PUBLIC HEALTH IMPLICATIONS OF THE HOUSING, WATER AND SANITATION CONDITIONS IN KABURINI SLUM OF KAKAMEGA TOWN, KENYA

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DECLARATION

This research project is my original work and has not been presented for a degree or any other award in any other institution.

Signature…… Date……..

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This research project has been submitted for examination with our approval as university supervisors.

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ABSTRACT

In many African countries, including Kenya, rapid slum population growth is majorly experienced in towns and cities. Slum dwellers face many challenges such as poor housing conditions, improper excreta and waste water management, improper management of solid waste, insufficient and unsafe drinking water, and limited general cleanliness. This study is an assessment of public health implications of the housing, water and sanitation conditions in Kaburini slum of Kakamega town in Kenya. The specific objectives were to 1) determine the housing conditions in Kaburini; 2) evaluate the access to water and sanitation situation in Kaburini; and 3) assess the public health implications of the housing, water and sanitation conditions in Kaburini. The study objectives were achieved using a random sample of 62 households in Kaburini. The data generated from the field was analyzed using descriptive statistics. The results show that Kaburini slum suffers from poor housing, water and sanitation conditions, which is a major health risk for the residents. Most of houses are made of mud walls; have structural defects and dead spaces; get damp, cold and develop molds during the rainy seasons; and are overcrowded. Although the major source of water was piped water, a large majority of the households did not treat their drinking water. On sanitation, majority of households shared latrines which were not regularly cleaned and disinfected and used by many people per latrine. Lastly, the slum did not have any formal mode of waste disposal. Household waste was dumped in the open. The study recommends provision of good housing, water and sanitation conditions to the urban poor households and civic education on environmental sanitation.

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Special thanks go to my spouse Alima Mukasia, daughter Valerie Natasha, sons Trevor Innocent and Clyde Ishaan, for their invaluable love, moral support and encouragement throughout my studies. May the Lord bless you. Above all, I thank the Almighty God whose kindness and grace were immeasurable throughout the research period.

DEDICATION

To my Mum, Alice Nyabeta, and Dad, James Mariita, for their significant contribution in the family during the primary stages of socialization.

TABLE OF CONTENT

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study Problem

Urbanization is one of the major social changes all over the world. It is a result rural to urban migration with the increase of the number of people being equal to urban migration (Misilu et al., 2010). If this process of formation and growth of towns and cities is not planned and takes place rapidly, it will lead to emergence of informal settlements with poor and inadequate housing, poor sanitation conditions and unsafe drinking water, which can hasten the proliferation of diseases (Godfrey & Julien, 2005; Moore et al., 2003). Poor urban residents in informal settlements are over and over again undercounted, and the indicators used to quantify essential deficiencies are not offering the information to policy-makers which are needed to formulate and put into practice policies to deal with urban deficiencies (Lucci & Bhatkal, 2014).

Approximately 700 million people globally use unsafe drinking water, while about 2.5 billion citizens are not accessing reliable and enhanced sanitation facilities (UNICEF, 2015; WHO/UNICEF, 2014; Bartras et al., 2014). In India, those who do not use an enhanced sanitation facility are 792 million people and individuals who relied on shared sanitation had increased threat of diarrhea (Heijnen et al., 2014). A research done in Uganda's slums of Mukono and Kampala showed that there is a relationship between water, sanitation, and wellbeing. This was affirmed by the outbreak of ailments such as cholera, typhoid and diarrhea in children below 5 years of age (Bwire et al., 2013; WHO, 2015).

In many African countries, including Kenya, rapid slum population growth is majorly experienced in towns and cities (Hove et al., 2013). Slum dwellers are faced by a myriad of challenges such as poor housing conditions, improper excreta and waste water management, improper management of solid waste, insufficient and unsafe drinking water, and limited general cleanliness (Mukama et al., 2016). Diseases associated with diarrhea are brought about by water which is contaminated, poor sanitation and cleanliness (Bartram & Carncross, 2010).

In sub-Saharan Africa's urban centres, over 72% of the people reside in dilapidated neighbourhoods where overcrowding, poor drainage, poor garbage disposal, poor toilet facilities, and deficiency of clean and safe water access are rife (Ramin, 2009; UN, 2014; Andy Haines, 2012). This makes water related diseases to be prevalent in children below 5 years (Neelim, 2011; Bartram et al., 2014). On the other hand, over 68% of residents in Nairobi live in slums and face inadequacy of sanitation facilities (UN-HABITAT, 2014).Fundamentally, the safety of water may be compromised through haulage and how it is stored in household in spite of being from sources classified as improved (Boateng et al., 2013).

Studies on increased diarrheal diseases have linked them with poor sanitation (Alirol et al., 2011). Shared sanitation is associated with increased diarrheal diseases (Fuller et al. 2014). Notably, diarrhea is second in the causes of child deaths in the globe as well as the leading in Africa (Haydar et al., 2009). Statistics in sub-Saharan Africa show that the percentage is highest with an average of 18% households sharing sanitation (UNICEF/WHO, 2013).

1.2 Statement of the Problem

Slums are characterized by tribulations such as excreta and waste management; deprived housing and state of a home; insufficient and unsafe water and food; inadequate and poor sanitation facilities; and poor vector and vermin management (Mukama et al., 2016; UN-HABITAT, 2016; Addo, 2013). Whereas housing is an integral component of social conditions that determine the quality and welfare of urban residents, poor housing is now a public environmental health risk, especially in developing countries (Firdus & Ahmad, 2013; UN-HABITAT, 2012). For example, exposure to family unit air pollution, particularly from unhygienic cooking fuels, contributes to about 33% of the total sickness affliction from breathing related infections (Pruss-Ustun et al., 2016).

Respiratory sicknesses such as asthma, acute respiratory infections and tuberculosis are caused by air pollution of high levels from muck fuels and overcrowded living conditions (Sclar et al., 2005; UNICEF, 2012). Similarly, household members staying in

insufficiently ventilated houses have high level risk of suffering from indoor pollution related diseases (Hargreaves et al., 2011; Van Ham et al., 2012; Meijer et al., 2012). Furthermore, households more likely to suffer from water-borne diseases are those with drinking water which is not safe (En & Gan, 2011; Nganyanyuka et al., 2014; Shaheed et al., 2014a; UNICEF/WHO, 2012; UNICEF, 2014).

Many people from rural areas are attracted to urban areas to access and exploit opportunities of towns and cities as they are also portrayed as engines of growth (UN HABITAT, 2006). Like other urban centers, Kakamega town is facing deteriorating environmental conditions and urban poverty, especially in its slums. These low class housing estates have poor housing and environmental conditions; limited access to safe and good quality drinking water; and poor sanitation conditions. This study is an assessment of public health implications of the housing, water and sanitation conditions in Kaburini slum of Kakamega town in Kenya.

1.3 Research Questions

1. What are the housing conditions in Kaburini slum of Kakamega town?
2. What is the access to water and sanitation situation in Kaburini slum of Kakamega town?
3. What are the public health implications of the housing, water and sanitation conditions in Kaburini slum of Kakamega town?

1.4 Objectives of the Study

1. To determine the housing conditions in Kaburini slum of Kakamega town.
2. To evaluate the access to water and sanitation situation in Kaburini slum of Kakamega town.
3. To assess the public health implications of the housing, water and sanitation conditions in Kaburini slum of Kakamega town.

1.5 Justification of the Study

According to Njiru & Moronge (2013), housing is an important component of development. Housing is an essential physiological need in every society and in the cornerstone of family wellbeing. It also plays a significant role to the happiness, continued existence and health of an individual (Aribigbola, 2011). However, slums in developing countries are characterized by poor state of housing, insufficient access to safe water, and limited access to sanitation. As such, majority of slum dwellers get ill with diseases linked with poor state of housing, insufficient access to safe water, and limited access to sanitation. The right to a safer city is important to all city residents. Slum dwellers need better housing conditions, better access to safe water, and access to enhanced sanitation. The poor health conditions of the slum dwellers may water down the urban and national health indicators. The results of this study will be important in empirical based involvement by the relevant stakeholders.

The assessment of sanitation conditions and health implications is imperative in Kenya, given that the global disease burden data reveal that poor sanitation is the sixth and eight principal causes of lost life years for women and men, respectively (Flaxman et al., 2010). Between 1990 and 2010, poor sanitation emerged fourth as the leading cause of fatality in children below five years. Morbidity and mortality rates in Kenya have also been attributed to by poor sanitation particularly in women and girls. A study of the health impacts related with sanitation in the slum is important as the findings may influence policy and mitigation measures.

1.6 Operational Definitions and Concepts

Slum: An area characterized with limited access and unsafe drinking water, inadequate and poor sanitation, poor structural and housing conditions, overcrowding, and susceptible residential standing (UN Habitat, 2016).

Housing: It is a means which should provide a place or shelter for harmonious meeting by a family unit of diverse age, gender, education, line of work, academic modes and

principles; and also provides meeting venues for interaction of households promoting a healthy living and enjoyment (UN, 1978).

Sanitation: It is the clean way of upholding wellbeing through deterrence of human getting in touch with risks of wastes besides the management and proper discarding of sewage wastewater and solid waste by way of provision of facilities and services (WHO, 2019).

CHAPTER TWO: LITERATURE REVIEW

2.1 Urbanization, Poverty and Informal Settlements

The human population, economic situations and environmental challenges of the 21st century are attributable to the emergence of urban centres. Water and vector-borne diseases are bred in conditions provided progressively by the developing countries' urban environments (Alirol et al., 2011). In developing countries, approximately 30% of urban residents live in slums (UN-Habitat, 2014). This could escalate to 60% by 2050 (UN DESA, 2013, UN DESA, 2014). Settlements which are not planned are common in all cities and have substandard living conditions. Urban centres experiencing quick growth in lower-income economies have slums which are featured by some degree of access to safe drinking water and proper sewer system because urban growth rate is higher than that of infrastructure development (Moe & Rheingans 2006; Corcoran et al., 2010).

Most developing countries in the world have a main agenda of mitigating poverty for sustainable development. Nevertheless, poverty is a multidimensional occurrence and deals with many facets of human and social behaviour. Essentially, poverty is linked with lack of earnings, and those whose income level is below that one of human basic needs are regarded as poverty-stricken (World Bank, 2005). The high rate of urbanization has led to emergence of many urban environmental challenges which are interconnected and toning to those of urban deprivation and informal settlements. They include poor sanitation, particularly in slum areas, which could give rise to outbreak of deadly diseases in urban centres.

Urban growth leads to emergence of informal settlements, shanty houses and squatter settlement which make the urban centres unsustainable thereby creating unhealthy living conditions. There is also poor solid waste management hence resulting into environmental health hazards to the urban residents.

2.2 Housing Conditions and Human Health

For a house to be safe and sound, it must be built on a safe location and should shield its residents from elements such as rain, heat, cold, dampness and mold by being made up of permanent structure. The non-durability of dwelling units has potential health implications for a large number of affected households (UN, 2007; Sheuya, 2007).Slum housing is in most cases extremely congested and defectively built with inferior quality materials (Haines et al., 2013; Ooko, 2013). A study of slums in India's capital revealed that diseases related dampness was observed in 72% of the surveyed households (CDCP, 2015). These diseases included throat irritation, coughing or wheezing, eye irritation, pathological fungus and nasal stuffiness, and skin irritation. Congestion in the houses also leads to diseases and lack of privacy (Park, 2015). Wetness is also associated with infections related to breathing such as coughs and asthma, while pests such as rats, mice, flies and cockroaches may spread various diseases (Sheuya, 2007).

According to UN-HABITAT (2006), for a house to have adequate living area for household members, it should have less than three people sharing one room. Staying in a house with inadequate living space is linked with respiratory diseases which results from insufficient ventilation, poor cleanliness, and exposure to contaminants in the environment (Hargreaves et al., 2011; UN-HABITAT, 2006). High risks of respiratory diseases are also common due to pollution in the house caused by biomass fuel used for cooking.

Crowding occurs when the number of household members in a house is more than the size of the living space available to accommodate them, whether considered as number of rooms, bedrooms or area of the floor (Howden-Chepman et al., 2017). Crowding is linked with exposure to infections and diseases. For instance in New Zealand, household congestion contributes to about 10% of hospital admissions (Back et al., 2013). In Europe, 3500 deaths every year result from overcrowding (Braubach et al., 2011).

Studies on impoverished housing conditions in older adults such as ease of access problems and indoor temperature control inadequacy are linked to serious health effects (Webb et al., 2013). Cold homes expose occupants to harmful health outcomes,

particularly in the aged who have low thermo regulatory and thermo discrimination (Jevons et al., 2016). A study by Pérez-Hernández et al. (2016) in Spain found out that feeling cold always was linked with worse extremity performance and higher occurrence of ill-health.

In their study of Wa Municipality in Ghana, Osumanu et al. (2016) found that 64% of houses in the study area were built with mud and plastered with cement. These houses had cracks, both inside and outside of the buildings. According to the respondents, the cracks paved way for entry of ants and termites into their rooms, contaminating food and water. The study also found that households living in mud houses complained of infiltration of mites and respiratory problems such as asthma and other allergies. The damp conditions promoted infestation of mites which are linked to allergies and asthma.

Globally, respiratory infections constitute 33% of the total disease burden and they arise from the use of firewood and kerosene for cooking which brings about indoor air pollution (Pruss-Ustun et al., 2016; Gordon et al., 2014; Sharma, 1998; Benicio & Ferreira, 2004; Fry et al., 2002). This is because the use of gas and electricity is too expensive for most low income households (Singh et al., 2015). A study by Gichuki (2005), in Mukuru kwa Njenga in Nairobi found that most houses were poorly constructed in the informal settlement. Notably, the building by laws and regulations set standards of Nairobi County are not observed in the planning structures and materials used for construction.

2.3 Access to Water and Human Health

According to UN (2012), an individual requires 50-100 litres of water per day. Despite being available, the water can be exposed to contamination. A study in Bandung Municipality in Indonesia found that it is during storage of water in households that bacteria post source contamination occurs (Subbaraman et al., 2013). The quality of water for drinking in slums may be improved by storing it safely and carrying out water treatment at household level and this reduces the threat of diarrheal diseases (Sodha et al., 2011; Fiebelkorn et al., 2012; Cheng et al., 2012). According to Muntalif et al. (2017), there is a higher water contamination risk in households that do not boil water compared

to those who do. Furthermore, according to Nastiti et al. (2013), 40% of households in Bandung Municipality in Indonesia that store water for drinking at home use open containers.

A study by Ercumen et al (2015) in Bangladesh found that 70% of the households drink water stored in containers and that diarrhea prevalence was 10.6%. The water quality was tested and 89% of the samples turned positive for *E.Coli,* showing that contamination took place at the storage stage in households. In Kenyan slums, Kamau & Njiru (2018) found that majority of the household stored drinking water poorly. They stored it in uncovered open wide-mouthed containers placed on the ground. Moreover, water in these containers was drawn by dipping a drawing vessel which posed a risk of contamination at household level. The study also found that the majority of the households were exposed to water borne diseases a result of not treating water.

Anchored in the UN definition, improved and safe water sources are classified into water to living units, piped to plot, public tap or stand pipe, tube well or bore hole, and sheltered dug well. Conversely, water sources that are not improved include a well that is not protected, surface water, lake, spring, pond, stream and canal water (WHO/UNICEF, 2003). Reaching out to enhanced water sources is the only authority for sustainable access to safe drinking water. The creation or active intercession protecting contamination from outside, particularly from fecal matter defines enhanced water source (UNICEF, 2014).

Even though water sources considered as improved do not provide protection unlike unimproved sources (Patunru, 2015), there is a collection of growing literature which reveals that adequate microbial quality of water is not guaranteed from improved sources (Shaheed et al., 2014a). Global studies reveal that safe water is not provided by many of the improved water sources (Onda et al., 2012). Consequently, diseases such as typhoid, diarrhea and dysentery can be transmitted by water. Half a million deaths annually are estimated to be caused by water (WHO, 2016). This contamination may also be caused by insufficient and lack of proper water storage system (Freeman et al., 2014; Shaheed et al., 2014b).

Studies indicate that many water sources were contaminated with fecal matter in spite of them being considered improved. For instance, Heitzinger et al. (2015) carried out a survey in Peru and established that 47% and 43% of source and stored water samples, respectively, were contaminated. Similarly, Shaheed et al. (2014b) in their study of peri-urban households in Cambodia found that half of the samples collected from the tap contained *E. coli.* In Kakamega, Kioko & Obiri (2012) in their study on determination and perception of safe water in peri-urban communities of the town found that 3% of the respondents had the right information on how to determine safe drinking water, while 97% risked drinking unsafe and contaminated water.

A study done in Nairobi by Wanyonyi (2005) showed that about 70% of the households used water from the municipal as the primary drinking water. Similarly, drinking water was stored in containers with narrow necks by majority of the households. It was noted that water collection and storage practices are key in determining the water quality in households (Sobsey, 2002).

A study by Muriithi (2014) in Korogocho slum of Nairobi showed that about 73% of the respondents used piped water but there were reported cases of children below five years having suffered from diarrhea. It was noted that contamination of water occurred during drawing, transportation or storage. The study also found that 41% of the households took untreated water because of the perception that piped water is safe for drinking. According to Mutui (2007), more than half of the households in Kasarani in Nairobi treated their drinking water by boiling which made it safe for consumption.

2.4 Access to Sanitation and Human Health

Most children below the age of 5 years die from diarrheal diseases related to exposure to hazardous and poor sanitation (Cheng et al., 2012). A good sanitation facility reduces diarrheal diseases as it detaches the human waste from getting into direct contact with humans and therefore ensuring harmless fecal disposal. This reduces the risk of fecal contagion (Andres et al., 2014). The Joint Monitoring Programme of UNICEF and WHO considers an unimproved sanitation as that which is shared by two or more households.

Childhood diseases in Kenya's urban areas are associated with environmental health hazards such as unhygienic sanitation and bacteria from improper drainage, and contagion of fecal matter with food and drinking water (APHRC, 2012). A study by Carburn & Hilderbran (2015), in Mathare slum in Nairobi, Kenya showed that 12% of the households did not have a solid waste collection system which is organized. It also found that 48% of the households had a child who had been ill with diarrheal, malaria, typhoid or respiratory infection within six months to the study period.

A study by the Centre for Microbiology Research in a Nairobi slum found that more than a quarter of children less than 5 years of age had at least an intestinal parasite related to poor sanitation. Equally, 12-54% of women in Nairobi slums are estimated to have at least intestinal parasite (Mbae et al., 2013). Then again, poor sanitation conditions in slums are linked with up-regulation of inflammatory responses which cause asthma (Cooper et al., 2012).

Based on the WHO/UNICEF Joint Monitoring Programme definition, slabbed pit latrines are considered as enhanced hygiene (Satterthwaite, 2016). However, they become unsuitable in crowded settlement environments (Nakagin et al., 2016). In sub-Saharan Africa, only 40% of the people living in urban centres in had enhanced sanitation and 33% had piped water in their homes in 2015. Similarly, poor garbage disposal and collection and low quality housing provide procreation sites for parasites and disease vectors (Hagan et al., 2016). A study by Kioko & Obiri (2012) in the peri-urban communities of Kakamega town in western Kenya on solid waste contamination and water safety found that 78% of the households used open disposal pits, 13% incinerated the litter, and 9% strew the waste in farmlands.

A study done in Mukuru kwa Njenga in Nairobi by Gichuki (2005) showed that households dumped all their garbage haphazardly on empty plots and streets, notably with no organized service for collecting garbage. Similarly, Mutui (2007) found that most of the garbage from households is collected every week and only 5% of the households in Kasarani resort to burning and dumping garbage on the roadside. The study also found that majority of the households used flush toilets and about half of them shared a sanitation facility. In Gichuki's (2005) study, an average of 15 households shared a

sanitation facility in Mukuru kwa Njenga. According to Muriithi (2014), sanitation facilities are never adequate in informal settlements.

2.5 Theoretical Framework

This study applies two theoretical frameworks: the Causality Model (Process Theory) and the Integrated Behavioural Model for Water, Sanitation and Hygiene. The underlying reasons which led to access to poor quality water, impoverished sanitation and housing conditions among slum dwellers start as a result of a process and did not come instantaneously.

The Causality Model (Process Theory)

Causality, trigger and outcome are agencies that connect the cause with the effect. The former is partially responsible for the latter, while the latter is reliant on the former. Universally, a process has a myriad of causes, which are taken to be underlying factors and all depend on its history. Numerous effects could be as a result of another outcome. Generally, causality accepted to be temporally bound-causes always come first before their dependent effects (Heckman, 2008).

According to Heckman (2008), causality generally shows how the world moves forward. The concept of progression is suitably explained. It is like those of agency and effectiveness. Therefore, a leap of acuity may be required to comprehend it. Consequently, the conceptual structure of ordinary language is developed from causality (Copley, 2015). In this theory, factors such as urbanization lead to emergence of slums. This exposes residents to poor housing conditions, unimproved water quality and sanitation. The effects are health risks such as diarrhea, typhoid, pneumonia and tuberculosis. This theory explains the occurrence of slums as a result of migration which points to environmental health hazards in that new locality.

The theory is significant to the study as it helps to understand the causes and effects of environmental health risks. As such, the environmental conditions in the study area started as a process. Urbanization leads to movement of people to the urban centres who

are more often forced to live in the informal settlements and therefore exposed to poor environmental conditions.

The Integrated Behavioural Model for Water, Sanitation and Hygiene

This theory argues that WASH behaviours are caused by three interrelating dimensions. They are the psychosocial, the contextual, and the technological dimensions (Bandura, 1989). Firstly, the behavioural and psychological determinants that influence behavioural outcomes and technology adoption form the psychosocial dimension. Secondly, the determinants associated with the individual environment that can influence behaviour change and adoption of new technologies form the contextual dimension. Thirdly, the specific features of the espousal and sustainability of its product value are contained in the technological dimension.

This theory centers on the health implications that the slum residents are facing. This theory focuses on some determinants that when observed and measures taken will help the slum dwellers to reduce the environmental health risks that instigate the wellbeing outcomes. The theory helps in the understanding of the existence of health implications slum dwellers face.

2.6 Gaps in the Literature Review

There are two major gaps that emerge from the literature review:

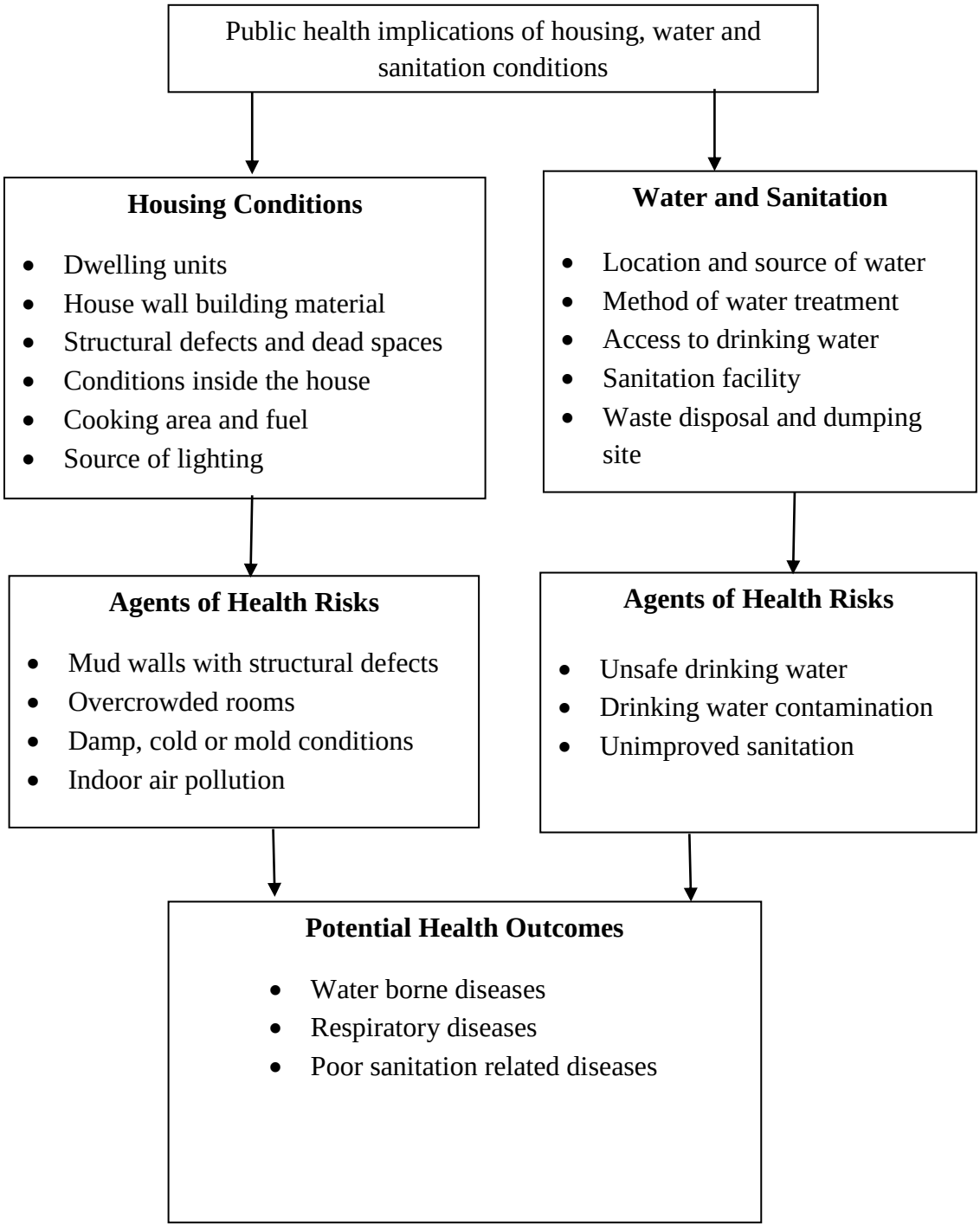
1. While a lot of studies have been carried out in the informal settlements, little is known on the linkage between a compound of conditions such as housing, water and sanitation and potential public health risks.
2. Most of the studies have been done in capital cities. This study was done in a small and medium size town, Kakamega.

2.7 The Conceptual Framework

According to UN-HABITAT (2016), slums are areas of human habitations characterized with impoverished structural housing, congestion, inadequate access to safe water, poor sanitation conditions and insecure residential status. As per the conceptual framework (Figure 2.1), housing conditions such as house wall building material, dwelling units, conditions inside the house, fuel used for cooking, and source of lighting may lead to environmental health risks through mud walls, structural defects, overcrowded rooms, dampness, cold and mold conditions, and indoor air pollution.

On the other hand, water and sanitation situation such as location and source of water; method of water treatment; access to drinking water; sanitation facility; and waste disposal and dumping site may lead to environmental health risks through access to unsafe drinking water; drinking water contamination; and unimproved and poor sanitation. In both processes, the potential health outcomes are a number of water borne, respiratory and poor sanitation related diseases (Ezeh et al., 2016).

Figure 2.1: The Conceptual Framework



Source: Researcher (2019)

CHAPTER THREE: STUDY AREA AND RESEARCH METHODOLOGY

3.1 The Study Area

3.1.1 Geographical Location

The study area is Kaburini slum of Kakamega town in Kenya. Kakamega town is the headquarters of Kakakmega County. The neighbouring counties are Bungoma County to the north, Nandi County to the east, Vihiga County to the south and Siaya County to the west (Figure 3.1). Kakamega Municipality where Kaburini slum is located has an area of 3050.2 km^2 (Figures 3.2 and 3.3).

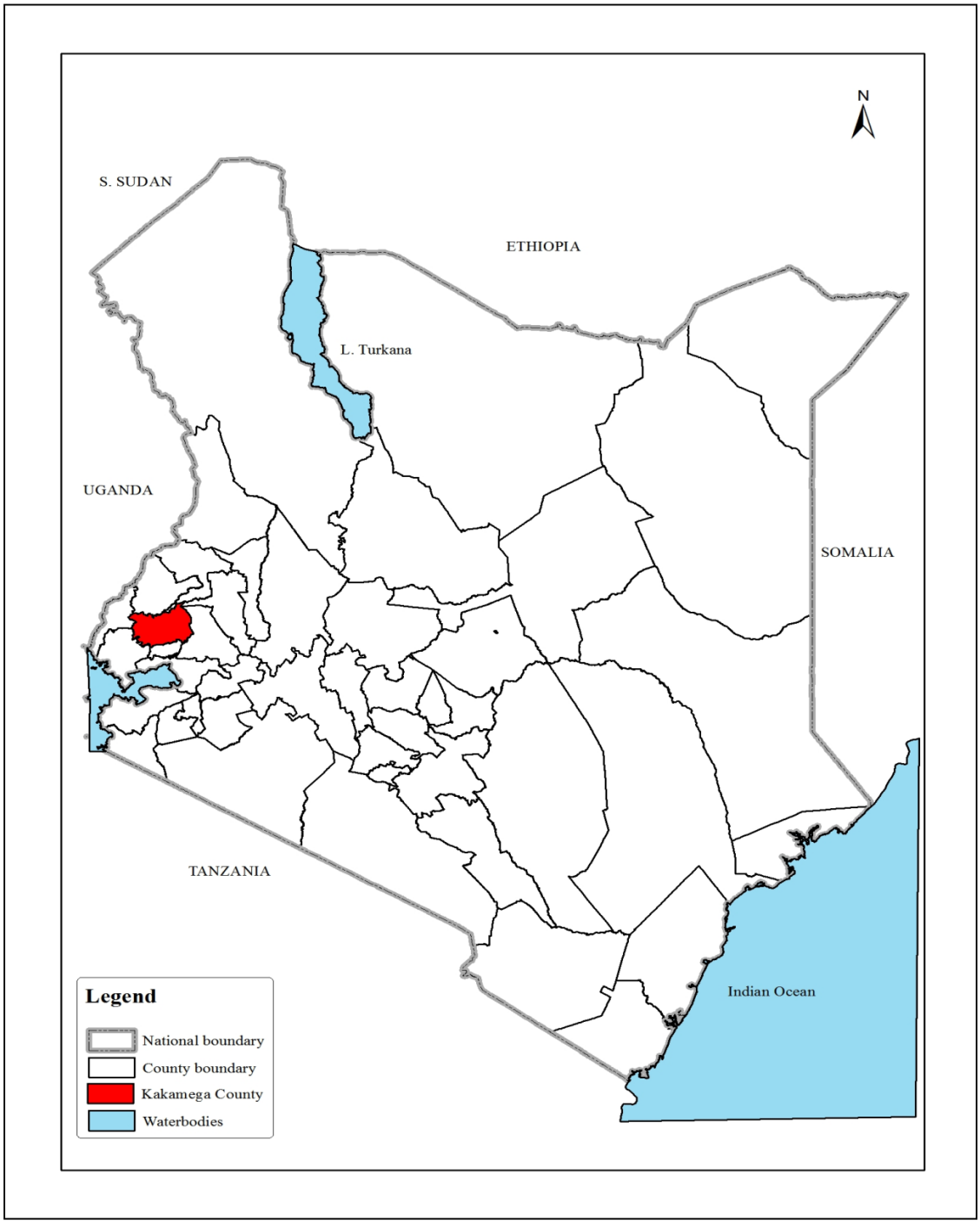
3.1.2 Climate

Kakamega experiences two rain seasons; the long rains which commence in March and end in June, and the short rains in the months of July, August and September. On the other hand, the months of December, January and February are the driest. Normally, the amount of rainfall ranges from 1,000mm to 2,400mm per annum in northern and southern parts, respectively. There are high temperatures all year round in the study area. The mean maximum temperature ranges from 28^oC to 32^oC, while the mean minimum temperature ranges from 11^oC to 13^oC. Low temperatures are usually noted down at night while very high temperatures are recorded at day time.

3.1.3 Population Characteristics

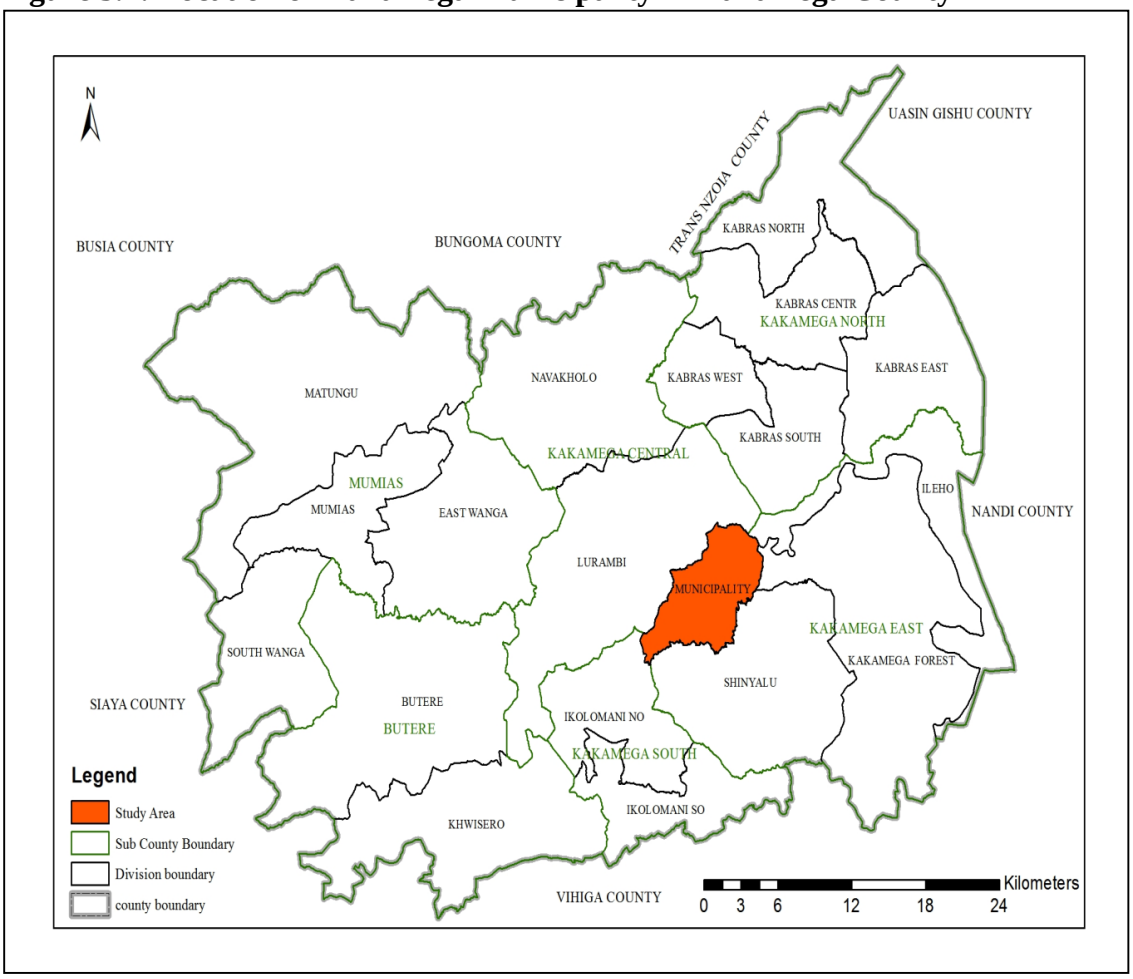
The Municipality has a population of 350,000 people. The main commercial activities of Kaburini residents include selling of second hand clothes, hardware, motor garages, pottery, printing and milling. The study area has social challenges such as prostitution and alcoholism which contribute to the rising cases of HIV/AIDS infections. There are also incidents of insecurity in the area as a result of many youth who are unemployed making them resort to criminal activities such as robbery, burglary and theft.

Figure 3.1: Location of Kakamega County in Kenya



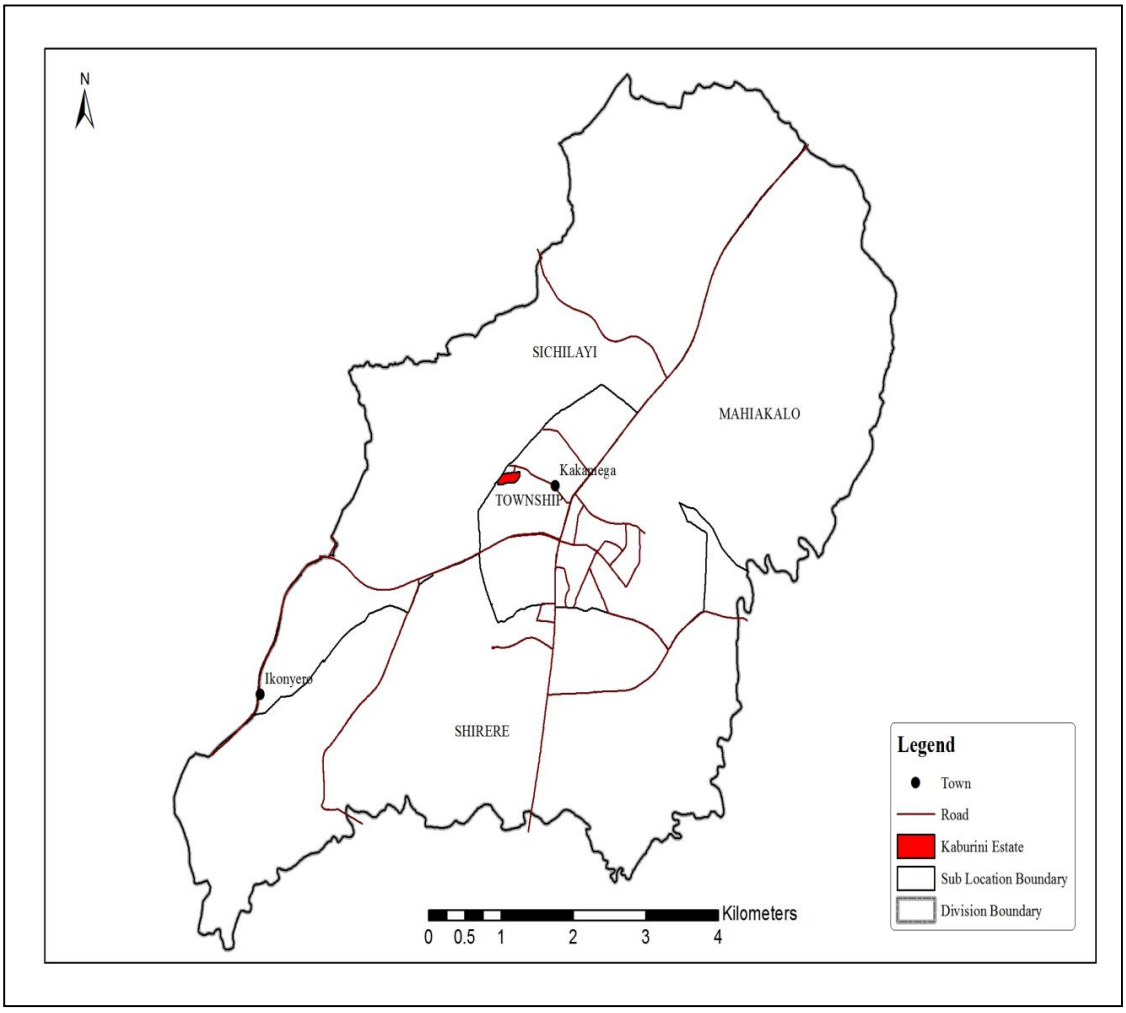
Source: Central Bureau of Statistics (1999)

Figure 3.2: Location of Kakamega Municipality in Kakamega County



Source: Central Bureau of Statistics (1999)

Figure 3.3: Location of Kaburini Slum in Kakamega Municipality



Source: Modified from Central Bureau of Statistics (1999)

3.1.4 Housing

There are four categories of housing estates in Kakamega. They are the high class, above average, middle class and low class estates. The low class housing estates in the town are Kaburini, Maramu, Masingo, and Majengo. These areas are characterized with poor housing conditions, impoverished sanitation conditions, lack of proper planning; lack of essential services, and susceptibility to crime and diseases.

3.1.5 Sources of Water

Kakamega town and its surroundings are supplied with water mainly from River Isiukhu. The old and new intakes built in 1956 and 1992, respectively, supply the water. River Isiukhu Water Supply System and Boreholes System have a total design capacity of 8,696m^3 per day. While the demand for water is 12,796m^3/day, the average production is 5,667m^3 per day which is merely less than half of the total amount of water needed by the consumers. This necessitates development of alternative water sources as a result of water scarcity in the town. They include shallow wells which have been dug by most of the business operators and equipped with submersible pumps to supplement the supply.

The low income areas are supplied with water by the county government through its six safeguarded springs. There are also unprotected springs from which most of the slum dwellers access water. The unprotected springs are prone to pollution from pit latrines. For example, there is a pit latrine just about five meters from Masingo spring. There is also roof catchment whereby tanks have been built by the residents to be used during the rainy season to harvest roof water.

3.1.6 Sanitation

The county government has offered dust bins for collecting litter in designated areas within the town. It is then taken by trucks for disposal. In some residential areas such as Milimani, Otiende, Mudiri, Amalemba, Lurambi and Kefinco, waste is disposed in compost pits. Additionally, general disposal is carried out in several areas, particularly in the low income areas, in back streets and in open spaces. Some of these areas are difficult to clean as plastics are dumped all over the place. Furthermore, there is no designated site for solid waste disposal. Major residential estates such as Central Business District, Mudiri, Town Scheme, Amalemba, and Otiende have a water-borne sewerage system. Some areas such as Mlimani, Kefinco, Lurambi, Sichirai and Lutonyi are served by septic tanks. Slum areas such as Kaburini, Masingo, Maramu and Majengo are served by pit latrines.

3.2Methodology

3.2.1 Target Population and Sampling

The target population for this study was all the households in Kaburini slums. The number of households in the study area was established as per the 2009 population census (KNBS, 2009).Using a total number of 209 households in Kaburini, the study randomly sampled 68 households using the following formula according to Nassiuma (2002).

$n = (NCv^2) / (Cv^2 + (N-1)\ e^2)$

Where: n =the desired sample size; N= target population; Cv =coefficient of variations (take 0.5); and e = tolerance at desired level of confidence (0.05) at 95% confidence level.

$n = (NCv^2) / (C\ v^2 + (N-1)\ e^2)$

$= 209\ x0.5^2/0.5^2 + (208)\ 0.05^2$

$= 209 \times 0.25 /0.25 + 208 \times 0.0025$

$= 52.25 / 0.25 + 0.52$

$= 52.25 / 0.77$

$= 67.9$

$= 68$

3.2.2 Sources and Methods of Data Collection

The study used both primary and secondary sources of data. Primary data was collected through the use of a pre-coded questionnaire, key informant interviews and direct field observation. The questionnaire provided quantitative data while key informant interviews provided qualitative data for in-depth understanding of the study problem. The pre-coded questionnaire was used to collect primary data on: dwelling units, household building material, structural defects and dead spaces on walls, cooking area and fuel, source of light, location and source of water, method of water treatment, access to drinking water, and mode of waste disposal and dumping site. Secondary data was obtained from existing records and published literature relevant to the study problem. The secondary data were

on health records, relevant characteristics of the study area, and information used in the literature review.

3.2.3 Methods of Data Analysis

Data collected from the field was largely subjected to descriptive statistics. Data from the completed questionnaires was first cleaned for errors and inconsistencies and then coded before being entered into the Statistical Package for the Social Sciences software platform. The data set was then used to produce frequency distributions (tables, pie-charts and graphs) and cross-tabulations that were used to describe the sample data. On the other hand, qualitative data was subjected to content analysis for better interpretation.

3.2.4 Ethical Considerations

When conducting the research, I had to be aware of the following ethical issues:

1. Voluntary participation: The respondents were not forced to participate in this research and they took part in it at their own free will.
2. Confidentiality of Information: The respondents were assured of confidentiality of information that they provided to be used for the research.
3. Informed consent on the respondent: An assurance was given to the respondents on the fact that the provided information would not be disclosed to anyone whatsoever who is not directly related to the study at hand.

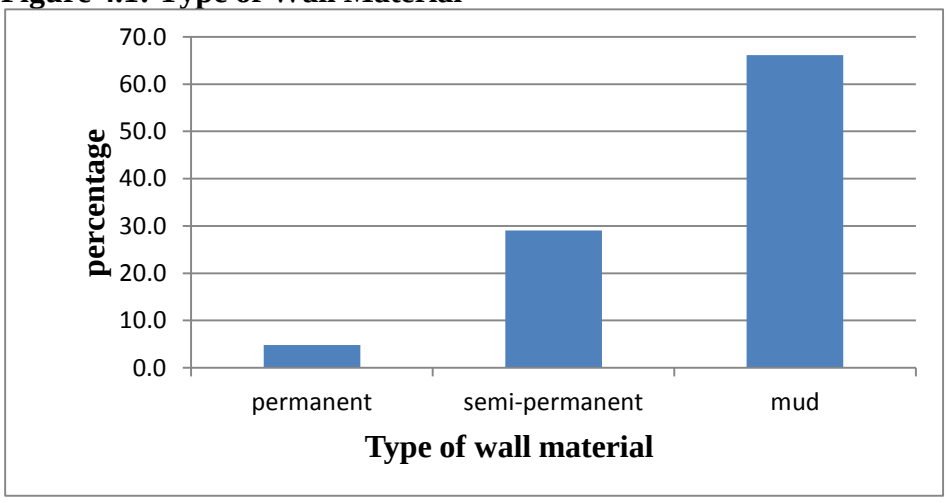
CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Housing Conditions

4.1.1 House Wall Building Material

More than half of the households (66%) lived in houses with walls made of mud, 29% had semi-permanent walls, while 5% had permanent walls (Figure 4.1). All the housing structures had iron sheet roofing. The houses made of mud walls were in deplorable conditions and needed repairs (Plate 1).Most of these houses had structural defects and dead spaces, which could allow cockroaches, rodents and pests in the house. Majority of these houses get damp, cold or moldy, particularly during the rainy season.

Figure 4.1: Type of Wall Material



Source: Researcher (2019)

These results are similar to those of Wa Municipality in Ghana (Osumanu et al., 2016), which found out that 64% of the houses in their study area had walls made of mud and had cracks that paved way for ants and termites which contaminated water and food.

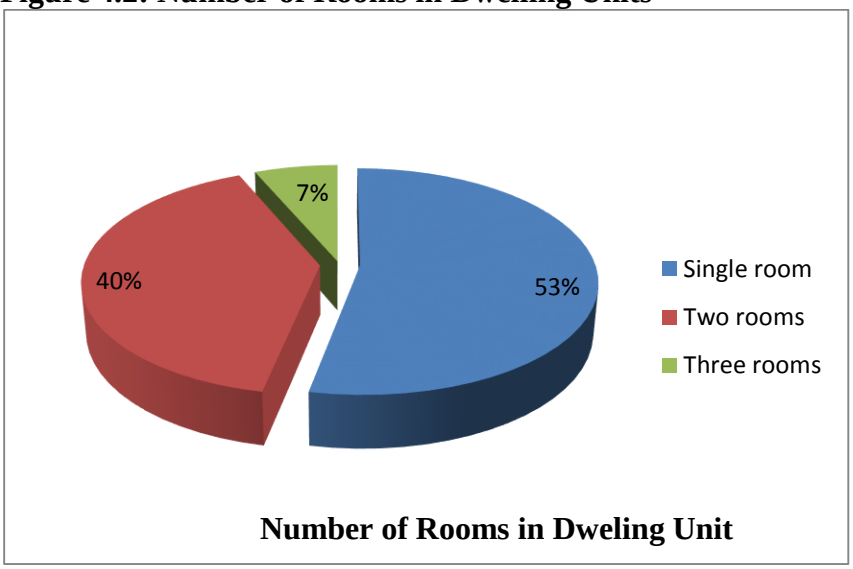
Plate 1: House with Wall Made of Mud

Source: Researcher (2019)

4.1.2 Number of Rooms in Dwelling Units

Half of the households (53%) lived in dwelling units with one room, 40% had two rooms dwelling units, while 7% had three rooms dwelling units (Figure 4.2). The one room houses served as the sitting room, bedroom and kitchen. Overcrowding was noted in the one room dwelling units, in some cases with more than three household members. According to UN-HABITAT (2006), for a house to have adequate living area for household members, it should have less than three people sharing one room. Similarly, according to Howden-Chepman et al. (2017), crowding exists when the number of house occupants surpasses the size of the habitation space, whether gauged as number of rooms, bedrooms or area of the floor.

Figure 4.2: Number of Rooms in Dwelling Units



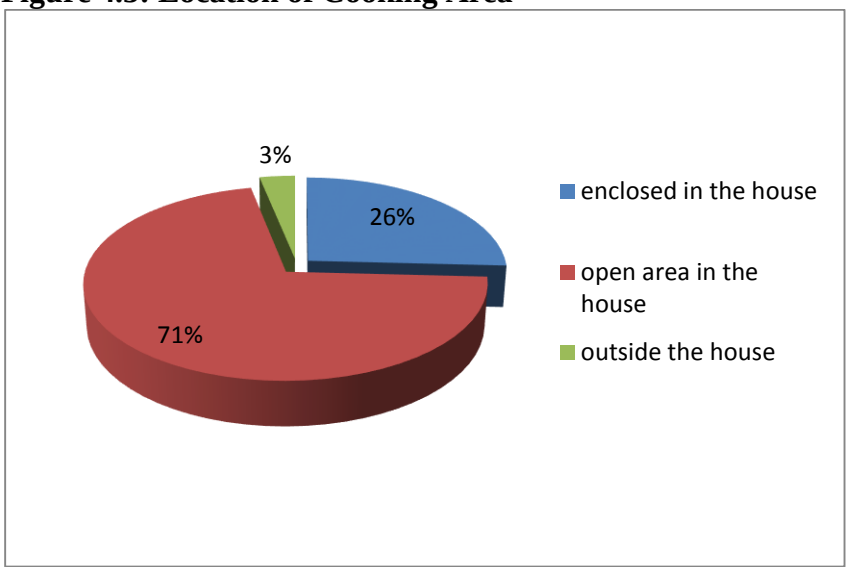
Source: Researcher (2019)

4.1.3 Cooking Area and Fuel

Most of the dwelling units in Kaburini do not have designated kitchens. As such, 71% of the households used an open area in the house to cook, while 3% cooked outside the house (Figure 4.3). Those who had a kitchen were 26% of the households but the kitchens are small and poorly ventilated. Those who use open spaces had challenges during the rainy season and were forced to relocate to their small rooms which worsened the room congestion situation.

The study also found out that 79% of the households in Kaburini slum used charcoal for cooking, 15% used kerosene, 5% used firewood, while 2% used gas (Table 4.1). According to Muchiri (2008), more than 70% of family units in Kenya depend on biomass as a source of cooking fuel.

Figure 4.3: Location of Cooking Area



Source: Researcher (2019)

Table 4.1: Type of Cooking Fuel

Cooking Fuel	Frequency	Percentage
Kerosene	9	15
Firewood	3	5
Charcoal	49	79
LPG	1	1
Total	62	100

Source: Researcher (2019)

4.1.4 Source of Lighting

Nine out of every 10 households use kerosene for lighting (Table 4.2). They use kerosene tin lamps and lanterns. Only 8% of the households had access to electricity. The use of kerosene for lighting is attributed to the low incomes of residents of Kaburini who cannot afford electricity costs. The respondents claimed that they have no any other option but to use kerosene for lighting because they cannot afford electricity connection and monthly payments. Furthermore, Kaburini is an informal settlement that may not be formally connected to the electricity grid.

Table 4.2: Type of Lighting Fuel

Source of Lighting	Frequency	Percentage
Tin lamp	35	56
Lantern	22	36
Electricity	5	8
Total	62	100

Source: Researcher (2019)

4.2 Water and Sanitation Situation

4.2.1 Source of Water

Over three quarters (77%) of the sampled households depend on piped water (Table 4.3). The piped water is either individual household connection (3%), provided by the landlord (18%), or accessed from other piped water sources (57%). Slightly less than one quarter (23%) of the households used water from springs (Plate 2). As such, the sampled households largely depend on piped water. A further analysis reveals that for 79% of the households, the location of the source of water was off plot. That is, they fetched water away from their dwelling units. Only 21% of the households had on plot sources of water.

Table 4.3: Source of Water

Source of Water	Frequency	Percentage
Piped water(individual)	2	3
Piped water(landlords)	11	18
Piped water(from elsewhere)	35	57
Spring	14	23
Total	62	100

Source: Researcher (2019)

Piped water is paid for while spring water is fetched freely. The prices of water limit the amount of water available for use in some households. However, as will be seen later,

most of these households do not treat their drinking water. This is a misconception that piped water is safe for drinking. According to Subbaraman et al., (2013) and Onda et al. (2012), enhanced sources of water do not necessarily provide safe drinking water and hence could transmit diseases such as diarrhea and typhoid.

Plate 2: A Spring Serving as a Source of Water

Source: Researcher (2019)

4.2.2 Treatment of Water

The study found out that only 9 households treated water before drinking. The other 52 households who are the majority do not treat their drinking water because of the perception that piped water is from a safe source. This poses a health risk to the household members as the water may be contaminated at the point of use. The 9 households treated their drinking water through boiling, use of chemicals and filtering (Table 4.4). According to Kamau and Njiru (2018), majority of the households in Kenya's urban slums use untreated drinking water thus exposing them to water borne

diseases. The same results were found in Kenya's peri-urban communities as confirmed by a survey done by Kioko & Obiri (2012).

Table 4.4: Treatment of Drinking Water

Mode of treatment	Frequency	Percentage
Boiling	5	8
Use of chemicals	3	5
Filtering	1	2
None	53	85
Total	62	100

Source: Researcher (2019)

The study results show that 40% of the households in Kaburini use wide-necked containers, such as buckets and pots, to store drinking water. The other households (60%) use narrow-necked containers. The type of container used for storing drinking water influences its safety. Containers with wide necks have a large open surface area that is prone to contamination directly or indirectly through frequent drawing of the water from the containers.

The cups and jugs dipped in these containers to draw water enhanced the risk of dirt and contamination. Furthermore, some households do not clean these containers before storing water in them. Findings of Nastiti et al. (2013) also showed that 40% of the households in Bandung Municipality in Indonesia stored drinking water using open containers, putting them at risk of water contamination. Similarly, a study by Ercumen et al. (2015) in Bangladesh found that 70% of the households drew their drinking water from a storage vessel.

4.2.3 Perception on Quality of Drinking Water

The respondents determined the quality of water mainly through the source of water and the colour of water. Sources of water that are not piped were largely considered unsafe. On the other hand, water with brown colour was also considered unsafe for drinking. As

such, 95% of the households perceived piped water as safe for drinking, while 5% perceived it as fairly safe for drinking. That is the reason majority of the households did not treat their piped water before drinking. Consequently, 92% of the households considered surface water as unsafe for drinking, while 8% considered it fairly safe.

4.2.4 Type and Location of Sanitation Facility

Pit latrines are the dominant type of sanitation facility in Kaburini slum. Almost all the households (95%) used pit latrines, a flush toilet was accessed by 3% of the households, while one of the households had no access to a sanitation facility. These pit latrines are not in very good structural and sanitation conditions (Plate 3). Most of them are not well maintained and are prone to overflowing, especially during the rainy season. Furthermore, these sanitation facilities also doubled as bathrooms.

Plate 3: A Pit Latrine

Source: Researcher (2019**)**

The pit latrines are more likely to be located on the plots or near the plots where the residents stay. Pit latrines for 60% of the households were located on their plots, 27% had

theirs located off plot but not far from the house, while 11% had theirs located off plot but far from the house (Table 4.4).

Table 4.4: Location of Sanitation Facility

Location of Plot	Frequency	Percentage
On plot	37	60
Off plot, not far from the house	17	27
Off plot, far from the house	7	11
Not applicable	1	2
Total	62	100

Source: Researcher (2019)

4.2.5 Use of Sanitation Facility

The study found out that 11% of the households do not share a sanitation facility; 2% had between 3 and 6 people sharing; 16% had between 7 and 9 people sharing; 7% had 10 people sharing; and the rest (64%) had more than 10 people sharing a sanitation facility. According to Kamau & Njiru (2018), a large majority of households in the Kenyan slums share a sanitation facility.

Information was sought on cleaning and disinfecting the shared sanitation facilities. The study found out that 53% of the households clean and disinfect their facilities, while 37% do not clean and disinfect their sanitation facilities. The research also found out that 34% of the households who cleaned and disinfected their sanitation facilities did it on a daily basis while, 23% cleaned and disinfected theirs only when they were dirty.

4.2.6 Disposal of Household Waste

Majority of the households (95%) dumped their waste in open spaces, 3% burned it, while 2% scattered it on plot farms (Table 4.5 and Plate 4). Through personal observations, it seems there was no garbage collection system or authority that served the residents in the study area. Kioko & Obiri (2012) in their study of peri-urban areas in

Western Kenya found out that dumping pits were used by 78% of the households. 13% and 9% of the households burned and scattered the litter in farmlands, respectively.

Table 4.6: Mode of Waste Disposal

Mode of Waste Disposal	Frequency	Percentage
Dumping in open sites	59	95
Burning	2	3
Scattering in on plot farms	1	2
Total	62	100

Source: Researcher (2019)

Plate 4: Dumping of Household Waste

Source: Researcher (2019**)**

Furthermore, the waste is more likely to be dumped near the houses. About half of the households (53%) dumped their waste in the plots where they lived, 27% did it off plot but not far from the house, while 15% did it off plot but far from the house (Table 4.7).

Table 4.7: Location of Waste Dumping

Location of Plot	Frequency	Percentage
On plot	33	53
Off plot, not far from the house	17	27
Off plot, far from the house	9	15
Not applicable	3	5
Total	62	100

Source: Researcher (2019)

4.3 Health Implications of Housing, Water and Sanitation Conditions in Kaburini

4.3.1 Public Health Risk Indicators

The public health concerns that affect at least half of the households in Kaburini slum of Kakamega town include:

1. Living in a mud-walled house with deplorable conditions, structural defects and dead spaces.
2. Living in a mud-walled house that get damp, cold or moldy, particularly during the rainy season.
3. Living in overcrowded single dwelling units.
4. Using charcoal, kerosene and firewood for cooking in poorly ventilated houses.
5. Using kerosene tin lamps and lanterns for lighting in poorly ventilated houses.
6. Not treating drinking water and using wide-necked containers, such as buckets and pots, to store drinking water.
7. Using pit latrines that are not well maintained, are not in very good structural conditions, and are not regularly cleaned and disinfected, as the main sanitation facility.
8. Location of pit latrines near the dwelling units.
9. More than 10 people sharing a pit latrine that is not well maintained, cleaned and disinfected.
10. Dumping of household wastes in open spaces near the dwelling units.

4.3.2 Potential Health Risks of Housing, Water and Sanitation Conditions

Pests such as rats, mice, flies and cockroaches are bred in poorly maintained houses. In addition, contagious diseases are spread and caused by these pests. Poor structural housing has been linked with a higher threat of chronic illness by epidemiological studies. Moreover, damp, cold, and moldy houses are associated with asthma and other recurring respiratory infections such as coughs.

Lack of ventilation in an overcrowded house, unhygienic conditions, and exposure to environmental pollutants are associated with respiratory diseases. According to UN-HABITAT (2006), for a house to be considered to have adequate living area for members, not more than three people should share the same room. Living in a overcrowded house is linked with respiratory diseases as a result of lacking enough aeration, lacking cleanliness, and exposure to contaminants in the environment.

According to Gordon et al. (2014), exposure to indoor air pollution from the burning of bio-fuels has been drawn in as a contributory agent of respiratory diseases in Kenya. They argue that respiratory diseases in poor households are caused by indoor cooking. Impoverished households use unclean sources of energy for cooking and live in inferior quality housing conditions exposing them to diseases. In actual fact, indoor air pollution related health effects continue to subject urban slum households to continuous suffering. The available attestation shows that indoor air pollution from biomass fuels and traditional cooking stoves expose women and young children who spend most of their time near the cooking area to health problems. According to Matzopoulos et al. (2006), the use of kerosene is a major health issue in slums from indoor air quality perspective.

Water contamination and water borne diseases risk is increased by not boiling drinking water and by use of wide-necked containers to store drinking water. The perception by majority of the households that piped water is an improved source and hence safe for drinking exposed them to health risks. They overlooked the point of use treatment and possible contamination putting the health status of the family at stake. According to Onda et al. (2012), enhanced sources of water do not necessarily provide safe water for

drinking, hence could transmit diseases such as diarrhea and typhoid. In addition, Subbaraman et al. (2013) found out that contamination of water occur during storage as post source contamination.

The sharing of sanitation facilities makes cleaning of these facilities ineffective which could likely increase the incidence of diarrhea in the target population. Also, lack of enough toilet facilities compromise the health of household members as this could lead to dysentery, cholera or typhoid. A study by the Centre for Microbiology Research in a Nairobi slum found that 25% of children five year old and below have intestinal parasite related to poor sanitation. Finally, the open dump sites attract flies, rats and other vectors that can cause diseases.

4.3.3 Knowledge and Cases of Diseases in Kaburini Slum

Information was sought on the knowledge of typhoid and diarrheal diseases in Kaburini slum. 82% of those interviewed were aware of diarrhea cases in the area, while 18% were not. On the other hand, 93% of the respondents were aware of typhoid cases in the area, while 7% were not. The respondents were further asked on the knowledge of if any of the household members had ever contracted typhoid and/or diarrhea to the best of their knowledge. It was found out that 32% of the households had a member who had suffered from one or both of the diseases (Table 4.8). 21% of the households experienced diarrhea, while 11% households had members who had suffered from typhoid. Majority of the households (68%) had not experienced cases of diarrhea and typhoid.

Table 4.8: Cases of Typhoid and Diarrhea

Case	Frequency	Percent
Diarrhea	13	21
Typhoid	7	11
None	42	68
Total	62	100

Source: Researcher (2019)

The study also sought to know the number of times the households suffered these diseases in the year the study was carried out. 10% of the households suffered once, 16% twice, 3% thrice, while another 3% of the household member suffered five times. 23% of the households visited hospital, while 10% did not go to hospital. 19% went to a public hospital, while 3% went to private hospital. Finally, the respondents were asked if any of the household member had ever suffered from respiratory diseases such as tuberculosis, pneumonia and cough. The results show that 48% of the households had cases of a member of the household who had suffered from one or more of the respiratory diseases. On the other hand, 52% of the households did not have a member who had suffered from any of the diseases.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUTION AND RECOMMENDATIONS

5.1 Summary of Findings

5.1.1 Housing Conditions

Majority of the households stayed in mud walled houses and all the housing structures in the study area had iron sheet roofing. Most of the mud walled houses were in deplorable conditions and needed repair. Inside the mud walled houses there were structural defects and dead spaces. Furthermore, majority of the households stay in single room dwelling units, which are overcrowded and get damp, moist and mold, particularly during the rainy season. A high number of the households used charcoal for cooking, while Kerosene was the main source of fuel used to light houses.

5.1.2 Access to Water and Sanitation

Majority of the households depend on piped water for their domestic use, while a few households fetched their water from a spring. Most of the piped water sources were on the plots of most of the households and they paid for it. A small proportion of the households treated drinking water by boiling and use of chemicals. Majority did not treat their drinking water and stored the drinking water in containers with wide mouths. This is largely because piped water was perceived as safe for drinking. Households in Kaburini slum use pit latrines as their main sanitation facility. Most of the latrines were located on the plots and used by many people per latrine. Although they were cleaned and disinfected, this was done irregularly and only when they are visibly dirty. On the other hand, household waste was disposed in the open in the plots. The slum lacked a common place for waste disposal garbage collection system.

5.1.3 Public Health Implications

The public health concerns that affect at least half of the households in Kaburini slum of Kakamega town include living in houses made of mud walls and with deplorable conditions, structural defects and dead spaces; living in overcrowded single dwelling units; using charcoal, kerosene and firewood for cooking in poorly ventilated houses; using kerosene tin lamps and lanterns for lighting in poorly ventilated houses; not treating drinking water and using wide-necked containers to store drinking water; using pit latrines that are not well maintained, are near the houses, are not regularly cleaned and disinfected, and are shared by many people; and dumping of household wastes in open spaces near the dwelling units. A number of household members had experienced cases of respiratory diseases such as tuberculosis, pneumonia and coughs. In addition some household members had suffered from diarrhea and typhoid.

5.2 Conclusion

Poor housing, water and sanitation conditions may be an avenue of spreading diseases through diseases vectors, air pollution, overcrowding, contamination of water, and unhygienic environment. As such, poor housing, water and sanitation conditions are potential health risks. Indeed, slums are areas of human habitations characterized with impoverished structural housing, congestion, insufficient access to safe water, unhygienic sanitation, and insecure residential status, which may lead to environmental health risks.

5.3 Recommendations

1. Policy implementers should be strict on observing standards and specifications in the building code, as well as Occupational Safety and Health Act.

2. The county government should enhance accessibility of the low income earners to affordable modest housing.

3. There is need for civic education about water quality and poor sanitary habits, and the diseases associated with them.

4. Other improved water sources and sanitation facilities should be offered through joint efforts between the water supply and sanitation service providers.

5. The county government should create controlled dumping sites. This could end the haphazard or unrestrained dumping of litter.

REFERENCES

Addo, A.I. (2013), Assessing residential satisfaction among low income households in multi-habited dwellings in selected low income communities in Accra: Policy review. *Urban Studies Journal*, 5(4):1-20.

Alirol, E., B. Getaz, F. Chappuis& L. Loutan (2011), Urbanization and infectious diseases in a globalised world. Lancet Infectious Diseases 11: 131– 41.

Alirol, E., L. Getaz, B. Stoll, F. Chappuis& L. Lutan (2011), Urbanisation and Infectious Diseases in a Globalised World. *Lancet Infect Dis.* 11: 131-41.

Andres, L. A., B. Briceño, C. Chase, & J.A. Echenique (2014), Sanitation and Externalities: Evidence from Early Childhood Health in Rural India. Policy Research Working Paper6737. WashingtonDC: World Bank.

Andy Haines, N. B. (2012), Promoting Health and Advancing Development through improved Housing in low-income settings. *Journal of Urban Health*.

APHRC (2012), Urban Health in Kenya: Key Findings: The 2000 Nairobi Cross-Sectional Slum Survey. Nairobi: African Population and Research Centre.

Aribigbola, A. (2011), Housing affordability as a factor in the creation of sustainable environment in the developing world: The example of Akure, Nigeria. *J. Hum. Econ* 35(2): 121-131.

Baker, M.G., A. McDonald, A. Zhang & P. Howden-Chapman (2013), Infectious Diseases Attributable to Household Crowding in New Zealand: A Systematic Review and Burden of Disease Estimate. He KaingaOranga/Housing and Health Research Programme, University of Otago: Wellington, New Zealand.

Bandura, A. (1989), Human agency in social cognitive theory. *Am Psychol.*, 44(9): 1175–1184.

Bartram, J. & S. Carncross (2010), Hygiene, Sanitation and Water: Forgotten foundations of health. *PLoS Medicine,* 7(11).

Bartras, J., Colford, J., & Clasen, T. (2014), Burden of disease from inadequatewater, sanitation and hygiene in low and middle income settings: A retrospective analysis of data from 145 countries. *Tropical Medicine and International Health*.

Benicio, M.H., M.U. Ferreira, M.R. Cardoso, S.C. Konno & C.A. Monteiro (2004), Wheezing Conditions in early childhood: Prevalence and risk factors in the city of Sao Paulo, Brazil. *Bull World Health Organ*, 82:516–522.

Boateng, D., M. Tia-Adjei& E.A. Adams (2013), Determinants of household water quality in the Tamale Metropolis, Ghana. *Journal of Environment and Earth Science*, 3: 70–77.

Braubach, M., D.E. Jacobs & D. Ormandy (2011), Environmental Burden of Disease Associated with Inadequate Housing. Geneva: World Health Organization.

Bwire, G., M. Malimbo, B. Maskery, Y.E. Kim, V. Mogasale& A. Levin (2013), The burden of cholera in Uganda, *PLoS Neglected Tropical Diseases,* 7(12).

Centre for Disease Control and Prevention. Facts about mold and dampness. (n.d.).

Cheng J.J, C.J Schuster-Wallace, S. Watt, B.K. Newbold& A. Mente (2012), Anecological quantification of the relationship between water, sanitation and infant, child, and maternal mortality. *Environmental Health* 11.

Constitution of Kenya (2010), Art 43 (1)(b), 2014.

Copley, B. (2015), Causation in Grammatical Structures. Oxford UniversityPress.

Corburn, J. & C. Hilderbrand (2015), Slum Sanitation and the Social Determinants of Women's Health in Nairobi, Kenya. Hindawi Publishing Corporation.

Corcoran, E., C. Nellemann, E. Baker, R. Bos, D. Osborn, &H.Savelli(2010), The central role of waste water management in sustainable development. A rapid response assessment. UN-HABITAT, GRID- Arendal, New York.

En, W.L. & G.L Gan (2011), Factors associated with use of improved water sources and sanitation among rural primary schoolchildren in Pursat Province, Cambodia. *The Southeast Asian Journal of Tropical Medicine and Public Health*, 42: 1022–1031.

Ercumen, A., A.M. Naser, L. Unicomb, B.F Arnold, J.M. ColfordJr& S.P. Luby (2015), Effects of source-versus household contamination of tubewell water on child diarrhea in rural Bangladesh: A randomized controlled trial. *PloS one*, *10*(3).

Ezeh, A., O. Oyebode, D. Satterthwaite, Y.F. Chen, R. Ndugwa, J. Sartori, B. Mberu, G.J. Melendez-Torres, T. Haregu&S.I. Watson (2016), The history, geography, and sociology of slums and the health problems of the people who live in slums.

Fiebelkorn, A.P., B.Person, R.E. Quick, S.M. Vindigni, M. Jhung, A. Bowen & A. Parker (2012), Systematic review of behavior change research on point-of-use water treatment interventions in countries categorized as low- to medium-development on the human development index. *Social Science & Medicine,* 75(4):622–633.

Firdaus, G. & A. Ahmed (2013), Relationship between housing health: A cross sectionalstudy of an urban centre of India. *Indoor Built Environ.* 22(3):498-507.

Flaxman, A. D., J. K., Rajaratnam, J.R. et al. (2010), Neonatal, post-neonatal, childhood, and under-5 mortality for 187 countries, 1970–2010: a systematic analysis of progress towards Millennium Development Goal 4. *The Lancet*, *375*(9730), 1988-2008.

Freeman, M.C., M.E. Stocks, O. Cumming, A. Jeandron, J.P. Higgins, J. Wolf & V. Curtis (2014), Hygiene and health: Systematic review of handwashing practices worldwide and update of health effects. *Tropical Medicine and International Health,* 19:906–916.

Fry, S, B., B. Cousins & K. Olivola (2002), Health of children living in urban slums in Asia and the near east: Review of existing literature and data. EnvironmentalHealth Project, U.S. Agency for International Development.

Fuller, J.A., T. Clases, M. Heijnen& J.N.S Eisenberg (2014), Shared sanitation and the prevalence of diarrheal in young children: Evidence from 51 countries, 2001-2011. *Am J Trop Med Hyg*, 2014(9).

Gichuki, G. R (2005), Environmental Problems and Human Health in Urban Informal Settlements: A case study of MukurukwaNjenga, Nairobi.

Godfrey, R. & M. Julien (2005). "Urbanization and Health." *Clinical Medicine* 5(2): 137–41.

Gordon, S.B., N.G. Bruce&J. Grigg (2014), Respiratory risks from household air pollution in low and middle income countries. *LncetRespir Med*, 2014(2):823-60.

Hagan, J.E., P. Moraga, F. Costa et al. (2016), Spatio-temporal determinants of urban leptospirosis transmission: Four-year prospective cohort study of slum residents in Brazil. *PLoSNegL Trop Dis*, 2016(10).

Haines, A., N. Bruce, S. Cairncross, M. Davies, K. Greenland, A. Hiscox, S. Lindsay, D. Satterthwaite& P. Wilkinson (2013), Promoting health and advancing

development through improved housing in low-income settings. *Journal of Urban Health*, 90:810–831.

Hargreaves, J.R., D. Boccia, C.A. Evans, M. Adato, M. Petticrew& J.D. Porter (2011),The social determinants of tuberculosis: From evidence to action. *American Journal of Public Health*, 101(4):654-662.

Haydar, S., M. Arshard & J.A. Aziz (2009). Evatualion of Drinking water Quality in Urban Areas of Pakistan: Acase study of Southern Lahore. *Pak.J.engg.& Appl.Scie., 5:*16-23.

Heckman J. (2008), Econometric Causality. *International Statistical Review*. 76(1):1–27.

Heijnen, M., P. Routray, B. Torondel& T. Clasen (2015), Shared sanitation versus individual household latrines in urban slums: A cross-sectional study in Orissa, India. *The American Journal of Tropical Medicine and Hygiene*, *93*(2):263-268.

Heitzinger, K., C.A. Rocha, R.E. Quick, S.M. Montano, D.H. Tilley Jr., C.N. Mock & S.E. Hawes (2015), Improved but not necessarily safe: An assessment of fecal contamination of household drinking water in Rural Peru. *The American Journal of Tropical Medicine and Hygiene*, 93:501–508.

Hove, M., E.T. Ngwerume& C. Muchemwa (2013), The urban crisis in sub-Saharan Africa: A threat to human security and sustainable development. *Stability*, 2(1).

Howden-Chapman, P., N. Roebbel& E. Chisholm (2017), Setting Household Standards to Improve Global Health. WHODepartment of Public Health, Environmental and Social Determinants of Health.

Jevons, R., C. Carmichael&A. Crossley(2016), Minimum indoor temperatures threshold recommendations for English homes in winter: A systematic review. *Public Health*, 2016(136):4-12.

Kamau, N. & H. Njiru (2018), Water, Sanitation and Hygiene Situation in Kenya's Urban Slums. *Journal of Health Care for the Poor and Underserved*, *29*(1):321-336.

Kioko, K.J. & J.F. Obiri (2012), Household attitudes and knowledge on drinking water enhance water hazards in peri-urban communities in Kenya. *Journal of Disaster Risk Studies*, 4(1).

Lim S. S. , T. Vos& A. D. Flaxman et al. (2010), "A comparative risk assessment of burden of disease and injury attributable to 67risk factors and risk factor

clusters in 21 regions, 1990–2010:a systematic analysis for the Global Burden of Disease Study2010*,"The Lancet*, vol. 380, no. 9859, pp. 2224–2260, 2012.

Lucci, P. & T. Bhatkal (2014), Monitoring progress on urban poverty. *Are current data and indicators fit for purpose*.

Matzopoulos, R., E. Jordaan& G. Carolissen (2006), Safety issues relating to paraffin usage in Eshane, KwaZulu-Natal. *Journal of Energy in Southern Africa*, 17:4-9.

Mbae, C.K., D.J. Nokes, E. Mulinge, J. Nyambura, A. Waruru& S. Kariuki (2013), Intestinal parasitic infection in children presenting in diarrhea in outpatient and inpatient settings in an informal settlement of Nairobi, Kenya. *BMC Infectious Diseases*, 13(1).

Meijer, M., J. Rehl, K. Bloomfield &U. Grittner (2012), Do neighbourhoods affect individual mortality? A systematic review and meta-analysis of multi-level studies. *SocSci Med*, 74:204-12

Misilu, M., E. Nsokimieno, E., Chen, S. & L. Zhang (2010), Sustainable Urbanization's Challenges in Democratic Republic of Congo, Journal of Sustainable Development, 3 (2), pp 153-158.

Moe, C. L., & R. D. Rheingans (2006), Global challenges in water, sanitation and health. *Journal of water and health*, *4*(S1), 41-57.

Moore, M., P. Gould & B.S. Keary (2003), "Global Urbanization and Impact on Health." *International Journal of Hygiene and Environmental Health* 206(4–5): 269–78.

Muchiri, L. (2008), Gender and equity in bioenergy access and delivery in Kenya.Practical Action East Africa.

Mukama, T., R. Ndejjo&D. Musoke (2016), Practices, concerns, and willingness to participate in solid waste management in two urban slums in central Uganda. *Journal of Environmental and Public Health*, 2016.

Muntalif, B. S., A. Nastiti, D. Rosmin, A. Sudradjat, S.V. Meijerink& A.J.M. Smits (2017), Household Water Supply Strategies in Urban Bandung, Indonesia: Findings and Implications for Future Water Access Reporting. ITB Journal Publisher.

Muriithi, D.I.(2014), Risk Factors Influencing Diarrheal Occurrence among Children under Five Years Old in Informal Urban Settlements: A Case Study Of Korogocho, in Nairobi County, Kenya.

Mutui, F.N. (2007), Waste Disposal, Sanitation and Health in Nairobi. A case study of Kasarani, Nairobi.

Nakagiri, A., C.B. Niwagaba, P.M. Nyenje, R.N. Kulabako, J.B. Tumuhairwe& F. Kansiime (2016), Are pit latrines in urban areas of sub-Saharan Africa performing? A review of usage, filling, insects and odour nuisances.*BMC Public Health*, 2016:16:120.

Nassiuma, D. K. (2002), Survey sampling. Theory and methods.

Nastiti, A., W.A. Primasuri, B. Setiani, A. Sudradjat, I. Latifah, D. Roosmini& S.V. Meijerink (2013), Water and Sanitation in Urban Slum: A Case from Bandung Municipality, West Java, Indonesia.

Neelim, A. (2011), The impact of safe sanitation facilities in reducing the prevalence of waterborne diseases in rural Bangladesh. *Waterlines*, 30:328–342.

Nganyanyuka, K., J. Martinez, A. Wesselink, J.H. Lungo& Y. Georgiadou (2014), Accessing water services in Dar es Salaam: Are we counting whatcounts?*Habitat International*, (44):358–366.

Njiru, M.M. & M. Moronge (2013), Factors affecting growth of mortgage industries in Kenya: A case study of National Housing Corporation. *Int. J. Soc. Sci. Entre pri.* 1(7):26-35.

Onda, K., J. LoBuglio& J. Bartram (2012), Global access to safe water: Accounting for water quality and the resulting impact on MDG progress. *International Journal of Environmental Research and Public Health*, 9:880–894.

Ooko, T.O. (2013), Effects of Rapid Urbanisation on Access to Adequate Housing in Kakamega.

Osumanu, I.K., E.A. Kosoe& F. Dipilah (2016), Residential housing in Ghana's low-income urban areas: An analysis of households living conditions in the Wa Municipality. University for Development Studies, Tamale Ghana.

Park, P. K. (2015), Preventive and Social Medicine (23 ed.). Bhanot Publishers.

Patunru, A.A. (2015), Access to safe drinking water and sanitation in Indonesia. *Asia & the Pacific Policy Studies*, 2:234–244.

Pérez-Hernández, B., E. Garcia-Esquinas&P. Guallar-Castillon (2016), Housing conditions and limitations in physical function among older adults. *J Epidemiol Community Health*, 70:954-60.

Prüss-Ustün, A., J. Wolf, C. Corvalán, R. Bos& M. Neira (2016), Preventing disease through healthy environments: A global assessment of the burden of disease from environmental risks. Geneva: WHO.

Ramin, B. (2009), Slums, climate change and human health in sub-Saharan Africa. Bulletin of the World Health Organization, 87.

Satterthwaite, D. (2016), Missing the millennium development goal. Targets for waterand sanitation in urban areas. *Environ Urban, 2016 (*28):99-118.

Sclar, E.D, P. Garau& G. Carolini (2005), The 21st century health challenge of slums and cities. *Lancet* 365:901-903.

Shaheed, A., J. Orgill, C. Ratana, M.A. Montgomery, N.A. Jeuland& J. Brown (2014b), Water quality risks of 'improved' water sources: Evidence from Cambodia. *Tropical Medicine and International Health*, 19:186–194.

Shaheed, A., J. Orgill, M.A. Montgomery, M.A. Jeuland& J. Brown (2014a), Why 'improved' water sources are not always safe. Bulletin of the World Health Organization, 92:283–289.

Sharma, S., G.R. Sethi, A. Rohtagi, A. Chaudhary&R. Shankar(1998), Indoor air quality and acute lower respiratory infection in Indian urban slums. *Environ Health Perspect*, 106:291–297.

Sheuya, S., P. Howden-Chapman& S. Patel (2007), The design of housing and shelter programmes: The social and environmental determinants of inequalities. *Journal of Urban Health*, 84:98–108.

Singh, R., X. Wang, J.C. Mendoza & E.K. Ackom (2015), Electricity (in) accessibility to the urban poor in developing countries. *Wiley Interdisciplinary Reviews: Energy and Environment*, 4(4):339–353.

Sobsey, M.D.(2002), Managing Water in the Home. Accelerated Health Gains from Improved Water Supply; WHO/SDE/WSH/02.07; WHO:Geneva.

Sodha, S.V., M. Menon, K. Trivedi, A. Ati, M.E. Figueroa, R. Ainslie, K. Wannemuehler& R. Quick (2011), Microbiologic Effectiveness of Boiling and Safe Water Storage in South Sulawesi, Indonesia, *Journal of Water and Health*, 9(3):577-585.

Sphere, (2011), The Sphere Handbook, Humanitarian Charter and Minimum Standards in Humanitarian Response.

Subbaraman, R., S. Shitole, T. Shitole, K. Sawant, J. O'Brien, D.E. Bloom & A. PatilDeshmukh (2013), The Social Ecology of Water in a Mumbai Slum: Failures in Water Quality, Quantity, and Reliability, *BMC Public Health*, 13(1).

UN (2007), The Millennium Development Goals Report 2007. New York: United Nations.

UN (2012), The human right to water and sanitation.

UN (2014), United Nations Department of Economic and Social Affairs. Worldurbanization prospectus. The 2014 Revision.

UN DESA (2013), UN DESA (UN Department of Economics and Social Affairs)Worldeconomic and social survey: Sustainable development challenges UN DESA, New York.

UN DESA (2014), UN DESA (UN Department of Economics and Social Affairs) World urbanization prospects*The 2014 revision* UN DESA, New York.

UN Habitat (2016), Slumsalmanac 2015-16. Tracking improvement in the lives of slum dwellers. (Nairobi, Kenya: UNON, Publishing Services Section).

UN-HABITAT (2003), Water and sanitation in the world's cities. Local action for global goals. London: Earth Scan.

UN-HABITAT (2006), The State of the World's Cities Report2006/2007. Nairobi: Earthscan.

UN-HABITAT (2012), State Of World's Cities Report 2012/2013: Prosperity of Cities. Nairobi: United Nations Human Settlement Programme.

UN-HABITAT (2012), Sustainable Housing for Sustainable Cities. A Policy Framework for Developing Countries. Nairobi: UN-HABITAT.

UN-Habitat (2014), The global urban indicators database 2014UN-Habitat, Nairobi.

UN-HABITAT (2014), The State of African Cities: Re-Imagining Sustainable Urban Transitions. Nairobi: UN Habitat.

UN-HABITAT (2016), World Cities Report: Urbanization and Development Emerging Futures. Nairobi: UN-Habitat.

UNICEF (2012), State of the World's Children Report 2012.

UNICEF (2014), The Rights to safe Water and to Sanitation. UNICEF Current Issues, 3(2014):1–5.

UNICEF (2015), Water, Sanitation, and Hygiene.

UNICEF/WHO (2012), Progress on Drinking Water and Sanitation: 2012 Update (Report). New York: UNICEF and World Health Organization.

UNICEF/WHO (2013), Progress on Sanitation and Drinking Water-Update. Geneva, SUI: UNICEF and World Health Organization.

United Nations (1978), The Role of Housing in Promoting Social Interaction. Department of Economics and Social Affairs, New York.

Van Ham, M., D. Manley, N. Biley, L. Simpson & D. Macclenan (2012), Neighbourhood effects research: New perspectives. London: Springer.

Wanyonyi, G.I.(2009), The Role of the Household Point-of-Use Systems in Urban Water Supply: The Case of Selected Areas of Nairobi.

Webb, E., D. Blane& R. de Vries (2013), Housing and Respiratory Health at Older Ages. *J Epidemial Community Health*, 67:280-85.

WHO (2015), Typhoid fever-Uganda. Geneva, Switzerland.

WHO (2019), Sanitation - Fact Sheet. World Health Organization.

WHO (2016), Drinking-Water. Fact Sheet. World Health Organization.

WHO/UNICEF (2003), Types of drinking water sources and sanitation. World Health Organization and United Nations Children Fund.

WHO/UNICEF (2014), Joint Water Supply, & Sanitation Monitoring Programme. Progress on Drinking Water and Sanitation: Update. World Health Organization.

World Bank (2005), Overview: Understanding, measuring and overcoming poverty.

APPENDIX: QUESTIONNAIRE

PUBLIC HEALTH IMPLICATIONS OF HOUSING, WATER ANDSANITATION CONDITIONS IN KABURINI SLUM OF KAKAMEGA TOWN

Date of Interview	
Name of Respondent	

HOUSEHOLD DEMOGRAPHIC CHARACTERISTICS

1. Household Characteristics:

Name	Relation to Hh Head	Sex	Age	Marital Status	Education Level	Occupational Status	Type of Occupation

Relation to Household Head
[1] Household head
[2] Spouse
[3] Son/daughter
[4] Brother/sister
[5] Father/Mother
[6] Other relative
[7] Non relative
[8] Worker
[9] Other

Marital Status
[1] Never married
[2] Married
[3] Divorced
[4] Widowed
[5] Separated
[6] Staying together
[7] Not stated/don't know

Occupational Status
[1] Regular (formal) employment
[2] Temporary (formal) employment
[3] Self-employed/formal sector
[4] Self-employed/informal sector
[5] Casual labour
[6] Unemployed (looking for a job)
[7] None (student/child)
[8] Home maker
[9] Other

Sex
[1] Male
[2] Female

Education level
[1] None
[2] Primary
[3] Secondary
[4] Above secondary
[5] Not stated/don't know

Age (in completed years)

2.1 In which year did you come to Kakamega town?
2.2 In which year did you come to this estate?
2.3 What is your tenure status? *[1]* Own *house [2]* Rented *[9]*Other
2.3 a) **If rented**, how much do you pay per month?
2.4 How much is your monthly income?

HOUSING CONDITIONS

3.1 Observe roofing materials of house: *[1]* Iron sheet *[2]* Tin *[3]* Grass *[9]*Other
3.2 Observe wall material of the house: *[1]* Permanent *[2]* Semi-permanent *[3]* Mud *[4]* Iron sheet*[5]* Tin *[6] Wood [9]*Other

3.3 Observe the type of floor material of the house: *[1]* Cement *[2]* Tiles *[3]* Wood *[4]* Earth*[5]* Other

3.4What is the size of this house? *[1]* Single room *[2]* Two rooms *[3]* One bed room*[4]* Two bedrooms

3.5 What is the size of the rooms*? [1]* Small [2] Medium *[3]* Large
3.6 How many household members live in this house?
3.7 Are there insects, pests and rodents intruding in this house? *[1]* Yes *[2]* No
3.8 Are there structural defects and dead spaces on the walls? *[1]* Yes *[2]* No
3.9 Does this house get damp, cold or moldy at times? *[1]* Yes *[2]* No

4.0Where is your cooking area located? *[1]* Enclosed area in the house *[2]* Open area in the house*[3]* Outside the house

4.1Which type of fuel do you use for cooking?*[1]* Paraffin *[2]* Firewood *[3]* Charcoal *[4]* Electricity *[5]* LPG *[6]* Biogas *[7]* Solar*[9]* Other

4.3Which type of fuel do you use for lighting?*[1]* Tin lamp *[2]* Lantern *[3]* Fuelwood*[4]* Pressure lamp *[5]* Electricity *[6]* Gas lamp*[7]* Solar

4.4 Has any member of the household suffered from any of the respiratory diseasessuch as coughs, pneumonia or tuberculosis?[1] Yes [2] No

ACCESS TO WATER

Access to Water Situation

5.1 What is your source of water?*[1]* Piped water (individual) *[2]* Piped water(landlords) *[3]* Piped water (from elsewhere)*[4]* Bore hole *[5]* Shallow well *(i)* Protected *(ii)* Unprotected *[6]* Private water vendors*[7]* Roof Catchment/rain water *[8]* Surface water *(i)* River *(ii)* Lake *(iii)*Spring*(iv)* Pond *(9)* Other.

5.2 What are the uses of water?*[1]* Drinking *[2]* Cooking *[3]* Washing *[9]* Other
5.3 What is the location of the water source?*[1]* On plot *[2]* Off plot
5.4 Do you buy the water? *[1]* Yes *[2]* No
5.4 a) **If yes**, how much per unit?
5.5 Do you treat the water? *[1]* Yes *[2]* No
4.5 a) **If yes**, which mode of water treatment do you use?*[1]* Boiling *[2]* Use ofchemicals *[3]* Filtering *[4]*Solar disinfection*[9]*Other

5.6 Which type of vessel do you use to store drinking water?*[1]* Bucket *[2]* Pot *[3]* Narrow-necked container *[4]* Bottle

5.7 How do you access drinking water from the storage vessel?*[1]* Drawing it using smaller vessels*[2]* Pouring it direct from the storage vessel

5.7 a) **If you draw it using smaller vessels**, which are these vessels?
5.7 b) Do you clean them before drawing water from the storage vessel when they are not in use for some time? *[1]* Yes *[2]* No

Access to Water and Household's Health Situation
6.1 Are there cases of people who have suffered from diarrheal in this area?[1] Yes [2]No

6.2 Are there cases of people who have suffered from typhoid in this area?[1] Yes [2] No
6.3 Has any member of this household suffered from any of these diseases this year?*[1]* Yes *[2]* No *[9]* Don't know

6.3 *(a)* **If Yes**

Household Member	Disease	No. of times suffered this year?	Visited hospital? *[1]* Yes *[2]* No	Which hospital? *[1]*Public *[2]*Private (Indicate name)	If paid *[1]* Yes *[2]* No	How much? (in total)

Perception on Access to Water
7.1 How do you determine and perceive water safe for drinking?*[1]* Colour of the water *[2]* Taste *[3]* Checking suspended solids *[4]* Temperature of the water*[5]* Source of the water *[6]* Smell *[7]* Boiling

7.2 What is your perception about the following sources of water in this estate in terms of safety for Drinking?

a)	Piped water	*[1]* Safe	*[2]* Fairly safe	*[3]* Not safe
b)	Borehole water	*[1]* Safe	*[2]* Fairly safe	*[3]* Not safe
c)	Shallow well	*[1]* Safe	*[2]* Fairly safe	*[3]* Not safe
d)	Water from private vendors	*[1]* Safe	*[2]* Fairly safe	*[3]* Not safe
e)	Rain water	*[1]* Safe	*[2]* Fairly safe	*[3]* Not safe
f)	Surface water	*[1]* Safe	*[2]* Fairly safe	*[3]* Not safe

ACCESS TO SANITATION
8.1 Does this household have access to a sanitation facility i.e. toilet? *[1]* Yes *[2]* No
If yes
8.1 a) What type of sanitation facility does the household have access to?*[1]* Traditional pit latrine *[2]* Improved pit latrine *[9]*Other

8.1 b) Where is the sanitation facility located?*[1]* On plot *[2]* Off plot, not far from here *[3]* Off plot, far from here

8.2 Do you pay to use the sanitation facility?*[1]* Yes *[2]* No
8.3Is the sanitation facility shared? (i.e. with other people)*[1]* Yes *[2]* No
8.3 a) **If yes**, approximately how many people or householdsshare it?*[9]* Don't know
8.4 Is the shared sanitation facility cleaned and disinfected? *[1]* Yes *[2]* No
8.4. a) **If yes**, how often?*[1]* Daily *[2]* Only when it is very dirty
8.5 How do you dispose the domestic solid waste?*[1]* Dumping in open sites *[2]* Burning *[3]* Scattering in on plot farms

8.5 a) **If it is a dumping open site,** where is it located?*[1]* On plot *[2]* Off plot, not far from here *[3]* Off plot, far from here