UNIVERSITY OF NAIROBI

DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES

RISK FACTORS INFLUENCING DIARRHOEAL OCCURRENCE AMONG CHILDREN UNDER FIVE YEARS OLD IN INFORMAL URBAN SETTLEMENTS: A CASE STUDY OF KOROGOCHO, IN NAIROBI COUNTY, KENYA

MURIITHI DAVID IKUA

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DECLARATION

This academic research project is my original work and has not been presented for the award of a degree in this or any other university.

SIGNATURE: _____ _____

CANDIDATE: **MURIITHI DAVID IKUA** **DATE**

This project is submitted in partial fulfilment for the award of Master of Arts Degree in Environmental Planning and Management with our approval as the University Supervisors

SIGNATURE: _____ _____

SUPERVISOR: **DR. MARGARET KIRIMI** **DATE**

SIGNATURE: _____ _____

SUPERVISOR: **MR. WAKAJUMMAH** **DATE**

DEDICATION

I dedicate this Research Project to my Mother; Reginah Wangui Muriithi, a single mother who sacrificed a lot to give me a solid foundation for my education.

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ABSTRACT

The main objective of this study was to establish the relationship between risk factors of childhood diarrhoea and it's occurrence in Korogocho slum in Nairobi County. The hypotheses to be tested were; there is no significant relationship between environmental and socio economic risk factors and the occurrence of diarrhoea among children below five years in Korogocho slum. The study variables included sources and treatment of drinking water, accessibility, type and cleanliness of toilet facilities, levels of education, income and hand washing habits by mothers. Data on diarrhoea outcome and its determinants was based on two week recall and self reporting survey. The households for respondents (mothers of children under five years of age) were selected using systematic random sampling. Every third household with a child below five years of age was selected, when there was no child in the third house hold, the researcher went to the next household with a mother of a child below five years until a sample size of 90 respondents was achieved.

Data was collected using well designed open ended questionnaires and analyzed using descriptive and chi square statistics. The results showed that community and household environmental factors had a positive impact on diarrhoea of children under five years of age in Korogocho slum. However, access to and sharing of toilet facilities was not found to be statistically significant in occurrence of diarrhoea in children below five years of age. Treatment of drinking water was found to be an effective measure of reducing diarrhoea incidence in children below five years of age since it was found to be significantly associated with it. Socio economic factors were also significantly associated with diarrhoea occurrence of children under five years old. For example, childhood diarrhoea did not decrease significantly with higher education of the mothers though hygiene habit of the mother was influenced by the level of

education. The study established that washing of hands by mothers was statistically significant in reducing occurrence of childhood diarrhoea. Based on two weeks recall, 36.4% of mothers reported that their children under five years old had suffered from diarrhoea. This prevalence was higher than earlier estimated (31%) by African Population and Health Research Centre in 2006. Based on the results, the study identified several recommendations and suggested areas for further research. The key recommendations are the need to institutionalize deliberate interventions to provide slum dwellers with clean and quality drinking water and proper sanitation facilities to ensure safe and effective disposal of faecal waste.

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LIST OF ACRONYMS AND ABBREVIATIONS

APHRC	African Population and Health Research Centre
AMREF	African Medical Research Foundation
CBR	Crude Birth Rate
CBS	Central Bureau of Statistics
CDD	Control of Diarrhoea Disease
CDR	Crude Death Rate
CWC	Child Welfare Clinic
DHS	Demographic and Healthy Surveys
EDHS	Eritrea/Ethiopia Demographic and Healthy Survey
ICPD	International Conference on Population and Development
IMCI	Integrated Management of Childhood Illnesses
IMR	Infant Mortality Rate
INCO	International Scientific Co operation Activities
IRC	International Research Centre
KDHS	Kenya Demographic and Healthy Survey
KPHC	Kenya Population and Housing Census
KNBS	Kenya National Bureau of Statistics
MDG	Millennium Development Goals
MEME	Multiple Exposure-Multiple Effect Model
MOPHS	Ministry of Public Health & Sanitation
NASSEP	National sample survey and evaluation programme
ORS	Oral Rehydration Salts
ORT	Oral Rehydration Therapy
POS	Point of Use
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programmed
UNFPA	United Nations Population Fund
UNICEF	United Nation Children Funds
UoN	University of Nairobi
USAID	United States Agency for International Development
WHO	World Health Organization

CHAPTER ONE
1.0 INTRODUCTION

1.1 Background to the Study

Diarrhoea is a symptom of infections caused by a host of bacterial, viral and parasitic organisms most of which are spread by faecal contaminated water (Charles, P. et al, 2006). Infection is more common when there is a shortage of adequate sanitation and hygiene and safe water for drinking, cooking and cleaning. Water contaminated with human feaces e.g from sewage, septic tanks and latrines may contain the infectious diarrheoal pathogens that may contaminate food during preparation. Diarrhoeal disease can also spread from person to person, aggregated by poor personal hygiene. Food is a major cause of diarrhoea when it is prepared or stored in unhygienic conditions. Childhood diarrhoea can be caused by numerous things, ranging from a change in diet to an intestinal infection. Infection is caused by a virus, bacteria or parasite through mediums such as contaminated drinking water, food and unclean surroundings (Briggs, D. 2008). Children can pick up the bacteria and viruses that cause diarrhoea through contact with contaminated food or water or by touching contaminated surfaces and then placing hands into their mouths. Frequent handwashing is important to prevent diarrhoea especially before and after eating, after changing daipers and after using bathrooms and toilets (Ahmed 1992).

The contribution of factors to the current global burden of diarrheal disease is closely linked to conditions in and around people's homes. This is because the major source of environmental pollutants originates from households that do not have efficient means of disposing off their waste products. In urban centres most of the determinants of urban ill health lie within the sectors of water and sanitation and housing condition. When people are overcrowded in an area, they exert pressure on the available social amenities like toilets facilities and water sources. This

scenario is commonly found in slums and other deprived environments like marginalized areas. (Maria, C.N et-al, 2013)

The World Health Organization (WHO, 2005) has identified at least four environmental health risks in its world health report. These risks are: unsafe drinking water, poor sanitation, unhygienic conditions and outdoor pollution. Childhood diarrhoea is one of the major health risk associated with household and community environment. (Timaeus, I.M and Lush, L, 1995), Smith and Ezzati, (2005) classified health risks estimated and attributed to disease burdens as including: household environmental risks such as contaminated source of water, poor disposal of human waste, un hygienic conditions, indoor air pollution from solid-fuel use and exposure to malarial mosquitoes; community environmental risks such as urban outdoor solid pollution like ineffective disposal of household and industrial wastes and water pollution. Moreover, people living in conditions of urban poverty often suffer from a wide range of other health problems, many of which have little to do with the physical environment, even if they are closely linked to poverty (Smith and Ezzati, 2005).

Since 1950, urban population has grown from under 17% of the world's population to approximately 50% in 2000. It is estimated that 90% of future population growth will be in urban areas and most of the growth is likely to be among the poor (UNICEF, 2005). Approximately 0.5 billion people in the world lack adequate sanitation, contributing to more than 5 million deaths each year, of which more than half are children (United Nations, 2001). Currently, about 50% of the developing world's population is exposed to polluted water sources and poor sanitation. Inadequate sanitation remains a leading cause of poor health and death at a global level. In 2012, diarrhoeal diseases are the second leading cause of child deaths in the world according to recent studies. A recent report by the World Health Organization and UNICEF (2013) estimates that

approximately 2.5 billion people live without improved sanitation, of which almost 1 billion people continue to defecate in open. Despite this, sanitation remains a neglected issue with global financial investments representing only 1/5 of the total water, sanitation and hygiene sector expenditure.

Within Sub-Saharan Africa, there are regional differences in the rural and urban areas in the under five years diarrheal mortality differentials. Garenne (2006) found particularly large differentials in the south and eastern part of the African continent and negligible differences in few countries in West Africa e.g. Liberia and Chad. This difference was attributed to a wide range of risk factors in eastern and southern part of the African continent than West Africa. In 1990, a number of countries in Sub-Saharan Africa were found to have high childhood mortality rates in urban areas than rural areas. The high childhood mortality rate in urban areas was linked to diarrhoea due to unsafe drinking water, poor sanitation and unhygienic conditions (Cairncross and Valdmanis, 2006). According to the World Health Organisation, diarrhoeal diseases of under five years accounted for an estimated two million in developing countries each year (WHO, 2002). It has long been among the principal diseases affecting children of less than five years of age and the burden of these diseases falls predominantly on infants and children's living in low-income settings in what is termed as slums in developing countries.

Diarrhoea among children below five years is one of the leading causes of childhood mortality in developing countries. In Kenya it is the third highest cause of death after malaria and tuberculosis among children below five years (Ziraba et al 2012). Despite diarrhoea being a disease that is easy to prevent and treat in Kenya, it continues to be a major burden of disease to the Kenyan economy where close to 100 children die every day from diarrhoeal diseases

(UNICEF 2013). The mortality due to diarrhoea disease is worse in slums which are characterized by poor hygiene and poor sanitation

In Kenya, overcrowded urban settlements have been found to pose high prevalent rates of diarrhoea of about 31% among children below five years of 31% (African Population and Health Research Centre, APHRC 2006). These areas are the low income urban environments commonly referred to as urban slums. In these areas, water is often collected from local wells, contaminated by local pit latrines; the toilets are far or have long queues, some people defecate in the open or dispose of faeces by wrapping them in paper or in plastic bags known variously as the "wrap-and-throw" method or, more popularly in Kenya, as "flying toilets" as the bags are sometimes literally thrown away (Kibera Water and Environmental Sanitation Programme, KWAHO 2008). Children are especially unlikely to use distant, crowded or costly toilets, but rather use open fields and their faeces are especially hazardous in contaminating food, water and other surfaces where children play. Open sewers are also common in Kenyan major urban centres especially in slums and these contaminate drinking water either during pipe delivery or at the point of the source. Likewise household solid waste remains unbagged and uncollected, providing a breeding ground for flies and other pests. Children without safe places to play are likely to encounter faecal material and other household wastes in the neighbourhood environment increasing chances of being infected by diarrhoea germs. Food preparation is often done outside, or in dirty kitchens where flies are present. Flies are carriers of germs that can cause childhood diarrhoea. Hand washing in slums is not effectively done because of lack of clean water, soaps or disinfectants. (Keusch, Fontaine et al., 2006).

In Kenya, diarrhoeal disease is one of the most frequent causes of childhood morbidity and a major contributor to childhood mortality (K'oyugi, 2004). In Kenya 31% of child mortality rate

is attributed by diarrhoea (WHO, 2005). The Ministry of Public Health and Sanitation (MOPHS, 2010) acknowledged that 16 million (48%) Kenyans out of 39 million do not have access to safe drinking water and majority of these constitute 13 million who live in the rural areas and in urban informal settlements. Since the year 1999, Kenya has been implementing water sector reforms to address disparities and shortcomings noted in the service delivery of water supply.

According to the National Council for Population and Development report (2011), the sanitation situation in Kenya is bad as it is estimated that 16.4 million people lack basic sanitation services, 4.8 million of these live in urban informal settlement. In the report, it is indicated that sanitation has been lagging behind the water sector and many a time there has been poor role definition in terms of responsibilities for the different aspects of sanitation within the government structures. However, initiatives are now in place aimed at developing a National Environmental Sanitation Policy and a draft policy document is already in place (NCPD, 2011). The draft water policy aims at developing a clear and naturally acceptable framework for environmental sanitation as an essential service and major determinant for improving health and standards of living in Kenya. The Kenya morbidity disease pattern indicates that over 60% of diseases are waterborne or sanitation related. The status of sanitation has worsened over the years due to overcrowding. According to a joint Ministry of Health and Ministry of Water and irrigation rapid assessment in 2009, the National coverage stood at 49%. Health statistics in Kenya have also shown the same trend in diarrhoea prevalence of 23% in 1983, 19% in 1990, 16% in 1996 and more recently 13% in 2009 in urban informal settlements (United Nations Children's Fund, UNICEF 2013; Juma, 2004).

1.2 Statement of the Problem

The under five years old children morbidity due to diarrhoea disease is worse in Nairobi which is characterized by poor hygiene and sanitation due to its many informal settlements (31%). Statistics from the Kenyatta National hospital show that on a given day paediatricians attend to between 10 and 20 cases of diarrhoea in children below five years (Kariuki P.N 2010). The numbers also show that 3 to 5 of these cases are severe and are therefore referred for admission. Majority of these cases come from the Nairobi informal settlements, Korogocho being among the leading slums. The high prevalence of diarrhoeal disease is largely attributable to by poor sewerage disposal, contaminated water and poor hygiene at house hold level.

In Korogocho, the fourth largest slum in Nairobi after Kibera, Mukuru and Mathare, more than 12,000 households have little or no access to clean water supply and effective sanitation infrastructure. It is estimated that 95% of Korogocho residents have no access to good sanitation and only 19% of livelihoods have access to piped water (APHRC, 2002). The health of the under five years children is negatively affected by inadequate water and sanitation and the rate of diarrhoea among these children in Korogocho is more than double that of Nairobi as a whole (Well, 2005). The major contributors of diarrhoea of under five years have been found to be contaminated drinking water and food, lack of proper toilet facilities, ineffective disposal of household wastes, lack of hand washing practice after visiting toilets and before handling foods as well as low education levels especially among mothers of under five years children. Data collected by APHRC (2012) on establishing causes of childhood death over a ten year period (2003-2011) showed that 8.34% of all deaths recorded in Korogocho were linked to diarrhoeal disease. There has been a significant but consistent decline of diarrhoea related deaths in the last 10 years ranging from12.7% in 2003 to 10.6% in 2011 with the lowest drop to 4.6% in 2008.

Childhood diarrhoeal cases have however remained high and unchanged in urban informal settlements despite vigorous attempts by the Government, Community Based organizations and NGOs to reduce the incidence of childhood diarrhoea. The improved sanitation facilities over six years period in Korogocho may explain the reduction in death resulting from diarrhoea between 2003 and 2011 while more research is needed to establish the reasons for high and rather stable childhood diarrhoea morbidity rate over a period of time. APHRC (2012) found a positive link between childhood diarrhoea and the changing state of human waste disposal facilities available to the residents of Korogocho between 2006 and 2012. Data from Nairobi Urban Health and Demographic Surveillance Systems (NUHDSS, APHRC 2012) showed consistent improvement in sanitation facilities relating to human waste disposal in Korogocho. The use of shared clean toilets increased from 1.8% of households in 2006 to 4.5% in 2012. The use of flush toilets increased from 17.7% to 44.6% of households over the same period while households that use shared pit latrines decreased from 52.6% in 2006 to 31.1% in 2012.

Improvement in the state of toilet facilities available to children in Korogocho slum was also observed by APHRC (2012). Over the period 2006 to 2012 the proportion of households where children aged 0-5 years used shared traditional pit toilets declined from 8.6% in 2006 to 0.9% in 2012. Similarly the proportion of households in which children under five years of age have no toilet facility reduced from 2.6% in 2006 to 0.7% in 2012. The current study therefore is aimed at examining the relationship of major environmental and socio economic factors with diarrhoea occurrence among children under five years in Korogocho slum following major improvements that have been made on the risk factors over a period of time. This is especially in line with the fourth millennium development goals (MDG) target 5 that aims at reducing mortality rate among children less than five years by two thirds by year 2015 (UN 2005).

1.3 Overall objective

The General objective of this study is to examine the relationship between environmental risk factors and socio economic factors to the occurrence of diarrhoea among children below the age of five years in Korogocho slum.

1.4 Specific Objectives

This study sought to establish:

1. The relationship between environmental risk factors such as source and quality of drinking water, levels of sanitation and occurrence of diarrhoeal disease in children below five years in Korogocho slum
2. The relationship between socio economic risk factors such as level of education of the mother, household income and hand washing practice by mothers and occurrence of diarrhoeal disease in children below five years in Korogocho slum
3. Policy recommendations on strategies that can be used to reduce childhood diarrhoea in Korogocho slum.

1.5 Research Questions

This study sought to address the following questions:

1. What is the relationship between source and treatment of drinking water and occurrence of childhood diarrhoea in Korogocho slum?
2. What is the relationship between sanitation and occurrence of childhood diarrhoea in Korogocho slum?
3. What is the relationship between the level of education of the mother and hand washing during critical times by mothers and occurrence of childhood diarrhoea in Korogocho slum?

1.6 Hypotheses

The following two hypotheses are presented as a basis for examining some important relationships in this study:

1. Ho There is no significant relationship between environmental risk factors and the occurrence of diarrhoea among children below five years in Korogocho slum.

   H_1 Alternative

2. Ho There is no significant relationship between socio economic risk factors and the occurrence of diarrhoea among children below five years in Korogocho slum.

   H_1 Alternative

1.7 Justification of the Study

The study hopes to provide an informed assessment of risk factors leading to diarrhoea in children in a deprived urban environment such as Korogocho Slum. Such assessments provide an important input to the national development and evaluation of policies by the health sector and activities of other sectors that directly manage or influence the determinants of health. Furthermore, the study hopes to provide additional information required for the national development of such policies and activities that will constitute the effective interventions on social considerations such as the availability of resources on such types of settlement environments. Information on disease burden relating to risk factors rather than diseases is likely to be more relevant to policy makers because it may allow action to be directly targeted to modify exposure. Although there has been extensive research on water and sanitation and related diseases, there is scarcity of information as to why diarrhoea morbidity has remained relatively stable. The risk factors facing children in deprived urban settlements such as Korogocho require such detailed examination as this study will undertake to reveal the issues underlying the

diarrhoea infections. This study is therefore of great significance in identifying the extent to which the identified determinants contributes to diarrhoea morbidity among children below five years. Moreover this study makes possible recommendations that can help to improve the health standards and livelihoods of the people affected directly and indirectly.

1.8 Scope and Limitations of the study

This study was conducted in a slum called Korogocho which is an informal settlement located on the North Eastern side of Nairobi. The study dwelt specifically on households that live in this slum area and have been affected directly by childhood diarrhoea and therefore the study was limited in both scope and methodology. By examining the children under five years old, the study limited itself in terms of its study population. This is notwithstanding the fact that diarrhoea affects other parts of the population as well. Moreover, the study employed quantitative research methodology which limited its access to personal information that could inform the study. The study was also limited to the environmentally related household and a few socio economic factors despite the fact that there are other non - environmental factors that may influence the prevalence of diarrhoea.

A number of challenges were encountered in this study. Korogocho being one of the major slums in Nairobi posed the problem of insecurity. The researcher was to use the minimum time possible in the study area due to high insecurity. The security personnel that were available were part of the youth which claimed to be the vigilant group in the area and charged very expensively to take the researcher around. Some of the streets in Korogocho were impassable due to poor drainage of house hold wastes and human wastes that tampered all over. This meant that the researcher and his assistants were to wear closed shoes and dark clothes to avoid contaminating with waste. The research assistants were also very reluctant in this kind of environment. The long procedure of

obtaining a permit from the local administration and Nairobi County Government to conduct a research in this area was a big challenge. This notwithstanding the unwillingness of the respondents to co-operate even after a through introduction and explanation of the purpose of the study, the researcher faced difficulties in eliciting responses from some of the interviewers who could deliberately refuse to cooperate and others could ask for a fee in order to fill the questionnaire. In some circumstances the researcher could miss the respondent in a house hold and attempts to make a call back was not always successful as the members of the household could not give the respondent's contacts. Majority of the working mothers were available very late in the evenings which posed a big threat for the researcher to visit the study area late in the evening because of insecurity. Lastly just like any other research, this study required a lot of time and financial resources in terms of travelling, paying research assistants, enhancing security, printing and photocopying, internet and library fee. These resources were very limited to the researcher which hampered the timely completion of this project.

1.9 DEFINITION OF KEY TERMS

Access to sanitation- in this context means households having access to excreta disposal facilities either in the dwelling or located within convenient distance of less than 100 metres from the dwelling and were well maintained

Access to water- Refers to accessibility of at least 20 litres per person a day from a source within 30 minutes from the household (Howard and Batram 1998)

Behavioural Factors- also known as Confounding factors. They are independent variables that distort association between another independent variable and the problem under the study as it is related to both. These includes hand washing by mothers during critical times, child feeding habits and food preparation habits

Child care takers- in this context refers to person taking care of the child under five years and in this project the mother was considered

Child mortality - The probability of dying between the first and fifth birthdays.

Crude birth rate - The number of death per 1000 population.

Crude death rate - The number of deaths per 1000 population.

Demographic factors- refers to the factors associated with family size, population density, age, gender and other population dynamics that may affect children healthy.

Dependent variable- incidences of diarrhoea morbidity among children under five years of age

Diarrhoea episode- referred to the passing of three or more loose or liquid stools within a 24 hour period (Matrines et al, 1993)

Diarrhoea Morbidity- is an incidence of ill health mainly caused by the passing of three or more loose or liquid stools within a 24 hour period (Matrines et al, 1993) . It is measured in

various ways often by the probability that a randomly selected individual in a population at some date and location would become seriously ill in some period of time.

Diagnosis- The identification of the nature and cause of anything, used in many different disciplines with variations in the use of logics, analytics and experience to determine the cause and effect relationships.

Diarrhoea pathogens - An infectious agent, a germ, microbe or micro organism such as a virus or bacterium that cause diarrhoea

Enteric pathogens-They are gastro intestinal organisms spread by contamination of foods mainly of animal origin

Environmental risk variables- these are factors that the physical environmental surrounding human being. They include access to water, sanitation and garbage disposal, water sources, water storage conditions, per capita water consumption, cost of water, access to and the sharing of latrines, disposal of household wastes and disposal of child faeces

Gastro intestinal infection-Diarrhoea which is characterized by frequent and watery bowel movement, often caused by gastro intestinal injection by gastro, such as parasites, viruses or bacteria.

House hold and community environmental factors- include water sources, water storage conditions, per capita water consumption, cost of water, access to and the sharing of latrines, disposal of household wastes and disposal of child faeces

Household- Refers to a person or group of persons who reside in the same homestead and normally share food and other amenities and answerable to the same household head (KPHC, 2009)

Independent variables- includes the socio economic, demographic, household and community environmental and behavioural confounding factors

Infant mortality rate- The probability of dying between birth and exactly one year of age, expressed per 1000 live births.

Informal urban settlement – A settlement usually found on the periphery of cities and big towns characterized by lack of proper sanitation, safe water supply, unhygienic streets and lack of other basic human necessities.

Life expectancy at birth- The number of years a new born infant would live if prevailing factors of mortality at the time of birth were to stay the same throughout the child's life.

Logistic Regression-Logistic Regression is a type of predictive model that can be used when the target variable is categorical variable with two variables. In this case a child either survives or dies.

Morbidity- Morbidity is an incidence of ill health. It is measured in various ways often by the probability that a randomly selected individual in a population at some date and location would become seriously ill in some period of time.

Mortality- A measure of the number of deaths (in general or due to a specific cause) in this case diarrhoea.

Socio-economic factors-These are the social factors that affects daily activities of a human being. They includes the level of education of the child caretakers, source of livelihood and the amount of income per household or per child caretaker

Under- five mortality rate- The probability of dying between birth and exactly five years of age, expressed per 1000 live births.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter presents literature on studies in Kenya and outside Kenya related to risk factors associated with childhood diarrhoea. It begins by reviewing literature done globally, then narrowing down to Africa and finally discussing literature on Kenya about diarrhoea of under five years and its risk factors. The chapter also outlines gaps identified in the empirical studies in different parts of the Globe and how the current study intends to fill those gaps. This chapter also contains the conceptual and theoretical framework and finally concludes by discussing the variables under investigation.

2.2Global perspective on environmental and socio-economic factors to childhood diarrhoea

Environmental conditions and their impact on under five years children diarrhoea are strongly linked to demographic and socio-economic development and the pressures these factors have on the environment. Specific country studies have examined the impact of several leading risk factors; an education medical book for prevention of diarrhoea by World Health Organization (2005) in Africa quantified two risk factors based on information about causation, prevalence and exposure of the disease. According to this study, almost 16 percent of the entire global burden of diarrhoea is attributed to poor water and sanitation.

A global study by WHO in 2005 for the preparation of a fact sheet to raise awareness on the global problem of diarrhoea in children below five years and its effect showed that the occurrences of childhood diarrhoea is significantly associated with social economic factors such as family size, annual family income, educational status of parents and children, and occupation

of mothers, though their contribution to the occurrence of childhood diarrhoea is small in comparison to the environmental and behavioural factors. Environmental causes of diarrhoea may be categorized in many ways, such as by referring to medium which may carry hazards, as individual risk factors (agents), or according to the nature of the hazard. Lopez and Murray 1998, characterize medium that carry hazards to include: water used for drinking which gets contaminated by hazards that cause diarrhoea as a result of poor disposal of faecal matter and household wastes. This is in his book entitled the "Global Mortality and the contribution of risk factors: Global burden of disease study".

Roy, A. et al. (2011) in his research to assess the slum free cities of the Asian century in the post colonial Government advocated that the slum dwellers of Vellore town in the south Indian state of Tamil Nadu of India discard their garbage along street sides that degrades the quality of life and therefore increases the burden of diarrhoeal disease to children below the age of five years. In the same study, Roy, A. (2011) also reported that slum dwellers of Calcutta which is the capital city of West Bengal, India reside in unhygienic environmental conditions manifested by overcrowding and poor building materials. Due to poor drainage system water logging in the slums of Tamil Nadu and Calcutta becomes critical during monsoon seasons and rain water often enters into houses of these poor people as only 5% of the households had good drainage system. This surface run off comes with lot of germs that may cause diarrhoea infections to children below the age of five years.

Sharma, K. (2009) in his studies of rediscovering Dharavi, a slum in Mumbai India which is one of the largest slums in the world in his book entitled stories of Asia's largest slums, reported that slum dwellers of Jammu town in India, the headquarters of Jammu province in Asia throw their solid waste and other garbage in the open which pollute the surrounding environment. In this

area, the housing conditions were also of substandard type, as most of the dwellers lived in kutcha houses (houses made of reeds)**.** The lack of infrastructural facilities including waste collection and sewerage, public transportation, education and electricity supply affect all aspects of life and mostly the health of children below age of five years.

Sundari (2008) revealed in her findings that 79% of migrant households of Chennai lived without latrine facility and used open fields for defecation. This study was done in the slums around the coromandel coast of the Indian state of Tamil Nadu. The main objective of her study was to assess the environmental and socio economic factors that affected the residents of these slums as a major cultural, economic and education centre known as the "Detroit of India" Only 13% of the migrant households living in these slums were found to have access to the community toilets, provided by the municipality. In another study with the same objectives, Sundari, S. (2008), also revealed that five million slum residents were living without toilets facilities in Mumbai in India. Owing to absence of sufficient number of community toilets, the people residing in slums of Jammu, Chennai and Mumbai were forced to excrete in the open. This scenario was found to have been directly associated with diarrhoea occurrence among children below five years.

In another study done in Chandigarh which is a city and a union territory in the northern part of India that serves as the capital city of states of Punjab, Gupta et al. (2007) reported poor environmental conditions in the urban households of the slum dwellers of Chandigarh, as only 33.4% of the urban poor were found to have access to the sewerage system in comparison to 98% in case of urban areas. The city tops the list of Indian States and union territories by per capital income. The main objectives of his studies were to assess the rural migrants and urban segmentation on the reproductive, child health and inequalities in Chandigarh and also to evaluate diarrhoeal diseases and infections and control programmes in Delhi slums in northern

part of India. Gupta et al. (2007) also reported that the residents of urban areas of Chandigarh were more conscious about their health as 94% households treated their water before drinking in the form of filtration, boiling etc. However, the rural and slum households were least bothered about these things as, only 10.8% and 2% used these techniques, respectively to make water safe for drinking.

The situation of sanitation in Accra metropolitan area, Ghana was reported to be very serious, as provision of toilets facilities was related to the household wealth. Pit latrines were common in low income households while flush toilets dominated wealthy groups. (Boadi, K.O., 2005). This study focused on urban population in the Karle lagoon, Accra Ghana to help environmentalists make valid policies in settlements in urban centres. In another study conducted in Tmale in Ghana to assess the implications of urbanization and rapid development to the environment and health implications in African cities, Boadi, K.O (2005) revealed that in Ghana, human excrement, garbage and wastewater were usually deposited in surface drains, open spaces and streams. The poorly disposed excreta was a health hazard in children below the age of five years as they were likely to be contaminated by germs that caused severe diarrhoea and to some extent death. More than 90% of all urban poor of Tmale were found to store solid waste inside their house for at least 24 hours before taking outside. Boadi, K.O (2005) also reported that about 30-60% of the urban resident of Africa lives in slums and squatter settlements which are built on floodplains, marshy places and dumping sites at periphery of cities due to inadequate land and inability of poor to afford secure land.

Most of the communicable diseases are commonly found in the slums due to poor housing conditions and environmental factors which account for 25% of all preventable ill-health (WHO, 1998). Ballantyne and Oelofse (1999) reported that slum dwellers of the Mizamoyethu

community of South Africa lives in poor housing conditions and for them it is the first element that needs to be upgraded if quality of life and health of children under five years is to be improved. These findings were from his study in assessing the informal settler's perception of environmental quality in Mizamoyethu community in South Africa. According to World Bank report (2011), most of the environmental burdens in African cities results from lack of affordable housing for the poor which lead to the formation of slums and squatter settlements. Living conditions in many urban slums are worse than those in the poorest rural areas of the country. This increases the burden of diseases associated poor sanitation and polluted drinking water in the slums of the African countries. One of these diseases was under five years diarrhoea.

2.3 Water supply, quality, sanitation and hygiene status in slums

Around 1.1 billion people globally do not have access to improved water supply sources whereas 2.4 billion people do not have access to any type of improved sanitation facility. About 2 million people die every year due to diarrhoeal diseases most of them children less than five years of age. The most affected are the population in developing countries living in extreme conditions of poverty, normally the peri urban dwellers. Among the main problems which are responsible for the situation are; lack of sustainability of water supply and sanitation services, poor hygiene behaviours and inadequate sanitation in public places. Providing access to sufficient quantities of safe water, the provision of facilities for sanitary disposal of excreta and creating awareness on sound hygiene behaviours are of capital importance to reduce the burden of disease caused by the risk factors (WHO, 2012)

Water quality deterioration in distribution systems mainly caused by inappropriate planning design and construction or inadequate operation and maintenance and water quality control has been linked to a significant proportion of the burden of water borne and water related illness. The

quality of drinking water is a powerful environmental determinant of health. Assurance of drinking water safety is foundation for the prevention and control of water borne diseases. (WHO, 2011)

An important fraction of the burden of water related diseases is attributable to the way water resources are developed and managed. In many parts of the world the adverse health impact of water pollution causes significant preventable disease. The WHO Water Sanitation and Health Program focuses on environmental management and health impact assessment and also emphasize options to integrate health risk assessment and management into strategies and programs of environmental conservation. (WHO, 2012)

Even though progress towards MDG target represents important gains in access for quality water supply for billion of people worldwide, it has been uneven. This is because inaccessibility persists due to sharp geographic, socio cultural and economic inequalities. This information is according to a joint monitoring program for water supply and sanitation (JMP). The overall aim of the JMP is to report globally on the status of water supply and sanitation sector and to support countries in improving their monitoring performance to enable better planning and management at the country level. (WHO, 2014)

According to a global study by WHO in 2005 for the preparation of a fact sheet to raise awareness on the global problem of diarrhoea in children below five years and its effect showed that poor water quality is a leading cause of morbidity and mortality worldwide and a defining danger to life in slums. The global estimate was based on a subset of 72 countries of the under five years population however data average was insufficient to calculate the regional average. Growing number of poor people who lack basic needs, such as access to clean water and food are more susceptible to diseases driven by malnourishment and air, water and soil pollutants

(Semenza, J. 1998). This study was conducted with an objective of assessing the water distribution systems and Diarrhoeal disease transmission in sub Saharan countries. The study was conducted in Uzbekistan which is a double landlocked country in central Asia. The conditions of slum dwellers of Sub-Saharan countries were found to be highly miserable, as not only the quality but availability of drinking water was also a major issue in these countries.

Afsar, A. (1999) reported that urban slum dwellers in Bangladesh were devoid of water supply to their homes and the average time required to collect water from a common standpipe or well was 30 minutes per trip and at least two trips were necessary just to collect a bucket of drinking water. The inaccessibility of water was found to be significantly associated with childhood diarrhoea though rural urban dichotomy and convergence was found to be an emerging reality of Bangladesh in affecting the health of children below five years. This study was conducted in Bangladesh with an aim of evaluating factors that influenced the occurrence of vibro cholera in Bangladesh. Bangladesh is a country in South Asia which is among the most densely populated countries in the world.

Further (Boadi, K.O 2005) reported that most of the urban poor of Tmale city of Ghana collected water from sources located distantly. In this study, most households were found not to have adequate water for domestic, hand washing and sanitation purposes. This increased the risk of transmitting dirt to children below the age of five years which could contribute to diarrhoeal infections. In another study, the municipal water supply to the 128 migrant households in Tirupur slums of Mumbai city in India was found to be of poor quality and unfit for human consumption (Sundari, 2008). This contaminated water was found to be a risk factor in diarrhoea occurrence in children below five years.

A study conducted in four informal settlements in Nairobi (Kibera, Mathare, Mukuru kwa Njenga and Korogocho) by WHO in 2002 to explore the community member's expression and undertaking of the linkages between urban poor environments and child illness revealed that the polluted Nairobi river and its tributaries causes diarrhoea in children below five years. The pollution of the river mainly comes from the poorly disposed faecal matter, poorly disposed housed hold wastes and industrial effluents from the industries.

In Nairobi, 94% of slum residents were found buying domestic water from the vendors and paid about 8 times more for it than their non-slum counterparts. In addition, water supply was irregular and vendors were found to charge increased prices indiscriminately. Hygiene was also compromised during periods of water shortage (Kimani, et al., 2005). This study was conducted in Nairobi to assess the health and livelihood implication of the marginalization of slum dwellers in the provision of water and sanitation services in Nairobi city.

2.4 Extent of these risk factors in contributing diarrhoea in children under five years

Studies conducted in developing countries have focused on socio-economic and environmental variables that affect the incidence of diarrhoea, particularly housing conditions, parental education, and income. A study from the Republic of Congo and south west Ethiopia revealed that children coming from households that obtained water from protected sources like treated tap water were less likely to have diarrhoea as compared to those who got their water supply from unprotected sources like open wells (Teklemariam S, et al 2003). The objective of this study was to evaluate the environmental determinants of diarrhoea morbidity in under five years children in Keffa-sheka zone of south west Ethiopia and Republic of Congo. According to the information obtained from Nekemte Health Center Addis Ababa in Ethiopia, diarrhoea disease of under five years is one of the major public health problems in the area and it is among one of the top ten

diseases causing morbidity and mortality in under-five children. Safe drinking water is one of the fundamental requirements of human life without which life cannot be sustained beyond a few days, without access of adequate clean and safe drinking water tends to enhance the spread of diarrhoeal disease especially in children less than five years (UNICEF 2005).

Hygiene and literacy may be closely related. Although the evidence is inconclusive, some studies conducted primarily in Africa especially in Ethiopia, republic of Congo, and Kenya have shown that diarrhoea rates are highest in families with the lowest levels of educational attainment. This is because families with basic education levels are aware of some of the factors that may cause diarrhoea and knowledge on management of the disease. This was according to a research done by (Boerma and Ginneken 1996) with an objective of assessing the severity of under five years diarrhoea disease in African continent in preparation for a journal entitled "Journal of Diarrhoeal Diseases Research". However, Feachem (1996) in the case control study of improved sanitation on diarrhoea morbidity in Maseru the capital city of Lesotho for the WHO Bulletin, argues that such observations in themselves alone are not useful indicators of childhood diarrhoea because families with the lowest educational attainment may be those with the lowest income, poorest housing, most crowding, and worst sanitary facilities and these confounding variables can promote the transmission of diarrhoea pathogens. He further argues that if, after controlling the puzzling variables such as sanitary facilities, hygiene and overcrowding, educational attainment shows a significant impact on the incidence of diarrhoea, the most likely reason is that educational differences cause behavioural differences that affect the transmission of enteric pathogens. These are gastro intestinal organism spread by contamination of foods mainly of animal origin. Several other factors such as age of the child, breast-feeding, washing of hands and covering of food may also be closely related with diarrhoea morbidity due to increased rate

of transmission either as a result of not washing hands after visiting toilets and not covering of foods.

Luby et al (2004) in Pakistan showed that effective hand washing was important in control of childhood diarrhoea because they were significantly associated to each other. The objective of his study was to measure effectiveness of hand washing in controlling childhood diarrhoea. This study used a randomly assigned 25 neighbourhoods to hand washing promotion comprising of 306 households which randomized as controls. Children living in households that received hand washing promotion and plain soap in town of Muzzargarh had a lower incidence of diarrhoea compared with children living in control neighbourhoods of Karachi town in the same country.

A study carried out in Tumpat District, Malaysia also indentified the risk factors for diarrhoea of under five years as drinking un boiled water, storage of cooked food before consumption, bottle feeding and absence of washing water in latrines. (Sabina M.K 1992). The results of this study indicated that drinking water that is not treated either by boiling to significant degrees Celsius or use of chemicals is likely to contribute to occurrence of diarrhoea in children due to contaminated pathogens. Storage of cooked food is likely to be contaminated with germs especially in overcrowded and polluted conditions while bottle feeders may not be cleaned thoroughly due to shortage of water and may be contaminated by houseflies that transmit pathogens to the child during feeding. Lack of washing water in latrines makes the attendants to carry diarrhoea pathogens in their hands and transmit to the under five years children when handling their food. According to Yohannes *et al.* (1992); and Boerma and Ginneken (1996), the incidence of diarrhoea is usually highest at 6–23 months of age and declines after the second birthday. This is because breast-feeding plays a direct role in terms of protection against diarrhoea up to the age of 6 months, and also has an indirect effect, by its contribution to the

nutrition of young children into the second year of life. Immunization may not be directly related to diarrhoea morbidity but measles immunization is likely to protect children against measles-associated diarrhoea. Unlike the current study, this study focused on breast feeding only but did not consider the environmental and social economic factors such as source and safety of drinking water, access and cleanliness of toilet facilities and level of education among mothers.

Diarrhoea morbidity of under five years children in the rainy season as compared with the other seasons is usually higher (KWAHO, 2008 and Roy, A.2011). This is because of running surface water which becomes contaminated by poorly disposed human waste. This water collects into collection points and sometimes consumed without treating it. A study done by Woldemichael G. (2001) also examined the effect of some environmental and socio-economic factors that determine childhood diarrhoea in Eritrea. He used data from the 1995 Eritrea Demographic and Health Survey (EDHS). The results showed that type of floor material, household economic status and place of residence are significant predictors of diarrhoea. This is because a cemented floor is easy to wash as compared to non cemented floor which is full of dust and highly contaminated with germs. Economic status in this sense referred to the income levels that affects place of residence, feeding habits, waste disposal and knowledge about treatment of water and under five years diarrhoea.

A comparative study of urban areas of Ghana, Egypt, Brazil and Thailand with an objective of assessing the intra-urban differentials in child health for the health transition journal clearly indicates that children's health is affected by environmental conditions and economic status of the household (Timaeus and Lush, 1995). According to these authors, children from better-off households have lower diarrhoea morbidity and mortality in Egypt, Thailand, and Brazil. Such differentials in diarrhoea diseases by household economic status were due to differences in child

care practices, for instance preparation of weaning foods and personal hygiene (Timaeus and Lush, 1995). This study used a clustered randomized sample of 320 respondents in urban setting. This study however did not consider the poor urban environment and its implications on the health of children below five years which the current study stands to fill.

Risk factors for diarrhoea among children below five years in Kampala district in Uganda were studied using multi-stage sampling (Nasinyama, G.W 2000). The overall objective of this research was to evaluate the extent of risk factors for acute childhood diarrhoea among inhabitants of Kampala District. The findings of this study showed that households that used municipal water supplies and those who boiled drinking water were significantly less likely to suffer from diarrhoea of under five years than those who used other sources and or who did not boil drinking water. The level of income was inversely associated with occurrence of diarrhoea in a member of the household. Although, there is a difference that exists with various study findings already discussed in this chapter, the influence of improved water supply and sanitation factors on the prevalence of diarrhoea diseases has been addressed in a number of studies.

A cross sectional study conducted randomly in south Jeddah, Saudi Arabia to assess the existing flood protection in the area showed the main risk factors of diarrhoea of under five years were: the number of children less than five years living in the same house hold, sewage spillage near the home, eating out after school hours and using reusable clothes or sponges to dry dishes (Al-Ghamdi, M A 2009). Arif and Ibrahim (1998), in Pakistan conducted a research on diarrhoea morbidity differentials and found out that Sanitation facilities like toilets and latrines are closely related with the occurrence of diarrhoea of under five years old children. The better the sanitation facilities, the less likely the child is to get the diarrhoea disease. These facilities in most parts of the country are far from satisfactory. Water that is pure at its source may become polluted as it

passes through the broken pipelines, a common phenomenon in urban localities where drinking-water is supplied through pipelines (Malik, 1998). Repairing of these pipelines coupled with improvements in water storage patterns in home can help reduce the water-borne transmission of pathogens that cause diarrhoea. Apart from examining the environmentally related risk factors, this study also examined the interventions needed to deal with these risk factors.

2.5 The impact of these risk factors on the health of children under five years

Espo (2002) employed logistic regression to assess associations between childhood diarrhoea morbidity and various linear environmental predictor variables. The results indicated that source of drinking water and sanitation facilities were strong predictors of infant mortality. Woldemicael (1988) examines the effect of some environmental and socioeconomic factors that determine childhood diarrhoea in Eritrea. He uses data from the 1995 Eritrea Demographic and Health Survey (EDHS). The method employed was logistic regression and the results showed that type of floor material, household economic status and place of residence are significant predictors of diarrhoea. Other than the socio economic factors affecting diarrhoea investigated in the above studies, the study also attempted to discover an important relationship between diarrhoea morbidity using the logistic regression model and household environmental factors in an urban settlement with particularly high prevalence of diarrhoea in a poor urban setting like Korogocho slum.

A comparative study of urban areas of Ghana, Egypt, Brazil and Thailand by Timaeus and Lush (1995) clearly indicates that children's health is affected by environmental conditions and economic status of the household. According to these authors, children from better-off households have lower diarrhoea morbidity and mortality in Egypt, Thailand, and Brazil. Such differentials in diarrhoea diseases by household economic status are probably due to differences

in child care practices, for instance preparation of weaning foods and personal hygiene (Timaeus and Lush, 1995). Despite this comparative study having dealt with major environmental conditions likely to influence occurrence of diarrhoea, it did not consider the accessibility and availability to toilet facilities as a major predictor of diarrhoea in children below five years. The current study therefore intends to fill such gaps.

Jacoby and Wang (2003) examined the linkages between child mortality and morbidity, and the quality of the household and community environment in rural and urban China using a competing risks approach. The data source was the 1992 China National Survey for Children which resembled the demographic and health surveys (DHS) in Kenya. The key findings include; (1) access to safe water or sanitation reduces child mortality risks by about 34% in rural areas; (2) higher maternal education levels reduce child mortality and female education has strong health implication i.e. controlling for other factors influencing diarrhoea occurrence, (a child living in a neighborhood with more educated mothers has about 50% lower mortality risk); (3) access to safe water/sanitation, and immunization reduce diarrhoea incidence in rural areas, while access to modern sanitation facilities (flush toilets) reduces diarrhoea prevalence in urban areas. This study strives to indicate that effective policy interventions for improving health outcomes often lie both within and outside the health sector. These studies focused mainly on the effect of the demographic and socio economic factors on survival rates and morbidity rates in children as a result of diarrhoea incidence. The current study fills the gap of the impact of similar factors on the diarrhoea incidence and morbidity of children below five years which was not addressed.

Based on the data from the 1992 China National Survey for Children which resembles the demographic and health surveys (DHS), Jacoby and Wang (2003) projected that air quality in the

cities and lack of access to clean water in the countryside are the key factors for children's health. They then looked at water, sanitation and cooking fuels as health indicators to verify this projection. They noted that there is a great deal of literature identifying the key determinants of child morbidity. They noted that children born in hospitals and livings in better neighborhoods are more likely to survive while access to safe drinking water is another critical variable that predict occurrence of diarrhoea. They also noted that mother's education also plays a role in the survival rate for children under five years of age. In their conclusion their estimation results showed that children born in rural areas face much higher mortality risk compared with those born in urban areas. Summary of gaps indentified in similar studies done globally includes the following, A global study by WHO in 2005 for the preparation of a fact sheet to raise awareness on the global problem of diarrhoea in children below five years and its effect showed that the occurrences of childhood diarrhoea is significantly associated with family size and educational status of parents and children. However this study did not classify the type of environment that this relationship exists. The global estimate was based on a subset of 72 countries of the under five years population however data average was insufficient to calculate the regional average. The current study identified a poor urban setting to be greatly affected due to many underlying environmental factors.

A comparative study by Jennifer Bryce et al 2013 on differentials child health in urban areas of Brazil, Egypt, Ghana and Thailand did not consider slums in urban setting which this study would like to consider and fill this gap. Despite many studies looking at the relationship between variables and the incidence of diarrhoea, these studies did not look at the possible intervention and management of the diarrhoea. This current study instead looks at the possible measures that can be taken to reduce the incidence of diarrhoea in Korogocho slum. Other studies considered

diarrhoea as a major cause of mortality rates in children. The current study has provided the framework of child morbidity due to diarrhoea incidence and not mortality as was the case in the previous studies discussed in this chapter. Finally majority of the above studies used past demographic surveys as a major source of secondary data while the current study used Primary data as a major source of data.

2.6 Environmental and socio-economic conditions in Kenyan slums and Diarrheoa occurrence in children under five years

Slums in cities of most developing countries are characterized by poor infrastructure facilities such as solid waste disposal, sewage disposal, and drainage which lead to environmental degradation and in absence of sufficient number of community toilets, these people are forced to excrete in the open (Bhardway, 2007).

The accumulation of garbage in four informal settlements in Nairobi city, namely Kawangware, Korogocho, Viwandani and Njiru was found to be a consequence of lack of dumping sites in the communities and the inability of the city council to collect the garbage for appropriate dumping (Amuyunzu and Taffa, 2004). This study was done in Nairobi with an aim of assessing the trend of poverty, environmental and child health in Nairobi informal settlements. The authors reported that the uncollected garbage often accumulate and block drainage and the poor drainage in the informal settlements contaminates drinking water through broken pipes which may increase chances of children of under five years contaminating diarrhoea pathogens. Likewise, members of slum settlements in Nairobi city used sewerage water, rain water and water from broken pipes for various purposes such as drinking, washing etc. (Amuyunzu and Taffa, 2004).

In another study done by Kimani et al. (2007) on health and livelihood implication of the marginalization of slum dwellers in the provision of water and sanitation services in Nairobi city,

reported that informal settlements in Nairobi continues to be characterized by poor living conditions, including lack of affordable house, clean water, inadequate toilet facilities, poor garbage disposal and drainage mechanisms. The slum dwellers of Korogocho in particular lack basic environmental facilities such as sanitation, drinking water supply, electricity etc. (Osumanu, 2007).

According to research done by Clive J. Mutunga (2004) in his unpublished thesis entitled "Environmental determinants of child mortality in urban Kenya", an important relationship exists between diarrhoea morbidity and age of child and number of children living in the household. High prevalence of diarrhoea was at the age of weaning and in households with large number of living children. However, the effects of toilet facility and maternal education were not found to be statistically significant when other factors are held constant.

A study done by KWAHO (2008) on water and environmental sanitation in Kibera also revealed that informal settlements (like Korogocho) in Nairobi are faced by many challenges like inadequate water supplies, few and poor sanitation facilities and unhealthy environmental conditions (heaps of garbage and overcrowding) that are likely to increase the incidence of diarrhoea. In the current study, these factors emerge as environmental risk factors. This study by KWAHO in Kibera has a lot of similarities with current study apart from the geographical setting and the period of study. The specific findings of KWAHO found some association between drinking water source and diarrhoea morbidity although this association appeared to be seasonal ie high morbidity during rainy season and low during the dry season. This is because the surface run off during the rainy season collected diarrhoea germs from feaces and household wastes dumped on the footpaths and along the drainage and this run off mixed with drinking water in cases where the delivery pipes were broken and there increasing chances of diarrhoea in children

below five years. No significant association was found between source of drinking water and child mortality. Interventions to prevent diarrhoea includes safe drinking water, use of improved sanitation and handwashing with soap to reduce disease risk. Diarrhoea can be treated with solution of clean water, sugar and salt with zinc tablets. According to KWAHO, the most severe threat posed by diarrhoea is dehydration. During diarrheoa episode water electrolytes are lost through liquid stool, vomit, sweat, urine and breathing. Dehydration occurs when these loses are not replaced and when it becomes severe it can lead to death.

Another study conducted by (K'oyugi 2004) on Kenyan urban informal settlement in Kibera on the impact of house hold and community level environmental factors such as overcrowding in places of residence, source and quality of domestic water, disposal of human wastes, washing of hands and covering cooked food of infant and child mortality in rural Kenya showed that, lack of excreta disposal facility, the presence of excreta in the yard, lack of latrines and absence of refuse disposal pit revealed a significant association with higher diarrhoea in Kenya. Another study that was done on diarrhoea determinants in Kenya using KDHS 2004 by (Gachogu P 2008) showed that lack of excreta disposal facility, the presence of faeces in the yard, lack of latrines and absence of refuse disposal pit were associated with higher diarrhoea morbidity. This study used the Kenya Demographic survey 2005 and was a representation of the whole country. This study differed with the latter in terms of area setting; it focused on both rural and urban settings and also used a multi sect oral approach of both urban and rural areas while the current study has limited itself in one urban poor environment in a major city. Open field defecation is a primary practice to easily acquire diarrhoea related infections. The only factor that contributes to the increased risk of diarrhoea among children in the multivariate logistic regression analysis is the duration of owning latrine for a longer period by households. This indicates that a behavioural

change towards sanitation is not a matter of an overnight goal. It requires long-term sustained effort of health promotion that aims the utilization of latrine facilities.

Improvements in the existing poor sanitation conditions can bring about a significant drop in the incidence of diarrhoea. But, contrary to expectation, Ikiara J.K 2002 in his M.A thesis on environmental factors and how they relate to the health of pre-school age children in Kibera slum found that water supply did not show significant association with diarrhoea morbidity. This means that it may be the quality and usage pattern of water at home, not the cleanliness of water at its source, which largely determines the impact on diarrhoea morbidity.

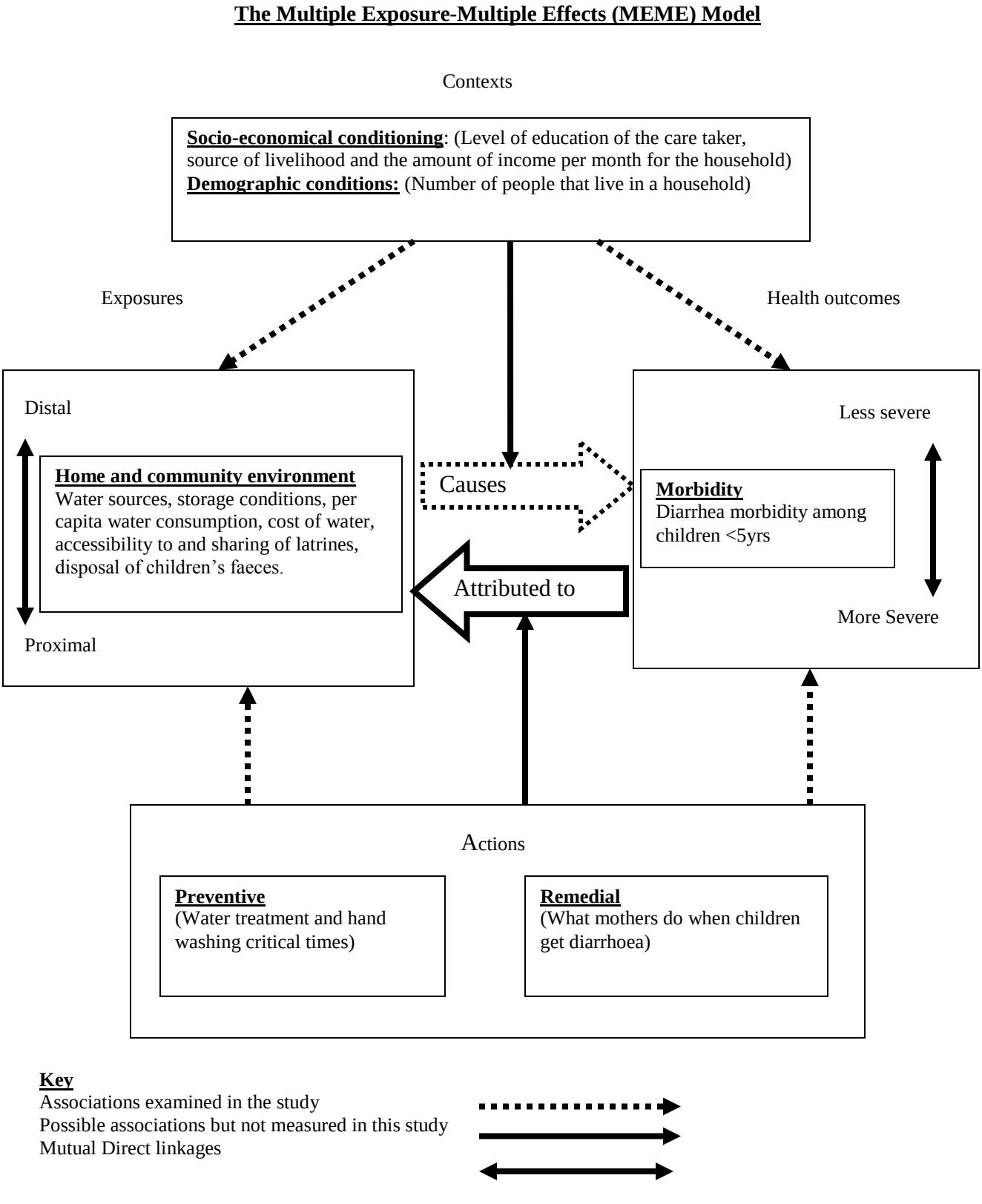
There are many gaps that exist between other similar studies done in Kenya and the current study. These gaps have been discussed as follows; Clive J Mutunga 2004, looked at Nairobi as a whole without considering the socio economic status and areas prone to high risks of environment pollution like slums. This current study stands a better chance to fill the gap left by Mutunga of segregating a slum only as an area of study. KWAHO 2008 study in Kibera showed major similarities with the current study in terms of variables under investigation and diarrhoea incidence. The only gaps that exist between these two studies are area of study, period of study and the study population. The results of K'oyugi study in 2004 concurred with the results of the current study despite the fact that K'oyugi dwelt on many slums within Nairobi while the current study focussed on Korogocho alone. However this current study did not consider variables such as overcrowding in places of residence, covering of cooked food for the infant as was the case by k'oyugi. A study done by Gachogu P. in 2008 used KDHS 2005 which was a secondary source of data. Her study area was Kenya as a whole and the results of the study were a representation of the whole country. Her study also failed to consider behavioural factors such as washing hands during critical times by mothers of under five years of age.

The current study fills these gaps by using primary sources of data, looking at behavioural factors such as washing of hands by mothers before handling food and after visiting toilets and of course considering a small area of study to acquire as accurate results as possible. A study by Ikiara J.K (2002) was similar in terms of environmental setting but the only gap that came up was that he considered accessibility and cleanliness of domestic water as a factor only and excluded sanitation and accessibility to toilet facilities. This current study tried to fill this gap by looking at various environmental factors that might have a significant relationship with childhood diarrhoea. A study done by Muthee Veronica conducted in 2009 in Kibera on risk factors associated with diarrhoea of children showed that water and sanitation conditions in the house and community exposed children to pathogens and pollutants. Inadequate latrines and open defecation practice compounded by unhygienic behaviour at the household and community level created a hazardous environment to the children. Her study also indicated that latrines in Kibera did not provide an adequate solution to the excreta disposal. The current study found a significant association between accessibility to latrines and occurrence of diarrhoea and found out that provision of adequate toilets and latrines facilities in Korogocho could highly reduce the incidence of diarrhoea. In conclusion, past studies have also shown that encouraging practice in latrine use, the presence of school children in a household, duration of owning a latrine, peer pressure, and self initiation to own latrine due to the promotional activity of health extension workers were the major factors affecting utilization of latrines.

2.7 Theoretical Framework

Many environmental risks are versatile and their health consequences can be far-ranging in both time and space and therefore can be a challenging task to develop informed policies for such risks. Integrated environmental health impact assessment aims to support policy by assessing environmental health effects in ways that take into account the complexities and uncertainties involved. For such assessment to be successful, a clear and agreed conceptual framework is needed which define the issue under consideration and sets out the principles on which the assessment is based. Conceptual frameworks facilitate involvement of stakeholders, support harmonized discussions, help to make assumptions explicit, and provide a framework for data analysis and interpretation. Various conceptual frameworks have been developed for different purposes; Knol, Briggs and Lebret (2009) proposed three-level taxonomy of conceptual framework for use in environmental health impact assessment. At the first level of the taxonomy, structural frameworks show the wide context of the issues at hand. At the second level, relational frameworks describe how the assessment variables are causally related. At the third level, this causal structure is translated into an operational model, which serves as a basis for analysis. The different types of frameworks are complementary and all play a role in the assessment process.

Figure 2.1 Theoretical Framework



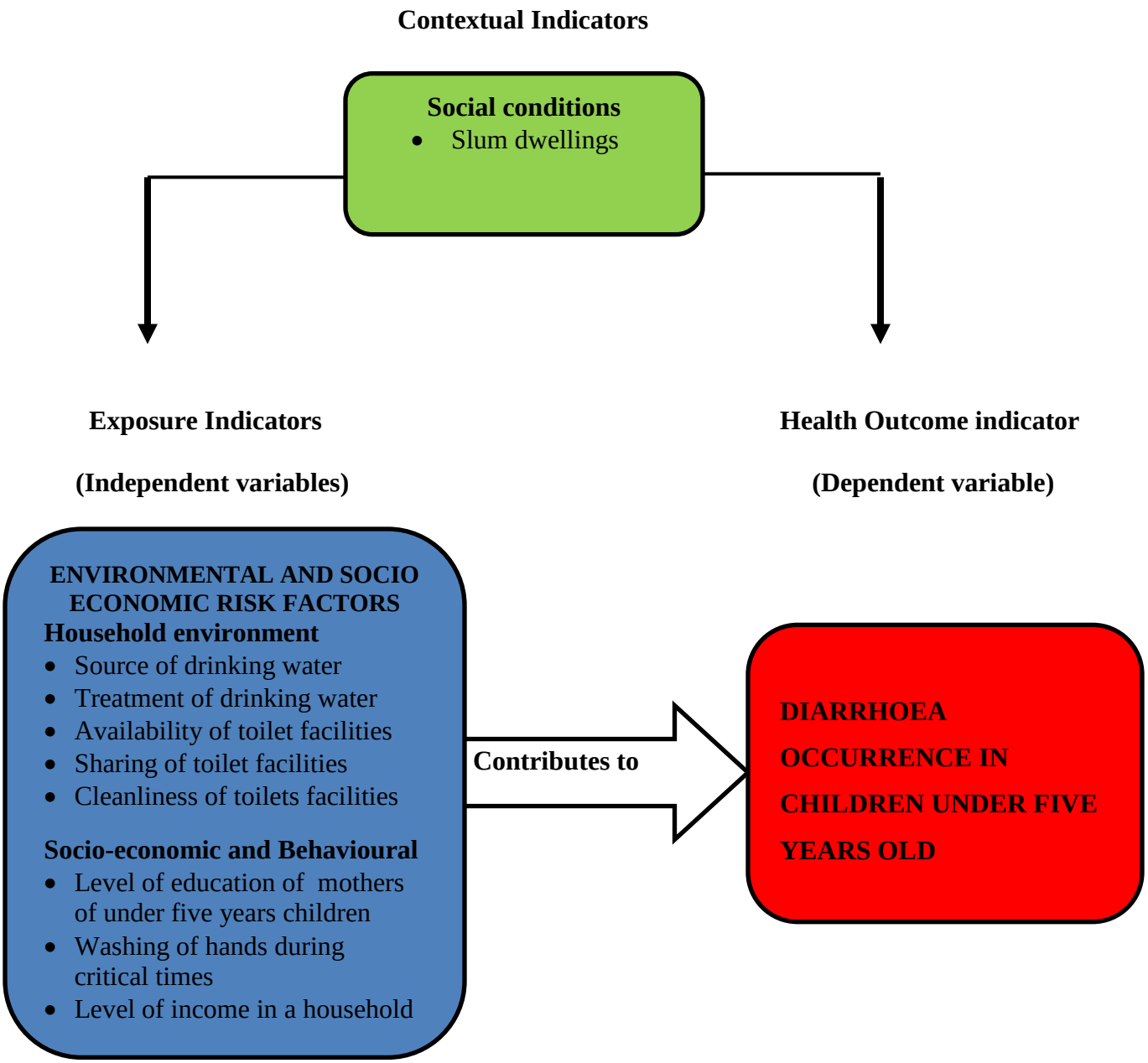
Source: (Briggs, D. 2003)

This study employed the Multiple Exposure-Multiple Effects model (MEME) (Briggs, 2003) to serve as underlying theoretical model to understand the links between environmental and socio-economic factors (Water sources, treatment of water, accessibility to and sharing of latrines, cleanliness of toilet facilities, level of income, educational levels and hand washing practice by mothers) and health outcomes (diarrhoea occurrence among children below five years). The model was considered best because it depict the circumstances under which the two groups of variables; dependent variables (diarrhoea occurrence in children below five years) and the independent variables (Water sources, treatment of water, accessibility to and sharing of latrines, cleanliness of toilet facilities, level of income, educational levels and hand washing practice by mothers) may interlink by representing the socioeconomic, demographic and environmental factors at household level. Other models like Mosley and Shen model, (2012) considered one variable at time without looking at the relationship between the independent variables and therefore could not be applicable in this study. The MEME model developed as a basis for defining indicators of children's environmental health and regarded health effects as the result of exposures to both proximal (i.e. closely related) and more distal (i.e. more indirectly related) risk factors, operating within different environmental settings and wider social, demographic, environmental and policy contexts (Briggs, D. 2008).

This study operationalised the second level risk factors which focus on the important phenomena within certain dwellings and the logical useful links by which these are related. As such, they tend to be chain like in structure to indicate the dynamics of the system to show their causal relationships. In this specific assessment form, these frameworks tend to lose their structural and sequential characteristics of their generic counterparts. Instead, they present a comprehensive picture of multiple variables and interactions. While the general principles on which these

assessment-specific frameworks are built are more or less fixed, the details of the models will inevitably vary from one issue to another. One way of providing information on the state of the environment and its potential effects on health is in the form of indicators. The Multiple Exposures Multiple Effects (MEME) model provides the conceptual and theoretical basis for the development, collection and use of children's environmental health indicators. This model emphasizes the complex relationships between environmental exposures and child health outcomes. Individual exposures can lead to many different health outcomes; specific health outcomes can be attributed to many different exposures. Exposures and health outcomes as well as the associations between them are affected by contextual conditions, such as social, environmental, economic or demographic factors. The MEME model thus describes the four ingredients required for the monitoring of children's environmental health: exposure indicators, health outcome indicators, contextual indicators, and action indicators.

Figure 2.2 Operational Conceptual Framework



Conceptual Framework (Adopted from Briggs, D. 2008)

2.8 Association between independent variables and the dependent variable

Source of drinking water

The source of drinking water determines whether water is contaminated or not. Tap water is considered a safe source of water but in a slum, this water might be contaminated due to breakage of pipes especially where pipes are laid along sewer lines. Water vendors and kiosks may also contaminate water in the process of drawing and delivering domestic water. Containers used to carry and store water are rarely cleaned which might store germs that can cause diarrhoea especially to under five years. Nairobi River and one of its tributary Gitathuro River which runs along the boundary of Korogocho slum is highly contaminated with sewerage and industrial chemicals which are usually unlawfully dumped in it and therefore exposing residents to high risks of diseases when they use this highly polluted water. Households that use this water for domestic purposes might get diarrhoea more often due to many pollutants found in it. Korogocho experiences water scarcity, a problem that has lasted for over one decade. It is becoming very difficult for many residents here to continue with their daily chores since they are forced to walk for long distances in search of the precious commodity. In order to measure this variable of source of drinking water in Korogocho and the occurrence of diarrhoea in children below five years, this study classified source of drinking water into three categories i.e. stands pipes, vendors and kiosks.

Access to and sharing of toilet facilities

Sharing of toilet facilities is a situation where a number of households share one toilet facility. Past studies have shown that in Korogocho, there is one toilet for every 30-40 families. Shared toilets are never cleaned regularly and quite often neglected. When these toilet facilities are not well maintained, they may contribute to acute diarrhoea of children below five years especially

when they and their mothers visit these toilets and fail to wash their hands after and before feeding. The faecal matter in the surrounding environment may contaminate drinking water which may increase the incidence of diarrhoea. Access to toilet facilities in this study was measured by describing respondents that had access to toilet within a reasonable distant and those who didn't. Likewise cleanliness of toilet facilities was measured by describing those toilets that were regularly cleaned and those that were not regularly cleaned.

Disposal of household wastes and children faecal matter

When household wastes are poorly disposed, for example when dumped in the open environment near the residences, they decompose attracting pests like houseflies which transmits micro organism that are likely to transmit diseases. The house flies may contaminate water and food which contribute to diarrhoea for children under five years as a result of disease like cholera. This variable was not used in data analysis due to its inability to be measured however its physical observation formed a basis of making relevant conclusions about the study area. Children faecal matter may also be disposed in open environment especially where toilets facilities are inaccessible especially at night. Baby diapers are also poorly disposed increasing chances of contaminating diarrhoea pathogens.

Frequency of washing hands, household income and level of education of the mothers

The level of education of the mother is critical in managing diarrhoea. Mothers with education are aware of the importance of washing hands during critical times. Critical times in this case means after visiting toilets, before preparing meals and before feeding the young children. Washing of hands is also affected by un availability of adequate clean water and level of income. This is because most households incur cost of buying water which may not be adequate for domestic purpose and hand washing as frequent as possible. Due to scarcity of water in

Korogocho, washing of hands during critical times is not always possible. This increases chances of contaminating diarrhoea. Washing of hands during critical times was measured by classifying mothers who either washed hands after visiting toilets or changing baby diapers and before handling food and those who did not in relation to diarrhoea occurrence in their children less than five years.

CHAPTER FOUR

3.0 STUDY AREA AND RESEARCH METHODOLOGY

3.0 STUDY AREA

3.1 Introduction

This chapter presents a description of the study area by looking at the geography of Nairobi region where Korogocho slum is located in terms of settlement patterns and a brief history of the origin of slum in Nairobi. Themes presented about the study area include; demographic characteristic, healthy status, infrastructure, housing, water and sanitation, waste disposal and thematic maps of the area.

3.2 Background information about the study area

The city of Nairobi, capital of Kenya is one of the largest cities in Eastern Africa with a population well over three million (UNEP 2013). Nairobi is estimated to have the fastest annual population growth in Africa where 75 percent of this growth is absorbed by its slums (UN Report 2013). The recent UN 2013 report describes Nairobi's informal settlements as some of the most dense, unsanitary and insecure slums in the world. Slums cover only 6 percent of Nairobi's total residential land area, but house at least 50 percent of its population. (Graham Alder 2013). The roots for the formation of Nairobi's slums can be traced back to the pre-independence period when the urban layout was based on government sanctioned population segregation into separate closed society for Africans, Asians and Europeans. During this period, slums essentially developed because of the highly unbalanced allocation of public resources towards the housing and infrastructural needs of the separate sections. The post colonial period saw a relaxation of the colonial segregation policies, and major population shifts occurred, notably rural to urban migration with little obstruction to the large number of urban shacks as they were not located

near the central business district. Slums sprang up all over the town in the proximity of employment zones. Spatial segregation during this period continued to be reinforced but this time more by socio economic and cultural stratification. The post independence period also saw rapid urban population growth without corresponding housing provision, poor population resettlement due to new developments and extension of city boundaries that included rural parts within urban boundaries often changing the characteristics of settlements.

Nairobi has experienced huge relatively steady increase in population since Kenya became independent in 1963. Between 1962 and 1969 censuses, the population nearly doubled, growing from 260,794 to 509,206 residents. Nairobi's population at the time of the 1989 census was 1,324,574. In 2003 the city had an estimated population of 1,810,000 and today it is estimated to have a population of more than 3 million. The growth rate of Nairobi is currently 4.1% and it is estimated that Nairobi's population will reach 5 million in 2025 (World Bank 2011).

Like most rapidly growing urban areas in Africa, Nairobi has experienced a variety of problems in recent years. These problems include overcrowding, poor housing, water shortages and poor sanitation. Slums accommodate the majority of Nairobi's population and are generally of two types; squatter settlements and illegal sub divisions of either government or private land. A number of slums are located on land that is unsuitable for construction and all have high to very high population densities. Slums and informal settlement are widely located across the city, typically in the proximity to areas within employment opportunities. Several policy initiatives have been undertaken and facilities have been established to address issues of slums including enabling strategy, the Nairobi informal settlements coordination committee, Nairobi situation analysis, the poverty reduction strategy paper and the local authority transfer fund. They address

a series of themes including settlement upgrading, community participation and improved access to services.

3.3 Korogocho slum

Korogocho is located 11 Kilometres on the North Eastern side of Nairobi city centre with a population of 41,946 people and a total of 12,909 households pressed in a 0.9square kilometres area (Census Report 2009). Korogocho comprises of three sub locations namely; Nyayo, Korogocho and Gitathuro. Each sub location is further subdivided into villages totalling to nine villages in the entire area. These villages are; Kisumu ndogo, Korogocho, Korogocho B, Highridge, Gitathuro, Nyayo, Grogan A, Grogan B and Gomongo. Each village has an elder who reports directly to the chief of Korogocho location. Korogocho is an informal settlement in Nairobi County, Nairobi East District, Kasarani Division and Korogocho Location with one administrative chief. Korogocho is one of the largest slum in neighbourhoods of Nairobi that was founded as a shanty town on the outskirts of Nairobi in early 70s. In 2009 it was estimated to be the fourth largest slum in Nairobi, after Kibera, Mathare and Mukuru kwa Njenga. In terms of ethnicity, Korogocho residents come from more than thirty ethnic groups, although most of them are from the Kikuyu, Luo, Luhya and Somali ethnic groups. Majority of residents can be classified as low income earners who are exposed to poor living conditions and environment characterized by poor and ineffective waste disposal and contaminated water supply which are likely to increase the incidence of diarrhoea among children below five years.

The area is served by only one tarmac road while the footpaths are usually congested and fully polluted with household wastes, open sewerage and drainage systems. There are little formal infrastructure serving Korogocho residents and most housing was built by families living there and is made up of mud and recycled materials. Despite this, many of the residents pay land rent

for the right to live there while others pay rent to those who have constructed their habitations. With poor infrastructure, few resources, overcrowding, and proximity to the Dandora dump site, health of many residents in Korogocho is poor.

Informal settlement in Nairobi, including Korogocho reported to have child mortality rate of 18% of children dying before their 5th birthday predominantly as a result diarrhoea and other preventable deseases. The chronic lack of clean water and proper sanitation leads to social as well as health problems adding to residents problems. The lack of clean water and improper waste disposal are a big threat to the lives of korogocho residents due to the risks of water borne diseases. Although some pay-toilets have been set up in Korogocho, the cost remains unaffordable forcing residents to dispose off excreta in plastic bags which litter the whole area. In korogocho the broken sewer line running from the neighbouring kariobangi estate has been emptying its effluence into the slum, chocking the already narrow pathways between rows of houses and contaminating tap water through broken pipes.

Korogocho has been described to have very few toilets and as a result people use flying toilets and the condition jeopardise the health of the entire community. People also walk for long diatances to access toilets and this poses insecurity to women and young girls especially at night. Korogocho slum borders the largest dumping site in Nairobi-the dandora dumping site posing environmental health and security risk for the residents and surrounding settlements. Korogocho has a large population with little access to health and social services, living largely in structures made out of temporaly building materials, mud walling and roofing made up of substandards materials such as sacks, cartons papers and polythene. There is no proper sanitation and waste management and water provision is limited while the road network is inadequate. Poor hygiene in this slum has resulted to the rapid spread of diarrhoea and other water borne diseases like

cholera and tryphoid. Korogocho slum is faced with lack of access to clean water and poor waste disposal and the progress towards the number of people without access to safe drinking water and saniation by 2015 has been slow.

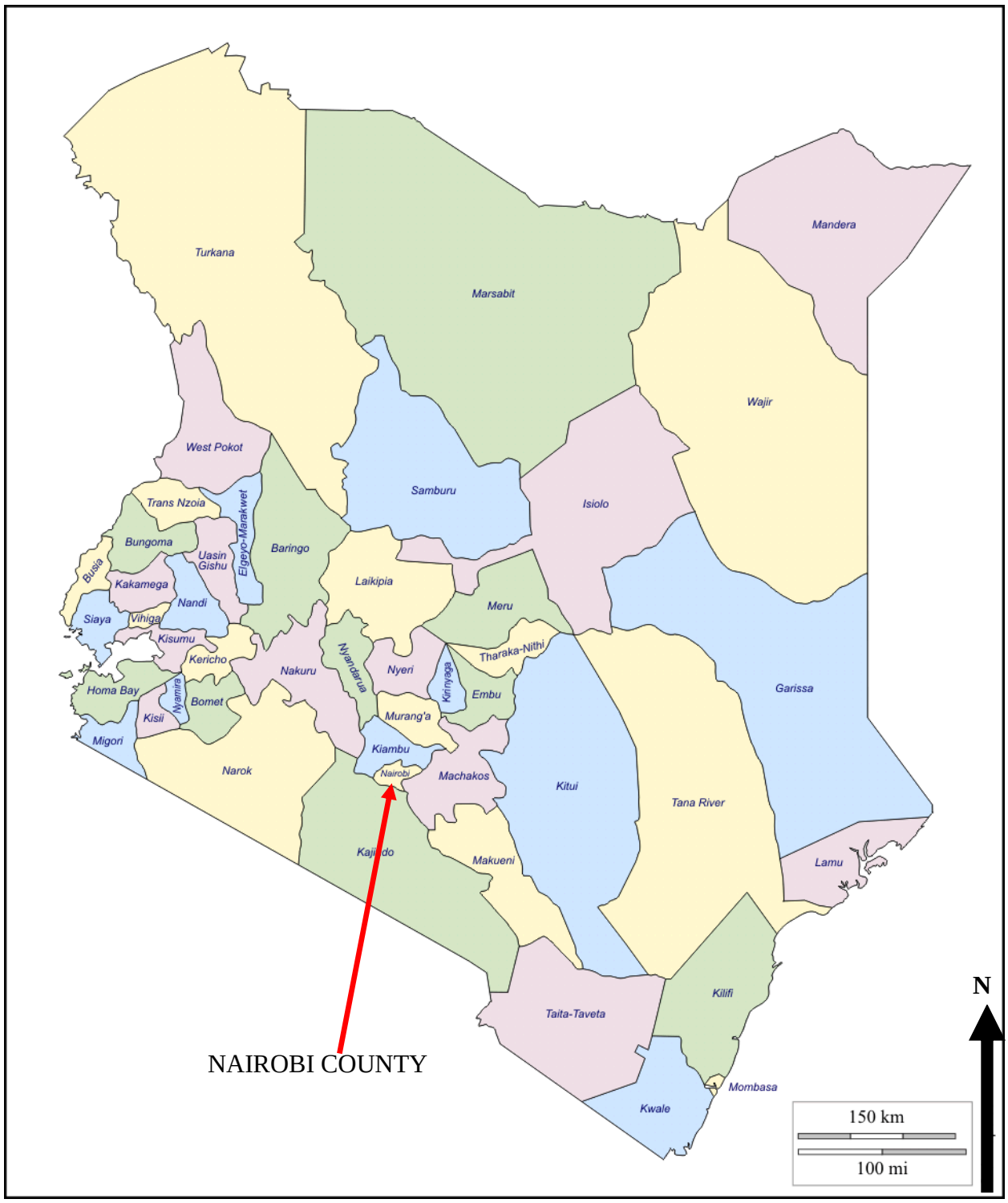
In 1999, the African Enterprise Kenya (AEK), a non goverment organization conducted a participatory urban appraisal in this community with the help of the existing Community Based Organizations (CBOs) and community leaders. They found out that lack of clean water and poor sanition which included flying toilets and poor disposal of human waste was a felt need of the korogocho community. Due to poor saniation and drainage systems, the slum area of korogocho had a very high rate of water borne deseases like typhoid and cholera. In the year 1999-2002, after a need assessment by African Enterprise in partnership with the australian Government was to build 90 water kiosks, 60 toilets and 3,000 meters of drainage systems. Since then cases of these dirrhoea related diseases have greatly reduced.

The level of saniation in korogocho is bad such that when the toilets are full, they just open the drain to disperse the waste. When there is not enough water the waste stays in the street until the rainy season. During the rainy season the dry faecal matter is carried by running streams to the nearby river through the open street drains where unsuspecting children play outside their homes are exposed to faecal matter increasing the chances of contaminating diarrhoea pathogens. In korogocho most of the toilets are emptied using tins which are then emptied into the river. A number of people use these river in korogocho to draw water for domestic use mainly loundry purposes. According to residents of korogocho, human waste is poorly disposed off in the streets. This is caused by the emptying of toilets which are full but more simply because there are no enough toilets for the residents of korogocho. Where toilets are available, they are mostly available during the day, at night people are forced to use alternatives including polythene bags

and open fields. This behaviour increases levels of community diseases including cholera, dysentry and typhoid in korogocho whose symptoms are severe diarrhoea. Such deseases particulary affect children and as a result, healthcare costs make up a considerable parts of women expenditure. In early 1990s poor waste disposal, contaminated drinking water and food supplies significantly contributed to water borne diseases in korogocho slum (WHO 2005). This research showed that 4 times more children aged zero to five years were dying in slum settlement than in the rest of the population with diarrhoea being among the leading causes of childhood deaths. This scenario has not changed much in recent times.

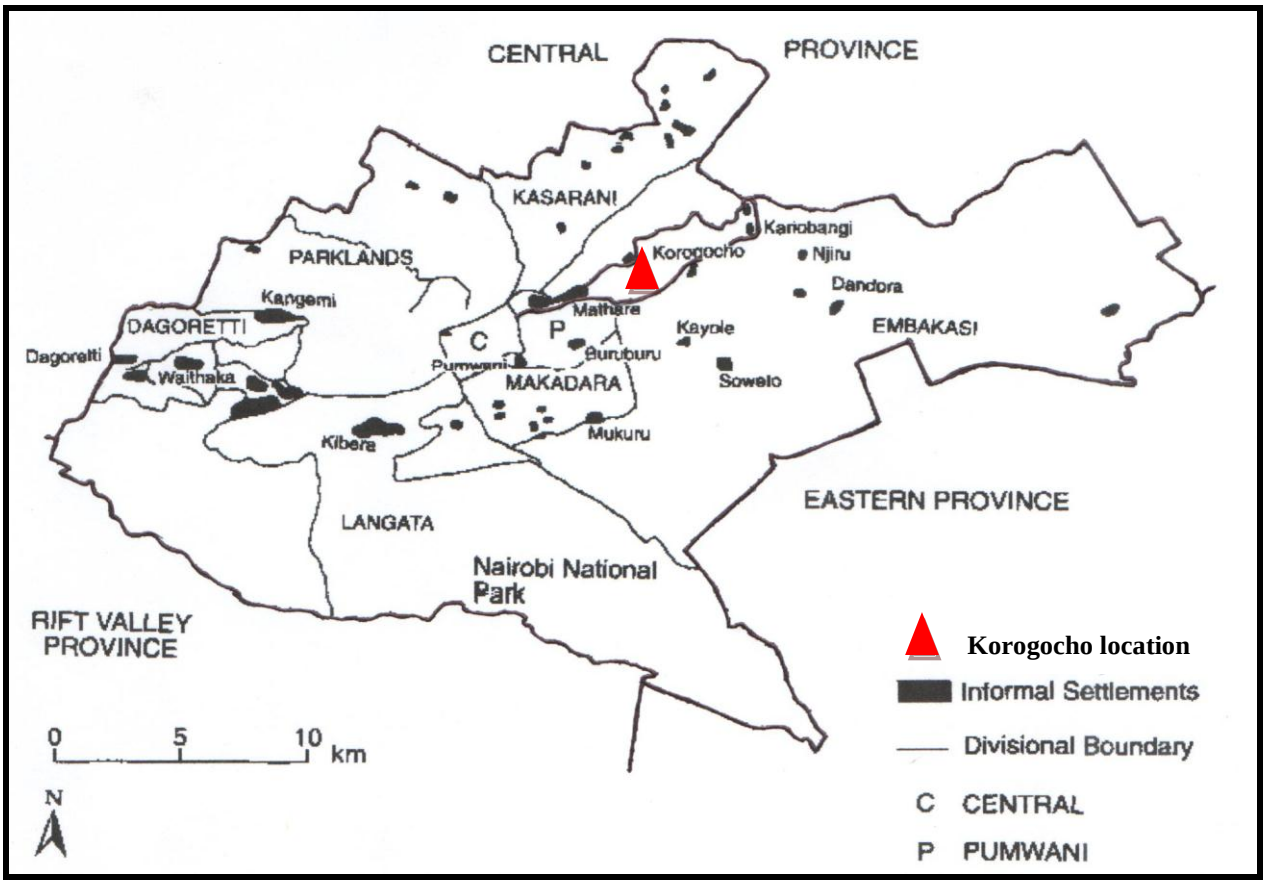
Less than 30% of the population of Korogocho have access to latrines so people are forced to defacate in fields, ditches and buckets. In such crowded condition diarrhoea deseases are inevitable and often fatal. At present each one door latrine in korogocho is shared by approximately twenty families. This means that there is still enormous need for more latrines. There are several water kiosk in korogocho sponsored by NGOs but can hardly quench the thirst of an estimated 50,000 people. On the days when rationed water does not flow from the legal taps in korogocho, thousands of people in this slum face dismal and potentially dangarous choice. They use contaminated rain water collected through contaminated roof tops, spend scarce income on questionable water sold by vendors or take their chances by drinking from the polluted streams. In korogocho, sewage and other pollutants quickly find their way into water used for drinking, cooking and washing and this makes it's under five years children to be more prone to diarrhoeal infections and other infectious diseases.

Figure 3.1: Map of Kenya showing Nairobi County where Korogocho slum is located



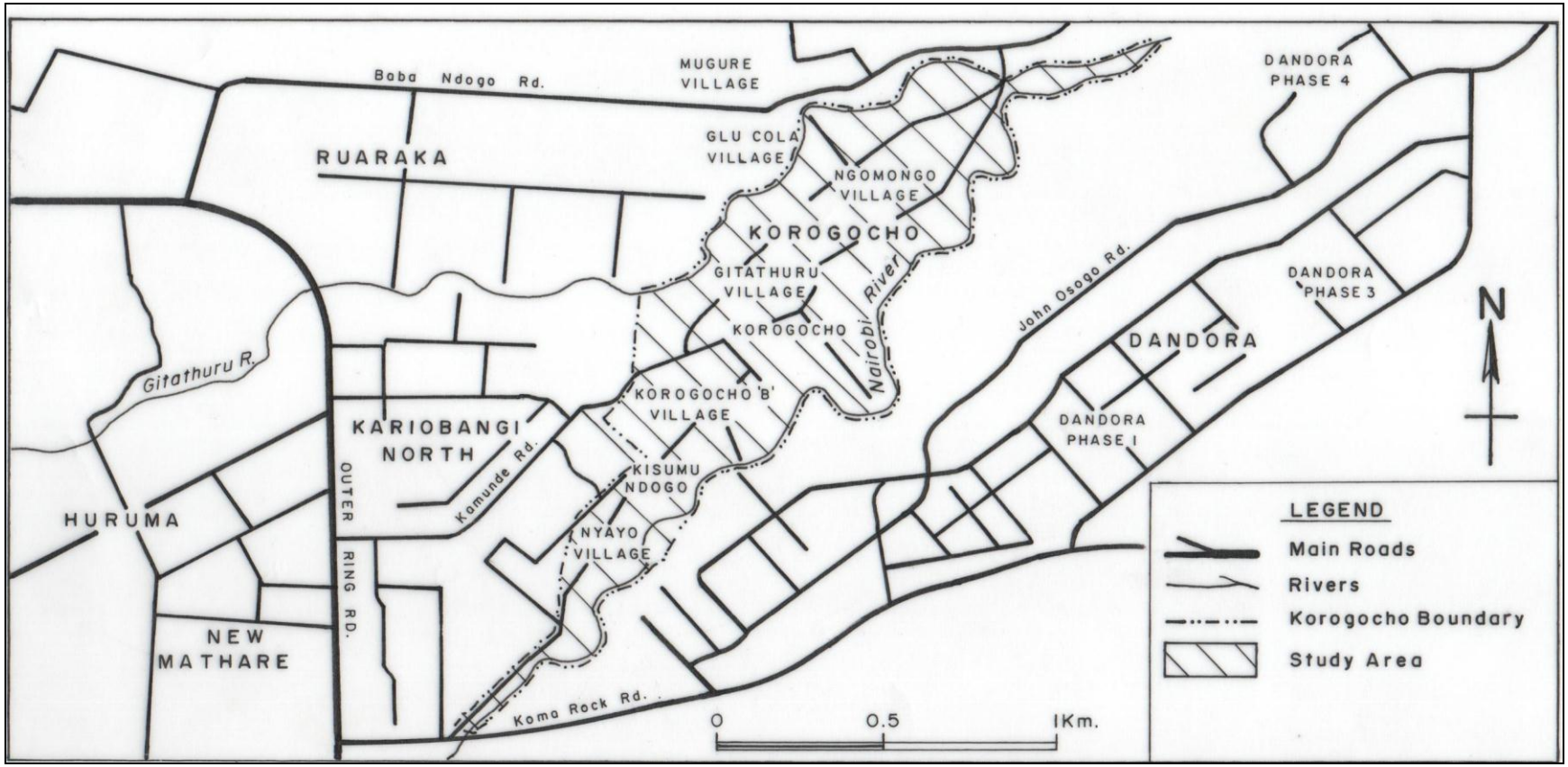
Source: Adapted from WHO/UNICEF 2014

Figure 3.2: Map of Nairobi County showing Korogocho location-The study area



Source: **UNCHS-Habitat. 2010**

Figure 3.3: Map of Korogocho showing the study area



Source: Researcher

3.4 RESEARCH METHODOLOGY

3.5 Introduction

This chapter deals with methodology used to collect, process and analyse data. It also gives the types and sources of data, target population and how the sample was selected. A summary table has been outline showing the population distribution of the study area and the number of households selected in each village.

3.6 Study design

The research design that was adopted in this study was survey design which involved sampling three out of nine villages based on demographic and socio cultural factors and randomly selecting the households in each pre determined village to collect data from mothers of children aged five years and below. The questions asked in the questionnaires were based on the research variables to illicit responses that could be analysed to measure the study objectives and test the null hypothesis.

3.7 Data sources

Data used in this study was primary and secondary. Primary data was generated as first hand information from the field work while secondary data was generated from secondary sources like books, journals, articles, academic thesis and projects.

3.8 Target population and sampling frame

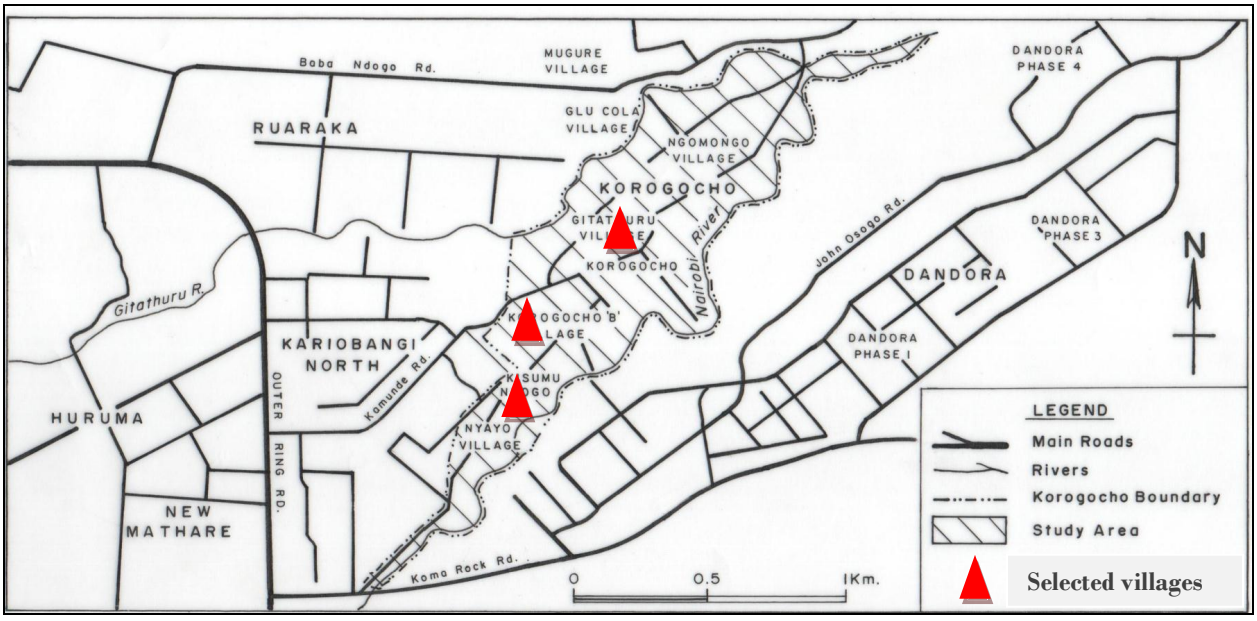
The target population in this study were women with children aged five years or less in a household. The total number of households in Korogocho was 12,909 and the sample population was drawn from the three sub locations of Korogocho and one village in each sub location. The households where a woman had more than one child aged five years or below was treated the same with households where a woman had only one child below five years although diarrhoea

occurrence was considered in either of the child. The sample size was 90 respondents proportionately distributed across the three sub locations of Korogocho location.

3.9 Sampling procedure and selection of sample

Korogocho slum was purposively sampled and selected from other slums like Kibera, Mathare and Mukuru kwa Njenga within Nairobi County because the researcher had prior knowledge about the administrative and location of the slum better than other slums within Nairobi. Korogocho being an enumeration area located in Ruaraka Constituency comprises three sub locations namely; Nyayo, Korogocho and Gitathuro. Each sub location is further subdivided into villages totalling to nine in the entire area. These villages are; Kisumu Ndogo, Korogocho, Korogocho B, Highridge, Gitathuro, Grogan A, Grogan B and Ngomongo. Based on this distribution, three out of nine villages were selected on the basis of social and cultural attributes like ethnicity and mode of living (Kisumu Ndogo, Korogocho B and Gitathuro).

Figure 3.4: Map of Korogocho showing the three selected villages for the study



Source: Researcher

Selection of respondents was done through systematic random sampling. Every third household with a child below five years was selected, when there was no child in the third house hold, the researcher went to the next household with a mother of a child below five years until a sample size of 90 was achieved. To ensure that the results of the study could be used to make an accurate generalization at 95% confidence levels, sample size was arrived at using Fisher et al (1998) formulae of calculating desired sample size as shown below based on the established 31% diarrhoea prevalence among the under five in Korogocho (APHRC, 2002).

$$n = z^2pq/d^2$$ Where:-

n= the desired population sample size (when the population is greater than 10,000)

z= the standard normal deviation (1.96) that corresponds to 95% confidence levels

p= the Proportion of target population estimated to portray a particular characteristic (31% of the population is children aged less than 5yrs with diarrhoea infection. APHRC, 2002) thus

p= 0.31, q=1.0-p=0.69,

d= degrees of accuracy desired (0.05)

The equation yielded a population sample size of 328, with the estimated house hold size ratio to the total population of 1:3.5 (2/7), the household sample size was arrived at by multiplying the population size by the ratio of house hold size to the total population as shown in the equation

$$n = \frac{2}{7}(z^2pq / d^2)$$

In this case, a sample size of households of 93±3 was considered statistically significant to yield fairly accurate results. The sample size was distributed proportionately in the three sub locations as shown in the table. The sample distribution in each sub location was based on the number of housed proportionately distributed to the total sample size and the total number of households.

Table 3.1 Population and sample size distribution table

Sub Location	Total Pop (Census2009)	No of household	No/Names of villages	Village selected	Selected no. of households (n)	Percentage of the total sample size
Nyayo	9,638	3,300	Kisumu ndogo Nyayo Highridge	Kisumu Ndogo	23	25.6%
Korogocho	10,370	3,129	Korogocho B Ngomongo Grogan A	Korogocho B	22	24.2%
Gitathuro	21,735	6,480	Gitathuro Korogocho Grogan B	Gitathuro	45	50.2%
Total	**41,743**	**12,909**			**90**	**100%**

Source: Researcher

3.10 Data collection instruments

Primary data for this study was collected through administration of questionnaires to the respondents. A semi-structured questionnaire was orally administered to mothers of children aged less than five years to facilitate proper understanding of the questions to give responses that were not biased. The questionnaire contained items linked to the variables of the study as indicated in the study questions. These variables were: source of drinking water, treatment of drinking water, access to toilet facilities, cleanliness of toilet facilities, level of mother's education and hand washing by mothers during critical times. The researcher also made observations of the community and household environment to reinforce data collected through questionnaires. The questions were structured to collect data on both the environmental determinants of diarrhoea such as water source, water treatment, accessibility to and sharing of latrines, disposal of children faeces and hand washing during critical times for example after visiting toilets, before feeding the baby and during food preparation and the socio economic determinant such as level of education of the mothers. The above independent variables and the

occurrence of diarrhoea among children below five years over two weeks recall period were fully investigated. Spot check observations was done to support data collected from the questionnaires. Secondary data was generated from secondary sources like books, journals, articles, academic thesis and projects to support primary sources.

3.11 Data Processing and Analysis

The primary data from the questionnaire was cleaned of any errors and omissions and then coded for entry into the computer system. The raw data was extracted from the questionnaires by entering the results in an excel sheet. The data was then organized, coded and filtered using SPSS software. Both descriptive and inferential statistics techniques were employed to analyze the coded data. Data was first analyzed using descriptive statistics and cross tabulation. The descriptive statistics gave firsthand information about occurrence of diarrhoea in children below five years for the respective characteristics. Descriptive statistics of percentages and frequency tables were calculated for each variable in relation to the occurrence of diarrhoea in children below five years. Data was then subjected to further analysis using chi square statistics techniques. The Chi square technique was used to test the relationship between the dependent variable and the independent variables. The qualitative variables like occurrence of diarrhoea in children under five years was operationalised by setting frequencies of respondents who reported diarrhoea occurrence and those who reported non occurrence. Both responses were coded differently in the SPSS software to perform a quantitive analysis test using chi square statistic.

Data was put in the contingency tables to obtain the expected values and the degrees of freedom. The Chi square analysis used the formulae of observed and expected values to arrive at the critical value (χ^2) as shown below.

$\chi^2 = \sum\left(\frac{O-E}{E}\right)^2$ Where; χ^2 = Calculated Chi square value O = Observed frequency

E = Expected frequency $\sum$ = Summation of

The chi square results were presented in the format of chi square values (χ^2), degrees of freedom (d) and statistical significance test (p). The chi square value and the degrees of freedom were used to decide the probability or p-value of independence. When the computed χ^2 statistic exceeded the critical value in the table for 0.05 probability level, the null hypothesis of equal distribution was rejected. Likewise when the computed χ^2 statistic fell below the predetermined alpha level of significance (0.05), the null hypothesis of equal distribution failed to be rejected.

Two major assumptions were made; one was that the data set was large enough to use chi square test. In cases where the sample size was small i.e. more than 20% of the contingency cells having expected values <5, a general description was made. Secondly the independence assumption was made i.e. data was not interrelated but rather categorical and independent from each other.

Chi square test of independence showed whether pairs of variables were related and whether there was any significant association to reject the null hypothesis. Failing to reject the null hypothesis meant that the sample size could have been small or data could have been inadequate to reject the null hypothesis and therefore more research needed to be done to establish the cause of this relationship.

Chi square test statistics was adopted in this study because it is easier to compute than other statistics and can be used with data that has been measured on nominal (categorical) scale. Chi square makes no assumption about the distribution of the population; other statistics assume certain characteristics about the distribution of the population as normality.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the analysis of data and results of the study. It begins by describing results in percentage frequencies and counts as the main descriptive methods of data analysis and later finding the prevalence of diarrhoea and the significance of association between the dependent and independent variables using the Chi square values (χ^2), degrees of freedom (d) and the statistical significance levels (p=0.05).

4.2 Diarrhoea prevalence in children below five years in Korogocho 2 weeks prior the study

Based on two weeks recall, 35.6% of the child mothers reported that their children had suffered diarrhoea related illness two weeks prior to the study against 64.4% who reported non occurrence. The response rate was 100%

Table 4.1 Diarrhoea occurrence two weeks prior the survey

Total sample size	**90**	**100%**
Sample size that reported Diarrheoa	32	35.6%
Sample size that did not report Diarrheoa	58	64.4%

Source: Researcher

The prevalence was higher than earlier estimated (31%) by AMREF (2002) and APHRC (2006) though the difference was small. This difference could have been contributed by different methodologies of data collection, recall period and difference in times at which the study was carried out. Majority of the children suffered one diarrhoea episode in the last two weeks before the study. The high prevalence could have been attributed by many factors such as lack of

adequate water and dirty environmental conditions, poor children excreta disposal, contaminated latrines, poor garbage disposal, ineffective hand washing and lack of proper education and awareness on how to prevent occurrence of childhood diarrhoea.

4.3 Environmental risk factors

In regard to environmental factors several factors were considered, these included source of drinking water, safety and treatment of driking water, access and type of toilet facility, sharing and cleanliness of toilet facility.

4.3.1 Sources of drinking water in Korogocho

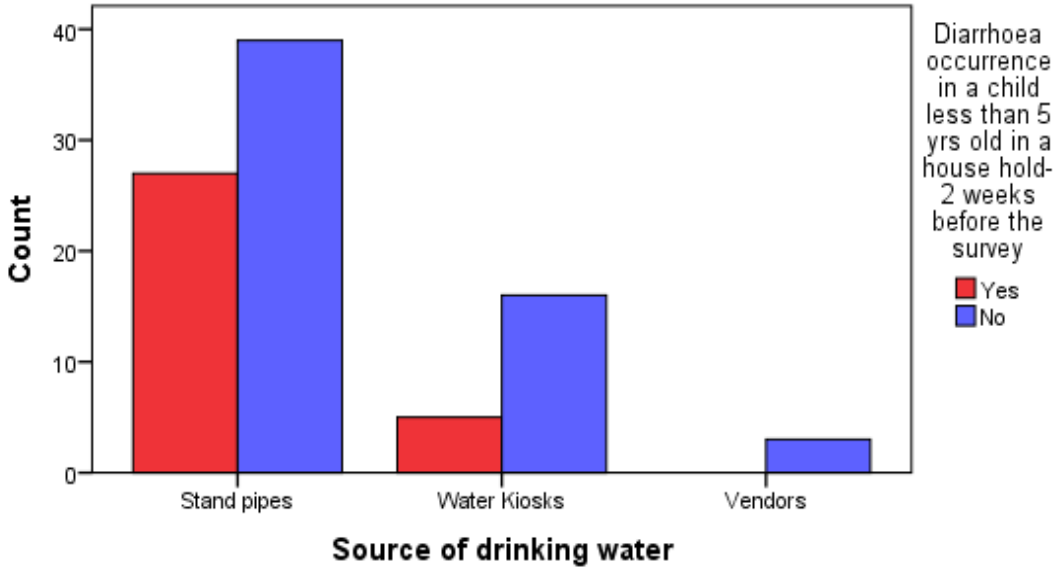
Majority (73.3%) of respondents in Korogocho reported that their main source of drinking water was from stand pipes. Other sources of water were water kiosks (23.3%) and small water vendors (3.3%).

Table 4.2 Sources of Water in Korogocho

Source of drinking water	Total count	% count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Stand pipes	66	73.3	27	39
Water Kiosks	21	23.3	5	16
Vendors	3	3.3	0	3
Totals	90	100	32	58

Source: Researcher

Figure 4.1 Sources of drinking water and occurrence of childhood diarrhoea



Source: Researcher

Establishing relationship between source of drinking water and occurrence of diarrhoea in children <5yrs

Sources of drinking water were classified as stand pipes, water kiosks or vendors. Water kiosks and vendors sources were combined to form one contingency cell. Data for these variables were put in a contingency table as shown in the table below for chi square test.

Table 4.3 Contingency table for source of drinking water and occurrence of childhood diarrhoea

Source of drinking water and Diarrhoea occurrence in children less than 5 years in a house hold-2 weeks before the survey -Cross tabulation for chi square analysis				
Source of drinking water		Diarrhoea occurrence in **children less than 5 years** in a house hold-2 weeks before the survey		Total
		Yes	No	
Standpipes	Observed Count	27	39	66
	Expected Count	23.5	42.5	66.0
Water Kiosks and Vendors	Observed Count	5	19	24
	Expected Count	8.6	15.4	24.0
Total	Observed Count	32	58	90
	Expected Count	32.0	58.0	90.0

χ^2 =3.745 d=2 p=0.05 Critical value = (5.99)

Source: Researcher

The Chi square test for this variable (χ^2 =3.745) did not show a significant relationship between source of drinking water and diarrhoea occurrence among children below five years. This could be interpreted that water could have been polluted mainly at the point of drawing, during transportation or storage. This test was not statistically significant at (p> 0.05) implying that this relationship of association was likely to have happened by chance. The null hypothesis that there was no significant relationship between source of drinking water and the occurrence of diarrhoea failed to be rejected.

Plate 4.1 A photograph showing residents of Korogocho buying water in a kiosk

4.3.2 Safety and treatment of drinking water

In regard to treatment of drinking water to make it safe for drinking, the study found that not all households treated water for drinking despite the fact that majority of the residents were aware that water from taps and other sources could have been contaminated with germs. Most of the

residents who never treated water (41.1%) believed that water from stand pipes, vendors and tanks were chlorinated and therefore safe for consumption.

Table 4.4 Treatment of drinking water

Treatment of drinking water	Total count	Percentage count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Yes	53	58.9	11	42
No	37	41.1	21	16
Totals	90	90	32	58

Source: Researcher

Establishing relationship between treatment of drinking water and occurrence of diarrhoea in children <5yrs

Treatment of drinking water was categorized into two; those respondents who treated drinking water either by boiling or using "water guards" and those who never treated water for drinking. Data for these variables were put in contingency tables for chi square analysis as shown below

Table 4.5 Contingency table for treatment of drinking water and occurrence of childhood diarrhoea

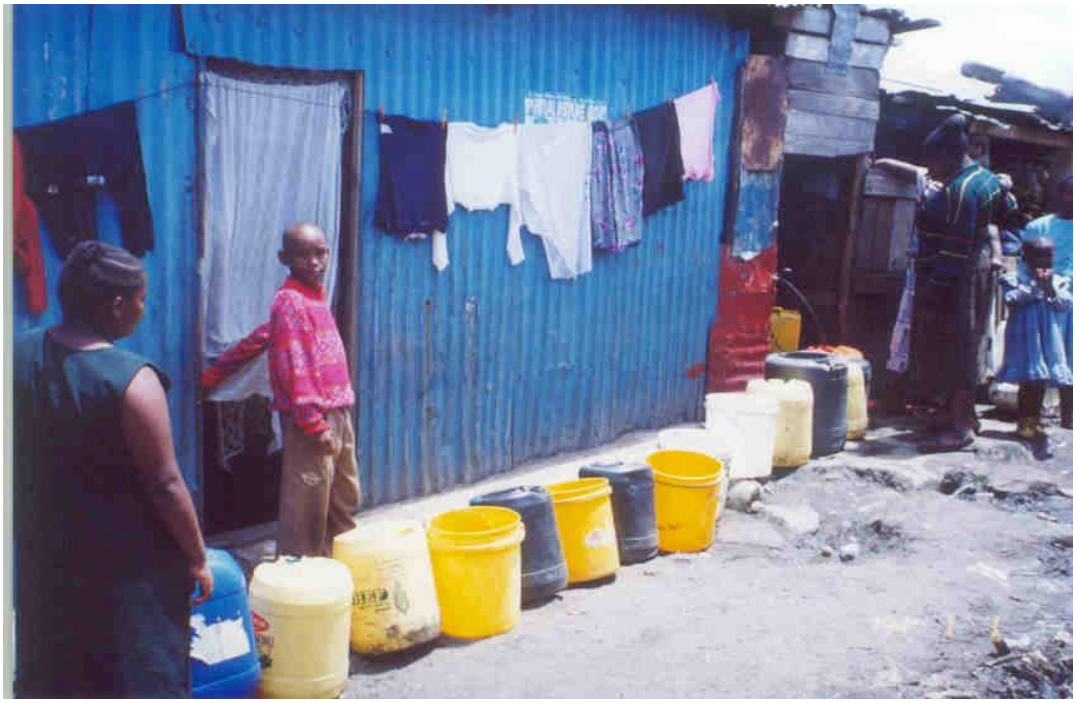
Treatment of drinking water and Diarrhoea occurrence in children less than 5 years in a house hold. Cross tabulation for chi square test				
Treatment of drinking water		Diarrhoea occurrence in **children less than 5 years** in a house hold-2 weeks before the survey		Total
		Yes	No	
Yes	Observed Count	11	42	53
	Expected Count	18.8	34.2	53.0
No	Observed Count	21	16	37
	Expected Count	13.2	23.8	37.0
Total	Observed Count	32	58	90
	Expected Count	32.0	58.0	90.0

χ^2 =12.325 d=1 p=0.05 Critical value = (3.84)

Source: Researcher

The Chi square analysis for this variable $\{\chi^2 = 12.325\}$, revealed that there was a significant relationship between treatment of drinking water and diarrhoea occurrence in children below five years. This means that the households that treated water were less likely to experience diarrhoea incidences compared to those who did not treat water. The null hypothesis that there was no significant relationship between treatment of drinking water and the occurrence of diarrhoea disease in children below five years was rejected. This statistical test was significant at $p<0.05$, meaning that the association achieved was not likely to have been contributed by chance of random sample.

Plate 4.2 Residents queuing for non affordable water



4.3.3 Faecal waste disposal and sanitation facilities

Excreta are the primary source of diarrhoea disease agents which are further transmitted through contaminated foods and fluids. Restraining of excreta is the best means to prevent diarrhoea diseases agents from being transmitted. In Korogocho slum excreta was mainly disposed in pit

latrines. Although 90.2% of the respondents reported having access to latrines, observation showed that proper disposal of faecal matter was not always the case, children's excreta were found along foot paths, open drains and near water sources. The study also indicated that in spite of the presence of latrine facilities, they are inadequate and at times overflowing. The few latrines that were considered better were charged on use. The income levels in this region indicated that majority of residents could not afford these well maintained toilets. Finally this study found out that the residents faced maintenance challenges owing to the high number of people sharing these latrines. Some of the latrines in Korogocho overflow due to lack of maintenance and exhaust services. In regard to latrine cleaning, 39% of the respondent reported that their latrines were cleaned mainly by the tenants regularly. Nevertheless, 61% of respondents reported that latrines were not cleaned whenever they incurred dirt or on a daily basis due to cost involved in cleaning the latrines and more so ignorance of the tenants and users.

Plate 4.3 Residents dumping raw human waste in a river in Korogocho

i) Availability and access to toilet facilities

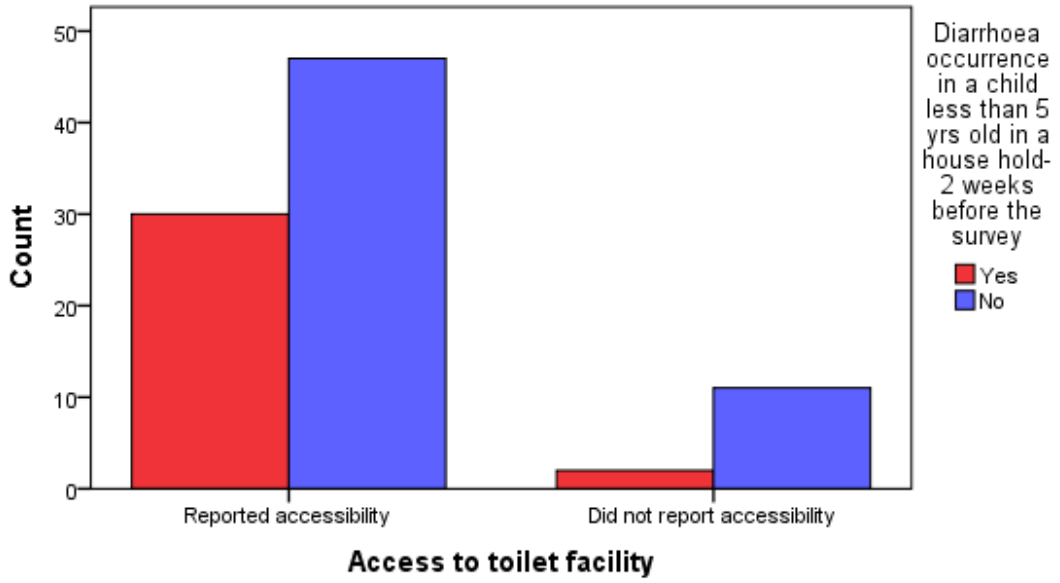
Availability of toilet facilities is a major factor that determines the occurrence of diarrhoea in children below five years. Access to toilet facilities was measured by asking the respondents whether there was available toilet within a reasonable distance from the dwelling places at all times. The response was categorized into two; those that had access to and those that did not have access to. In Korogocho, most of the respondents reported not to own a toilet (83.3%) while a few reported to own a toilet (16.7%). Most of the toilet facilities composed of pit latrines which were not well maintained and could overflow especially during the rainy season (93.3%). Only a very small proportion of respondents reported to have flush toilets inside their houses (6.7%). The flush toilets were also found to pose a big challenge when water was not available in taps. 88.9% of the respondents reported to sharing of toilet facilities which was a very big proportion of the total population. The sharing of these essential facilities would make the cleaning of these facilities ineffective which could likely increase the incidence of diarrhoea in the target population. 36.7% of the respondents reported that their toilet facilities were never cleaned regularly while 63.3% reported that their toilets were regularly cleaned by the tenants and land lords. This information has been summarized in the three tables below

Table 4.6 Access to toilet facilities (sanitation status)

Access to toilet facility	Total counts	Percentage count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Yes	77	85.6	30	47
No	13	14.4	2	11
Totals	90	90	32	58

Source: Researcher

Figure 4.2 Access to toilet facilities and occurrence of childhood diarrhoea



Source: Researcher

access to toilet facilities was found not to have a significant relationship with diarrhoea occurrence in children below five years. This could have been attributed by the fact that young children rarely use toilet or latrine facilities.

Plate 4.4 Poor toilet facilities in Korogocho

Faecal matter overflowing from the latrine

Although more than 85% of the respondents admitted to having access to a toilet facility, latrines were found to be inadequate and a times overflowing. The better maintained latrines were few and used at a fee. The study found out that residents faced maintenance challenge owing to the high number of people sharing them.

Table 4.7 Sharing of toilet facilities

Sharing of toilet facility	Totals	Percentage count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Yes	78	86.7	30	48
No	12	13.3	2	10
Totals	90	100	32	58

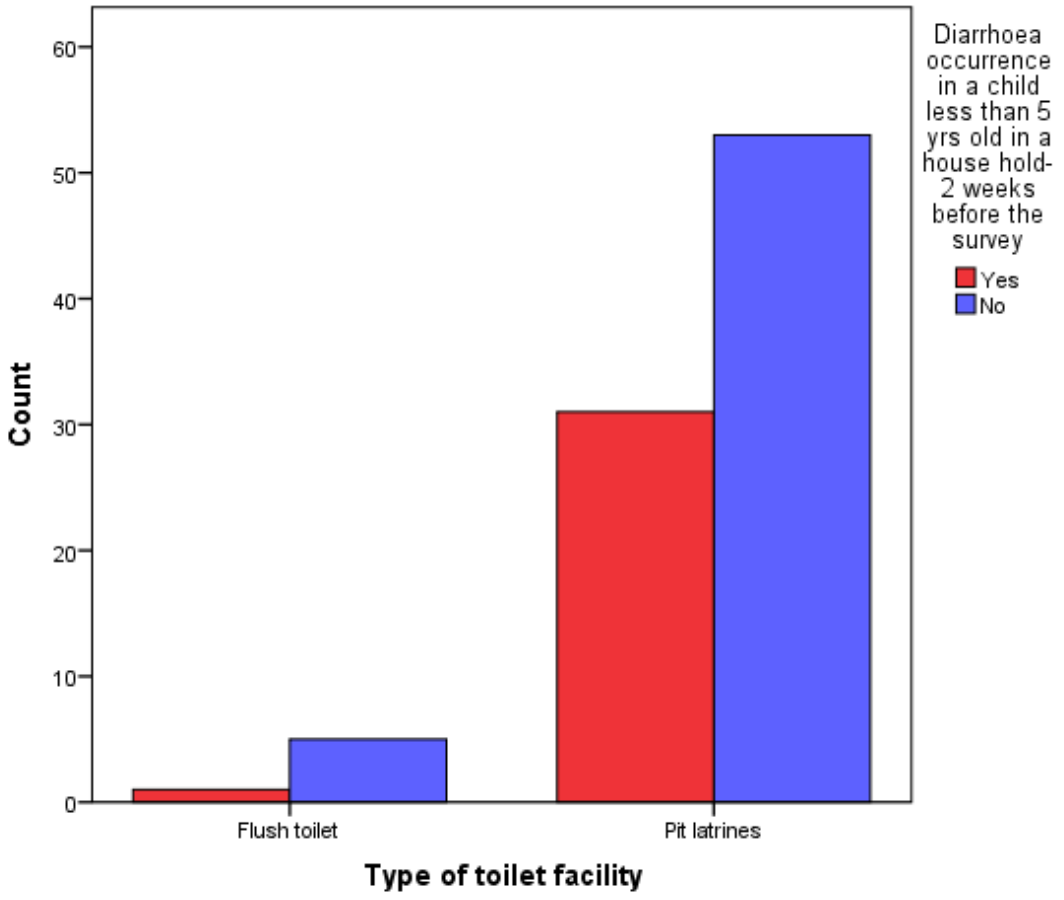
Source: Researcher

Plate 4.5 A photograph showing shared toilet facilities in Korogocho

ii) Type of toilet facility

Type of toilet facility affect the disposal of faecal matter, flush toilets with adequate water is likely to reduce contamination of faecal matter with the surrounding environment while a poorly constructed pit latrine is likely to increase contamination with faecal matter. Type of toilet facility used by the respondents was categorized as either Flush toilets or Pit latrine. No other means of human waste disposal was considered for this study. 93.3% of residents admitted to usage of pit latrines. Most these latrines were poorly constructed and could overflow when full and during rainy season. Only 6.6% reported to have access to flush toilets which suffered from inadequate water supply.

Figure 4.3 Type of toilet facility and occurrence of childhood diarrhoea



Source: Researcher

Plate 4.6 Type of toilet facility in Korogocho; Flush

Plate 4.7 Type of toilet facility in Korogocho; Pit latrine

In regard to latrine cleaning, majority of respondents (61.1%) reported that their latrines were not regularly cleaned mainly because of the high cost incurred to pay the workers to clean them, high cost of water and ignorance. Only 38.9% of respondents reported that their latrines were cleaned regularly or whenever they incurred dirt**.**

Table 4.8 Regular cleaning of toilet facilities

Cleaning of toilet facility regularly	**Total counts**	**Percentage count**	**Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey**	
			Yes	No
Yes	35	38.9	9	26
No	55	61.1	23	32
Totals	90	100	32	58

Source: Researcher

Establishing relationship between cleanliness of toilet facilities and occurrence of diarrhoea in children <5yrs

Cleanliness of toilet facilities was measured by asking respondents whether their toilet facilities were regularly cleaned or not. Since all the cells had values more than five, chi square test was used to analyse data. Data for these variables were put in a contingency table as shown below

Table 4.9 Contingency table for cleaning of toilet facilities and occurrence of childhood diarrhoea

Cleaning of toilet facility regularly and Diarrhoea occurrence in children less than 5 years in a house hold-Cross tabulation for chi square test				
Cleaning of toilet facility regularly		Diarrhoea occurrence in **children less than 5 years** in a house hold-2 weeks before the survey		Total
		Yes	No	
Yes	Observed Count	9	26	35
	Expected Count	12.4	22.6	35.0
No	Observed Count	23	32	55
	Expected Count	19.6	35.4	55.0
Total	Observed Count	32	58	90
	Expected Count	32.0	58.0	90.0

χ^2 =2.421 d=2 p=0.05 Critical value = (5.99)

Source: Researcher

The Chi square analysis for this variable $\{\chi^2 = 2.421\}$, revealed that there was no significant relationship between regular cleaning of toilet facilities and the occurrence of diarrhoea in children below five years. This null hypothesis that there was no significant relationship between regular cleaning of toilet facilities and occurrence of diarrhoea among children below five years failed to be rejected. This test was not statistically significant at p>0.05 and therefore the likelihood that this relationship occurred by chance was high.

Plate 4.8 A photograph showing deplorable condition of excreta disposal in Korogocho

A Pit latrine constructed across a river channel

4.4 Discussion of findings on environmental factors associated with childhood diarrhoea

The discussion of findings done below is based on the study objectives that the researcher set out to achieve. Through this discussion, the study seeks to show the achievement of answers to these questions based on the findings and on literature reviewed for this study.

This study set out to identify the environmentally related risk factors that cause diarrhoea to children less than five years of age. In order to single these out, the study first sought to establish the prevalent environmental risk factors and assess their prevalence within the study area. These environmental risks were categorised into two broad groups thus: household environmental risk factors and community environmental risk factors. Studies conducted in developing countries have focused on socio-economic and environmental variables that can affect the incidence of diarrhoea, particularly housing conditions. The study assessed household environmental risk factors which were considered as factors that emanated from the environment within the dwelling places and its immediate surroundings. The study focused on three house hold environmental risk factors which were contaminated with water supply, sanitation (toilet facilities and disposal of faecal matter) and the general hygiene of the mother. Clearly indicated by these results is the fact that contaminated water, sanitation and hygiene have a high tendency to be environmental risk factors for the diarrhoeal disease burden. This is agreed with a study by Teklemariam , *et al* (2003) from the Republic of Congo which revealed that children coming from households that obtained water from protected sources like treated tap water were less likely to have diarrhoea as compared to those who got their water supply from unprotected sources like open wells. Without clean and safe water, life cannot be sustained beyond a few days and the lack of access to adequate clean and safe water supplies leads to the spread of disease. Children bear the greatest health burden associated with poor water and sanitation

(WHO/UNICEF 2005). Moreover, a study carried out in Tumpat District, Malaysia by (Sabina M.K 1992) also indentified the risk factors for diarrhoea of children under five years as drinking un boiled water, storage of cooked food before consumption, bottle feeding and absence of washing water in latrines. This is because of running surface water which becomes contaminated by poorly disposed human waste. This water collects into collection points and sometimes consumed without treating it. In the context of this study, community environmental risk factors were taken to mean those factors that are borne by individual households by virtue of belonging to that particular community, whereas the household factors were specific to individual households while community factors were shared by all who live within the research area. These were identified as urban outdoor pollution and others. The study found that urban outdoor pollution like overflowing latrines, faecal waste along the footpaths and uncollected garbage is indeed an environmental risk factor. Lopez and Murray 1998 characterise household wastes dumped near social dwellings had potential hazards of transmitting pathogens that can lead to diarrhoea in children. Lopez and Murray 1998 also described insects like house flies from dumpsites usually contaminate water and food which when consumed by young children could lead to diarrhoea. This study established that the prevailing Dandora dump site near Korogocho and rotten agricultural produce in Korogocho market could also contribute to diarrhoea of children.

Having established the environmental risk factors, the study sought to establish which of these risk factors caused a direct relationship with diarrhoea among children below five years of age. This aspect of data captured the essence of the current study. The study found that source of drinking water, access to and sharing of toilet facilities was not related to occurrence of diarrhoea in children less than five years in Korogocho. This meant that water could have been

contaminated during drawing as a result of using dirty containers and mishandling of water already fetched. Poor sanitation and hygiene constituted the greatest household environmental risk factors that cause diarrhoea among children below five years. However no relationship was observed between access, sharing and type of toilet facilities and occurrence of childhood diarrhoea. This could have been as a result of young children not attending toilet facilities but rather using containers at the house and diapers which could later be emptied to the latrines and diapers thrown in the damp pit. According to the World Bank (2011), environmental health risks fall into two broad categories. The first are the traditional hazards related to poverty and lack of development, such as lack of safe water, inadequate sanitation and waste disposal and indoor air pollution. The effects of environmental exposures on health depend on the social settings in which the exposures occur and on individual behaviors. Behavioral risk factors are sometimes closely related to physical risk factors (e.g. hygiene is related to sanitation) and modify the health impacts of the physical risk factors.

The study then examined the community environmental risk factors that caused diarrhoea in children less than five years old within the research area. In this case, the information got from secondary sources found that outdoor land and water pollution was a prevalent cause of diarrhoea infections in children. This fact corresponded to WHO (2002) reports that among the ten identified leading mortality risks in high-mortality developing countries, outdoor land and water pollution are ranked high. The study further established that the nearby dumpsite posed a threat by providing stench and house flies that would likely become a vector for disease, especially diarrhoea.

Access to safe drinking water was a critical variable in this study; childhood diarrhoea occurrence was not related with source of drinking water. There was no significant relationship

found between the two variables (p>0.05) .This could have been due to the fact that different water providers in Korogocho slum could interfere with water either at the point of drawing or during transportation hence contaminating it. Poor storage at homes could have also contributed to this relationship. This means that sources and storage of water did not guarantee water safety. The results from the spot checks also indicated that some pipes which transported water were broken thus contaminating water with either raw sewage or household waste. The reliance on water from venders and water kiosk in Korogocho was however due to a short fall of appropriate water sources. In agreement with the previous study (Roots, G 2001), diarrhoea was independent of source of water supplied to homes which meant that sources of water did not guarantee water safety. In this case the null hypothesis that there was no significant relationship between source of drinking water and the occurrence of diarrhoea among children below five years was failed to be rejected.

Treatment of drinking water have been found to be one of the ways of purifying drinking water by killing germs that might contribute to diarrhoea infections in children. In this study, it was found to be an effective way of reducing incidences of diarrhoea among children below five years. A direct significant association was noted between treatment of drinking water in a household and the occurrence of diarrhoea in children below five years (p<0.05). The common method of water treatment in the study area was found to be boiling drinking water, though some households were noted having used “water guards”. In this case the null hypothesis that there was no significant relationship between treatment of drinking water and the occurrence of diarrhoea was rejected. This meant that households that treated water for drinking were less likely to encounter diarrhoea in children under five years compared to the households that did not treat water for drinking.

In regard to human waste disposal, the study found out that having access to a latrine facility did not guarantee proper disposal since they were inadequate and often overflowing. Among households with or without access to a latrine, childhood diarrhoea morbidity (33.3% and 2.2% respectively) was not statistically different (p>0.05). This could have been due to the fact that even children in the households with access to the latrine were at risk since the surrounding environment was contaminated hence unsafe. This did not concur with the study of Gyimah (2003) on childhood diarrhoea morbidity whose study indicated that having access to a latrine facility ensures proper disposal of human waste. This test failed to reject the null hypothesis that there was no significant relationship between availability of toilet facilities and the occurrence of diarrhoea. More research needs to be done to establish this relationship.

Past studies have shown that the shared toilets in a slum are cleaned and maintained by the tenants. It has therefore been argued by health workers and environmentalist that sharing of toilet facilities is likely to contribute to diarrhoea infection in children below five years. This study did not find any significant relationship between sharing of toilet facilities and diarrhoea infection in children below five years and therefore the null hypothesis failed to be rejected at (p>0.05) significant levels. Cleaning and type of toilet facilities was not found to be related with occurrence of diarrhoea among children below five years and therefore these null hypothesis failed to be rejected in the following levels p>0.05. This meant that the sample size used could have been small to reject the null hypothesis therefore more research needed to be done to establish the cause of this relationship.

According to information from secondary sources, diarrhoea in children under five years was also high in areas where garbage collection was nonexistent and drainage was poor creating an ideal condition for diarrhoea pathogens to multiply. Uncollected garbage was dumped into

drainage ways that were clogged. Inadequate drainage and uncollected waste posed health threat to children who played near the piles of garbage. These conditions provide breeding sites for flies and other insects which carries diarrhoea pathogens from refuse to food and water. These findings were similar to those of K'oyugi 2004 who indicated that poor waste disposal and refuse collection are associated with childhood diarrhoea. Furthermore contaminated community environment following open defecation lead to gross fecal pollution of the neighborhood thus expose children to risk of diarrhoea. Contaminated community environment following open defecation lead to gross fecal pollution of the neighborhood thus expose children to risk of diarrhoea. Similar associations have been reported from Zimbabwe (Root, 2001) although this was not true for Malawi and Zambia (Kendal and Mandise 2003) which indicated that hygiene habits of the care givers can prevent exposure to diarrhoea

4.5 Socio economic factors

4.5.1 Education levels of mothers of children below five years

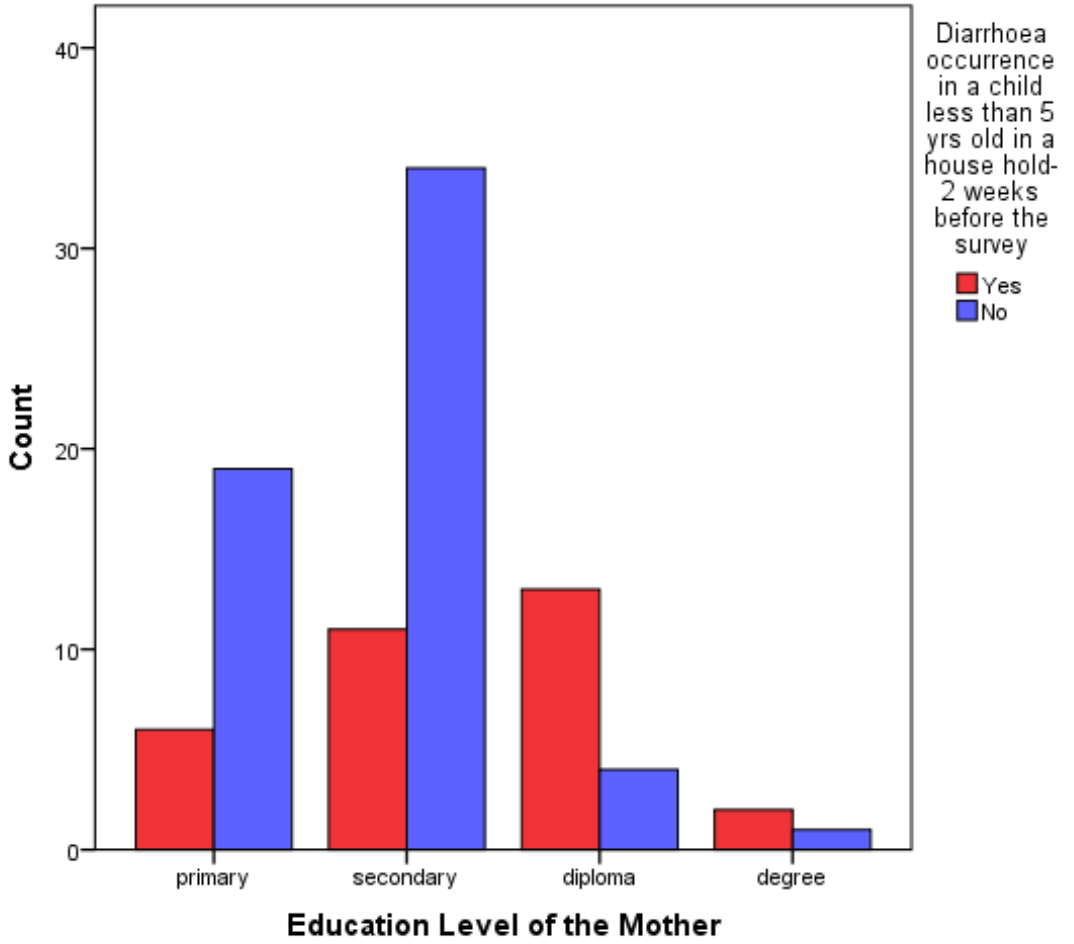
In regard to the education level of mothers, majority of mothers reported to have undergone secondary school and above (72.2%). 27.8% of mothers reported to have attained a minimum of primary education while none reported not to have education at all. The table 4.2 below shows distribution of level of education among the respondents in this study.

Table 4.10 Education level of the mother

Education Level of the Mother	Total count	Percentage count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Primary	25	27.8	6	19
Secondary	45	50	11	34
Post Secondary	20	22.2	13	4
Totals	90	100	32	58

Source: Researcher

Figure 4.4 Education levels of the mother and occurrence of childhood diarrhoea



Source: Researcher

Establishing relationship between level of education of the mother and occurrence of diarrhoea in children <5yrs

Level of education of the mother was classified into four categories: respondents with none meaning those who never went to school at all, Primary level which included those who at least attended primary education, secondary level, Diploma and Degree. Data for Diploma and Degree levels were combined to form post secondary levels. No one reported to have no education at all and therefore this level was excluded in analysis. Since all the cells had values more than five, chi square test was used to analyse data. Data for these variables were put in a contingency table as shown in the table below

Table 4.11 Contingency table for education level of mothers and occurrence of childhood diarrhoea

Education Level of the Mother and Diarrhoea occurrence in children < 5 years in a house hold-2 weeks before the survey -Cross tabulation for chi square test				
Education Level of the Mother		Diarrhoea occurrence in a child (0-60 Months) in a house hold-2 weeks before the survey		Total
		Yes	No	
Primary	Observed Count	6	19	25
	Expected Count	8.9	16.1	25.0
Secondary	Observed Count	11	34	45
	Expected Count	16.0	29.0	45.0
Post secondary education	Observed Count	15	5	20
	Expected Count	7.1	12.9	20.0
Total	Observed Count	32	58	90
	Expected Count	32.0	58.0	90.0

χ^2 =16.728 d=3 p=0.05 Critical value = (7.81)

Source: Researcher

The Chi square analysis for this variable $\{\chi^2 = 16.728\}$, revealed that there was significant relationship between levels of education of the mother and the occurrence of diarrhoea of children below five years. p<0.05 means that an increase in education did not cause a significant reduction in diarrhoea below five years. This could further be interpreted as education alone could not reduce diarrhoea prevalence among children below five years as other factors compounded its occurrence. The null hypothesis that there was no significant relationship between the level of education of the mother and occurrence of diarrhoea in children below five years was rejected.

4.5.2 Hand washing practice by mothers of children under five years

Hand washing practice is a key health behavior that is crucial in attaining better health. This study indicated that child mothers wash hands mainly before eating (57.8%) and after visiting toilets (56.7%). The main concern of these two behaviors is the proportion of mothers who do

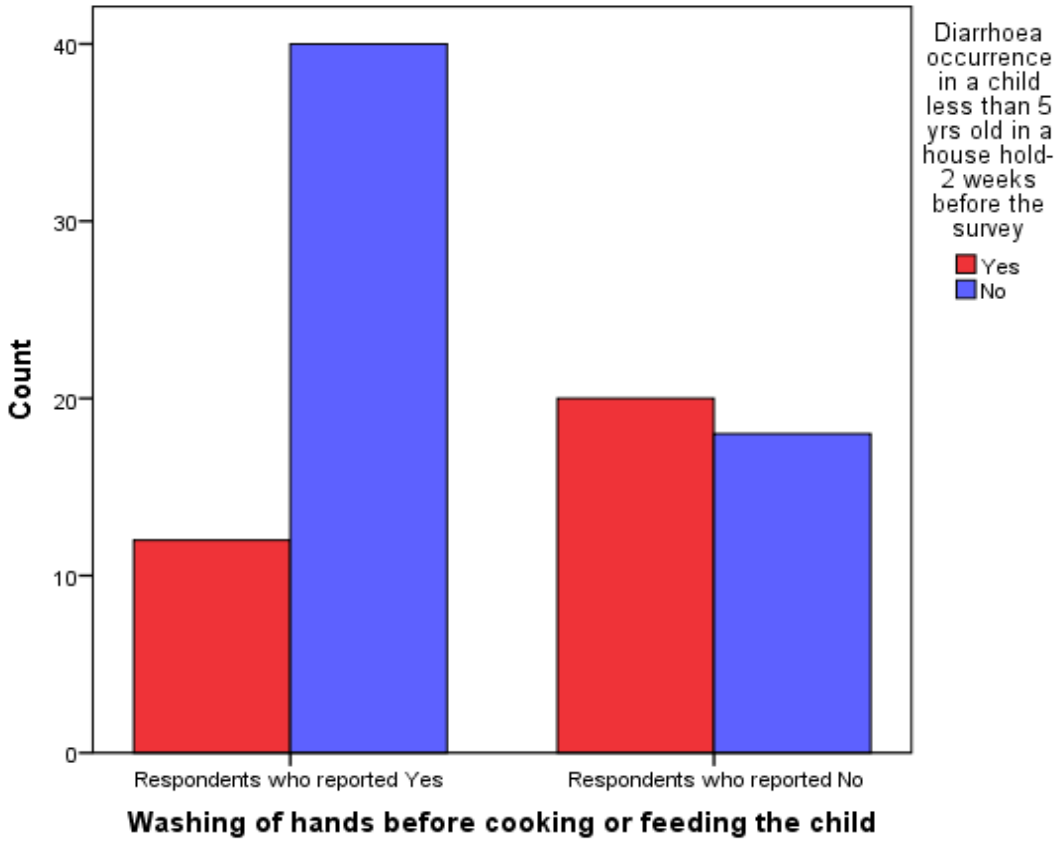
not wash hands after visiting toilets and before feeding because these are the critical times that the likely hood of transmitting germs to the child is high.

Table 4.12 Hand washing practice by mothers of under five years children in Korogocho

Washing of hands before cooking or feeding the child	Total count	Percentage count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Yes	52	57.8	12	40
No	38	42.2	20	18
Totals	90	100	32	58

Source: Researcher

Figure 4.5 Washing of hands by mothers before cooking or feeding the child and occurrence of childhood diarrhoea



Source: Researcher

Establishing relationship between hand washing practice by mothers before cooking and feeding the child and occurrence of diarrhoea in children <5yrs

Washing hands by mothers before preparing meals and feeding the child was considered as one of critical times where diarrhoea pathogens are likely to be transmitted from the mother to the child. This variable was classified into two i.e. those regularly practiced hand washing during this critical time and those who did not. Data for these variables were put in a contingency table as shown in the table below

Table 4.13 Contingency table for hand washing practice by mothers and occurrence of childhood diarrhoea

Washing of hands before cooking or feeding the child and Diarrhoea occurrence children less than 5 years in a house hold -Cross tabulation for chi square test				
Washing of hands before cooking or feeding the child		Diarrhoea occurrence in a child (0-60 Months) in a house hold-2 weeks before the survey		Total
		Yes	No	
Yes	Observed Count	12	40	52
	Expected Count	18.5	33.5	52.0
No	Observed Count	20	18	38
	Expected Count	13.5	24.5	38.0
Total	Observed Count	32	58	90
	Expected Count	32.0	58.0	90.0

χ^2 =8.370 d=1 p=0.05 Critical value = (3.84)

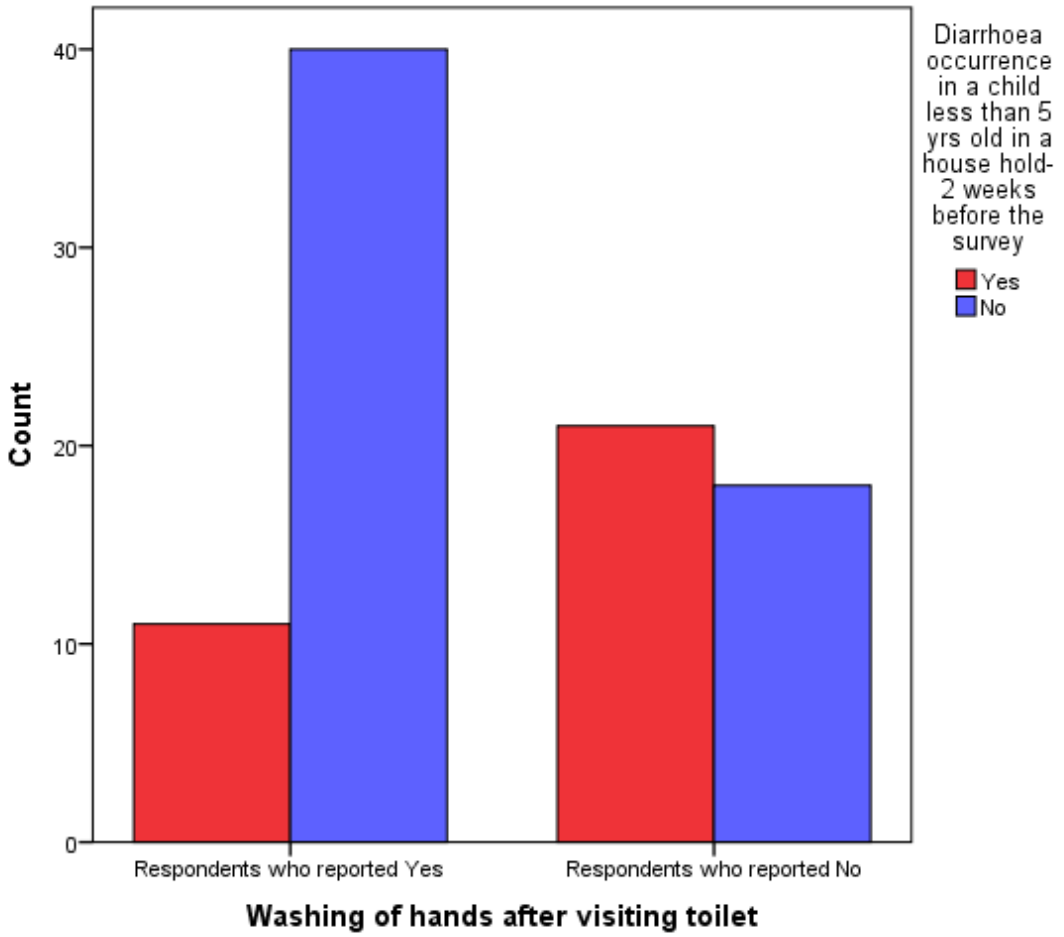
Source: Researcher

Table 4.14 Hand washing practice by mothers of under five years old children

Washing of hands after visiting toilets	**Total count**	**Percentage count**	**Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey**	
			Yes	No
Yes	51	56.7	11	40
No	39	43.3	21	18
Totals	90	100	32	58

Source: Researcher

Figure 4.6 Washing of hands by mothers after visiting toilet and occurrence of childhood diarrhoea



Source: Researcher

Establishing relationship between hand washing practice by mothers after visiting toilets and changing baby diapers and occurrence of diarrhoea in children <5yrs

Washing of hands after visiting toilet and after changing baby diapers was considered as another critical time where diarrhoea germs can be transmitted by mothers to the child. The response was classified into two either those regularly washed their hands during this critical time or those who did not. Since all the cells had values more than five, chi square test was used to analyse data. Data for these variables were put in a contingency table as shown in the table below

Table 4.15 Contingency table for hand washing practice by mothers and occurrence of childhood diarrhoea

Washing of hands after visiting toilet and Diarrhoea occurrence in children less than 5 years in a house hold - Cross tabulation for chi square test				
Washing of hands after visiting toilet		Diarrhoea occurrence in a child less than 5 years in a house hold-2 weeks before the survey		Total
		Yes	No	
Yes	Observed Count	11	40	51
	Expected Count	18.1	32.9	51.0
No	Observed Count	21	18	39
	Expected Count	13.9	25.1	39.0
Total	Observed Count	32	58	90
	Expected Count	32.0	58.0	90.0

χ^2 =10.048 d=1 p=0.05 Critical value = (3.84)

Source: Researcher

The Chi square analysis for these variables $\{\chi^2 = 8.370\}$ and $\{\chi^2 = 10.048\}$ respectively, revealed that washing of hands by mothers of children below five years was found to have a significant relationship to reject the null hypothesis that washing of hands by mothers before handling food and after visiting toilet was not significantly associated with diarrhoea occurrence of children below five years. This relationship could be interpreted that mothers who washed their hands regularly, their children were less likely to experience diarrhoea infections unlike those mothers who did not wash their hands regularly. These tests were statistically significant at (p<0.05) meaning that there results were not affected by any chance of random sampling.

Plate 4.9 Under five years old children seated near uncollected garbage and flowing sewage

4.5.3 Level of income in a household and occurrence of diarrhoea in children <5yrs

Level of income in a house hold was measured by asking the respondents the main source of income in the house hold and the Monthly income the household get from various sources. The income was categorized in bracket as shown in the table below. The main source of income for the respondents was salaried, casual employment and small scale businesses. 69% of respondents reported that the household in which they came from earned less than Ksh 5,000 per month while the rest 31% reported to have an income of more than Ksh 5,000 per month. With the high cost of living such as rent expenditure, food expenditure, water shortage, lack of toilets and health expenditure, it was evident that the low levels of income affected the resident's livelihood and therefore health of children below five years.

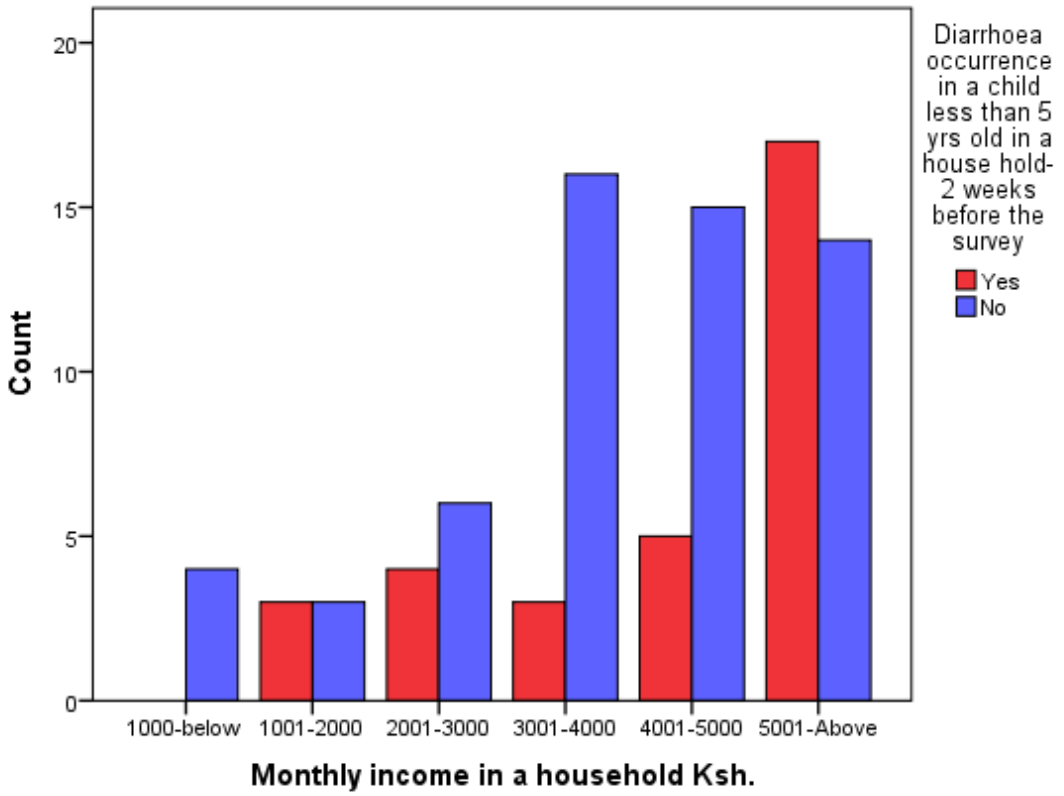
Table 4.16 Level of monthly income in a household

Monthly income in a household Ksh,	Total count	Percentage count	Diarrhoea occurrence in children less than 5 years- 2 weeks before the survey	
			Yes	No
Below 1000	4	4.4	0	4
1001-2000	6	6.7	3	3
2001-3000	10	11.1	4	6
3001-4000	19	21.1	3	16
4001-5000	20	22.2	5	15
5001-Above	31	34.4	17	14
Totals	**90**	**100**	**32**	**58**

Source: Researcher

The study indicated that low household income did not increase the chances of children getting diarrhoeal disease, however a significant relationship was noted between the level of income in a household and the occurrence of diarrhoea in children below five years. This could be explicated by the fact that those earning low income are less likely to afford fee charged on water and pay toilets or to purify drinking water thus being at risk of diarrhoea. The findings concurred with those of Muthee Veronicah (1999), Millard (1994) and Ahmed (1992) who also indicated that household socio economic status is associated with child's survival because it determines the amount of resources such as food, good sanitation and health care given to children.

Figure 4.7 Income levels and diarrhoea occurrence in children under five years old



Source: Researcher

4.6 Discussion of findings on Socio-economic factors associated with diarrhoea occurrence in children under five years

Children health is particularly dependent on the care giver and mostly the mother because she deals with the child most of the times. The poor understanding of transmission of diarrhoea infections and prevention among mothers increases the risks of exposure to infections among children. Childhood morbidity did not decrease significantly with higher education of child mothers though hygiene habit of the mother would be influenced by the level of education. This relationship was illustrated by a significant relationship between the level of education of the mother and the occurrence of diarrhoea in their children below five years of (p<0.05). This could further be interpreted as education alone could not reduce diarrhoea prevalence among children

below five years as other factors compounded its occurrence. It was likely that with little earnings that the household got, they were not able to purchase optimum amount of water to maintain proper hygiene and also to purify drinking water. Similar associations have been reported from Zimbabwe (Matovu, G. 2000),) although this was not true for Malawi and Zambia (Kandak and Mandise 2003) which indicated that hygiene habits of the care givers can prevent exposure to diarrhoea. Mother's knowledge allows them to recognize symptoms and use health services more effectively than their less educated counterparts. Knowledge about the causes of diarrhoea disease is also vital as this directly or indirectly influences the mother's care to the child. This study established that 18.9% of children suffered diarrhoea from mothers who had Diploma education and above.

The study further indicated that low household income increases chances of children getting diarrhoea ($p<0.05$). This could be explained by the fact that those earning low incomes are less likely to afford fee charged on water and sanitation or to purify drinking water thus more at risk. These findings concurred with those of Ahmed, 1992 and K'oyugi, in 2007 who also indicated that household socio economic status is associated with child's survival because it determines the amount of resources such as food, good sanitation and health care that are available to children.

Washing of hands by mothers before cooking and after visiting toilets was also found to be statistically significant to the occurrence of diarrhoea of children less than five years in Korogocho. 21% of diarrhoea occurrence was noted where mothers reported not frequently washing their hands after visiting latrines and 26.7% from mothers who did not wash their hands before cooking and before feeding the child. This study also noted a slight significant association between washing of hands by the mothers after visiting toilet and the level of education. This is due to the fact that mothers with some level of education were aware about the importance of

hand washing compared to those who did not have any educational knowledge. This association was also noted by Veronicah Muthee in her thesis of diarrhoea morbidity in Kibera, 2009.

In regard to socio-economic factors, mother's education also plays a role in the survival rate for children under five years of age. Educated care takers especially mothers allows them to recognize symptoms and use health services more effectively than their less educated counterparts. Knowledge about the causes of diarrhoea disease is also vital as this directly or indirectly influences the care given to the child. Diarrhoea of children under five years was particularly dependent on mothers understanding of transmission of diarrhoea infections among children. This can result in delayed referral to clinics or hospitals thus necessitating hospitalization when diarrhoea becomes severe. Childhood diarrhoea did not decrease significantly with higher education levels though a significant relationship was noted and thus this null hypothesis was rejected. However hygiene habits like washing of hands after visiting toilet of mothers would be influenced by the level of education in which case this test was statistically significant at p>0.05

It was noted that with the little earnings that the household got could not allow them to buy optimum amount of water to maintain proper hygiene and also to purify water. The study further indicated that low house hold income increase the chances of children getting diarrhoea attack. This could be explicated by the fact that those earning low income are less likely to afford fee charged on water and sanitation or to purify drinking water thus more at risk. These findings concurred with those of Ahmed, 1992 and Millard in 1994 who also indicated that, house hold socio economic status is associated with child's survival because it determines the amount of resources (such as food, good sanitation and health care) that are available to children.

Washing of hands by mothers and caregivers is critical after visiting toilet and before handling food for the children. These periods were regarded as critical times in this study. A significant relationship was found between washing of hands by mothers during critical times and occurrence of diarrhoea in children below five years. The null hypothesis in this case were rejected at $p<0.05$ significance levels.

4.7 Evaluating possible interventions to reduce the incidences of childhood diarrhoea

The study then sought to establish the possible interventions that could be adopted to mitigate the effects of environment risk factors for disease burden in such a deprived settlement as Korogocho. These interventions were based on the environmental risk factors identified earlier. These include poor water, sanitation and hygiene, and outdoor pollution. With regard to water, there is need to improve the supply of water to the slum. Clean water should be provided by the City Council to reduce dependency on unclean water which often causes diarrhoea infections in children. Alternatively, the use of boiled water or disinfectants such as water guard to treat the water should be emphasized.

With respect to sanitation and hygiene, the study found that the building of more toilet facilities to improve the disposal of faecal waste was a necessary intervention. This would provide an alternative to the 'flying toilet' phenomenon that is prevalent in such settlements. Moreover, the study found that proper disposal of waste was a vital intervention and that there was need to build more toilet facilities to enhance this disposal of faecal waste. Moreover, regular collection of garbage was necessary in ensuring a reduction in diarrhoea infections among children.

A washing-hands campaign would enhance cleanliness and ensure reduced diarrhoea infection in children. According to Boerma and Ginneken (1996), hygiene and literacy may be closely related. Factors such as washing of hands and covering of food may also be closely related with

diarrhoea morbidity due to increased rate of transmission. A study by Luby et al (2004) in Pakistan showed that effective hand washing was important in control of diarrhoea. Children living in households that received hand washing promotion and plain soap had a lower incidence of diarrhoea. With regard to the community environmental risk factors, the study found that effort needs to be made to provide adequate house hold waste disposal mechanisms. This was an appropriate intervention in terms of outdoor pollution resulting from garbage disposal near the dwellings.

In Korogocho, in spite of the fact that nearly half (48.3%) of the child care takers did not consider their drinking water safe 25% did not do anything to improve the safety of the drinking water. This could however have been due to the additional costs incurred in purifying drinking water. This study further indicated that households that treated water either by boiling or use of "water guards" were less at risk of contaminating diarrhoea

While health regulations requires that one latrine for each family or group not exceeding 6 persons (WHO/UNEP 2013), the current study found that Korogocho was far from the standards. The high population sharing latrines exposed maintenance challenges because of filling very fast. Inadequately equipped to exhaust them due to the high cost exhaustion, some latrines also built near the river are designed to let faecal matter freely flow through drilled holes on the sides of the latrines as a coping mechanisms to counteract filling up of latrines. A study by Grimason (2000) also noted that sharing of latrines is challenging particularly in regard to maintenance and frequency of cleaning. In Korogocho the problem is greatly compounded by inadequate water supplies and prohibitive cost of water. Most of the environmental factors did not yield a significant relationship with occurrence of diarrhoea and therefore the related hypotheses were failed to be rejected. Some of the socio economic factors like level of education, income levels

and behavioural factors like hygiene levels and hand washing practice by mothers were found to have a significant relationship with diarrhoea occurrence of children below five years

Based on the findings, the following measures of managing diarrhoea were evaluated. With regard to water, there is need to improve the supply of water to the slum. Clean water should be provided by the County Government to reduce dependency on unclean water which often causes diarrhoea infections in children. Alternatively, the use of boiled water or disinfectants such as "water guard" to treat the water should be emphasized. With regard to environmental risk factors, the study found that effort needs to be made to provide adequate house hold waste disposal mechanisms. This was an appropriate intervention in terms of outdoor pollution resulting from garbage disposal near the dwellings. With regard to education levels of mothers, though the association with diarrhoea was negative there is need to increase access in education for a girl child. This is because a significant relationship was found between level of education of the mother and hand washing during critical times. Knowledge about initial management of diarrhoea at home is critical before the child is taken to the hospital since diarrhoea causes rapid dehydration which could lead to child death. Well educated child mothers are able to recognize symptoms and seek healthy services more effectively than their less educated counterparts.

Handwashing by mothers before handling food and after visiting toilet was found to have a significant relationship with diarhhea of children below five years, there is therefore the need to promote handwashing campaign in slums and other deprived areas to create awareness on the importance of proper handwashing through mass media, schools and local administration. With regard to handwashing there is also need to provide soaps and disinfectants that can remove dirt and kill germs. With respect to sanitation and hygiene, the study found that construction of more toilet facilities to improve the disposal of faecal waste was a necessary intervention though

having a good toilet only did guarantee diarrhoea freeness among children below five years. However this would provide an alternative to the ‘flying toilet’ phenomenon that is prevalent in such settlements. Moreover, the study found that proper disposal of waste was a vital intervention and that there was need to build more toilet facilities to enhance this disposal of faecal waste

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This study sought to establish the environmental risk factors in diarrhoea prevalence in children in deprived urban settlements, using the Korogocho slum as a case study. In chapter four, the data collected was presented and analysed. In this chapter, the summary of major findings in chapter four was discussed and conclusions and recommendations made based on these findings. The discussion of findings was based on the questions the study set out to achieve.

5.2 Summary of major findings

Prevalence of diarrhoea in Korogocho was found to be 36% which was 5% higher than the previous study that was done by APHRC in 2002 of 31% in a similar environment. Childhood diarrhoea morbidity was found to be independent of the source of water. This could have been due to the fact that different providers supplied water in Korogocho hence improper handling and storage of water could have contaminated it. The results from spot checks also indicated that some water pipes which conveyed water had broken and consequently contaminating water with germs.

In regard to human waste disposal, the study found out that having access to a latrine facility did not guarantee proper disposal since they were inadequate and unhygienic. However among households with or without access to a latrine, childhood diarrhoea was not statistically different. This could have been due to the fact that children in households with access to latrines were at risk due to contaminated and unsafe neighborhood environment. This concurred with the study

of gyimah (2003) on childhood diarrhoea morbidity whose study indicated that having access to a latrine facility ensures proper disposal of human wastes.

Environmental risks were compounded in Korogocho where garbage collection was nonexistent and drainage was poor creating an ideal situation for insects and other disease vectors to thrive. Uncollected garbage was dumped into drainage ways that were clogged. Inadequate drainage and uncollected water posed health threat to children who tended to play near the standing water and drainage ditches. These conditions provided breeding sites for flies and other insects which transmits pathogens from refuse to food and drinking water.

In regard to education level of the mother, childhood diarrhoea morbidity did not decrease significantly with higher education of child mothers. Though hygiene habits of the mother would be influenced by the level of education, it was likely that with little earning those households were not in a position to buy optimum amount of water to maintain proper hygiene and to purify drinking water. This study indicated that low household incomes increase the chances of children getting diarrhoea attack. The findings concurred with similar associations reported from Zimbabwe (Root, 2001) and Ahmed, 1992 who also indicated that house hold socio economic status is associated with childhood health.

Hand washing by mothers during critical times was found to significantly contribute to diarrhoea incidence. This study found out that diarrhoea incidence in children under five years was lower among mothers who washed their hands regularly after visiting latrines and before preparing and feeding babies. Washing of hands was found to be affected by the availability of water in the household and the knowledge of diarrhoea preventive measures among mothers of under five years of age.

5.3 Conclusions

Based on the discussion above, several conclusions can be drawn from the findings of the study. Firstly, it can be concluded that not all household environmental risk factors are the principal causes of diarrhoea among children aged under five years. This is because not all these risk factors are continuously in contact with such children. The environment in the household is a determinant of the health levels in the household. The lack of hygiene, clean water, and proper sanitation all contribute in making children susceptible to diarrhoea infections.

Secondly, the study concluded that community environmental risk factors complemented the household environmental risk factors in enhancing the incidence of diarrhoea among children under five years of age. The presence of faecal deposits all over the immediate environment of the households in the study sample and the presence of a dumpsite nearby contribute towards the enhancement of diarrhoea infections in children. Arif and Ibrahim (1998) found out that sanitation facilities like toilets and latrines are closely related with the occurrence of diarrhoea of under five years children. The better the sanitation facilities, the less likely the child is to get the diarrhoea disease. These facilities in most parts of the country are far from satisfactory. Improvements in the existing poor sanitation conditions can bring about a significant drop in the incidence of diarrhoea.

Thirdly, this study concludes that diarrhoea infections in children under five years have significant impact on families of these children. The incidence of diarrhoea causes an increase in poverty as a result of increased cost of medication. In Korogocho, the indicators for water and sanitation conditions in the home and community environment depicted shortage and exposed children to pathogens and pollutant risks. The lack of convenient and affordable access to water has left residents to buy water from the vendors or walk long distances to public supply sources.

According to secondary sources of data, the cost incurred in purchasing, storing or purifying water was higher for households with low income earnings hence reducing the food budget which affects health particularly for the vulnerable children. Point of use treatment of water in the houses using "water guards" seem to provide safety to the drinking water as an alternative to boiling of drinking water. Indeed, repeated attacks of diarrhoea signify poor hygienic standards.

The indicators for provision of sanitation facilities similarly indicated shortage. Inadequate latrines and open defecation practice compounded by unhygienic behaviours at the household and community level created a hazardous environment. Latrines in Korogocho did not provide an adequate solution to the excreta disposal needs as they are not accessible at crucial times and also poorly maintained. Following unhygienic disposal of excreta in the homes and community environment, children who normally have the drive to play and expose themselves in the community were more likely to come into contact with these excreta exposing them to risk of diarrhoea.

Secondary data revealed that living in overcrowded conditions is significant factor leading to childhood diarrhoea illness in Korogocho slum. Overcrowded conditions are mainly because of the cost of housing and large family sizes. The findings from similar studies that sought to investigate the relationship between demographic factors and diarrhoea morbidity among the under five years indicates that diarrhoea morbidity was significantly higher among households with large size of family members (four people or more). This study established that the socio-economic factors or variables also contribute to childhood diarrhoea morbidity in the slum which is characterized by multitude of problems including poverty among residents. Household income is low and the rate of unemployment is rampant with many of residents depending on casual

jobs. With low income earnings, the resources including food, good sanitation and health care especially for children under five years are inadequate.

The findings in this study lead to a conclusion that inadequate water and sanitation results in higher prevalence of childhood diarrhoea morbidity in Korogocho slum. This is accompanied by inappropriate hygiene behaviours, overcrowding and poverty which predispose children to more risk of diarrhoea illness. The interactions between multiple risk factors and diarrhoea morbidity are however complex within the context of home and environment which goes beyond access to water and sanitation. This complex relationship was also noted by Briggs 2003 in his complex theoretical model

5.4 Recommendations to Policy makers and Government agents

Following the conclusions above, the following recommendations were made:

1. There is need to institute deliberate interventions by Nairobi County Government to provide slum dwellers with clean water and sanitation facilities to ensure safe disposal of faecal and solid waste.
2. The environmental considerations need to be seriously adopted by the County and central Governments to ensure safer settlements free from pollution.
3. Provision of clean and quality drinking water should be a pre-requisite to the lives of people living in urban poor environment by County and central Governments.
4. The Government and other stake holders should ensure that the residents have got clean and proper toilet facilities to minimize the risks of children contaminating diarrhoea.

5.5 Suggestions for Further Research

The issues that arise out of this study are many and they can be the subject of serious research. These issues include studying the impact of such factors on the disease burden in deprived settlements. Further research may also be carried out on interventions that can be made to cushion children from being adversely affected by environmental risk factors.

The study also calls for further research pertaining to the use of water guard in treating drinking water in Korogocho slum. There is a need to undertake a study with a view to measure the effectiveness, appropriateness and affordability of use of “water guards” as a way of treating drinking water. Moreover it is important to find out whether people are aware of an effective basic home treatment of drinking water as well as feasibility of introducing eco toilets in the region.

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APPENDIX A: SAMPLE QUESTIONNAIRE

Code._____
Date._____

INTRODUCTION

I'm David Ikua Muriithi, a student at the University of Nairobi Pursuing a degree in Master of Arts in Environmental Planning and Management. The purpose of this study is to assess risk factors or determinants of diarrhoea among children under five years in Korogocho residential Zone. I'm therefore requesting you to give me attention and answer the following questions.

CONFIDENTIALITY AND VOLUNTARY PARTICIPATION.

Effort will be made to keep your personal information confidential. Your participation in this exercise is voluntary.

BENEFITS

You will be given information regarding prevention of future reoccurrence of diarrhoea. The results obtained from this study may be used to effectively manage the disease.

PROBLEM OR QUESTIONS

If you have any problem or question about the research study, you should contact; David Ikua Muriithi- 0723 871 745

Demographic Data

1. Age of the Mother in yrs (Tick appropriately)

15-19	
20-24	
25-29	
30-34	
35-39	
40-44	
45-49	
50+	

2. Area of Residence/Name of the village_____
3. Duration of residence in years_____
4. Number of occupants in the house_____

Background information and socio-economic status

5. What is your level of education (Tick appropriately)

Parent	Formal education level				
	None	Primary	Secondary	Diploma	Degree
Mother					

6. a) What is your main source income?

b) What is your monthly income in a household (in Ksh.)

1000-Below	
1001-2000	
2001-3000	
3001-4000	
4001-5000	
5001-Above	

Water supply and hygiene practices

7. Where do you get water used in the home; Stand pipes ( ) Water kiosks ( ) Vendors ( )
8. Do you boil or treat water for drinking; Yes ( ) No ( )
9. Do you always wash your hands before cooking or feeding the baby Yes ( ) No ( )

Latrines/Toilets and Excreta Disposal

10. Do you own a latrine/Toilet Yes ( ) No ( )
11. Do you have access to Latrine/toilet facility; Yes ( ) No ( )
12. Which type of disposal system do you use; Flush ( ) Pit latrine ( )
13. How many people use the latrine/toilet facility_____
14. Is the toilet regularly cleaned; Yes ( ) No ( )
15. How do you dispose of children's faeces; Latrine ( ), Open yard ( ), Open drains ( ), others specify_____
16. Do you think that young children's faeces are harmful in any way; Yes ( ), No ( ), Don't know ( )
17. If yes how? Explain_____
18. Do you always wash your hands after visiting the toilet; Yes ( ) No ( )
19. If no in 18 why? _____

Childhood diarrhoea (less than five years)

20. What is the age of the child in Months_____
21. Has the child had diarrhoea in the last two weeks? Yes ( ) No ( )
22. Does the child have any other disease/medical complication_____

End

APPENDIX B: CHI SQUARE DISTRIBUTION TABLE USED IN THIS STUDY

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of x^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57
22	9.542	12.338	14.041	17.240	21.337	26.04	30.81	33.92	40.29
24	10.856	13.848	15.659	19.037	23.337	28.24	33.20	36.42	42.98
26	12.198	15.379	17.292	20.843	25.336	30.43	35.56	38.89	45.64
28	13.565	16.928	18.939	22.657	27.336	32.62	37.92	41.34	48.28
30	14.953	18.493	20.599	24.478	29.336	34.80	40.26	43.77	50.89
40	22.164	26.509	29.051	33.660	39.335	45.62	51.80	55.76	63.69
50	27.707	34.764	37.689	42.942	49.335	56.33	63.17	67.50	76.15
60	37.485	43.188	46.459	52.294	59.335	66.98	74.40	79.08	88.38

NB: When the computed χ^2 statistic exceeded the critical value in the table for 0.05 probability levels, the null hypothesis of equal distribution was rejected. Likewise when the computed χ^2 statistic fell below the predetermined alpha level of significance (0.05), the null hypothesis of equal distribution failed to be rejected.