ASSESSING THE QUALITY OF DRINKING WATER AT SOURCE AND POINT OF CONSUMPTION IN NAKASONGOLA DISTRICT

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Abstract

Drinking water quality assessed from the source to the point of consumption in Nakasongola District. The purpose of the research was to locate specific points where contamination of drinking water occurs and assess the water handling practices affecting its quality. 109 households were visited and 333 samples from their sources of water, transport and storage containers were analysed. The quality of water was measured using Escherichia coli as an indicator for faecal contamination and diarrhoeal disease cases experienced in the last three months. The research found that 55.3% water samples from rural setting indicated that contamination occurs at the source as opposed to 50.7% from urban setting with regard to storage in the household. On interviews, 76% of the households indicated that faecal contamination occurs at the source. It is recommended that water from various sources be treated. Water supply programs should focus on sanitation practices at the point of consumption.

Declaration

I declare that I am the author of this dissertation and that any assistance I received in its preparation is fully acknowledged and disclosed in the dissertation. I have also cited any sources from which I used data, ideas or words, either quoted directly or paraphrased. I also certify that this dissertation was prepared by me specifically for the partial fulfillment for the degree of Master of Public Health at Uganda Christian University.

Signed by; ……………………………… Date…………………………

ZZIWA MOSES

RJ11M21/063

Approval

This research and dissertation has been supervised and approved by the supervisor.

Sign by…………………………………….. Date……………………………………

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Dedication

This dissertation is dedicated to my family members for their support especially Rebecca for all the pains she endured during my absence, and to those that made my studies possible.

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List of acronyms and abbreviations

BH	Borehole
CFU	Colony forming units
DALYs	Disability Adjusted Life Years
DHO	District Health Officer
DWD	Directorate of Water Development
HMIS	Health Management Information System
IDP	Internally Displaced Persons
IQR	Interquartile range
MWE	Ministry of Water and Environment
PS	Protected spring
PSP	Public stand post
RWHT	Rain Water Harvesting Tank
SW	Shallow Well
UBOS	Uganda Bureau of Statistics
UDHS	Uganda Demographic and Health Survey
UNCED	United Nations Conference on Environment and Development
WHO	World Health Organization
WRMD	Water Resource Management Department

CHAPTER ONE

1.0 Introduction

In many parts of the developing world, drinking water is collected from unsafe surface sources outside the home and is then held in household storage vessels. Drinking water may be contaminated at the source, during transportation, at storage and in drinking containers.

Contaminated drinking water is a principal cause of diarrhoeal diseases that result in 2.5 million childhood deaths annually (Kosek et al, 2003). World Health Organization 2006 reported that diarrhoea accounted for about 4% of the total global burden of disease, and, worse still, the burden is unevenly distributed – the annual Disability Adjusted Life Years (DALYs) lost due to diarrhoea is five times higher in children aged 5 years and below compared to the rest of the population. International water quality standards permit no detectable level of harmful pathogens at the point of distribution. However, microbiological water quality deteriorates in the course of collection, transport and household storage (van Zijl, 1966 and Hoque et al, 2006). Thus, access to safe source alone does not ensure the quality of water that is consumed. Furthermore, a better water source does not lead to full health benefits in absence of improved water storage and sanitation (Checkley et al, 2004).

In rural areas of most developing countries, women and children collect water from a communal source, often located several hundred metres from the home. The sources themselves may be unimproved (hand dug wells, unprotected springs, rivers), with low and seasonal flow rates, or improved (public taps, boreholes or pumps, protected wells, protected springs or harvested rainwater), (Gundry et al, 2006).

According to Water Hope Foundation Report, 2011, approximately 87% of Ugandans live in rural areas, in villages and small trading centres, where only 50% have access to safe drinking water. Three out of every four Ugandans have to walk for more than one and half kilometers to obtain water. In the same report (Water Hope foundation Report, 2011), it was highlighted that 70% of the population has no access to adequate sanitation facilities. Consequently, such water borne and water related diseases as diarrhoea, guinea worm and malaria have high incidences in Uganda. Once still, Water Hope foundation, 2011 reported that tap water is of very poor quality and drinking water has to be boiled and filtered but few Ugandans have awareness and means to see the whole decontamination process through. Exposure to diarrhoea-causing agents in Uganda is frequently related to the use of contaminated water and to unhygienic practices in food preparation and disposal of excreta (UDHS, 2006).

In a recent study (WATSUP, 2010), it was revealed that 24% of the population of Uganda received water from piped water supplies and 76% from a point water source (deep borehole, shallow well, protected spring, and rain water harvesting tank). The study also revealed that 44% of the population in Nakasongola District had access to safe water while 56% of the population is served by point water sources.

1.1 Background of the study

A systematic review of 57 studies published before 2002 by Wright et al. (2004) showed that water contamination occurs between source and point of use. This pattern has been confirmed by subsequent studies of water contamination in rural Sierra Leone; Clasen and Bastable, (2003) and rural Honduras; Trevett, Carter and Tyrrell, (2005). However, it is unclear exactly when this contamination takes place.

Pruss et al, (2002); Lindsborg et al, (19880 in Malawi; Gundry et al, (2006) in rural households of South Africa and Zimbabwe had repeatedly observed that the microbiological quality of water in transportation and drinking vessels in the homestead were lower than that at the source, suggesting that contamination might occur at different stages during the process from collection of water to consumption. According to Wright et al, (2004), bacterial counts in water at source and water stored in the household indicated that contamination was greater in cases where the faecal coliform counts in water at source were low.

Furthermore, a study that was conducted by analysts from WRMD in 6 randomly selected IDP camps in Kitgum and Gulu districts found that drinking water in homes was heavily contaminated with faecal coliforms even when the water source used by the household had good water quality, MWE, (2006). Consequently, in-house contamination may reverse the health benefits that are gained by improvements in community water supply.

The practice of open storage of drinking water allows for faecal contamination to occur inside the household. Contamination by hands and domestic animals had been shown to be the predominant causes of declining quality of water {Jensen et al, (2002); Schmidt and Cairncross (2009)}.

Water may become contaminated at any point between collection, storage, serving or handling in households (Tambekar et al, 2005). Microbial contamination of collected and stored household water is caused not only by the collection and use but unsanitary and inadequately protected (open, uncovered or poorly covered) water collection and storage containers.

Tambekar et al (2004); Gundry et al (2004); Hutin et al (2003); Tambekar et al (2006) observed that unsanitary methods of dispensing water from household storage vessels, including contaminated hands and dippers and inadequate cleaning of vessels, lead to accumulation of sediments and pathogens. Personal and domestic hygienic practices indirectly depend on the education level of the family members, water hygiene education, socio-cultural status, number of children in the house, etc {W.H.O (2003); Tambekar et al (2006); Fewtrell et al (2005)}.

Nakasongola District is located in the northern part of the Central Region of Uganda and comprises of two counties with eight sub-counties and three town councils. It has a population of 150,000 people of which 74% have access to safe water; Uganda Water Supply Atlas, (2010) and 72% access to safe sanitation; District Annual Sanitation Report (2010/2011). The Population and Housing Census report 2002 revealed that 40% of households in Nakasongola travel a distance of above 1 km to the nearest source of water, requiring collection and transportation from the source and subsequent storage of water within the household in buckets, clay pots, Jericans, open drums, and after eventual treatment put in a drinking vessel before consumption whereas 14% of the households use uncovered pit latrines. Hand washing with soap after visiting a toilet was 12% and knowledge about the dangers associated with children's faeces among women aged 15 – 49 years old was as low as 45% (District LQAS survey report 2011).

The study assessed points of faecal contamination of drinking water along the potential contamination pathway from the water source to the drinking cups used in the household (Fig.1). Although water can be collected at different water sources, this study focused on water collected from dug wells, boreholes, valley tanks/dams, lakeshores, piped water systems and taps. Each of these points within the pathway from source to mouth were assessed. Water quality was measured in terms of prevalence of waterborne diseases, water sources and water handling practices.

1.2 Statement of the problem

Government of Uganda through the Ministry of Water and Environment provide the district with a District Water and Sanitation Conditional Grant which finances either the establishment of boreholes or gravity flow schemes or latrine stances. In Nakasongola district, people had water but still die because of its poor quality. Accessibility to safe drinking water varied from 45% in Lwabiyata Sub County to 95% in Kakooge, Nabiswera Sub Counties and Nakasongola Town Council; DWD, Ministry of Water and Environment, (2010). Many people, especially women and children, spend a large percentage of their day and of their daily calories intake in fetching and carrying water for family as well as for livestock. Often the water they fetch is polluted and the cause of diseases, yet it is the only source available to them.

Unhygienic excreta and stage disposal, solid waste accumulation and poor domestic and personal hygiene practices have contributed greatly to the spread of diseases. Poor environmental conditions arising from these practices encourage vermin and insects to multiply and leads to contamination of food and water supplies, either at source or in the home.

Although the International Drinking Water Supply and Sanitation Decade (1981-1990) resulted in increases in the number with regular access to safe drinking water, 48% of the people in Nakasongola District (Annual District Rural Water and Sanitation Development Conditional Grant Report 2010) are still without all year round access to potable water, and 43% of the households (Nakasongola District Annual Sanitation Report 2010/2011) are without hygienic methods for excreta disposal.

The infant mortality rate is as high as 78/1000 live births and under 5 mortality rate of 128/1000 live births (DDP, 2010/11-/2015/16) as a result of diseases related to water and sanitation provision commonly dysentery and typhoid.

The most common and widespread health risk associated with drinking-water is microbial contamination. About 4.6% of the total disease burden in the district is contributed by diarrheal diseases due to inadequate sanitation, polluted water or unavailability of water (Higher Local Government Statistical Abstract – Nakasongola District, 2009). The District Annual Report (HMIS 128), 2009/10 indicated that diarrhoeal diseases increased from 8,130 cases in 2009/10 to 8,574 cases in 2010/11. Lack of access to safe water and sanitation was associated with incidences of water-borne diseases – particularly diarrhoeal diseases in Lwabiyata and Nakasongola Town council.

A number of studies have repeatedly indicated that the microbiological quality of water in transportation and drinking vessels in the home is lower than that at the source, suggesting that contamination may occur at different stages during the process from collection of water to consumption. It is therefore upon this background that the researcher found it necessary to conduct a study to assess the quality of drinking water at source and point of consumption, and to assess the water handling practices at households in both rural and urban settings in Nakasongola District.

1.3 Hypothesis

1. There is no relationship between points where feacal contamination of drinking water occurs and the quality of drinking water from the point of collection to the point of use in Nakasongola District.

2. There is no relationship between water handling practices and the quality of drinking water from the point of collection to the point of use in Nakasongola District.

3. There is no relationship between hygiene and sanitation practices and the quality of drinking water from the point of collection to the point of use in Nakasongola District.

1.4 Purpose of study (General Objective)

The purpose of the research was to locate specific points where contamination of drinking water occurs in the process from the point of collection to the point of use and to assess the water handling and hygiene practices affecting the quality of drinking water in Nakasongola District.

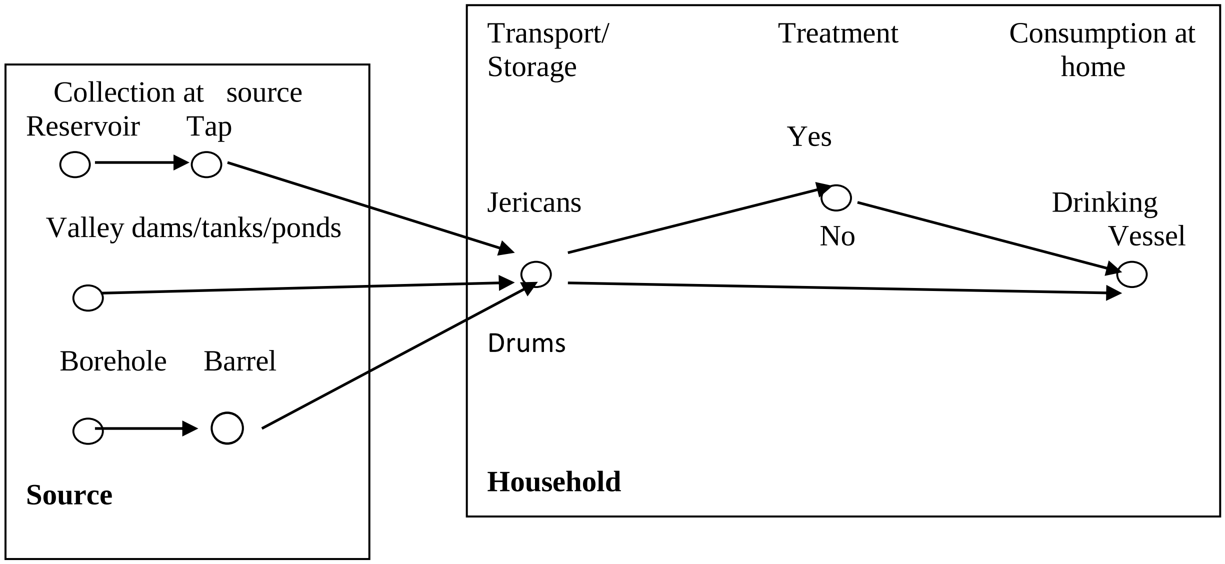
1.4.1 Specific objectives

1. To identify the most common points where faecal contamination of drinking water takes place in Nakasongola District.
2. To assess water handling practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola District.
3. To assess hygiene and sanitation practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola District.

1.5 Type of research

A cross-sectional study which employed both quantitative and qualitative techniques of data collection on quality analysis of drinking water; water handling and hygiene and sanitation practices was conducted in Nakasongola district particularly in Lwabiyata Subcounty and Nakasongola Town Council from 24th September to 9th November 2012.

Figure 1: Conceptual framework



The conceptual framework shows potential contamination pathway from source of water to the point of consumption in the household. The circles represent sampling points where the researcher collected water samples for microbiological analyzes. The points included the water sources where the participating households collected their drinking water, the containers used for transport/storage of water in the household, treated water in the home and the cup used for scooping drinking water from the storage container.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter analyses the related literature on the research studies conducted on quality of drinking water at source and point of consumption. The review was based on studies conducted in developing countries by World Health Organization (WHO) and other researchers. It is structured according to the research objectives and variables that provide the main themes.

2.1 Common point for faecal contamination

The risk of microbiological contamination of drinking water during collection and storage in the home had long been recognized by researches such as van Zilj 1966; VanDerslice & Briscoe 1995. According to the surveys carried out by Van Zilj (1966) on preschool children in seven countries namely, Ceylon, East Pakistan, Iran, Mauritius, Sudan, the United Arab Republic and Venezuela, he observed that drinking water taken from piped supply was stored for cooling in earthen jars which were, without exception, faecally contaminated.

While reviewing water contaminations that occur during home water storage, Gilman et al. (1985) observational studies indicated that mean coliform levels were substantially higher in household water containers than in water sources. However, VanDerslice and Briscoe (1993) studies showed coliform levels in water storage containers and sources to be comparable and one of their studies showed lower coliform levels in storage containers than in water sources. In five other studies carried out in Philippines and in a suburban community in Rangoon, Burma, VanDerslice and Briscoe (1993); Han et al. (1989) respectively compared paired samples from individual water sources and household storage containers, the results were similar; faecal coliform concentrations were generally, and sometimes dramatically, higher in stored water than in source water.

Swerdlow et al. (1992) during the cholera epidemic in Peru, sampled water from municipal taps and from stored household water from these taps and noted a thousandfold increase in mean faecal coliform counts. Hazen (1988) observed that faecal coliform bacteria may not be ideal indicators for faecal contamination since field studies conducted in Thailand by Echeverria et al. (1987); in Bangladesh by Spira et al. (1982); and in Calcutta by Deb et al. (1982) identified enteropathogens in stored water. Deb et al. (1982) observed that "people generally took stored water from the buckets by dipping in their hands thus resulting in contamination of otherwise safe water by their infected fingers". During a cholera epidemic in Bahrain, Gunn et al (1981) identified V cholerae 01 in stored household drinking water.

Similarly, Han et al (1989) in Myanmar identified toxigenic E coli in two of 40 water samples from household storage vessels but in none of 20 samples collected on the same day from the water sources. Furthermore, Khairy et al. (1982) in Egypt isolated two parasitic pathogens, Strongyloides and Ascaris from 10% to 15% of water samples collected from earthenware household storage vessels but no pathogens were identified in source water samples. These studies indicated that contamination with pathogens as well as indicator organisms occurs during household water storage.

2.2 Water handling practices

According to the field investigations conducted by Mintz *et al. (*1995); Lindskog & Lindskog (1987); Hammad & Dirar (1982); and Swerdlow *et al. (*1997), certain practices and vessel characteristics that are associated with the contamination of household water or the disease resulting there from, such as using large-mouth vessels to collect and store water, transferring water from collection vessels to storage vessels, and accessing water by dipping hand-held utensils rather than via a tap or by pouring were identified. Patel & Isaacson (1989); Roberts *et al.* 2001 observed that after contamination occurs, the design of the vessel and the time period before consumption also influence the survival of the bacteria. Similarly, according to the research conducted by Tuttle et al. (1995) in Zambia, he reported that stored water was more likely to be dipped out in patients' homes and more likely to be poured in homes of healthy neighbours, suggesting that hands and objects introduced into stored water were a source of contamination. In this study, healthy subjects often stored their water in a narrowmouthed plastic vessel used to sell vegetable oil, whereas infected patients were more likely to use an open bucket into which hands could be inserted. Koehler et al. (1991) in Texas found coliform bacteria significantly less often in storage vessels with openings less than 10 cm in diameter, from which water was typically poured, than in containers with wider openings, into which hands and dipping utensils could more easily be introduced. In another research study carried out by Chidavaenzi et al. (1998) observed that using uncovered water containers is likely to increase water contamination between source and point of use as hands are dipped into vessels to scoop a cupful of water. Wright et al. (2004); Schmidt et al. (2009); Oswald et al. (2007); Baltazar et al. (1993); Emerson et al. (1996) and Cairncross et al. (1996) in their research studies reported that dirty hands may contaminate water not only through handling during collection and transportation but also when handling drinking vessels or scooping drinking water from storage vessels.Many observations suggest that treating water in a home can prevent illness. Empirical studies in the past two decades include Swerdlow et al. (1992); Weber et al. (1994) and Blake et al. (1993) demonstrated that persons whose families boil drinking water at home were at lower risk of cholera specifically and diarrhoea in general. A research study carried out by Mujica et al.

(1994) in the Amazon revealed that acidification of drinking water with citrus fruits juice protects against cholera. Another research study by Khan et al. (1984) in Bangladesh indicated that families that were taught to add alum potash to their stored household drinking water, fewer family contacts became infected with V cholerae than among families who did not use alum. Kirchhoff et al. (1985), evaluated point-of-use disinfection using 10% sodium hypochlorite in Brazil in which 20 families (112 persons) who collected their drinking water from a contaminated pond were randomly assigned to one of two groups (treatment and placebo groups). The study revealed that, mean faecal coliform counts were significantly higher in placebo treated water samples than in samples of hypochlorite treated water. Similarly, Oo et al. (1993), evaluated alum potash treatment of household water in Myanmar where stored drinking water samples from 50 control households and from 50 households where alum treatment was used were tested for faecal coliform bacteria and observed that mean faecal coliform counts were similar in both households before the addition of alum but lower in the treatment households 24 and 48 hours after alum was added.

2.3 Hygiene and sanitation practices

Fewtrell et al. (2005) observed that hygiene interventions that promote hand washing with soap show the highest reduction in diarrhoea (45%), nearly twice the reduction recorded from provision of improved water supplies. Aiello et al. (2008) noted that hand washing had shown to be effective at reducing respiratory illness by an average of 21%. Schmidt et al. (2009) noted that controversy exists regarding health impact assessments of household water treatment and hand washing interventions because it is often not possible to blind participants and because behavioural and health outcomes are frequently self reported.

It has been suggested that dirty hands play an important role in contaminating water stored in households. Pinfold et al. (1990) conducted a study among 10 households in Thailand and found stored water quality was a function of how the stored water was used (i.e., drinking or washing) but not of water quality at the source, suggesting that water handling may be a mechanism of contamination. Wright et al. (2004); Levy et al. (2008) in their studies provided support for this idea with reports of lower levels of contamination in water containers with covers or narrow mouths to prevent hands from entering.

Faecal indicator bacteria (FIB), which occur in high concentrations in faeces, are used to indicate the presence of faeces in water and on hands and thus signify risk of faecal-oral illness transmission. Kaltenthaler et al. (1991); Pickering et al. (2010) and Hoque et al. (1995) in their studies in developed countries acknowledged that hand washing with soap reduced FIB on hands. Ologe (1989) observed that where basic sanitation is lacking, there is more likelihood of indicator bacteria from faeces being introduced into stored water.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the methodology that was used in testing the hypothesis. Basically it presents the study area, target population, study population, study setting, study design, sample population, method of selecting the sample, size of the sample and rationale, ethical considerations, tools for data collection, reliability and validity of tools for data collection, measures to ensure validity, internal and external generalisability, variables, data collection methods, pilot study (pre-test) and data analysis. A comparative cross-sectional household study which employed both quantitative and qualitative techniques of data collection on quality analysis of drinking water, water handling and hygiene practices was conducted in Nakasongola District particularly in Lwabiyata Subcounty and Nakasongola Town Council to assess the quality of drinking water at the source and point of consumption, and also to assess water handling and hygiene practices affecting the quality of drinking.

3.1 Study Area (Appendix 6)

The study was conducted in Nakasongola Town Council and Lwabiyata Sub County. The two local governments were purposively selected because of the highest and lowest rate of access to safe water and sanitation (95% and 85%), and (74% and 64%) respectively; DWD, Ministry of Water and Environment, (2010); District Annual Sanitation Report (2010/11). Similarly, the prevalence of diarrhoeal diseases in the selected study area in FY 2009/10 was as high as 938 and 894 cases respectively (DHO, HMIS 2009/10). Nakasongola Town Council is the biggest urban area in the district with an estimated mid-year population of about 7,800; Uganda Bureau of Statistics, (2011), while Lwabiyata Sub County is a rural remote sub county with an estimated mid-year population of about 12,800; Uganda Bureau of Statistics (UBOS), (2011).

3.2 Target Population

The target population was households with at least a child under five years old and the mother and/or housewife who consented as the respondents as in most cases, was the individual responsible for the management of drinking-water in the household.

3.3 Study Population

The study population comprised of 3,517 eligible respondent participating households from which 111 respondent participating households were selected using the modified systematic random sampling technique, 38 respondent participating households selected from Lwabiyata Sub County and 73 from Nakasongola Town Council.

3.4 Study Setting

The study was conducted in the rural setting in Lwabiyata Sub County and urban setting in Nakasongola Town Council respectively.

3.5 Study design

A cross-sectional study to assess the quality of drinking water at the source and point of consumption was conducted. It employed both quantitative and qualitative methods of data collection. The researcher administered a structured questionnaire (Appendix 2) to collect data on water, sanitation and demographic characteristics. The questionnaire was translated into Luruuli (Appendix 3); the language used in the study area. The questions were related to water sources, type of water transport containers, water-treatment methods and cleaning habits, type and material of water-related issues and sanitation facilities. The person that was interviewed was the mother and/or housewife as in the most cases, was the individual responsible for the management of drinking water in the household. Since the main goal of the research was to locate specific points where faecal contamination of drinking water occurs in the process from the point of collection to the point of use and to assess the water handling practices affecting the quality of drinking water in Nakasongola District, the researcher measured the quality of water at all stages along the potential contamination pathway from the water source to drinking cup (Fig.1). Microbiological samples at all households where extended questionnaires were conducted were collected. Samples were also taken at all drinking water sources used by these households. The samples were coded in such a way that the results of water source samples could be linked to the results of the samples at the corresponding households and transported for testing to the Department of Health by the researcher. The term "dinking cup" was used to describe all kinds of vessels used for actual drinking. The microbiological samples were analysed using a membrane filtration method i.e. WAGTECH Potatest water testing kit. 100 ml samples were passed through a 0.45 micron membrane filter (Millipore Corporation, Bedford, Massachusetts, USA) and incubated on membrane lauryl sulphate broth (MLSB) at 44°C for 18 hours in a WAGTECH Potatest water testing kit. The quality of water was quantitatively assessed through the enumeration of yellow colony forming units of E.coli, an indicator organism for faecal contamination and diarrheal disease cases experienced in the last three months by the household. The researcher also conducted an observational survey to make an assessment of water handling practices. In this study, water handling practices described handling practices during collection, transport, storage, treatment and consumption; whereas hygiene referred specifically to those behaviours related to safe management of human excreta disposal such as hand washing with soap or the safe disposal of children faeces.

3.6 Sample Population

The sample population was one hundred eleven (111) participating households/respondents selected from the two study areas with seventy three (73) chosen from Nakasongola Town Council and thirty eight (38) from Lwabiyata Sub County. You may notice that the sample population was not the same for the two study areas because the researcher used the rate of access to safe water of 0.95 and 0.45 respectively to compute the sample population.

3.7 Method of selecting the sample

Due to the homogenous nature of the study population, modified systematic random sampling technique was used in the selection of the sample. The researcher identified the needed sample size by using the Leslie Kish formulae, 1965 and then divided the total number of households with the sample size to obtain the sampling fraction. The researcher then used the sampling fraction as the constant difference between the participating households. That is, for Lwabiyata Sub County, the sample size was thirty eight (38) and the sampling fraction of 55. Likewise, for Nakasongola Town Council the sample size was seventy three (73) and the sampling fraction of 20. The researcher randomly selected the first household with at least one child under five years old from the total list of households from each study area. Then, the researcher selected each 55^{th} and 20^{th} household from the sample respectively bearing in mind the presence of a child under five years old. The researcher then interviewed mothers/or house wives and also collected water samples from household drinking water sources, transport/storage vessels, treated water and drinking container/vessel for microbiological testing.

3.8 Size of the sample and rationale

The sample size of 111 households was calculated using the Leslie Kish formulae, 1965 as shown below;

$$\mathbf{n} = \frac{t^2 \times p(1-p)}{m^2}$$

Description:

n = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated access rate to safe water source in the study area

m = margin of error at 5% (standard value of 0.05)

For Nakasongola Town Council (urban setting) with access rate to safe water source of 95% (0.95) the sample size was 73 whereas for Lwabiyata Sub County (rural setting) with access rate to safe water source of 45% (0.45) the sample size was 38.

3.9 Ethical Considerations

Permission was sought from relevant organs, i.e. the Department of Science and Technology, School of Research and Postgraduate Studies, Uganda Christian University – Mukono. Interviews were conducted after seeking consent from the interviewee. No information or data was put in this study without the consent of the relevant authorities.

To seek participant’s consent to participate in the study, an informed consent form (Appendix 4) that detailed information about the goals, objectives of the study, the research methodology to be used, any risks or benefits, the option not to participate and their right to anonymity and confidentiality was used. Participants were asked to acknowledge by signature or thumbprint. In instances in which written communication was not appropriate, the researcher read and translated the information contained in the consent form and asked the participant to acknowledge by signature or thumbprint.

3.10 Tools for data collection

A structured questionnaire was used to collect qualitative data on the type of water sources, home based water treatment methods, water handling practices and behaviors and sanitation facilities (Appendix 2). Water samples were collected from participating households according to the standard method described in the guidelines of the World Health Organization for the quality of drinking water.

3.11 Reliability and validity of tools for data collection

A structured questionnaire (Appendix 2) was use to collect data on water, sanitation and demographic characteristics. The tool was pretested to check for reliability and validity (repeatability and accuracy) before it was used. After pretesting, the researcher made adjustments in the questionnaire and the questionnaire was used to collect the data.

3.12 Measures to ensure validity

Water samples were collected according to the standard method described in the guidelines of the World Health Organization for the quality of drinking water. A structured questionnaire (Appendix 2) was used to collect data on water handling, hygiene and sanitation practices.

3.13 Internal/External/Generalisability

The findings of the study were generalizable to the population of the study areas in particular and to Nakasongola District in general.

3.14 Variables

3.14.1 Exposure variables

The exposure variables for the study were the type of water sources, type of water transport/storage vessels, water treatment method and cleaning habits, type and material of water related issues, and sanitation facilities.

3.14.2 Outcome variables

The outcome variable for the study was the quality of drinking water.

3.15 Data collection

Pre-visits to the study areas were made to discuss the exercise with the relevant authorities and seek permission from the Town Council and Sub County Authorities. During the visits, the purpose of the study was explained to all the respondents and their consent obtained prior to administering the questionnaire.

The microbiological quality of drinking water was quantitatively assessed through the enumeration colony forming units of Escherichia coli, an indicator for faecal contamination by use of WAGTECH Potatest water testing kit.

A detailed structured questionnaire (Appendix 2) and observation was used to collect qualitative data. The questions were both open and close ended related to household water handling, hygiene and sanitation practices. The person that was interviewed, was the mother and/or housewife as in most cases, was the individual responsible for the management of drinking-water in the household.

3.16 Pilot study (Pretest tools)

The questionnaire was pre-tested and afterwards modified to meet the objective of the study. The questionnaire was pre-tested in an area with similar characteristics as the selected study area to enable it to be redesigned if need be.

3.17 Data Analysis

Source data was cleaned by verifying completeness/fill rate, validity, frequency distributions and lists of values, patterns, maximum and minimum values, and referential integrity.

The relationship between stated variables was evaluated using Pearson's correlation co efficiency using Statistical Package for Social Scientists (SPSS). According to Amin (2005), the correlation coefficient always takes a value between -1 and 1, with 1 or -1 indicating perfect correlation (all points would lay along a straight line in this case). A positive correlation indicates a positive association between the variables (increasing values in one variable correspond to increasing values in the other variable), while a negative correlation indicates a negative association between the variables (increasing values in one variable correspond to decreasing values in the other variable). A relationship value close to zero indicates no association between the variables.

The use of a regression analysis was due to the fact that it is a statistical tool for the investigation of relationships between variables. Usually, the investigator seeks to ascertain the causal effect of one variable upon another and for this case, all variables were significant, i.e., could contribute to water quality.

Tables and graphs were used to summarize the numerical data that was collected. A stratified analysis was performed to evaluate for confounders in this study. The collected data was disaggregated into homogeneous subgroups ("Strata") to see if the association seen in the undivided, aggregate data holds true during subsequent analysis. Stratification of the data may reveal otherwise hidden confounding factors.

SPSS software version 11 and the Microsoft Excel software 2007 were used to process the data. The Microsoft Excel software 2007 was used to code, categorize and summarize the data obtained from the field.

CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

4.0 Introduction

This chapter focuses on data analysis, presentation and interpretation and is structured in accordance with the objectives of the study, that is, to identify the most common points where faecal contamination of drinking water takes place, to assess water handling practices affecting the quality of drinking water from the point of collection to the point of use, to assess hygiene and sanitation practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola District. This study was a comparative analysis as it involved assessing the quality of drinking water at source and point of consumption in Nakasongola District both in the Rural and Urban setting.

4.1 Background Information of Respondents

4.1.1 Quality of water (Cases of Diarrhoeal Diseases in the Last Three Months)

Water quality was measured in terms of prevalence of diarrheal diseases. In addition, the quality of water taken by a household was quantitatively assessed through the enumeration of yellow colony forming units of E.coli, an indicator organism for faecal contamination and diarrheal disease cases experienced in the last three months by the household, although typically, water quality is determined by comparing the physical, biological and chemical characteristics of a water sample with water quality guidelines or standards.

Table 1: Demographic Respondents of Households (Summation o f Rural HH=38, Urban HH =71)

Response	**Rural Households**	**Urban households**	**Pearson Correlation value**
Number of People	**Frequency/percent**	**Frequency/percent**	**Quality of water**
2 to 3	1 (2.6%)	8 (11.3%)	0.418
4 to 5	8 (21.1%)	15 (21.1%)	
6 to 7	12 (31.6%)	24 (33.8%)	
8 to 9	5 (13.2%)	8 (11.3%)	
10+	12 (31.6%)	16 (22.5%)	
Education Level			0.0413
None	5 (13.2%)	9 (12.7%)	
Primary	25 (65.8%)	22 (31.0%)	
Secondary	7 (18.4%)	26 (36.6%)	
Tertiary institution	1 (2.6%)	8 (11.3%)	
University	-	6 (8.5%)	
Type of Floor			-0.0611
Natural soil floor	31 (81.6%)	25 (35.2%)	
Earth rammed floor	3 (7.9%)	7 (9.9%)	
Concrete floor	1 (2.6%)	15 (21.1%)	
Cement screed floor	3 (7.9%)	24 (33.8%)	

Source: Primary data

Number of People Sleeping in the Household

From Table 1 above, there were no big differences in the number of people sleeping both in the rural and urban households. Among the rural households a good number of them were above 10 people sleeping in a household (31.6% response) and another 31.6% were between 6 and 7 in number, followed by 21.1% and these were between 4 and 5 people. The situation among urban households was also characterized by large number of people, for example, 33.8% of the households in urban areas were between 6 to 7 people, followed by 22.5% were above 10 in their households. Using Pearson correlation coefficient, there was a significant relationship (Pearson correlation value =0.418) between the number of people sleeping in the household and the quality of drinking water. This was an indication that a household with a large number of people sleeping in a single household were likely to affect the quality of their drinking water compared when they were few.

Education level reached by the Household

From Table 1 above, there were drastic differences in the level of education among the rural and urban households, for example, most respondents in rural setting (65.8%) had attained primary level while in urban setting only 31% had ended in primary level. Very few rural households (18.4%) had attained secondary level, tertiary level (2.6%) and none of them had attained university education. The results indicated that there were higher levels of education among urban households as compared to their counterparts in rural areas. However, using Pearson correlation coefficient, there was a significant relationship ((Pearson correlation value =0.0413) between education levels of the household and the quality of drinking water, an indication that educated households are more likely to enhance better quality of drinking water than their counterparts with less education level.

Type of Floor of Main House

The results in Table 1 above indicate that most rural households (81.6%) had natural soil floors and very few of them had earth rammed floor (7.9%), concrete floor (2.6%), and cement screed floor (7.9%). On the other hand, a good number of households in the urban setting (33.8%) had cement screed floor and 35.2% had natural soil floor and 21.1% had concrete floor. On a whole, the urban households had better floor of main house as compared to their rural counterparts. The Pearson Correlation Coefficient indicated that there was a less significant relationship ((Pearson correlation value = - 0.0611) between the type of floor in the main house and quality of water, an indication that a household can have better quality of water for drinking or not regardless of the type of floor of the main house.

Table 2: Additional Demographic Features of Respondents of Households (Summation o f Rural HH=38, Urban HH =71)

Animals Owned	**Rural Households**	**Urban households**	**Pearson Correlation value**
Yes (pigs, goats, cattle, etc.)	33 (86.8%)	54 (76.1%)	**Quality of water**
No	5 (13.2%)	17 (23.9%)	0.0711
Main Source of Drinking Water	**Rural Households**	**Urban households**	
Borehole	3 (7.9%)	45 (63.4%	
Valley tank	30 (78.9%)	4 (5.6%)	0.2214
Piped water supply	-	21 (29.6%)	
Lake	5 (13.2%		
Rain water	-	1 (1.4%)	
Time taken to go	**Rural Households**	**Urban households**	

get water			
Number of minutes	29 (76.3%)	46 (64.8%)	- 0.061
Water on premises	-	5 (7.0%)	
Don't know	9 (23.7%)	19 (26.8%)	
4		1 (1.4%)	

Source: Primary data

Domestic Animals Owned

From Table 2 above, majority of the rural households (86.8%) had domestic animals while 13.2% had no such animals. However, even among urban households, many of them (76.1%) had domestic animals while only 23.9% did not have such animals. This finding is an indication that domestic animals were owned by both urban and rural households, although the level of ownership was high among rural households. The results indicated that there was a significant relationship between availability of domestic animals in the household and quality of drinking water ((Pearson correlation value =0.0711), an indication that households with domestic animals were more likely to affect the quality of drinking water than their counterparts without such animals.

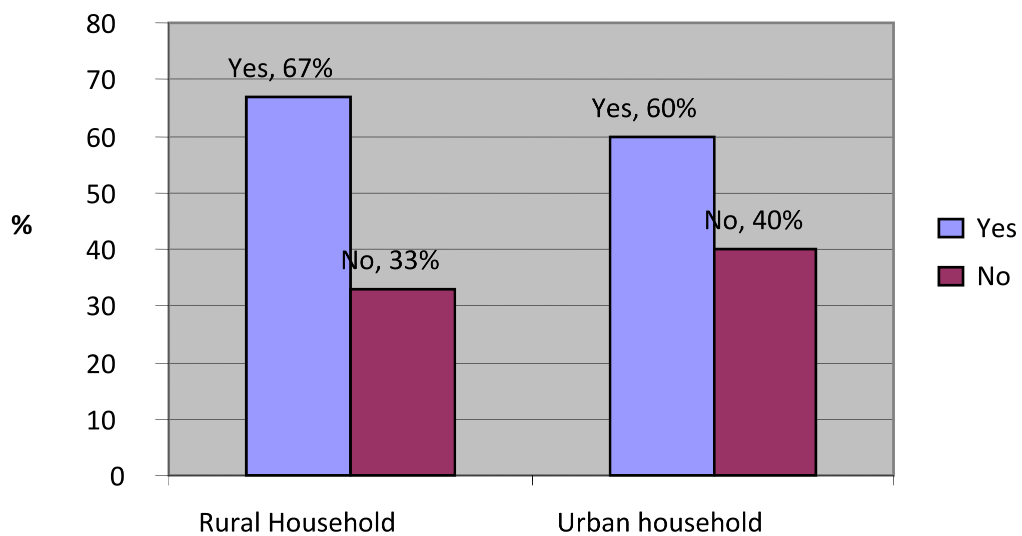
Main Source of Drinking Water

From Table 2 above, the major source of drinking water among rural households was valley tank as indicated by 78.9% response, followed by lake (29.6%) and borehole (7.9%). For the case of urban households, the major source of drinking water was borehole (63.4%), followed by piped water supply (29.6%) and valley tank (5.6%). In the context of this study, since borehole water is considered as safe water source, which was largely used by urban households, it can be said that there were safer water in urban areas of Nakasongola than in the rural areas. The results indicated a significant relationship between the source of water (Pearson correlation value = 0.2214) and quality of drinking water. Through laboratory analyses of water samples from the various water sources, it was found that water from unprotected sources was more likely to be of poor quality than piped and borehole water.

Time taken to go get water and come back

From Table 2 above, most rural households spent about half an hour in the process of fetching water (76.3%) and urban households spent about 46 minutes to get water and come back. It can be said that there were no big differences in the time taken to fetch water in the rural area and urban setting. However, there was a less significant relationship between time taken to go get water and come back and the quality of water for drinking (Pearson correlation value = - 0.061)

Figure 2: Cases of Diarrhoeal Diseases in the Last Three Months



Source: Primary data

From Fig.2 above, majority of the rural households (67%) had had cases of diarrhoeal diseases in the last three months while 33% had not had any in the last three months. The situation was not so different from that in urban setting where 60% of the households had had cases of diarrhoeal diseases while 40% had not. On a whole the results indicated that in both urban and rural settings of Nakasongola District, there are still cases of consumption of poor quality water which was measured in terms of cases of diarrhoeal diseases experienced by the household in the last three months. It should further be pointed out that household contract diarrhoeal diseases which is illness caused by drinking water contaminated by human or animal faeces, which contain pathogenic microorganisms.

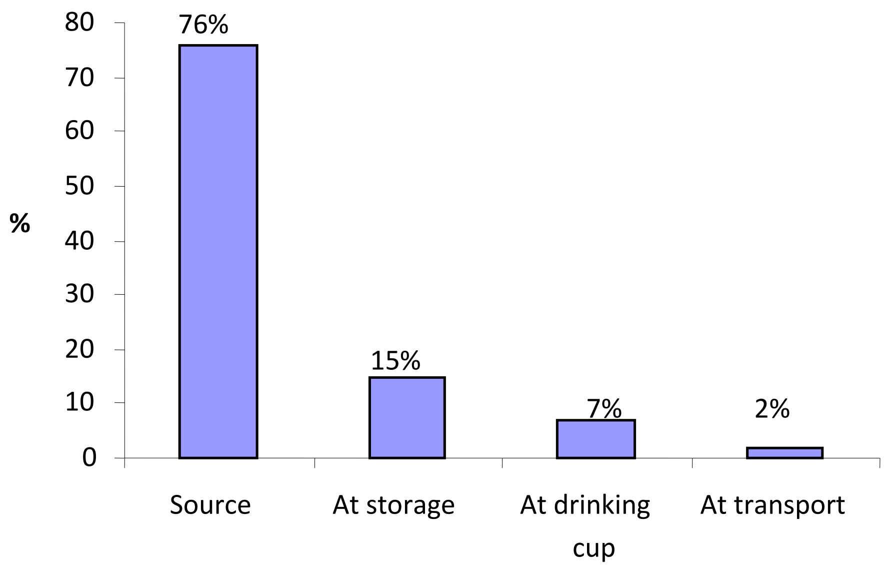
4.2 The most common points where faecal contamination of drinking water takes place in Nakasongola District

The results from this objective were obtained mainly through laboratory investigations of water samples collected from the water sources use by the participating households, containers/vessels used for transporting water to the household, stored water in the household and from the drinking cup and the following results were obtained. Drinking water in Nakasongola District was derived from two basic sources: surface waters, such as Lake Kyoga, and groundwater. Through experimentation, all water contained natural contaminants, particularly inorganic contaminants that arise from the geological strata through which the water flows and, to a varying extent, anthropogenic pollution by both microorganisms and chemicals. In general, groundwater was found to be less vulnerable to pollution than surface waters. However, this study was more interested in identifying the most common points where faecal contamination of drinking water takes place in Nakasongola District.

Through observation, it was found out that there were a number of possible sources of man-made contaminants, some of which are more important than others. These fall into the categories of point and diffuse sources. Discharges from runoff from agricultural land and from hard surfaces, such as roads, are not so obvious, or easily controlled. Such sources were found to give rise to a significant to nearby water sources such as unprotected water sources.

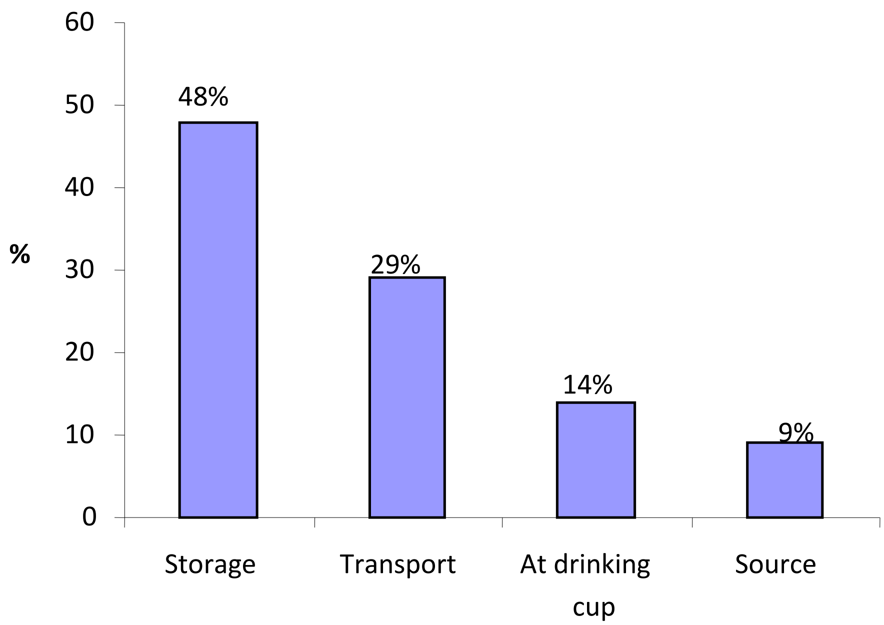
Within Nakasongola Town Council, poorly sited latrines and septic tanks were a significant source of contamination, especially of valley tanks. Local industries such as UGA PLY also gave rise to contamination of water sources, particularly when chemicals are handled and disposed of without proper care. This was more common on water in valley dams and valley tanks. For piped water supply, it was reported that if treatment was not optimized, unwanted residues of chemicals used in water treatment could also cause contamination, and give rise to sediments in water pipes. However, areas of feacal contamination were cited in broken pipes. The respondents were asked to rank the most common points where faecal contamination of drinking water may take place in Nakasongola District and the following results were obtained.

Figure 3: Drinking water from Lake and River



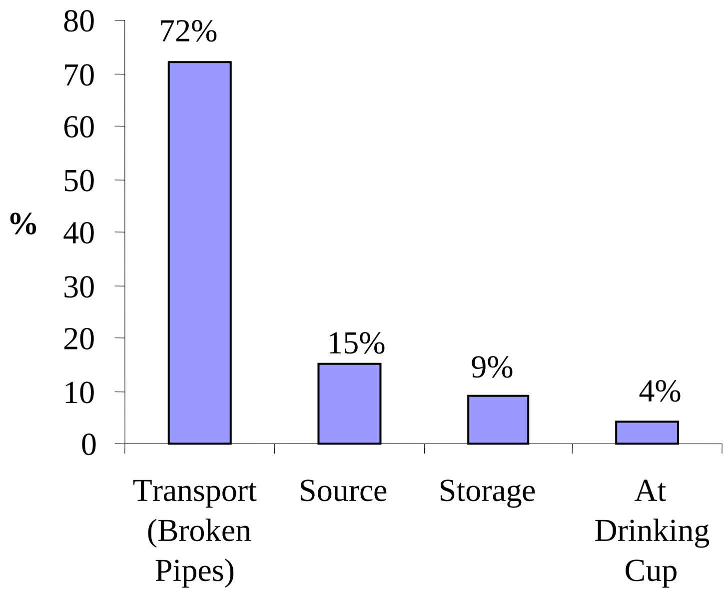
From Fig. 3 above, majority of the households (76%) indicated that for lake and river water, the most common point where faecal contamination takes place in Nakasongola District was at the source. According to information obtained from the District Health Officer, this water was at high risk of contamination at the source because there is a risk that faecal matter and chemical deposits from nearby locations that can get into it. He pointed out that some of these contaminants include animal or human wastes on ground level and minerals in the water leaking out from landfills, road salts, septic systems and industry; solvents that can end in the water stream from chemical spills in nearby locations; and pesticides that are left in the ground and that with the help of rain will end up in the water stream.

Figure 4: Drinking water from Boreholes



From the results in Fig. 4 above, most borehole water was said to be contaminated most at storage (48%), transportation (29%), drinking (14%) and lastly at source. However, borehole water was found to be safer for drinking than lake water. It is therefore, evident that a borehole is one of the simplest and most reliable water sources for communities in Nakasongola District and since the water comes from underground, it is safer than lake water.

Figure 5: **Drinking water from Piped Water Supply**



From Fig. 5 above, 72% of the respondents indicated that broken pipes was the major source of contamination of piped water supply. In an interview with the District Health Officer, it was pointed out that broken pipes can be caused by many different things. Sometimes they break just because they are old, but more typically, they have cracked or been jarred loose by vibrations in the house. Remodeling work might be one reason why pipes finally break, but even a steady stream of trucks traveling down the street can shake loose pipes or create a fracture in a toilet tank.

4.2.5 Laboratory Results

The focus on this section was due to the fact that E.coli or Escherichia coli are bacteria that normally live in the intestines of humans and animals. Although, most strains of these bacteria are harmless, several are known to produce toxins that can cause diarrhea. One particular E.coli strain called O157 can cause severe diarrhea and kidney damage. In contrast to the harmless E.coli strains normally found in the gut of all warm-blooded animals, the O157 strain produces a potent toxin. This causes severe diarrhoea and in some cases renal failure and death. Toxigenic E.coli, including O157 and other strains, are carried by 10-15% of healthy ruminants, including cattle, sheep, goats and deer. The bacteria may be transmitted to humans by consumption of raw or undercooked meats, or by faecal contamination of foodstuffs or water supplies.

Table 3: Laboratory Results (Summation o f Rural HH=38, Urban HH =71)

Number	Rural Households	Urban households
Number of CFU/100ml in drinking water source	3 (7.9%)	18 (25.4%
1-10	21 (55.3%)	31 (43.7%)
11-50	8 (21.1%)	5 (7.0%)
>50	6 (15.8%)	17 (23.9%)
Number of CFU/100ml in the container used for transporting water to the household		
0	7 (17.6%)	13 (18.3%)
1-10	18 (47.4%)	29 (40.8%)
11-50	8 (21.1%)	8 (11.3%)
>50	**5 (13.2%)**	**21 (29.6%)**
Number of CFU/100ml in Treated Water Found in the Household at the Time of Visit		
0	13 (34.2%)	1 (1.4%)
1-10	16 (42.1%)	36 (50.7%)
11-50	3 (7.9%)	18 (25.4%)
>50	6 (15.8%)	16 (22.5%)

Source: Primary Data

Number of CFU/100ml in drinking water source

From Table 3 above, 55.3% of the rural households collected drinking water from the water source with CFU/100ml in the IQR 1-10, followed by 21.1% in IQR 11-50 and 15.8% in IQR >50. For the case of urban households, 43.7% collected their drinking water from the water source with CFU/100ml in the IQR 1-10, 23.9% in IQR >50 while 25.4% from the water source with zero (00) CFU/100ml.

Number of CFU/100ml in the container used for transporting water to the household

Table 3 further indicated that among the rural households, 47.4% of the containers used for transporting water to the household had CFU/100ml in IQR 1-10, followed by 21.1% whose containers had CFU/100ml in IQR 11-50 , 17.6% had zero (0) CFU/100ml while 13% had CFU/100ml in IQR >50. Among urban households, 40.8% of the containers used for transporting water to the household had CFU/100ml in IQR 1-10, followed by 29.6% whose containers had CFU/100ml in IQR >50, 18.3% had zero CFU/100ml while 11.3% had CFU/100ml in IQR 11-50.

Number of CFU/100ml in stored drinking water

From Table 3 above, 42.1% of rural households had CFU/100ml in IQR 1-10 in their stored drinking water, followed by 34.2% who had zero CFU/100ml in their stored drinking water. On the other hand, 50.7% of urban households had CFU/100ml in IQR 1-10 in their stored drinking water and 25.4% had CFU/100ml in IQR 11-50 and another 22.5% had CFU/100ml in IQR > 50 in their stored drinking water.

Because E.coli bacteria are always present in human and animal faeces in very high numbers, they are used as an indicator of faecal pollution in the microbiological surveillance of drinking water. On very rare occasions, low numbers of E.coli are detected in drinking water. This does not indicate that O157 is present, or that there is an immediate risk to health. Detection of E.coli does however necessitate an immediate investigation of the water supply system in order to identify and eliminate the source of pollution.

Number of CFU/100ml in Treated Water Found in the Household at the Time of Visit

From the results in Table 3 above, 42.1% of rural households had CFU/100ml in IQR 1-10 in their treated water found in the household at the time of visit, followed by 34.2% with zero CFU/100ml. 15.8% had CFU/100ml in IQR >50 in their treated water found in the household at the time of visit. On the other hand, 50.7% of the urban households had CFU/100ml in IQR 1- 10 in their treated water found in the household at the time of visit, followed by 25.4% with CFU/100ml in IQR 11-50.

Table 4: Water handling practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola district (Summation o f Rural HH=38, Urban HH =71)

Person who fetches water	**Rural Households**	**Urban households**
Adult woman	13 (34.2%)	34 (47.9%)
Adult man	3 (7.9%)	13 (18.3%)
Female child (Under 15 years)	10 (26.3%)	11 (15.5%)
Male child (under 15 years)	12 (31.6%)	13 (18.3%)
Type of Transport Container Used to Collect Water		
Jerican	38 (100%)	67 (94.4%)
Bucket		2 (2.8%)

Clay pot		1 (1.4%)
Open drum		1 (1.4%)
Type of Storage Container Used to Store Water for Drinking		
Jerican	19 (50%)	50 (69%)
Clay pot	12 (31.6%)	2 (3%)
Open drum	7 (18.4%)	20 (29%)
Availability of Stored Water in Household		
Yes	30 (78.9%)	66 (93%)
No	8 (21.1%)	5 (7.0%)
Type of Container used to Storage of Drinking Water		
Bucket	3 (4.2%)	10 (18%)
Jerican	14 (19.7%)	50 (69%)
Clay pot	50 (70.4%)	2 (3%)
Open drum	4 (5.6%)	10 (18%)

Source: Primary data

Person who fetches water

From the results in Table 4 above, 34.2% of the rural household respondents indicated that adult women fetched water and this was followed by male child (under 15 years of age) who constituted 31.6% response. In addition, female child (under 15 years of age) were also reported to be among the persons who fetched water as indicated by 26.3% response. On the other hand, majority of the people who fetched water in urban areas were adult women (47.9%), followed by adult men (18.3%) and also male children (18.3%) and lastly female children (15.5%).

Type of Transport Container Used to Collect Water

From the results in Table 4 above, indicates that the most common type of transport container used to collect water by rural households was plastic jerican (100%). On the other hand, 94.4% of the urban households also used jericans as the most common type of transport container used to collect water. It can be said that there were no significant differences in the type of transport container used to collect water both among rural and urban households.

Type of Storage Container Used to Store Water for Drinking

From the results in Table 4 above, half of the rural households (50%), stored their water for drinking in jericans, followed by 31.6% who stored in pots and open drum (18.4%). On the other hand, more urban households (69%) stored their water for drinking in jericans, followed by those who stored their drinking water in open drums (29%) and clay port (3%)

Availability of Drinking Water in the Household

The results in Table 4 above indicate that there were no differences in the availability of drinking water both among rural households and urban households. In both cases (rural and urban households) 94.7% of the respondents indicated that water for drinking was available. This can be attributed to the fact that water for drinking is a necessity for life.

Availability of Stored Water in Household

The results from Table 4 indicates that in both cases, there were availability of stored water, that is, 78.9% response for rural households and 93% for urban households. It can be said that in both cases households stored water in their households and this can also be attributed to the fact that water if a necessity in life.

Type of Container used to Storage of Drinking Water

Table 4 above, reveals that among rural households, 70.4% stored their water for drinking in ports, followed by 19.7% in jericans. For urban households, majority stored their water for drinking in jericans (69%) and 18% stored in buckets and another 18% stored in open drums**.**

Table 5: Regression Analysis Showing the Relationship between Various Water Handling Practices and Quality of Water

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.830	.813		3.482	.001
	Person who fetches water	-.157	.120	-.231	-1.306	.201
	Type of storage container used to store water for drinking	-.042	.098	-.072	-.427	.672
	Presence of stored water in the household	.119	.751	.031	.159	.875
	Presence of water for drinking in the household	.601	.551	.289	1.091	.283
	Container for water for drinking covered	-.598	.583	-.273	-1.026	.313

a. Dependent Variable: Number of CFU/100ml in drinking water source

For this particular analysis, regression analysis was run against number of CFU/100ml in drinking water source, which in the context of this study was one of the variables for water quality. All variables were significant, although there were differences in the level of significance, for example, the Person who fetches water (sign value = 0.201), was more significant, followed by Presence of water for drinking in the household (sign value = 0.283), container for water for drinking covered (sign value = 0.313), type of storage container used to store water for drinking (sign value = 0.672) and lastly Presence of stored water in the household (sign value = 0.875).

Verification of hypotheses:

Rejected hypotheses: There is no relationship between Various Water Handling Practices and Quality of Water

Accepted hypotheses: There is a relationship between Various Water Handling Practices and Quality of Water

4.4 Hygiene and sanitation practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola district

Table 6: Hygiene and Sanitation Practices (Summation o f Rural HH=38, Urban HH =71)

Number	Rural Households	Urban households
Container for water for drinking covered		
Yes	31 (81.6%)	64 (90.1%)
No	7 (18.4%)	7 (9.9%)
Frequency of cleaning drinking water storage container		
At least daily	0	4 (5.6%)
Half weekly	13 (34.2%)	28 (39.4%)
Weekly	14 (36.8%)	23 (32.4%)
More than once a week	8 (21.1%)	7 (9.9%)
More than a week	3 (7.9%)	0
Not done at all		9 (12.7%)
Means of scooping water from the drinking water storage container		

Dips in a cup	32 (84.2%)	57 (80.3%)
Pour it out	6 (15.8%)	10 (14.1%)
Dips in a ladle (has a handle)	0	2 (2.8%)
Others	0	2 (2.8%)

Source: Primary data

The question of whether container for water for drinking is covered

From Table 18 above, both rural households and urban households covered their water for drinking as indicated by 81.6% and 90.1% respectively.

Frequency of cleaning drinking water storage container

Table 19 above revealed that a good number of rural households (34.2%) indicated that they cleaned their drinking water storage containers while 36.8% cleaned weekly. In addition, 21.1% pointed out that they cleaned their containers for storage of drinking water more than once a week. On the other hand, 39.4% of the urban households cleaned their water storage containers half weekly, 32.4% cleaned the containers weekly and only 9.9% said to clean the water containers for drinking water more than once a week. Only 5.6% cleaned the water storage containers at least daily.

Means of scooping water from the drinking water storage container

From table 20 above, the most common means of scooping water from the drinking water storage container among the rural households in Nakasongola district was by dipping in a cup (84%) and the same was for the urban households (80.3%).

Table 7: More Hygiene and Sanitation Practices

Number	Rural Households	Urban households
Cleaning of Cup used to scoop water from storage container for drinking water		
Yes	38 (100%)	60 (84.5%)
No		11 (15.5%)
Total	**38**	**71**
Frequency of cleaning drinking cup	**Rural Households**	**Urban households**
At least daily	20 (52.6%)	53 (74.6%)
Half weekly	8 (21.1%)	6 (8.5%)
Weekly	10 (26.3%)	5 (7.0%)
Not done at all		7 (9.9%)
Total	**38**	**71**
Frequency of cleaning drinking cup	**Rural Households**	**Urban households**
Yes	08 (21%)	50 (70.4%)
No	30 (79%)	21 (29.6%)
Treatment of water to make it safe		
Filter through a cloth	10 (26.3%)	6 (8.5%)
Boil	19 (50%)	39 (54.9%)
Let it sand and settle	1 (2.6%)	1 (1.4%)
Nothing is done	8 (21.1%)	22 (31.0%)
Add bleach/chlorine		3 (4.2%)

Source: Primary data

Cleaning of Cup used to scoop water from storage container for drinking water

According to Table 7 above, all rural households (100%) indicated that they cleaned their cups used to scoop water from storage container for drinking water. On the other hand, 84.5% of the urban households also indicated to have cleaned their cups scoop water from storage container for drinking water.

Frequency of cleaning drinking cup

The results in Table 7 above, indicates that more than half of the rural households (52.6%) said to have cleaned drinking cup at least on daily basis, followed by 26.3% who cleaned their drinking cups weekly. In addition, 21.1% cleaned their cups for drinking water half weekly. On the other hand, in among urban households, 74.6% cleaned their cups for drinking water at least daily.

Treatment of water to make it safe

From the results in Table 7 above, there were low levels of treatment of water in rural areas as indicated by 79% of the households who did not treat water. For the case of urban households (70.4%) of them treated their water and in an interview with some urban households boiling was the major source of water treatment to make it safe.

Things Done to Make Water Safer to Drink

The results in Table 7 above, indicates that boiling of water was the major method of making water clean (50% for rural households and 54.9% for urban households). For many households (21.1% among rural households and 31% among urban households) nothing was done.

Table 8: Hygiene and Sanitation Practices

Number	**Rural Households**	**Urban households**
Always	24 (63.2%)	40 (56.3%)
Sometimes	4 (10.5%)	9 (12.7%)
Never	10 (26.3%)	22 (31.0%)
Number	**Rural Households**	**Urban households**
Yes	1 (2.6%)	43 (60.6%)
No	37 (97.4%)	28 (39.4%)
Number	**Rural Households**	**Urban households**
Yes	1 (2.6%)	34 (47.9%)
No	37 (97.4%)	37 (52.1%)
Number	**Rural Households**	**Urban households**
Available	1 (2.6%)	17 (23.9%)
Not available	37 (97.4%)	54 (76.1%)
Number	**Rural Households**	**Urban households**
Traditional pit latrine	24 (63.2%)	48 (67.6%)
VIP latrine	4 (10.5%)	12 (16.9%)
Bush	10 (26.3%)	8 (11.3%)
Ecosan toilet		1 (1.4%)
Flush toilet		2 (2.8%)

Frequency of Treating Drinking Water

From Table 8 above, majority of rural households frequently treated drinking water, although many more (26.3%) did not treat water for drinking. Among the urban households, 56.3% always treated their water for drinking and 31% did not treat the water.

Washing hands after visiting the toilet

The focus on hand washing was due to the fact that frequent hand-washing is one of the best ways to avoid getting sick and spreading illness. From the results in Table 8 above, there were low levels of hand washing after the toilet among the rural households as indicated by 97.4%. Hand washing was high among urban households (60.6%) although 39.4% did not wash their hands.

Wash hands with soap after visiting a toilet

From the results in Table 8 above, majority of the households in the rural areas did not wash their hands with soap (97.4% response). On the other hand, 47.9% of rural households washed their hands after visiting a toilet and 52.1% did not wash. Nevertheless, the level of hand washing was higher among urban households as compared to their rural counterparts.

Availability of Soap for Hand washing near the toilet

The study further indicated that there was lack of soap for washing hands among the rural households (97.4% response) as evidenced by Table 8. On the other hand, 23% of the urban households had soap and 76.1% had no soap for washing their hands. The level of soap usage during hand washing was also higher among urban households as compared to their rural counterparts.

Type of Toilet Facility

As evidenced by Table 8 above, in rural households, most respondents (63.2%) had traditional pit latrines while a good number (26.3%) still went to the bush and only 10.5% had VIP. For the case of urban households, 67.6% had traditional pit latrines, 16.9% had VIP latrines, 11.3% found their way in the bush, 2% had flush toilets and 1.4% used Ecosan toilets.

Table 9: Regression Analysis showing the relationship between hygiene and sanitation practices and the quality of drinking water from the point of collection to the point of use in Nakasongola district

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.365	1.062		3.168	.004
	Frequency of cleaning drinking water storage container	.029	.061	.101	.483	.633
	Means of scooping water from the drinking water storage container	-.297	.218	-.280	-1.365	.183
	Frequency of cleaning drinking cup	-.005	.082	-.010	-.056	.956
	Treatment of water to make it safer to drink at home	-.556	.575	-.584	-.966	.342
	Frequency of treating water for drinking	-.190	.233	-.271	-.816	.421
	Soap and water for hand washing near the toilet	-.121	.425	-.050	-.286	.777
	Type of toilet facility present	.012	.043	.054	.279	.782

a. Dependent Variable: Cases of diarrhoeal diseases

The use of a regression analysis was due to the fact that it is a statistical tool for the investigation of relationships between variables. Usually, the investigator seeks to ascertain the causal effect of one variable upon another and for this case, all variables were significant, i.e., could contribute to water quality. The most significant was the means of scooping water from the drinking water storage container (sign value = 0.183), treatment of water to make it safer to drink at home (sign value = 0.342), frequency of treating water for drinking (sign value = 0.421), frequency of cleaning drinking water storage container (sign value = 0.633), soap and water for hand washing near the toilet (sign value = 0.777), type of toilet facility present (sign value = 0.782) and lastly type of toilet facility present (sign value = 0.782).

Verification of hypotheses

Rejected hypotheses: There is no relationship between hygiene and sanitation practices and the quality of drinking water from the point of collection to the point of use in Nakasongola district

Accepted hypotheses: There is a relationship between hygiene and sanitation practices and the quality of drinking water from the point of collection to the point of use in Nakasongola district

CHAPTER FIVE

DISCUSSION/INTERPRETATION OF RESULTS

5.0 Introduction

This chapter deals with the discussion of results and is also structured in accordance with the objectives of the study, that is, to identify the most common points where faecal contamination of drinking water takes place, to assess water handling practices affecting the quality of drinking water from the point of collection to the point of use in and to assess hygiene and sanitation practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola District.

5.1 The most common points where faecal contamination of drinking water takes place in Nakasongola District

Through laboratory investigations, observation and administration of questionnaires, it was found out that there were a number of possible sources of man-made contaminants, some of which are more important than others. These fall into the categories of point and diffuse sources. Discharges from runoff from agricultural land and from hard surfaces, such as roads, are not so obvious, or easily controlled. Such sources were found to give rise to a significant to nearby water sources such as unprotected sources. Majority of the households (76%) indicated that a water source was the most common point where faecal contamination of drinking water takes place in Nakasongola District.

According to information obtained from the District Health Officer, drinking water was at risk of contamination at the source because there is a high risk that faeces and chemical deposits from nearby locations can get into the drinking water source. He pointed out that some of these contaminants include animal or human wastes on ground level, water leaking out from landfills, road salts, septic systems and industry; solvents that can end in the water stream from chemical spills in nearby locations; and pesticides that are left in the ground and that with the help of rain will end up in the water stream.

Most borehole water was said to be contaminated most at storage (48%), transportation (29%), drinking (14%) and lastly at source. However, borehole water was found to be safer for drinking than lake water. It is therefore, evident that a borehole is one of the simplest and most reliable water sources for communities in Nakasongola District and since the water comes from underground, it is safer than lake or river water. This is supported by Gilman et al. (1985) who points out that observational study indicated that mean coliform levels were substantially higher in household water containers than in water sources.

The respondents indicated that broken pipes was the major source of contamination of piped water. In an interview with the District Health Officer, it was pointed out that broken pipes can be caused by many different things. Sometimes they break just because they are old, but more typically, they have cracked or been jarred loose by vibrations in the house. Remodeling work might be one reason why pipes finally break, but even a steady stream of trucks traveling down the street can shake loose pipes or create a fracture in a toilet tank. Basing on these results, we can concur with Swerdlow et al. (1992) who during the cholera epidemic in Peru, sampled water from municipal taps and from stored household water from these taps and noted a thousand fold increase in mean faecal coliform counts.

Within Nakasongola Town Council, poorly sited latrines and septic tanks were a significant source of contamination, especially of valley tanks. Local industries (UGA PLY) also gave rise to contamination of water sources, particularly when chemicals are handled and disposed of without proper care. This was more common on water in valley dams and valley tanks. For piped water, it was reported that if treatment was not optimized, unwanted residues of chemicals used in water treatment could also cause contamination, and give rise to sediments in water pipes. However, areas of feacal contamination were cited in broken pipes. The respondents were asked to rank the most common points where faecal contamination of drinking water takes place in Nakasongola District and the following results were obtained.

Looking at E.coli or Escherichia coli although, most strains of these bacteria are harmless; several are known to produce toxins that can cause diarrhea. However, a good number of the rural households (55.3%) had CFU/100ml in IQR 1-10, followed 42.1% in stored drinking water. For the case of urban households, 43.7% had it in IQR 1-10 and 23.9% in IQR >50 while 25.4% had zero (0) CFU/100ml in drinking water source. This is supported by van Zilj (1966); VanDerslice & Briscoe (1995) who pointed out that the risk of microbiological contamination of drinking water during collection and storage in the home has long been recognized.

The results further indicated that among the rural households, 47.4% of them had CFU/100ml in IQR 1-10 in the container used for transporting water to the household, followed by 21.1% in IQR 11-50 and 17.6% had zero (0) CFU/100ml while only 13% in IQR >50. Among urban households, 40.8% had CFU/100ml in IQR 1-10 in the container used for transporting water to the household; followed by 29.6% in IQR > 50 and 18.3% had zero CFU/100ml while 11.3% in IQR 11-50.

A good number of rural households (42.1%) had CFU/100ml in IQR 1-10 in stored drinking water, followed by 34.2% who had zero CFU/100ml in stored drinking water. On the other hand, 50.7% of urban households had CFU/100ml in IQR 1-10 in stored drinking water and 25.4% in IQR 11-50 and another 22.5% in IQR >50.

A good number of rural households (42.1%) had CFU/100ml in IQR 1-10 in treated water found in the household at the time of visit, followed by 34.2% who had 0 CFU/100ml. 15.8% were in IQR >50. On the other hand, 50.7% of the urban households had CFU/100ml in IQR 1-10 their treated water found in the household at the time of visit, followed by 25.4% in IQR 11-50.

The above results are in line with the views of Han et al (1989) who in Myanmar identified toxigenic E coli in two of 40 water samples from household storage vessels but in none of 20 samples collected on the same day from the water sources. Furthermore, Khairy et al. (1982) in Egypt isolated two parasitic pathogens, Strongyloides and Ascaris from 10% to 15% of water samples collected from earthenware household storage vessels but no pathogens were identified in source water samples. These studies indicated that contamination with pathogens as well as indicator organisms occurs during household water storage.

5.2 Water handling practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola district

Among the rural households, the highest number of respondents who fetched water for the household was adult women. In addition, female children (under 15 years) were also reported to be among the persons who fetched water as indicated by 26.3% response. On the other hand, majority of the people who fetched water in urban areas were adult women (47.9%), followed by adult men (18.3%) and also male children (18.3%) and lastly female children (15.5%).

The most common type of transport container used to collect water by rural households was plastic jerican (100%). On the other hand, 94.4% of the urban households also used jericans as the most common type of transport container used to collect water. It can be said that there were no significant differences in the type of transport container used to collect water both among rural and urban households.

Half of the rural households (50%), stored their water for drinking in jericans, followed by 31.6% who stored in pots and open drum (18.4%). On the other hand, more urban households (69%) stored their water for drinking in jericans, followed by those who stored their drinking water in open drums (29%) and clay pots (3%)

However, there were no differences in the availability of drinking water both among rural and urban households. In both cases (rural and urban households) 94.7% of the respondents indicated that water for drinking was available. This can be attributed to the fact that water for drinking is a necessity for life.

In both cases, there were availability of stored water, that is, 78.8% responses for rural households and 93% for urban households. It can be said that in both cases households stored water in their households and this can also be attributed to the fact that water if a necessity in life.

Among rural households, 70.4% stored their water for drinking in pots, followed by 19.7% in jericans. For urban households, majority stored their water for drinking in jericans (69%) and 18% stored in buckets and another 18% stored in open drums**.** However, Tuttle et al. (1995) in Zambia, reported that stored water was more likely to be dipped out in patients' homes and more likely to be poured in homes of healthy neighbours, suggesting that hands and objects introduced into stored water were a source of contamination. In this study, healthy subjects often stored their water in a narrow mouthed plastic vessel used to sell vegetable oil, whereas infected patients were more likely to use an open bucket into which hands could be inserted.

For this particular analysis, regression analysis was run against CFU/100ml of water sample from drinking water source, which in the context of this study was one of the variables for water quality. All variables were significant, although there were differences in the level of significance, for example, the Person who fetches water (sign value = 0.201), was more significant, followed by Presence of water for drinking in the household (sign value = 0.283), container for water for drinking covered (sign value = 0.313), type of storage container used to store water for drinking (sign value = 0.672) and lastly presence of stored water in the household (sign value = 0.875). These findings are supported by Mintz *et al. (*1995) who pointed out that field investigations have identified certain practices and vessel characteristics that are associated with the contamination of household water or the disease resulting there from, such as using large-mouth vessels to collect and store water, transferring water from collection vessels to storage vessels; Lindskog & Lindskog (1987), and accessing water by dipping hand-held utensils rather than via a tap or by pouring {Hammad & Dirar (1982); Swerdlow *et al. (*1997)}.

5.3 Hygiene and sanitation practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola district

Both rural households and urban households covered their water for drinking as indicated by 81.6% and 90.1% respectively. A good number of rural households (34.2%) indicated that they cleaned their water while 36.8% cleaned weekly. In addition, 21.1% pointed out that they cleaned their container for storage water more than once a week. On the other hand, 39.4% of the urban households cleaned their water storage containers half weekly, 32.4% cleaned the containers weekly and only 9.9% said to clean the water containers for drinking water more than once a week. Only 5.6% cleaned the water containers at least daily.

The most common means of scooping water from the drinking water storage container among the rural households in Nakasongola District was by dipping in a cup (84%) and the same was for the urban households (80.3%).

All rural households (100%) indicated that they cleaned their cups used to scoop water from storage container for drinking water. On the other hand, 84.5% of the urban households also indicated to have cleaned their cups scoop water from storage container for drinking water.

More than half of the rural households (52.6%) said to have cleaned drinking cup at least on daily basis, followed by 26.3% who cleaned their drinking cups weekly. In addition, 21.1% cleaned their cups for drinking water half weekly. On the other hand, in among urban households, 74.6% cleaned their cups for drinking water at least daily.

In addition, there were low levels of treatment of water in rural areas as indicated by 79% of the households who did not treat water. For the case of urban households (70.4%) of them treated their water and in an interview with some urban households boiling was the major source of water treatment to make it safe.

The results indicated that boiling of water was the major method of making water clean (50% for rural households and 54.9% for urban households). For many households (21.1% among rural households and 31% among urban households) nothing was done.

Although many observations suggest that treating water in a home can prevent illness. Empirical studies in the past two decades include Swerdlow et al. (1992); Weber et al. (1994) and Blake et al. (1993) demonstrated that persons whose families boil drinking water at home were at lower risk of cholera specifically and diarrhoea in general, many more rural households (26.3%) did not treat water for drinking. Among the urban households, 56.3% always treated their water for drinking and 31% did not treat the water.

The focus on hand washing was due to the fact that frequent hand-washing is one of the best ways to avoid getting sick and spreading illness. From the results of the study, there were low levels of hand washing after the toilet among the rural households as indicated by 97.4%. Hand washing was high among urban households (60.6%) although 39.4% did not wash their hands and in the context of this study, this was dangerous to human health and Wright et al. (2004); Schmidt et al. (2009); Oswald et al. (2007); Baltazar et al. (1993); Emerson et al. (1996) and Cairncross et al. (1996) reported that dirty hands may contaminate water not only through handling during collection and transportation but also when handling drinking vessels or scooping drinking water from storage vessels

Although scholars like Fewtrell et al. (2005) observed that hygiene interventions that promote hand washing with soap show the highest reduction in diarrhoea (45%), majority of the households in the rural areas in Nakasongola District did not wash their hands with soap (97.4% responses). On the other hand, 47.9% of rural households washed their hands after visiting a toilet and 52.1% did not wash. Nevertheless, the level of hand washing was higher among urban households as compared to their rural counterparts.

The study further indicated that there was lack of soap for washing hands among the rural households (97.4% responses). On the other hand, 23% of the urban households had soap and 76.1% had no soap for washing their hands. The level of soap usage during hand washing was also higher among urban households as compared to their rural counterparts.

Among the rural households, most respondents (63.2%) had traditional pit latrines while a good number (26.3%) still went to the bush and only 10.5% had VIP. For the case of urban households, 67.6% had traditional pit latrines, 16.9% had VIP latrines, 11.3% found their way in the bush, 2% had flush toilets and 1.4% used Ecosan toilets.

The use of a regression analysis was due to the fact that it is a statistical tool for the investigation of relationships between variables. Usually, the investigator seeks to ascertain the causal effect of one variable upon another and for this case, all variables were significant, i.e., could contribute to water quality. The most significant was the means of scooping water from the drinking water storage container (sign value = 0.183), treatment of water to make it safer to drink at home (sign value = 0.342), frequency of treating water for drinking (sign value = 0.421), frequency of cleaning drinking water storage container (sign value = 0.633), soap and water for hand washing near the toilet (sign value = .777), type of toilet facility present (sign value = 0.782) and lastly type of toilet facility present (sign value = 0.782).

CHAPTER SIX

RECOMMENDATIONS AND CONCLUSIONS

6.0 Introduction

This chapter lays down the recommendation and conclusions relating to the research study conducted in Nakasongola District.

6.1 Recommendations

Based on the results of the research, the following recommendations were made;

It is recommended that all water from various sources be treated in order to lender it safer to drink. In addition, drinking water quality guidelines and standards should be emphasized by the Government/ District to organizations or institutions engaged in the provision of water supply to the communities to ensure provision of clean and safe water for human consumption, thereby protecting human health. These should be based on scientifically assessed acceptable levels of toxicity to either humans or aquatic organisms.

There is need for the District Authorities to conduct regular water quality surveillance to all water sources currently used by the local communities for drinking so that the communities are advised in case the water sources are found to be of poor quality.

All water supply programs at community level should focus more on sanitation practices at the point of consumption.

Local communities must be sensitized about the importance of home based treatment of drinking water; hand washing and why they should use soap in hand washing. Hand washing should be routine and basic that it is often taken for granted.

6.2 Conclusions

The purpose of the study was to locate specific points where contamination of drinking water occurs in the process from the point of collection to the point of use in Nakasongola District. The objectives of this study was to identify the most common points where faecal contamination of drinking water takes place, to assess water handling practices affecting the quality of drinking water from the point of collection to the point of use and to assess hygiene and sanitation practices affecting the quality of drinking water from the point of collection to the point of use in Nakasongola District.

From the results of the study, majority of the households indicated that lake or river water becomes faecally contaminated in Nakasongola District at the source. However, borehole water was found to be safer for drinking than lake or river water. It is therefore, evident that a borehole is one of the simplest and most reliable water sources for communities in Nakasongola District and since the water comes from underground, it is more safer that lake or river water.

The water handling practices were unsatisfactory, for example, the most common type of transport container used to collect water by rural households was plastic jerican (100%). In addition, there were low levels of treatment of water in rural areas as indicated by 79% of the households who did not treat water. For the case of urban households (70.4%) of them treated their water and in an interview with some urban households boiling was the major source of water treatment to make it safe. The results indicated that boiling of water was the major method of making water safe to drink (50% for rural households and 54.9% for urban households). For many households (21.1% among rural households and 31% among urban households) nothing was done. It is therefore important that local communities must be sensitized about the importance of home based treatment of drinking water; hand washing and why they should use soap in hand washing. Hand washing should be routine and basic that it is often taken for granted.

APPENDICES

APPENDIX 1: REFERENCE

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APPENDIX 2: QUESTIONNAIRES

Serial number of interviewee---------------------Date--

Household information

A RESEARCH IS BEING CONDUCTED TO ASSESS THE QUALITY OF DRINKING WATER AT SOURCE AND POINT OF CONSUMPTION IN NAKASONGOLA DISTICT, UGANDA.

Demographic and housing characteristics/factors

A1. How many people sleep in this household?

a) 2-3 [ ] b) 4-5 [ ] c) 6- 7 [ ] d) 8- 9 [ ] e) 10+ [ ]

A2. Among the people who sleep here, how many are children under 5 years old?

a) 1 [ ] b) 2 [ ] c) 3 [ ] d) 4 [ ] e) 5+ [ ]

A3.What is the highest level of education that you reached?

a) None [ ] b) Primary [ ] c) Secondary [ ] d) Tertiary institution [ ] e) University [ ]

A4.What is the type of floor of your main house?

a) Natural soil floor [ ] b) Earth rammed floor [ ] c) Concrete floor [ ] d) Cement screed floor [ ]

A5. Do you own domestic animals? Name the animals raised.

a) Yes [ ] b) No [ ] …………………………………………………………………….

B. Most common points where faecal contamination of drinking water

Practical work for the researcher

B. Collect microbiological samples from all drinking water sources and of stored drinking water at all households participating in the study and code the samples in such a way that the results of water source samples can be linked to the results of the samples at the corresponding households and transport to the District Health Departmental Laboratory for biological testing. Upon analysis of the samples, answer Qns. B1 and B2).

B1. How many colony forming units present in 100ml of source water sample?

a) 0 [ ] b) 1-10 [ ] c) 11-50 [ ] d) >50 [ ]

B2. How many colony forming units present in 100ml of stored drinking water sample?

a) 0 [ ] b) 1-10 [ ] c) 11-50 [ ] d) >50 [ ]

B3. Has any member of this household had diarrhoeal disease (Dysentery, Cholera, and Diarrhoea) in the last three months?

a) Yes [ ] b) No [ ]

C. Water handling practices

C1.What is the main source of drinking water for members of your household?

a) Borehole/shallow well [ ] b) Protected spring [ ] c) Valley tank/unprotected spring [ ] d) Piped water system [ ] e) River/Swamp/Lake [ ] f) Rain water [ ]

C2.How long does it take to go there, get water and come back?

a) No. of minutes [ ] b) Water on premises [ ] c) Don't know [ ]

C3. Who usually goes to this source to fetch water for your household?

a) Adult woman [ ] b) Adult man [ ] c) Female child (under 15 years) [ ] d) Male child (under 15 years) [ ] e) Don't know [ ]

C4.What type of container do you use to transport water from the source to your household?

a) Bucket [ ] b) Jerican [ ] c) Clay pot [ ] d) Source pan [ ] e) Water cistern [ ]

f) Open drum [ ]

C5.What type of container do you use for storage drinking water in your household?

a) Bucket [ ] b) Jerican [ ] c) Clay pot [ ] d) Source pan [ ] e) Water cistern [ ]

f) Open drum [ ]

C6. Do you have any water stored in your household?

a) Yes [ ] b) No [ ]

C7. Do you have water for drinking in your household right now?

a) Yes [ ] b) No [ ]

C8. If yes, to B7, Is the container where water for drinking is kept covered?

a) Yes [ ] b) No [ ]

C9. How often do you clean the container used for storage water for drinking?

a) At least daily [ ] b) Half weekly [ ] c) Weekly [ ] d) Not done at all [ ]

e) More than once a week [ ] f) After two weeks [ ]

C10. How do you scoop water from the container used for storing water for drinking?

a) Dips in a ladle (has handle) [ ] b) Turns a faucet [ ] c) Dips in a cup [ ]

d) Pours it out [ ] e) Other [ ]

C11. Does the cup used for scooping water from the container clean?

a) Yes [ ] b) No [ ]

C12. If yes to B11, how often do you clean the cup?

a) At least daily [ ] b) Half weekly [ ] c) Weekly [ ] d) Not done at all [ ]

C13. Do you treat your water in any way to make it safer to drink?

a) Yes [ ] b) No [ ] c) Don’t know [ ]

C14. What do you usually do to make water safer to drink?

a) Add bleach/Chlorine [ ] b) Filter through a cloth [ ] c) Boil [ ]

d) Use a water filter (ceramic, sand, composite) [ ] e) Solar disinfection [ ]

f) Let it stand and settle [ ] g) Nothing is done [ ]

C15. How often do you treat your water for drinking?

a) Always [ ] b) Sometimes [ ] c) Never [ ]

C16. In your opinion, where do you think faecal contamination of drinking water takes place?

a) At the water source [ ] b) During transport from the source [ ] c) During storage in the home [ ] d) In the drinking cup [ ]

D. Hygiene and Sanitation

D1. Do you always wash your hands after visiting the toilet?

a) Yes [ ] b) No [ ]

D2. Do you wash your hands with soap after visiting the toilet?

a) Yes [ ] b) No [ ]

D3. Ask to observe if soap and water for hand washing are near the toilet

a) Available [ ] b) Not available [ ] c) Not allowed to observe [ ]

D4. What kind of toilet facility do members of this household usually use?

a) Traditional/Conventional [ ] b) Sanplat/VIP [ ] c) Ecosan [ ] d) Flush Toilet [ ] e) Do not have [ ] f) Bush [ ]

APPENDIX 3: LULUURI TRANSLATED QUESTIONNAIRE

Enamba ya mubuli………………………………Ebirobyakwezi…………………………………

Okuswaganirya kukoleibwe okusobola okwetejja obusai bwa yamaizzi aganywebwa wegasyomebwa amwei nejegazwira okunywebwa omubyalo no mutawuni omumaggomboloola okwerugurya e disiturikiti ya Nakasongola omu Uganda

ENGEERI NE BITURO BYABANTU

A1. Abantu baingai abababasya omu ekka jinni

a) 2-3 [ ] b) 4-5 [ ] c) 6-7 [ ] d) 8-9 [ ] e) 10+ [ ]

A2. Omubantu abarara ‘ni abaana baingai nga bali ansi wamyaka etanu?

a) 1 [ ] b) 2 [ ] c) 3 [ ] d) 4 [ ] e) 5+ [ ]

A3. Wakangire mucyakameka omukusoma kwamu

a) Tinayegereku [ ] b) Primary [ ] c) Secondary [ ] d) Tertiary institution [ ] e) University [ ]

A4. Ansi omunyumba yamu wakwisana watyai

a) Wakwisana nkawabulicya [ ] b) Wagwaye [ ] c) Waaliwo enkokoto [ ] d) Waseminti [ ]

A5. Olinawo ebisolo byakumugwa……………………………………………..

a) Ye [ ] b) Be [ ]

ENSISIKARA YAMAIZI

B3. Omu ekka jinni waariwo omwei eyalwaire ekiddukano omumyezi esaatu emabega

a) Ye [ ] b) Be

ENKWATA YAMAIZE EKA

C1. Amaizi gakunywa omu ekka jinni mugaiyai

a) Kunaikonto [ ] b) Kwizuba lwansulo ezomboke [ ] c) Kukidiba oba onkusulo ezigarara [ ] d) Gamudumu [ ] e) Kumugera, mumugera oba kunyanja [ ] f) Gaikendi

C2. Kikutwara ibangaki okwaba okusyoma 'maizi nokwira

a) Kisera kidoli [ ] Amaizi gali kulubuga [ ] c) Timaite [ ]

C3. Nani asyoma amaizi omu ekka jinni

a) Isemaka [ ] b) Nyabweze [ ] c) Baala abaali ansi wamyaka ikumi naitanu [ ] d) Bojjo abaali ansi wamyaka ikumi naitanu [ ] e) Timaite [ ]

C4. Okolesya ki okusyoma amaizi gakunywa okuluga wemugaya

a) Baketi [ ] b) Kidomola [ ] c)Nsuwa [ ] d) Sepiki [ ] e) Katanka kamayizi [ ] f) Pipa [ ]

C5. Kiki cokolesya okubikamu amaizi gakunywa'ni ewamu

a) Baketi [ ] b) Kidomola [ ] c)Nsuwa [ ] d) Sepiki [ ] e) Katanka kamaizi [ ] f) Pipa [ ]

C6. Olinawo amaizi gobikire omunyumba jinni

a) Ye [ ] b) Be [ ]

C7. Olinawo'kumaizi gakunywa ani omunyumba yamu

a) Ye [ ] b) Be [ ]

C8. Nicaaba nga kitufu okukibulyo B7, omukintu cyobikamu amaizi gakunywa okiswekaku

a) Ye [ ] b) Be [ ]

C9. Omala ibangaki okunabya ekintu ecyo cobikiramu amaizi gakunywa

a) Wakiri bulilunaku [ ] b) Emirundi ebiri nekitundu omusabiiti [ ] c) Buli sabiiti [ ] d) Ndowo gonze omulundi ogumwei [ ] e) Nyakalyamu omulundi gumwei omusabiiti [ ] f) Nsinjaku esabiiti [ ]

C10. Ngeriki gyosenamu amaizi omukintu ecyo cobikiramu amayizi gakunywa

a) Nyibukamumbe lwendo oluliku obukwatiro [ ] b) Nsindabula tap [ ] c) Nyibukamumbe kikopo [ ] d) Ngaitululambe mukikopo [ ] e) Cekatakire nicyo nkolesya [ ]

C11. Ekikopo ekikolesebwa okusena'maizi gakunywa mwogabika kikwera

a) Ye [ ] b) Be [ ]

C12. Nicaaba nga kitufu omu B11, omala ibangaki okunabya ekikopo kini

a) Wakiri bulilunaku [ ] b) Kitundu cyasabiiti [ ] c) Buli sabiiti [ ] d) Tikinabibwa nakadyoli [ ]

C13. Amaizi gamu agakunywa olina engeri gyogatambamu okusobola oganywa

a) Ye [ ] b) Be [ ] c) Timaite [ ]

C14. Bulincya okolotyai okulinda'amaizi gamu agakunywa okuba nga ogwanywa

a) Ngatamu omubazi [ ] b) Ngasengeiza nga nkolesya olugoye [ ] c) Ngasumbambe d) Ngasengeizesya musenyu [ ] e) Nganikira muisana [ ] f) Ngalekambe negateka [ ] g) Ndowo kikolebwa [ ]

C15. Omala ibangaki okutamu okusairya amaizi gamu agakunywa

a) Ntera [ ] b) Ebiro ebimwei [ ] c) Tingasairya [ ]

C16. Omundowooza jamu, olowooza obi ayingirirai omaizi gakunywa

a) Kwizuuba [ ] b) Mukugaleta ekka [ ] c) Mumbikka yago ekka [ ] d) Mukikopo ekinywerwamu [ ]

D. OBUKUNI

D1. Onaba omungalo nga ozwire omucyoloni

a) Ye [ ] b) Be [ ]

D2. Onaba omungalo nosabuni nga ozwire omucyoloni

a) Ye [ ] b) Be [ ]

D3. Nakwenderye okumanya oba osabuni namaize birampi nekyoloni

a) Bilowo [ ] b) Tebilowo [ ] c) Tikikwikirizibwa kwaba ampi nacyoloni [ ]

D4. Kikaki cyacyoloni a Bantu beka jinni cyebakolesya

a) Enyomboka ejikaire [ ] b) Cyoloni ekiluku epaipo [ ] c) EcoSan [ ] d) Yamaizi [ ]

e) Tindina [ ] e) Twaba mukisiko [ ]

APPENDIX 4: CONSENT FORM

Study Title: Assessing the quality of drinking water at source and point of consumption in Nakasongola District.

Principal Investigator

Zziwa Moses, MPH Officer, Uganda Christian University –Mukono

Telephone: +256- 772466468

Email: moseszziwa66@yahoo.com

Introduction

The purpose of the study is to determine whether poor household water handling and hygiene practices are not associated with faecal contamination of drinking water in Nakasongola District.

I anticipate each questionnaire interview will take 20 minutes to complete. I will ask the questions and record your responses. When complete, your anonymous questionnaire will be inserted in an envelope and stored in a locked box to protect your identity. Data collection will be completed by 30th June 2012, and it will take me until August to compile my report.

Study Procedure

The study as a whole will utilize a questionnaire where I will conduct interviews and record your responses. I will also take samples of water at the source where you collect water for drinking, transport vessels, storage vessels and from the cup used for drinking.

Benefits

The benefit of the study will be to inform policy makers both at the District and Sub County/ Town Council on how to plan for water supply and hygiene education sessions and you will get to know how to improve and maintain the quality of your drinking water. The study will also help those people most affected by water quality problems to evaluate and change the situation.

Risks

I will be using codes. No other personal identifiers will be kept.

Rights to Refusal or Withdraw

I do not anticipate that the questions will be difficult to answer, but some may cause you to think about situations in your household that are distressing and may cause emotional discomfort. You may refuse to answer any question and may withdraw from the study at any time.

Confidentiality

Paper data will be kept in a locked room or file cabinet. Electronic data will be kept in password protected hard drives. Access will be by me and Uganda Christian University- Mukono.

……

Participant Consent Form

I have read the information sheet for participants for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study at any time, or to decline to answer any particular questions in the study. I agree to provide information to the researcher under the conditions of confidentiality set out on the information sheet.

I agree to participate in this study under the conditions set out in the information sheet form.

Signature……………………………………………………………………………………..

Name:…………………………………………………………………………………….

Date ………………………………………………………………………………………..

Researcher's Name and contact information:……………………………………………………

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Supervisor's Name and contact information………………………………………………………..

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APPENDIX 5: LOCATION OF NAKASONGOLA DISTRICT ON THE MAP OF UGANDA

APPENDIX 6: LOCATIONS OF THE STUDY AREAS ON THE MAP OF NAKASONGOLA DISTRICT