WATER SANITATION PRACTICES AMONG RESIDENTS OF DENSELY POPULATED SETTLEMENTS OF KANO METROPOLIS, KANO STATE

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF PHYSICAL AND HEALTH EDUCATION, FACULTY OF EDUCATION, BAYERO UNIVERSITY KANO IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE M.Sc. (Ed) DEGREE IN HEALTH EDUCATION.

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SEPTEMBER, 2019

DECLARATION

I hereby declare that this work is the product of my own research efforts, undertaken under the supervision of Dr. Abubakar I. Hassan, and has not been presented and will not be presented elsewhere for the award of a degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research for this dissertation and the subsequent preparation of this dissertation by Ahmad Isyaku (SPS/15/MHE/00003) were carried out under my supervision.

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APPROVAL PAGE

This work has been read, examined and approved as meeting the requirements, for the award of Master of Science Degree (M.sc. Ed) in Physical and Health Education (Health Education).

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ACKNOWLEDGEMENTS

The researcher wishes to express his profound gratitude to Almighty Allah for His blessings to carry out this work successfully. The researcher is grateful to Dr. Abubakar I. Hassan, his Supervisor, for his professional advice, suggestions, encouragement, corrections and objective critisms of every submission made to him, which made this work successful. May Allah bless him and increase his knowledge, reward him abundantly and continue to guide him in all his undertakings as well as his families.

The researcher appreciates the guidance accorded him by Dr. Ahmad A.M Getso, the Head of Department, all academic staff of the Department such as; Prof. Lasun Emiola, Prof. M.G. Yakasai, Prof. O.O Oyerinde, Prof. Muhammad, Professor Sadiq Isma'ila, Dr. A.T. Yusuf, Dr. A.I. Darki, Dr. M. Njidda, Dr. M.J. Yakasai (P.G Coordinator), Dr. L.I Yazid, Dr. A.M. Madaki, Dr. A.I. Hassan,Dr. M.H. Darma, Dr. H. Umar (Mrs), Dr. A.H Bello, Dr. K.S. Kankarofi, Dr. A.A. Aniki, Mal, Sunusi Mandawari and Faculty of Education Representative to School of Postgraduate Studies Professor Y. U. Haruna and the entire staffs of School of Post Graduate Studies, as well as all Departmental Administrative and supportive staff of Physical and Health Education. May Allah reward you all. The assistance rendered by H.O.D Medical Fagge, Ibrahim Kwachiri, Haruna CCO of Kano metropolis LGAs and their traditional rulers especially ward heads during the research is highly appreciated. The researcher wishes to further acknowledge his research assistants; Haj. Jimmai, Jibrin muhd and Hamidan Sani that contributed immensely in the administration of the instrument. The researcher acknowledges Bilya K. Sule, Sale Saminu, Sadiya Sani for their contributions during collation. Finally, sincere appreciation is given to Kano State Primary Health Care Management Board for sponsoring the researcher through the course of the study.

DEDICATION

This work was dedicated to my elderly mother, Malama Hadiza Shawai, who despite her health condition, continued to encourage and support me with motherly advise throughout the conduct of this work.

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ABSTRACT

This study assessed water sanitation practices of residents of densely populated settlements of Kano metropolis, Kano state. Kano Metropolis is densely populated that become at risk of water born diseases and has a highest death rate of one in every five children died before they reach five (5) years of age due to water born diseases. Six (6) research questions and six hypotheses guided the study. A cross sectional survey design was used for the study. The population of this study comprised all residents of densely populated settlements of Kano Metropolis Local Governments Areas which was 4,176,529. A Sample of 500 participants were used which were selected through multi stage sampling procedure and 460 filled questionnaires were retrieved. The instrument for data collection was a researcher developed questionnaire on a modified four (4) points Likert scale with a reliability index of 0.76. Frequency counts and percentages were used to organise the demographic characteristics of the respondents, Chi-square was used to test hypotheses 1 to 3 while ANOVA was used to test hypotheses 4 to 6 at 0.05 level of significance. The findings of the study revealed that residents of densely populated settlements in Kano metropolis significantly do not purify their water to make it safe for drinking and cooking (χ^2=172.878, df=1, $p<0.05$); residents of densely populated settlements in Kano metropolis significantly store their water to make it safe for drinking and cooking (χ^2=40.209, df=1, $p<0.05$); residents of densely populated settlements in Kano metropolis significantly transport their water to make it safe for drinking and cooking (χ^2=12.71, df=1, $p<0.05$). The result also revealed that water purification to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements of Kano metropolis based on sources of water (F=1.086, df=2;402, $p>0.05$); water storage to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements of Kano metropolis based on sources of water (F=1.128, df=2;402, $p>0.05$); water transportation to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements in Kano metropolis based on sources of water (F=0.197, df=2;402, $p>0.05$). It was recommended among others that there is need for a greater improvement of safe water supply through Government's intervention and create awareness on good practices of water sanitation among residents of densely populated settlements.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Safe drinking water, sanitation and good hygiene are fundamental to health, survival and human development (World Health Organization & United Nations Children's Fund 2013). According to Moe and Rheingans (2006), 1.1 billion people in the world lack access to improved water supplies and 2.6 billion people lack adequate water sanitation. Unsafe water, inadequate sanitation and insufficient hygiene practices account for an estimated 9.1% of the global burden of disease and 6.3% of all deaths (Prüss-Üstün, Bos, Gore & Bartram, 2008).

The significance of water to human cannot be over-emphasised and there are numerous scientific and economic facts that stated that water shortage or its pollution can cause severe decrease in productivity and increase in deaths of living species ((Haruna, Ejobi & Kabagambe, 2005;Mwabi,Adeyemo, Mahlangu, Mamba, Brouckaert, Swartz, Offringa, Mpenyana-Monyatsi, & Momba, 2011). Reports by Food and Agricultural Organisation of United State of America revealed that in African countries, particularly Nigeria, water related diseases are interfering with basic human development (Food and Agricultural Organization, [FAO], 2007).

Water sanitation refers to all measures necessary for improving and protecting water and its sources for promoting health and wellbeing of the people (United Nation international Children Emergency Fund,[UNICEF], 2008). It is also used to cover the wider concept of controlling all the factors in the water and its sources which may have deleterious impacts on health and wellbeing (Department For International Development,[DFID], 2008).

However, WHO defined improved drinking water source as any water source that is by nature of its construction or through active intervention, protected from underground and outside contamination. This category includes household connections, public standpipes, boreholes, and protected dug wells, protected springs, and rain harvested water. On the contrary, “unimproved drinking water source” refers to “any type of open surface water, uncovered, or unprotected well” (World Health Organization; UNICEF, 2013). It should be noted that this definition is different from “safe drinking water” which means “water that is free of waterborne pathogens or other contaminants causing diseases”. Several studies have shown evidence of bacteriological contamination in the drinking water of different households, even when that water is supplied from an “improved drinking water source” (Vacs Renwick, 2013; Wright, Gundry & Conroy, 2005). Intermittent piped water supply and unsafe water storage practices were considered the two main causes of contamination. In most developing countries, continuous piped water supplies are rarely provided. In addition to microbial infiltration in the system due to backpressure condition, an intermittent system also causes households to store water in ways that are subjected to recontamination (Vacs Renwick, 2013; Wright, et al., 2005; WHO, 2013).

WHO (2005) attributes 3,520,000 (88%) of the 4 million annual cases of diarrhoeal disease to consumption of unsafe drinking water and poor water hygiene, WHO (2007) estimates that 94% of diseases are preventable through modification of the environment including improving availability of safe drinking water and hygiene. The purification of water reduces the concentration of particulate matters including suspended particles, parasites, bacterial, algae, viruses, fungi and a range of dissolved and particulate materials derived from the surface that water may have made contact with after falling as rain. This will reduce the prevalence of diarrhoeal disease that is associated with consumption of unsafe water, (WHO, 2007).

Most of the common sources of water that are available to local communities in Nigeria are being contaminated with number of anthropogenic factors, of which pollution remains the most dominant problem. Water pollution occurs when unwanted materials with potentials to threaten human and other natural systems find their ways into rivers, lakes, wells, streams or even reserved fresh water in homes and industries. The pollutants are usually pathogens, silt and suspended solid particles such as soils, sewage materials, disposed foods, cosmetics, automobile emissions, construction debris and eroded banks from rivers and other waterways. On the other hand, this contaminated water is directly consumed without proper treatment which is becoming a common practice to local and densely populated communities which may likely lead to spread of diseases such as typhoid, dysentery, cholera, hepatitis among others (Garba, Hassan & Galadima 2010).

Water purification is one of the ways used to sanitize water; it is a process of removing undesirable chemicals, biological contaminants, suspended solids and gases from contaminated water with the aim of making it safe for drinking or other specific purpose. The processes aimed at purifying water at home, it includes protection of the source, storage, sedimentation and decantation, boiling, filtration and various forms of chemical disinfection. Hence, there are different means by which individuals get access to water and this depends on a person's geographical location (Lucas & Gilles, 2003; Obionu, 2007).

Moreover, good water storage facilities and cleanliness will reduce the prevalence of diarrhoeal disease that is associated with consumption of unsafe water. Also, treatment of water at the household level has been shown to be one of the most effective and cost-effective means of preventing waterborne diseases. Hence vulnerable populations such as people living in densely populated areas should take ownership of their water security by treatment and safe storage of household water, using ideal method of construction of sources of water that include good sanitary well or bore-hole, collection of water from sources using clean permanent container, good and clean sanitary storage facilities and proper hygienic at the point of use (UNICEF, 2008).

In developing countries, many people are living in densely populated communities and have to collect their drinking water some distances away from the household and transport it back in various types of containers. Microbiological contamination of the water may occur between the collection point, transportation and the point-of-use in the household due to unhygienic practices causing the water to become a health risk (United Nations 2010).

Kano metropolis has for centuries been the most important commercial and industrial nerve centre of Northern Nigeria attracting millions of people from all parts of the country and beyond. Migration and natural growth rate of 3% is expected to continue to increase the population and waste stream in the years to come. With a population presently estimated at 13.4 million, Kano metropolis has total population of 4,176,529 and is among the fastest growing cities in Nigeria with population density of over 8000 habitants per square kilometre, (World Population Review, 2019).

Population density is usually computed as population per square kilometre (Km^2) of land area excluding area occupied by water. Therefore, Kano metropolis is a densely populated in which their storage water and its source are all polluted due to human insanitary attitudes. Nigeria Centre for Diseases control (2017) reported that the overwhelming water related diseases burden in Kano metropolis is attributed to the above mentioned problem of poor water sanitation practices. It is against this background that this study will be undertaken to appraise water sanitation practices of residents of densely populated settlements of Kano metropolis.

1.2. Statement of the problem

WHO (2007) stated that water contamination can be prevented through improving availability of safe drinking water by various methods of water purification which reduce the concentration of particulate matter including suspended particles, parasites, bacterial, algae, viruses, fungi and a range of dissolved and particulate material derived from the surface that water may have made contact with after falling as rain.

According to Water Aid (2014), about 63 million people in Nigeria do not have access to clean and safe water. Water Aid Nigeria has continued to raise awareness of water, sanitation and hygiene issues through a number of media programmes but yet water borne diseases are still at alarming rate. For example, data obtained from the most recent Nigerian Demographic Health Survey (NDHS, 2018) showed that Kano has the highest annual live-births and deaths figures in the country. This translates to one in every five children in Kano State dying before the aged of five with diarrhoea accounting for 16% of the 70,000 deaths of under-five children in the state. This implies that over 11,200 under-five children lose their lives due to diseases associated with poor water sanitation.

Moreover, the population density of Kano metropolis is about 8000 inhabitants per km^2 within the Kano closed-settled zone compared to the national average of 267 inhabitants per km^2. It is also one of the most crowded cities in the country with migration rate of 30 to 35 per cent per annum (UNDP, 2018). These figures indicate that water contamination is significant in Kano metropolis and that its management would require innovative strategies. As a result of that, potable water supply in Kano metropolis faces serious challenges because of rapid population growth, urbanization, budgetary constraints, corruption and imperatives of development and social equity.

Despite the fact that there is increased awareness of effects of drinking contaminated water, poor siting of water sources and importance of water purification by Health workers and mass media at all levels of Kano metropolis, yet there is a high number of diseases related to poor water sanitation such as diarrhoea, cholera, dysentery, poliomyelitis and death cases resulting from lack of proper water sanitation practices, were recorded (Nigeria Centre for Diseases Control, 2018). Records from Health facilities indicate that majority of the diseases complaints in hospital and clinics by patients are associated with water sanitation problem, (Nigeria Centre for Diseases Control, 2018). For example a record from Dala MCH of Dala LGA revealed that 259 cases out of 674 reported in the month of August, 2018 were associated with water related diseases. Similarly in August, 2018 the Rijiyar Lemo MPHC of Fagge LGA reported a total of 844 cases in which 44% and the cases were water related diseases. Likewise, Murtala Special Hospital of KMC L.G.A., reported 3854 cases of sickness, of which 1620 of the cases were water related diseases (Nigeria Centre for Diseases Control, 2018).

The above situations in the hospitals in focus is in line with what WHO and UNICEF (2018) report that diarrhoea, accounts for over 21 per cent of child deaths in Nigeria with an estimated 70,000 deaths mainly among under-five children yearly. Kano alone contributes a big chunk of this annual death figure. It is in line with this background that this study will be conducted to assess the water sanitation practices of residents of densely populated settlements of metropolis of Kano state. Therefore, the following research questions were used to guide the conduct of the study:-

1. Do residents of densely populated settlements purify water in a way that is safe for drinking and cooking in Kano metropolis?

2. Do residents of densely populated settlements store water in a way that is safe for drinking and cooking in Kano metropolis?

3. Do residents of densely populated settlements transport water in a way that is safe for drinking and cooking in Kano metropolis?

4. Does water purification method differ among residents of densely populated settlements in Kano metropolis based on source of water?

5. Does storage method of water differ among residents of densely populated settlements in Kano metropolis based on source of water?

6. Does transportation method of water differ among residents of densely populated settlements of Kano metropolis based on source of water?

1.3. Hypotheses

The following hypotheses guided the conduct of the study:

1.3.1. Major Hypothesis

Residents of densely populated settlements of Kano metropolis do not significantly utilize safe water sanitation practices.

1.3.2. Sub Hypotheses

1 Residents of densely populated settlements do not significantly purify water to make it safe for drinking and cooking in Kano metropolis.

2. Residents of densely populated settlements do not significantly store water to make it safe for drinking and cooking in Kano metropolis.

3. Residents of densely populated settlements do not significantly transport their water from source of water to make it safe for drinking and cooking in Kano metropolis.

4. Water purification will not significantly differ among residents of densely populated settlements in Kano metropolis.
5. Method of water storage will not significantly differ among residents of densely populated settlements in Kano metropolis.
6. Method of water transportation will not significantly differ among residents of densely populated settlements of Kano metropolis.

1.4. Purpose of the study

The study assessed the current status of water sanitation practices of the study area in order to suggest interventions that will reduce incidence of diseases that are related to poor water sanitation practices.

1.5. Significance of the study

This study would be of benefit to traditional rulers, existing community structures, Government and Nongovernmental organisation in the following ways:-

1. It would provide useful information to traditional leaders and existing community structures to give priority on awareness to residents of densely populated settlement on the importance of water sanitation practices.
2. To provide existing situations of water sanitation practices in densely populated areas of Kano metropolis in order to provide useful information for State government and NGOs so as to improve their water sanitary services in the area and to strengthen awareness to residents of densely populated settlements in Kano metropolis LGAs.
3. It would contribute to the existing body of knowledge in Health Education and other allied health disciplines.

4. It would allow Governments to provide knowledge to the residents of densely populated settlements on their current situation of water sanitation practices and measures to be taken for the prevention of water born diseases.

1.6. Delimitation of the study

This study was delimited to residents of densely populated LGAs of Kano metropolis which include Dala, Fagge, Kano municipal, Gwale, Ungogo, Tarauni, Kumbotso and Nassarawa LGAs. It was also delimited to two selected settlements that are densely populated from each LGA. The study will be confined to water purification practices, water storage practices and water transportation from source of water.

1.7. Operational Definition of Terms

The following terms were defined as they were used in the study!

Residents - People living in densely populated settlements of Kano metropolis.

Water sanitation practice- Activities carried out by residents of densely populated settlement of Kano metropolis to make their water safe for cooking and drinking such as keeping water clean and removing contaminants from it.

Densely populated settlements- Settlements in Kano metropolis that has 400 and above people per square kilometre.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0. Introduction

This study assesses water sanitation practices of residents of densely populated settlements of Kano metropolis. In this chapter, related literatures were reviewed under the following subheadings:

- Overview of water sanitation.
- Water sanitation practices.
- Methods of water purification among residents of densely populated settlements.
- Methods of water storage among residents of densely populated settlements.
- Methods of water transportation among residents of densely populated settlements.
- Factors affecting water sanitation practices.
- Diseases associated with poor water sanitation practices
- National water sanitation policy
- Water sanitation in densely populated settlements.
- Empirical studies on water sanitation practices among residence of densely populated settlements.
- Summary.

2.1. Overview of water sanitation

Water sanitation is the process of cleaning water to make it safe for drinking, bathing, cooking and other uses. Clean water is important to people in every country because harmful substances in water can cause illness and even death. For example, untreated water may contain viruses, bacteria and other dangerous substances that represent health risks for those who consume it (Green, 2008). Faust and Othman (1998) viewed water sanitation as physical and chemical processes for making water suitable for human consumption and other purposes. Butterwoth & Sousan (2001), defined water sanitation as a process for enhancing the quality of water so that it meets the water quality and criteria for its fitness for the intended use. They further asserted that water sanitation or hygiene originally focused on improving the qualities of drinking water.

According to WHO (2007), water sanitation/purification is the removal of contaminants from raw water to produce safe water that is pure enough for human consumption. Substances that are removed during the process of water treatment include bacteria, algae, viruses, fungi, minerals and man-made chemical pollutions.

Water sanitation is the process of purifying water to reduce the concentration of particulate matter including suspended particles, parasites, bacterial, algae, viruses, fungi and a range of dissolved and particulate material derived from the surface that water may have made contact with after falling as rain. This will reduce the prevalence of diarrhoeal disease that is associated with consumption of unsafe water. Treatment of water at the household level has been shown to be one of the most effective and cost-effective means of preventing waterborne diseases. Hence vulnerable populations take ownership of their water security by treatment and safe storage of household water { UNICEF (2008),WHO (2013), }.

2.1.1. Sources of water

Sanitize water sources" is any sources that are by nature of its construction or through active intervention, protected from outside contamination, in particular from contamination with fecal matter". This category includes household connections, public standpipes, boreholes, and protected dug wells, protected springs and rain harvested water. On the contrary, "un-sanitize water sources" refers to "any type of open surface water, uncovered, or unprotected well" (World Health Organization & UNICEF, 2013). Water sources means locations or places where fresh water flow abundantly in the form of river, lake, pond or stream. Sanitize water sources refers to locations or origin where water that are useful or potentially useful to man comes from. According to WHO (2005), sanitize drinking water sources should be constructed and design to protect the water source from outside contamination.

i. **Rain water**

Rain water is a product of a natural process of distillation, it is also prime source of all water, a part of the rain water sinks into the ground to form ground water, part of it evaporates into the atmosphere and some runs off to form streams and rivers, which flow ultimately into the sea. Rain water is the purest in nature. Physically it is clear, bright and sparkling. Chemically, it is very soft containing only traces of dissolved solids. Bacteriologically, rain water from clean districts is free from pathogenic agents Dhaar and Robbani (2008).

Rain water tends to become impure when it passes through the atmosphere it picks up suspended impurities from the atmosphere such as dust, soot and microorganisms and gasses such as carbon dioxide, nitrogen, oxygen and ammonia. The rain water is one of purest form of water and does not contain suspended / dissolved impurities. However when this water is collected through rain water harvesting, it gets contaminated because of contact with roof surface/ground and some of the impurities get mixed in it. These impurities are required to be removed before collecting the harvested rain water in storage tank or diverting it or recharging of ground water aquifers (Kaushal, 2004).

A compelling advantage of rain water over other water source is that it is one of the purest sources of water available. Indeed, the quality of rain water is an overriding incentive for people to choose rain water as their primary water source, or for specific uses such as watering houseplants and gardens. Rain water quality almost always exceeds that of ground or surface water as it does not come into contact with soil and rocks where it dissolves salts and minerals and it is not exposed to many of the pollutants that often are discharged into surface waters such as rivers, and which can contaminate groundwater (Fewtrell, et al., 2005). However, rain water quality can be influenced by characteristics of area where it falls, since localized industrial emissions affect its purity. Thus, rain water falling in non-industrialized areas can be superior to that in cities dominated by heavy industry or in agricultural regions where crop dusting is prevalent. Rain water is soft and can significantly reduce the quantity of detergents and soaps needed for cleaning, as compared to typical municipal water. In addition, soap scum and hardness deposits disappear and the need for a water softener, often an expensive requirement for well water systems, is eliminated, (Van Metre & Mahler, 2003). Water heaters and pipes will be free of deposits caused by hard water and will last longer. Rain water's purity also makes it an attractive water source for certain industries for which pure water is a requirement (Kaushal, 2004).

ii. **Spring water**

Springs are found mainly in mountainous or hilly terrain. A spring may be defined as a place where a natural outflow of groundwater occurs. Spring water is usually fed from a sand or gravel water-bearing soil formation called an aquifer, or a water flow through fissured rock. Where solid or clay layers block the underground flow of water, it is forced upwards to the surface. The water may emerge either in the open as a spring, or invisibly as an outflow into a river, stream, lake or the sea (Meuli & Wehler, 2001).

In general, spring water is of good quality. Pathogenic contamination is unlikely if the source meets certain criteria. These include the thickness of the soil layer, the type of soil and the velocity of infiltration of the surface water. The soil formation should be thick enough for natural filtration and biological action to remove pathogenic organisms before the water enters the aquifer feeding the spring. The type of soil determines the speed of the flow through the voids in the soil and so influences the purification mechanisms and the concentration of suspended solids. If the soil layer is not thick enough, any human activity should be restricted or even forbidden in the catchment area. Otherwise, local farmers may be allowed to conduct some agricultural activities in the catchment area (but outside the protection area around the spring) under some restrictions such as no use of artificial fertilizers or harmful chemicals. This may contribute to the protection of the catchment because they have a direct interest in protecting the area for their crop and their water supply (Meuli et al, 2001).

iii. Underground water

Groundwater is fresh water (from rain or melting ice and snow) that soaks into the soil and is stored in the tiny spaces (pores) between rocks and particles of soil. Groundwater accounts for nearly 95 percent of the nation's fresh water resources. It can stay underground for hundreds of thousands of years, or it can come to the surface and help Fill Rivers, streams, lakes, ponds, and wetlands. Groundwater can also come to the surface as a spring or be pumped from a well. Both of these are common ways we get groundwater to drink. About 50 percent of our municipal, domestic, and agricultural water supply is groundwater. Ground water is universally distributed both as a natural outpouring of an aquifer in the form of springs and as wells excavated in earth, to reach an aquifer. Ground water contains excess of inorganic matter and little or no organic impurities. It is free from suspended matter and comparatively with surface water; it is less aerated and less agreeable in taste. Ground water drawn from adequately protected deep wells is naturally free from pathogens when it is properly collected. Water collection means taking water from a natural source and feeding into a distribution system. The source can be an underground reserve, a body of standing water, a body of flowing water or any natural substance from which water can be extracted (Dhaar & Robbani, 2008).

2.1.2. Types of sanitized water

"Sanitized water means "water that is free of waterborne pathogens or other disease causing contaminants". Several studies have shown evidence of bacteriological contamination in the drinking water of different households, even when that water is supplied from an "sanitized water source" (Vacs Renwick, 2013; Wright, et al., 2005). Intermittent piped water supply and unsafe water storage practices were considered the two main reasons of contamination. In most developing countries, continuous piped water supplies are rarely provided. In addition to microbial infiltration in the system due to backpressure condition, an intermittent system also causes householders to store water in ways that is subjected to recontamination (Vacs Renwick, 2013), (Wright, et al., 2005). Water is also considered sanitized or pure from a sanitary point when it contains no evidences of pollution from the wastes of man or animal, and is considered pure when it contains no lime or salt to form boiler scale, or organic matter in sufficient amount to cause foaming, (Del razo & Garcia, 2011).

There are different categories of sanitized water intended for human consumption such as:-

i. Prepared water such as Distilled water, water from tap.
ii. Water from spring.
iii. Natural mineral water such as water from sanitary well, borehole water and protected rain water.

2.2. Water Sanitation practices

Treating a water supply to kill germs is called disinfection, water sanitation or water purification. Communities get their water from sources such as bores, rivers, lakes and dams. The water from these sources is often contaminated; sometimes only slightly, sometimes badly. This is why the water supplier makes provision for water treatment (usually chlorination) between the water source and the storage tank or in the tank. This treatment should keep the water free of live germs and parasites, (Aini, FakhrulRazi, Mumtazah, Meow & Chen, 2007).

Faust and Aly (1998) viewed water sanitation practice or treatment as physical and chemical processes for making water suitable for human consumption and other purposes. They also viewed it as a process for enhancing the quality of water so that it meets the water quality criteria for its fitness for the intended use. Moreover, water treatment originally focused on improving the qualities of drinking water. According to WHO (2007), water purification is the removal of contaminants from raw water to produce safe water that is pure enough for human consumption.

WHO (2013) opined that water treatment is any practices or method used to alter the chemistry composition or natural "behaviour" of water. Water available in nature from surface or underground sources is described as raw water. It requires treatment before it can be supplied for human consumption. The nature of treatment is determined by the quality of raw water and the impurities present in it. Ground water may need only partial treatment, surface water especially that obtained from river may require complete treatment before it can be released for supply. Water sanitation comprises protection of water sources from outside and underground contamination, methods of safe water purification, safe water Transportation, and Safe water storage. Water purification includes natural and artificial methods. Controlling pollution by dilution is a natural way in rivers and stream water. Amount of sewage or polluting matter, which enters river or stream, gets diluted so much that it loses its bad effect on human health. Dilution is an important means of purification (Adelana, & MacDonald, 2008).

2.3 Method of water purification among residents of densely populated settlements

Before addressing methods of treating water at the household level, it is important to emphasize the need to use the best possible source of water. There are many ways in which pollution can threaten drinking-water quality at the source, or point of collection, Meena, Lucy, Micheal & Courtney (2012) These risks include the following:

- Poor site selection,
- Poor protection of the water source against pollution,
- Poor structure design or construction,
- Deterioration or damage to structures,
- Lack of hygiene and sanitation knowledge and practice in the community.

Protecting the water source reduces or eliminates these risks and can lead to improved water quality and health. Actions that can be taken at the community level can include some of the following: Meena, Lucy, Micheal & Courtney (2012)

- Regularly cleaning the area around the water source,
- Moving latrines away from and downstream of water sources,
- Building fences to prevent animals from getting into open water sources,
- Lining wells to prevent surface water from contaminating groundwater,
- Building proper drainage for wastewater around taps and wells,
- Stabilizing springs against erosion and protection from surface run-off contamination,
- ensuring watershed use is non-polluting.

Sedimentation

Sedimentation is a physical treatment process used to reduce the turbidity of the water. This could be as simple as letting the water settle for some time in a small container, such as a bucket or pail. The sedimentation process can be accelerated or "assisted" by adding special chemicals or native plants, also known as coagulants, to the water. Coagulants help the sand; silt and clay join together and form larger clumps, making it easier for them to settle to the bottom of the container. The common chemical coagulants used are aluminium sulphate (alum), polyaluminium chloride (also known as PAC or liquid alum), alum potash and iron salts (ferric sulphate or ferric chloride). Native plants are also traditionally used in some countries, depending on the local availability, to help with sedimentation. For example, prickly pear cactus and moringa seeds have been used to help sediment water, Rosa & Clasen (2010)

Filtration

Rosa & Clasen, (2010) stated that Filtration is also commonly used to reduce turbidity and remove pathogens. Filtration is a physical process that involves passing water through filter media. Some filters are also designed to grow a biological layer that kills or inactivates pathogens and improves the removal efficiency. Sand and ceramic are common filter media, although membranes and other media can also be used. Various types of filters are used by households around the world, including:

- Biosand filters,
- Ceramic pot filters,
- Ceramic candle filters,
- Membrane filters.

Other filters use media such as activated carbon that adsorb and hold contaminants like a sponge rather than mechanically remove them like a sieve. The capacity of these filters is used up once the adsorption sites become fully occupied, Rosa & Clasen, (2010).

Disinfection

Another approach to treating water in the home is to kill or inactivate pathogens through disinfection. The most common methods used by households around the world to disinfect their drinking-water are Singh, (2012).

- Chlorine disinfection,
- Solar disinfection (SODIS),
- Ultraviolet (UV) disinfection,
- Boiling.

When water has high levels of turbidity, pathogens "hide" behind the suspended particles and are difficult to kill using SODIS and UV disinfection. Reducing turbidity by sedimentation and filtration will improve the effectiveness of these disinfection methods. The effectiveness of chlorine disinfection is also impacted by pH, chlorine demand and temperature. The effectiveness of boiling is not impacted by the chemical or physical condition of the water. Distillation is another method of using the sun's energy to treat drinking-water. It is the process of evaporating water into vapour, and then capturing and cooling the vapour so it condenses back into a liquid. Any contaminants in the water are left behind when the water is evaporated Singh, (2012).

2.4 Methods of water storage among residents of densely populated settlements

Already treated or purified water has to be stored properly to prevent recontamination. Safe storage means keeping your treated water away from sources of contamination, and using a clean and covered container. It also means that drinking from the container should be done in a way that cross-contamination can be avoided. The container should prevent hands, cups and dippers from touching the water, so that the water does not get recontaminated (CAWST 2009). There are several possibilities to store water. They range from very small covered buckets to large tanks or cisterns. Another possibility is to store water in bottles. Furthermore, the hygienic conditions in a household are crucial. Good hygienic measures include the following (WHO 1997):

- Careful storage of household water and regular cleaning of all household water-storage facilities.
- Construction, proper use, and maintenance of latrines.
- Regular hand washing, especially after defecation and before eating, preparing food or handling drinking water.
- Careful storage and preparation of water and food.

Treated water should be stored in plastic, ceramic, or metal containers especially when using treatment options that do not leave residual protection. The following characteristics of containers serve as physical barriers to recontamination (CDC & U.S. AID 2009):

- A small opening with a lid or cover that discourages users from placing potentially contaminated items such as hands, cups, or ladles into the stored water.
- A spigot or small opening to allow easy and safe access to the water without requiring the insertion of hands or objects into the container.

- A size appropriate for the household water treatment method, with permanently attached instructions for using the treatment method and for cleaning the container.

The following aspects should be considered when planning for safe storage and prevention of recontamination (WHO 1997):

- Location of storage vessel
- Design of storage vessel
- Removal of water

Jerry cans

In many countries in Africa, 20-litre jerry cans, initially used to transport vegetable cooking oils, are cleaned and used to transport and store water. They are easy to carry on the head (see also human powered distribution) and are a good option for safe storage. The opening is too small to allow hands or utensils into the water; instead the water is removed by pouring. Drilling a hole in the plastic and adding a tap provides easier access to the treated water and allows for a hand-washing station in the home. Used jerry cans cost approximately US$1-5 on the market in Africa (CDC & U.S. AID 2009).

Bucket with lid and tap

Five gallon (19-litre) buckets are widely available in many countries and are often used for water transport and storage. Buckets can be modified for safe storage by ensuring the installation of a tight-fitting lid, or by drilling a hole through the plastic and installing a sturdy tap. Furthermore, a label with instructions for water treatment should be placed on the bucket, and people should be instructed to use the tap instead of dipping into the bucket. In Haiti, this is an easy educational message, since the tap is seen as a sign of higher socioeconomic status, and families take pride in using it. Taps and labels can be imported or locally made (CDC & U.S. AID 2009).

Modified clay pots

In many cultures, clay pots are the preferred storage container, because the water inside the container is cooled as water evaporates through the clay. In some rural areas, water is transported in clay pots, but in most areas water is transported in plastic containers and then stored in clay pots. By working with local potters, it is possible to modify clay pots to have a tap and an adequate cover, as seen in the two examples (CDC & U.S. AID 2009).

Large storage plastic tanks

For settlements in rural areas, large storage tanks are a possible solution if there is no connection to a water distribution network. They are either filled by tank trucks or by a rain water harvesting system. Plastic tanks are available in all sizes, from small to very large. It should be considered that they are UV stabilised, durable and impact resistant, impervious and made out of non-toxic material (e.g. food grade approved polyethylene), Costs depend on manufacturer, country and size. The water in storage tanks should be tested regularly (Vegas 2011)

Storage for domestic and animal use and agricultural use must be strictly separated. An outlet such as a tap or a piping system should always be appropriately designed to prevent contact with hands or other sources of contamination, thus pouring treated water from the container rather than scooping the water out of it. Tanks, buckets or other storage types must be cleaned and flushed regularly to prevent health risks and recontamination. Purified water at household level should be used as soon as possible, preferably the same day, to minimise the risk of recontamination (CAWST 2009). In general, water from sources such as reservoirs, rainwater tanks, covered buckets or other water sources must be -purified before used as drinking water. It is also highly important to wash hands regularly, especially after defecation and before eating, preparing food and handling drinking water (WHO 1997).

Methods of water transportation among densely populated settlements

In developing countries, many people are living in densely communities and have to collect their drinking water away from the household and transport it back in various types of containers (Sobsey, 2013). Microbiological contamination of the water may occur between the collection point and the point-of-use in the household due to unhygienic practices causing the water to become a health risk (Sobsey, 2013; Guchi, 2015).

To improve and protect the microbiological quality and to reduce the potential health risk of water to these households, intervention strategies is needed that is easy to use, effective, affordable, functional and sustainable (CDC, 2015; Sobsey, 2013). Many different water collection and storage systems have been developed and evaluated in the laboratory and under field conditions (Sobsey, 2013). In addition, a variety of physical and chemical treatment methods to improve the microbiological quality of water are available (Sobsey, 2013).

In most developing countries, women are responsible for the collection and transportation of water (Sobsey, 2013). The work involved in fetching the water may differ in each region, it may vary according to the specific season, it depends on the time spent queuing at the source, the distance of the household from the source and the number of household members for which the water must be collected (WHO, 2016). Water for domestic use is collected either by dipping the container inside the water supply, collecting rainwater from a roof catchment system or by using different types of pumps connected to the water supply system (Sobsey, 2013). The methods of transportation of the water from the source water supply could be either by a wheelbarrow, a donkey cart, a motor vehicle, using a rolling system or by carrying the container by hand or on the head (CDC, 2015). A common practice often seen in densely rural areas was the use of leaves or branches with leaves to stop water slopping out during transit in wide-neck storage and transport containers and also showed that these leaves can be an additional source of coliform bacteria to the drinking water,(Chalchisa, Megersa & Beyene, 2017).

However, studies carried out in Densely peri-urban communities in South Africa (Jensen, Jayasinghe, Van der Hoek, Cirncross & Dalsgaard, 2004) have showed that although the households were supplied with good quality water complying with South African drinking water specifications, the water in the household storage containers had increased levels of indicator microorganisms. This implied that secondary contamination was introduced after the water collection and transportation. Consequently, many of these studies have indicated that improvements at the water source are useless as water is contaminated during collection, transportation and storage in households due to poor sanitation practices.

Source water contamination is likely to have a wide effect on the community because it can introduce new pathogens in the home environment (Sobsey, 2013). However, several studies have reported that the microbiological quality of the water deteriorates after collection, during transport and during storage at the point-of-use due to secondary contamination factors (Jensen, Jayasinghe, Van der Hoek, Cirncross & Dalsgaard, 2004).

2.6. Factors affecting water sanitation practices

Both human activities and natural activities can change the physical, chemical, and biological characteristics of water, and will have specific ramifications for human and ecosystem health. Water quality is affected by changes in nutrients, sedimentation, temperature, pH, heavy metals, non-metallic toxins, persistent organics and pesticides, and biological factors, among many other factors (Carr & Neary, 2008). The following are the factors that affect water sanitation practices.

2.6.1 Chemicals and other toxins

Diverse human-produced organic chemicals can enter surface and groundwater through human activities, including pesticide use and industrial processes, and as breakdown products of other chemicals (Carr & Neary, 2008). Many of these pollutants, including pesticides and other non-metallic toxins, are used globally, persist in the environment, and can be transported long ranges to regions where they have never been produced (United Nation Water Assessment Programme, 2009). Organic contaminants sometimes called "persistent organic pollutants", or POPS, such as certain pesticides, are commonly found to be contaminating groundwater by leaching through the soil and surface waters through runoff from agricultural and urban landscapes. DDT a pesticide that has been banned in many countries but is still used for malaria control in countries throughout Africa, Asia, and Latin America remains persistent in the environment and is resistant to complete degradation by microorganisms. Even in countries where DDT has been banned for decades, it is still consistently found in sediments, waterways, and groundwater. For some of these materials, non-lethal doses may be ingested by invertebrates and stored in their tissues, but as larger organisms consume these prey species, the amounts of pesticides and other materials bio-accumulate, eventually to toxic levels. Some pesticides break down in the environment over time, but breakdown products may also be toxic and can concentrate in sediments, to be released in large volumes during scouring events or other disturbances, (Jaga & Dharmani, 2003).

2.6.2 Lack of potable water supply

This is also factor that affects water sanitation practice in urban settlements due to insufficient supply. As mentioned earlier, a high percentage of the urban poor remain excluded from water sanitation networks. In fact, less than 15 percent of those living in Asia and Africa have access to water sanitation (Brick, Primrose, Chandrasekhar, Roy, Muliyil, & Kang, (2004). It was further stated that less than 50 percent of the poorest urban residents in Africa, and less than 40 percent in Asia have access to piped water (WHO & UNICEF, 2010).

A number of explanations have been proposed for the inadequate supply of safe water, and especially, sanitation. Building water sanitation infrastructure is costly and may involve numerous technical, bureaucratic, and legal constraints (Water Aid, 2014). Overcoming these constraints is further complicated by the complementarities in water sanitation provision: Many of the safest sanitation improvements require adequate water supply, and modern sanitation solutions without water may actually be counterproductive for health. Water infrastructure must, therefore, be provided either before sanitation infrastructure is built, or ideally as a joint project, which in turn increases the costs of service provision. Improvements in the planning and delivery of services are essential to promote more efficient use of water resources. However, overcoming technical supply problems must be complemented by a resource management framework involving national, State, and local authorities (Federal Republic of Nigeria, 2005).

2.6.3 **Pollution of water sources**

Due to a lack of space, *pit latrines* are often constructed close to *groundwater sources* such as wells*, hand pumps or springs.* During heavy rains, the latrines tend to get flooded, resulting in water seeping through the soil, contaminating the *groundwater*. Lack of proper construction of public drainages which are constructed near water pipe that result in water contamination when the pipe is break. Additionally, as the impervious and un-vegetated ground of *slum* areas has little or no retention during heavy rains, human and animal wastes are flushed into the *river* systems polluting urban water supplies, *rivers* and productive coastal waters (Malik, Yasar, Tabinda & Abubakar, 2012).

2.6.4 Poverty

Adults *who* are ill themselves or *who* need to take care of their children are less productive. Additionally, the *health* costs induced by the lack of adequate *water, sanitation and hygiene* practices can consume a large part of the poor household's income. The time spent to fetch water cannot be invested into income-generating activities ((Malik, Yasar, Tabinda & Abubakar, 2012).

Green, (2008) furthermore, asserted that water should only be stored in a material that is created specifically for long term storage of liquids intended for consumption. It is important that hygienic containers should be used to store water as some containers can leak, crack, degrade or otherwise cause problems to the stored water. Sometimes it is difficult to find or buy a good storage container, but the most important things are to make sure that it is covered and the water stored undergoes adequate treatment so that it can be safe for drinking.

2.6.5 Poor collection, transportation and storage system

Clasen, Schmidt, Robert and Cairncross (2007) observed that water collection is caused by contamination that occur during and after collection often because of poorly designed open containers and improper hygiene and handling during transportation. Water transportation is the movement of water over large distance to another place. The benefits of protected sources on water quality and health are limited unless safe transport and storage can be ensured. Water storage means keeping water in a special place while it is not being used. In the context of this study water storage referred to as keeping water away from sources of contamination and using a clean and covered container to hold it. Murcott, (2006), asserted that water storage container may be a reservoir, a water bottle, jerry can, clay pot, rubber pot, with lid drum and tank. The container should prevent hands, cups and dippers from touching the water so that the water does not get re-contaminated. Storage container should be well protected from outside contamination and use for no other purpose other than the storage of clean water.

2.6.6 Level of education

In a study conducted by Okoga (2007) found that the higher a woman's level of education, the more likely she is to be conscious of her health and that of her family. She is also more likely to take positive actions that are capable of promoting good health. She can have education on safe storage of water and treatment of unsafe water for domestic use. Conversely, the illiterate women may lack the basic education on efficient use and pollution prevention, even as they may have learned strategies to conserve safe water.

2.6.7 Uncontrolled disposal of human wastes

A major activity that leads to widespread water quality problems is the disposal of human waste. Faecal contamination often results from the discharge of raw sewage into natural water a method of sewage disposal common in developing countries, and even in more advanced countries like China, India, and Iran (Carr & Neary, 2008). Even in developed countries, partially or inadequately treated sewage remains a major source of water quality contamination.

Lack of adequate sanitation contaminates water sources worldwide and is one of the most important forms of global water pollution. Worldwide, 2.5 billion people live without improved sanitation (UNICEF, 2008). Over 70 percent of these people, or 1.8 billion people who lack sanitation, live in Asia. The amount of faecal coliform bacteria (associated with faecal matter) detected in Asia's rivers is 50 times the WHO guidelines, indicating a high level of dangerous microbial contaminants (United Nation Environmental Programme, 2001). In Asia, and in countries around the world, these pathogenic microbes can be introduced into drinking water from unsafe or inadequate water treatment, leading to a wide range of serious health threats. Of the world's regions, sub-Saharan Africa moved forward the slowest in achieving improved sanitation: only 31 percent of residents had access to improved sanitation in 2006. Even improved sanitation does not guarantee the protection of water quality; often there is no wastewater treatment to protect water bodies from receiving collected sewage. Over 80 percent of the sewage in developing countries is discharged untreated in receiving water bodies (United Nation World Water Assessment Programme, 2009). Open defecation poses an extreme human health risk and significantly compromises quality in nearby water bodies. Eighteen percent of the world's population, or 1.2 billion people, defecate in the open (UNICEF, 2008). Over a billion people, or one out of every three people who live in rural areas, defecate in the open. In Southern Asia, 63 percent of rural people – 778 million people practice open defecation. Faecal coliform, an important marker to gauge the extent of contamination with human or animal sewage, indicates the failure of adequate sanitation and wastewater treatment, and also the existence of pathogens.

2.6.8 Rapid population Growth

The rapidly increasing urbanization rate has huge implications for freshwater use and wastewater management. Cities face rising water and sanitation demands and problems such as pollution and overexploitation. Especially the large urban population living in slums often lack access to safe water and sanitation services, (United Nations Children's Fund, 2006).

The rapid growth rate of the population has significant impact on the water supply in Kano State. Drought and rainfall seasonality are the main features associated with Sudan-Sahel area, similarly, increase income level, raised living standard, which also lead to high water consumption. Definitely, increase in population will exert high pressure on available water resources and infrastructural facilities use for water supply, for different types of uses intended (Rahman, Vahter & Sohel, 2006).

2.6.9 Climate change

Climate change has a major impact on the world's freshwater resources, water quality, and water management (Pruss-Ustun, Bos, Gore and Bartram, 2008). Increases in water temperature and changes in the timing and amount of runoff are likely to produce unfavourable changes in surface-water quality, which will in turn affect human and ecosystem health. The threats posed by climate change will serve as an additional stressor to many already degraded systems, particularly those in developing countries. Global surface temperatures are rising, and there is evidence that the rate of warming is accelerating. Current climate models project that rising greenhouse-gas concentrations will "likely" increase global mean surface air temperature between 1.1˚C and 6.4˚C relative to a 1980- 1999 baseline (Meuli et al. 2001). Water temperature is an important determinant of surface-water quality, as it controls the types of aquatic life that can survive, regulates the amount of dissolved oxygen in the water, and influences the rate of chemical and biological reactions. As a result, higher surface-water temperatures from climate change will accelerate biological productivity, increase the amount of bacteria and fungi in the water, and promote algal blooms (Kundzewicz, Mata, Arnell, Doll, Kabat & Miller, 2007).

2.6.10. Man power and competency

The proper planning, implementation and management of water resources programme and project depend principally on the availability of competent personnel, (Prüss-Üstün, Bos, Gore Bartram, 2008). It is a common knowledge that in Nigeria, there has been a marked shortage of manpower in water resources particularly at professional and sub-professional levels. This paucity of trained personnel in the middle technical and management levels has been limiting the scale of success of various developments. The professional and sub-professional are very few in number and some of them inexperienced. The few available ones have been spread too thingy on the design, construction, operation and maintenance of the existing projects. In order to cope with the challenges in the next decade, there is need to step up manpower training, (Okeke, & Ozoh, 2009).

2.7 Diseases associated with poor water sanitation practices

Unsafe or inadequate water sanitation, and hygiene cause approximately 3.1 percent of all deaths worldwide, and 3.7 percent of DALYs (disability adjusted life years) worldwide (WHO 2007). Worldwide, unsafe or inadequate water sanitation and hygiene cause approximately 1.7 million deaths a year (WHO 2007). While the majority of the health threats posed by poor water quality is the result of microbial contaminants and subsequent disease in developing countries, the historical and current use of chemicals for industrial and agricultural purposes along with the chemical by-products of waste management are also compromising water quality, leading to other, serious health problems for wildlife and humans around the world, (WHO, 2013)

Classification of water diseases base on

1. Water born diseases
2. Water base diseases
3. Water wash diseases'
4. Water related diseases
5. Water diseases due to high or low concentration of nutrients

1. **Water born diseases**

Worldwide, waterborne diseases are among the leading killers of children under five years old and more people die from unsafe water annually than from all forms of violence, including war (WHO, 2007). There are four main classes of water-related disease: waterborne (faecal-oral), water-washed, water-based, and water-related insect vector. Many water-related diseases are the result of poor quality water that is used for drinking, washing, and other uses. Further details on two classes of water-related disease that are directly related to poor water quality are described below.

Waterborne diseases include those, for which water is the agent of transmission, particularly those pathogens transmitted from excreta to water to humans. These include most of the enteric and diarrheal diseases caused by bacteria, parasites and viruses, such as cholera, Giardia, typhoid, and rotaviruses. Drinking water contaminated by human or animal excreta is the main cause of water born diseases. The first such diseases identified were typhoid and cholera, and both remain a serious problem in many regions of the world. The most common causes of severe diarrheal disease include Rotavirus, Pathogenic E. coli, Campylobacter jejuni, and protozoan parasites. The leading cause of severe diarrhoea in children is Rotavirus, and almost every child who reaches the age of five will have an episode of rotavirus gastroenteritis. Epidemic diarrheal diseases are caused by Shigella and Vibrio cholera. Both are highly infectious and are prone to severe epidemics, (UNICEF 2008). In addition the human health effects caused by waterborne transmission vary in severity from mild gastroenteritis to severe and sometimes fatal diarrhoea, dysentery, hepatitis and typhoid fever. Contaminated water can be the source of large outbreaks of bacterial and viral disease, including cholera, dysentery and cryptosporidiosis; for the majority of waterborne pathogens, however, there are other important sources of infection, such as person-to-person contact and food. Most waterborne pathogens are introduced into drinking-water supplies in human or animal faeces, do not grow in water and initiate infection in the gastrointestinal tract following ingestion.

1 Bacterial pathogens

Most bacterial pathogens potentially transmitted by water infect the gastrointestinal tract and are excreted in the faeces of infected humans and other animals. However, there are also some waterborne bacterial pathogens, such as Legionella, Burkholderiapseudomallei and atypical mycobacteria that can grow in water and soil. The routes of transmission of these bacteria include inhalation and contact (bathing), with infections occurring in the respiratory tract, in skin lesions or in the brain. (Amman, Michalke, & Schramel, 2002)

a) Typhoid fever

Typhoid, a common worldwide bacterial disease which is spread through contaminated food and water that causes septicemia, a causes liver inflammation. Typhoid fever is an infection that causes clinical symptoms of fever, abdominal pain, body rashes, terry stool, weakness, poor appetite, headaches, generalized aches and pains, and lethargy etc .It is caused by Salmonellae typhi, Enterobacteria under Enterobacteriaceae family Gram negative motile bacteria. Salmonella typhi can survive in water for 7 days in sewage for 14 days and in ice cream for 1 month. In warm dry conditions most of the bacilli die in few days. Typhoid fever presents one of the classical examples of water born diseases. Diagnosis of typhoid fever is made when the Salmonella bacteria is detected with blood culture or stool culture. Besides this, several other tests were also performed for early diagnosis of Typhoid fever like immune-chromatographic assay (detection of IgM of Salmonella typhi by ICT) and Widal test (demonstration of salmonella antibodies against antigens O-somatic and H-flagellar). It was observed that approximately 3%-5% of patients become carriers of the bacteria after the acute illness (Joint monitoring Programme, 2010). In 2000, it was estimated that over 2.16 million episodes of typhoid occurred worldwide, resulting in 216 000 deaths, out of which more than 90% of this morbidity and mortality occurred in Asia (Centre for Diseases control and Prevention, 2015). It is also found that almost one third of the global population is living in developing South Asia where disease occurrence is high especially in rural areas and people are unaware of water-borne diseases and cost of illness. To maintain rural health, waterborne diseases can be reduced by introducing health interventions like proper water and sanitation facilities, (Malik ,Yasar , Tabinda & Abubakar, 2012).

b) Cholera

This is disease of rapid onset characterized by vomiting, profuse dehydrating diarrhoea with watery stools and marked toxaemia. Muscular cramps, suppression of urine and shock occur later. The incubation period is 1-7 days. Cholera is notifiable disease. The disease is caused by bacteria called "vibrio- cholerae". The reservoir of infection is a sick person, a convalescent patient or a carrier (through the faeces or urine). Cholera my begin suddenly as a water born disease in a situation were by sanitized water falls short in summer and the people are found to use both unfiltered and tank water, (Fewtrell, Kaufmann, Enanoria & Colford, 2005).

c) Dysentery

Dysentery is characterized by diarrhoea (containing blood, mucus and pus), fever and sudden onset of abdominal pain. The incubation period is 1-7 days. The disease I cause by bacteria of genus Shigella (non motile gram-negative bacilli). The disease is transmitted through drinking contaminated water or food with shigella organism. Younger children are more liable than older persons to acquired shigella infections (Nwankoala, H.O. (2011). Treatment of the infection, water sanitation practice and hygiene are the method of controlling the disease (Bukenya, 2006).

1. Viral pathogens:-

Viruses associated with waterborne transmission are predominantly those that can infect the gastrointestinal tract and are excreted in the faeces of infected humans (enteric viruses).

a) Poliomyelitis

Poliomyelitis is a highly infectious disease caused by wild poliovirus types 1, 2 and 3. The virus is transmitted from person to-person through ingestion water or food contaminated with infected fecal matter. Following infection, the virus is shed intermittently in excrement for several weeks with little or no symptoms in majority of cases, (Keller, Frey, & Walker, 2008). The initial symptoms of poliomyelitis include fever, fatigue, headache, vomiting, neck stiffness and pain in the limbs. The virus multiplies in the intestine, from where it can invade the nervous system and can cause paralysis. Initial symptoms of polio include fever, fatigue, headache, vomiting, stiffness in the neck, and pain in the limbs. In a small proportion of cases, the disease causes paralysis, which is often permanent. There is no cure for polio; it can only be prevented by immunization and water sanitation practices and hygiene. Of the 3 types of wild poliovirus (type 1, type 2 and type 3), type 2 wild poliovirus transmission has been successfully stopped (WHO, 2015).

b) Hepatitis A

There are six types of viral hepatitis- A and E which are transmitted by ingestion contaminated water or food by faeco-oral transmission and B,C, D and G are blood-borne infections. The disease is caused by a virus known as Hepatitis Virus A which characterized by loss of appetite, jaundice, enlargement of the liver and raised level of liver enzymes. The incubation period varies from 15 to 40 days with an average of around 20 days (WHO, 2000). The disease is widespread but is more common in tropics and subtropics. Human is the reservoir of infection, excreting the organism in urine and faeces. Faeco oral spread is the most important mode of transmission by direct or indirect contact, but explosive epidemics is through drinking water and food. The control of the infection is through personal hygiene, water sanitation practice and hygiene (WHO, 2000).

2. Water-based diseases

Water-based diseases come from hosts that either live in water or require water for part of their life cycle or are caused by parasites that spend part of their lifecycle in water. These diseases are passed to humans when they are ingested or come into contact with skin. The two most widespread examples in this category are schistosomiasis, which results from contact with snails that serve as hosts, and dracunculiasis (Guinea worm), which results from ingesting contaminated host zooplankton. There are about 160 million people in 74 countries who are infected with schistosomiasis, a tenth of whom suffer severe effects (UNICEF, 2008), and schistosomiasis could be responsible for 200,000 deaths in sub-Saharan Africa alone (Zhang & Koukounari, 2007). The disease continues to spread where irrigation projects produce habitat that favors the host snails. Major outbreaks of schistosomiasis often follow the construction of large dams. In the Sudan, the construction of Sennâr dam led to the infection of nearly the entire nearby population.

I. Protozoan pathogens:-

Protozoa and helminths are among the most common causes of infection and disease in humans and other animals. The diseases have a major public health and socioeconomic impact. Water plays an important role in the transmission of some of these pathogens. The control of waterborne transmission presents real challenges, because most of the pathogens produce cysts, or eggs that are extremely resistant to processes generally used for the disinfection of water and in some cases can be difficult to remove by filtration processes (Esrey et al, 1991).

a) Ascariasis

Ascariasis is caused by the large roundworm Ascarislumbricoides. Eggs are passed in the faeces of an infected person and in poor sanitation conditions may contaminate the soil. Ingestion of infective eggs, from contaminated soil or from uncooked products contaminated with soil or wastewater containing infective eggs, cause the disease. Transmission does not occur from person to person. The knowledge on transmission pathway indicates that the

disease is fully attributable to unsafe Water Sanitation and Hygiene. The eggs can survive for months or years in favourable conditions and can, thus, pose an infective hazard for a considerable period of time. A total of 14 studies examining the level of ascariasis and water and sanitation provision were identified by Esrey et al. (1991). These studies reported reductions between 0–83percent, with a median reduction from all the studies of 28%. More recently, Clasen, Schmidt, Roberts & Cairncross, (2007) reported big differences in infection between children exposed to untreated wastewater and those exposed to either partially treated wastewater or rainwater irrigation (defending upon the age group under consideration). Similar results were reported by Mara et al. (2007), who showed that Ascaris infection was five times higher in children in the wastewater impacted regions compared to control regions. In Indonesia, Tanaka et al. (1998) reported a 64% reduction in Ascaris infection in people who used a latrine compared
with those who did not. A biological gradient is suggested from the results of the four rigorous studies identified by Esrey et al. (1991) where the rate of morbidity reduction was dependent upon the level of sanitation facility. The work of Coura-filho et al (1998) also indicates a dose–response relationship with children exposed to increasingly contaminated water having increased rates of infection. The relationship is plausible and the study results are coherent. Eggs have been isolated from faecal samples, soil samples, water samples and hand-washing samples (Jalan, Somanathan & Chaudhuri, 2009). Additional experimental evidence is provided by the studies that have examined the increased use of latrines and noted the parallel decrease in both egg counts in soil and levels of infection.

b) Schistosomiasis

Schistosomiasis is caused by infection with trematodes of the Schistosoma species. Transmission of the disease occurs when people come into contact with water containing cercariae (the mobile larval stage of the life cycle), which penetrate the skin. Water is contaminated by infected humans who excrete the schistosome eggs in their faeces or urine (depending upon the Schistosoma species). The final link in the chain of infection is provided by an intermediate snail host, which the parasite needs in order to complete its life cycle. Current knowledge on disease transmission indicates that the disease is fully attributable to unsafe WSH. Esrey et al. (1991) identified 12 studies that related water and sanitation facilities to the rates of schistosomiasis. Reported decreases in infection rates varied between 59% and 87%, with the median value of the rigorous studies being a 77% reduction. Numerous studies, in addition to those identified above, have noted the relationship between contact with contaminated water and high levels of infection with schistosomiasis (Ibrahim & Fondo 2012). These have been conducted in various countries and have examined different Schistosoma species. Larson et al. (1999) found that individuals reporting water contact less than once a week had a smaller excess risk of schistosomiasis than that reporting water contact at least weekly. A number of studies have examined re-infection with schistosomiasis following an intervention programme (such as treatment of infected individuals). In China, Zhaowu et al. (1993) found that re-infection was associated with the frequency of water contact, the type of water contact and the proximity of residence to snail-infected water. In Brazil, discontinuation of a control programme led to an increased prevalence of schistosomiasis (Coura-Filho et al. 1998). Risk factors for the disease included any form of water contact.

I. **Helminth**

The word "helminth" comes from the Greek word meaning "worm" and refers to all types of worms, both free-living and parasitic. The major parasitic worms are classified primarily in the phylum Nematoda (roundworms) and the phylum Platyhelminthes (flatworms including trematodes).

a) Dracunculus medinensis (guinea worm)

Dracunculus medinensis, commonly known as “guinea worm,” belongs to the phylum Nematoda and is the only nematode associated with significant transmission by drinking-water. Infection with guinea worm is geographically limited to a central belt of countries in sub-Saharan Africa. Drinking-water containing infected Cyclops is the only source of infection with Dracunculus. Dracunculusmedinensis is the only human parasite that may be eradicated in the near future by the provision of safe drinking-water. Infection can be prevented by a number of relatively simple control measures, (Carr & Neary, 2008).

b) Trichuriasis

Trichuriasis is caused by ingestion of the human infectious eggs of the whipworm Trichuristrichiura. The infection is not directly transmissible from person to person. As with other faecal–oral transmitted diseases, the mode of transmission indicates that the disease is fully attributable to unsafe Water Sanitation and Hygiene, although the risk factors for trichuriasis in relation to WSH do not seem to have been as well researched as the other illnesses covered here. Studies of prevalence often show an association between Ascaris and Trichuris infection (Smith et al. 2001), suggesting similar modes of transmission. Of the studies that were identified, Henry (1981) found that Trichuris infections decreased by 50% after water supplies and latrines were installed in a rural area of Saint Lucia. Roy et al. (2006) noted that the prevalence of infection was associated with a number of factors, including socioeconomic status, water supply, sanitary disposal of faeces and family size. Similarly, Narain, (2003) found that open field defecation and large family size were independently associated with Trichuris infection.

c) Hookworm disease

Hookworm infection is caused by Ancylostomaduodenale or Necatoramericanus, and results from the ingestion or skin penetration of the hookworm larvae that live in the soil. Larvae develop in the soil through the deposit of faeces containing eggs from infected persons. The disease is therefore caused by poor sanitation and hygiene practices. The disease is not transmitted from person to person. Eleven studies were identified by Esrey et al. (1991) which examined water, sanitation and hookworm infection. From the nine that could be used to calculate a reduction in morbidity, the range was 0–100%, although only one of these was considered to be rigorous. Sorensen et al. (1994) found that the severity of hookworm infection was lower in children coming from communities with good sanitary facilities. Norhayati et al. (1995) studied the re-infection of children in a hookworm endemic area. In the absence of any interventions the re-infection rate at 4-months post-treatment was 30%. The authors suggested that long-term strategies incorporating education on personal hygiene, provision of toilets and safe water supply were required to control the rapid reinfection. Norhayati et al. (1995) reported that hookworm egg counts were significantly higher in Vietnamese women who used fresh human faeces as a fertilizer in comparison to those who used either treated human faeces or did not use human faeces as a fertilizer.

3. Water-washed diseases

Water washed disease are caused by poor personal hygiene, and skin and eye contact with contaminated water.

a) **Trachoma**

Trachoma is a chronic contagious eye disease, which can result in blindness, caused by Chlamydia trachomatis. Transmission occurs by several routes (Dolin et al. 1997), all of which are hygiene related (e.g. direct infection by flies, person-to-person from clothing used to wipe children’s faces and by hand-to-face contact). Risk factors for the disease include lack of facial cleanliness, poor access to water supplies, lack of latrines and a high number of flies. A total of 16 studies were identified by Esrey et al. (1991) which examined the role of Water Sanitation and Hygiene on the level of trachoma. The median reduction in trachoma was 50% (0–91) from all the studies and 27% (0–9) when considering the rigorous studies. More recently Solomon et al (2003) identified 39 studies which examined the level of trachoma in relation to environmental causation; they report that relative risks ranged between 1 and 4. Thirteen of the 16 studies identified by Esrey et al. (1991) reported positive effects, i.e. a water, sanitation or hygiene intervention resulted in lower levels of trachoma. The studies were conducted in a variety of locations including Australia, China, India, Mexico, Mozambique, the Sudan and Tunisia. Prüss and Mariotti (2000) reported that the biological gradient was verified in most of the studies in which it was investigated, although they also noted that few studies examined this issue. Preventative measures through hygiene education and interventions aimed at reducing fly numbers have both resulted in decreases in trachoma.

4. Water-related diseases

Water related diseases are caused by insect vectors, especially mosquitoes that breed or feed near water (Ministry of Health, 2013).

i. Malaria

Malaria is caused by the protozoan parasite Plasmodium which spends part of its life-cycle in humans and part in certain species of mosquitoes. Five species of Plasmodium cause malaria in humans: Plasmodium falciparum, P. vivax, P. malariae, P. ovale, and the monkey malaria parasite P. knowlesi. Of these, P. falciparum is the most important in most parts of the tropics and is responsible for most severe illnesses and deaths due to malaria. Malaria parasites are transmied by female mosquitoes belonging to the genus Anopheles. Male Anopheles mosquitoes only feed on plant juices and nectar and cannot transmit malaria. The life-cycle of the malaria parasite is divided into three dierent phases: one in the mosquito, the sporogonic cycle; and two in the human host – the erythrocytic cycle (in human red blood cells) and the exo-erythrocytic cycle (outside the red blood cells) (WHO, 2013).

The life-cycle of mosquitoes has four distinct stages: the egg, larva, pupa and adult. The time taken for the various stages to develop depends on temperature and nutritional factors, with development more rapid at higher temperatures. There are about 490 species of Anopheles mosquitoes including sibling species. Approximately 60–70 species worldwide can transmit malaria and of these, about 30 are vectors of major importance. Some anophelines prefer to bite animals and only rarely transmit malaria parasites to humans. Others do not live long enough to permit development of the parasite, or the parasite does not seem to be able to develop in the mosquito, (WHO, 2013).

A female anopheline mosquito normally mates only once in the lifetime and usually requires a blood-meal after mating before the eggs can develop. Blood-meals are generally taken every 2–3 days, before the next batch of eggs is laid. About 100–150 eggs are laid on the water surface during oviposition. Oviposition sites vary from small hoof-prints and rain pools to streams, swamps, canals, rivers, ponds, lakes, rice elds, and sometimes even dirty water. Each species of mosquito prefers a particular type of habitat for oviposition (CDC, 2015).

A larva hatches from the egg after 1–2 days and generally oats below and parallel to the water surface, where it breathes air. It feeds by filtering food particles from the water. When disturbed, the larva quickly swims downwards but soon needs to return to the surface to breathe. The pupa undergoes a major transformation, from living in water to becoming a flying adult mosquito, the pupa is shaped like a comma. It stays under the surface and swims down when disturbed which last 2-3 days after which the skin splits. The adult mosquito then emerges and rests temporarily on the water's surface until it flies (CDC, 2015).

5. Water diseases due to high concentrations of nutrients:-

High concentrations of nutrients or low can pose serious risks to human health. The potential health effects of nitrates are numerous and include methemoglobinemia (infant blue baby syndrome); cancers; thyroid disruptions; and birth defects. Blue-baby syndrome occurs when the oxygen carrying capacity of haemoglobin is blocked by nitrites (caused by the conversion of nitrates in the stomach), leading to oxygen deprivation and suffocation. Infants are especially susceptible because their stomachs easily convert nitrates to nitrites. High levels of nutrients like nitrates have also been linked to stomach cancer and negative reproductive outcomes (Carr & Neary, 2008). Nitrites react with both natural and synthetic organic compounds to produce N-Nitroso compounds in the human stomach.

Epidemiological evidence also points to a risk to thyroid function from drinking high concentrations of water with nitrates. One study shows an increase in hypertrophy, a condition marked by enlargement of the thyroid, the gland responsible for many of the body's endocrine and hormonal functions (Vacs Renwick, 2013). Other studies have indicated a possible link between exposure to nitrites, nitrates, and N-Nitrosocompounds to birth defects. The effects of exposure were first observed in animal studies, but have since been observed in human epidemiological studies (Ward, Levallois, Brender, Gulis & Nolan, 2005).

A range of other contaminants are known to have direct and indirect impacts on human health, including non-organic and organic contaminants. Metals, such as mercury, copper, and zinc are naturally found in the environment; at low concentrations they are essential for ecosystem and human health. However, extended exposure or exposure at high levels can have serious consequences for humans as these metals tend to bio-accumulate in tissues. Human activities, particularly the increase in mining and industrial processes since the 19th century, have increased the concentration of metals in the environment (Carr & Neary, 2008). For example, mercury, which is largely a by-product of fuel combustion, mining, and waste-incineration (Pacyna et al., 2006), is highly toxic. Since fish bio-accumulate metals, they can contain high concentrations of mercury and expose people to concentrations sometimes tens of thousands of times higher than that found in the water source, posing a serious threat to human health (WHO, 2005). The mercury found in fish and shellfish is most often methyl mercury, which is particularly toxic. Consumption of methyl mercury, particularly by small children and pregnant women, can lead to developmental and neurological damage. In adults, it has been linked to coronary heart disease (Mozaffarian, 2005). Inorganic mercury also poses a range of acute and chronic health effects, with long-term oral exposure to low amounts potentially leading to renal damage and immunological effects (WHO, 2013).

2.8. National water sanitation policy

More than one billion people lack access to safe water and over three billion, half of humanity, do not have adequate water sanitation facilities. The failure to promote a safe water supply and healthy hygiene practices often lead to the transmission of infectious diseases. WHO estimates that 2.5 million people died from diarrhoeal diseases in 2017, 80% of them being children under the age of five. The number of people without adequate water sanitation facilities could reach 5.5 billion in the next 20 years, (WHO, 2007).

Access to safe water and sanitation is a human right as declared by the United Nations. In carrying out their humanitarian mandate in alleviating and improving the condition of the vulnerable populations of the world, both in ordinary times as well as in emergencies, the International Federation of Red Cross and Red Crescent Societies and individual National Red Cross and Red Crescent Societies are increasingly involved in the provision of water and sanitation services as part of the overall health and care interventions (WHO, 2007).

The Federal Government of Nigeria approved a National Water Supply and Sanitation Policy in 2000. Although some mention is made of sanitation in the Policy Paper, the subject is not addressed in sufficient depth. For instance, the Institutional roles of relevant Government

Agencies involved with sanitation at the three tiers of Government, the Private Sector, NGOs and Development Partners need to be defined. The roles and responsibilities of communities and individuals and the Financing Mechanism should be specified. Hygiene education and capacity building for operators responsible for improving the status quo need to be addressed. These and other gaps have necessitated the call for this National Water Sanitation Policy to provide a framework for the sustainable development and management of appropriate sanitation services and hygiene education at all levels, (Federal Ministry of Water Resources, 2012)

2.8.1 Scope of the Nigeria water sanitation policy

This policy applies to all water and sanitation interventions carried out by National Societies and the International Federation. National Societies and the International Federation's programming and advocacy aims at incorporating water and sanitation objectives into general health and development programmes as well as in emergency situations. Water and sanitation is a Health initiative, clearly defined and seen as one of the most important aspects of preventive/public health. The Federation's basic health policy has underlined the need for a community-based approach. Community-based health care can therefore not be considered without addressing the issue of water and sanitation coverage (WHO & UNICEF, 2018).

2.8.2 Responsibility

National Societies and the International Federation have the responsibility to ensure that all water sanitation activities and programmes are carried out in compliance with this policy; that all staff and volunteers participating in such programmes are aware of the rationale and content of the policy; and that all relevant governmental, intergovernmental and non-governmental partners are adequately informed about this policy. It is the responsibility of the

International Federation and its National Societies to adhere to government policies/standards with regards to water quality issues. In the absence of such standards, the WHO drinking water guidelines need to be followed (WHO & UNICEF, 2018).

2.8.3 National water policy in Nigeria

For years, water services in Nigeria used a "top-down and supply-side approach, which has failed in the country due to many reasons including poor community and other stakeholders' participation; poor management of the infrastructure and inadequate financial resources. The availability of water in both quantity and quality is being severely affected by climate variability and climate change, with more extreme weather events. Demand is increasing as a result of population growth and other demographic changes (in particular urbanization) and agricultural and industrial expansion following changes in consumption and production patterns. Thus demand is outstripping supply at critical times of the year or in years of low water availability. Water sanitation for the purpose of this Policy, shall be defined as effective hygiene practice, handling and disposal of excreta, liquid (sewerage, sullage and storm water) and leachates from dump sites (solid wastes) in so far as it affects water sources. Sanitation, wherever mentioned in this policy shall refer to water sanitation, (Federal Ministry of Water Resources, 2012).

2.8.4 Objective

The objective of the Nigeria water sanitation policy is for all Nigerians to have access to adequate, affordable and sustainable sanitation through the active participation of Federal, State and Local Governments, NGOs, Development Partners, Private sector, communities, households and individuals, (Federal Ministry of Water Resources, 2012).

2.8.5 Targets

FMWR (2012) stated that, in order to achieve the objective of this policy, all tiers of government shall henceforth appropriate and release a separate vote for water sanitation of an amount equivalent to not less than 15% of their annual appropriation for water supply to implement water sanitation programmes for sanitation and achieve the following targets:

a. Review and improve coverage of water sanitation to 60% of the population by 2007.

b. Extension of water sanitation coverage to 65% by 2010.

c. Extension of water sanitation coverage to 80% by 2015.

d. Extension of water Sanitation coverage to 90% by 2020.

e. Achieve 100% water Sanitation coverage by 2025.

f. Sustain 100% water Sanitation coverage beyond 2025.

2.9. Water sanitation in densely populated settlements

Half of world's population lives in urban areas. By the middle of this century all regions will be predominantly urban, with the tipping point anticipated to be reached in Eastern Africa slightly after 2050. This unprecedented urban expansion poses an array of critical, water-related challenges, from access to basic services to environmental and human security. Urban expansion directly affects water availability and quality, as growing cities have a greater per capita demand for water and tend towards unwieldy institutional setups. This can often result in pollution and a mounting exposure to water-related disasters and health risks (World Water Assessment Programme, 2006).

Despite the continuing growth of megacities – which require natural resources and create waste in quantities not seen in human history– most of the world's urban populations live in cities with fewer than 500,000 inhabitants. The growth of these small and mid-size cities will have significant impacts on water resources in coming decades. While access to water supply and sanitation services in most established or formal urban areas is believed to be better than in rural areas, most of today's urban growth is occurring in informal urban areas, where residents have little access to safe drinking water or to adequate water sanitation services, increasing the danger of water- sanitation related diseases. (World Water Assessment Program, 2006).

Moreover, when water sanitation is provided in the community it support food production and the production of goods such as textiles for clothing, as well as economic and recreational activities including navigation, they regulate environmental flows, purify wastewater and detoxify wastes, regulate climate, provide protection from storms, mitigate erosion and offer cultural benefits; in particular aesthetic, educational and spiritual. An investment in the water sector is an investment in all the MDGs. The impact of water sector investments directly targeted at poor consumers is anything but subtle. A safe water supply immediately improve people's health and saves them time, which they can use for studying or improving their livelihoods so that they can earn more, eat more nutritiously, enjoy healthier lives, and contribute to the local (and national) economy. In addition, improved sanitation protects the poor from socially and physically degrading surroundings, health risks, and exposure to dangerous environmental conditions (United Nation World Water Development Report, 2014).

Two main water problems are affecting the sustainability of human settlements in different regions: the lack of access to water and sanitation, and increasing water-related disasters. These problems have incommensurable consequences on human health and well-being, safety, the environment, economic growth and development. Though water supply and sanitation coverage increased between 1998 and 2008, the growth of the world's urban populations jeopardizes those results. For example, partly because of rapid increases in the urban population, a growing number of people in urban areas defecate in the open (Joint Monitoring Programme, 2010).

Urban settlements are the main source of point-source pollution. More than 80% of sewage in developing countries is discharged untreated, polluting rivers, lakes and coastal areas. Even in some developed countries, treatment of urban wastewater is far from satisfactory. 'Urban wastewater constitutes a significant pollution load and is particularly hazardous when mixed with untreated industrial waste – a common practice. Many large cities still have no treatment plants or plants quickly become undersized as urban population growth outpaces investments. In addition to the sociological and health implications, increasing population density in urban settlements presents serious environmental impacts. The transformation of natural land surfaces into impervious surfaces such as streets, parking lots and buildings blocks rainwater and snowmelt from reaching the soil. It also increases the flow velocity of water, carrying pollutants into receiving water systems and further degrading water quality. This urban drainage effect increases the frequency of flash floods, causing casualties and infrastructure damage (World Water Assessment Programme, 2006).

Human populations affect water in direct and indirect ways. The former consist in modifications to the circulation of water and its quality by withdrawals, waste water disposal, river regulation etc. The latter consist in modifications of vegetation and soil cover: deforestation and compaction reduce the absorptive capacity of the soil and accelerate water runoff; this causes floods and deficits of recharge of aquifers; the loss of soil protection accelerates erosion and leaching, increasing water pollution; finally, air pollution affects the chemical properties of water through precipitations, (Watkinson, Murby, Kolpin & Costanzo, 2009).

Deforestation therefore causes significant changes in river flow patterns, with accelerated runoff and lost storage, in turn causing a higher occurrence of flooding in wet seasons and a greater likelihood of dried-up rivers in dry seasons. Population growth is an important factor (often overshadowing logging operations) in deforestation, through the needs for more crop land and wood, (Watkinson, Murby, Kolpin & Costanzo, 2009).

2.10. Empirical studies on water sanitation practices among residence of densely Populated settlements

Ahmed and Sattar (2007) from their researched titled'Awareness and the demand of safe drinking water practices in Pakistan' show that the gender of decision-makers regarding water purification is statistically significant suggesting that female decision-makers are more likely to adopt some water purification device than male decision-makers. In contrast, our findings suggest that in Cameroon, male-headed households are more likely to purify water as compared to female-headed households (marginal effect is not significant). The results also suggest that male-headed households are less likely to use improved sources as compared to female-headed households.

Larson and Gnedenko (1999) examined household water purification practices in densely settlement in Moscow. Survey results show that: over 88% of the sample boils water regularly due to concerns about water quality; 23 percent filter water regularly; over 30% settle water regularly; and about 13% buy bottled water regularly. A logistic regression framework is used to model the probability that a given respondent uses a specific avoidance measure (boil, settle, filter, and buy bottled water). Estimation results suggest that income affect the choice of purchasing bottled water, using filter and boiling. They also suggest that there is less filtering of water in the North and East locations as compared to Rublevo and West and the opinion on quality of water only affect the choice of settling water.

McConnell and Rosado (2000) in their study “Valuing Discrete Improvements in Drinking Water Quality through Revealed Preferences” use the data from densely populated area of Brazil and find that the demand for home water sanitation practices is positively affected by factors such as income, education and presence of young children in the household. Among the factors affecting the choice of a specific water purification method, McConnell and Rosado (2000) found that the more and alternative costs, the less likely it will be choose.

Bukenya (2006) in his study on “Household Perceptions of the Quality of drinking Water in Uganda” study is based on data from a sample of 487 surveyed households in Uganda. A simultaneous probit regression model is estimated to identify the determinants of the choice of a specific water purification method (boiling, buying bottled water or a combination). His findings indicate a strong relationship between income, educational level, presence of children in the household, location, and opinion on water quality on the type of avoidance measures undertaken to improve water. Results also show that boiling reduces the likelihood of household buying bottled water but demand for bottled water does not reduce the use of boiling water strategy.

Based on a household survey conducted in Abbottabad (Pakistan) titled Household’s Willingness to Pay for Safe Drinking Water by Haq et al. (2008), the result revealed that there are statistically significant effects of education on the water purification behaviour of the households. They also found that, higher income quartile is highly significant in all coping strategies. The variables “tap” and “fetching” have a significant impact on the water purification behaviour contrary to the variable “well”. The study suggests that there is a strong effect of the quality of water on all water purification behaviour of households.

Another survey was conducted in Southwest Sri Lanka by Fewtrell, Kaufmann and Kay (2005) titled Perception of health risk and averting behavior: An analysis of household water consumption was made, The result shows that the final sample contains 1,103 observations. Maximum Likelihood estimation results were shown. First, we find evidence that perceiving water as more risky in health effect increases the probability for the households to treat water before drinking it. This finding indicates that households are aware that treating water reduces the risk related to consumption of (unclean) water. Second and as expected, the researcher find that better health education is increasing households to have a higher probability to treat water. Third, contrary to what we find in the model of perceived risk is that channel through which the health information came does not seem to play a role. Also, we find that households who work for the government, and households with children less than three years old (known as being more vulnerable to waterborne diseases) have a higher probability to treat water.

Jalan et al. (2009) in a study conducted as Awareness and the demand for environmental quality: survey evidence on drinking water in urban India' use a household survey from urban India to estimate the effects of awareness proxies (education of adult household members, their exposure to mass media like newspapers, television or radio, and their occupations) on home water purification. They find that these measures of awareness have statistically significant effects on home purification and, therefore, on willingness to pay for water quality. The magnitudes of these effects are by no means small and are comparable to the wealth effects. Ahmed and Sattar (2007) and Ahmad et al. (2010) also find that measures of awareness such as different level of schooling of decision-makers and household heads and their exposure to mass media have statistically significant effects on home purification methods for drinking water.

The results of the logistic regression analysis used by Anderson et al. (2010) shows that the less clean the water and the more distant the water source, the more likely the rural African households in South Africa is to perceive water pollution as a problem. Households with less clean water, more educated household members, and that perceive water pollution as a problem are more likely to treat their water; education of household members and monthly household expenditures do not matter. Boiling and chemicals are the most common treatment methods (93.6%). Households with less clean water, with more educated members, with higher overall expenditures and with a more distant water source are more likely to chemically treat their water than to use another treatment option.

Based on a survey of 10,000 households in OCDE (organisation for Economic Co-operation and Development), the study of Johnstonne and Serret, (2012) reveal that negative perceptions of tap water quality affect the decision to purchase bottled water and home purification, with much greater effect on bottled water consumption. The same is true of household income. Household size, the presence of children in the household and length of residence affects the decision to invest in purification, but not bottled water consumption. The study also suggests that concern about solid waste has a negative impact on bottled water consumption, and car ownership has a positive impact.

A research conducted by Ibrahim, Fondo and Armand Luc (2012), titled Household Choice of Purifying Drinking Water in Cameroon the results shows that the measures undertaken by Cameroonian households to cope with unreliable water quality so as to minimize health hazards from contaminated water, a total of 1002 surveyed households (10.4%) declare that they purify water before drinking it. This indicate that there is more evidence to believe that for a given household of the overall sample, the household is likely satisfy with the quality of its drinking water. Of the total of households who treat their water, 168 boil water, 395 filter water, 366 used chemicals (chlorine or bleach), 136 decant water and 15 used other methods. 72 surveyed households combined several purification methods.

Among the 3131 households (32.39% of the whole sample) relying on unimproved sources, 2 847 households do not purify water before drinking while the 284 remaining households purify it. Among the 6 536 households (67.61% of the whole sample) relying on improved sources, 5 818 do not purify water before drinking while the 718 remaining households purify it.

2.11. Summary

Water sanitation is the process of cleaning water to make it safe for drinking, bathing and cooking. Water sanitation is also physical and chemical processes for making water suitable for human consumption and other purposes. Un-sanitized water sources mean locations or places where fresh water flows abundantly in the form of river, lake, pond or stream. Improved drinking water sources are sources that by nature of their construction and design are likely to protect the water sources from outside contamination, in particular from faeces matter. Thus, sanitized water sources include: a tap household connection, borehole, protected dug well, protected spring or rainwater collection.

Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids, and gases from water. The goal is to produce water fit for specific purposes. Most water is purified and disinfected for human consumption (drinking water), but water purification may also be carried out for a variety of other purposes, including medical, pharmacological, chemical and industrial applications. The methods used include physical processes such as filtration, sedimentation, and distillation; biological processes such as slow sand filters or biologically active carbon; chemical processes such as flocculation and chlorination; and the use of electromagnetic radiation such as ultraviolet light.

Water purification may reduce the concentration of particulate matter including suspended particles, parasites, bacteria, algae, viruses, and fungi as well as reduce the concentration of a range of dissolved and particulate matter.

The standards for drinking water quality are typically set by governments or by international standards. These standards usually include minimum and maximum concentrations of contaminants, depending on the intended use of the water.

Visual inspection cannot determine if water is of appropriate quality. Simple procedures such as boiling or the use of a household activated carbon filter are not sufficient for treating all possible contaminants that may be present in water from an unknown source

There are certain factors that affect water sanitation practices in densely populated settlement all over the world such factors include, lack of access to potable water due to population growth and rapid urbanization, pollution of water sources, climatic changes, uncontrolled disposal of human waste, lack of financial resources, lack of consumer awareness of the health hazards associated with poor water quality and sanitation practices.

Diseases associated with lack of water sanitation include water related diseases, water borne diseases, water base diseases, water wash diseases and health effect due to high concentration of nutrients. However, it is imperative to bear in mind that studies conducted in the developed countries of America, Europe, developing nations of Latin America, Asia and Sub-Saharan Africa cannot be transplanted completely into the Nigerian context. This phenomenon points to the need to assess water sanitation practices among residence of densely populated settlement in Kano metropolis Local Government Area of Kano State aimed at preventing water borne diseases and water related diseases among the populace.

CHAPTER THREE

METHODOLOGY

3.1. Introduction

This study assessed water sanitation practices of residents of densely populated settlements of Kano metropolis, Kano state. This chapter describes the following sub-headings:- research design, population of the study, sample and sampling technique, data collection instrument, validity of the instrument, reliability of the instrument, data collection procedure and data analysis.

3.2. Research Design

Cross sectional survey design was adopted for this study. Johnson and Onwuegbuzie (2004), stated that cross-sectional survey is a study aimed at determining the frequency of a particular attribute, such as a specific exposure, disease or any other health-related event, in a defined population at a particular point in time. Therefore, this study assessed the water sanitation practices of residents of densely populated settlements of Kano metropolis.

3.3. Population of the Study

The population of this study comprised all members of the households in 8 metropolis LGAs of Kano state, namely; Dala, Fagge, Gwale, Kano Municipal, Kumbotso, Nassarawa, Tarauni and Ungogo Local Government Areas. Records from Kano State National Population Commission (2017) shows that the entire 8 Metropolis LGAs have a total projected population of 4,176,529 in the year 2017. It was indicated that Nassarawa has 880,922, Dala has 618,282, Ungogo has 545,761, Kano Municipal has 539,661, Gwale has 534,544, Kumbotso has 436,983, Tarauni has 326,826, and Fagge has 293,550 people.

3.4. Sample and Sampling Technique

A sample of five hundred 500 respondents were involved in this study. Bartlett, Kotrlik and Higgins, (2001) stated that in a population of 1,000,000 people and above, a minimum sample of 384 is appropriate as sample. Multi stages sampling procedure was used to select the sample of this study.

Stage 1: Purposive sampling procedure, (also known as judgment, selective or subjective sampling) was used to select all the 8 LGAs that form Kano metropolis, namely; Dala, fagge, Gwale, Kano municipal, Kumbotso, Nassarawa, Tarauni and Ungogo LGA.

Stage 2: Purposive sampling was used in identifying all the densely populated settlements in each of the 8 LGAs based on minimum urban density index definition of 400 persons per square kilometre (Demographia World Urban Areas, 2018).

Stage 3: Simple random sampling also used, to select 2 densely populated settlements per LGA. Therefore, names of all densely populated settlements of each LGA were written on a sheet of paper and folded; the papers were put in a cup and were shake vigorously. Research assistants were directed to pick two pieces of papers from the cup one after the other.

Therefore, 16 settlements were selected from the eight LGAs of Kano and these settlements were used as sample of the research study.

Stage 4: Proportionate sampling technique was used which determined the number of respondents from each of the selected 2 densely populated settlements from each LGA. The procedure for proportionate sampling by Krejcie and Morgan (1970) formula is dividing the population of each settlement by the total population of 117,606 and multiplied by the selected sample size of 500 respondents.

Stage 5: Systematic random sampling technique was used in selecting respondents houses; in this stage, sampling frame of households was selected using a sampling interval of 15 households and the starting point of 6 was selected. The heads of households or housewives served as the respondents of this study (see table 3.4.1).

Table 3.4.1 Distribution of sample of the study:-

S/n	LGA	Selected densely populated settlements	Total population	Sample size selected using proportionate sample
1	Dala	Kofar Ruwa	9,399	40
2		Dan dinshe Qtrs A	6,220	26
3	Fagge	Dan Rimi	5,106	22
4		Rijiyar Lemo Unguwa Dagachi	6,024	26
5	Gwale	Dorayi Yamma	10,196	43
6		Diso	5,321	23
7	KMC	Sharada Cikin Gari	8,192	35
8		Yakasai tsakiya	8,644	37
9	KBT	Sheka Unguwar Dagachi	7,343	31
10		Na'ibawa Gabas	8,222	35
11	NSR	Giginyu Badawa	5,161	22
12		Tudun Wada	10,034	43

13	TRN	Unguwa Uku Ung. Ado Goro	9,161	39
14		Darmanawa Ung. Makabarta	5,236	22
15	UGG	Zango Galula Qrts.	6,295	27
16		Tudun Fulani babbar unguwa	7,052	30
		Total	**117,606**	**500**

3.5. Data Collection Instrument

A researcher developed questionnaire on modified Likert scale was used as instrument for data collection. The Questionnaire was named 'Appraisal of water sanitation practices questionnaire (AWSPQ). The instrument was divided into Sections A, B, C, and D. Section 'A' was on the demographic information of the respondents, section 'B', were items on water storage, 'C' was on water purification and section 'D' was on water transportation. The questionnaire required the head of household to respond by ticking any of the following: Always (A) 4 points, Frequently (F) 3 points, Sometimes (S) 2 points and Not at all (NA) 1 point. However, for easier analysis option (A) always and (F) frequently were merged or collapsed to become one variable, then (S) sometimes and (N) not at all were also collapsed together.

3.6. Validation of the Instrument

Five professional staff in the field of Health Education in the Department of Physical and Health Education, Bayero University, Kano vetted the instrument. Their suggestions and recommendations were in cooperated in the final draft of the instrument to the satisfaction of the researcher's supervisor.

3.7. Reliability of the Instrument

A pilot study was conducted at Bichi Local Government Area using twenty (20) copies of the questionnaire were administered to a densely populated settlement of Bichi Town using split-half method. The administered copies of the questionnaire collected, collated and were coded 1-20 and separated in to odd and even numbers obtained were analysed using Spearman Brown Prophecy Formula and a correlation coefficient of 0.76 was obtained, which indicated that the instrument was reliable enough for use in the study.

3.8. Data Collection Procedure

An introductory letter was collected from the Head of Department of PHE, Bayero University, Kano seeking the permission of traditional leaders and LGA officials for the conduct of the study in the selected settlements. Five hundred copies of questionnaires were distributed to residents in the selected sample settlements with the help of 3 research assistants and four hundred and sixty filled questionnaires were retrieved due to missing and damages. The research assistants were briefed on how to collect data from the respondents for at least eleven hours in one day at Rijiyar lemo MPHC; each was assigned to collect data from four settlements with the help of the ward head of the selected settlements. The ward head introduced the researcher and research assistant to the respondents. For the respondents that could not read and write, the researcher and the research assistants assisted them in interpreting the content of the questionnaire and recording their responses. The exercise lasted for four weeks.

3.9. Data Analysis

Frequency counts and percentage were used to organise the demographic information of the respondents. Inferential statistics of Chi square was used to test hypotheses 1 to 3 while ANOVA was used to test hypotheses 4 to 6 all at 0.05 level of significance.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter contains the results obtained after administering the questionnaire on water sanitation practices of residents of densely populated settlements of Kano metropolis, Kano state.

4.2 Results

Out of 500 copies of questionnaires administered, only 460 were retrieved and used for data analysis.

Table 4.2.1: Summary of demographic information of the respondents

Variables	Frequency	Percentage (%)
1.**LGA**		
Dala	**64**	**13.9**
Fagge	**44**	**9.6**
Gwale	**61**	**13.3**
KMC	**66**	**14.3**
Kumbotso	**56**	**12.2**
Nassarawa	**59**	**12.8**
Tarauni	**60**	**13.0**
Ungogo	**50**	**10.9**
Total	**460**	**100**
2.**Settlement**		
Dandinshe	26	5.7
Danrimi	22	4.8
Rijiyar lemo	22	4.8
Dorayi yamma	43	9.3
Diso	38	8.3
Sharada	35	7.6
Yakasai tsakiya	36	7.8
Sheka ung. Dagachi	30	6.5
Naibawa Gabas	31	6.7
Badawa	21	4.6
Tudun wada	43	9.3
Unguwa uku	38	8.3
Darmanawa	22	4.8
Zango Galula	25	5.4
T/Fulani Babbar unguwa	28	6.1
Total	**460**	**100.0**
3.**Gender**		
Male	178	38.7
Female	282	61.3
Total	**460**	**100.0**
4.**Age Range**		
18- 25 years old	133	28.9
Above 25 years old	327	71.1
Total	**460**	**100.0**
5.**Educational level**		

Primary	59	12.8
Secondary	184	40.0
High institution	138	30.0
Islamic school	79	17.2
Total	**460**	**100.0**
6.**Number of people living in household**		
Less than 3 people	48	10.4
4-6 people	137	29.8
More than 6 people	275	59.8
Total	**460**	**100.0**
7.**Source of drinking water**		
Open well	20	4.4
Bore hole	244	53.0
Pipe born water	196	42.6
Total	**460**	**100.0**

Table 4.2.1: item 1 indicated that 64 (13.9%) of the respondents were from Dala Local Government Area, 44 (9.6%) of another respondents from Fagge Local Government area, 61 (13.3%) of respondents from Gwale, 66 (14.3%) from Kano Municipal, 56 (12.2%) from Kumbotso, 59 (12.8%) from Nassarawa, 60 (13.0%) were also from Tarauni, while 50 (10.9%) of the respondents were from Ungogo Local Governments area. The 2nd item are densely populated settlements which Dandinshe has 26 (5.7%) respondents, Dan rimi and Rijiyar lemo has 22 (4.8%) respondents each, then 43 (9.3%) respondents from Dorayi yamma, Diso has 38(8.3%), Sharada with 35 (7.6%) respondents,Yakasai Tsakiya with 36 (7.8%) respondents, Sheka unguwar dagachi have 30(6.5%), Naibawa gabas with 31 (6.7%), Badawa with 21 (4.6%), Tudun wada 43 (9.3%), Unguwa uku has 38 (8.3%) respondents each, Darmanawa with 22 (4.8%), Zango Galula with 25 (5.4%), and Tudun Fulani Babbar unguwa with 28 (6.1%) respondents. The 3rd item is on gender; in which 178 (38.7%) of the respondents were male while 282 (61.3%) were female. This indicates that females are more than male that participated in the study. The forth item is age that indicates that 133 (28.9%) of the respondents were between age range of 18-25 years old while 327 (71.1%) were above 25 years old. This indicates that those above 25 years were more in the study area.

Moreover, in the educational level of the respondents which has a relation to water sanitation practices shows that; 59 (12.8%) had primary certificate while 184 (40.0%) had secondary certificate, 138 (30.0%) had certificate of high institution while 79 (17.2%) attended only Islamic school. The result indicates that those respondents with secondary and high institution were more than those with primary and Islamic school that took part in the study. This information was very important as it is one of the yardsticks by which level of water sanitation practices can be appraised.

Since people living in the same household is one of the factors that affect water sanitation practices, from table 4.2; item 6, respondents with less than 3 people living in the same household are 48 (10.4%), 4-6 people are 137 (29.8%) while above 6 people living in the same household are 275 (59.8%).

A source of drinking water by the residents of densely populated settlements was considerable importance in the study area. From the table 4.2 item 7 showed that 20 (4.4%) respondents were using open well as their source of drinking water, 244 (53.0%) were using bore hole while 196 (42.6%) of the respondents were using pipe born water sources.

Hypothesis testing:

Hypothesis 1: Residents of densely populated settlements in Kano metropolis do not significantly purify water to make it safe for drinking and cooking.

Table 4:2.2: summary of χ^2 on water purification practices of residents of densely populated settlements in Kano metropolis

Practice	**FO**	**FE**	χ^2	**df**	**p**
Not purified	371(80.6%)	230.0	172.878	1	0.001
Purified	89(19.4%)	230.0			
Total	**460**				

χ^2tab =3.84, df=1, $p < 0.05$

Table 4:2.2: is a summary of χ^2 analysis on water purification practices of residents of densely populated settlements. It indicates that 371(80.6%) of the respondents do not purify their water while 89(19.4%) of the respondents purify their water to make it fit for cooking and drinking. This means that the residents of densely populated settlements of Kano metropolis do not purify their water to make it safe for drinking and cooking. Statistical computation of χ^2 revealed that χ^2=172.878, df=1, p <0.05. Hence, the null hypothesis was accepted on the account that residents of densely populated settlements in Kano metropolis significantly not purify water to make it safe for drinking and cooking.

Hypothesis 2: Residents of densely populated settlements in Kano metropolis do not significantly store water to make it safe for drinking and cooking.

Table 4:2.3: **Summary of χ^2 on water storage practices of residents of densely populated settlements in Kano metropolis**

Practices	**FO**	**FE**	**χ^2**	**df**	**p**
Poor storage	162(35.2%)	230.0	40.209	1	0.001
Proper stored	298(67.8%)	230.0			
Total	**460**				

χ^2 tab =3.84, df=1, p<0.05

The table 4:2.3 indicates summary of χ^2 on water storage practices of residents of densely populated settlements. The result shows that 162 (35%) do not store their water properly, while 298 (65%) store their water properly. This means that the residents of densely populated settlements of Kano metropolis store their water properly to make it safe for drinking and cooking. Statistical computation of χ^2 revealed that χ^2=40.209, df=1: p<0.05. Hence, the null hypothesis was rejected on the account that residents of densely populated settlements in Kano metropolis significantly store water to make it safe for drinking and cooking.

Hypothesis 3: Residents of densely populated settlements of Kano metropolis do not significantly transport their water from source of water to make it safe for drinking and cooking.

Table 4:2.4: Summary of χ^2 on water transportation of residents of densely populated settlements in Kano metropolis.

Water transportation	FO	FE	χ^2	df	p
Poor transportation	44(9.6%)	230	18.288	1	0.001
Proper transportation	416(90.4%)	230			
Total	**460**				

χ^2 tab =3.84, df=1, p<0.05

Table 4:2:4 indicates summary of χ^2 on proper water transportation by residents of densely populated settlements. The result indicates that 44(9.6%) do not properly transport their drinking water, while 416(90.4%) transport their drinking water properly. This means that the residents of densely populated settlements of Kano metropolis transport their water properly to make it safe for drinking and cooking. Statistical computation of χ^2 revealed that χ^2=18.288, df=1: p<0.05. Hence, the null hypothesis was rejected on the account that residents of densely populated settlements of Kano metropolis significantly transport their water from source of water to make it safe for drinking and cooking.

Hypothesis: 4: Water purification to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements in Kano metropolis based on sources of water

Table 4:2.5: Summary of ANOVA on difference in water purification practices among residents of densely populated settlements of Kano metropolis based on sources of water.

Group	Sum of square	df	Mean square	F	P
Between group	21.373	2	10.687	1.086	0.339
Within group	3955.847	402	9.840		
Total	**3977.220**	**404**			

F tab=3.80, df=2 , p>0.05

Table 4:2.5 is the summary of ANOVA analysis on difference in water purification practices among residents of densely populated settlements. The result indicates that (F=1.086, df=2;402 P>0.05). This means that there was no significance difference in water purification practices among residents of densely populated settlements of Kano metropolis base on sources of water (P>0.05). Hence, the null hypothesis was accepted on the account that water purification to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements in Kano metropolis based on sources of water.

Hypothesis: 5: Storage of water to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements in Kano metropolis based on source of water.

Table 4:2.6: Summary of ANOVA on difference in water storage practices among residents of densely populated settlements of Kano metropolis base on sources of water.

Group	Sum of square	df	Mean square	F	P
Between group	22.580	2	11.290	1.128	0.325
Within group	4024.566	402	10.011		
Total	**4047.146**	**404**			

F tab=3.80, df=2, p>0.05

Table 4:2.6 7 indicates ANOVA summary on water storage practices among residents of densely populated settlements based on sources of water. The result shows that (F=1.128, P>0.05), hence, the null hypothesis was accepted on the account of storage of water from source to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements of Kano metropolis based on sources of water.

Hypothesis 6: Safe transportation of water from source to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements of Kano metropolis based on source of water.

Table 4:2.7: Summary of ANOVA on difference in water transportation practices among residents of densely populated settlements of Kano metropolis based on sources

of water.

Group	**Sum of square**	**df**	**Mean square**	**F**	**P**
Between group	2.127	2	1.064	0.197	0.821
Within group	2166.722	402	5.390		
Total	**2168.849**	**404**			

F tab=3.80, df=2, p>0.05

Table 4:2.7 indicated ANOVA summary on water transportation practices among residents of densely populated settlements base on sources of water. The result shows that (F=0.197,P>0.05), hence, the null hypothesis was accepted on the account that transportation of water from sources to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements of Kano metropolis based on sources of water.

4.3 Discussion

This study appraised the water sanitation practice of residents of densely populated settlements of Kano metropolis, Kano State. The variables considered are water purification methods, water storage method, water transportation methods and difference of water sanitation practice among residents of densely populated settlements of Kano metropolis. A finding from the study indicates that there is no significant water purification practices among residents of densely populated settlement of Kano metropolis which lead to the accepting of null hypothesis one. The finding is surprising, looking at cases of illness which are related to poor water sanitation practices, a considerable poor water purification practices of 371 (80.6%) have been reported in this study. This finding of this study is in line with that of Gnedenko (1999) titled avoiding health risks from drinking water in Moscow. His results showed that there is less water filtering in densely populated settlements of North and East locations of Moscow. Another research that is in line with the finding of this study is that of Ibrahim, Fondo, and Armand Luc (2012), who found that households in Cameroon do not significantly purify water before drinking.

But the outcome of this study is contrary to the work of Fewtrell, Kaufmann and Colford (2005), who conducted a study on perception of health risk and averting behaviour: their finding indicated that households are aware that safe storage and water treatment reduces the risk related to consumption of unclean water. Furthermore, UNICEF (2008) explained that good storage facility is essential in preventing water contamination by animals, insects and children.

The results of this study also shows that residents of densely populated settlements in Kano metropolis significantly store water to make it safe for drinking and cooking. This is in line with World Health Organization (2006), in its survey on Guidelines for drinking-water quality in densely populated communities of Indian. This result showed there is significant safe water storage using standard water storage facilities. This result is also in line with that of CDC (2007), on safe storage and Health consequences in old Atlanta, the result of which showed that households stored their water properly. The finding of Ordinioha (2011), is however, not in line with this study. His finding showed that the rural communities of Niger Delta are not storing their drinking water properly due to their closeness to the rivers.

This study was not in line with finding of Desalgn, Sissay & Tesfaye (2013) revealed that from the total respondents, 66.2% of households used clay pots for household water storage while the remaining 33.8% stored water in Jerrican except in Adada, which was the majority of the respondents use Jerrican both for the collection and storage of the water. Respondents that preferred clay pots were revealed increasing of the risk of faecal coliforms than those of respondents using jerrican. This current result was not in harmony with the finding in urban population of Bangladesh that revealed that traditional pots increased the load of faecal coliforms (Spira & Khan, 2018). Similarly, Seid et al. (2003) reported that the water stored in clay pots was shown higher proportion of load of faecal coliform than that of narrow necked container.

The findings of this current study further revealed that there is a significant proper water transportation practice among residents of densely populated settlements of Kano metropolis. This is in line with the findings of Mellisa, Oprysko and Laura (2013), from their study of Impact of Water-Vending Kiosks and Hygiene Education on Household Drinking Water Quality in Rural Ghana, which showed that there is a decrease in contamination of water during transportation from water health centre by using standard jerry. The finding of this study is however in contrast with Malik, Yasar, Tabinda and Abubakar (2012), in their study titled, "Waterborne diseases cost of illness and willingness to pay for diseases interventions in rural communities of developing countries." They found that there is limited access to water sources and similarly households have very little knowledge on effective hygienic water transportation to home and mostly households transport water in an open container that lead to hand contamination.

This finding was also contrary to Adeoye, Adeolu and Ibrahim(2013) in their study in Kwara State revealed that, the drinking water of densely settlements of Kwara was contaminated during transportation to the household. Due to poor environmental sanitation and hygiene level in the communities, the water source could be contaminated at source by human or animal, during transportation or at the household during the process of storage.

This study was also not in line with the study of Thomas and Cairncross (2004) in which their finding shows that there is main contribution for household water contaminations were unrestricted and unhygienic water collection and storage activities such as: selection household containers, lack of cover, ignorance of washing of containers before collection and transporting to storage containers, transfer of water out of storage container by dipping and placement of drinking or water drawing utensils on floor, because of this the feacal coliform load increases by two fold in household container than sources (Thomas and Cairncross, 2004).

The outcome of this study also revealed that water purification, storage and transportation to make it safe for drinking and cooking do not significantly differ among residents of densely populated settlements in Kano metropolis based on sources of water. This finding in line with the finds of Meena et al (2014) in their research titled “clearing the water: a focus on water quality solution in densely population of India and Kenya. The study assessed significant difference in water purification and storage practices. Both studies conducted in India and Kenya did not show statistically significant difference in the results.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

This study appraised water sanitation practices of residents of densely populated settlements of Kano metropolis, Kano state. To achieve the purpose of this study, six research questions, one major hypothesis with six sub-hypotheses were formulated and tested. The study was delimited to water purification practices, safe water storage and safe water transportation practices. Cross sectional survey design was adopted for this study to determine what exist with regard to practices of water sanitation. Four million one hundred and seventy six thousand five hundred and twenty nine (4,176,529) made up the total population of Kano metropolis local governments area that comprised eight (8) local governments (Dala, Fagge, Gwale, Kano municipal, Kumbotso, Nassarawa, Tarauni, and Ungogo). Sample of five hundred (500) respondents were selected using multi stage sampling techniques. Data was collected using a self developed questionnaire of Likert- scale named Questionaire on appraisal of water sanitation practice of resident of densely populated settlement of Kano metropolis, kano state (AWSPQ).

Five experts in health education in the Department of physical and health education of Bayero University, Kano vetted the questionnaire to ascertain its validity. The reliability was tested using split-half method and correlation coefficient of 0.76 was obtained. The questionnaires were administered and duly collected with the help of three research assistants. Out of five hundred (500) questionnaires administered to the respondents, forty (40) copies were lost;

therefore four hundred and sixty (460) questionnaires were dully filled and returned for the analysis. For the purpose of analysis, data collected from the 460 respondents was organized and analysed using frequency counts and percentage to describe the demographic information of the respondents. Chi-square test was used to analyse the formulated hypotheses 1 to 3 and one way ANOVA was used to test hypotheses 4 to 6 all at 0.05 level of significance. The findings of the study revealed that:

1. Residents of densely populated settlements in Kano metropolis significantly do not purify water to make it safe for drinking and cooking.
2. Residents of densely populated settlements in Kano metropolis significantly store water to make it safe for drinking and cooking.
3. Residents of densely populated settlements of Kano metropolis significantly transport their water from source of water to make it safe for drinking and cooking.
4. Water purification to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements in Kano metropolis based on sources of water.
5. Storage of water to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements in Kano metropolis based on source of water.
6. Safe transportation of water from source to make it safe for drinking and cooking does not significantly differ among residents of densely populated settlements of Kano metropolis based on source of water.

5.2 Conclusion

Based on the findings of this study, it was concluded that:-

1. Residents of densely populated settlements in Kano metropolis do not purify water to make it safe for drinking and cooking.

2. Residents of densely populated settlements in Kano metropolis store water to make it safe for drinking and cooking.

3. Residents of densely populated settlements in Kano metropolis transport water as safely as possible for drinking and cooking.

4. Water purification methods used by residents of densely populated settlements in Kano metropolis does not differ based on source of their water.

5. Water storage methods used by residents of densely populated settlements in Kano metropolis does not differ based on source of water.

6. Water transportation methods used by residents of densely populated settlements of Kano metropolis does not differ based on source of water.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. There is need for a greater improvement of safe water supply through Government's intervention by the provision of pipe born water and boreholes in the study areas.
2. Safe water storage practice should be maintained among residents of densely populated settlements and this should also be encouraged by the production of standard water storage containers by private companies.
3. More awareness on good practices of water sanitation through health talks, handbills, billboard and sensitization by community organisations, should be created among residents of densely populated settlements. This will also work toward encouraging the residents and the water sellers to improve upon their practices.

5.3 Recommendations for further studies

1. It is recommended that a study should be conducted to assess the sanitary conditions of sources of water supply to residents of densely populated settlements.
2. It is also recommended that a further study should be conducted to investigate the impact of safe water on health promotion among residents of densely populated settlements of Kano metropolis.

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QUESTIONAIRE ON WATER SANITATION PRACTICE OF RESIDENT OF DENSELY POPULATED SETTLEMENT OF KANO METROPOLIS, KANO STATE,

Dear sir/madam

I am a post graduate student of Bayero University, Kano, conducting a study on "**water sanitation practice of resident of densely populated settlements of Kano metropolis, Kano State".**

Your views in this research is very important, only you are therefore expected to tick (√) any response that best suits for you in the boxes provided for each question. In section B, you are expected to express your opinion to each statement by ticking any of the following:-

Always - (A)

Frequently - (F)

Sometimes - (S)

Not at all - (NA)

Your response simply represents your feelings and does not necessarily indicate whether you are wrong or right. Please be truthful in your response, be assured that your response will be used for the research purpose only.

Thanks you very much.

Ahmad Isyaku

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SECTION A: Demographic information of the respondents.

1. Name of LGA_________________
2. Name of settlement________________
3. Gender:
   (a) Male ( ) (b) Female ( )
4. Age:_____________
5. Educational level
   (a) Primary ( ) (b) Secondary ( )(c) High institution ( ) (d) Islamic school ( )
6. Number of people living in the household
   a) Less than 3 b) 4-6 c) more than 6
7. **Sources of drinking water:-**

(a) Open well ( ) (b)Bore hole( )(c)Pipe born water( )

WATER SANITATION PRACTICES:-

Instruction: please tick (√) the one that best represents your opinion from the alternatives provided..

S/N	Item	Responses			
	Section B:water storage	**Always**	**Frequently**	**Sometimes**	**Not at All**
1	I kept my water away from toilet.				
2	I stored my drinking water in protected container.				
3	I regularly wash and clean my storage container.				
4	My storage container is not accessible to animals, insects and birds.				
5	My storage container has a hard cover that is difficult for children to open.				
	Section C:water purification	**Always**	**Frequently**	**Sometimes**	**Not at All**
1	I always add chemical to my drinking water to make it safe for drinking.				
2	I boil my drinking water to make it safe for drinking.				
3	I filter my water if there are sediments before drinking.				
4	I always use combination of two methods of water purification to make it safe for drinking.				
5	I always purify my water by adding water guard to make it safe for drinking and cooking.				
	Section D:water transportation	**Always**	**Frequently**	**Sometimes**	**Not at All**
1	I always wash and clean my water transporting container before and after use.				
2	My water transporting container is separated with toileting container.				
3	I cover my water transporting container				
4	I always buy drinking water from water transporter that has good personal hygiene				
5	I do not use water transporting container for animal feeding.				