other environment problems include poor sanitation,inadequate supply of drinking water, communicable disease like gastroenteritis (diarrhea, shigellosis,amoebiasis,giardiasis etc.), skin disease(scabies,ring worm,etc.),respiratory tract infections etc. The social and physical environments that define the urban context are shaped by multiple factors and multiple players at multiple levels. Global trends, national and logical governments, civil society, markets and the private sector shape the context in which local factors operate.Governance interventions in the urban setting must consider national and municipal determinants and should strive to influence both the urban living and working environments as well as intermediary processes that include social process and health knowledge. The framework assumes that the urban environment in its broadest sense(physical,social,economicand political) affects all strata of residents, either directly or indirectly. It should be pointed out that interventions can also influence the key global, national and municipal drivers. The health sector has an important role to play, for instance via the "healthy cities" approach.

Radioactivity in the environment is treated as one of the severe health hazard for the human beings. Even a low level activity in the air can cause a significant damage with in the body. Radiation doses in the environment come from two sources, first one from natural sources like Potasium-40, Carbon-14, Uranium-238, Uranium-235, Thorium 232 etc. and the second source is manmade. Manmaderadioactive sources in the environment mainly comes from nuclear fission products released in the environment due to nuclear accident or nuclear tests. As nuclear fallout changes from time to time so exposure levels in the air near the ground also changes from time to time.About one-fifth of the total burden of disease in Bangladesh is associated with environmental factors.Two of the three causes of death and sickness are respiratory illness and diarrheal diseases. Both of these are strongly associated with the environment radiation and have a significant impact on the health of children as well as others.In the present work, due to lack of instruments it has not been detected any kind of radiations. So further work should be done in this field.

4.7.4 Source of treatment

Government medical treatment is not available for the slum dwellers of the area. They do not get proper treatment from government center. There are some private clinics in this area. But this type of clinic takes high doctors' fees. These high charges of the doctors and clinics force slum dwellers to avoid the medical facilities of clinics. A few of the slum dwellers go to the government hospital only when they suffer severely of any disease. They take different cheap traditional treatment when they suffer from diseases. These are homeopath, herbal and local doctors. Among these local doctors is only the seller of medicine in the area who has no institutional recognition. It is observed that maximum people respondents expend average 400-500 TK per month in their treatment because their monthly low income. As a result they suffer economical problem through the whole year. InFigure 4.33it is seen that only 15% go to govt. hospital, about 30% go to homeopath or take herbal treatment 20% do not treatment.

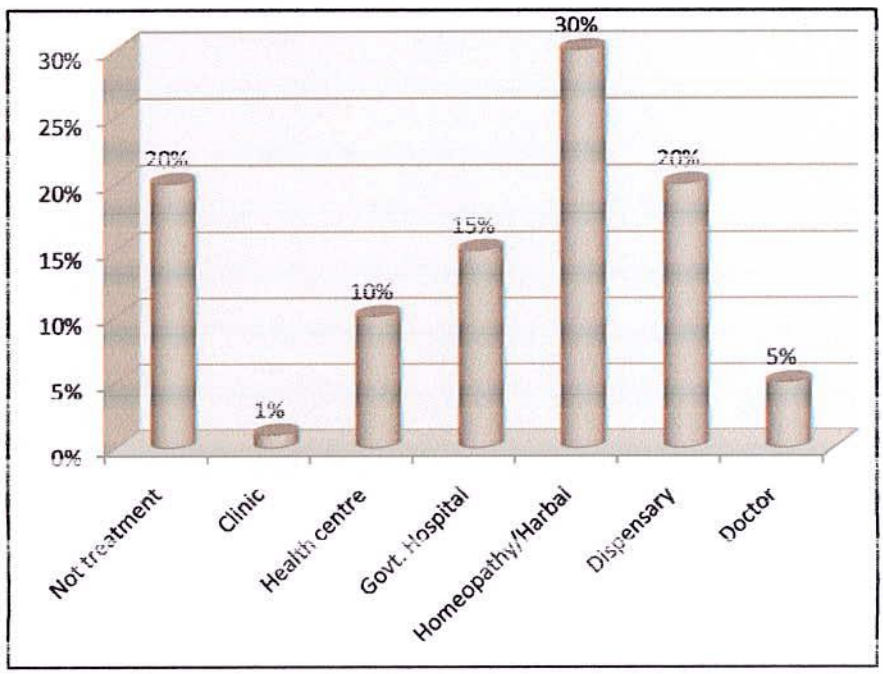


Figure 4.33 Treatment facilities of the slum dwellers in study area

4.7.5 Odor Pollution

The unscientific accumulation and dumping of solid waste, sewer overflow, stagnation of water in open drains. and decomposition of wastes in open place are the major sources of odor and bad smells in the slum area. Due to a lack of proper management and ignorance, these farms are causing odor and water pollution. A large number of city dwellers feel discomfort due to odor pollution. About 50% of the total households made comments that disposal of solid waste. about 18% unclean open drains.about 30% unhygienic latrine about 2% cattle/poultry farm and the poorly managed decomposed wastes of nearby dustbin or open place are the major sources of odor pollution in the study area. The main cause of odor pollution is given below the Figure 4.34.

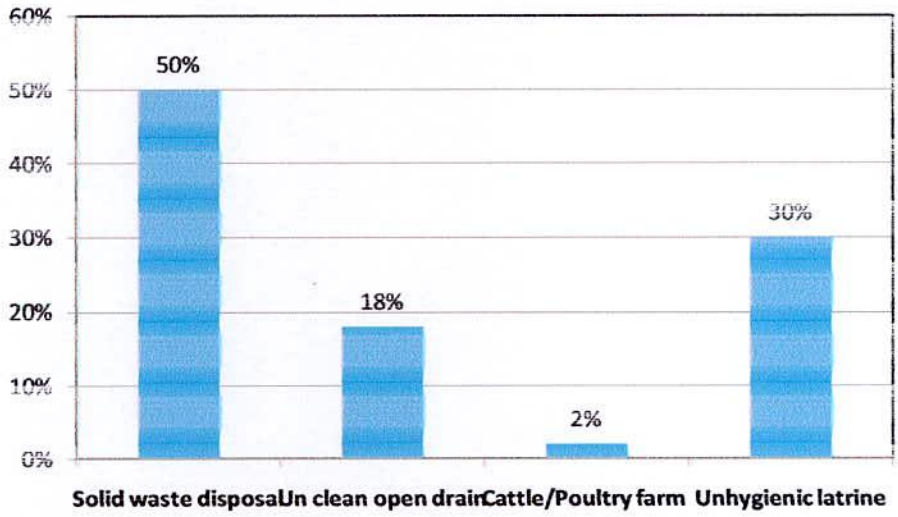


Figure 4.34: Causes of odor pollution in study slum area.

4.7.6 Knowledge about Balance Diet:

Maximum people have no knowledge about balance diet. Figure 4.33 Shows that about 91% respondents have no knowledge about diet and only 9% have knowledge about balance diet.

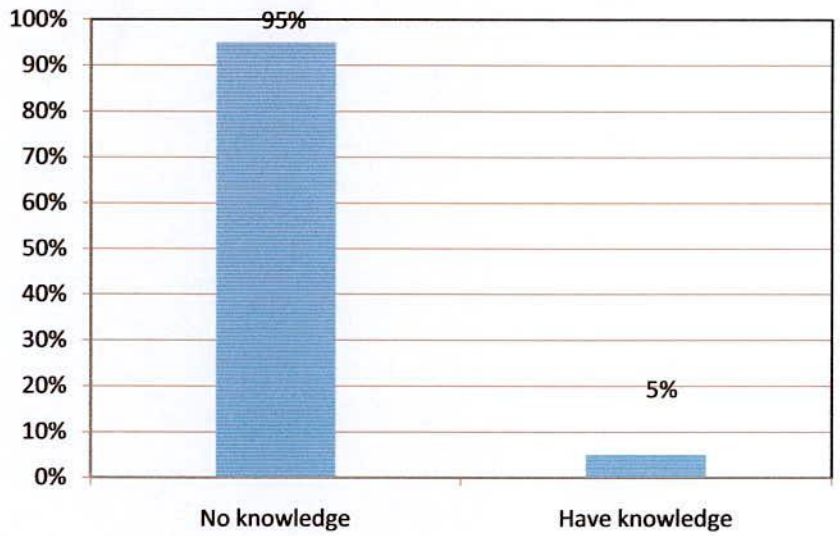


Figure 4.35: knowledge about balance diet.

4.7.7 Bad effects of sources of Energy Used for Cooking:

Khulna city is not connected to piped gas supply. In the study area maximum respondent comments that they are depends on different kinds of fuels for Cooking. Like that wood,bamboo,paper etc.As a result it creates heavy smoke that is harmful for health, especially for breathing/inhalation.

Physical environmental problem include many problems and that are water logging,odor pollution, inadequate drainage system, lake of drainage clearance, noise pollution, excessive mosquito and presence iron in ground water.

4.8 Background Radiation level and its impact on health

Radiations in different environmental samples are very harmful for different human diseases. In Khulna region background radiation level from different samples such as air, soil, groundwater, surface water, sediment and different vegetable samples have been studies in details.

Radioactivity in soil samples

In Khulna city at Rupsha activity concentration for ^{226}Ra, ^{232}Th and ^{40}K radionuclide in soil samples were studies. In soil samples,the activity concentration of ^{226}Ra was found in the range of 40.86±4.3BqKg^{-1}to 53.92±7.86BqKg^{-1}, with an average value of 50.16±7.2BqKg^{-1}. This value was slight greater than the worldwide average value of 35BqKg^{-1}. The activity concentrations of ^{232}Th were found in the range of 64.9±6.6 BqKg^{-1} to 94.16±6.74 BqKg^{-1}, with an average value of 77.23±7.43 BqKg^{-1}, this value was higher than that of the world average value of 30 BqkKg^{-1}. And the activity concentrations of^{40}K have been found in the range of 581.02±77.66 BqKg^{-1} to 1098.5±124.9 BqKg^{-1}, with an average value of 864.63±101.69 BqKg^{-1}. This value was significantly higher than that of worldwide average value of 400 BqKg^{-1}.The activity concentrations of Pb-214, Bi-214, Pb-212, Tl-208 and Ac-228 in soil samples was found to be varied from 46.11±3.92 BqKg^{-1} to 60.06±5.13 BqKg^{-1}, 39.19±12.38 BqKg^{-1} to 60.98±11.39 BqKg^{-1}, 66.04±3.1 BqKg^{-1} to 79.39±3.03 BqKg^{-1}, 54.74±6.81 BqKg^{-1} to 83.19±7.21 BqKg^{-1} and 64.12±11.1 BqKg^{-1} to 120.01±10.92 BqKg^{-1} respectively(Tuhina, 2016). In that study only 10 samples were studies. This study should be done all the region in Khulna city so that radioactivity in soil as well as plants or any kinds of foods, vegetables grown in that soil can be determined.

Radioactivity in sediment samples

The activity concentrations of Pb-214, Bi-214, Pb-212, Tl-208 and Ac-228 in sediment and sand samples were found to be varied from 43.84±3.55 BqKg^{-1} to 58.58±4.93 BqKg^{-1}, 35.6±4.47 BqKg^{-1} to 59.19±5.66 BqKg^{-1}, 58.43±2.89 BqKg^{-1} to 80.27±3.56 BqKg^{-1}, 54.22±5.82 BqKg^{-1} to 83.93±7.45 BqKg^{-1} and 60.16 ±11.81 BqKg^{-1} to 94.68±14.02 BqKg^{-1} respectively from Rupsha river. In sediment samples,the activity concentrations of^{226}Ra was found in the range of 40.86±4.31 BqKg^{-1} to 58.27±5.23 BqKg^{-1}, with an average value of 58.27±5.23 BqKg^{-1}. This value was slight greater than the worldwide average value of 35

$BqKg^{-1}$. The activity concentrations of ^{232}Th was foundin the range of 57.6±6.84 $BqKg^{-1}$ to 82.78±7.5 $BqKg^{-1}$, with an average value of 73.99±7.56 $BqKg^{-1}$, this value was higher than that of the world average value of 30 $BqKg^{-1}$. And the activity concentrationsof ^{40}K was in the range of 578.39±74.62 $BqKg^{-1}$ to 1038.69±110.7 $BqKg^{-1}$, with an average value of 881.49±100.25 $Bq.Kg^{-1}$ This value was significantly higher than that of worldwide average value of 400 $BqKg^{-1}$.

Table 4.5: The average concentration of ^{226}Ra, ^{232}Th and ^{40}K in different soil samplesin different countries

Country	Radioactivity Concentration(Bq/kg)			Reference
	^{226}Ra	^{232}Th	^{40}K	
India	44.21	174.48	93.10	Singh (2005)
Egypt	17	18	320	UNSCEAR 2000
United States	40	35	370	UNSCEAR 2000
Argentina	-	-	650	UNSCEAR 2000
Pakistan(Kohistan)	42.11	43.27	418.27	Hasan M. Khan (2011)
China	32	41	440	UNSCEAR 2000
China	40.3	59.6	751.2	Lu X. (2012)
Cameroon	-	16.67	186.96	Tchokossa (2012)
Hong Kong SAR	59	95	530	UNSCEAR 2000
India	29	64	400	UNSCEAR 2000
India (Kalpakkam)	22.6	92.8	434.1	Sowmya(2010)
Japan	33	28	310	UNSCEAR 2000
Korea, Rep. of	-	-	670	UNSCEAR 2000
Iran (Islamic Rep. of)	28	22	640	UNSCEAR 2000
Denmark	17	19	460	UNSCEAR 2000
Iraq	-	20.09	984.30	
Palestine	-	23.8	120	Kaleel Mohammed Thabayneh(2011)
Ghana	13.61	24.22	162.08	Faanu (2011)
Saudi Arabia	23.8	18.6	162.8	A. El-Aydarous (2007)
Serbia	51	50	608	SVETLANA GRDOVIĆ(2010)
Yemen	44.4	58.2	822.7	A. I. AbdEl- mageed (2010)
Nigeria	41.1	78.6	223.5	A. M. Umar(2012)

Nigeria(Plateau)	-	2.72	35.4	I. R. Ajayi(2008)
Belgium	26	27	380	UNSCEAR 2000
Luxemburg	35	50	620	UNSCEAR 2000
Switzerland	40	25	370	UNSCEAR 2000
Bulgaria	45	30	400	UNSCEAR 2000
Malaysia	99.13	139.98	598.24	Saat (2011)
Romania	32	38	490	UNSCEAR 2000
Greece	25	21	360	UNSCEAR 2000
Portugal	44	51	840	UNSCEAR 2000
Spain	32	33	470	UNSCEAR 2000
France	38	38	599	UNSCEAR 2000
Jordan	56	29	501	(New York: UNSCEAR) (2000)
Italy	64	80	670	UNSCEAR (2000)
USA	40	35	370	UNSCEAR (2000)
Cyprus	17	-	140	UNSCEAR (2000)
Northern Malaysian Peninsula	57	68	427	Almayahi(2012)
Armenia	46	30	360	UNSCEAR 2000
Lithuania	16	25	600	UNSCEAR 2000
Ireland	37	26	350	UNSCEAR 2000
Russia	19	30	520	UNSCEAR 2000
OAP data	172	211	511	UNSCEAR (2000)
Bangladesh	50.46	85.42	900.79	Tuhina (2016)
Bangladesh	52.22	90.65	870.45	Tuhina (2016)
Worldwide mean	30	35	400	UNSCEAR 2000

Radioactivity in vegetable samples

In Khulna city at Rupsha Upazila the activity concentration of ^{226}Ra, ^{232}Th and ^{40}K in Paddy samples were found to be varied between 17.59±4.44 to 42.32±4.48Bqkg^{-1}, BDL to 3.75±2.995Bq/kg, and 35.97±150 Bqkg^{-1} to 170.12±135.49 Bqkg^{-1} respectively, with an average of 24.43±5.16 Bqkg^{-1}, 2.048±2.798 Bqkg^{-1} and 93.96±133.75 Bqkg^{-1}. The highest activity concentration of170.12±135.49 Bqkg^{-1} for ^{40}K was found in Paddy samples collected from Khanabad. It is less than world average activity concentration. On the other hand, the activity concentration of ^{226}Ra, ^{232}Th and ^{40}K in Arum samples were found to be varied between BDL. to 8.78±3.08Bqkg^{-1}, BDL to 2.53±4.32Bqkg^{-1}, and 426.91±107.23 Bqkg^{-1} to 1280.71±133.89 Bqkg^{-1} respectively, with an average of 5.77±2.97 Bqkg^{-1} of ^{226}Ra,maximum Arum samples were found BDL for ^{232}Th and 758.298±109.66 Bqkg^{-1} of ^{40}K The highest activity concentration of 1280.71±133.89 Bqkg^{-1} for ^{40}K was found in Arum sample collected from Khan Mohammadpur. The highest activity concentration of1712.47±221.96Bqkg^{-1} for ^{40}K was found in Papaya sample collected from Aichgati in Khulna (Nahar, 2016). It shows that papaya in Khulna has higher radioactivity concentration than the other parts of Bangladesh as well as than world average value for root vegetables and fruits suggested by (UNSCEAR, 2000). In the slum area Papaya is very famous due to its low cost. As a result it is very harmful for those people who eat Papaya regularly. So a details survey for radioactivity in Papaya should be done in the slum area.

Radioactivity in Rupsha river water sample and tube-well water

Various places in Khulna at Rupsha in surface water samples, the activity concentrations of 226Ra and ^{232}Th were found in the range of 1.26±0.98 Bq/L to 5.51±2.5 Bq/L, with an average value of 2.56±1.5 Bq/L and 0.15±0.5 Bq/L to 1.57±2.9 Bq/L, with an average value of 0.69±1.26 Bq/L respectively. ^{40}K has been found in only one sample in the range of 109.65±32.17 Bq/L.In drinkwater samples as tube-well water samples, the activity concentrations of ^{226}Ra and ^{232}Th were found in the range of 'below Detection Level' to 4.97±1.45 Bq/L, with an average value of 2.14±1.37 Bq/L and 'below Detection Level' to1.58 ±2.92 Bq/L, with an average value of 0.60±1.03 Bq/L respectively. ^{40}K has been found in only one sample in the range of 6.7±30.34 Bq/L (Tuhina, 2016).

Uranium concentration in ground water is very harmful for human kidneys. Maximum Acceptable Concentration (MAC) levels of uranium in drinking water is of Australia (15 μg L^{-1}; ADWG 1996), U.S. (30 μg L^{-1}; U.S.EPA 2000), Canada (20 μg L^{-1}; Health Canada 2002), WHO (15 μg L^{-1}; WHO 2003). Average concentrations in groundwater were found to be 3μg L^{-1} (Cothern, 1983) with ranges of 0.015-973.0 μgL^{-1} in domestic supplies in U. S. (Drury, 1981). Uranium concentrations in domestic and surface water samples in India were 0.67-20.26 μgL^{-1} (Bansal, 1992) whereas in hot springs water it varied in the range 1.4-7.4 μgL^{-1}(Chakarverti, 1980). Uranium concentrations up to 700 μgL^{-1} have been found in private groundwater supplies in Canada (Moss, 1985). The mean uranium concentrations in over 1,00,000 surface waters throughout the UK has been determined to be 0.65 μgL^{-1} with a maximum observed concentration of 233 μgL^{-1}. In a 1980-1981 survey of 13 selected sites in south-central British Columbia, the mean uranium concentration (n=519) in surface water and ground supplies was 4.06 μgL^{-1}(PBC, 1981). The mean and median levels of naturally derived uranium in groundwater of 287 wells samples in southeastern Manitoba (1982-1984) were 58.3 μgL^{-1} and 10 μgL^{-1} respectively and the maximum value was 2020 μgL^{-1}. Uranium concentrations in water from the western Himalayas to range from 0.89 to 63.4 μgL^{-1} (Virk, 2001). Concentrations of uranium in mineral waters from a high background regions in Brazil to be 0.8 to 2.0 μgL^{-1}. In a survey of 56 randomly selected bottled mineral waters in Europe observed uranium concentrations to range from 0.0104 to 9.45 μgL^{-1}. Uranium is present in sea water at concentrations of about 3.3 μgL^{-1} (Kaya, 1993). The range of uranium content is to be 0.50±0.33 to 56.27±0.52 ppb from various of Bangladesh (Sultana, 2009). Table 4.6 shows that range of uranium concentration in groundwater worldwide.

Uranium Concentration in Groundwater in Khulna

Khulna Division located to the south- west of Bangladesh and with an area of 22273.21 sq km, is bounded by Rajshahi Division to the north, Bay of Bengal to the south, Dhaka and Barisal Divisions to the east, West Bengal to the west.

Table 4.6 Uranium concentration in groundwater world wide

Sr. no.	Country	Range of Uranium Concentration (ppb)	References
1	Ontario, Canada	0.04-4.21 (0.4)	(OMEE, 1996); (Moss, 1985)
2	USA	0.01-652	(Drury *et.al.*, 1981; Edgington, 1965)
3	New York, USA	0.03-0.08	(Fisenne, 1986)
4	Argentina	0.04-11.0 ppb(1.3)	(Bomben, 1996)
5	Australia	>20 ppb	(Hostetler, 1998)
6	Turkey	0.24-17.65 ppb	(Kumru, 1995)
7	India	0.08-471.27 ppb	(Talucder, 1983)
8	Japan	(0.0009)	(Nozaki, 1970)
9	Norway	>20	(Frengstad, 2000)
10	New Mexico	>20	(Hakonson, 2002)
11	Jordan	0.04-1.400(2.4)	(Gedeon, 1994)
12	Kuwait	0.02-2.48	(Bou-Rabee, 1995)
13	South Greenland	0.5-1.0	(Brown, 1983)
14	Himalayas	0.89-63.4	(Virk, 2001)
15	Finland	2.1-2900(26)	(Kahlos, 1980)
16	Cyprus	0.005-38(086)	(Smith, 2000)
17	Pakistan	0.05-5	(Akram, 2004)
18	Sea Water	3.0-3.6	(Kaya, 1993)
19	Chapainawbabgonj, Bangladesh	<47 ppb	(BGS, 2000)
20	Bangladesh	0.99-56.10 ppb	(Sultana, 2009)

Table 4.7 Uranium Concentration inground water in Khulna Division

Sr. no.	Location (Khulna Division)	uranium concentration	Sr. no.	Location (Khulna Division)	uranium concentration
1	Asasoni-1 (Satkhira)	9.21±0.84	15	Monirampur -1(Jessore)	16.64±0.77
2	Kaligonj (Satkhira)	8.68±0.87	16	Chougacha (Jessore)	8.68±0.87
3	Asasoni-2 (Satkhira)	9.74±0.82	17	Jhikargacha (Jessore)	9.74±0.82
4	Satkira (Satkhira)	10.81±0.79	18	Kashobpur (Jessore)	9.21±0.84
5	Dedhata (Satkhira)	10.28±0.80	19	Monirampur-2 (Jessore)	8.68±0.87
6	Asasoni-3 (Satkhira)	6.03±1.01	20	Noapara-2 (Jessore)	9.21±0.84
7	Dumuria-1 (Khulna)	41.59±2.49	21	Naragati (Narail)	11.87±0.76
8	Dumuria-2 (Khulna)	23.01±1.07	22	Lohagara (Narail)	12.93±0.74
9	Rupsa (Khulna)	38.94±2.27	23	Kalia (Narail)	34.69±1.93
10	Therokhada (Khulna)	29.38±1.52	24	Sreepur (Magura)	10.81±0.79
11	Bathiaghata (Khulna)	16.64±0.77	25	Sadar (Magura)	7.62±0.92
12	Bagharpara (Jessore)	44.25±2.71	26	Sadar (Jhenaidah)	14.52±0.74
13	Noapara-1(Jessore)	7.62±0.92	27	Sadar (Maherpue)	20.36±0.92
14	Avoypara (Jessore)	8.68±0.87			

* Uncertainty arises from counting statistics.
** Standard deviation of three measurements.

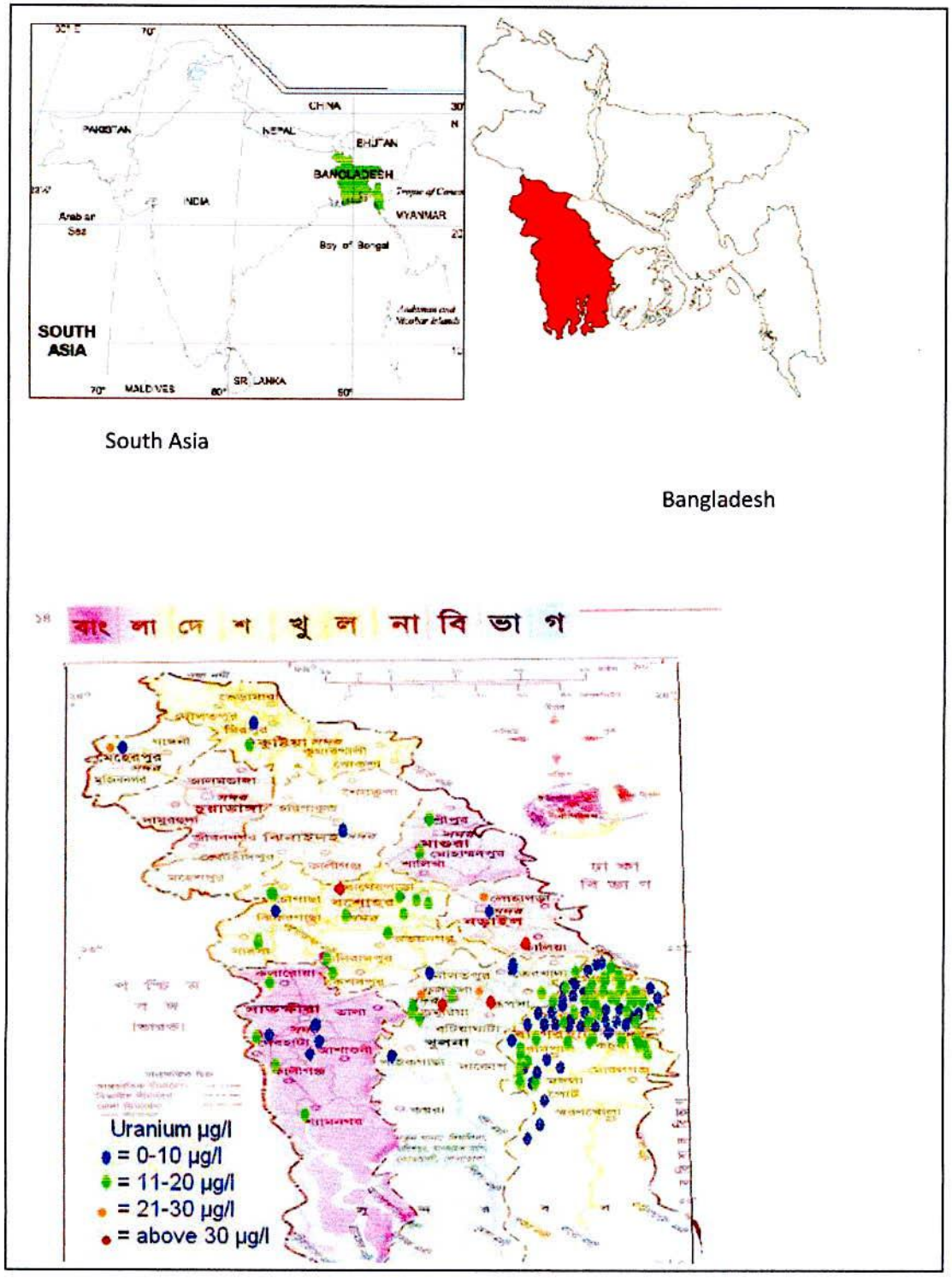


Figure 4.36: Map of Khulna Division in Context of the South Asia and Bangladesh.

From the present research work it is observed that the slum people are suffering various kidney diseases. As Uranium concentration in drinking water is very harmful for kidney disease so it is very much essential to test Uranium concentration in every tube-well water, at the slum area in Khulna City. Due to lack of instruments at KUET and short time in M. Sc. course, it was impossible to test the Uranium concentration in all tube well water. So further work should be done in this area.

CHAPTER V

CONCLUSION

The presence of slum is a common scenery in developing countries in the world. The socio-economic condition of the slum people in our country always remains in substandard level. The poor economic condition is responsible for this condition. Slums are densely populated and neglected parts of cities. Slums lack basic services, particularly access to pure water and sanitation. Many people crowded into small living spaces. Living conditions in slums and their poor health considered as an increasing concern for governments worldwide.Generally slum people face many problems particularly housing, sanitation, waste disposal faciiities, drainage facilities.Slum dwellers have the access of deep tube well for drinking water and sanitary latrines facilities. This tube well water is contaminated by both arsenic and radioactive substances such as uranium. Waste disposal system is not so good.

In the study areas, the presence of substandard housing is characterized by poor structure, overcrowding and inadequate floor space. Majority of slum houses are of very poor quality. In study area most of the house room is one door and there is no window. This environment is unhealthy. People living in these rooms in bad housing conditions are more likely to have mental health problems, such as anxiety and depression, to contract meningitis, have respiratory problems and experience long-term ill health. It is observed that 35% respondents have completed primary education and 19% are day labor.

Solid waste from households and the community are a serious health hazard and lead to the spread of infectious diseases. The less number of tube-well is present in the slum area and this tube-well is not tested for arsenic or radiation. Quality of drinking water is important for health and it is highly related with public health. Any kind of contaminated particle present means a lot ofof health problems. There are two types of water, one is iron mixed water and another is sweet water. According to the respondents, 40% are sufferingfrom iron problem in drinking water. Most of the slums have very little access to drainage facilities. Worse drainage system is one of the reasons of polluted environment in the study area.

All narrow drains are open drains. There is no provision for the regular cleaning of the drains in the slum areas in the city. The waste disposed in the drains may over flow sometimes. It causes environmental pollution as well as the health hazard. The condition of most of the latrine is unclean platforms and leakage of septic tanks problem have found in study areas. The surrounding space of latrine in the slums area is mostly dirty and unhygienic.

Major problem faced by the slum dwellers is physical environmental problem. Physical environmental problem include many problems such as water logging, odor pollution, inadequate drainage system, lake of drainage clearance, noise pollution, excessive mosquito and presence iron in ground water.

These interventions should be complemented with poverty alleviation strategies that supported labor-intensive economic growth, sound macroeconomic management, good governance and social development, including the empowerment of women, and by global trade policies that stimulate the growth of Bangladesh's economy. Surveillance should be used to monitor the implementation of policies and programs and to assess their impact.The work may attribute to further research on water supply and sanitation study. It will guide those who will work to improve the present.

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Appendix

Questionnaire for Household Survey

Sample no: ….. Date:……..Name of the area: ……..Ward no: …….

1. Identification of the respondent:

Name of the Respondents	
Occupation	
Religion	
Address	

2. Household information:

House household members		
Male		
Female		
Child		
Ownership of household	Tenant	☐
	Owner	☐
	Others	☐

3. Housing structure:

Tin shade and mud wall	☐
Straw/Golpata/shade and mud wall	☐
Straw shade/ bamboo wall	☐
Brick/cement shade and wall	☐

4. Educational qualifications:

Illiterate	☐
Can read and write	☐
Primary education	☐
Secondary education	☐
HSC and above	☐

5. Occupational patterns:

Rickshaw puller	☐	Day labor	☐
Retail shopkeeper	☐	Vegetable seller	☐
Tailors	☐	Paper Bag seller	☐
Hawkers	☐	Shrimp processor	☐
Servants	☐	Do not work	☐
Monthly Income			

6. Condition of Water Supply:

Sources	Road side tab	☐
	Deep tube well	☐
	Shallow tube well	☐
	Pond water	☐
	River water	☐
Tube-well distance from house		
Perception about the quality of drinking water	1.	
	2.	
	3.	
Water storage container	1.	
	2.	
	3.	
Taking of water purification measure: Yes☐No☐ . Arsenic Test: Yes☐No☐		
If yes measurement type	1.	
	2.	
	3.	
Perception about the quality of drinking water	1.	
	2.	
	3.	

7. Household and environmental Sanitation:

Mode of defecation	Sanitary latrines				☐
	Hanging latrine				☐
	Pit latrine				☐
	Ring slab latrine				☐
Ownership of latrine	Owned latrines				☐
	Owned by landlord				☐
	Common latrines				☐
Use of latrine by children					
Disposal of children's feces					
Practice of hand washing materials from toilet			Child		
			Adult		
Use of sandal during defecation	Child	Use	☐	Not Use	☐
	Adult	Use	☐	Not Use	☐
	Child	Use	☐	Not Use	☐

	Adult	Use	☐	Not Use	☐
Perception about the access in sanitation facilities	1.				
	2.				
	3.				

8. **Solid/ Liquid waste Disposal Systems:**

Disposal place of solid waste	
Disposal place of Liquid waste	
Perception about the access in solid waste disposal	1.
	2.
	3.

9. **Drainage System:**

No planned drainage facilities		☐
Short drainage facilities		☐
Perception about the access in drainage facilities	1.	
	2.	
	3.	

10. **Hygienic Knowledge and Health Status:**

Homewards environment	Clean	☐
	Dirty	☐
At least one member last 3 months		☐
At least one member during survey		☐
Types of diseases	1.	
	2.	
	3.	
Source of treatment	1.	
	2.	
	3.	
Expense per month		
Knowledge about balanced diet	No knowledge	☐
	Have knowledge	☐

Table 1: Educational level of four slum areas

Education level	Illiterate	Can Read and Write	Primary	Secondary	H.S.C	Higher Education
Muripotti	20%	30%	40%	19%	4%	1%
Jabdipur	10%	30%	36%	16%	8%	2%
Bastuhara	25%	40%	50%	23%	1%	0%
Bagmara	5%	20%	14%	1%	4%	2%

Table 2: Income level per month (in Taka) of the respondents in the study area

Range of income	Muripotti	Bastuhara	Jabdipur	Bagmara	Average
4000-6000	72%	70%	30%	28%	50%
6001-8000	60%	55%	20%	9%	36%
8001-10,000	10%	18%	8%	12%	12%
<10,000	2%	3%	2%	1%	2%

Table 3: Types of latrine in the study area

Type of latrine	Muripotti	Jabdipur	Bagmara	Bastuhara
Sanitary	60%	40%	31%	55%
Ring slab	30%	50%	40%	30%
Pit	0%	1%	3%	2%
Hanging	2%	5%	20%	8%
Open/Drain	8%	4%	6%	5%

Table 4: Ownership pattern of the latrine

Ownership of latrine	Owned	Common	Community on latrine
Muripotti	5%	26%	69%
Jabdipur	29%	30%	41%
Bastuhara	8%	64%	28%
Bagmara	11%	42%	47%

Table 5: Disposal of solid waste into different places in four slum area

Disposal place	Muripotti	Jabdipur	Bastuhara	Bagmara
Near the house/ Open place	11%	65%	30%	40%
Municipal collection	22%	0%	0%	0%
Indiscriminately	45%	25%	50%	27%
Road side drain	12%	10%	20%	22%
Community bin	12%	0%	0%	22%

Poster Presentation

1. A CHOWDHURY*, J SULTANA, *"A Study On Impact Of Physical Environment On Health Of The Slum People in Khulna City"* International Conference on Physics, (2016), Bangladesh Physical Society, 10-12 March, 2016, p 115.

A STUDY ON IMPACT OF PHYSICAL ENVIRONMENT ON HEALTH OF THE SLUM PEOPLE IN KHULNA CITY

A CHOWDHURY*, J SULTANA
*Email: [illegible]
Department of Physics, Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh

Abstract

Bangladesh is one of the rapidly urbanizing countries. The urban population, particularly poor, live in a crowed, damp, and highly polluted environment. The present work has been designed to investigate the life-style health, sanitation profile, the existing status of access of the slum dwellers, identify the status of water use, hygienic condition and its impact on health of the slum people of Jabdipur slum, Bagmara slum, Bastuhara slum and Moripatty slum of Khulna City in Bangladesh. The area has been selected by using purposive sampling technique and data has been collected from 300 households, which have been surveyed by using systematic random sampling technique. Data has also been collected via questionnaires, personal interview, direct observation and focus group discussion. It has also been explored the water security and safety at the point of consumption, problems faced in getting safe drinking water, drainage facilities, solid waste disposal system, knowledge of the features of hygienic latrine, awareness about health etc. It has been found that the services to water supply, sanitation and health is hardly related to income, occupation, housing and educational status. It has also been found that housing structure and occupational pattern of the slum people are highly vulnerable situation. Income level, sanitation, solid waste disposal, drainage patterned are in greater vulnerable and thus vulnerable situations exist due to their unhealthy physical

Objectives

- To assess the existing physical environment of the slum people.
- To find out the consequences of environmental factors with respect to housing, literacy, income and occupation.
- To investigate the life-style health, the status of water use, sanitation profile and hygienic condition and its impact on health of the slum people

Introduction

Slum population has largely increased in Bangladesh over the last three decades along with the growth and expansion of cities and towns. Khulna is one of the metropolitan cities of Bangladesh. It is an industrial based city. Large numbers of industrial laborers are lived in the city area. Most of them live in the slum area. It is one of the reasons responsible for growing slums. The city has 520 slum clusters with population of [illegible] which is [illegible] of cities population. The urban facilities are not satisfactory for urban dwellers in Khulna city. Poverty, high density, the absence of utilities and lack of infrastructure are common features of urban slums. The environment of slums is extremely unhygienic. As such it is needed to take necessary steps regarding their physical environment, which can ensure the better urban environment to safeguard the urban masses. In this context this study is very much crucial. This study would be helpful to find out the problems of different types of services and facilities. This research also identifies the major environmental problems which affect the slum dwellers in the selected study areas. As a result this can provide a guideline to establish further strategies for developing physical environment of urban slums.

Methodology

Slum people have huge number of problems. They are generally facing physical environmental problems. The area has been selected for this study by using purposive sampling technique. Data has been collected from 300 households at different slums area of Khulna City by field survey and systematic random sampling method. The data collection procedure involves questionnaire preparation. Primary data has been collected through household survey. The secondary data has been collected through some secondary sources such as relevant book or journal, internet, Khulna City Corporation office, Bangladesh Bureau of Statistics, published and unpublished sources, newspaper etc. The collected data have been analyzed through some statistical software. All the survey data have been analyzed by cross tabulation, multiple response and description manner to fulfill the objectives.

Results and Discussion

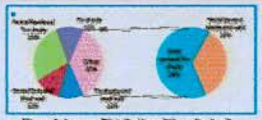

Figure 1: Average Distribution of the criteria of residence of the studied individuals.

Figure 2: Educational level of four slum area.

Figure 3: Average level of education of four slums area.

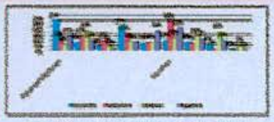

Figure 4: Occupational pattern of the respondents.

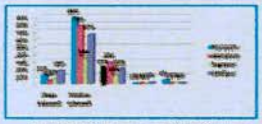

Figure 5: Source of water supply in four slum areas.

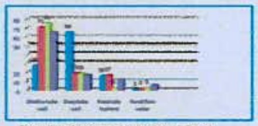

Figure 6: Various uses of water from different sources.

Figure 7: People's perception about drinking water quality in four slums area.

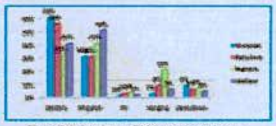

Figure 8: Various types of latrine in the study area.

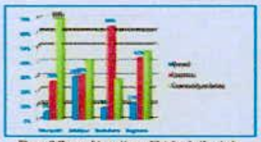

Figure 9: Ownership pattern of latrine in the study area.

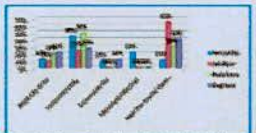

Figure 10: Disposal of solid waste into different places in four slum area.

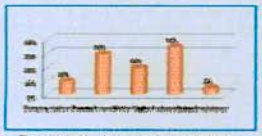

Figure 11: Problems in access to drainage facility in study area.

Figure 12: Distribution of diseases suffered by slum dwellers in study area.

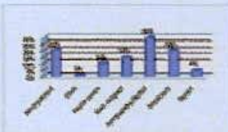

Figure 13: Treatment facilities of the slum dwellers in study area.

Figure (1 to 4) indicates the socio economic profile of the study area. Figure (5to7) shows the condition of water supply facilities in the study area. Figure (8 to 13) shows the sanitation facility, Solid waste disposal system, Drainage system, Hygienic knowledge and health status of the study slum area.

Table 1: [illegible]

[illegible]		[illegible]	[illegible]
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	50%	5%
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	45%	55%
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	50%	10%
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	50%	10%
[illegible]	Criteria	[illegible]	Pure
	Percentage	90%	10%
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	85%	15%
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	[illegible]	[illegible]
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	[illegible]	[illegible]
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	[illegible]	[illegible]
[illegible]	Criteria	[illegible]	[illegible]
	Percentage	[illegible]	[illegible]

All the parameters that has been studies has been found very much unsustainable condition. Their household sizes are beyond of their capacity to provide the fundamental requirements. Their general socio-economic conditions are too low. The educational pattern, occupations, income range are also in such a condition that they are always leads a vulnerable conditions. Other environmental consequences such as water supply, sanitation, solid waste disposal and drainage system are also not in a sustainable condition. Above all these circumstances, increase the adverse impact on their health. Table 1 indicates the different vulnerability of the study area based on the vulnerability assessment of slums. Here it has been observed housing structure and occupational pattern of the slum people are highly vulnerable situation. Income level, sanitation, solid waste disposal, drainage pattern, disease profile, treatment facilities etc are in greater vulnerability. Also vulnerability exists in water quality and water supply.

Conclusion

The study conclude that the services to water supply, sanitation and health is hardly related to income, occupation, housing and educational status. It has been found that housing structure and occupational pattern of the slum people are highly vulnerable situation. Income level, sanitation, solid waste disposal, drainage patterned are in greater vulnerable and thus vulnerable situations exist due to their unhealthy physical environment. As a result common infectious diseases can flourish here easily such as malnutrition, diarrhea, dysentery, cough, fever, skin disease etc. The unhygienic residential environment of the slums is the main cause of this diseases

Acknowledgement

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