DECLARATION

This dissertation is my original work and has not been presented for a degree in any other University

..... 20/9/2010

SELLINA AYOMA ONYANGO DATE

This dissertation has been submitted for examination with our approval as University supervisors

..... 20/9/2010

PROF. E.G. KARURI DATE

..... 20/9/2010

DR. P.B. GATHURA DATE

DEDICATION

This Dissertation is dedicated to:

My beloved father Dr. Walter Habil Onyango, my dear mother Mrs. Joyce Zighe Onyango and my siblings; Martha, Patrick and Elsie.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to Almighty God for the gifts of life, friendship and provision.

My deepest gratitude to my supervisors Prof. E.G. Karuri, Dr. J.K. Sehmi, and Dr. P.B. Gathura for their continuous guidance throughout the study as well as for the interest they showed in the project.

I am deeply indebted to Mr. H.F. Kaburia, Mr. J.K. Macharia, and Mr. K.A. Marimba for the technical help offered to me during my field work and laboratory work. Also my special thanks to Mr. Wimbia for one of a kind assistance with the project work.

My special thanks go to Mr. J. Mugo and Mr. K. Onyango for assistance in aspects of computer work and data analysis.

I extend my sincere gratitude to Dr. A. Mwangi and Prof. W. Kogi-Makau for the favorable learning atmosphere at the Applied Human Nutrition Unit.

The help offered to me by the Chairman of the Department of Public Health, Pharmacology, and Toxicology Prof. W. Ogara is highly appreciated.

I would like to extend my heartfelt gratitude to all my close friends especially Mr. A. Okello, Mr. J. Kariuki, Mr. R. Otieno, and Ms. B. Njoroge for the encouragement and support during my studies.

Last but not least, I am deeply indebted to my parents Dr. and Mrs. Walter Onyango for the generous funding without which this study would not have been possible. I am also grateful to my siblings Martha, Patrick and Elsie for their steadfast support.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

AI:	Adequate Intake
DRI:	Dietary Reference Intake
FAO:	Food and Agriculture Organization
GoK:	Government of Kenya
HIV/AIDS:	Human Immune-Deficiency Virus/Acquired Immune-Deficiency Virus
HR/hr:	Hour
IOM:	Institute of Medicine
ISO:	International Organization for Standardization
JMP:	Joint Monitoring Programme
KEBS:	Kenya Bureau of Standards
KIHBS:	Kenya Integrated Household Business Survey
L:	Litre(s)
MAC:	Maximum Acceptable Concentration
MDG:	Millennium Development Goal
ml:	millilitre
MoEST:	Ministry of Education, Science and Technology
MoH:	Ministry of Health
MoW:	Ministry of Water
MPN:	Most Probable Number
MWI:	Ministry of Water and Irrigation
N/F:	Non-formal schools

NWC:	Nairobi Water Company
POU:	Point of Use
SPSS:	Statistical Package for Social Sciences
The Network:	The International Network to Promote Household Water Treatment and Safe Storage
UNDP:	United Nations Development Programme
UNICEF:	United Nations Children's Fund
WHO DRI:	World Health Organization - Dietary Recommended Intake
WHO:	World Health Organization
WSS:	Water and sanitation services

DEFINITION OF TERMS

Adequate Intake (AI): The recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate-used when a Recommended Dietary Allowance cannot be determined.

Culture: Patterns of human activity and the symbolic structures that give such activities significance and importance. Culture may be identified in terms of consumption and consumer goods, the general processes which produce such goods and give them meaning, as well as the social relationships and practices in which such objects and processes become embedded. This study will examine intake and handling practices of drinking water in relation to socio-economic class.

Handling practices: Treatment-, storage- and drinking- vessels and technology.

Non Formal Education: Any organized systematic learning activity outside the framework of the formal system which meets the learning needs of particular sub-groups of the population, being either children or adults.

Potable water: Water that is safe for drinking.

Sanitation: The hygienic means of preventing human contact from hazards of waste in order to promote health.

Water Contaminants: Harmful substances or organisms present in drinking water. Contaminants may be microbial, physical, biological, or chemical agents of disease.

Water treatment: The removal of contaminants to make water safe for consumption (drinking). Examples include chlorination, boiling, solar disinfection and filtration.

Water quality: The physical, chemical and biological characteristics of water. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to drinking water, safety of human contact and for the health of ecosystems.

ABSTRACT

The Government of Kenya, in the fight against water borne diseases, introduced a public health intervention in primary schools. The importance of water in the diet is taught to school children from ten years of age. The effectiveness of the intervention has not yet been assessed.

The study was carried out in Westlands Division of Nairobi urban area. The children were sampled from the private, public and non-formal schools; to represent the wealthy, middle class and poor socio-economic classes respectively. Multi-step random sampling method was used. Dietary intake, handling practices and water quality were investigated in a crossectional study using a structured questionnaires, 24hour recall forms, photographs, and laboratory analysis of microbiological water quality. Findings would be used to evaluate the intervention and for epidemiological risk assessments.

The collective mean intake was 0.54 L/day. Children from public schools consumed the highest amount (0.67 L/day); followed by those from non formal schools who consumed 0.58 L/day while those from private schools recorded the lowest intake of 0.39 L/day. The means were not significantly different ($p > 0.05$).

The boys consumed a higher mean amount (0.6L/day) than the girls (0.5 L/day). There was considerable variation between the intakes. The mean differences were not significant ($p > 0.05$).

Most of the water was from public taps (32.2%) and taps inside the house (32.2%). Other sources were bottled water (23%), borehole (5.3%) and vendor supplied water (1.4%). The differences were significant ($p < 0.05$).

Seventy two percent of children treated the water before drinking. Twenty seven percent of children did not treat their water either because it was bottled or they considered it 'ready to drink'. The children from public schools had the highest percentage of those who treated water. The differences were significant ($p < 0.05$). The most common treatment method was boiling (84.8%) followed by chemical methods (7.8%). Other methods were commercial filtering and dispensers. The differences were significant ($p < 0.05$).

Parents and family (50.2%) had the most influence on the quantity and quality of water the children drank, 45.9% attributed it to themselves, 2.5% to teachers and 1.4% to their friends. The differences were significant ($p < 0.05$).

CHAPTER ONE

INTRODUCTION

1.1: BACKGROUND INFORMATION

The United Nations (UN) has acknowledged that the main challenge to human survival is access to clean and safe water in sufficient quantities. The combination of safe drinking water and hygienic sanitation facilities is a precondition for health and for success in the fight against poverty, hunger, child deaths, and gender inequality. It is also central to the human rights and personal dignity of every woman, man, and child on earth.

Millennium Development Goal (MDG) 7, Target 10, calls for reduction by half the proportion of people without sustainable access to safe drinking water by 2015. Reaching this target implies tackling both the quantity (access) and quality (safety) dimensions to drinking water provision.

The UNDP (2006) report shows that more people die from water related diseases than in military conflicts around the world; and water borne diseases kill more children under five years of age worldwide than HIV/AIDS and malaria combined.

The WHO and UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation in its 2006 report titled *Meeting the MDG drinking target. Water and sanitation: the urban and rural challenge of the decade,* declared that Sub-Saharan Africa is the regional-area of greatest concern. It is a region of the world where, over the period 1990–2004, the number of people without access to drinking water increased by

23% and the number of people without sanitation increased by over 30%. Accordingly, more intensive, effective, and concerted action by all stakeholders is needed if the MDG drinking water and sanitation target is to be met in this region.

Point of use (POU) level interventions can make an immediate contribution to the safety component of this target, and would significantly contribute to meeting the MDGs in situations where access to water supplies is secure, but point of use water quality is not assured (WHO, 2007).

The Government of Kenya (GoK) through the Ministry of Water (MoW) National Water Services Strategy (2007-2015) states that the water and sanitation services (WSS) is poor for a majority of the country's people. Only approximately 57% of households countrywide use water from sources considered safe (KIHBS, 2005/2006). Sustainable access to safe water is 68% in urban settings and drops to as low as 20% in the settlements of the urban poor where half of the urban population lives. With a population growth of up to 10% in the low income urban settlements, many 'hot spots' continue to develop in many towns and therefore, sustainable access to safe water is declining. Sustainable access to safe water in the rural setting is estimated at 40% (GoK, 2007).

The sanitation coverage countrywide is estimated at 50%. Living conditions in the settlements of the urban poor are appalling due to the resulting unsanitary environment. Missing sanitary installations and uncontrolled disposal of excreta pollutes the water sources from which most of the informal providers draw water. Vendors sell water of uncontrolled quality to consumers who have to spend hours to fetch it at prices that are

often between 5 and 20 times the tariff applied on consumers with a metered water connection (GoK, 2007).

Since 1990, WHO and UNICEF have teamed up to track progress on global water and sanitation goals through the Joint Monitoring Programme (JMP) for Water Supply and Sanitation. In the JMP 2006 report, the Millennium Project Task Force on Water and Sanitation defined safe drinking water as *water that is safe to drink and is available in sufficient quantities for hygienic purposes.* This definition poses a challenge in monitoring terms. The terms 'safety' and 'quantity' requirements cannot easily be measured through the household surveys currently used by JMP as the basis for its estimates. Measuring safety requires not only physical, chemical, and microbial testing, but also sanitary inspection of drinking water sources.

To overcome these problems, JMP uses the classification 'improved' or 'unimproved' water sources. Improved drinking water sources are assumed more likely to provide safe drinking water than unimproved ones.

Not necessarily all people who have access to improved facilities or sources actually use them. To provide realistic estimates, JMP has therefore adopted *use* as the primary indicator for monitoring progress in both water and sanitation. Current JMP coverage estimates are expressed as a percentage of the population *using* improved drinking water sources (WHO/UNICEF, 2006).

1.2: STATEMENT OF THE PROBLEM

The importance of water in the diet is taught in the school syllabus to children 10 years of age. This topic addresses issues of dietary requirements and proper treatment and storage of drinking water (Kenya Institute of Education, 2002). The effectiveness of this intervention is unknown. This survey study was therefore carried out to determine estimates of daily intake, as well as handling practices, consumption patterns and quality of drinking water among children aged 10-12 years.

1.3: JUSTIFICATION OF THE STUDY

The JMP faces challenges in monitoring use of drinking water. Research shows that unhygienic handling of water during transport, or within the home can contaminate previously safe water. Those who have access to improved water sources, are in fact, exposed to contaminated water, and therefore at risk of water-borne diseases. Because of the numerous factors that influence use of water, WHO has adopted a participatory or 'bottoms-up' approach to monitoring utilization of drinking water. In Kenya, information on use of drinking water is limited.

1.4: OBJECTIVES OF THE STUDY

Overall objective:

To determine estimates of daily intake, as well as handling practices, consumption patterns and quality of drinking water among children aged 10-12 years in Westlands division, Nairobi, Kenya.

Specific Objectives:

1. To determine dietary intake of drinking water among the children
2. To determine point of use handling of drinking water by categories of children
3. To identify social networks that influence intake and handling practices of children
4. To analyze the microbiological quality of drinking water from at point of use in public school

1.5: BENEFITS OF THE STUDY

Findings obtained would be useful in evaluating the school syllabus. In addition, the results would be useful for monitoring utilization of drinking water, as well as for risk assessments in epidemiological studies.

1.6: LIMITATIONS OF THE STUDY

Dietary data for drinking water alone was collected and analyzed. Water from other fluids and food sources were not analyzed. This was due to the lack of information on water content of Kenyan foods and dishes.

This study does not seek to determine dietary adequacy of drinking water, rather to establish current intakes among respondents.

Water quality assessments were carried out for public schools only.

CHAPTER TWO

LITERATURE REVIEW

2.1: Introduction

'Many studies of water issues are preoccupied with identifying water-short countries. This neglects the many millions of people who do not have adequate water despite the fact that their countries do have adequate water supplies in the aggregate. Just as in the case of food, we should not rely so much on averages but should focus more on the plight of individuals.' (Kent, 2005)

Currently, access to safe drinking water is estimated by the percentage of the population using improved drinking water sources. Improved drinking water technologies are those more likely to provide safe drinking water than those characterized as unimproved. See Table 1.

Inadequate water supply facilities have made water storage a common practice in urban areas of Kenya. The microbiological quality of water stored in tanks depends on the original quality of water put in the tank. If the tank was not open to contamination, the stored water would purify itself of the harmful bacteria over time by natural processes (Watt, 1986). The possibility of pollution of water occurring between collection and use especially where public standpipes are used has long been recognized (Wagner and Lanoix, 1959).

TABLE 1: UNICEF/ WHO CLASSIFICATION OF WATER SOURCES

Improved water sources	Unimproved water sources
• household connection	• unprotected well
• public standpipe	• unprotected spring
• borehole	• rivers or ponds
• protected dug well	• vendor-provided water
• protected spring	• tanker truck water
• rainwater collection	• bottled water*

* Bottled water is not considered improved due to limitations in the potential quantity, not quality, of the water

Source: (UNICEF, WHO; 2004)

Risks of water contamination between collection and use are as a result of various reasons such as collection and storage of drinking water in open vessels which are not regularly cleaned, use of communal cups to draw water as well as touching water during collection, storage and use have been confirmed by Burgers *et al* (1988).

2.1: WATER BORNE DISEASES

Water-borne diseases are "dirty-water" diseases; mainly attributed to water that has been contaminated by human, animals, or chemical wastes. Worldwide, it has been shown that

water-borne diseases are responsible for over 12 million deaths a year. This is mainly due to poor sanitation facilities; and unsafe drinking, washing, and cooking water (Hinrichsen *et al*, 1998).

Water-borne diseases are among the most recent emerging and re-emerging infectious diseases throughout the world. The emerging and re-emerging infectious diseases have recently proven to be the biggest health threat worldwide and they contribute between 70-80% of health problems in developing countries.

The most well known water-borne diseases such as cholera, dysentery, and typhoid are the leading causes of morbidity and mortality. The causative agents of water-borne diseases may be bacterial, viral, and protozoal in nature, and this is true during both epidemic and endemic periods.

The burden of these diseases is most felt in almost all African countries, especially in the tropical areas of the region, including Kenya. The bulk of these have been reported from the other countries in the tropical rain forests, of Tanzania, Uganda, the Central African Republic, Rwanda, and Burundi (Chabalala and Mamo, 2001).

Infectious diseases caused by pathogenic bacteria, viruses, protozoa and helminthes are the most common and widespread health risk associated with drinking-water. For pathogens transmitted by the faecal–oral route, drinking-water is only one vehicle of transmission. Contamination of food, hands, utensils and clothing can also play a role, particularly when domestic sanitation and hygiene are poor. Improvements in the quality and availability of water, in excreta disposal and in general hygiene are all important in reducing faecal–oral disease transmission (WHO, 2006).

2.2: COMBATING WATER-BORNE DISEASES AT THE HOUSEHOLD LEVEL OR POINT OF USE

Combating waterborne diseases at the household level is the focus of the WHO through The International Network to Promote Household Water Treatment and Safe Storage (The Network).

The Network makes a case for managing water in the home: health can be compromised when harmful bacteria, viruses, and parasites contaminate drinking water either at the source, through seepage of contaminated run-off water, or within the piped distribution system.

Moreover, unhygienic handling of water during transport, or within the home can contaminate previously safe water. For these reasons, many of those who have access to improved water supplies, are in fact, exposed to contaminated water, and therefore at risk of water-borne diseases. The current recommended low cost technologies are chlorination, solar disinfection, filtration, combined flocculation/disinfection systems, boiling, and safe storage.

Water that is safe at point of collection is subject to contamination during collection, transportation, and use in the home mainly through unclean hands. Vessels with narrow mouths and taps can significantly reduce such contamination and reduce risk of water-borne disease. The WHO has projected that such point of use quality interventions could play a key role in reducing diarrhoeal disease morbidity by up to 70% (WHO, 2007).

2.3 WATER QUALITY (BACTERIOLOGICAL) EXAMINATION

Water quality examination is based on the determination of certain microorganisms. The most important parameter of drinking water quality is the bacteriological condition. Standards for bacteriological water quality are based on microorganisms that are non-pathogenic but their presence serves as indicators of contamination. The levels of certain intestinal indicator microorganisms are used to determine the degree of health risks which may result from consuming the contaminated water. In addition, they are used to monitor the effectiveness of water treatment in reducing microbiological numbers so that the risks are reduced to acceptable levels.

According to both international and Kenya Bureau of Standards (KEBS) guidelines, chlorinated, or otherwise disinfected and otherwise treated water supplies should not contain coliforms in any 100ml sample of water entering the distribution system and no faecal *E coli* in 100ml sample of water.

Table 2 shows the WHO guidelines for verification of microbial quality.

TABLE 2: WHO GUIDELINE VALUES FOR VERIFICATION OF MICROBIOLOGICAL QUALITY OF WATER

Organisms	Guideline value
All water directly intended for drinking *E coli* or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Treated water entering the distribution system *E coli* or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Treated water in the distribution system *E coli* or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample

(WHO 2006)

Contamination of drinking water by human or animal excrement or sewage is dangerous especially if among the population there are cases of carriers of infectious enteric diseases which are water borne.

The use of normal intestinal flora rather than the pathogens themselves is universally accepted for monitoring and assessing the bacteriological quality of water. The criteria to be satisfied by an ideal indicator cannot be met by any one microorganism. The criteria being that it should be present wherever pathogens are present; should occur in greater numbers than the pathogens; should be more resistant to disinfectants and to aqueous environments than the pathogens; and should grow readily on relatively simple media. However, many of these criteria are best fulfilled by *E coli*, and to lesser extent thermo-tolerant coliform bacteria. Thus *E coli* is the indicator used universally to assess bacteriological contamination of water.

2.3.1: *ESCHERICHIA COLI*

Escherichia coli (E coli) is found in large numbers in the faeces of humans and of nearly all warm blooded animals. It is found in sewage, effluent, all natural waters and soils subjected to recent faecal contamination. The presence of *E coli* in water indicates the need for immediate action.

2.3.2: COLIFORM GROUP

Coliforms have for a long time been recognized as suitable microbiological indicators of drinking water quality. Coliforms are defined as microorganisms which display β-

galactosidase activity (WHO, 1996). This group comprises *E coli*, *Citrobacter*, *Enterobacter* and *Klebsiella* species.

2.4: WATER IN THE DIET

Water can be considered the most important dietary constituent. A normal man or woman can live without food for 20 to 40 days, but without water, humans die in four to seven days. Over 60 percent of human body weight is made up of water, of which approximately 61 percent is intracellular and the rest extracellular (Howard and Bartram, 2003). Table 3 shows the normal body composition of a man weighing 65 kilograms (kg).

TABLE 3: A NORMAL CHEMICAL COMPOSITION OF A MAN WEIGHING 65 KG

Component	Kilograms	Per cent (%)
Water	40	61.6
Protein	11	17.0
Fat	9	13.8
Carbohydrate	1	1.5
Minerals	4	6.1

(Source: Passmore and Eastwood, 1986)

Water requirements are most effectively met by consumption of plain water or beverages that are more than 90% water by volume. Water may also be obtained from solid foods such as fruits and vegetables, which have high water content. Low moisture foods such as

grains and meat products do not contribute significantly to water intake (Grandean, 2007).

A minute amount of water is also produced in the body- about 350 to 400ml/d as a product of metabolism of carbohydrate, fat, and protein (Grandjean, 2005).

The minimum requirement for water is the amount that equals losses and prevents adverse effects of insufficient water (dehydration). The need for water in relation to body weight varies with age, sex, body weight, physiological status, physical activity and climatic environment.

The WHO estimated the following dietary requirements in its report "Domestic Water Quantity, Service Level and Health" (Howard and Bartram, 2003). In 2004, the Food and Nutrition Board established age and gender specific Adequate Intakes (AI) for water. Differences in gender standards are due to differences in body mass and activity levels. The Dietary Recommended Intakes (DRI) for water is shown in Tables 4 and 5

TABLE 4: DRI FOR BOYS AND GIRLS BIRTH TO EIGHT YEARS OF AGE

0 - 6 months	0.7 L/day of water, assumed to be from human milk.
7 – 12 months	0.8 L/day of water, assumed to be from human milk and complementary foods and beverages
1 - 3 years	1.3L/day
3 - 8 years	1.7 L/day

Source: WHO 2004

TABLE 5: DRI FOR AGES NINE AND OLDER

9 – 13 years	Boys	2.4 L/day
	Girls	2.1 L/day
14 - 18 years	Boys	3.3 L/day
	Girls	2.3 L/day
19 – 70+	Men	3.7 L/day
	Women	2.7 L/day

Source: WHO 2004

Loss of body water (dehydration) amounting to 10% of the body weight impairs work performance and is associated with nausea, weakness, delirium, and hyperthermia. Signs of dehydration include poor skin turgor, skin tenting on the forehead, decreased urine output, concentrated urine, sunken eyes, dry mucous membranes in the mouth and nose, orthostatic blood pressure changes and tachycardia. Water losses exceeding 20% of body weight are life threatening, and can lead to death if not treated in a timely manner.

The body's reaction to water levels comes from an area in the brain called the hypothalamus, which regulates thirst. Unfortunately, the hypothalamus does not signal the body that it is thirsty and needs more water until dehydration is well on its way.

Groups most vulnerable to dehydration are infants, elderly adults, and athletes, because they are either not able to adequately detect or express thirst sensations.

In rare cases, if a large amount of water is present in the body (for example in patients with compromised renal function), the ensuing increase in intracellular fluid volume can cause swelling of brain tissue, and can be fatal.

2.5: APPROACHES TO APPROXIMATING REQUIRED INTAKES

Controversy exists over the actual amount that is considered "adequate." Some authors argue that thirst is a sufficient indicator and regulator of water needs. Others argue that by the time the thirst sensation is felt, dehydration has already occurred, and therefore a daily-recommended amount ought to be specified.

Two approaches attempt to approximate water needs for the average, healthy individuals. The Institute of Medicine (IOM) outlines the following approaches:

- **Replacement approach:** The average urine output for adults is 1.5 liters a day. An additional liter of water a day is lost through breathing, sweating, and bowel movements. Food usually accounts for 20 percent of total fluid intake, so if one consumes 2 liters of water or other beverages a day (a little more than 8 cups) along with the normal diet; one will typically replace the lost fluids.
- **Dietary recommendations:** The Institute of Medicine (IOM) advises that men consume roughly 3.0 liters (about 13 cups) of total beverages a day and women consume 2.2 liters (about 9 cups) of total beverages a day.

In 1978, population-based estimates of total water and tap-water intake in women of reproductive age were derived using data from the 1977-78 United States Nationwide Food Consumption Survey. Three-day average intakes were calculated for 188 pregnant

women, 77 lactating women, and 6,201 non-pregnant, non-lactating control women. Total water intake and tap-water intakes were estimated. The results were fundamental in estimating amounts of nutrients and toxic substances that women of reproductive age obtain through the water supply.

Ershow and Cantor, (1989) analyzed data from the 1977-1978 Nationwide Food consumption Survey. They found that water consumed as plain drinking water averaged 31.4% of total intake. Beverages other than plain water provided 43.4% and food provided 255 of total water intake. The water content of the food portion of the diet varied widely.

In 1996, a pilot study on water consumption was carried out in the Québec City, Canada. Data was collected from 125 people using a 24-h recall plus a 2-day diary. Consumption of drinking water via liquid and food was assessed as well as the type of water consumed (tap, bottle or filtered water) and place of consumption (home or away from home). The pilot-study was weakened by a low participation rate (14%).

Global data on the consumption of drinking-water are limited. In studies carried out in Canada, the Netherlands, the United Kingdom and the USA, the average daily per capita consumption was usually found to be less than 2 litres, but there was considerable variation between individuals. As water intake will vary with climate, physical activity and culture, the above studies, which were conducted in temperate zones, can give only a limited view of consumption patterns throughout the world. At temperatures above 25°C,

for example, there is a sharp rise in fluid intake, largely to meet the demands of an increased sweat rate (Howard and Bartram, 2003).

2.6: DRINKING WATER QUALITY IN KENYA

Sang, *et al* (1983) noted that there was limited published information about the microbiological environmental pollution in Kenya. Muhammed and Morrison, (1975) sampled 24 open wells, seven rivers, four borehole and three springs in Kiambu District. Only one river was found to have portable water. All other waters were contaminated with faecal streptococci. They also isolated *Salmonella typhimurium* from one of the study rivers in the area.

In Nyanza Province, out of 67 community water sources sampled during wet and dry seasons, 35 (52.2%) had *Aeromonas* species (Muthotho *et al*, 1987). Further examination of these 35 samples showed that 26 (74.3%) had faecal coliforms.

A study by Waiyaki *et al*, (1985) of community water sources in Siaya, Kisumu and South Nyanza districts showed that large numbers of faecal *E coli* were present in many community water sources. They isolated enterotoxigenic *E coli* (E.T.E.C) from eight water sources which showed a high rate (24.2%) of E.T.E.C contamination. By the time of their surveys, cholera and other diarrhoeal diseases remained endemic in many parts of Kisumu District. Other microorganisms isolated in the same study included *Vibrio parahaemolyticus* and *Shigella dysenteriae* type 10.

Bacteriological analyses of 71 random water samples from boreholes around Nairobi City showed that 30 (42%) were contaminated with coliforms, and 18 (25%) had faecal coliforms (Kaba, 1990).

Khalid (1993) analyzed bacteriological contaminations of water samples from boreholes and domestic water tanks from five locations in Kiambu District. This study recorded total bacterial counts which ranged from 1 to 6280 colonies per ml of water, with 90% of the 70 water samples being positive for faecal coliforms.

CHAPTER THREE

MATERIALS AND METHODS

3.1: STUDY SETTING

Westlands division is one of the eight divisions that form Nairobi Province, the Capital city of Kenya. It is situated on the North West side of the province. Other divisions are Kasarani, Embakasi, Dagoretti, Madaraka, Langata, Starehe and Kamukunji. Westlands is an urban area with great discrepancies between the rich and the poor. It is home to some of the most affluent residential areas such as Lavington, State House, Kileleshwa, Loresho, Spring Valley, and Riverside Drive. On the other hand, several slums are located in Westlands division. These are Deep Sea, Suswa, Maasai Village, Tausi Village, Kibagare and Kangemi.

The middle class reside in Parklands, Highridge, Milimani and Kilimani

3.1.1: ADMINISTRATION

Westlands division is divided into six locations. These are Kitusuru, Kangemi, Kilimani, Kileleshwa, Parklands, and Highridge. The division is further divided into locations and sub-locations, which are headed by chiefs and assistant chiefs.

3.1.2: EDUCATION

The Nairobi City Council Education Department oversees all the schools in Westlands division. The department works in close liaison with the Ministry of Education in matters related to the implementation of the school's curriculum, education policies and evaluation. Schools in Westlands division are divided into two zones: Kilimani and

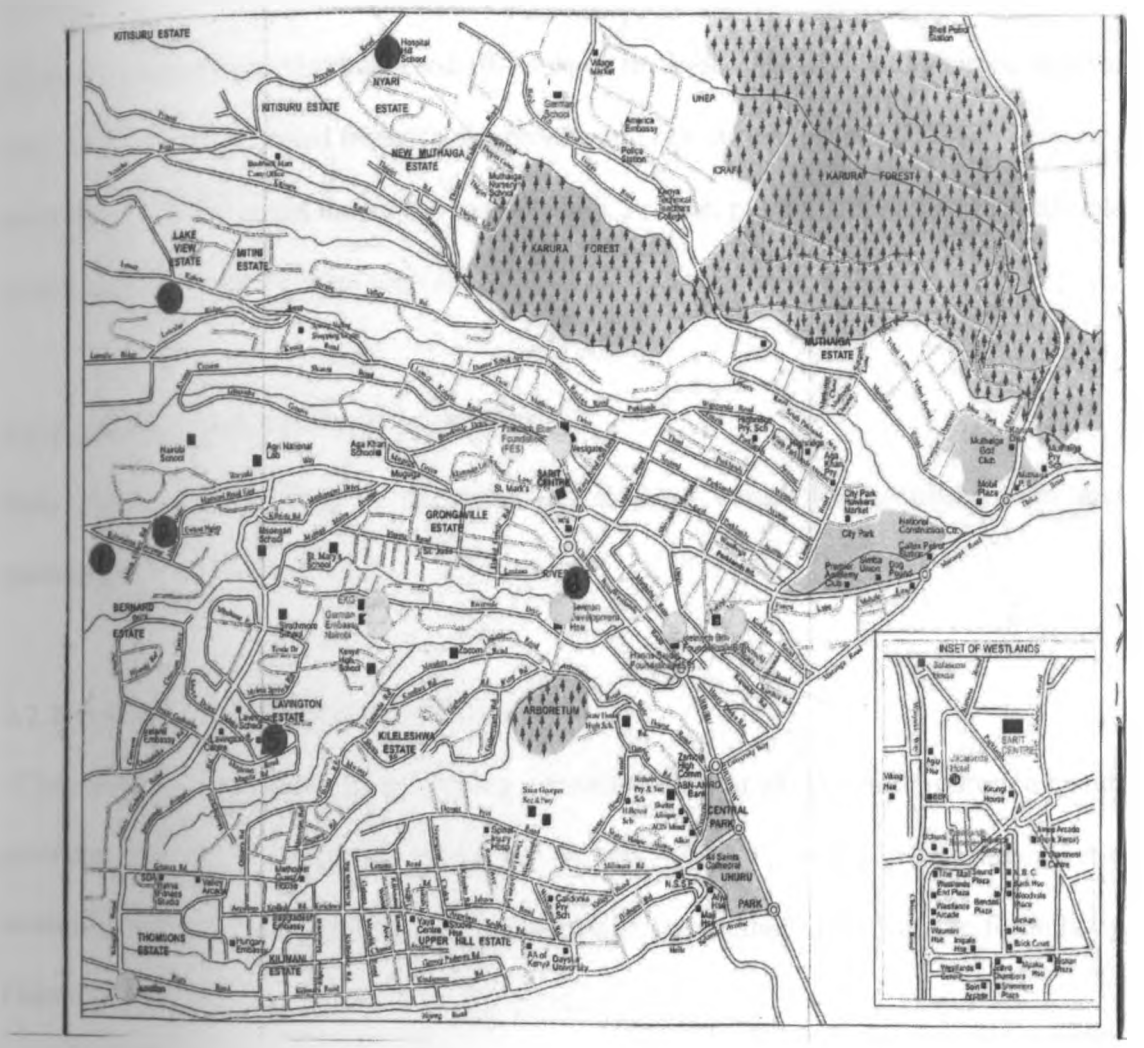
Parklands. There are three categories of schools in each zone: Private, Public, and Non-formal schools (Nairobi City Council, Education Department, 2003). Private schools are high cost; public schools have free tuition but most require parents to buy stationery, textbooks, uniforms, and sometimes furniture. Non-formal schools are typically located in slum areas, and cater for the children from low economic backgrounds. Table 6 shows number of schools in Westlands division as of 2003.

TABLE 6: NUMBER OF SCHOOLS IN WESTLANDS ADMINISTRATIVE ZONES

Division	Zone	# of Private schools	# of Public Schools	# of Non Formal schools
WESTLANDS	Kilimani	25	12	32
	Parklands	9	13	13
	Total	34	25	45

Source: Nairobi City Council, Education Department, 2003

A map of the study area is shown in Figure I.



Source: Tourist Maps Kenya, 2000

FIGURE I: MAP OF WESTLANDS AND LOCATION OF SCHOOLS

Key:

1 – Shekinah Glory School (Non Formal)

2 – Excel Primary school (Non Formal)

3 – Farasi Lane Primary (Public)

4 – Hospital Hill School (Public)

5 – St. Austin's Academy (Private)

6 – Consolata Academy (Private)

3.2: STUDY DESIGN

The study was a cross-sectional descriptive and analytic study on the daily intake and of drinking water among children aged 10-12 years in Westlands Division, Nairobi, Kenya. The children were selected from Public, private and non-formal schools.

Multistage sampling was employed in this study. Private, public, and non-formal schools were randomly selected from both zones.

3.2.1: DATA COLLECTION METHOD

Data was collected using a questionnaire, 24-hour recall forms, observation and photography.

3.2.2: SAMPLE SIZE DETERMINATION

'Close to half of all people in developing countries suffer at any given time from a health problem caused by water and sanitation deficits' (UNDP, 2006). There are several methods of determining sample size. In this study, the method used was the formula by Fisher *et al* (1991)

$n= (z^2pq)/ d^2$

Where:

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

z = the standard normal deviate, usually 2 which corresponds to the 95% confidence interval

p = the proportion of the targeted population estimated to have to have a particular characteristic. In this study p = 50%

$q = 1.0 - p$

d = degree of accuracy desired, usually set at .05

$$n = \frac{(2)^2 (.50) (.50)}{(.05)^2}$$

$n = 400$

Fisher *et al* further instructs that if N (the entire population) is less than 10,000, the required sample size is smaller. Therefore final sample estimate (n_f) is further calculated using the modified formula (Fisher *et al*, 1991)

$$n_f = \frac{n}{1 + (n/N)}$$

Where:
n_f = the desired sample size (when population is **less than** 10,000)

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

N = the estimate of the population size

$$n_f = \frac{400}{1 + (400/1000)}$$

$n_f = 284$

Proportionate sampling was used to obtain the sample from each category.

Figure I shows a flow diagram of the sampling procedure

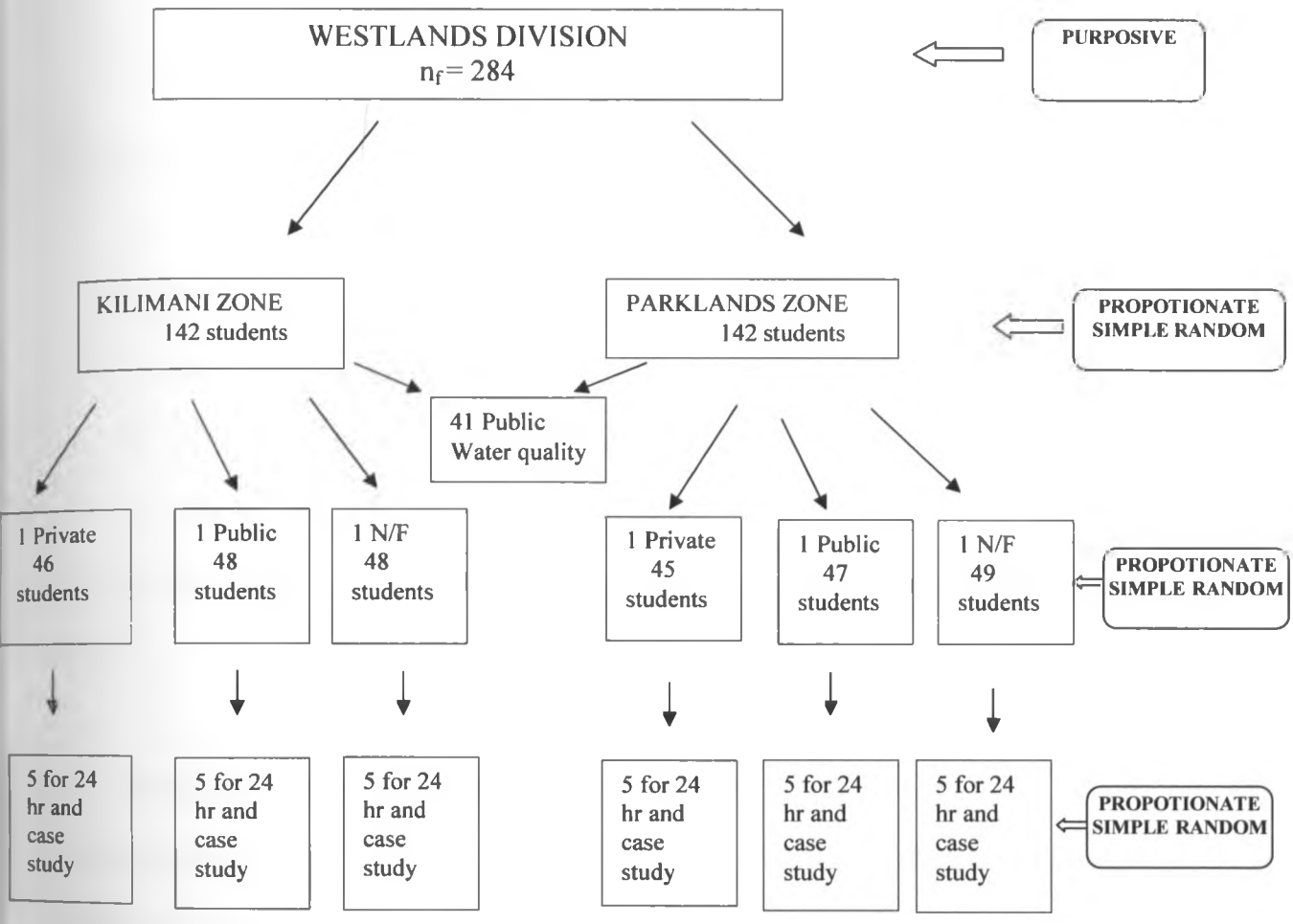


FIGURE II: FLOW DIAGRAM OF THE SAMPLING PROCEDURE

3.2.3: RECRUITMENT AND TRAINING OF PERSONNEL

The study involved three (3) guides to assist the researcher.

The guides were recruited on the basis of the following criteria:

- A resident or similar background as the respondents
- Have at least obtained the Kenya Certificate of Secondary Education (KCSE)

- Fluency in written and spoken English and Swahili and predominant language of respondents
- Sociable and outgoing personality
- Previous experience in data collection an added advantage

The guides underwent one-day training. The training curriculum contained:

- An overview of the study
- Study objectives
- Data collection techniques
- Ethics and conduct while in the field
- Briefing on allowances

The principal researcher conducted the training. Learning methods were lecture and role-play.

3.2.4: ETHICAL CONSIDERATIONS

Authorization to conduct the study was obtained from the Ministry of Higher Education, Science and Technology (MoHEST), Kenya. The administrators of the study site and the local provincial administration were also informed of the intended study prior to data collection. Respondents were interviewed only after their parents or guardians signed the Informed Consent Form. Those who did not want to be interviewed had their wishes respected. Confidentiality of the information collected was maintained.

3.2.5: DATA QUALITY ASSURANCE

The study questionnaire was pre-tested and appropriate modifications made. Data cleaning was done at the end of each day's work.

3.2.6: DATA MANAGEMENT

Categories under a particular variable were coded using numerical codes. Most of the coding was done during the questionnaire design stage (pre-coding). Some coding was done before data entry. Field editing, as well as machine editing was done to check for errors such as omissions, logistical inconsistencies, and improbabilities.

Data entry was carried out using Statistical Package for Social Sciences (SPSS). Data analysis was also carried out using SPSS software.

TABLE 7: LOG-FRAME

Narrative Summary	Objectively Verifiable indicators	Means of verification	Important assumptions
Goal			
To contribute towards monitoring the use of drinking water in Nairobi, Kenya	Research thesis		Staff and parental support for children to take part in study
Purpose			
To provide data on daily intake and quality of drinking water among children (10-12 years) in Westlands, Nairobi, Kenya	• Descriptive and inference statistics of water consumed • Descriptive statistics of various treatments, storage methods and vessels used • Descriptive and inference statistics of social networks that influence dietary adequacy and handling practices • Descriptive and inference statistics of microbiological water quality	• 24 hour recall forms • Questionnaires • Case study notes • Photographs • Laboratory results	• Children will be willing to participate and will secure signed consent forms from principle guardians • Children will accurately recall diet in preceding 24 hr period
Outputs			
• Dietary assessment • Current treatment, storage and drinking vessels and technology • Identification of social networks that influence dietary adequacy and handling practices • Microbiological water quality	Proportions, Means, standard deviations, percentages Correlation		
Activities	**Inputs**		
• 24 hour recall • Questionnaire interviews • Observation (case study) • Water quality	Budget for permits, personnel, transport, tools, stationary, printing & photocopying, communication, and contingency. **Total: KES. 45,043**	Completed forms questionnaires, photographs and case study notes	• Participation of children and consent from parents.

Table 8: Matrix for Data Processing/Analysis Plan

Sub-objective 1: Determine current level of water intake Q- How much drinking water do children consume? **Measurements:** Dietary assessment			
Variables	**Initial processing**	**Basic stat.**	**Advanced stat.**
Quantities (liters per day)	• Data entry and cleaning	• Frequencies • Means • standard deviation	• Chi-square • t-test
• **Sub-objective 2:** Description of various treatments, storage methods and vessels Q- How do children handle water at point of use? **Measurements:** Observation (Case study) and Photographs			
• Types of treatment • Storage methods • Vessels	• Data entry and cleaning	• Frequencies • Means • standard deviation	• Chi-square • t-test
Sub-objective 3: Identification of social networks that influence dietary adequacy and handling practices Q- What are the social networks that influence handling and dietary adequacy of the children? **Measurements:** Questionnaire			
	• Data entry and cleaning	• Frequencies • Means • standard deviation	• Chi-square • t-test
Sub-objective 4: To analyze the microbiological quality of drinking water at point of use Q- What is the microbiological quality of drinking water at point of use? **Measurements:** Total coliform count and Presence/Absence of *E coli*			
• Total coliform count • Presence/ Absence of *E coli*	• Data entry and cleaning	• Frequencies • Means • standard deviation	• Chi-square • t-test

3.3: WATER INTAKE

The dietary assessment was carried out using a 24 hour recall of a sub sample of 30 children. Fifteen males and fifteen females were randomly selected, ten from each social class. The 24 hour recall is a retrospective method whereby respondents have to think back what they ate or drank during the previous twenty four hour period.

Only intake of drinking water was analyzed in this study. The dietary data were recorded in common household units and converted to litres during data processing.

3.4: BACTERIOLOGICAL ANALYSIS OF WATER

Only coliforms and *E coli* were analyzed in this study. The bacteriological examination of water was carried out using the following standard techniques.

3.4.1: STERILIZATION OF GLASSWARE AND MEDIA

All glassware and media used in the study (sampling bottles, pipettes, petridishes, Durham tubes) were thoroughly washed with hot water containing detergent and rinsed with distilled water. They were then dried in a hot air oven at 100°C. Sodium thiosulphate was added (0.1ml, 3%) to each sample bottle and all the glassware were sterilized in a pressure cooker at 121°C for 15 minutes. All media used in the study were prepared and sterilized according to the manufacturers' recommendations (see Appendix II)

3.4.2: WATER SAMPLING

A total of 41 samples were collected from the same schools and the same watering points the children were drinking from. In these schools, samples were obtained from taps direct

from mainline systems, taps from storage reservoir tanks and from various containers. Five hundred millilitre bottles and stoppers were used. For samples from the distribution line and tanks, the tap was opened to allow water to flow for two minutes to clear the water that was within the piping system. The tap was turned off and sterilized using 70% alcohol and flaming with a blow lamp. The tap was regulated to allow a thin and gentle stream of water. The sample bottle was held from the bottom and filled with water to about quarter way and stored immediately. The sample bottle was clearly labelled and packed in an ice cooled container. For samples taken from storage containers without taps, the container was lifted and water poured into an open sample bottle without splashing. The stopper was immediately replaced; the bottle clearly labelled and packed in an ice –cooled container. All samples were transported into the laboratory and analysed within 3 to 6 hours of sampling.

3.5: TOTAL COLIFORM COUNT USING MULTIPLE TUBE TECHNIQUE

3.5.1: PRESUMPTIVE TEST

Double strength McConkey broth was used (Appendix A2.1). Fifty (50) ml of double strength broth was distributed into one universal bottle. In addition 10ml of the same broth was distributed into 5 universal bottles. Five (5) ml single strength broth was distributed into a set of five fermentation tubes. All the universal tubes and fermentation tubes were provided with inverted Durham tubes for collection of any gas formed. The broth was sterilized in a pressure cooker at 121°C for 15 minutes and then cooled.

Water samples were shaken several times to distribute the microorganisms, bottle stoppers removed and mouths flamed. Using a sterile pipette, 10 and 50 ml of the sample

was transferred into each of the 5 fermentation tubes containing 5ml single strength broth.

All the bottles and tubes were incubated at 37°C for 24 to 48 hours and observed for gas and acid production. The Most probable Number of coliforms was computed from McCrady's Statistical Tables.

3.5.2: CONFIRMATORY TEST USING SOLID MEDIUM

Eosin methylene blue agar (EMBA) was reconstituted, prepared and sterilized according to the manufacturer's recommendations (Appendix- A2.3). A 20ml amount of the molten agar was aseptically dispensed into sterile perti-dishes and cooled. The broth in the positive presumptive tubes (subsection 3.8.1) was mixed by rotating the tubes several times. Using a sterile wire loop, a small portion of the broth culture was removed from each of the tubes and streaked onto a plate of EMB agar. All the plates were incubated at 37°C for 24 hours. Appearance of deeply coloured nucleated colonies with or without metallic surface luster on the plates within the incubation period constituted a positive confirmatory test.

3.5.3: TEST FOR *ESCHERICHIA COLI*

Plates of EMB agar of the confirmed test (subsection 3.8.2) showing a metallic sheen were recultured on another EMBA plate, for further isolation. The streaked plates were incubated at 37°C for 24 hours. Colonies showing metallic sheen were tested for production of Indole, acid (Methyl red reactions), acetylmethycarbinal (Voges – Proskaurer test) and growth on Citrate media (IMViC) to confirm whether they were *E coli*.

A portion of the colony having a metallic sheen was incubated into a fermentation tube containing Tryptone water broth prepared as given in Appendix A 2.4. Two portions from the same colony were incubated into a tube containing Methyl red Vogues Proskaurer medium (MRVP), prepared as given in (Appendix A 2.5), and another portion into a universal bottle containing Simmon's citrate agar which was prepared as given in (Appendix A 2.6). All tubes were incubated at 37°C for 48 hours. After the incubation period, Indole reagent (Appendix A 2.7) was added to Tryptone water, MRVP and Creatinine (Appendix A 2.9) and Potassium hydroxide (Appendix A 2.10) to the other MRVP tube.

Presence of *E coli* microorganisms was indicated by the following reactions of IMViC test: Indole positive, Methyl red positive, VP negative and Citrate negative (IMViC + + - -). Confirmed *E coli* positive microorganisms were preserved in Nutrient agar (Appendix-A 2.11).

CHAPTER FOUR

RESULTS

The objectives of the study were to determine dietary adequacy of water among the children; to determine the contribution of drinking water to the Dietary Recommended Intake (DRI) for water among the children; to describe point of use (POU) handling of drinking water by categories of children; to identify social networks that influence intake and handling practices of children; and, to analyze the microbiological quality of water at the point of use.

4.1: INTAKE OF DRINKING WATER

The collective mean intake of drinking water was 0.54 L/day. Children from public schools consumed the highest amount (0.67 L/day); followed by those from non formal schools who consumed 0.58 L/day while those from private schools recorded the lowest intake of 0.39 L/day of drinking water. The means were not significantly different ($p > 0.05$). There was considerable variation between the intakes, as shown by the standard deviations. See table 9.

TABLE 9: DRINKING WATER INTAKE BY SCHOOL TYPE

School type	Mean (L/day)	N	Std. Deviation
Private	0.39	10	0.58
Public	0.67	10	0.24
Non formal	0.58	10	0.47

Figure III shows frequencies of water intake by school type.

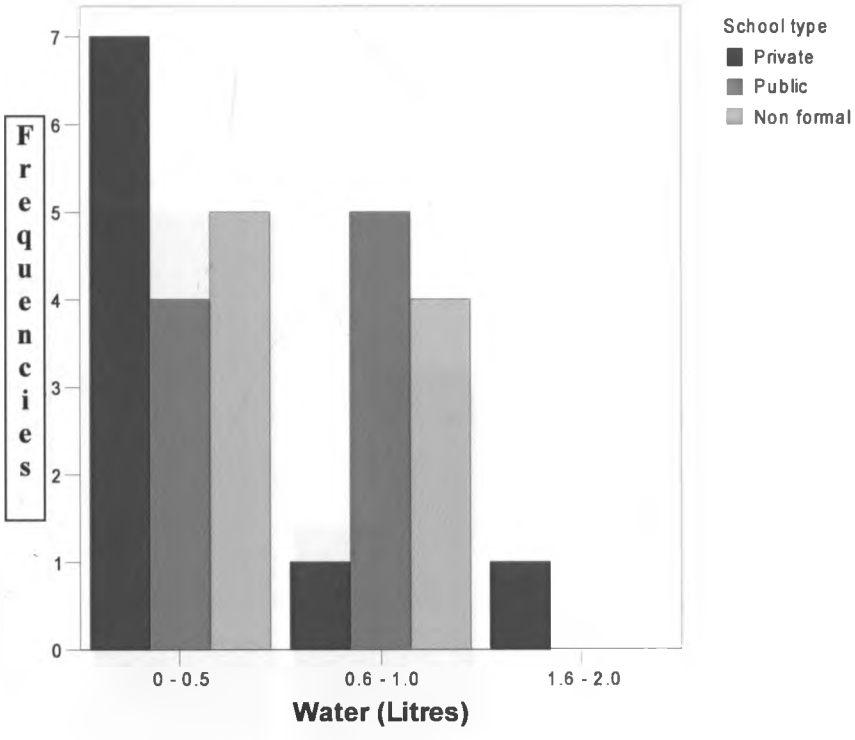


FIGURE III: FREQUENCIES OF WATER INTAKE BY SCHOOL TYPE

The boys consumed a higher mean amount of water (0.6L/day) than the girls (0.5 L/day). There was considerable variation between the intakes, as shown by the standard deviations. The differences were not significant ($p > 0.05$). See Table 10.

TABLE 10: DRINKING WATER INTAKE BY SEX

Sex	Mean (L/day)	N	Std. Deviation
Male	0.6	15	0.55
Female	0.5	15	0.34
Total	0.5	30	0.45

Figure IV shows frequencies of water intake by sex.

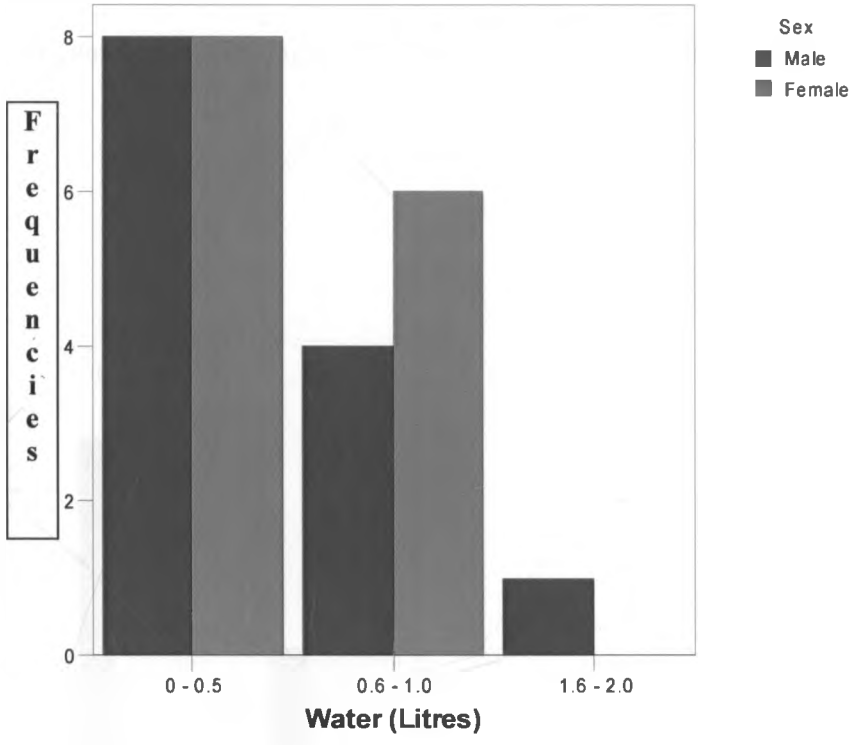


FIGURE IV: FREQUENCIES OF WATER INTAKE BY SEX

4.2: POINT OF USE (POU) HANDLING OF DRINKING WATER BY CHILDREN

Most of the water was from public taps (32.2%) and taps inside the house (32.2%) from the Nairobi Water Company main line. Other sources were bottled water (23%), borehole (5.3%) and vendor supplied water (1.4%). The differences of sources per school type were significant ($p < 0.05$). Figure V shows frequencies of water sources by school type.

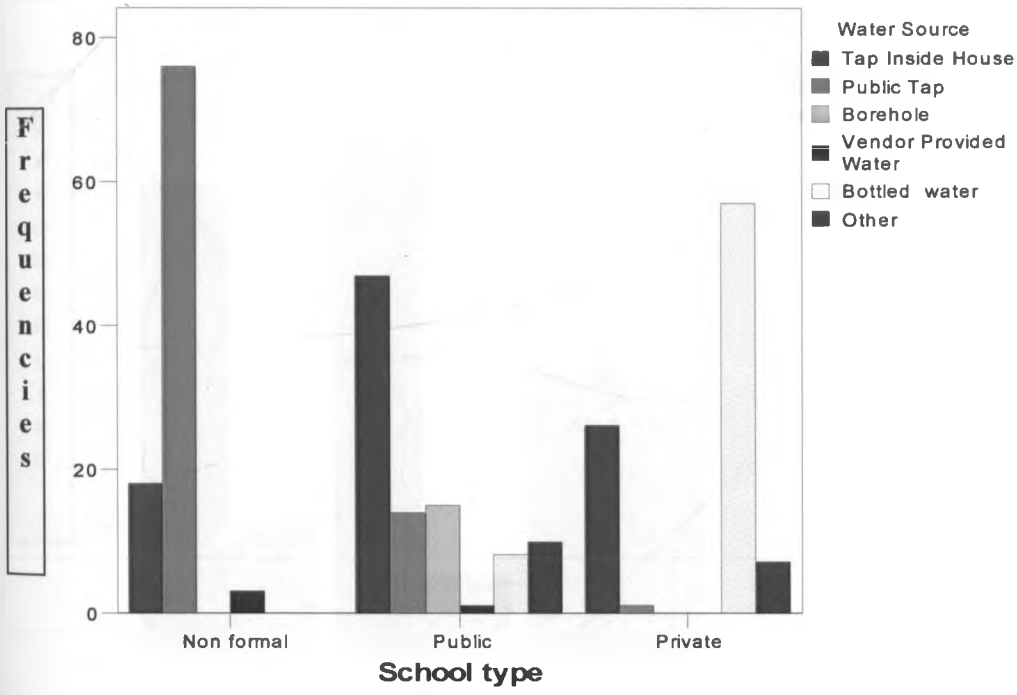


FIGURE V: FREQUENCIES OF WATER SOURCES BY SCHOOL TYPE

Seventy two percent of children treated the water before drinking. Twenty seven percent of children did not treat their water either because it was bottled or they considered it 'ready to drink'. The children from public schools had the highest percentage of those who treated water. The differences were significant ($p < 0.05$). Figure VI shows frequencies of treatment before use by school type.

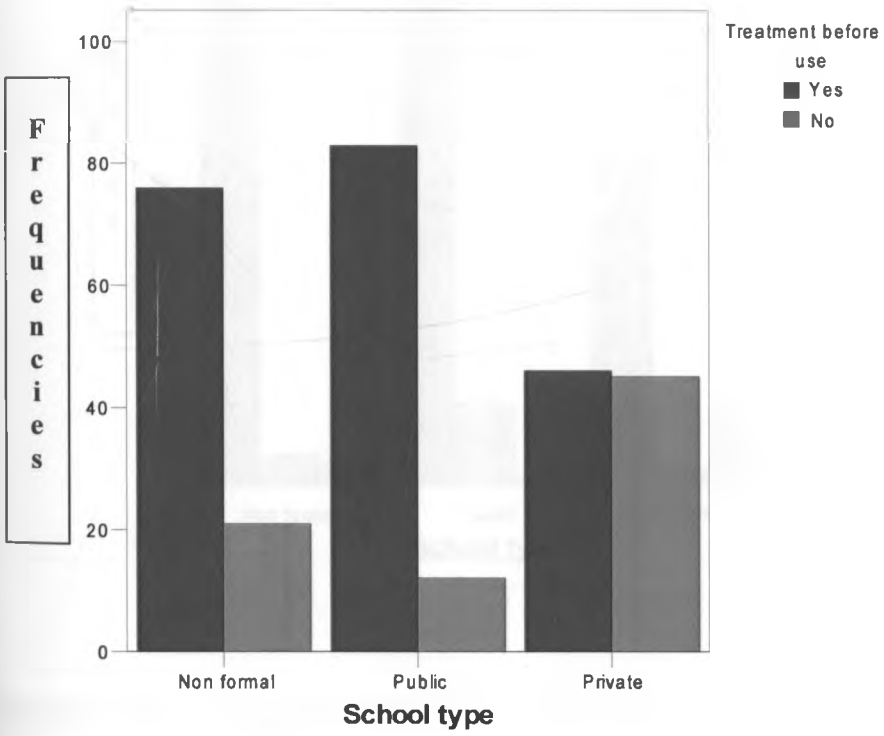


FIGURE VI: FREQUENCIES OF TREATMENT BEFORE USE BY SCHOOL TYPE

The most common treatment method was boiling (84.8%) followed by chemical methods (7.8%). Other methods were commercial filtering and dispensers. The differences were significant ($p < 0.05$). Figure VI shows frequencies of treatment methods used by school type.

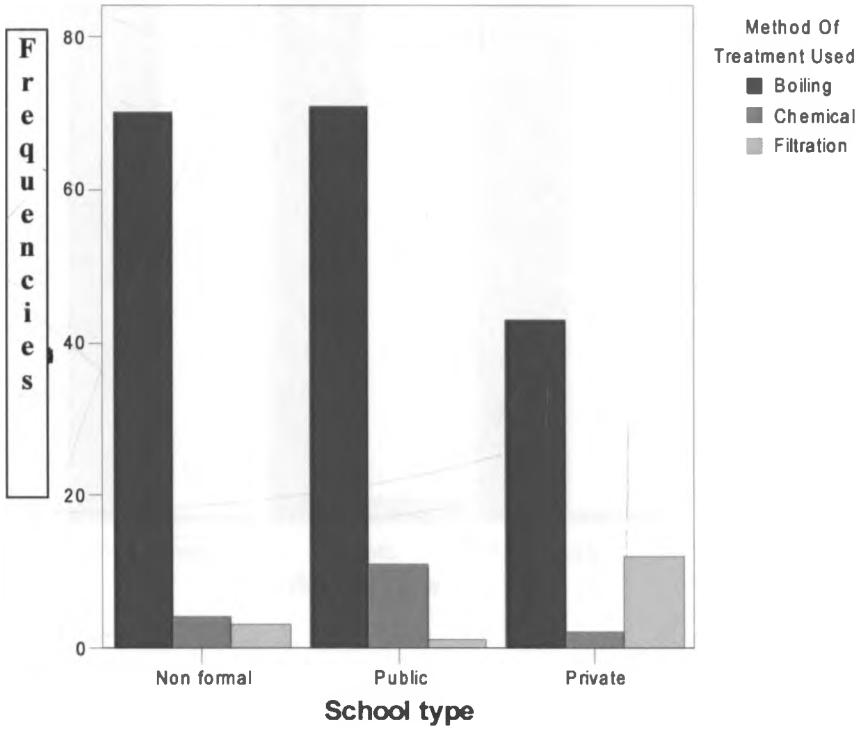


FIGURE VII: FREQUENCIES OF METHOD OF TREATMENT USED BY SCHOOL TYPE

Pertaining to storage methods, 97.5% stored water in covered containers. Only 2.5% did not as shown in Figure VIII. The differences were not significant ($p > 0.05$).

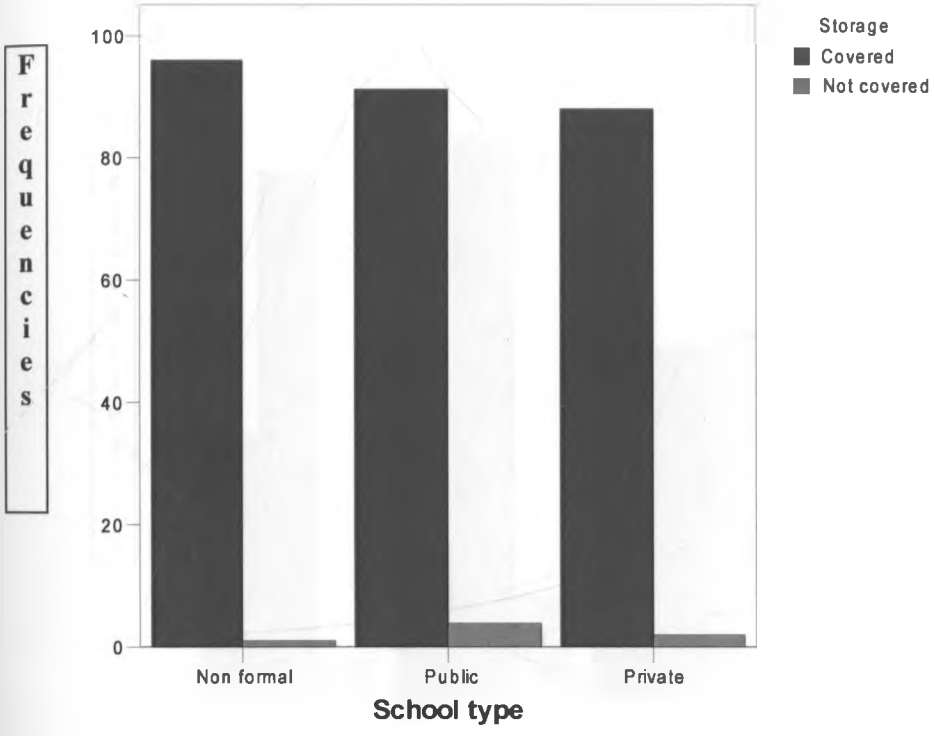


FIGURE VIII: FREQUENCIES OF COVERED STORAGE BY SCHOOL TYPE

Regarding methods of drawing water, 59.2% pour water into the container, 19.5% dip the container to scoop water, while the remaining 21.3% use taps from mainlines, reservoirs, filters, or dispensers as shown in Figure VIII. The differences were significant ($p < 0.05$).

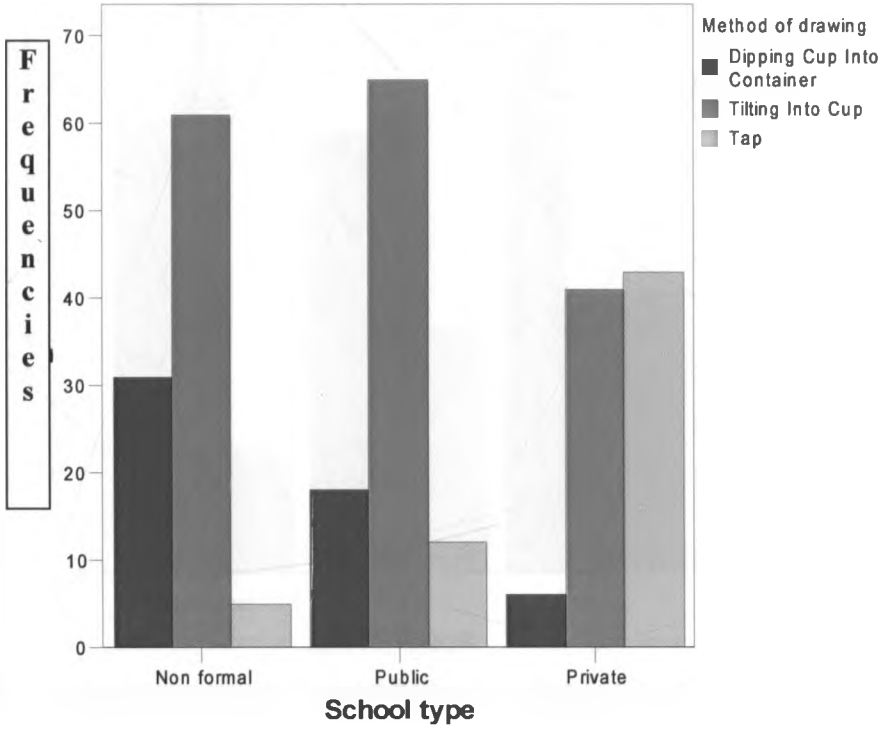


FIGURE IX: FREQUENCIES OF METHOD OF DRAWING BY SCHOOL TYPE

As concerns consumption patterns, majority (39.1%) drank water 'with meals', 42% of children drank water 'when thirsty', and 18.9% 'throughout the day', as shown in Figure X. The differences were significant ($p < 0.05$).

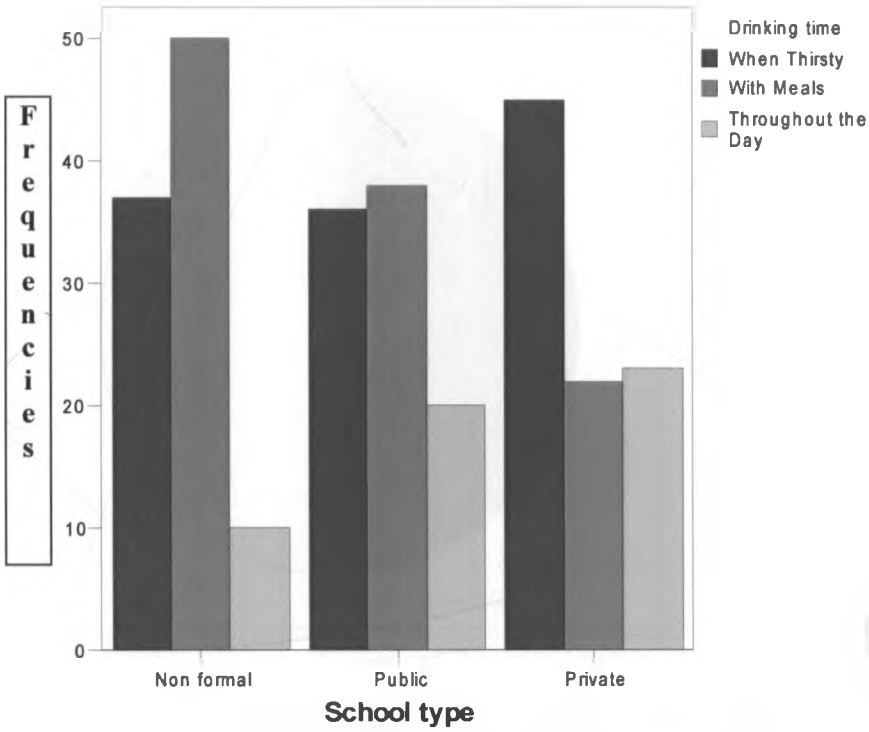


FIGURE X: FREQUENCIES OF DRINKING TIME BY SCHOOL TYPE

4.3: SOCIAL NETWORKS THAT INFLUENCE DIETARY INTAKE AND HANDLING PRACTICES OF CHILDREN

Parents and family (50.2%) had the most influence on the quantity and quality of water the children drank, 45.9% attributed it to themselves, 2.5% to teachers and 1.4% to their friends. See Figure XI. The differences were significant ($p < 0.05$).

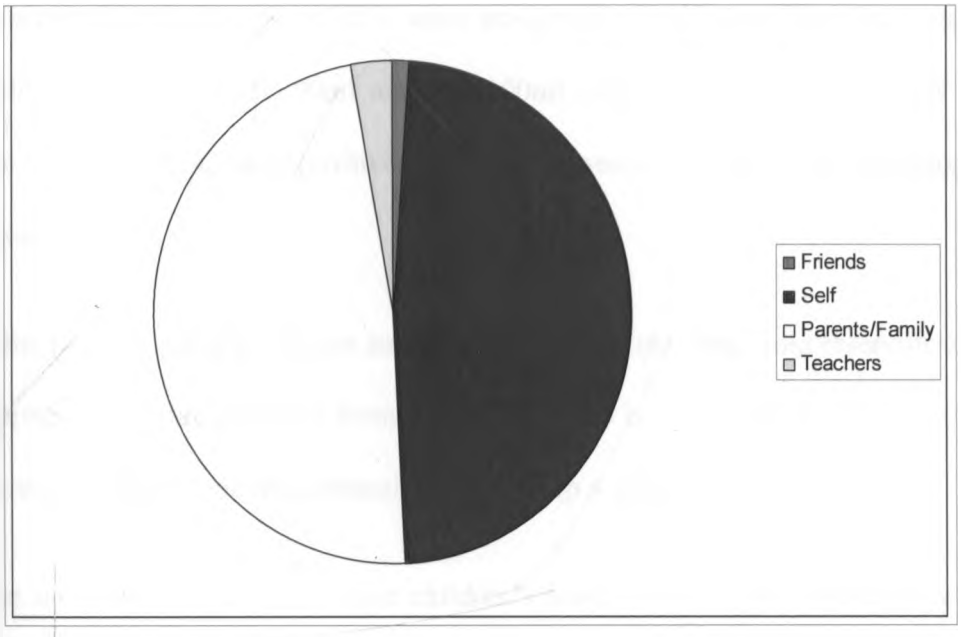


FIGURE XI: FREQUENCIES OF INFLUENCER OF CONSUMPTION PATTERNS

Qualitative data on treatment, storage and drinking methods and vessels, was obtained through observation and case study. A wide variety of treatment, drinking and storage vessels were observed. Some were very complex and expensive while others simple, as would be expected among different social classes. Most interesting was the practice of drinking water with tap directly inside mouth. Appendix III shows photographs of various handling practices observed.

4.4: WATER MICROBIOLOGICAL QUALITY

The Most probable Number of coliforms was computed from a 5-Tube Statistical Table and recorded as number of coliforms per 100 ml of water sample. The Most probable Number of coliforms was computed from McCrady's Statistical Tables.

The results summary statistics are shown on Appendix III. Of the forty one (41) samples collected, thirteen samples (32%) were positive for coliforms. The lowest and highest coliform counts were 0/100ml and 180/100ml respectively with a mean of 21/100ml. Five samples (12 %) were positive for *E coli*. Presence of *E coli* is an indication of recent contamination.

Of the positive samples, eleven samples (29%) were obtained from reservoir tanks and 2 samples (5%) were obtained from Mainline. There is a very strong association between the reservoir tanks and the contamination level ($p < 0.05$).

Four samples of water taken from children's hands were positive for coliforms and one was positive for *E coli*. See Appendix III.

CHAPTER FIVE

DISCUSSION

Water, water, everywhere, and not a drop to drink"
The Rime of the Ancient Mariner, Samuel Taylor Coleridge (1798)

Water is the most familiar and abundant substance on earth. It is essential for all forms of life. In solid form (ice) and liquid form, it covers about 70% of the earth's surface. It is present in varying amounts in the atmosphere. Most of the living tissue of a human being is made up of water; it constitutes about 92% of blood plasma, about 80% of muscle tissue, about 60% of red blood cells, and over half of most other tissues. It is also an important component of the tissues of all other living things. (Columbia Electronic Encyclopedia, 2008)

While a human can survive more than a week without food, a person will die within a few days without water. Everyday the body loses water through respiration (breath), perspiration (sweat), and excretion (urine and feaces). For optimal body functioning, it is crucial that the water supply be replenished daily through the diet (The Gale Group, 1999). The World Health Organization recommends that children aged 9-13 years should consume 2.4L/day for boys and 2.1L/day for girls (WHO, 2005).

'Water is an essential component of our diets. We must have potable water as part of our bodily intake, and for sanitation. There are reasonable substitutes for many other things we consume, but there is no substitute for water.' (Kent, 2005)

The paradox of water, however, is that despite its abundance, millions of the world's people lack access to safe water. The United Nations Development Programme (UNDP) argues that this situation is not because of scarcity, but because people are locked out by poverty, inequality and government failures. (UNDP, 2006)

Furthermore, not all water is suitable for drinking. 'Potable water' is the term used to describe water that is safe for drinking. It must be palatable, and of sufficient quality to

be drunk and used for personal and domestic hygiene without causing significant risk to health. (Sphere Standards, 2004)

Controversy exists on the amount of water intake considered adequate. This study did not seek to determine adequacy, rather to establish current intake levels.

In this study, good practices of water treatment and storage were recorded and observed. A wide variety of treatment, drinking and storage vessels were observed. Some were very complex and expensive while others simple, as would be expected among different social classes. Most interesting were the practices of drinking water from the hands and with tap directly inside mouth. This practice should be discouraged as they may lead to contamination of the water and thereby increased risk of infection. No case of solar disinfection was observed.

Olayo, (2009) noted that water borne diseases such as cholera remain a global threat to public health and one of the key indicators of social development. 'Recurrent epidemics and the inclusion of new areas that were previously not affected should be a wake-up call to all, that the very poor among us are increasing the urgent measures needed to be taken to save them from dying early from such preventable diseases.' Appendix V shows some newspaper articles on the prevalence of water borne diseases in Kenya.

Khalid, (1993) reported that livestock and human feaces are probable sources of contamination to water storage tanks through seepage of contaminants through cracks and loose pipe joints or contaminated by humans during or after fetching from storage tanks. Chemuliti, (1999) observed that human contamination of drinking water after it had been fetched from the out house tanks and standpipes was an important contributor to

the presence of *E coli*. Bacterial pollution of stored water was mainly attributed to drawing water using contaminated scoops as well as touching the water with contaminated hands.

CONCLUSIONS

Water intake of the children is lower than those from previous studies, with considerable variations among individuals.

Poor point of use practices such as dipping to scoop, and drinking from unclean hands pose a risk of contamination.

Family and especially mothers have the most influence on water intake and handling practices of the children. A considerable number of children credit themselves for the quality and quantity of water consumed. It is possible that the school syllabus has had an impact on the appropriate utilization of drinking water.

The presence of pathogenic microorganisms in drinking water indicates that the consumers are at risk of contracting waterborne diseases such as cholera, typhoid and dysentery.

RECOMMENDATIONS

The mitigation of water borne diseases requires an integrated approach. The following are recommendations for all stakeholders including all government institutions, relief organizations, private service providers and consumers:

1. Further studies should to be carried out to establish the water content of local foods, and dishes.
2. Implement the WHO Network to Promote Household Water Treatment and Safe Storage (The Network) strategy. The low cost technologies are chlorination, solar disinfection, filtration, combined flocculation/disinfection systems, boiling, and safe storage.

3. Public Health interventions should also be targeted at ensuring the integrity of the mainline distribution systems and storage tanks.

4. All storage tanks must be cleaned regularly, well maintained and should be tightly sealed at the top and at the inlet.

5. Further studies should be carried out to establish the prevalence and incidence of waterborne diseases among school going children in Westlands division.

REFERENCES

Batmanghelidj F. (1992) Your Body's Many Cries for Water. Falls Church, VA: Global Health Solution. Internet: www.watercure.com Accessed March 20 2008

Bradley, D. J., (1997). Health aspect of water supplies in tropical countries. In: Water, waste and health in hot climates (Ed. Feachem, R. G., McGarry, M. and Marra, D.). Wiley, Chichester: 42-48

Burgers, L., Boot, M., Wijk-Sijbesma, C., (1988). Hygiene education in water supply and sanitation programmes. Literature review with selected annotated bibliography. (Technical paper series: No 27). The Hague, Netherlands, IRC International Water and Sanitation Center: 1988

Chabalala, H. and Mamo, H. (2001) Prevalence of water-borne diseases within the health facilities in Nakuru District, Kenya. Applied Epidemiology University of Nairobi Kenya. Internet: http://www.doh.gov.za/docs/misc/keniawaterdisease.pdf Accessed April 6 2008

Chemuliti, J. K. (1999). Assessment of bacteriological quality of drinking water in Kibera Sub-location of Nairobi City, Kenya. Master of Veterinary Public Health Dissertation. University of Nairobi.

Columbia Electronic Encyclopedia. "Water." Columbia University Press. Internet: <Reference.com http://www.reference.com/browse/columbia/water>. Accessed May 05 2008

Ershow A.G, Brown L.M, and Cantor K.P., (1991). Intake of tap-water and total water by pregnant and lactating women. American Journal of Public Health, Vol. 81, (3) 328-334, American Public Health Association

Ershow A.G, Cantor K. P, (1989). Federation of American Societies for Experimental Biology, Life Sciences Research Office, National Cancer Institute (U.S.), Epidemiology

and Biostatistics Program. Total water and tapwater intake in the United States population-based estimates of quantities and sources. Life Sciences Research Office, Federation of American Societies for Experimental Biology. Bethesda, M.D: 83-95

Fisher, A., Laing, J., Stoeckel, J., and Townsend, J., (1991). Handbook for Family Planning Operations Research Design, 2nd Edition. The Population Council. USA: 40-43

Granddjean, A. Water requirements, impinging factors and recommended intakes (2005) in Nutrients in Drinking Water - Protection of the Human Environment Water, Sanitation and Health World Health Organization (2005) Water, Sanitation and Health Electronic Library, Fourth Edition

Grandjean, A. (2005). Water requirements, impinging factors and recommended intakes in Nutrients in Drinking Water - Protection of the Human Environment Water, Sanitation and Health World Health Organization (2005) Water, Sanitation and Health Electronic Library, Fourth Edition

Grandjean, A., Grandjean, N. (2007). Dehydration and cognitive performance. Journal of the American College of Nutrition, Vol. 26, No. 90005, 549S-554S (2007). The American College of Nutrition. U.S.A: 11-58

Hinrichsen, D. (1998). Solutions for a water-short world, population reports, series M, No 14. John Hopkins. USA In: Chabalala, H and Mamo, H (2001) Prevalence of water-borne diseases within the health facilities in Nakuru District, Kenya. Applied Epidemiology University of Nairobi Kenya. Internet:
http://www.doh.gov.za/docs/misc/keniawaterdisease.pdf Accessed April 6 2008

Howard, G. and Bartram, J. (2003). Domestic Water Quantity, Service, Level and Health. World Health Organization. Ref Type: Report World Health Organization (2005) Water, Sanitation and Health Electronic Library, Fourth Edition
http://www.cohre.org/store/attachments/RTWP%20-NWSS%20June%2007%20draft.pdf

Accessed March 8 2008

JMP (2007) Monitoring drinking water and sanitation. WHO/UNICEF, Geneva: 22-24

Joint Monitoring Program (2007). Monitoring drinking water and sanitation. WHO/UNICEF, Geneva: 22-24

Kaba, G. (1990). Microbiological quality of ground water in some areas around Nairobi, Kenya. Master of Veterinary Public Health Dissertation. University of Nairobi.

Kent, G. (2005) Freedom from want: the human right. Georgetown University Press. Washington D. C.: 187-189

Kenya Bureau of Standards (1985). Specification of drinking water. Part one: The requirements for drinking water. KEBS, Nairobi, Kenya

Kenya Demographic and Health Survey (2003). Kenya Bureau of Statistics. Nairobi: 10

Kenya Institute of Education (2002, 2006), Republic of Kenya Ministry of Education, Primary Education Syllabus Volume 2: 47, 56

Kenya Integrated Household Business Survey (2005/2006). In: Republic of Kenya, Ministry of Water and Irrigation (2007) The National Water Services Strategy (2007-2015) Draft. Nairobi: 1-10.

Khalid, M.A.R.S. (1993). Assessment of the microbiological quality of drinking water in Kikuyu Division of Kiambu District, Kenya. MVPH Dissertation. University of Nairobi.

Levallois, P., Guévin, N., Gingras, S., Lévesque, B., Weber, J. -P., and Letarte, R. (1998). New patterns of drinking-water consumption: results of a pilot study. Elsevier Science B.V., Québec: 1-2.

Mahan, L. and Escott-Stump, S. (2000). Krause's Food, Nutrition & Diet Therapy, 10th Edition. In: Nutrition Fact Sheet: Water, Northwestern University. Internet: http://www.northwestern.edu/ Accessed February 12 2008

Mahan, L. and Escott-Stump, S. Krause's Food, Nutrition & Diet Therapy, 10th Edition, 2000. In: Nutrition Fact Sheet: Water, Northwestern University. Internet: http://www.northwestern.edu/ Accessed February 12 2008

Mayo Foundation for Medical Education and Research (2006). Water: How much should you drink every day? Internet: http://www.mayoclinic.com/ Accessed April 12 2008

Mbaka, M. (2003). An assessment of bacteriological quality, with special emphasis on the presence of *E coli*, in the roof-collected rain water from some peri-urban areas of Nairobi, Kenya. MVPH Dissertation. University of Nairobi.

Muhammed, S. I. and Morrison, S. M. (1975). Water quality in Kiambu District, Kenya. East Africa Medical Journal. **52**: 269-279

Muthotho, J. N., Waiyaki, P. G., Ichoro, C. G. and Furuse, K. (1987). Recent advances in medical research with a symposium on appropriate technology in disease control. In: 8th Annual Medical Scientific Conference, Nairobi, Kenya: 314-319

Nairobi City Council, Education Department (2003), Information Brochure. Nairobi: 11-36

Olayo, B (2009). *Daily Nation*, June 29, 2009. Nairobi, Kenya. Page 11

Passmore, R. and Eastwood, M. (1986). Davidson and Passmore Human Nutrition and Dietetics 8th Edition. Churchill Livingston, Hong Kong: 8

Republic of Kenya (2007). Ministry of Water and Irrigation: The National Water Services Strategy (2007-2015) Draft. Nairobi: 1-10. Internet:

http://www.cohre.org/store/attachments/RTWP%20%20NWSS%20June%2007%20draft.pdf Accessed March 8 2008

Sang, F., Gatheru, Z., Koske, N., Mori, K., Hayashi, T. and Utsonomiya, A. (1983). Cholera surveillance in Kwale District, Coast Province. Fourth Annual Medical Scientific Conference, KEMRI/KETRI, Nairobi, Kenya: 12-17

Simiyu, K. W. (1997). An evaluation of the bacteriological and some physico-chemical qualities of water in the upper Athi River Basin, Kenya. MVPH Dissertation. University of Nairobi.

Singh, D. et al (2008) Children's Right to Water as a Contested Domain: Gendered reflections from India. In: Development: water for people. Volume 51. Number 1. March 2008. Society for International Development (SID): 102

Singh, N., Wickenberg, P., Åström, K., Hydén, H. (2008). Children's Right to Water as a Contested Domain: Gendered reflections from India. In: Development: water for people. Volume 51. Number 1. March 2008. Society for International Development (SID): 102

Sphere Project (2006) Water Quality. Humanitarian Charter and Minimum Standards in Disaster Response. Internet: http://www.sphereproject.org/ Accessed April 2 2008

Sphere Project (2006). Water Quality. Humanitarian Charter and Minimum Standards in Disaster Response. Internet: http://www.sphereproject.org/ Accessed April 2 2008

The Gale Group (1999) Water. Nutrition and Well-Being A to Z. Internet: <Reference.com http://www.reference.com/browse/tgnwb/3436200264>. Accessed 05 May, 2008.

The Institute of Medicine (2004) Dietary Reference Intakes: Water, Potassium, Sodium, Chloride, and Sulfate. Internet: http://www.iom.edu/CMS/3788/3969.aspx Accessed April 2 2008

Tourist Maps Kenya (2000), Expanded Map of Nairobi and surbubs. Internet: www.touristmapskenya.com

UNDP (2006) Summary Human Development Report. 'Beyond scarcity: power, poverty and the global water crisis'. UNDP, Geneva:15

UNESCO World Water Day (2006) Water and Culture. Internet: http://www.who.int/water_sanitation_health/Water&cultureEnglishv2.pdf Accessed February 12 2008

UNICEF (2006). Meeting the MDG Drinking Water and Sanitation Target - A Mid-Term Assessment of Progress. UNICEF, Geneva: 1-15

UNICEF/WHO (2004) Meeting the MDG Drinking Water and Sanitation Target - A Mid-Term Assessment of Progress. UNICEF/WHO, Geneva: 1-30

US Department of Agriculture (1979). Manual of Food Codes and Conversions of Measures to Gram-Weight for Use in Individual Food Intake Data from 1977-78. Nationwide Food Consumption Survey. Consumer and Food Economics Administrative Report No. 352. Hyattsville, MD: Human Nutrition Information Service.

Wagner, E. G. and Lanoix, J. N. (1959). Water supply for rural areas and small communities. WHO monograph series, No. 42. Geneva.

Waiyaki, P. G., James, M. N., Sang', W. K. and Catherine, G. I. (1985). Isolation of enteropathogens from community water sources in Nyanza province, Kenya. Sixth Annual Medical Scientific Conference, Nairobi, Kenya: 13-18

Watt, S. B., (1986). Ferrocement Water Tanks and their construction: 23-25

WHO (1996). Indicators of microbial water quality. Water Quality: Guidelines, Standards and Health. Edited by Lorna Fewtrell and Jamie Bartram. Published by IWA Publishing, London, UK. ISBN: 1 900222 28 0

WHO (2006). Guidelines for drinking-water quality [electronic resource]: incorporating first addendum. Vol. 1, Recommendations. – 3rd ed. Pg 121-144

WHO (2007). Combating waterborne disease at the household level. International Network to Promote Household Water Treatment and Safe Storage. Geneva:10-12 Internet:http://www.who.int/household_water/advocacy/combating_disease.pdf Accessed April 6 2008

WHO/UNICEF, (2007). Monitoring drinking water and sanitation. Joint Monitoring Program, Geneva: 22-24

Appendix I: DATA COLLECTION TOOLS

A1.1 QUESTIONNAIRE

UNIVERSITY OF NAIROBI

DAILY INTAKE AND QUALITY OF DRINKING WATER AMONG CHILDREN AGED 10-12 YEARS IN WESTLANDS DIVISION, NAIROBI, KENYA

A. GENERAL INFORMATION

A1. Questionnaire Number_____ A 2. School (Name)_____

A3. Consent given Yes [ ] No [ ]

Date ____/____/____ Time started_____

(Day/Month/Year)

B. DEMOGRAPHIC DATA

B1. Name of student_____

B2. Age_____ B3. Sex [please tick] 1.Male [ ] 2. Female [ ]

C. WATER AND SANITATION

C1. What is your main source of **drinking water?** [Please tick]

1. Tap inside house [ ]
2. Public tap [ ]
3. Borehole [ ]
4. Vendor-provided water [ ]
5. Tanker truck water [ ]
6. Bottled water [ ]
7. Other[ ] (please specify)_____

C2. Do you do anything to your drinking water before use? [Please tick one]

1. Yes [ ]
2. No [ ]

C3. If Yes, what method of treatment do you use for your drinking water? [Please tick]

1. Boiling [ ]
2. Chemical [ ]
3. Ultra violet [ ]
4. Other [ ] [please specify]_____

C4. If No, please explain why _____

C5. How do you store your drinking water?

_____

C6. Do you cover the drinking water? [Please tick one]

1. Yes [ ]
2. No [ ]

C7. How do you draw water from that container? [Please tick one]

1. Dipping cup into container [ ]
2. Tilting into cup [ ]
3. Other [ ] [please specify] _____

C8. When do you usually drink water? [Please tick one]

1. When thirsty [ ]
2. With meals [ ]
3. Throughout the day [ ]

C9. Who usually influences how much water you drink? [Please tick one]

1. Parents/Family [ ]
2. Teachers [ ]
3. Friends [ ]
4. TV/ Radio [ ]
5. Other [ ] [Please specify] _____

C10. Which member(s) of your family usually treats and prepares water for drinking?

_____

Time ended_____

THANK YOU

A1.2 CONSENT FORM

Dear Parent/Guardian,

RE: REQUEST FOR PERMISSION TO INTERVIEW AND ADMINISTER QUESTIONNAIRE ON YOUR CHILD

Greetings.

I am a student at the University of Nairobi pursuing a Master of Science Degree in Applied Human Nutrition.

I am writing to request for permission to interview your child for my study entitled **'Daily intake and quality of drinking water among children aged 10-12 years in Westlands division, Nairobi, Kenya'**

This study is a survey and focused purely on academic purposes. Privacy and confidentiality of each interviewee will be strictly observed and upheld.

Please sign and return the attached permission slip to the class teacher.

Thank you for your support, participation and facilitation towards the success of this project.

Yours faithfully,

Sellina Onyango

DAILY INTAKE AND QUALITY OF DRINKING WATER AMONG CHILDREN AGED 10-12 YEARS IN WESTLANDS DIVISION, NAIROBI, KENYA

I Mr/Mrs _____ allow my child _____

to participate in the above mentioned research project.

Signature _____ Date _____

Appendix II: MEDIA COMPOSITION AND PREPARATION

A2.1 PREPARATION OF MCCONKEY BROTH

Reagents	Gram per liter
Peptone	20.0 gram
Lactose	10.0 gram
Bile salts	5.0 gram
Sodium chloride	5.0 gram
Bromocresol Purple	0.01 gram

The double strength MacConkey broth was prepared by dissolving 80 grams of the mixture of the above reagents in 1.0 L of distilled water. While, the single strength MacConkey broth was prepared by dissolving 40 grams of the mixture of the same reagents in 1.0 l of distilled water. Each solution was dispensed into universal bottles and fermentation tubes containing Durham tubes. All bottles and tubes containing the broths were sterilized in a pressure cooker at 121°C for 15 minutes. The pH of the agar and the broth was 7.4.

A2.2 PREPARATION OF BRILLIANT GREEN LACTOSE BILE (2%) BROTH

Reagents	Gram per liter
Peptone (Oxoid L37)	10.0 gram
Lactose	10.0 gram
Ox-Bile (Purified)	20.0 grams
Brilliant Green	0.0133 gram

40 grams were suspended in 1.0 L of distilled water. The broth was distributed into fermentation tubes fitted with Durham tubes. The mixture was sterilized in a pressure cooker at 121°C for 15 minutes. The pH of the broth was 7.4.

A2.3 PREPARATION OF THE EOSIN METHYLENE BLUE AGAR (Oxoid)

Reagents	Gram per liter
Peptone (Oxoid L37)	10.0 gram
Lactose	10.0 gram
Dipotassium hydrogen phosphate	2.0 gram
Eosin Y	0.4 gram
Methylene Blue	0.06 gram
Agar No. 3 (Oxoid L 13)	15.0 grams

37.5 grams of the media was suspended in 1.0 L of distilled water and boiled to dissolve completely. The mixture was sterilized in a pressure cooker at 121°C for 15 minutes, and cooled to 60°C. The mixture was shaken in order to oxidize the Methylene Blue (i.e. restore its blue colour) and to suspend the precipitate which is an essential part of the medium. The pH of the broth was 6.8. The agar was dispensed into sterilized Petri dishes and left to solidify. The pH of the broth was 7.5.

A2.4 PREPARATION OF TRYPTONE WATER AGAR (Oxoid)

Reagents	Gram per liter
Tryptone	10.0 gram
Sodium chloride	5.0 gram

15 grams of the medium were suspended in 1.0 L of distilled water and dissolved by boiling. The mixture was sterilized in a pressure cooker at 121°C for 15 minutes, and cooled to 60°C. The medium was then distributed into sterile fermentation tubes.

A2.5 PREPARATION OF METHYL-RED VOGES-PROSKAUER MEDIUM (MRVP)

Reagents	Gram per liter
Peptone (Oxoid L49)	5.0 gram
Phosphate buffer	5.0 gram
Dextrose	5.0 gram

15 grams of the medium were suspended in 1.0 L of distilled water and dissolved by boiling. The mixture was sterilized in a pressure cooker at 121°C for 15 minutes, and cooled to 60°C. The pH of the broth was 7.5. The medium was then distributed into sterile fermentation tubes.

A2.6 PREPARATION OF SIMMONS CITRATE AGAR (LAB 69)

Reagents	Gram per liter
Magnesium Sulphate	0.2 gram
Ammonium dihydrogen phosphate	1.0 gram
Dipotassium phosphate	1.0 gram
Sodium Citrate	2.0 gram
Sodium chloride	5.0 gram
Lab M Agar No. 2	15.0 gram
Bromothymol blue	0.08 gram

24.4 grams of the medium were suspended in 1.0 L of distilled water and dissolved by boiling with constant stirring and mixing. The agar was sterilized in a pressure cooker at 121°C for 15 minutes. The pH of the broth was 6.8. The medium was then distributed into sterile universal bottles and allowed to solidify.

A2.7 PREPARATION OF INDOLE REAGENT (ERLICHS REAGENT)

Reagents	Gram per liter
p-dimethylaminobenzaldehyde	1 gram
Absolute Ethanol	95 ml
Conc. HCL	20 ml

I gram of p-dimethylaminobenzaldehyde was dissolved in 95 ml of absolute ethanol. 20 ml of concentrated hydrochloric acid were added to the solution. The final solution was put in a brown bottle to protect it from light.

A2.8 PREPARATION OF METHYL RED SOLUTION

Reagents	Gram per liter
Methyl-red	0.04 gram
Ethanol	40 ml
Distilled water	to 100 ml

A 0.04 gram of the methyl-red was dissolved in 40 ml of ethanol and diluted using 100 ml of distilled water.

A2.9 PREPARATION OF 1% CREATINE SOLUTION

Reagents	Gram per liter
Creatine	1 gram
0.1 N-HCL	100 gram

One gram of creatine was dissolved in 100 ml of 0.1 N-HCL acid.

A2.10 PREPARATION OF 40% POTASSIUM HYDROXIDE

Reagents	**Gram per liter**
Potassium Hydroxide (KOH)	40 gram
Distilled water	to 100ml

40 grams of potassium Hydroxide were added to 100ml of distilled water.

A2.11 PREPARATION OF NUTRIENT AGAR

Reagents	**Gram per liter**
LAB M Peptone	5.0 gram
LAB M Beef Extract	3.0 gram
Sodium chloride	8.0 gram
LAB M Agar No. 2	12.0 gram

28 grams of the medium were suspended into 1.0L of distilled water. This was dissolved by bringing to boil with constant stirring, and mixing. It was then sterilized in a pressure cooker at 121°C for 15 minutes. It was then dispensed into universal bottles and fermentation tubes, and was allowed to solidify. The pH of the agar was 7.3.

Appendix III: WATER QUALITY RESULTS

Sample No.	Source	MPN/100ml McCrady's Probability Tables	Presence/ Absence of *E coli*	Type of school
1	Mainline	0	*E coli* negative	Public
2	Reservoir tank	0	*E coli* negative	Public
3	Reservoir tank water sampled from child's hands	0	*E coli* negative	Public
4	Reservoir tank	0	*E coli* negative	Public
5	Reservoir tank	0	*E coli* negative	Public
6	Main Line	0	*E coli* negative	Public
7	Reservoir tank water sampled from child's hands	35	*E coli* negative	Public
8	Main Line	0	*E coli* negative	Public
9	Reservoir tank	180	*E coli* positive	Public
10	Main Line	0	*E coli* negative	Public
11	Main Line drank from cup	0	*E coli* negative	Public
12	Reservoir tank	180	*E coli* positive	Public
13	Reservoir tank	1	*E coli* negative	Public
14	Reservoir water sampled from child's hands	50	*E coli* positive	Public
15	Main Line	0	*E coli* negative	Public
16	Reservoir tank	0	*E coli* negative	Public
17	Mainline	0	*E coli* negative	Public
18	Reservoir tank	180	*E coli* negative	Public

19	Reservoir tank water sampled from child's hands	180	*E coli* negative	Public
20	Main Line	0	*E coli* negative	Public
21	Reservoir tank	2	*E coli* positive	Public
22	Carried from home	0	*E coli* negative	Public
23	Mainline	0	*E coli* negative	Public
24	Borehole	0	*E coli* negative	Public
25	Borehole	0	*E coli* negative	Public
26	Reservoir tank	2	*E coli* negative	Public
27	Main Line	8	*E coli* negative	Public
28	Reservoir tank	0	*E coli* negative	Public
29	Main Line	0	*E coli* negative	Public
30	Main Line	1	*E coli* positive	Public
31	Reservoir tank	0	*E coli* negative	Public
32	Main Line	0	*E coli* negative	Public
33	Reservoir tank	0	*E coli* negative	Public
34	Reservoir tank	0	*E coli* negative	Public
35	Reservoir tank	2	*E coli* negative	Public
36	Main Line	0	*E coli* negative	Public
37	Reservoir tank	0	*E coli* negative	Public
38	Reservoir tank	0	*E coli* negative	Public
39	Main Line	0	*E coli* negative	Public
40	Reservoir tank	50	*E coli* negative	Public
41	Main Line	0	*E coli* negative	Public

Appendix IV: PHOTOGRAPHS SHOWING SOME SOURCES, TREATMENT METHODS, STORAGE METHODS AND DRINKING PRACTICES

Plate A: A photograph showing a household water dispenser observed in the home of child in private school.

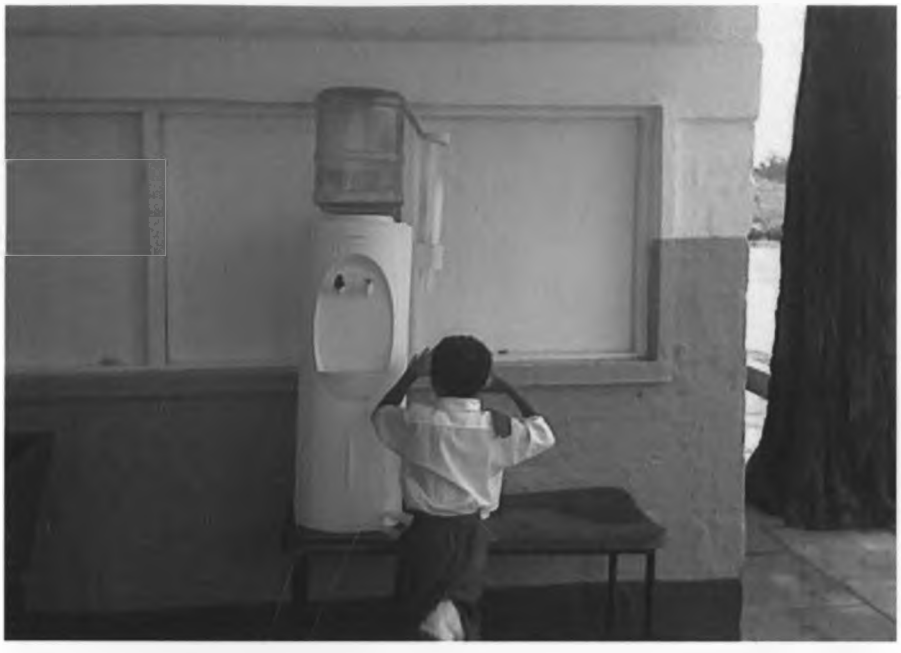


Plate B: A photograph showing a school water dispenser in a private school

Plate C: A photograph showing a household metal water filter observed in the home of child in a private school.

Plate D: A photograph showing a household ceramic water filter observed in the home of child in a private school.

Plate E: Photograph showing an electric water boiling kettle observed in the home of child in a public school.

Plate F: A photograph showing a plastic water tank with cups in a private school

Plate G: A photograph showing a plastic storage tank and jerrican in non formal school in a slum. One cup was used by the entire class.

Plate H: A photograph showing boiled water stored in thermos (hot) and refilled water bottle observed in home of child in public school.

Plate I: A photograph showing boiled water stored in a covered aluminum saucepan with plastic cup used for scooping the water. This was observed in the home of child in public school.

Plate J: A photograph showing 'the practice' of drinking water using hands. This was observed in a public school.

Plate H: A photograph showing 'the practice' of drinking water with tap directly inside mouth. This was observed in a public school.

Appendix V: NEWSPAPER ARTICLES ON WATER BORNE DISEASES IN KENYA

PUBLIC HEALTH

BERNARD OLAYO

Why cholera is killing Kenyans

AS THE DEATH TOLL FROM cholera continues to rise, we need to ask ourselves why the disease continues to kill Kenyans so late in our development history.

Our health experts know how to prevent the disease, and health education messages on how to prevent the disease are disseminated. Most people know these facts already.

In previous years, cholera outbreaks were mainly confined to Nyanza, Coast, Western and North-Eastern provinces. However, during the current epidemic, areas like Rift Valley, Central and Nairobi provinces have also been affected.

The response to the epidemic has been predictable, with bureaucrats underestimating the magnitude even as major hospitals reported many cases.

Most of the officials have focused their prevention efforts on health education with messages urging the affected communities to improve hygiene and sanitation standards.

In doing so, however, we have failed to acknowledge certain basic principles about the disease that could help us prevent future outbreaks.

- Cholera is a disease of poverty and the increasing spread of the disease across the country is an indication of the rising number of indigents in our society.
- The absence or shortage of safe water and sufficient sanitation, combined with a generally poor environment, are the main reasons why the disease is spreading so rapidly.

Typical at-risk areas include peri-urban slums, where basic infrastructure is not available, as well as camps for internally displaced people, where minimum requirements of clean water and sanitation are not met.

■ THE PROVISION OF SAFE WATER and sanitation is a formidable challenge, but it remains the critical factor in reducing the impact of cholera outbreaks and preventing future outbreaks.

With frequent water shortages in Nairobi and water vendors selling the vital commodity at prices above the reach of most poor people, Nairobi is now in the throes of cholera. It is not as though the people choose not to be clean; the problem is that they cannot afford it.

The post-election violence is an important factor in looking at the current epidemic since is left many displaced people vulnerable to cholera, especially in places like Rift Valley and Central provinces where the disease was previously non-existent.

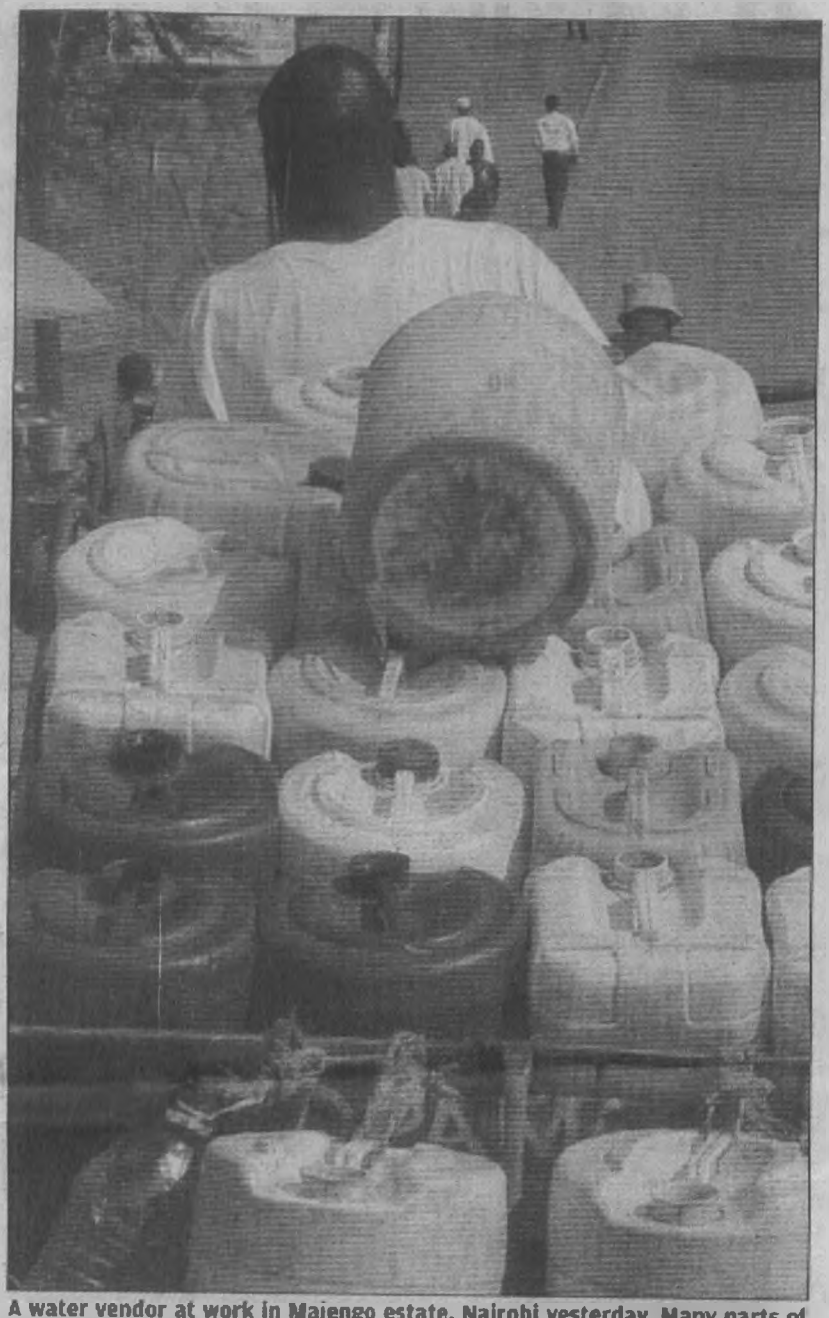
Cholera remains a global threat to public health and one of the key indicators of lack of social development. Recurrent epidemics and the inclusion of new areas that were previously not affected should be a wake-up call to all, that the very poor among us are increasing and urgent measures need to be taken to save them from dying early from such preventable diseases.

Kenya is a signatory to the UN Declaration on the Millennium Development Goals. I know the country is not on track for achieving most goals, but unless the government takes measures to achieve goal No. 1 "Eradication of Extreme Hunger and Poverty", then we should prepare for worse outbreaks in the future.

Dr Olayo is a public health specialist.

Source: *Daily Nation*, June 29, 2009. Nairobi, Kenya. Page 11

The water burden



A water vendor at work in Majengo estate, Nairobi yesterday. Many parts of the city are facing an acute water shortage and residents are forced to buy the precious commodity from vendors as Nairobi Water and Sewerage Company continues with the rationing programme. [PHOTO: COLLINS KWEYU/STANDARD]

Source: *The Standard*, June 29, 2009. Nairobi, Kenya. Page 10