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THE EXTENT TO WHICH THE HOUSING ENVIRONMENT IS A CONTRIBUTOR TO CHILD MORBIDITY IN NAIROBI AND ITS POLICY IMPLICATIONS

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DECLARATION

I, Otieno Raymond Otieno declare that this thesis is my original work and has not been presented in this or any other university for the award of degree.

Candidate

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This thesis has been submitted for examination with our approval as university supervisors

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I would like to thank my friends and my family who gave me a lot of moral encouragement through this journey.

May the LORD God Almighty Bless you all.

DEDICATION

To my family and friends whose encouragement I treasure.

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ABSTRACT

Provision of adequate housing is a major challenge in many urban areas of the developing countries. In Kenya, the housing problem in major cities is exacerbated by rapid growth of the urban population without the corresponding expansion in housing provision. Nairobi, the capital city, has been the most affected with a large proportion of the population living in housing conditions characterized by poorly built physical structures, inadequate services and overcrowding. These conditions have health implications on the city residents as morbidity rates stemming out of housing environmental conditions are on the rise.

This study examines the extent to which the housing environment is a contributor to child morbidity in Nairobi. It study examines relationship between the housing environment and the two morbid conditions that are the leading causes of death in early childhood i.e. Diarrhea and Acute Respiratory Infection (ARI). The study's main objective is to investigate the relationship between the housing environment and prevalence of child morbidity in Nairobi. In this regard, the study establishes the prevalence rate of diarrhoea and acute respiratory infection, vis-à-vis housing conditions in Nairobi and, secondly, it assesses the relationship between housing conditions and these forms of child morbidity in Nairobi.

The analysis in this study is based on a sample of 432 children under the age of five in Nairobi from 2003 Kenya Demographic and Health Survey (KDHS). This study utilizes descriptive statistics and cross tabulations to compare prevalence rate of these forms of child morbidity vis-à-vis housing conditions. In assessing the nature of the relationship between the housing and the morbid conditions this study utilizes logistic regression modeling.

Results show lower prevalence rates of diarrhoea among children who live in housing which have water piped into dwelling, housing which have flush toilets, and housing having non-earthen floors. Results also show low prevalence rates of ARI among children living in housing that have non-earthen floors. Further analysis using logistic regression modeling at the multivariate level reveal that the type of floor and type of sanitation facility used in a dwelling are significant predictors of diarrhoea among children under the age of five. Children living in housing with non-earth floors are 71 percent less likely to have diarrhoea when compared to those living in housing with earthen floors. Also, children living in housing where sanitation is in the form of flush toilets are 57 percent less likely to have diarrhoea compared to those living in housing environments where the sanitation facilities are pit toilets (traditional pit latrine and ventilated improved pit latrine). In the case of ARI, the type of floor is a significant predictor with children living in dwellings that have non-earth floors being 63 percent less likely to have ARI compared to those residing in dwellings where the floors are earthen.

Findings of this study open up an area that has not been explored very much in the developing countries in regard to the mitigation of child morbidity. The overall housing environment plays an important role in health improvement. However, many programs aimed at reducing there prevalence of disease (for instance of diarrhoea) have predominantly targeted only the services in housing (e.g. water and sanitation) to the neglect of other crucial aspects. This study gives a justification to go beyond what traditionally or universally regarded as "improved" provision of water or sanitation by international agencies and governments. It also highlights the importance of physical attributes of the housing as indicated by the type of floor material which is often ignored in

intervention programmes yet these too are significant as clearly shown by this study. Non-earth floors such should be viewed as a health measure.

CHAPTER ONE

1. INTRODUCTION

1.1. Background to the Study

Infants and young children under the age of five compose the most populous age bracket in Kenya. This group constitutes 14.2 percent of the population in urban areas. This cohort is by far the most vulnerable to health risks within the immediate family and the community environment. Statistics indicate that infant mortality rate is 61 deaths per 1,000 live births while under five mortality is 93 per 1, 000 live birth in urban areas. This means that almost one in every ten children born in urban centers in Kenya dies before attaining his or her fifth birthday. In Nairobi, the statistics for infant mortality rates and under-five mortality rates are slightly higher at 67 and 95, respectively. (Central Bureau of Statistics [CBS] et al., 2004).

The ability to survive the first few years of life and the quality of that survival is a function of many environmental and social stresses that impinge upon the individual child beginning during pregnancy and continuing through infancy and childhood. Ministry of Health (2004) records that most of the deaths in children aged below five years are due to five illnesses namely pneumonia, diarrhea, malaria, measles and malnutrition.

This study covers Nairobi (the capital city of Kenya) and focuses on two morbid conditions that are the leading causes of death in early childhood i.e. Diarrhea and Acute Respiratory Infection (ARI). These morbidity conditions are major contributors to child mortality in the Sub-Saharan countries and other developing countries. According to World Health Organization (1996), in the African region, diarrhoeal diseases are still leading causes of mortality and morbidity in children under five years of age. UNICEF and WHO (2003) point out that diarrhea kills two million children in developing countries

every year. Martinez et al (2008) give estimation that in urban areas in Kenya the percentage of children under the age of five with diarrhea in the year 2003 was 17 percent.

ARI is a dominant infection cause of severe morbidity and mortality in childhood; ARI accounts for about 17 percent of mortality in children under the age of five (UNICEF, 2009). World Bank (1991) state that a typical child appears to have around ten episodes per year and a 25 percent chance of having an ARI on any particular day. ARI may be responsible for 30 percent of visits and admission by children to a health facility. In Kenya, Martinez et al (2008) also say that 16.4 percent of children were recorded to be with ARI in 2003.

The focus on an urban setting is borne out of the assumption that children living in urban settings have long been considered better off in terms of their health and survival, but this urban advantage has declined in some areas and is increasingly being called into question. Sheridan (2005) alludes to the fact that children who live in poor urban settlements face some of the most difficult environmental conditions with regard to housing, and investigations of health differentials reveal that child mortality and morbidity rates in these settlements can equal or exceed those in rural areas.

It is for this reason that this study proposes to explore and analyze the impact of the housing characteristics on the above mentioned child morbidity conditions (viz. Diarrhea and ARI) in Nairobi.

1.2. Problem statement

The housing environment sustains human life. On the other hand, the housing environment is also a profound source of ill health for many people. Lubell et al (2007) found that young children spend most of their time at home than adults and are more vulnerable to the

many environmental threats in the home. Chaudhuri (2004) also alludes to the same; he says that the housing environment carries the biggest risks to health of people at large especially to children who spend more that 90 percent of their time in the household environment—a likely exposure to hazardous substances. In the developing world, childhood diarrheal disease and acute respiratory infections represent a large portion of the global burden of diseases and are strongly related to housing conditions. According to World Resources Institute (1999), in the least developed countries, one in five children do not live to see their fifth birthday because of avoidable health threats posed by the environment.

Throughout the developing world, the greatest environmental health threats tend to be those closest to home. Many in these countries live in situations that imperil their health through steady exposure to biological pathogens in the immediate environment. Hundreds of millions of others, both children and adults, suffer ill health and disability that undermine their quality of life and hopes for the future because of threats to health posed by the housing environment. These environmental health threats - arguably the most serious environmental health threats facing the world's population today - stem mostly from traditional problems long since solved in the cities of wealthier countries. Such include : lack of clean water, sanitation, adequate housing, and protection from mosquitoes and other insect and animal disease vectors. Lack of adequate sanitation and waste collection often leads to improper disposal of feacal matter and other waste thus providing successful breeding places for houseflies and rodents. Such conditions have the effect of increasing diarrheal incidences. Overcrowding substantially increases the risk of disease transmission and multiple infections. A study conducted by UN-Habitat confirmed that infectious diseases are likely to thrive in overcrowded and low income households, owing to lack of ventilation, lack of hygiene and exposure to environmental contaminants (UN-

HABITAT, 1995). Studies have shown a connection between overcrowding and infection of children by diseases such as tuberculosis and bacterial meningitis infection. Compounded with other factors such as cooking fuel, parental bronchitis and parental smoking, overcrowding has a significant contribution to respiratory infections in children (UK Office of the Deputy Prime Minister, 2004). Physical attributes of housing also matter a building materials may fail to provide adequate insulation and protection from weather changes. In Bariloche, Argentina, insufficient protection against excessive cold resulted in a series of illnesses such as colds, pharyngitis, and neuralgia (Abaleron, 1995).

Devas and Rakodi (1993) pointed out that the challenges facing urban managers in Kenya are numerous and include demographic pressure, inadequate infrastructure, inadequate capacity and resources for service delivery among others. Various urban areas have housing environments that is characterized by overcrowded dwellings (in terms of the number of occupants), lack of piped water within the dwelling, non hygienic ways of disposal of human excreta, dwellings made of rudimentary materials that compromise on hygiene (e.g. earthen floors) or materials that are not able to shield from adverse weather conditions.

This research examines the impact of key elements in housing environment in Nairobi on the prevalence of two common child morbidity conditions viz., diarrhea, and acute respiratory infection.

1.3. Objectives

To investigate the relationship between the housing environment and prevalence of child morbidity in Nairobi. This study shall confine the *housing environment* to water, sanitation, physical (structural) qualities of housing structures as indicated by type of material used in floors, quality of living spaces (overcrowding).

Specific objectives:

- To establish the prevalence rate of diarrhoea and acute respiratory infection vis-à-vis housing conditions in Nairobi
- To assess the relationship between housing conditions and child morbidity (diarrhoeal morbidity and acute respiratory infection) in Nairobi
- Subsequently give recommendations for policy makers as well as identify gaps for future research.

1.4. Hypothesis

There is a significant contribution by the housing environment to prevalence of child morbidity in Nairobi

1.5. Justification of the study

Infant and child mortality rates are basic indicators of a city's or country's socio-economic situation and quality of life in a more sensitive way than adult mortality. Reducing child morbidity has a consequence of saving lives of children which in turn means saving the manpower for future and for the prosperity of the city and ultimately the nation. It is therefore imperative that appropriate policy measures for reducing child morbidity and mortality are adopted and implemented both at the city level and at the national level.

This study of child morbidity in the city of Nairobi is useful as it analyzes key variables in the housing environment and their relation with the prevalence rates of the morbidity conditions in question. Such knowledge forms a suitable basis on which evidence-based appropriate policy measure and programs for improving housing conditions and reducing child morbidity can be developed in order to increase the survival chances of children in the City of Nairobi.

Therefore, this study is essential as it points out with comprehensive evidence the relationship that exists between the housing environment and child morbidity in Nairobi. The study ,in this respect, will provide the necessary database for future reference and the relevant information for policy makers by identifying housing environment variables that increase the risk of children having ill-health thus allowing policy makers, programme planners, and players in the construction industry to direct resources to improve health outcomes and consequently child survival. This study will therefore provide a basis for policy makers and urban managers for exploring an integrated policy that appreciates and encompasses the housing environment and its contribution to health

1.6. Scope and the limitations of the Study .

This study is limited to Nairobi. This is the largest urban centre in Kenya. The study focuses on investigating of the relationship between the housing environment and child morbidity in this setting. The study also focuses on children under the age of five. Despite the fact that there could be several factors affecting child morbidity, this study shall confine itself to the housing environment by looking at the following key variables: water, sanitation, physical quality of housing as indicated by the type of floor, quality of living spaces /sufficient living area as already mentioned. Additionally, this study does not delve into the etiological aspects of these morbid conditions.

Due to the constraints of time and resources, it was not possible to conduct survey of Nairobi to collect data. The researcher therefore relies upon the Kenya Demographic and Health Survey (KDHS) 2003 datasets. These are existing datasets acceptable for research purposes. The 2003 KDHS is the latest in a series of national level population and health surveys to be carried out in Kenya in the last three decades. The KDHS is designed to provide data to monitor the population and health situation in Kenya and among others things it examines the basic indicators of child health in Kenya. Given that the research

relies upon an existing dataset collected for other purposes other than the research objectives at hand. This has limited the variables available for study to the ones mentioned above[1].

1.7. The Study Area

Nairobi is the capital city of Kenya. For administrative purposes, the City of Nairobi as three districts and is divided into eight divisions: Kasarani, Embakasi, Westlands, Central Nairobi, Pumwani, Makadara, Dagoretti and Kibera as shown in Map1.

The City of Nairobi occupies an area of 696 km2 (268.7 sq mi). Although it covers only 0.1 per cent of Kenya's total surface area, Nairobi has about eight per cent of the Country's total population (3.36 million)[2]. The city's overall population density currently (2010) is estimated at around is estimated at 4832 per square kilometre[3]. The population density of Nairobi varies significantly from extremely high in the Kibera divisions to very low in the upmarket residential area of Muthaiga in Westlands divisions see Map 2. Nairobi Urban Sector Profile by UNHABITAT gives a picture of this. Kibera has density 49,228 persons/Km2) whereas Muthaiga in Westlands division has a density of 481 persons/Km2. (UNHABITAT, 2006). It is estimated that 60 per cent of the city's official population live in informal and often precarious settlements but occupying only 5 percent of the residential area of the city (Syagga, *et. al* ,2001).

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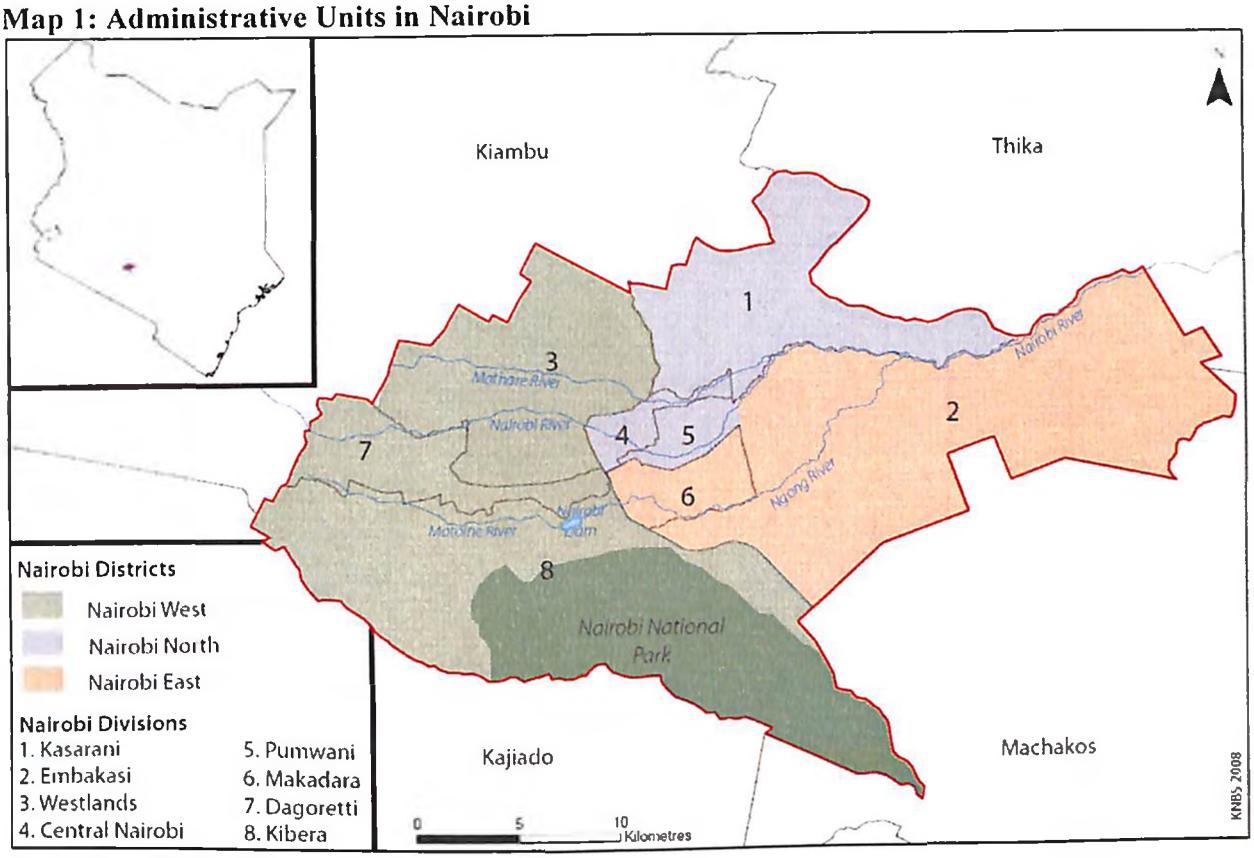
[1] In regard to the physical attributes of housing the available datasets does not contain important variables such as type of walls. The variable in the datasets which is important to this study is *the type of floor*. In this study this variable has been is dichotomized as earthen and non-earthen. This study, however, does delve into the intricate construction details of housing or behavior of material.

[2] Calculated by the researcher using data from Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision*, http://esa.un.org/unup.

[3] Calculated by the researcher using by dividing the population estimate (from *World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision*) by the total area of Nairobi

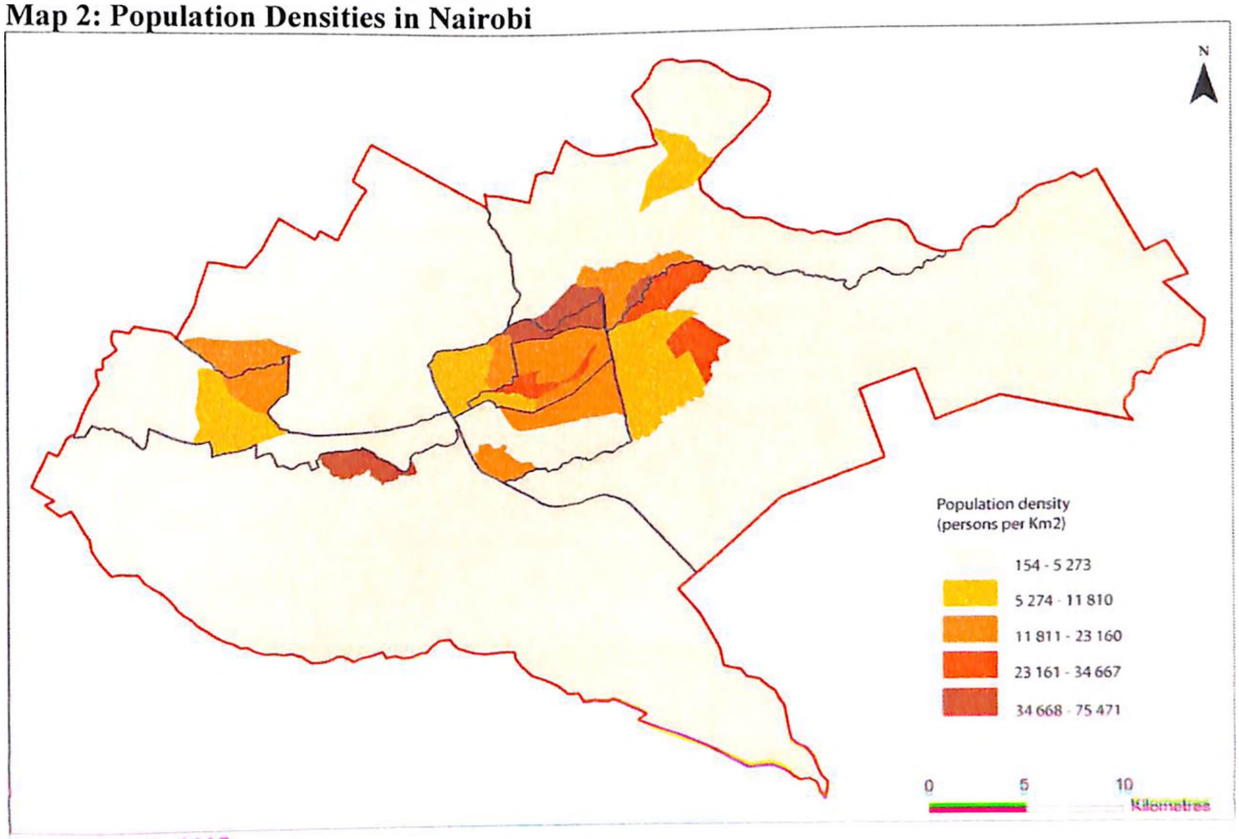
According to the 1999 Kenya Population and Housing census, children under five years of age comprised 13.6 percent of the population in Nairobi (Central Bureau of Statistics, 2001).

Map 1: Administrative Units in Nairobi



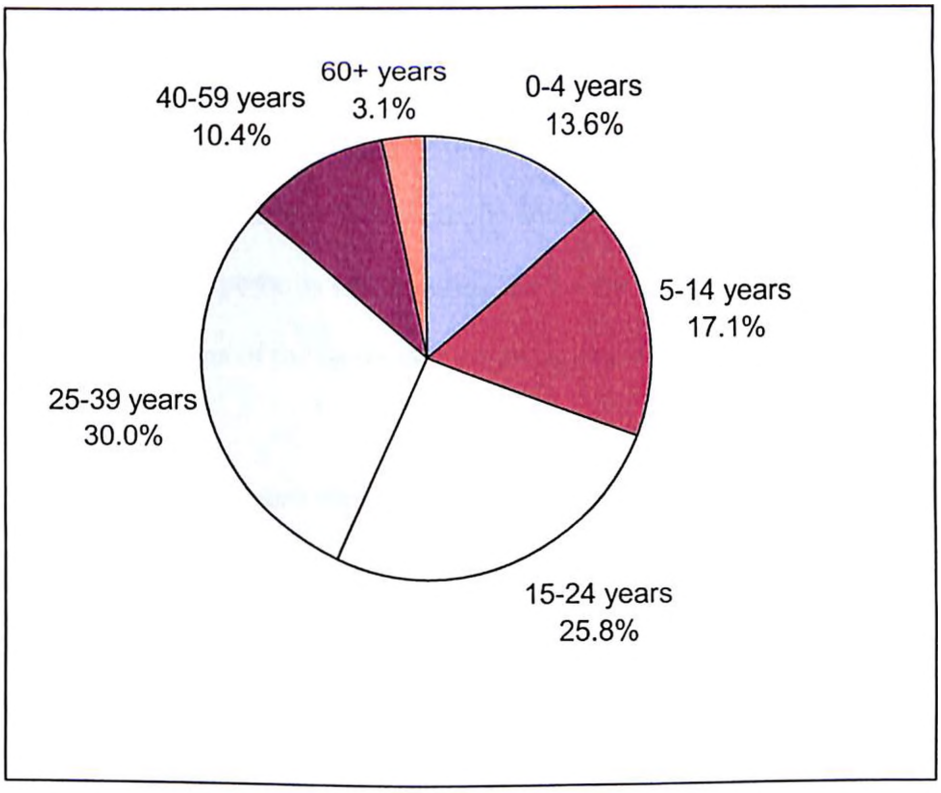
Source Kenya National Bureau of Statistics, 2008

Map 2: Population Densities in Nairobi



Source: UNEP, 2007

Chart 1: Percentage distribution of Nairobi's population by age



Source: Central Bureau of Statistics, 2001

1.8. Outline of Chapters

This study comprises the following group of chapters geared toward achieving the objectives:

Chapter One: Introduction to the study

This chapter gives an introduction to the study and presents the problem statement. It gives the objectives, hypothesis and justification for the study. This chapter also gives the scope and the limitations of the study and the background information of the area of study.

Chapter Two: Literature Review and Theoretical Framework

This chapter reviews a variety of literature that link child health and morbidity to the housing fabric. It gives a justification for assuming that there is a link between housing and child morbidity. It then proceeds to look at relevant studies of a similar nature undertaken in the Nairobi context and the country and the approaches used. Lastly,

Chapter Three: Research Methodology

This chapter presents the research philosophy subscribed to, the research methods employed in this study in the pursuit of the research objectives. It gives a theoretical framework for this study. It then delves in to the description of the data used the definition and operationalization of variables, and the formulation of the empirical model to be used.

Chapter Four: Data processing, Presentation and Data Analysis

This chapter presents the empirical analysis of the study on the extent to which the housing environment is a contributor to child morbidity in Nairobi. The results of the data analysis are presented and discussed in this chapter.

Chapter Five: Conclusion and Recommendations

This chapter summarizes the whole research, outline major findings and make conclusions based on the findings. Recommendations for policy are also given in this chapter

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Introduction

The protection of public health is a crucial element in the management of sustainable urban communities. This is because the quality of the city dwellers' health has a direct impact on their productivity, social cohesion, economic prosperity and generally overall happiness. Good health not only allows for full participation in the social, economic and recreational opportunities found in cities but it is also is a mark of sound urban management and quality public policy. On the other hand, as literature shows, poor health has negative effects, especially to infants and the very young are particularly vulnerable to illness and diseases because of their developing nervous and immune systems and their inability to avoid dangerous situations or environmental hazards (Oruamabo, 2005). The diseased state in children can lead to death; it also has the potential of constraining full psychological, emotional and physical development thus placing obstacles to their chances success later in life. The household cost-of-illness in children is evident especially too poor urban households who are often victims of catastrophic financial consequence of illness. Additionally, loss of man hours in productive economic activities while attending sick children is also another consequence that impacts the economy of the city and the nation at large.

This chapter reviews a variety of literature that link child health and morbidity to the housing fabric predominantly from an urban context presenting the most recent scenario by examining literature linking housing and health from studies done in both the developed and developing world. It gives a justification for assuming that there is a link between housing and child morbidity. It then delves into various researches that have been done linking some of the morbid conditions (diarrhoea and ARI) with urban infrastructural

services as well as other socio-economic and behavioral determinants identified to be to be having an impact on the health status of children under the age the of five years. It then proceeds to look at relevant studies of a similar nature undertaken in the Nairobi context and the country and the approaches used. Lastly, it gives a theoretical framework for this study

2.2. Housing and Health

The probable relationship between housing and health inequality particularly in the inner city neighbourhood has been acknowledged for some time. Tibaijuka (2009) says "Housing and associated services are essential for both production and human welfare, particularly health". She goes further to explain that early housing policies in several developing countries were shaped by various health considerations, even though much of the concerns was to prevent the spread of disease to high-income areas. Citing Ghana and Nigeria where the earliest form of interventions in the housing systems came in the form of public health legislations, she goes further to state that subsequent housing policies and programmes in the late 1940s and early 1950s recognized housing as one of the environmental factors that affect health. This recognition of the connection between improving the housing- urban environment and controlling disease followed the outbreak of the bubonic in early 1950s plague which claimed several lives (Tibaijuka, 2009)

In developed countries such as the United States of America, this recognition seemed to have occurred earlier. Breysse *et al.* (2004) in a sequential manner allude to the interventions and initiatives set up to address housing and health issues. They state that in 1938 the American Public Health Association addressed housing and health in the report *Basic Principles of Healthful Housing*. In 1971, the association identified knowledge gaps with respect to health, including the need to "understand and assess better the relative

effects on humans the various stresses that may exist in the housing environment". Breysee *et al.* (2004) also mention a renewed appreciation for the housing and health connection led to the United States' department of Housing and Urban Development (HUD) to implement the Healthy Homes Initiatives in 1999.

Although measuring the direct impact of housing quality on health was a difficult task, Takano and Nakamura (2001) estimated that indices of urban residential quality explained up to 25 percent of the variability in health status in Japan. Indeed, a substantial body of literature demonstrates poor housing can contribute to ill health – both directly because of environmental hazards and indirectly (e.g. by contributing to psychological stress that exacerbates illness). Krieger and Higgins (2002) allude to the fact that housing conditions are associated with a wide range of health conditions including respiratory infections, asthma, lead poisoning, injuries and mental health disorders. They go further to state that addressing housing issues offers public health practitioners an opportunity to address an important social determinant of health. With regard to *infectious diseases*, Krieger and Higgins (2002) state that overcrowding is associated with the transmission of tuberculosis and respiratory infections; the lack of housing and overcrowding found in temporary housing for the homeless also contribute to morbidity from respiratory infections and activation of tuberculosis. As far as *chronic diseases* are concerned, substandard housing (damp, cold and moldy housing) is associated with asthma and other chronic respiratory symptoms even after potentially confounding factors such as income, social class, smoking, crowding and unemployment are controlled for. Verhoeff *et al.* (1995) allude to the fact that damp houses provide a nurturing environment for mites, roaches, respiratory viruses, and mould, all of which play a role in disease pathogenesis. Howard (1993) also points out the fact that structural defects in housing provide entry to vermin within a dwelling, leaking pipes and other sources of water provide them with water to drink, and

inadequate food storage coupled with inadequate disposal facilities provide them with opportunities for opportunities of obtaining food. The dead spaces in walls harbor these pests and permit circulation among dwellings.

The exposure to toxic substances found within the housing environments is known to result in chronic health problems for example the passive exposure to indoor tobacco smoke is likely to result in respiratory disease (United States Environmental Protection Agency ,1992; Weitzman *et al* ,1990; Cook *et al* ,1997). Institute of Medicine (2000) also state that poor ventilation in such housing is likely to increase exposure to smoke. In the temperate regions where heating systems are employed to regulate indoor temperatures, Walker and Hay (1999) found that moderately elevated levels of carbon monoxide (from poor functioning heating systems) are likely to cause headaches whereas high levels are likely to cause acute intoxication.

In regard to the materials used in housing construction, the use of leaded paints in housing increases lead exposure (or poisoning as alluded too earlier) and this has been linked to neurodevelopment abnormalities as clearly pointed out by Needleman *et al.* (1990). Asbestos, a material for some time has been used for housing construction especially for roofs, has been found to cause *mesothelioma*[4] and lung cancer (Landrigan,1998). Jaakkolla *et al.*(1999) while studying the interior surface materials in homes and the development of bronchial obstruction among children in Oslo, Norway, found that polyvinyl chloride (PVC) flooring and textile walling materials to be closely associated with bronchial obstruction during the first two years of life.

[4] *Mesothelioma* is a rare form of cancer that develops from the protective lining that covers many of the body's internal organs, the *mesothelium*. It is almost always caused by exposure to asbestos. Most people who develop *mesothelioma* have worked on jobs where they inhaled asbestos particles, or they have been exposed to asbestos dust and fiber in other ways.

2.3. Why Focus on Child Morbidity?

In the field of environmental protection even experts did not always recognize children as different from adults as protective measure is often written with the average adult –not children- in mind (EPA, 2008). EPA (2008) also explains that children encounter their environments differently compared to adults; their neurological, immunological, respiratory, digestive and others physical systems are still developing and can be more easily harmed by exposure to environmental factors. Children eat more, drink more, and breathe more than adults in proportion to their body weight. Unclean food, water, and air are therefore more threatening to their health (EPA, 2008).

Essen *et al* (1978) allude to the fact that the housing conditions in which children live are important not only for humanitarian reasons , but they are also of additional importance since children in inadequate housing are likely to be retarded in their development or to have poor health. Breysee *et al.* (2004) gives a different dimension to reinforce this focus on children; he attributes the possible origins of many health risks they face to homes among other indoor environments, this is due to the reason that children spend as much as 80-90 percent of their time indoors . In deed, children play and learn by crawling, placing hands and other objects in their mouths – exploring the world with disregard to their own safety. These developmentally normal behaviours may lead to unintended exposure to environmental hazard within the housing environment.

Evidently, for children the housing environment is very important as far as health is concerned, and as Krieger and Higgins (2002) point out "it represents an important source of fetal and early childhood exposures to biological, chemical, and physical agents, as well as a strategic opportunity for intervention."

Prüss-Üstün and Corvalan (2006) estimate that one-quarter of the global disease burden are due to environmental factors. They say, for children, that proportion of rises to one-third. This burden is much greater in developing countries where infant death from environmental causes is twelve times higher than in developed countries. They further add that environmental interventions could prevent the deaths of over 2 million children under the age of five every year.

2.4. Justification for Assuming that there is a Link between the Housing and Child Morbidity

As mentioned earlier, the scope of this study is limited to two morbid conditions, i.e. diarrhoeal morbidity and acute respiratory Infections. The importance of diarrhoea and acute respiratory infections among children cannot be underestimated. Filmer and Pritchett (1999) allude to the fact that these two morbid conditions are the most prominent causes of death among children under the age of five, with each accounting for slightly over 10 percent of all deaths at the time (i.e. in 1999). A decade later these proportions are somewhat on the increase as WHO / UNICEF (2009) in their proportional distribution of cause-specific deaths among children under-five years of age globally indicate that acute respiratory infections (pneumonia) is the leading cause followed by diarrhoea in the proportions 17 percent and 16 percent, respectively. The findings show that nearly one in five child deaths is due to diarrhoea, the same can be said for ARI. These two together caused a third of under-five child mortalities reported. The same report shows that 46 percent of all deaths due to diarrhea occur in Africa. The developing world bears the burden of ARI as literature confirms that more than 90 percent of ARI-related deaths occur in the developing world (Black *et al.*, 2003; Williams *et al.*, 2002). It is thus worthwhile to consider these two morbid conditions when studying the link age between the housing and child morbidity.

2.4.1. Diarrhoea

In their study of infant and child mortality patterns in several Latin American countries, Puffer and Serano (1973) found that diarrhea disease were leading causes of post/neonatal deaths with the highest proportion being in the poorest districts. The study also reveals a strong synergy between poor nutrition and environmental factors, where children who were underweight after birth owing to poor maternal nutrition were also more susceptible to infections associated with unsafe water, poor sanitation and inadequate housing. The study also showed a high proportion of households showing high infant deaths as not having adequate water sources. This suggests that access to internal piped water in the household is likely to be of most direct benefit in lowering child mortality by reducing exposure to water-borne diseases.

Tagoe (1995), on the other had, found that the risk of having diarrhea to be significantly associated with toilet facility, whereby children living in houses with toilet facilities are about 50 percent less likely to contract diarrhea than children living in houses with no such facilities in Ghana. In regard to the type of sanitation facilities, Omar (1993) studied the relationship between diarrhoeal prevalence and the type of toilets used and found that people living in households with a flush toilet present had the lowest prevalence of diarrhoeal diseases, while the highest prevalence was found among people living in households using pit latrines. Osumanu (1987) alludes to the fact that since children living in households that use these facilities (pit toilets) cannot use them ,they resort to the use of chamber pots whose contents are thereafter thrown into latrine or buried in yard or, in the majority of cases -72 percent , thrown outside the dwelling, thrown outside the yard or rinsed away. He observed that in most cases chamber pots are not emptied immediately

after use, creating unsanitary conditions in homes, sometimes attracting flies and even domestic animals, all of which are potential carriers of pathogens.

Bradley *et al.*, (1991), state that regardless of differences from place to place, areas where water and sanitation provision is inadequate, children tend to have higher rates and intensity of diarrhea illness, worm infestation, skin infection and malnutrition, and that improved provision (including increase in amount of water used) contribute to reductions in morbidity and thereby mortality. Timaeus and Lush (1995) in their study of intra-urban differentials in child health consistently found a low prevalence of diarrhoea where water was piped into dwellings and where flush toilets were used by households in four countries. Although the evidence of specific links between water supply and such disorders is limited, the literature suggests that increase in the amount of water used contributes to better hygiene and that elimination of bacterial contaminations reduces the risk of infections through intake. According to Lopez (1996), although insufficient and unsafe water supplies and sanitation affect people of all ages, children's health and well-being is particularly compromised as approximately 84 percent of the global burden of diarrhea disease is experienced by children less than five years of age.

On the other hand, Caldwell (1980) places emphasis on the maternal aspects and suggests that educated mothers are also more likely to adopt improved child care practices such as boiling water used for children formulas. He suggests that an education mother may change intra family relationships leading to a more child centered orientation that would have a positive impact on a child's health. These findings have further been supported by latter studies. Tagoe (1995) found lower incidence of childhood diarrhea among children of educated mothers than among children of mothers with no formal education in Ghana. World Resources Institute (1998) further explains the scenario that education enables

caregivers to avoid health threats and deal with illness more easily. Educated mothers practice good hygiene and better child feeding, all of which increase a child's resistance against infectious diseases.

Osumanu (2007), while focusing on social and cultural dimensions, highlights the danger to which children are exposed to as a result of inappropriate behaviour and calls for need for appropriate interventions within the household environment and the need to educate mothers about the role of infection in causing diarrhoea. On the same note, Schultz (1984) drawing on household production theory, hypothesized that better educated mothers/ women earn more in the labor market and marry better educated men and consequently, they have higher family incomes enabling them purchase goods and services that improve child health in the home. However, Caldwell (1980) contended that education may also increase the effectiveness of women non-market activities, although he cautions the fact that market requires women to be absent from home which could also have an offsetting negative effect/ impact on quality of child care.

In regard to maternal education, a different point of view emerges from Benneh *et al*, (1993) and Huttly *et al* (1987) who found lack of association between maternal education and childhood diarrhoea. Huttly *et al* (1987), in their research, found no association between diarrhea and education but did find that poor housing , an unclean domestic environment , use of non-purified water and lack of soap were all associated with increased risk of diarrhoea. In addition, they found that early weaning was closely associated with diarrhoeal morbidity because of contaminated food and water. Davanzo and Habicht (1986) in their study of relative roles of prenatal and postnatal care, child health services, infant feeding, and family planning in reducing infant and child mortality in Malaysia concluded that improvements in water and sanitation contributed to infant and

child mortality declines especially for babies who do not breast feed. However, unlike education, these influences have become less important over time especially for babies who are not breastfed hence further for the improvement in water and sanitation.

Buttenheim (2008) in examining the effects of improved sanitation on child health in urban Bangladesh found that children's toileting matters more than adult toileting behavior in creating a safe, hygienic environment and reducing diarrheal disease concluded that sanitation programs must encourage the safe disposal of children's feaces in order to produce maximum health gains.

Generally, It is widely recognized that exposure to diarrhoeal pathogens in developing countries is conditioned by factors such as quality and quantity of water, availability of toilet facilities, housing conditions, level of education, economic status of households, place of residence and general sanitary conditions (personal or domestic hygiene) surrounding homes(Timaeus and Lush, 1995). Woldemicael (2001) points to the importance of floor material and says that since dirt floors cannot be washed; they are more likely to provide a breeding ground for various diarrhoea-causing agents than non-dirt floors. In a metropolitan area northeastern of Brazil, Campos *et al.* (1995) found that inadequate garbage disposal is associated with high morbidity and mortality rates due to diarrhea. Timaeus and Lush (1995) also found a strong association between the socio-economic status of the household and the incidence of childhood diarrhea in urban areas of Ghana. They go further to point out that that children's health is affected by environmental conditions and economic status of the household and because of this children from better-off household have lower mortality. This differential is largely attributed to differences in child care practices since better- off families can readily afford health care as opposed to poor families and this definitely means that children from rich families will have a lower

morbidity and mortality than the children from poor families. This is supported by the findings of a city-wide study of health and environment at the household level in Port Elizabeth, South Africa, there was an inverse association between wealth and diarrhoea. Thus children whose households are economically better off are less likely to experience diarrhoea, despite contaminated drinking water, than those who are further disadvantaged by their social and built environments (Seager *et al.*,1999).

2.4.2. Acute Respiratory Infection

ARI is a dominant infectious cause of severe morbidity and mortality in childhood. In Sub-Saharan Africa, the typical child appears to have around ten episodes per year and a 25 percent chance of having an ARI on any particular day. ARI is attributed to be responsible for 30 percent of visits and admission by children to a health facility. Diseases of the respiratory system (mainly pneumonia) are leading cause of death. This fact is supported by McMichael (2001) who goes further to state that the greatest aggregate burden of disease and premature death from air pollution is due to traditional heavy exposures to indoor air pollution in the Developing Worlds' rural and urban slum settings. Davies and Zar (2007) while acknowledging the multiple social and environmental factors associated with ARI morbidity and mortality in childhood point out environmental determinants particularly passive smoke exposure, overcrowding or poor living conditions and social factors principally poverty and poor access to both preventative (including immunization) and curative health services.

Children living in overcrowded and unfit conditions are more likely to experience respiratory problems such as coughing and asthmatic wheezing. However, the United Kingdom- a developed country- the scenario seems rather different since the balance of the evidence from five studies conducted in the country indicate a small relationship between overcrowding and respiratory conditions in children. On the other hand studies in

developing countries show a different picture, for example in a case-control study conducted the City of Sao Paolo, Cardoso *et al* (2004) found crowding of four or more 4 people sharing the child's bedroom to be associated with 2.5 fold increased risk of Acute Lower Respiratory Infection. D'Souza (1997) in studying housing and environmental factors and their effects on the health of children in the slums of Karachi, Pakistan found that upper respiratory tract infections are associated with overcrowding, poor housing structure, less humidity inside the house than outside, cooking inside the rooms, as well as airborne pollutants. Cappelletty (1998) also shares a similar opinion. There seems to be consistent evidence that damp and humid conditions are associated with ARI in children. Ozcirpici *et al.* (2004) found that a composite poor housing status score was associated with an increased incidence of ARI.

The United States Environmental Protection Agency (1997) and Herbarth *et al.* (1999) allude to the fact that the presence of particles in the air generated by domestic combustion processes is associated with the prevalence of respiratory diseases and allergies. Mishra (2003), while studying acute respiratory illness in preschool age children in Zimbabwe, also found that household use of high pollution biomass fuels is associated with ARI in children in Zimbabwe. De Francisco *et al.* (1993) found smoke during cooking to be the strongest risk factor for mortality from acute lower respiratory tract infections in Gambian young children. Smith *et al.* (2000) concluded that indoor air pollution that originated from biomass burning in houses multiplied by the large population at risk in the developing world as he reviewed the quantitative literature linking indoor air pollution from household use of biomass fuels with acute respiratory infections in young children in less developed countries.

Maternal factors also have been found playing critical role in the risk of children getting respiratory infections. Kazi and Azad (2009) found that a child born to mothers with primary education or uneducated had significantly 20 percent higher odds of suffering from ARI compared to children born to mothers with secondary or higher education. O'Dempsey *et al* (1996) in the Gambia found maternal factors having playing an important role; children of mothers with a personal source of income to be at lower risk of ALRI. This highlights the dilemma faced by mothers who while enhancing their children's health by increasing their income through working, may paradoxically place their children at risk by the required shortening duration of breast-feeding and placing children in daycare centers from a young age.

From the above literature it is evident that inasmuch as there are other factors e.g. maternal, child care practices among others, which play important roles in these morbid conditions the common denominator is the housing environment. The different studies and researches have shown that housing plays a significant role in the incidences and prevalence of these two morbid conditions via the basic services (water and sanitation), the physical qualities of the house, overcrowding, and indoor air quality.

One thing that should be noted is that the interaction between housing and the two morbidity conditions (diarrhoea and ARI) in children seem to be different. In other words, different aspects of housing interact differently with the with the morbidity conditions. Their association is the subject of study in this research.

2.5. Studies Undertaken in the Nairobi Context

Much of the studies of child health and morbidity in Nairobi have largely focused on the behavioral aspect of the mothers. For instance Keraka and Wamicha (2003) studied the environmental morbidity and mortality slum environments along Nairobi River where they

found that deaths of children who under the age of five years old were as results of environmentally caused diseases and women who had experienced multiple child deaths were often less resourceful and organized in caring for the remaining children. Ye *et al.* (2009) undertook a longitudinal approach to study seasonal pattern of pneumonia mortality among under-five children in Nairobi's informal settlements.

Regardless of the methodology of study the above studies have limited themselves to the 'Slum' or informal settlements, as they are politely called. The "Slum" at its simplest, is 'a heavily populated urban area characterized by substandard housing and squalor'. This definition encapsulates the essential characteristics of slums: high densities and low standards of housing (structure and services), and 'squalor'. And mostly the criteria that often been applied in this definition has been physical and spatial. Consequently, housing geographical concentration or coalescing of such settlements have Nairobi has attracted so much study in terms of health. This has lead to the stereotyping of health conditions of specific geographical locations of the city in regard to health concerns just because of the characteristics of the physical structures. However, the World Health Organization recognized that housing in its present day concept is more than just physical structure and hence should not be viewed too narrowly. Hardoy and Satterthwaite (1987) further explain that a better understanding of the links between housing and health demands a better understanding of the housing problem which goes beyond the inaccurate stereotype of the poor living in the geographical "*slums and squatters settlements.*" This is a weakness or gap in previous studies which this study hopes to fill by looking at the totality of Nairobi as an administrative urban region. This study, therefore, should not be construed to denigrate the importance of looking at such settlements as housing experts and urban consultants in the country concur on the fact that slum dwellers constitute the majority of Nairobi's population; an estimated 60 per cent of the city's official population live in

informal and often precarious settlements but occupying only 5 percent of the residential area of the city. Experts attribute that the failure of the Nairobi's authorities to provide access to land for housing and the necessary urban infrastructural services to the growing number of residents to be partly due to the lack of financial resources and poor management (Syagga, *et al* ,2001).

On the other hand, others have undertaken child morbidity studies at the national urban context. Mutunga (2004), for example, looked at the environmental determinants of child mortality in urban Kenya. Findings aggregated at the national level hides, not only regional disparities but also generalization of findings at the national urban scale is only important either to the extent that it allows for comparisons to be drawn between countries or to the extent that it allows for analysis of underlying determinants at the national level. This, however, leaves the urban manager without sufficient information or empirical facts on which policies and decisions within their given jurisdiction will be based.

The Housing Environment

A child's total environment has been recognized as a dominant force health and well being. Housing in all its different forms is one element of the environment, which exerts the most immediate influence on the children under the age of five. Although the child's health is an interaction between their human biology, maternal factors, lifestyle of the household, the health care system, the housing environment plays a major role as deficiencies in this environment.

Given the scope of this research it is important to have a brief look at the aspects of the housing environment under consideration and their individual interaction with child health. The components of housing environment under consideration include: physical building

characteristics as depicted by the material used in floor construction, water source and supply, sanitation, living space/ overcrowding.

2.5.1. Physical building characteristics

Ideally, the built environment is meant to offer protection against physical and biological agents of disease. It is meant to shelter and safeguard people against the weather elements; housing should also provide adequate protection against any hazard to the health result from its design and construction. One critical element of the built environment is the quality of material used in the construction of the floor of the dwelling. This is not only an important pointer to the permanency and durability of the housing structure as an earthen floor is an indicator of minimal work on the substructure of the building .Earthen floors invariably the lack of foundation, yet this is important for structural support for walling materials such as natural stones or concrete blocks that offer better insulation and protection than iron sheets or card boards in regard to the thermal conditions in the dwelling. Also, as mentioned earlier, the type of floor material could also serve as an indicator of environmental contamination. Since earthen floors cannot be washed, they are more likely to provide a breeding ground for various disease causing agents than non-non earthen floors. Hardoy and Satterthwite (1987) quote a study of child health undertaken in Wadi Riman, a squatter settlement in Amman (Jordan) that found that for every 1000 live births 86.1 children died before the age of three even though virtually all households had piped water and electricity and most had pit latrines. By the age of three nearly half the children were infected by one or more intestinal parasites and nearly one-third had suffered from acute respiratory infections in the period immediately preceding the survey. When the houses surveyed were divided into three types according to quality of construction and materials used, the proportion of children dying before the age of three was found to be substantially higher in the lowest quality category; 109.8 children died before the age of three for every 1000 live births.

2.5.2. Water Source

The provision for a safe and convenient and adequate supply of water is the most single important activity that can be undertaken for the health of the people wherever they live. The quantity available to a household and the price they have to pay for it has been proved to be as important to a family's health as its quality (Cairncross, 1990). This is important because the price influences the quantities used and especially for families where public agencies do not provide any water supply and households have to buy from unsanitary water vendors who sell the commodity exorbitantly.

To fully maximize the benefits of water supply, it should be easily accessible to within the housing environment, preferably piped within the dwelling given that the effects on children's health can be dramatic – a Brazilian study showed that infants were five times more likely to die in households using public standpipes as in those with water piped to the house (Victoria *et al*,1988). Though difficult to measure, the link that exists between water and child health undisputed. Provision of adequate supply of potable water that is easily accessible would greatly reduce health risks as water is not only consumed but also used for hygiene purposes in the dwelling.

2.5.3. Sanitation

Provision of hygienic means to dispose off excreta and adequate means to dispose of wastewater are a prerequisite to a healthy residential environment. The removal and disposal of excreta in ways that prevent human contact is central to reducing of burden of diseases. Feachem *et al* (1983) allude to the fact that human excreta is the principal vehicle for the transmission and spread of a wide range of diseases. Human excreta are the principal vehicle source of pathogenic organisms that contaminate food, water, and children's fingers and are subsequently ingested. Health risks are multiplied for those living housing environment where there are no waterborne sewerage system. The type of

toilet facility within the given housing environment is a general indicator of the level sanitation therein.

2.5.4. Living space / Overcrowding

As literature points out, overcrowding is one of the factors that influence and has been linked epidemiologically to a number of biological mechanisms, which may cause problems of their own. UNCHS (1995) has identified a number of risks that overcrowding increases: The risk of multiple infections; the risk of disease transmission; the risk of intensive exposure and severe diseases; the risk of long-term adverse effects of infection. Overcrowding also tends to bring with it the problems of water supply and sanitation, the dangers of human-induced accidents and the interruption of children's hour of sleep due to various activities in the home.

2.5.5. Others

Other aspects of the housing environment under consideration as alluded to in the literature include the *type of cooking fuel*. This is because indoor air pollution has been mentioned as an important contributing factor for respiratory infections as a major risk factor for acute, especially among children under the age of five years.

2.6. Conclusion

Evidently from this literature review most research on the morbidity or mortality of the children under five years has been predominantly done by health professionals and such research has concentrated on the incidence of diseases or on their biological processes. In Instances where there have been done by other professionals they have taken the form of focusing a single urban infrastructural service (e.g. Water or sanitation or occasionally both) and not looking at the overall housing environment as a composite unit to see how the important components of the built environment (Water, sanitation, physical structure, and living space/area) in a given urban context in interplay to relate to these two morbid

conditions. For example, not much research has been done on the likely influence of an element like the floor yet it is important when looking at environmental contamination as Woldemicael (2001) points out to the fact that dirt floors cannot be washed and as such they are more likely to provide a breeding ground for various diarrhoea-causing agents than non-dirt floors. The number of rooms in a given unit and the number of members of a household are also important indicators in the housing environment that point to the level of Overcrowding; Overcrowding imposes strain on facilities making observation of hygienic practices difficult which can further predisposes children to morbid conditions such as diarrhea among others.

Hardoy and Satterthwaite (1987) say that the most obvious reason why architects and planners have not addressed the health problems inherent in many residential areas in Third World cities is because "they are not paid to do so" and the housing or the built environment is viewed too narrowly in terms only of physical structure and thus the health-housing links are not viewed as important. Most of the critical health-housing links only become apparent when considering the impact on health of the physical environment provided by the house, the services and facilities it contains and its surrounds. They argue that stress has been laid on the importance to health of sufficient, safe domestic water supply, attention to water and food storage practices, washing and personal hygiene and the hygienic disposal of human wastes as if these were somehow not related to housing.

The other reason that Hardoy and Satterthwaite (1987) allude to as to why architects and planners have not been active in seeking to address the health problems in housing developments is because of the multiple causality of disease; other than the different aspects of the physical environment, health status is affected by socioeconomic factors such as diet, income, and level of education etc and in turn many of these are influenced by

the laws, codes, norms and practices of national, city and municipal governments. Lastly, Health issues are also deemed the responsibility of health professionals and this inhibits the involvement the professionals in the housing sector in health issues.

As clearly seen literature, indeed, gives a hint of the multi-faceted relationship between housing and health. In Developed nations research in the housing and health connection area has been extensive and there is plenty of knowledge about how the housing conditions are associated with a wide range of health conditions such as asthma, lead poisoning, injuries and mental health and this has led to the formation of institutions and initiatives not only to reduce substandard housing but also to ensure "Healthy Homes".

The global disease burden is due to environmental factors is much greater on children especially in greater in developing for those in developing world especially due to diarrhoea and ARI. From literature the studies on these two morbidity conditions have largely dwelled on one or two aspects of housing e.g. the infrastructural services (water and sanitation) to the exclusion of the other attributes of the housing environment hence the need to expand the scope. Spatially and administratively, there is also need for urban managers in Kenya to have sufficient information or empirical facts on which policies and decisions within their given jurisdiction will be based and that an only be availed through this type of study.

CHAPTER THREE

3. RESEARCH METHODOLOGY

This chapter presents the research philosophy subscribed to, the research methods employed in this study in the pursuit of the research objectives. It delves in to the description of the Data used the definition and operationalization of variables, and the formulation of the empirical model to be used.

3.1. Research Strategy

All science begins in philosophy, and hence, methodology has a philosophical basis that is oriented toward techniques and ways of knowing. Thus methodology becomes first an approach toward inquiry and then later it evolves into particular methods or techniques (Allen ,1978). This study followed the positivist paradigm. Morgan & Smircich (1980) explains that positivism is based on the assumption that social reality has an objective ontological structure and that individuals are responding agents to this objective environment. This assumed "objective world" is one in which scientific methods can more or less readily represent and measure, as positivism seeks to predict and explain causal relations among key variables. This paradigm is based on a number of principles, including: a belief in an objective reality, knowledge of which is only gained from sense data that can be directly experienced and verified between independent observers. Hoepfl (1997) states that research within this paradigm employ experimental methods and quantitative measures to test hypothetical generalizations and they also emphasize the measurement and analysis of causal relationships between variables .Additionally, Gephart (1999) affirms that the positivist paradigms hold that science is capable of providing definitive and objective statements regarding the proving or disproving of hypotheses, based on proof and deduction as well as statistics and mathematical reasoning. He summarized the following key features of this paradigm:

- An assumption that of an objective world that science can 'mirror' with privileged knowledge
- The goal of the paradigm is to uncover truths and facts as quantitatively specified relations among variables.
- The nature of knowledge or form of theory involves verified hypotheses involving valid, reliable and precisely measured variables.
- The criteria for assessing research entails: rigor; internal & external validity, reliability.
- The unit of analysis is the "variable".
- Research methods involve experiments; questionnaires; secondary data analysis; quantitatively coded documents. Whereas type(s) of analysis are quantitative in nature: regression; structural equation modeling among others.

This paradigm relies heavily on quantitative measures and this research has employed quantitative methods. Quantitative research involves counting and measuring of events and performing the statistical analysis of a body of numerical data (Smith, 1988). With the assumption behind the positivist paradigm is that there is an objective truth existing in the world that can be measured and explained scientifically, the main concerns of the quantitative paradigm are that measurement is reliable, valid, and generalizable in its clear prediction of cause and effect (Cassell & Symon, 1994).

Mugenda and Mugenda (2003) describe a quantitative research as one that produces quantifiable and numerical data and contrasts it with qualitative research which is limited to producing data in the form of statements or words rather than numbers. Frankfort-Nachmias and Nachmias, (1996) ,on the other hand, describe quantitative research as being deductive in nature and deals directly with the operationalization, the manipulation of

empirical variables, prediction and testing. It puts more emphasis on methodology; procedure; and on statistical measures of validity. Being deductive and particularistic, quantitative research is based upon formulating the research hypotheses and verifying them empirically on a specific set of data (Frankfort-Nachmias and Nachmias, 1992).

Given that the process of data collection is distinct from analysis, the researcher's own values, biases, and subjective preferences have no place in the quantitative approach. The researcher is ideally an objective observer who neither participates in nor influences what is being studied. For this reason Ting-Toomey (1984) says that researchers can view the communication process as concrete and tangible and can analyze it without contacting actual people involved in communication.

The strengths of the quantitative method include:

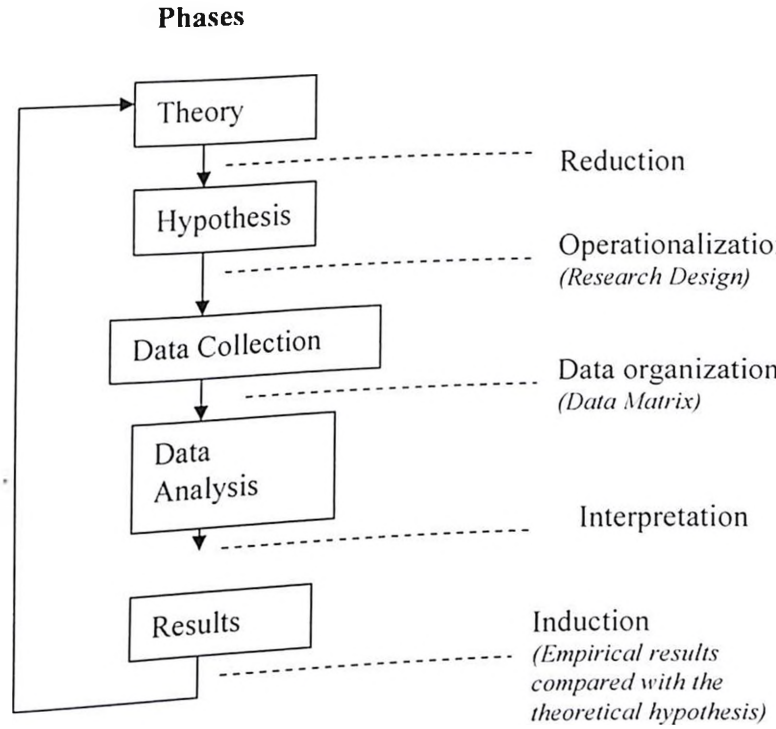
- Stating the research problem in very specific and set terms (Frankfort-Nachmias & Nachmias, 1992);
- Clearly and precisely specifying both the independent and the dependent variables under investigation;
- Following firmly the original set of research goals, arriving at more objective conclusions, testing hypothesis, determining the issues of causality;
- Achieving high levels of reliability of gathered data due to controlled observations, laboratory experiments, mass surveys, or other form of research manipulations (Balsley, 1970);
- Eliminating or minimizing subjectivity of judgment
- Allowing for longitudinal measures of subsequent performance of research subjects.

The weaknesses of the quantitative method include:

- Failure to provide the researcher with information on the context of the situation where the studied phenomenon occurs; Critics argued that positivistic methods strip contexts from meanings in the process of developing quantified measures of phenomena
- Inability to control the environment where the respondents provide the answers to the questions in the survey;
- Limited outcomes to only those outlined in the original research proposal due to closed type questions and the structured format;
- Not encouraging the evolving and continuous investigation of a research phenomenon.
- In particular, quantitative measures often exclude members' meanings and interpretations from data which are collected. These methods impose outsiders' meanings and interpretations on data.
- And they require statistical samples which often do not represent specific social groups and which do not allow generalization to or understanding of individual cases.
- Finally, quantitative and positivistic methods tend to exclude discovery from the domain of scientific inquiry.

Bryman (1988) gives a typical structure of a quantitative research as shown in Figure 3.1:

Figure 3.1: Typical Structure of Quantitative Research



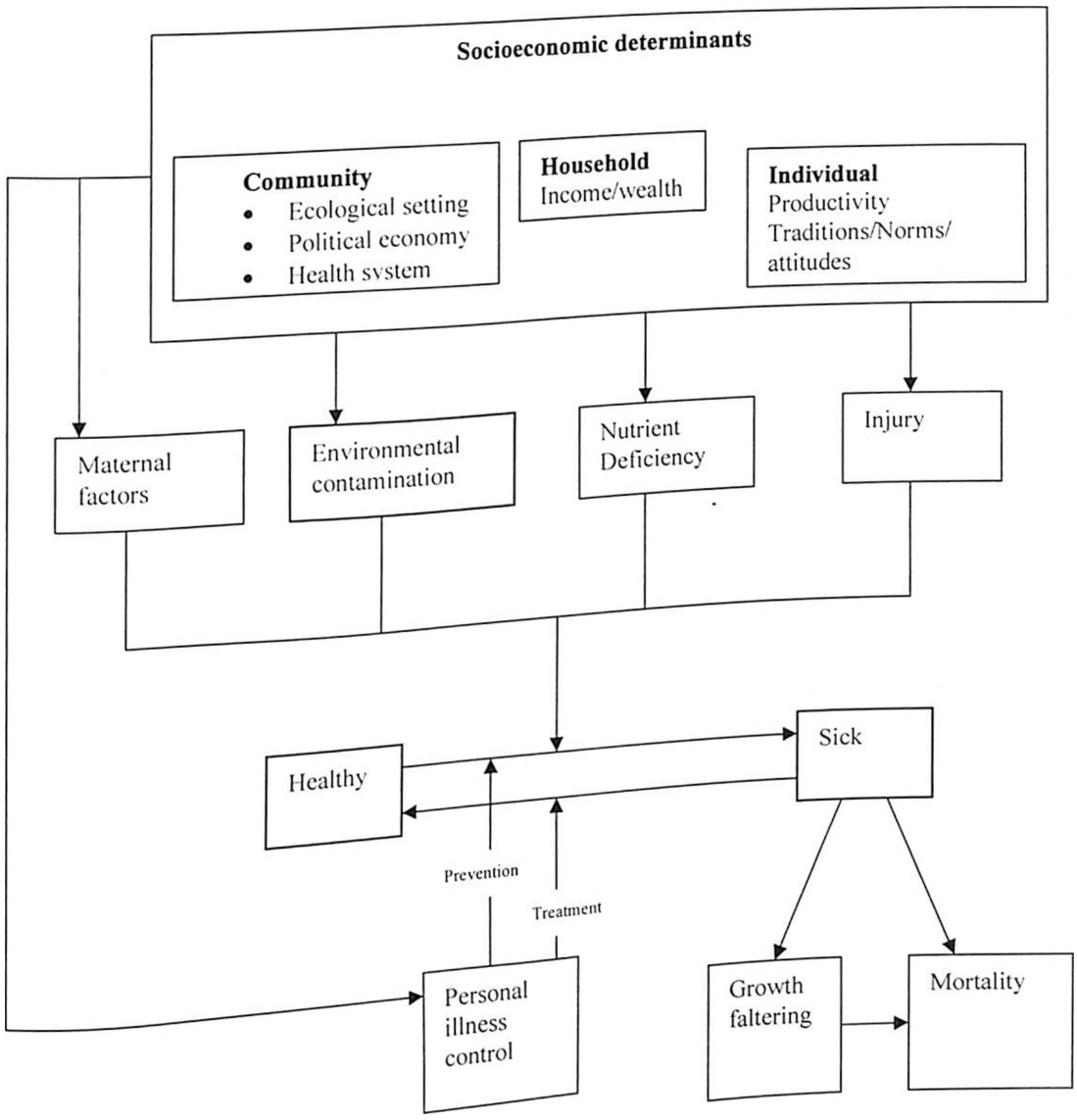
Adapted from Bryman (1988)

3.2. Theoretical Framework

The analysis of the relationship between child morbidity and the above components of the housing environment in this study has borrowed some principles from a broad and widely accepted framework for the analysis of child survival in developing countries developed by Mosley and Chen (1984). They made a distinction between distal (underlying) and proximal determinants in relation to health improvements. Distal determinants are for instance socio-economic conditions. They affect morbidity and mortality through the so called proximal determinants like the households environment including sanitary facilities and availability of safe water. In other words, socio-economic determinants must operate

through more basic determinants that in turn influence the risk of disease and the outcome of disease process. This framework has been used by many researchers in child morbidity and mortality studies. Keraka and Wamicha (2003) in their *Child Morbidity and Mortality in Slum Environments along Nairobi River* used an operational framework derived from a conceptual framework that has been adapted from Mosley and Chen's work. Omariba (2005) also based the selections of factors analyzed in his study of the *Changing childhood mortality conditions in Kenya* on the Mosley and Chen (1984) conceptual framework.

Figure 3.2: Model of Operation of Proximate Determinants



Source: Mosley and Chen, 1984

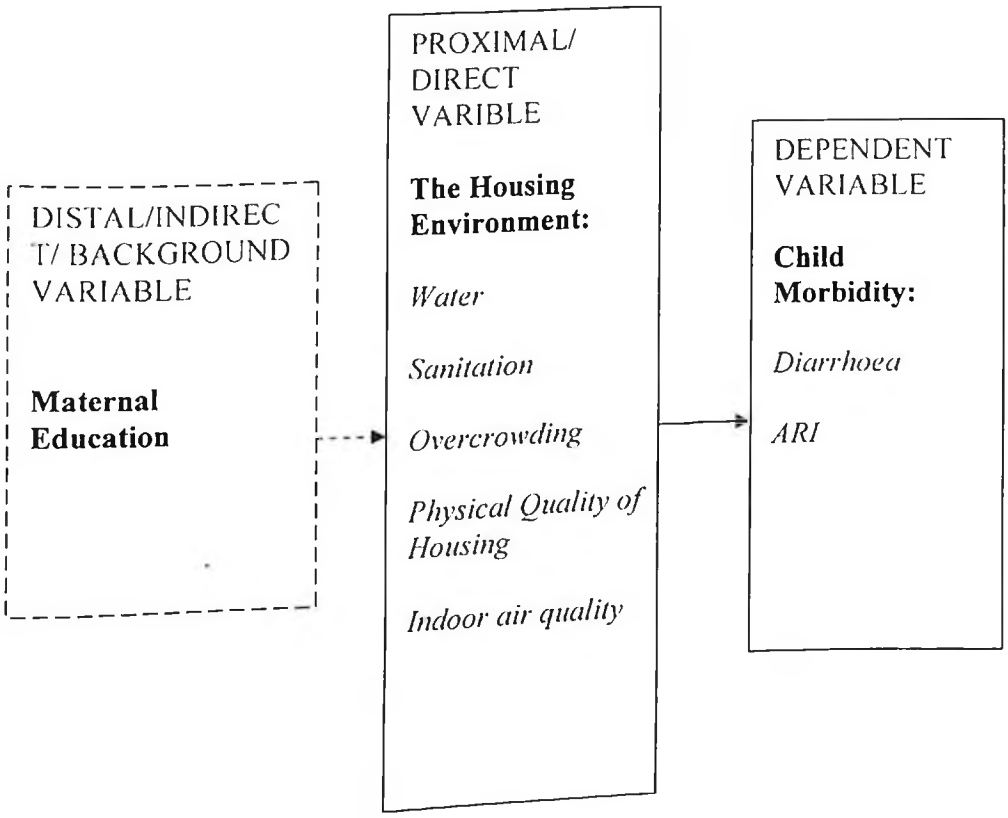
From the literature review there are a number of determinants that contribute to the different morbid condition in children under the age of five. The housing environment (a proximate determinant) has an impact on child morbidity, but the level of the effect is reduced or modified by maternal aspects, in this case maternal education[5] which is assumed to have an impact on attitudes given that "education is a transformer of *attitudes*" (Frost *et al.* ,2005). Thus the assumption here is that *maternal* education, through transformed attitudes and knowledge on good health and effective hygiene, is a mitigating factor reducing the impact of the effect of the housing environment on child's health. In this sense maternal education would be distal determinant. This study dichotomizes maternal education into two levels: (a) Primary level or below and (b) Secondary level or above.

Thus the construction of a theoretical model of operation has been based on the principles of path analysis[6] A general path diagram denoting the theoretical model of operation representing the causal model in the path analysis to illustrate this can take the format in Figure 3.3. In the model below the continuous arrow indicate a causal relationship, leading from the explanatory (causal) variable to the outcome variable (effect). Child morbidity is dependent upon the housing environment as hypothesized in this study. The broken arrow indicates the modifying effect of the maternal education. This study thus uses maternal education as a control variable.

[5] Studies have shown a strong positive correlation between maternal schooling and her health seeking behaviour and health practices. Maternal education operates through its influence on various characteristics like socioeconomic status of the household, by increasing maternal autonomy, and by forming more positive than fatalistic attitudes towards child health.(Kalita, 2006)

[6] *Path Analysis* is a methodological tool that helps researchers using quantitative data to disentangle the various (causal) processes underlying a particular outcome .Using Path Analysis one is able to examine the comparative strength of direct and indirect relationship among variables.

Figure 3.3: Operational Framework



Source: Researcher

This is a correlation research. This is a type of research whose main theme is to ascertain whether there is a relationship between two or more aspects of a situation or a phenomenon. It seeks to explore or establish a relationship, an association or interdependence. This study employed secondary data collection methods. Frankfort-Nachmias and Nachmias (1996) and Kumar (2005) say for findings to be accurate and suitable for greater generalization purposes a larger sample size is required. This is because findings based upon larger samples have more certainty than those based on smaller ones i.e. the larger the sample size, the more accurate the findings. The larger sample size and the intensity of this kind of a study require the enormous amounts of resources. To overcome this challenge the study utilizes datasets from the Kenya Demographic Health Survey 2003 (2003 KDHS). The researcher was allowed access to download these datasets by ICF Macro from their website (www.measuredhs.com)[7]. Kumar (2005) identifies three main factors that necessitate the use of secondary data namely: Conceptual- substantive factors, Methodological factors and Cost factors.

From a Conceptual- substantive point of view, this secondary data was the only relevant data available may be the only data available for the study of this kind of a problem. Also,

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[7] ICF Macro is an organization whose initiatives to help developing countries collect and use data to monitor and evaluate population, health, and nutrition programs. DHS has earned a worldwide reputation for collecting and disseminating accurate, nationally representative data through the Demographic Health Surveys (DHS). ICF Macro has availed DHS datasets among other resources online and these are available on request. Dataset access is only granted for legitimate research purposes. Before one is granted access to the datasets one must register as a DHS data user. This request must include contact information, a research project title, and a description of the analysis a researcher intends to perform with the data. When approved, full access is granted to all unrestricted survey datasets for a particular country.

The 2003 Kenya Demographic and Health Survey (2003 KDHS) datasets are reliable datasets given the nature of input and expertise involved in achieving and validating these products. The survey was implemented out by Central Bureau of Statistics in partnership with the Ministry of Health and the National Council for Population and Development. ORC Macro provided financial and technical assistance for the survey through the USAID-funded MEASURE *DHS+* programme, which is designed to assist developing countries to collect data on fertility, family planning, and maternal and child health. The Centre for Disease Control and Prevention (CDC) provided technical and financial support on the HIV component of the survey. Financial support for the survey was provided by the Government of Kenya and a consortium of donors, including: the U. S. Agency for International Development (USAID), the United Nations Population Fund (UNFPA), Japan International Cooperation Agency (JICA)/United Nations Development Programme (UNDP), the United Nations Children's Fund (UNICEF), the British Department for International Development (DFID), and the Centers for Disease Control and Prevention (CDC).

findings from the use of the secondary data of this nature can also be used for the purposes of comparison in future researches, comparisons between cities may expand generalization and provide additional insights. From a *Methodological point of view*, Reliable and accurate secondary data provides opportunity for replication. Thus the use of this secondary data enabled the researcher to increase the representativeness– a factor that contributes to more encompassing generalizations. From a *Cost point of view, undertaking a* Primary research to study this problem would have been a very costly undertaking especially due to the magnitude of household survey that would have demanded. Indeed, this research was infinitely less expensive owing to existing datasets avail availed at no cost by ICF Macro for this purpose.

Like other data collection methods, the use this secondary dataset for analysis posed certain limitations. Given that the data was collected for other different purposes it did not contain all the variables of interest for an elaborate study of the housing fabric for instance the material used for the construction of the walls. This was an inevitable gap since with primary data the researcher collects personally with specific research purposes in mind yet the KDHS is one that was data collected by others for different purposes.

Secondary data has been employed by various studies, Woldemicael (2001) while studying Diarrhoeal Morbidity among Young Children in Eritrea used data sets from the 1995 Eritrea Demographic and Health Survey (EDHS).

3.3. Survey Design and Variables of interest to this study in the KDHS datasets

The Kenya Demographic and Health Surveys (KDHS) 2003 was nationally representative given that it covered the entire country with large sample sizes, almost 10,000 households was selected for the KDHS sample nationally . The survey utilized a two-stage sample design. The first stage involved selecting sample points ("clusters") from a national master

sample maintained by CBS. The list of enumeration areas covered in the 1999 population census constituted the frame for KDHS sample. The second stage of selection involved the systematic sampling of households from a list of all households There were three core questionnaires in 2003 KDHS survey: A Household Questionnaire, a Women's Questionnaire, and a Male questionnaire. All women age 15-49 years who were either usual residents of the households in the sample or visitors present in the household on the night before the survey were eligible to be interviewed in the survey. Surveys were meant to provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition. Information obtained from the Women's Questionnaire was used to prepare the both the Children's datasets and the women dataset. On the other hand, the information from the household questionnaire was used to produce the household dataset (Central Bureau of Statistics *et al* 2004). Relevant to this study were the Children's dataset and the Household data file.

The variables to of interest to this study in the 2003 KDHS datasets that gave an indication of the nature of the housing environment included: *source of drinking water, the kind of Sanitation facility, the type of floor material used in the dwelling, the type of cooking fuel used by the household, the number of the usual members of the household (de jure members)* and *the number of habitable rooms in the dwelling*. On the other hand, the variables of interest with regard to morbid conditions in this study were: Diarrhea and ARI. Part of the DHS datasets already had a question: *Did child have diarrhoea two weeks before the survey?* In regard to ARI, It should be noted that prevalence of ARI as measured by the 2003 KDHS was based on mothers' subjective assessment of the child's symptoms, i.e., whether the child had been ill with a cough accompanied by short, rapid breathing in the two weeks preceding the survey. These signs are compatible with pneumonia. It should, however, be noted that morbidity data collected in surveys are subjective, i.e.

mother's perception of illness, unvalidated by medical examination. (Central Bureau of Statistics *et al* 2004). .

This study used the SPSS as a statistical tool. Every variable of interest to this study was recoded using SPSS syntax programming. Since the variables for computing 'the average number of persons who sleep per room' were missing in the Children's dataset. The researcher used SPSS to match the variables *number of members who sleep in the dwelling* and *the number of sleeping rooms available in the dwelling* (which are in the Household dataset) to the Children dataset. In the modeling and SPSS programming on the Children dataset filtering was be done to have outputs from cases that in the Nairobi region and whose place of residence were recorded as "Urban".

3.4. Definition of variables

In ascertaining the adequacy of the housing environment this study takes cognition of definitions postulated (in order to allow for comparability, international or otherwise) by the Kenya's Central Bureau of Statistic in the Kenya Integrated Household Budget Survey and international agencies like the United Nations Human Settlements Programme (UN-HABITAT), the World Health Organization (WHO) and the United Nations Children's Fund (*UNICEF*). For instance, *Safe (improved) water* source refers to water whose source is used piped to the dwelling, public tap, borehole or pump, protected well, protected spring, bottled water or rain water (WHO and UNICEF ,2003; UNCHS, 2004; CBS, 2007); *Improved sanitation* refers to access to facilities that hygienically separates human excreta from human, animal and insect contact. Facilities such as sewers or septic tanks, poor flush-latrines and ventilated improved pit latrines are considered improved. (WHO and UNICEF, 2003; UNCHS, 2004; CBS, 2007).

In this research the above definitions were not used. In the case of water, the main source of water in Nairobi were piped sources. For the purposes of this research the piped sources were dichotomized as *piped within the dwelling* and piped outside the dwelling in *public tap ,piped into compound/plot.* In regard to sanitation, this study dichotomized the type of toilets into *flush toilet* and pit toilets (traditional *pit toiled and the ventilated improved pit toilet).* The *type of floor* which acts as a proxy for the Structure -physical quality of the housing structure) was dichotomized into *earthen floor* and *non- earthen floors.*

Whilst taking cognizance of the various of the common indicators for measuring overcrowding (such as the average in-house living area per person or the number of households per area; housing-unit level indicators such as the number of persons per bed or the number of children under five per room), the UN-HABITAT also postulated a criterion/definition for a dwelling unit to be considered as to be having sufficient-living area; in other words a dwelling unit not being overcrowded. UN- HABITAT states that *a house is considered to provide a sufficient living area for the household members if three or less people share the same room* (United Nations Human Settlements Programme 2004). This study, in order to ascertain the adequacy of the living spaces, took the number of the people who usually sleep in the dwelling and divided this by the number of rooms used for sleeping in the dwelling to arrive at *the average number of persons per room*, an indicator of the adequacy of the living space , thus this variable was continuous. The dichotomized criterion by UN-HABITAT's definition was also used in certain instances in order to obtain additional information to aid descriptive analysis there are. All these variables of interest from the 2003 KDHS datasets were recoded using SPSS syntax programming and given value labels as shown.

Table 3.1: The measurement of the independent variables (housing environmental conditions)

Variable	measurement	Value label assigned in recode
Source of drinking Water	• Public tap ,piped into compound/plot • Piped into dwelling	• 1 • 2
Type of Toilet Facility (Sanitation)	• Pit Toilets (Traditional pit toilet, Ventilated improved toilet) • Flush Toilet	• 1 • 2
Type of floor	• Earthen • Non-earthen	• 1 • 2
The average number of persons per room	• Continuous(not categorical)	• Continuous(not categorical)
Type of Cooking Fuel	• Charcoal • Kerosene • LPG/Natural Gas/ Biogas/ Electricity	• 1 • 2 • 3

Also mentioned in the literature review was the indoor air quality plays a critical respiratory infections. The type of cooking fuel is thus added unto the independent variables when modeling for ARI. As alluded to in the previous chapter, this research looks at the maternal level of education as a control variable. The variable is thus defined and measured as shown in Table 3.2.

Table 3.2: The Measurement of the Control variable (Maternal Education)

Variable	measurement	Value label assigned in recode
Mother's highest level of education	• Primary level and below • Secondary level and above	• 1 • 2

The dependent variables in this study are aforementioned morbid conditions: Diarrhea and ARI . Part of the DHS datasets already have a question *Did child have diarrhoea two weeks before the survey?* In regard to ARI, It should be noted that prevalence of ARI as measured by the 2003 KDHS is based on mothers' subjective assessment of the child's symptoms, i.e., whether the child has been ill with a cough accompanied by short, rapid breathing in the two weeks preceding the survey. These signs are compatible with pneumonia. It should, however, be noted that morbidity data collected in surveys are subjective, i.e. mother's perception of illness, unvalidated by medical examination. (Central Bureau of Statistics *et al* 2004)

Table 3.3: The measurement of the dependent variables

Variable	Measurement	Value label assigned in recode
Diarrhoeal morbidity: Did child have diarrhoea two weeks before the survey?	• Yes • No	• 1 • 0
ARI morbidity: Presence of Acute Respiratory Infection morbidity	• Yes • No	• 1 • 0

3.5. Statistical methods of data analysis

The first part of the analysis is descriptive in nature giving the frequencies of the variables. In order to meet the first objective of this study (i.e. *to establish the prevalence rate of diarrheal diseases, acute respiratory infection, vis-à-vis housing conditions in Nairobi*), cross-tabulation producing two-way or multi-way tables showing percentages of responses among two or more variables was used. This gave the prevalence rates of the morbid conditions in children in different housing conditions.

In order to meet the second objective of this research (i.e. *to assess the relationship between housing conditions and acute respiratory infection, diarrheal morbidity in*

Nairobi), the second phase of the analysis took the form of logistic regression at both the bivariate and multivariate level. The statistical method of logistic regression was employed since it is the method is appropriate when outcomes are dichotomous. Logistic regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. With a categorical dependent variable, discriminant function analysis is usually employed if all of the predictors are continuous and nicely distributed; logit analysis is usually employed if all of the predictors are categorical; and logistic regression is often chosen if the predictor variables are a mix of continuous and categorical variables and/or if they are not nicely distributed (logistic regression makes no assumptions about the distributions of the predictor variables). A number of studies have used this method for instance. Woldemicael (2001) applied logistic regression on the 1995 Eritrea Demographic and Health Survey (EDHS) dataset on his study of the diarrhoeal morbidity among young children in Eritrea.

3.5.1. Logistic Regression modeling

The central mathematical concept that underlies logistic regression is the logit- the natural logarithm of an odds ratio. Given that the dependent variables are categorical logistic regression applies the logit transformation to the dependent variables. The logit is the natural logarithm (ln) odds of Y, and odds are the ratios of probabilities (π) of Y happening (i.e., a child being sick) to probabilities ($1-\pi$) of Y not happening (i.e., a child not being sick)

The simple logistic model has the form (assuming only one predictor X).

$$\text{logit}(Y) = \textit{natural}\ \log(\textit{odds}) = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta X \qquad (1)$$

The logit function is invertible, and so taking the antilog of Equation 1 on both sides, an equation to predict the probability of the occurrence if the outcome of interest was derived as follows:

$$\pi = \text{Probability } (Y = \text{outcome of interest} \mid X = x, \text{ a specific value of } X) = \frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}} \quad (2)$$

Where π is the probability of the outcome of interest (i.e., a child being sick), α is the Y intercept, β is the regression coefficient, and e=2.71828 is the base of the system of natural logarithms. X can be categorical or continuous. But Y is always categorical. According to Equation 1, the relationship between logit (Y) and X is linear. Yet according to Equation 2, the relationship between probability of Y and X is nonlinear. For this reason, the natural log transformation of the odds in Equation 1 is necessary to make the relationship between a categorical outcome variable and its predictor(s) linear.

Extending the logic of the simple logistic regression to multiple predictors (say X_1, X_2 ... X_n) a complex logistic regression is constructed as follows:

$$\text{logit } (Y) = \textit{natural} \log (\textit{odds}) = \ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 .... + \beta_n X_n \quad (3)$$

Therefore,

$$\pi = \text{Probability } (Y = \text{outcome of interest} \mid x_1, x_2 ..... x_n) = \frac{e^{\alpha+\beta_1 X_1+\beta_2 X_2 ....+\beta_n X}}{1+e^{\alpha+\beta_1 X_1+\beta_2 X_2 ....+\beta_n X}} \quad (4)$$

Where π is once again the probability of the event, α is the Y intercept, βs are the regression coefficients, and Xs are a set of predictors.

From the literature review the confounding factors for diarrhoea are water, sanitation, floor material and persons per room. Thus a complex logistic regression equation for diarrhea taking into account these confounding variables predictors is constructed as follows:

$$\text{logit } (Y_d) = \textit{natural log } (odds) = \ln\left(\frac{\pi_d}{1-\pi_d}\right) = \alpha_d + \beta_{d1}X_{d1} + \beta_{d2}X_{d2} + \beta_{d3}X_{d3} + \beta_{d4}X_{d4} \quad (5a)$$

Therefore the probability of having diarrhoea:

$$\pi_d = \frac{e^{\alpha_d + \beta_{d1}X_{d1} + \beta_{d2}X_{d2} + \beta_{d3}X_{d3} + \beta_{d4}X_{d4}}}{1 + e^{\alpha_d + \beta_{d1}X_{d1} + \beta_{d2}X_{d2} + \beta_{d3}X_{d3} + \beta_{d4}X_{d4}}} \quad (6a)$$

Where π_d =the probability of having diarrhoea, X_{d1}=water, X_{d2}=sanitation, X_{d3} =floor material *and* X_{d4} = persons per room.

But since from the literature review the there is no significant link between the Source of water and sanitation with ARI these variables were not included in the logistic regression modeling for ARI. Floor materials[8], Adequacy of Living spaces, type of cooking fuel are the variables under consideration. Thus equation taking into consideration these confounding variables predictors for ARI will be thus:

$$\text{logit } (Y_a) = \textit{natural log } (odds) = \ln\left(\frac{\pi_a}{1-\pi_a}\right) = \alpha_a + \beta_{a1}X_{a1} + \beta_{a2}X_{a2} + \beta_{a3}X_{a3} \quad (5b)$$

Therefore the probability of having ARI:

[8] Earth floors for their likeliness to be damp compared to Non-earth floors.

$$\pi_a = \frac{e^{\alpha + \beta_{a1} X_{a1} + \beta_{a2} X_{a2} + \beta_{a3} X_{a3}}}{1 + e^{\alpha + \beta_{a1} X_{a1} + \beta_{a2} X_{a2} + \beta_{a3} X_{a3}}} \quad (6b)$$

Where π_a the probability of having ARI, X_{a1}=Floor Material, X_{a2}=Persons per room and X_{a3} = Type of cooking fuel.

CHAPTER FOUR

4. DATA ANALYSIS AND FINDINGS

This chapter presents the empirical analysis of the study on the extent to which the housing environment is a contributor to child morbidity in Nairobi. The results of the data analysis are presented and discussed in this chapter. The KDHS data were processed in response to the objectives posed in chapter one of this research. The objectives were:

- To establish the prevalence rate of diarrhoea and acute respiratory infection vis-à-vis housing conditions in Nairobi
- To assess the relationship between housing conditions and child morbidity (diarrhoeal morbidity and acute respiratory infection) in Nairobi

This chapter is organized into four sections namely: *Distribution of the population by background characteristics; Cross tabulation to establish prevalence rates of morbidity in housing conditions; Bivariate Analysis;* and *Multivariate analysis*. The second objective of the study is achieved in the last two sections.

4.1. Distribution of the population by background characteristics

This section looks at the characteristics of the study population according to the study variable. It gives the frequency distributions of children under the age of five years according to various housing characteristics. The KDHS 2003 dataset was filtered by urban place of residence and Nairobi Region. Thereafter, the dataset was cleaned to remove missing values in the variables of interest in order to arrive at clean set of cases that was consistent i.e. cases not having missing values in all the variables of interest. After this process, the sample arrived at and has consequently been used in this study 432 children in Nairobi (N=432). The frequencies were computed and presented below in Table 4.1. The children under the age of five that with diarrhoea in the two weeks

preceding the survey were 12.3 percent (53 out of 432) whereas 15.5 percent had symptoms of ARI percent (67 out of 432)[9].

In Nairobi, the main source of water was tap water (piped water). This has been dichotomized in this study into two categories namely: Piped into dwelling and Piped but outside dwellings (i.e. Public tap: Piped into compound/plot). The proportion of the study population who lived in housing where the source of water were public tap or piped in yard/plot was 55.3 percent and those who lived in housing which had piped water into the dwelling was 44.7 percent.

For the purpose of this analysis, the predominant forms of sanitation in Nairobi were considered i.e. pit toilets (Traditional pit toilet, Ventilated improved toilet) and flush toilets. 27.5 percent (119 of 432) of the children in this study lived in housing whose sanitation facility were in the form of pit toilets whereas 72.5 percent lived in dwellings that had flush toilets.

Kerosene is the predominantly used fuel for cooking in Nairobi and 62.3 percent of the children under consideration lived in households where kerosene is used. 23.6 percent of the children lived in housing where LPG / natural gas or biogas or electricity was used and 14.1 percent lived in housing where charcoal is used.

[9] It is important to note that from the unclean KDHS sample the number of the children under the age of five in Nairobi were 508 Percentage of children under five years with diarrhoea in the two weeks preceding the survey were 13.8 percent (70 out of 508) whereas 16.6 percent had symptoms of ARI (83 out of 508).

Table 4.1: Frequency Distribution of the Children (under five years old) by background characteristics

Variable	Count	Percentage
Had diarrhea in last two weeks		
No	379	87.7
Yes	53	12.3
Total	432	100
Had acute respiratory infection		
No	365	84.5
Yes	67	15.5
Total	432	100
Source of water		
Public tap, piped in yard/plot	239	55.3
Piped into dwelling	193	44.7
Total	432	100
Type of toilet facility (Sanitation)		
Pit Toilets (Traditional pit toilet, Ventilated improved toilet)	119	27.5
Flush Toilet	313	72.5
Total	432	100
Type of floor material (Physical Characteristic)		
Earth floor	27	6.3
Non-earth floor	405	93.8
Total	432	100
Type of cooking fuel		
Charcoal	61	14.1
Kerosene	269	62.3
LPG/natural gas, biogas, Electricity	102	23.6
Total	432	100
Mother's Highest level of Educational		
Primary level and below	213	49.3
Secondary level and above	219	50.7
Total	432	100
Average number of household members sleeping per room used for sleeping		
1	17	3.9
2	91	21.1
3	135	31.3
4	91	21.1
5	57	13.2
6	23	5.3
7	15	3.5
8	2	0.5
9	1	0.2
Total	432	100.0

The analysis shows that 6.3 percent of the children under the age of five in Nairobi live in dwelling units whose floor is earthen whereas 93.8 percent lived in dwellings that had non-earthen floors. With regard to the sufficiency of living area, the highest number of children (135) lived in housing where the average number of household members sleeping per room was 3 this, this accounted for 31.3 percent of the children within this age bracket. However, if the average number of household members sleeping per room was dichotomized as per UN-HABITAT definition of overcrowding, 44 percent of the children under the age of five are regarded as living in overcrowded housing, i.e. living housing where more that three persons sleep per room.

In regard to the highest level of education of mothers, 49.3 percent of the children under the age of five in Nairobi had mothers whose highest level of education was primary school or below . On the other hand, 50.7 percent of the children had mothers whose highest level of education was secondary school and beyond.

4.2. Cross tabulation to establish prevalence rates of morbidity in housing conditions

At this stage the association between each of the independent variables and the dependent is investigated. The independent variables are cross tabulated against the dependent variables to give the prevalence rates for children morbidity in the different housing conditions. The results are summarized in Table 4.2 and Table 4.3 for diarrhoea and Table 4.4 for ARI.

Table 4.2: Prevalence of Diarrhoea among Children (under 5 years) on various housing characteristic and maternal education (2003)

Name of Variable	Had Diarrhoea in last two weeks (percent)		N
	Yes	No	
Source of water			
Public tap, piped in yard/plot	16.3	83.7	239
Piped into dwelling	7.3	92.7	193
Total	12.3	87.7	432
χ^2 value = 8.150			
Degrees of freedom (df) = 1			
Significance = 0.004			
Type of toilet facility (Sanitation)			
Pit Toilets (Traditional pit toilet, Ventilated improved toilet)	22.7	77.3	119
Flush Toilet	8.3	91.7	313
Total	12.3	87.7	432
χ^2 value = 16.570			
Degrees of freedom (df) = 1			
Significance = 0.000			
Type of floor material (Physical Characteristic)			
Earth floor	37.0	63.0	27
Non-earth floor	10.6	89.4	405
Total	12.3	87.7	432
χ^2 value= 16.415			
Degrees of freedom (df)=1			
Significance= 0.000			
Mother's Highest level of Education			
Primary level and below	14.6	85.4	213
Secondary level and above	10.0	90.0	219
Total	12.3	87.7	432
χ^2 value= 2.039			
Degrees of freedom (df)=1			
Significance= 0.153			
Average number of household members sleeping per room used for sleeping			
1	11.8	88.2	17
2	14.3	85.7	91
3	10.4	89.6	135
4	14.3	85.7	91
5	8.8	91.2	57
6	17.4	82.6	23
7	13.3	86.7	15
8	0.0	100.0	2
9	0.0	100.0	1
Total	12.3	87.7	432
χ^2 value= 2.788			
Degrees of freedom (df)=8			
Significance= 0.947			

The results in Table 4.2 indicate that there is a considerable discrepancy between the two piped water sources in terms of the prevalence of diarrhoea among children under the age of five. The prevalence rate of diarrhoea among children in housing where the source of water was public tap or piped into the compound/ plot was 16.3 percent, a figure more than double the rate where water is piped into dwellings (7.3 percent). In regard to sanitation, a higher prevalence of diarrhoea among children under the age of five was recorded in households that had pit toilets (22.7 percent). This was nearly three times that in households whose sanitation facility is flush toilet (8.3 percent).

In terms of the physical characteristics of dwellings, more than a third of the children under the age of five who live in housing environments with earthen floors (i.e. 37 percent) had diarrhoea; this was three and a half times the prevalence rate of diarrhoea among children who lived in houses with non-earth floor materials (10.6 percent).

When overcrowding is looked at, the prevalence of diarrhoea among children who lived in housing where the average number of household members sleeping per room is more than three was marginally above that of those who lived where three or less household members sleep per room. The prevalence of diarrhoea in the latter was 14.4 percent whereas in the latter it was 13.4 percent. The prevalence rate of diarrhoea among the children whose mother's highest level of education is primary school of below was 14.6 percent whereas that of those whose mothers attained secondary or higher levels of education was 10 percent.

Table 4.3: Prevalence of Diarrhoea among Children (under 5 years) on two housing typologies

	Had diarrhea in last two weeks (percent)		Total
	Yes	No	
Housing "A"	5.9	94.1	136
Housing "B"	15.2	84.8	296
	12.3	87.7	432

χ^2 value= 7.521
Degrees of freedom (df)=1
Significance=0.006

Housing "A" is housing that meets the following criteria

- has water piped into dwellings.
- has flush toilet
- has non-earth floor
- has three or less members sharing a sleeping room

Housing "B" is housing that lacks any of the above aspects

From Table 4.3 it is evident that only a third of children under the age of five in Nairobi lived housing "A". For children living in Housing "A" the prevalence of diarrhoea was much more less (5.6 percent) compared to the children living in Housing type "B" (15.2 percent)

In regard to ARI prevalence, the results in Table 4.4 indicate that a third of the children under the age of five in Nairobi who lived in housing in which the floor was earthen had ARI. This proportion was more than double the prevalence reported in housing with non-earth floors (14.3 percent).

In regard to the type of fuel used in the household and ARI, the highest prevalence of ARI was among those children who lived in housing where kerosene as used as the main cooking fuel, 17.8 percent of these had ARI; a prevalence greater than where other forms of fuels are used. Children who lived in housing where the main of cooking fuel used were "Charcoal" and "LPG/natural gas, biogas, Electricity" had an ARI prevalence of 8.2 percent and 13.7 percent, respectively.

Table 4.4: Prevalence of ARI among Children (under 5 years) on various housing characteristic and maternal education (2003)

Name of Variable	Had ARI in last two weeks (percent)		N
	Yes	No	
Type of Floor Material			
Earth floor	33.3	66.7	27
Non-earth floor	14.3	85.7	405
Total	15.5	84.5	432
χ^2 value=**6.982**			
Degrees of freedom (df)=1			
Significance= **0.008**			
Type of cooking fuel			
Charcoal	8.2	91.8	61
Kerosene	17.8	82.2	269
LPG/natural gas, biogas, Electricity	13.7	86.3	102
Total	15.5	84.5	432
χ^2 value=**3.85**			
Degrees of freedom (df)=2			
Significance= **0.145**			
Mother's Highest level of Education			
Primary level and below	16.9	83.1	213
Secondary level and above	14.2	85.8	219
Total	15.5	84.5	432
χ^2 value=**3.72**			
Degrees of freedom (df)=1			
Significance= **0.054**			
Average number of household members sleeping per room used for sleeping (Overcrowding)			
1	17.6	82.4	17
2	14.3	85.7	91
3	13.3	86.7	135
4	19.8	80.2	91
5	8.8	91.2	57
6	30.4	69.6	23
7	6.7	93.3	15
8	50.0	50.0	2
9	100.0	0.0	1
Total	15.5	84.5	432
χ^2 value= **15.961**			
Degrees of freedom (df)=8			
Significance= **0.042**			

The prevalence of ARI among children who lived in housing where the average number of household members sleeping per room is more than three was higher that of those who lived where three or less household members sleep per room. The prevalence of ARI in the former was 17.4 percent whereas in the latter it was 14 percent.

Among the children whose mother's highest level of education is primary school of below the prevalence rate of ARI was 16.9 percent that of whose mothers attained secondary or higher levels of education the ARI prevalence rate was 14.2 percent.

4.3. Bivariate Analysis

In this third stage of analysis the variables that showed an association with any of the morbidity conditions were analyzed. In the bivariate analysis, the relationship between the independent variables and the dependent variables was examined by carrying out a binary logistic regression to examine the effect of each of the independent variable and its significance in explaining the relationship between the variable and the morbidity conditions. Table 4.5 and Table 4.6 outline the results obtained for Diarrhoeal morbidity and ARI respectively.

From Table 4.5, the results of the bivariate analysis show that the odds of a child having diarrhoea is significantly decreased by a factor of 0.401 in children who live in housing where water is piped into dwelling. In other words, they are 59.9 percent less likely to have diarrhoea compared to those whose live in households who rely on water supply that is not piped into the dwelling i.e. public tap Piped into compound/plot or public tap ($p<0.01$) . The relation was significant at 0.05 level of significance.

Table 4.5: Bivariate logistic regression of Diarrhoea among children (under 5 years) on various housing variables

Variables	B	S.E	Significance (*p* value)	Odds ratio (exp β)
Source of water				
Public tap, piped in yard/plot (r)				1
Piped into dwelling	-0.914	0.328	0.005	0.401***
Constant	-0.721	0.447	0.106	0.486
Model Chi-square = 8.531 *Model Sig. = 0.003* *R square = 0.20*				
Type of toilet facility (Sanitation)				
Pit Toilets (Traditional pit toilet, Ventilated improved toilet) (r)				1
Flush Toilet	-1.175	0.300	0.000	0.309***
Constant	-1.226	0.219	0.000	0.293
Model Chi-square = 15.010 *Model Sig. = 0.000* *R square = 0.34*				
Type of floor material (Physical Characteristic)				
Earth floor (r)				1
Non-earth floor	-1.600	0.430	0.000	0.202***
Constant	-0.531	0.399	0.183	0.588
Model Chi-square = 11.887 *Model Sig. = 0.001* *R square = 0.27*				
Average number of household members sleeping per room used for sleeping				
Average number per room	-0.017	0.103	0.870	0.983
Constant	-1.908	0.387	0.000	0.148
Model Chi-square = 0.027 *Model Sig. = 0.87* *R square = 0.27*				
Mother's Highest level of Education				
Primary level and below (r)				1
Secondary level and above	-0.422	0.297	0.155	0.656
Constant	-1.770	0.194	0.000	0.170
Model Chi-square = 2.046 *Model Sig. = 0.153* *R square = 0.005*				
Housing Typology				
Housing "B" (r)				1
Housing "A"	-1.054	0.339	0.008	0.349***
Constant	0.665	0.487	0.173	0.514
Model Chi-square = 8.449 *Model Sig. = 0.004* *R square = 0.019*				

(r) – Reference category
***** Significant at 0.01 significant level**
**** Significant at 0.05 significant level**
*** Significant at 0.1 significant level**

In regard to the type of sanitation facility and diarrhoea, the odds of having children having diarrhoea are decreased by a factor of 0.309 if they lived in housing that has a flush toilet compared to when the form of sanitation facility were pit toilets {i.e. Children in housing with flush toilets are 69.1 percent less likely to have diarrhoea when compared to children housing with pit toilets ($p < 0.01$) }

The bivariate of analysis of the type of the physical characteristics of the dwellings in terms of the material used in the construction of the floor and diarrhoea shows that the odds of children having diarrhoea are decreased by a factor of 0.202 if the floor is non-earthen {i.e. children living housing with non-earth floors are 79.8 percent less likely to have diarrhoea compared to those living whose floors are earthen ($p < 0.01$) }.

When "Average number of household members sleeping per room used for sleeping "which is a continuous variable is subjected the logistic regression, the number of inhabitants in the dwelling not significantly related to the prevalence of diarrhoea among children under the age of five in Nairobi. A bivariate analysis of diarrhoea and the mother's highest level of education (which is a control variable in this study) show that in Nairobi the likelihood of children whose mother's highest level of education is secondary or higher education having diarrhoea is non-significantly reduced ($p>0.1$) when compared to those whose mothers attained the primary level education or lower.

Children living in "Housing A" (i.e. housing has water piped into the dwellings and the kind of sanitation was flush toilets and where the floor dwellings were non-earthen and the density of persons sleeping per sleeping was three or less) were 65 percent less likely to have diarrhoea compared to those who lived in "Housing B".

Table 4.6: Bivariate logistic regression of ARI among children (under 5 years) on various housing variables

Variables	B	S.E	Significance (*p* value)	Odds ratio (exp β)
Type of Floor Material				1
Earth floor (r)				
Non-earth floor	-1.096	0.432	0.011	0.334***
Constant	-0.693	0.408	0.090	0.500
Model Chi-square = 5.688				
Model Sig. = 0.017				
R square = 0.13				
Type of cooking fuel				1
Charcoal (r)				
Kerosene	0.889	0.493	0.071	2.433*
LPG/natural gas, biogas, Electricity	0.578	0.548	0.292	1.782
Constant	-2.416	0.467	0.000	0.089
Model Chi-square = 4.252				
Model Sig. = 0.119				
R square = 0.010				
Average number of household members sleeping per room used for sleeping				.
Average number per room	0.084	0.090	0.351	1.088
Constant	-1.996	0.354	0.000	0.136
Model Chi-square = 0.856				
Model Sig. = 0.355				
R square = 0.002				
Mother's Highest level of Education				1
Primary level and below (r)				
Secondary level and above	-0.210	0.266	0.431	0.811
Constant	-1.593	0.183	0.000	0.203
Model Chi-square =0.622				
Model Sig. =0.431				
R square = 0.001				

(r) – Reference category
***** Significant at 0.01 significant level**
**** Significant at 0.05 significant level**
*** Significant at 0.1 significant level**

In regard to ARI, the results of the bivariate analysis in Table 4.6 shows that children living in housing environments which have non-earth floors are 66 percent less likely to have ARI in comparison to those in earthen floors ($p<0.05$). The analysis of the type of cooking fuel and ARI indicates that children living in housing where kerosene is used as the main cooking fuel are 2.4 times more likely to have ARI in comparison to children in environments where charcoal is used ($p<0.1$).

When "Average number of household members sleeping per room used for sleeping" which is a continuous variable is subjected the logistic regression, the model is not significant. Inasmuch as the Chi-square's test at the cross tabulation level showed some level of association this variable is not a significant predictor of ARI prevalence in Nairobi the among children under the age of five. An increase in numbers non -significantly increases the prevalence of ARI among children under the age of five. The model has a p > 0.1. The bivariate analysis of ARI and the mother's highest level of education also show that in Nairobi show that the variable is not a significant predictor of ARI

4.4. Multivariate Analysis

Multivariate analysis involves two or more independent variables acting on a dependent variable. This section presents the multivariate results using logistic regression whereby in order to determine the net effect of selected independent variables. In order to carry out multivariate analysis with multiple predictors, the researcher checked for multicollinearity[10] by looking at the correlation matrix of the independent variables that were significant independent at the bivariate analysis. The correlation matrix , Table 4.7, shows that there is no independent variables that are highly correlated to qualify multicollinearity.

[10] Multicollinearity is a statistical phenomenon in which two or more predictor variables in a multiple regression model are highly correlated i.e. it exists whenever an independent variable with one or more other independent variables in a multiple regression equation. In this situation the coefficient estimated may change erratically in response to small changes in the model or the data. Multicollinearity does not reduce the predictive power or reliability of the model as a whole; it only affects calculations regarding individual predictors. That is, a multiple regression model with correlated predictors can indicate how well the entire bundle of predictors predicts the outcome variable, but it may not give valid results about any individual predictor, or about which predictors are redundant with others

Table 4.7: Correlation Matrix for Independent Variables

		Water Source	Type of toilet facility (Sanitation)	Type of cooking fuel	Type of floor material (Physical Characteristic)	Average number of household members sleeping per room used for sleeping
Water Source	Pearson Correlation	1	.523(**)	.228(**)	.194(**)	-.296(**)
	Sig. (2-tailed)	.	.000	.000	.000	.000
	N	432	432	432	432	432
Type of toilet facility (Sanitation)	Pearson Correlation	.523(**)	1	.216(**)	.226(**)	-.155(**)
	Sig. (2-tailed)	.000	.	.000	.000	.001
	N	432	432	432	432	432
Type of cooking fuel	Pearson Correlation	.228(**)	.216(**)	1	.072	-.279(**)
	Sig. (2-tailed)	.000	.000	.	.136	.000
	N	432	432	432	432	432
Type of floor material (Physical Characteristic)	Pearson Correlation	.194(**)	.226(**)	.136	1	-.126(**)
	Sig. (2-tailed)	.000	.000	.000	.	.009
	N	432	432	432	432	432
Average number of household members sleeping per room used for sleeping	Pearson Correlation	-.296(**)	-.155(**)	-.279(**)	-.126(**)	1
	Sig. (2-tailed)	.000	.001	.000	.009	.
	N	432	432	432	432	432

** Correlation is significant at the 0.01 level (2-tailed).

A Multivariate logistic regression model was employed to evaluate associations between the housing variables and the under-five childhood morbidity. This multiple logistic regression analysis was used to disentangle the separate influence of various factors when the housing variables alone are modeled for diarrhoea and the coefficients are shown in Table 4.8.Among the independent variables, only the type of toilet facility and type of floor material were found to be independently associated with childhood under-five morbidity. Children living in housing where the sanitation facility is a flush toilet are 57 percent less likely to have diarrhoea compared to children from households that use pit toilets ($p<0.05$). In regard to the physical characteristics of the dwellings, Children who lived in housing that had non-earthen floors were 71 percent less likely to have diarrhoea compared to those who lived in houses that had earthen floor. The most surprising was the

variable for source of water, in the presence of other variables were not significantly associated with diarrhoea in the multivariate analysis stage .This is most likely due to the fact that both the water sources was piped.

In Table 4.9 the mother's education was entered into the model but its effect was insignificant showing that in Nairobi the mother's level education was not associated with diarrhoea in this analysis.

Table 4.8: Multiple logistic regression of Diarrhoea among children (under 5 years) on multiple predictors

Variables	B	S.E	Significance (*p* value)	Odds ratio (exp β)
Source of water				1
Public tap, piped in yard/plot(r)	-0.416	0.413	0.314	0.660
Piped into dwelling				
Type of toilet facility (Sanitation)				1
Traditional pit toilet, Ventilated improved toilet (r)	-0.837	0.371	0.024	0.433**
Flush Toilet				
Type of floor material (Physical Characteristic)				1
Earth floor (r)	-1.251	0.459	0.006	0.286***
Non-earth floor				
Average number of household members sleeping per room used for sleeping				1
Average number per room	-0.142	0.112	0.208	0.868
Constant	0.753	0.788	0.339	2.123
Model Chi-square = 23.957				
Model Sig. = 0.054				
R square = 0.000				

(r) – Reference category
***** Significant at 0.01 significant level**
**** Significant at 0.05 significant level**

Table 4.9: Multiple logistic regression of Diarrhoea among children (under 5 years) on multiple predictors controlling for mothers education

Variables	B	S.E	Significance (*p* value)	Odds ratio (exp β)
Source of water				
Public tap, piped in yard/plot(r)				1
Piped into dwelling	-0.427	0.418	0.306	0.652
Type of toilet facility (Sanitation)				
Traditional pit toilet, Ventilated improved toilet (r)				1
Flush Toilet	-0.843	0.373	0.024	0.431**
Type of floor material (Physical Characteristic)				
Earth floor (r)				1
Non-earth floor	-1.276	0.478	0.008	0.279***
Average number of household members sleeping per room used for sleeping				
Average number per room	-0.138	0.114	0.228	0.871
Mother's Highest level of Education				
Primary level and below (r)				1
Secondary level and above	0.063	0.346	0.857	1.065
Constant	0.751	0.788	0.341	2.118
Model Chi-square 23.989				
Model Sig. 0.000				
R square 0.054				

(r) – Reference category
***** Significant at 0.01 significant level**
**** Significant at 0.05 significant level**

A multivariate analysis to disentangle the separate influence of various factors when the housing variables alone are modeled for ARI shows that only the type of floor, among the variables, was significant. The coefficients indicate that the children living in dwellings that have non-earth floors are 63 percent less likely to have ARI ($p<0.05$).shown in Table 4.10. When the model is controlled for mother's education (Table 4.11) the mother's education has an insignificant effect, the use of kerosene as the main cooking fuel non-significantly increases likelihood of a child having ARI ($p<0.1$)

Table 4.10: Multiple logistic regression of ARI among children (under 5 years) on multiple predictors

Variables	B	S.E	Significance (*p* value)	Odds ratio (exp β)
Type of Floor Material				
Earth floor (r)				1
Non-earth floor	-0.992	0.443	0.025	0.371**
Type of cooking fuel				
Charcoal(r)				1
Kerosene	0.806	0.497	0.105	2.239
LPG/natural gas, biogas, Electricity	0.678	0.562	0.227	1.970
Average number of household members sleeping per room used for sleeping				
Average number per room	0.046	0.098	0.641	1.047
Constant	-1.640	0.735	0.026	0.194

Model Chi-square 9.151
Model Sig. 0.057
R square 0.027
(r) – Reference category

**** Significant at 0.05 significant level**
*** Significant at 0.1 significant level**

Table 4.11: Multiple logistic regression of ARI among children (under 5 years) on multiple predictors controlling for mothers education

Variables	B	S.E	Significance (*p* value)	Odds ratio (exp β)
Type of Floor Material				
Earth floor(r)	-0.951	0.464	0.040	1
Non-earth floor				0.386**
Type of cooking fuel				
Charcoal(r)				1
Kerosene	0.829	0.503	0.099	2.291*
LPG/natural gas, biogas, Electricity	0.730	0.588	0.215	2.075
Average number of household members sleeping per room used for sleeping				
Average number per room	0.041	0.099	0.676	1.042
Mother's Highest level of Education				
Primary level and below(r)				1
Secondary level and above	-0.092	0.312	0.767	0.912
Constant	-1.644	0.735	0.025	0.193

Model Chi-square =9.239
Model Sig. =0.100
R square = 0.021
(r) – Reference category
**** Significant at 0.05 significant level**
*** Significant at 0.1 significant level**

4.5. Discussion on the Findings

The higher prevalence of diarrhoea among children living in households whose source of water is public tap or water piped in yard/ plot when compared to those children living where water is piped into the dwelling could be attributed to underlying safety problems in the former given that storage is usually in the form of containers and contamination is likely thus compromising the water safety. At the multivariate analysis, in the presence of other predictors, water piped into the dwelling is seen as non-significant predictor of childhood diarrhoea in Nairobi. This is not surprising due to the fact that technically the main sources of water in this study are the same i.e. both are piped water sources, regardless of whether it is piped in the public places or piped into dwelling. In the international organizations circles and Kenya's Central Bureau of Statistics and other related agencies all these piped categories would fall under what is regarded as "improved" sources of water and thus considered safe (WHO and UNICEF ,2003; UNCHS, 2004; CBS, 2007).

The higher prevalence of diarrhoea among children living in housing whose form of sanitation is pit toilets compared to where flush toilets are used is consistent with the findings of Tumwine *et al* (2002), Omar (1993) and Timaeus and Lush (1995). The higher prevalence of diarrhoea where pit toilets are used is likely due to the fact that children cannot use these facilities and either resort to defecation on in the yard or chamber pots whose contents are disposed off after use. Depending on how they are disposed of thereafter unsanitary conditions are likely to be created within the housing environment leading contamination by pathogens which Osumanu (2007) alludes to , especially if they are either thrown in the outside the dwelling or outside the yard, thus leading to higher prevalence of diarrhoea. In Nairobi, children living in housing environments where flush toilet is the form of sanitation 57 percent less likely to have diarrhoea compared to those

living in households that use pit toilets. This shows that the use of flush toilets has significant impact in reduction of diarrhoea among children.

The higher prevalence of diarrhoea among children living in housing whose flooring was earthen is not surprising and confirms the findings of Woldemicael (2001); since earthen floors cannot be washed , they are likely to provide breeding ground for various diarrhoea-causing agents than non-earthen floors. This high prevalence of diarrhoea is likely being a result of this fact. From the multivariate analysis, it is evident that children in Nairobi living in housing whose floor is non-earthen are 71 percent less likely to have diarrhoea compared to those living where the floor is earthen, indicating that non-earthen floors could potentially result in dramatic declines in diarrhoeal disease in Nairobi. This, however, study found no association between sleeping per room in the dwelling and diarrhoea among children in Nairobi.

Inasmuch as the prevalence of diarrhoea among children whose mother's highest level of education is primary school and below was marginally higher than for those whose mothers had secondary education or above there seemed to be lack of association. In the logistic regression, the lack of association between maternal education is not surprising as other studies (Benneh *et al*, 1993; Huttly *et al*.1987) found a similar lack of association between maternal education and childhood diarrhoea.

In regard to ARI, this study found a higher ARI prevalence among children living in housing with non-earth floors and also among children who lived in housing where the average number of household members sleeping per room is more than three. However, only the type of floor emerged significant at the multivariate analysis showing that

children living in housing that have non-earthen floors are 63 percent less likely to suffer from ARI.

This study found a high prevalence of ARI among children in households where Kerosene was used as the main cooking fuel compared to where charcoal or LPG, biogas, electricity was used. However, there was no significant association between the type of cooking fuel and prevalence of ARI in Nairobi probably because these fuels are regarded as 'medium' or mild pollutants. The rates of ARI did not vary significantly with maternal education and was insignificant thus going against the findings of Kazi and Azad (2009) who found an association in Bangladeshi. This study also did not find any association between sleeping per room in the dwelling and ARI among children in Nairobi.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

This chapter summarizes the whole research, outline major findings and make conclusions based on the findings. Recommendations for policy and future research are also given at the end of the chapter

5.2. Summary of Findings

This study set out to analyze the extent to which the housing environment is a contributor to child morbidity in Nairobi by looking at the relationship between housing variables and the two morbidity conditions which are major contributors to child mortality in the Sub-Saharan countries (i.e. Diarrhoea and ARI

The source of data for this study was Kenya Demographic health Survey (KDHS) 2003. A study sample was taken. This sample comprised of children under the age of five in Nairobi. The sample was cleaned to eliminate any missing variables and a clean sample of 432 children was arrived at.

The main objective of this study was to investigate the relationship between the housing environment and prevalence of child morbidity in Nairobi. This study confined itself water, sanitation, physical characteristic of housing as indicated by the type of material used in the construction of floors, the sufficiency of the living spaces(overcrowding) and the type of cooking fuel used in the housing.

Cross tabulation was used to meet the first objective of the study (*To establish the prevalence rate of acute respiratory infection, diarrhoeal diseases vis-à-vis housing conditions in Nairobi*) .In the cross tabulation the study revealed that the prevalence rate for diarrhoea was lower for children who lived in housing that had water piped into the dwellings, where the kind of sanitation was flush toilets, where the floor dwellings were non-earthen , and had marginally lower density of persons sleeping per room i.e. three or less. Overall, the children living in housing that has a combination of the following: water piped into the dwellings, flush toilets, non-earthen floor and the density of persons sleeping per room of three or less, had a diarrhoea prevalence rate of 5.9 percent whereas those who lived in housing that did not meet this criteria had a diarrhoea prevalence of 15.2 percent and indication that housing indeed has a relationship with diarrhoea. The former were 65 percent less likely to have diarrhoea compared to the latter.

In regard to diarrhoea, the findings of this study are consistent to those of Tumwine *et al* (2002), Omar (1993) and Timaeus and Lush (1995) who found type of sanitation facility also appears to be closely related with diarrhoea morbidity with lower prevalence rates in flush toilets compared to pits. In regard to low prevalence of diarrhoea where water has been piped into dwellings this study corroborates the findings of Timaeus and Lush (1995) who found the prevalence of diarrhoea among children who had water piped into their dwellings to be low compared to others where this was not the case.

In regard to ARI, this study found a higher ARI prevalence among children living in housing with non-earth floors and also among children who lived in housing where the average number of household members sleeping per room is more than three.

In a multivariate analysis using the housing predictors and diarrhoea the type of toilet and type of floor (an indicator of the physical characteristics of the dwelling) emerge to be significant and appears to have more effect in prediction of the probability of a child having diarrhoea. Water piped into the dwelling emerges to be non-significant in Nairobi due to the fact that technically the main sources of water in this study are the same i.e. piped water, regardless of whether it is piped in the public places or piped into dwelling. In the international organizations circles and Kenya's Central Bureau of Statistics and other related agencies all these piped categories would fall under what is regarded as "improved" sources of water. However shown in the cross tabulation there was remarkable discrepancy on the diarrhoeal prevalence among children where water was piped into the dwelling and where water was piped in spaces outside the dwellings. The bivariate analysis also showed a lower likelihood of those with piped water within the dwelling having diarrhoea. The number of people dwelling in the house was not significantly related to diarrhoea.

In regard to the ARI, the physical characteristics of the dwellings where children live as indicated by the type of floor material emerged as a significant predictor of ARI in the city of Nairobi. Children living in dwellings that have non-earthen floors were 63 percent less likely to have ARI when other factors were controlled for. The use of kerosene non-significantly increased the likelihood of having ARI among children in Nairobi this partly confirms. Maternal education and overcrowding emerged to be insignificant.

5.3. Conclusion

The study found that there is existence of a significant contribution by the housing environment to prevalence of child morbidity in Nairobi. These findings agree with other

studies carried out as alluded to. However, the number of people living within a dwelling (overcrowding) has been found to have an insignificant bearing on the child morbidity. Maternal education has an insignificant effect on the child morbidity in Nairobi given that when it was controlled there was no significant change on the contribution of the housing variable on child morbidity in Nairobi. Through logistic regression this study identified the "type of floor" to be the most important housing variable in regard to child morbidity. Children who lived in housing that had non-earthen floors were 71 percent less likely to have diarrhoea compared to those who lived in houses that had earthen floor whereas children living in dwellings that have non-earth floors are 63 percent less likely to have ARI. The nature of floor is not only an indicator of the physical characteristics of a dwelling but it could also serve as an indicator to of environmental contamination given that earthen floors are more likely to provide breeding ground for various disease causing agents compared to non-earthen floors.

5.4. Recommendations

The results of this study are of high policy relevance especially in the improvement of housing conditions in Nairobi. In the improvement of child health, basic health care delivery systems, treatment and preventive actions and programs in Nairobi must be improved alongside well-tailored and integrated housing strategies. This study has revealed that there is a need for considerable sophistication for local authorities to detect the relationships between the major health problems and the housing within their jurisdiction in order to design and implement appropriate interventions.

Evidently, the results of this study have implications housing policy. The policy should integrate aspects that will reduce child morbidity by addressing the provision of housing by taking cognizance of the physical aspects of housing do have a significant linkage with

child morbidity. This study opens up an area that has not been explored in the regard to the mitigation of child morbidity. Quality of housing stock can play an important role in health improvement .Many programs and campaigns aimed at reducing the prevalence of diarrhoea have predominantly targeted water and sanitation ignoring the physical attributes of the house yet these too are significant as clearly shown by this study. Non-earth floors such as concrete floors should be viewed as a health measure and part intervention for these health problems. It is therefore imperative that an integrated policy approach for addressing health in the housing policy should be established. This should recognize that sustainable human settlements depend on the creation of better living environment for human health.

The City Council of Nairobi must provide the normative framework and the supporting infrastructure for improvement of housing. Since housing in Nairobi currently is organized by city inhabitants themselves the local and national authorities need to improve the quality of such housing by guaranteeing sufficient affordable house sites served with piped water, sewer systems, cheap building materials and affordable credit. From this study it is evident that the Local government needs to invest more in the improvement of urban infrastructure services e.g. sewerage systems that would increase access to sanitation facilities such as flush toilets which ultimately reduce environmental health threats from improper sanitation.

Generally there is a lack of reliable and comprehensive data that would enable more of such analyses and monitoring. There is a great need for the City Council of Nairobi to have regular city-wide surveys where a comprehensive database can be available that would permit studies and monitoring of housing conditions and the health of urban population comparisons across different location and over time. This is likely to aid in the interventions that are evidence-based.

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APPENDIX

Results from the latest Kenya Demographic and Health Survey Reports

Diarrhoea:

The report of the latest Kenya Demographic and Health Survey (2008- 2009) released during the time this study was being concluded (June 2010). However, the datasets were not available to the researcher for further analysis. Nevertheless the published KDHS 2008-2009 report shows that the prevalence rate of diarrhoea among children under the age of five in Nairobi has marginally dropped to 11.9 percent as shown from the extract below. In 2003, the rate was about 14 percent- as analyzed in this study it was 13.8 percent (see footnote on page 54) and this is corroborated by the rate given in the *Kenya Demographic and Health Survey 2003* Report (13.9 percent).

Table 10.6 Prevalence of diarrhoea

Percentage of children under age five who had diarrhoea in the two weeks preceding the survey, by background characteristics, Kenya 2008-09

Background characteristic	Diarrhoea in the two weeks preceding the survey		
	All diarrhoea	Diarrhoea with blood	Number of children
Age in months			
<6	13.0	1.4	535
6-11	29.9	3.0	606
12-23	21.8	4.3	1,096
24-35	16.1	3.4	1,132
36-47	10.1	1.6	1,071
48-59	6.1	1.6	1,041
Sex			
Male	17.4	3.0	2,814
Female	15.1	2.2	2,667
Source of drinking water[1]			
Improved	15.4	1.7	2,185
Not improved	18.2	3.9	3,296
Toilet facility[2]			
Improved, not shared	14.1	1.7	1,009
Non-improved or shared	17.1	2.8	4,471
Residence			
Urban	16.8	1.3	1,010
Rural	16.5	2.9	4,471
Province			
Nairobi	11.9	0.4	312
Central	14.4	1.5	437
Coast	21.2	5.2	466
Eastern	14.9	1.1	843
Nyanza	16.2	4.2	1,024
Rift Valley	15.9	2.2	1,531
Western	17.2	2.0	653
North Eastern	16.0	3.6	155
Mother's education			
No education	22.7	6.2	708
Primary incomplete	19.2	3.1	1,508
Primary complete	14.3	1.9	1,552
Secondary +	12.6	1.0	1,393
Wealth quintile			
Lowest	19.8	5.1	1,340
Second	15.7	2.2	1,115
Middle	15.2	1.9	1,007
Fourth	18.2	2.7	997
Highest	12.5	0.4	1,022
Total	16.6	2.6	5,481

[1] See Table 2.7 for definition of categories.
[2] See Table 2.8 for definition of categories.

Source: Kenya Demographic and Health Survey 2008-2009 Report

Acute Respiratory Infections:

The published KDHS 2008-2009 report also shows that the prevalence rate of ARI among children under the age of five has significantly dropped in Nairobi to 6.5 percent as shown from the extract below. In 2003, the rate was about 16 percent- as analyzed in this study it was 16.6 percent (see footnote on page 54) and this is corroborated by the rate given in the *Kenya Demographic and Health Survey 2003* Report (16.4 percent).

Table 10.4 Prevalence and treatment of symptoms of ARI

Among children under age five, the percentage who had symptoms of acute respiratory infection (ARI) in the two weeks preceding the survey, and among children with symptoms of ARI, the percentage for whom advice or treatment was sought from a health facility or provider, and the percentage who received antibiotics as treatment, according to background characteristics, Kenya 2008-09

Background characteristic	Children under age five		Children under age five with symptoms of ARI		
	Percentage with symptoms of ARI	Number of children	Percentage for whom advice or treatment was sought from a health facility or provider[1]	Percentage who received antibiotics	Number of children
Age in months					
<6	4.7	535	58.8	32.2	25
6-11	9.5	606	60.3	37.5	58
12-23	9.3	1,096	55.4	33.5	102
24-35	7.0	1,132	57.3	47.0	79
36-47	8.1	1,071	54.1	44.8	87
48-59	6.3	1,041	52.8	41.2	65
Sex					
Male	7.7	2,814	57.4	48.1	216
Female	7.5	2,667	54.3	37.2	200
Mother's smoking status					
Smokes cigarettes/tobacco	9.8	115	72.9	(58.2)	23
Does not smoke	7.3	5,361	55.2	43.0	390
Cooking fuel					
Electricity or gas	3.5	199	*	*	*
Kerosene	8.7	258	*	*	21
Coal/lignite	(3.0)	36	*	*	0
Charcoal	7.0	944	59.8	37.2	66
Wood straw/dung/other fuel[2]	8.0	4,065	53.7	52.3	323
Residence					
Urban	7.0	1,010	65.5	46.5	71
Rural	7.7	4,471	53.9	39.2	346
Province					
Nairobi	6.5	312	*	*	20
Central	7.5	437	(45.2)	(24.5)	33
Coast	12.5	466	56.4	34.5	58
Eastern	6.0	843	(52.6)	(28.2)	50
Nyanza	7.9	1,024	54.6	34.8	81
Rift Valley	7.8	1,581	58.0	34.8	123
Western	6.0	655	(45.4)	(56.3)	39
North Eastern	6.7	166	(60.9)	49.4	11
Mother's education					
No education	14.8	708	57.2	46.3	105
Primary incomplete	9.2	1,808	52.9	34.0	166
Primary complete	5.6	1,668	57.4	44.9	94
Secondary+	3.9	1,298	61.5	50.3	51
Wealth quintile					
Lowest	11.3	1,340	56.5	47.7	151
Second	7.0	1,115	48.0	37.0	78
Middle	6.4	1,007	62.5	62.4	64
Fourth	6.9	997	52.0	42.1	69
Highest	3.3	1,022	62.6	28.2	34
Total	7.6	5,481	55.9	43.9	416

Note: Total includes 5 children for whom mother's smoking status is missing. Numbers in parentheses are based on 25-49 unweighted cases; an asterisk denotes a figure based on fewer than 25 unweighted cases that has been suppressed.

[1] Symptoms of ARI: cough accompanied by short, rapid breathing which was chest-related; is considered a proxy for pneumonia.

[2] Excludes pharmacy, shop, and traditional practitioner

[3] Includes grass, shrubs, crop residues

Source: Kenya Demographic and Health Survey 2008-2009 Report