CAREGIVERS FOOD-WATER HANDLING PRACTICES, KNOWLEDGE AND PREVALENCE OF FOOD-WATER BORNE DISEASES IN CHIDREN (1-5 YEARS) OF YATTA, KENYA: A CASE OF SAND DAMS

MUGENDI PERIS KARIMI
A56/81419/2015

A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN FOOD SAFETY AND QUALITY

DEPARTMENT OF FOOD SCIENCE, NUTRITION AND TECHNOLOGY
FACULTY OF AGRICULTURE
UNIVERSITY OF NAIROBI

2023

DECLARATION

I, **MUGENDI PERIS KARIMI** do declare that this dissertation is my original work and has not been submitted for the award of a degree in any other University.

SIGN: …… **Date**: 7/8/2023

Department of Food Science, Nutrition and Technology University of Nairobi

This research dissertation has been submitted with my approval as University supervisors.

Signature Date: 7/8/2023

Dr. Lucy G. Njue (Ph.D.)

Department of Food Science, Nutrition and Technology

University of Nairobi

Signature: Date: August 8, 2023

Prof. George O. Abong' (Ph.D.)

Department of Food Science, Nutrition and Technology

University of Nairobi

UNIVERSITY OF NAIROBI

PLAGIARISM DECLARATION FORM FOR STUDENTS

Name of Student:	MUGENDI PERIS KARIMI
Registration Number:	A56/81419/2015
College:	College of Agriculture and Veterinary Sciences (CAVS).
Faculty/School/Institute:	School of Agriculture.
Department:	Food science nutrition and technology.
Course Name:	MSc. Food safety and Quality.

Title of Research Dissertation: CAREGIVERS FOOD-WATER HANDLING PRACTICES, KNOWLEDGE AND PREVALENCE OF FOOD-WATER BORNE DISEASES IN CHIDREN (1-5 YEARS) OF YATTA, KENYA: A CASE OF SAND DAMS

DECLARATION

1. I understand what Plagiarism is and I am aware of the University's policy in this regard.
2. I declare that this MSc. DISSERTATION is my original work and has not been submitted elsewhere for examination, award of a degree, or publication. Where other people's work or my work has been used, this has properly been acknowledged and referenced under the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work.
4. I have not allowed and shall not allow anyone to copy my work to pass it off as his/her work.
5. I understand that any false claim in respect of this work shall result in disciplinary action, under University Plagiarism Policy.

Signature:  Date: 7/8/2023

DEDICATION

I dedicate this work to my husband Reuben Nathaniel Nganga and my loving family for their unending support and prayers during my study period.

ACKNOWLEDGEMENT

My sincere appreciation goes to my supervisors, Dr. Lucy G. Njue, and Prof.George O. Abong' their expertise, guidance, patience, concerns, encouragement, and support given to us during this work. I am deeply grateful to my husband and family, who have supported me financially and morally. Also, I thank the University of Nairobi, Department of Food Science, Nutrition, and Technology, for the provision of laboratory services and the competent technicians for their assistance. I would like to thank Yatta constituency- Machakos County residents who took part in this study. Last, but not least, our gratitude to our beloved once, children, and friends cannot be left silent. Above all, the Almighty God for granting us strength during the entire research period.

TABLE OF CONTENTS

Contents

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

ASAL: Arid and Semi-Arid Lands.

EPA': Environmental Protection Agency.

HWTS: Household Water Treatment and Safe Storage.

MDG's: Millennium Development Goals.

NGO's: Non –Governmental Organizations.

UNICEF: United Nations Children's Emergency Fund.

USA: United States of America.

WHO: World Health Organization.

WLD: Water for Life Decade.

WWD: World Water Day.

SPSS: Statistical Program for Social Sciences.

LIST OF DEFINITIONS

AGAR- it's a jelly-like substance for growing microorganisms.

CLEAN WATER is water that is safe to use for food preparation and drinking.

FOODBORNE DISEASES-Diseases caused by pathogenic microorganisms spread through ingestion of contaminated foodstuff.

HAZARDOUS/UNSAFE WATER- is water that has been contaminated by human, animal, or natural activities and is thus not suitable for drinking or food preparation.

PATHOGEN - A microorganism which causes illness.

RISK FACTORS- Variables associated with increased occurrence of the unpleasant outcome.

SAND DAM- A strengthened rubble cement wall erected across a seasonal sandy river. They are a low cost, simple, low maintenance means of storing surface runoff water, from heavy rains.

WATERBORNE DISEASES-Diseases caused by pathogenic microorganisms spread through ingestion of contaminated water.

WATER TREATMENT- The process of making water safe for drinking or food preparation. It can be achieved through filtration, boiling, chlorination, distillation, or a combination of the methods mentioned.

GENERAL ABSTRACT

The building of sand dams is the elected course of action to remedy the dry conditions. Sand dam creation in Yatta is depends on local expertise in harvesting, sieving, storage of water. This study aimed at assessing caregivers' food-water handling practices, knowledge and prevalence of food-water borne diseases in children (1-5 years) of Yatta, Kenya: a case of sand dams . Using Fischer's method, a sample of 50 respondents was determined as sufficient for the study. The 60 respondents were selected purposively from 5 wards. Two dams from two wards were also selected purposively for this study. Semi-structured questionnaires were used to collect data from the respondents. The data was then analyzed using SPSS version 25 and MS Excel. The results indicate that children who drank untreated (or poorly treated water) were suspected to suffer from water-borne diseases such as typhoid and cholera. Almost all respondents (89%) highly suspected dam water to be the main cause of water-borne illnesses. It was found that some respondents (39.3%) did not use any treatment method for dam water while 35.7% used chlorination, 21.4% boiling and 3.6% allowed the water to settle before use. About 33% respondents were found to acquire food from the open air market, 23% stored their foodstuff in an open area in the house, 71% alongside utensils and other kitchen ware, 26% in a granary and finally 4% in an indoor pantry. 14.28% of the respondents stored their water in plastic containers without lid while 66.07% stored in plastic with lid and 19.64% in metallic containers.

Level of education was attributed to respondents' knowledge on treating dam water with 17.9% having gone up to primary education and less than 8.9% having not gone to school at all. Some of them had never heard information concerning water treatment methods (7.1%). It was found that the majority did not use any treatment method of dam water, accounting to 39.3%, 35.7% used chlorination method, 21.4% boiling, and about 3.6% allowed the water to settle. This study concludes that there is poor water handling practices among caregivers using dam water in Yatta and there is need for training and awareness creation on proper water handling practices.

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Yatta is a constituency in Machakos County and is one of the dry areas in the county that receive low rainfall due to its location and altitude. Climatic changes have contributed to decreased rainfall and high temperatures in the area (Quinn *et al*., 2018). Due to its arid and semi-arid climate, the residents have resulted to creation of dams as a remedy to the dry conditions, with the water being used primarily for domestic and agricultural purposes.

Shortage of food and insufficient supply of clean water have become a national focus point with the highest effort experienced in arid and semi-arid areas of the republic (ASALS) which account for approximately 89% of Kenya's landmass (Njoka *et al*., 2016). These has led to huge challenges with many experiencing periodic water shortages and are thus unable to meet the water demand for their domestic and agricultural practices. Again, due to the meager amount of rainfall received in the region, domestic water harvesting methods such as the use of gutters and water tanks for storage are rarely practiced. Sand dams, ponds, and earth dams have increased in the region (Kimani *et al*., 2015). Sand dams are the most common method of water harvesting in the region due to their ease in construction, capacity to lower the rates of water evaporation, and risk of water contamination (Disler *et al*., 2019). This could be ascribed to the low speed of filtration process through the sand layers. However, the sand dams are usually left uncovered, hence prone to physical, microbial and chemical contamination, particularly during the rain seasons, which leads to increased surface runoff. The safety of water from the sand dams has been a vital focus area as it has a direct effect on the health of people residing in ASAL. The microbial load of water in sand dams is thus likely to raise cases of water-borne diseases. Moreover, chemical pollutants have short- or long-term health effects on humans while physical contaminants make water unusable and unsightly (*Ritchie et al., 2021*). Contamination of drinking water with fecal matter has been a possible risk as it leads to diseases like diarrhea, typhoid, and cholera, which sometimes results in death if the contaminated water is used in households. Unfortunately, few studies have focused on safety of domestic and drinking water from the sand dam (*Disler et al., 2019; Quinn et al., 2018),* and thus understanding of sand dam water needs to be enhanced, which necessitates this study.

Water boiling to reduce contamination is the most preferred method of purifying water at the household level (*Hald et al., 2016; WHO/UNICEF, 2010).* According to WHO (2015), 38% of Kenyans drink contaminated water. The report also established that contaminated water supply, hygiene, and sanitation, also stance a key hazard to children's health below the age of five. Furthermore, diarrhea has become common among children and there is increased concern as it has lifelong effects including constraining physical and cognitive growth (*WHO/UNICEF/JMP, 2015*).

Consequently, this study focused on assessing the most prevalent pathogenic microorganism(s) in sand dam water in Yatta constituency and the hazard factors related to dam water and drinking water treatment practices at the household level.

1.2 Statement of the problem

Yatta constituency is a semi-arid area and suffer drought and famine which affect water sources as majority of rivers are seasonal. Therefore, majority of the residents forage for long distances in search of clean water for drinking and domestic use *(Njoka et al., 2016).* Consequently, people have opted to sand dams creation to harvest rain water. The rain runoff water is contaminated with microbes, physical, and chemical contaminants that render it unfit for consumption. The contamination is attributed to poor disposal of human feacal matter. Additionally, sand dams are uncovered, thus making the water more susceptible to contamination from the environment *(Njoka et al., 2016).* Human activities like farming, washing and watering animals in the same dams lead to accumulation of chemicals and growth of microorganisms. There are poor water handling practices and the area lack policies on proper use of the stagnant water.

Safety of dam water is not guaranteed and compromise human health due to high prevalence of waterborne diseases in the area. Additionally, the residents do not treat water from the sand dams and consume it directly without any treatment *(Neufeld et al., 2020).* This increases their exposure to waterborne illnesses and burden of illnesses.

1.3 Justification

Improving water harvesting and handling practices among residents of Yatta will help reduce the high prevalence of water and foodborne diseases which have been a huge burden to the county government. Contaminated and untreated drinking water is a major contributor to diarrhea, fever, stomachache, and urinary infections. This has also been the case in Yatta; use of untreated dam

water has increased cases of disease symptoms reported among children less than five years. Water treatment is one of the best controls of these diseases. The findings of this study will create a venue for policy development towards training the locals on water treatment and handling practices to ensure access to quality and safe drinking water in Yatta.

1.4 Study Objectives

1.4.1 General Objective

To assess caregivers food-water handling practices, knowledge and prevalence of food-water borne diseases in chidren (1-5 years) – yatta, kenya: (a case of sand dams).

1.4.2 Specific Objectives

i. To assess water handling knowledge, treatment practices among caregivers of, (children aged 1-5 years) in Yatta constituency, Kenya
ii. To determine the prevalence of food and water borne illnesses and the risk factors among children aged 1-5 years in Yatta constituency, Machakos county, Kenya

1.5 Research questions

i. What are water treatment practices among caregivers of, (children aged 1-5 years) in Yatta constituency, Kenya?
ii. What is the prevalence of food and water borne illnesses and the risk factors among children aged 1-5 years in Yatta constituency, Machakos county, Kenya?

1.6 Limitations of the study

First were unresponsive caregivers, second was the inability of the caregivers to read and write because of age and level of education, therefore an interpreter was deployed

CHAPTER TWO: LITERATURE REVIEW

2.1 Sand Dam as a Source of Water

Sand dams are technique used for harvesting water by constructing small dams across seasonal rivers and streambeds in dry areas. The rain water runoff carries topsoil and surface runoff which are deposited behind the sand dam walls. Maturation is when the soil deposits have lasted for years but is highly dependent on the levels of soil erosion *(*Ritchie *et al*., 2021*).* An infiltration process is used to collect the water to a tank behind the dam, or to a tap *(*Kimani *et al.,* 2015*).* The residents near the dam reservoir benefit more compared to those living far. The dam water has many uses including irrigation, domestic use and watering animals thus improving the economic capacity of the locals (Frazão *et al.,* 2019). Additionally, the nearness to the water source decreases time used in searching for water. This improves their health in compared to their counterparts who are miles away from the water source. The availability of water near the households has also relieve children of water fetching duties hence giving them time to focus on schoolwork (Ritchie *et al.,* 2021).

Sand dams have been endorsed in ASAL because of their potential due to raise the water table, lower evaporation of water, and harvest sand for construction (Kimani *et al.,* 2015). However, as (Kimani *et al.,* 2015*)* reported, sand dam's method of water collection and the accessibility to both humans and animals, has become a major contributor to water pollution and contamination. Coliforms are a common occurrence signifying fecal contamination in the water (Kimani *et al.,* 2015). Additionally, this approach of harvesting water has an effect water turbidity and clarity. Traditional methods of water harvesting by use of scoops cause increased water turbidity compared to shallow wells. Therefore, residents are fortified to use more proficient abstraction methods or growth of vegetation cover on the dam (Clifton *et al.,* 2018; Kimani *et al.,* 2015*).*

2.2 Prevalence rate of Water and Food Borne Diseases from Sand dam water

Water a crucial natural resource which is limited in quality and quantity in majority of the countries especially in the developing countries (Mkwate *et al.,* 2017; Ndekezi *et al.,* 2019; WHO/UNICEF/JMP, 2015*).* Worldwide, more than 1 billion people cannot gain access to an adequate water source. Poor water quality has caused increased cases of water-borne diseases including cholera, dysentery, diarrhea, and typhoid fever (WHO/UNICEF, 2010). Sand dams,

widespread in ASALs, are categorized by harvesting water runoff during a heavy rainfall seasons (Ndekezi *et al.,* 2019). The fact that the dams are open and unprotected increases the likelihood of contamination from animals, mining, processing, and feacal matter among other contaminants. Subsequently, this compromises the health of people when they drink such water without proper treatment or processing. They end up being infected with acute microbial contamination or other long-term health effects, stemming from consuming chemically contaminated water (Ritchie *et al.,* 2021).

Ndekezi *et.al*., in a 2019 study, reported that 13% and 52% of water samples drawn from shallow wells and scoop holes respectively have high levels of Escherichia *coli.* The high infestation with *E. coli* is due animal fecal materials contaminating the water as the animals' graze at the riverbanks (Kioko & Obiri, 2012).

The World Health Organization, in a joint study with (UNICEF 2015), reported that roughly 3.2% of deaths (1.8 million people) and 4.2% of disability-adjusted life years (61.9 million people) worldwide can be attributable to unsafe water, poor sanitation, and hygiene. The study also reported that of the deaths attributable to hazardous drinking water, deficient hygiene, and sanitation, 99.8% of which occur in developing countries andthatalmost90% of the fatalities are of children. For years, the global accessibility of safe water and sanitation has been at the helm in the effort to reduce the global prevalence of water and food-borne diseases (WHO/UNICEF/JMP, 2015). Despite these efforts, both WHO and UNICEF agree that almost 1.1 billion people globally, do not have access to clean drinking water like a protected well or tap water (WHO/UNICEF/JMP, 2015).

According to (Clifton, *et. al,* 2018), there exist three vital types of infectious diseases that can be aggravated by change of climate water-borne, food-borne and vector-borne diseases (Clifton *et al.,* 2018). Human interaction with waterborne diseases occurs through contact with polluted drinking water, food, or recreational water. Water and food-borne illnesses are correlated to the consumption of pathogens via contaminated food or water, while vector-borne diseases are connected to the infections spread by arthropods e.g., mosquitoes. As above-mentioned, WHO/UNICEF (2015) data on the burden of disease points to the fact that about1.8 million people (3.2% of global deaths) and 61.9 million (4.2% of global death) people of disability-adjusted-life years universal are linked to poor sanitation, hazardous water, and hygiene. This tally to 88% of diarrheal infections globally which is the attributable fraction of diarrhea caused

by unsafe water supply and cleanliness and the disease burden from hookworm disease, trachoma, ascariasis, schistosomiasis, and trichiniasis. (Hald *et.al,* 2016), reported that these diseases arise from consumption of foodstuffs (including water) contaminated with chemicals or microorganisms. The researchers continue to argue that the dangers of contamination, predominantly in food, stem from the food chain and involve the pollution of soil, water, or air. The researchers' found the approximation of food-borne disease burden to be complex as most of the hazards causing food-borne diseases are not transmitted solely by food (Hald *et al*., 2016). (Hald *et.al* 2016) argue that food has many exposure routes, including transmission from animals, by humans, and via environmental routes, which includes water. In agreement with (WHO/UNICEF 2015), (Hald *et.al* 2016), find that water plays a major role in propagating food-borne diseases, hence, the separation of food and water as exposure vehicles is challenging, particularly at the community level.

2.3 Household Level water handling and treatment practices

The Millennium Development Goals (2002) (MDGs), put forth by the UN, necessitated the need for "sanitation and "safe water" issues to be on the global agenda (Akowanou *et al.,* 2016). This assertion, as (Akowanou *et al*., 2016) find, has led to the prioritization of water sanitation over sanitation and sanitation over hygiene. This paper, in agreement with (Akowanou *et al.,* 2016*)* argues that sanitation e.g., keeping fecal matter away from hands, foodstuff, and water is key to reducing the burden of infectious diseases nationally and globally. This 'subordination' of hygiene to water sanitation explains why community programs created to deliver clean water and sanitation have repeatedly not reaped the anticipated health benefits as one aspect undercuts the other. Where previous weight had been on providing access to "clean water for all", it is increasingly being argued by scholars from different points that the key means to reducing the burden of water-borne diseases is to incorporate the promotion of hygienic practices e.g., washing hands and domestic water treatment and storage into programs for the provision of improved water supply and sanitation (Akowanou *et al.,* 2016). Both UNICEF and (Akowanou *et al.,* 2016) agree that this approach is a cost-effective way to reduce the occurrence of both water and food-borne diseases. Given the current state of water quality in developing countries that are managed by municipal supplies, (Akowanou *et al.,* 2016) argue that for the underserved city populations, point-of-use chlorination of water at the household level could act as a more

effective and prompt means of shielding communities from both water and foodborne diseases. The researchers' further find, in agreement with this study, that drinking water quality is still a problem in developed countries, particularly in Eastern Europe. North America has also been found to have related issues. However, the study by (Akowanou *et al.,* 2016) established that countries in Northern Europe and America are now experiencing reduced risks of epidemics related to drinking water polluted with infectious pathogens such as typhoid, cholera, and viral hepatitis. However, the study also determined that there still are frequent instances of water-borne diseases resulting from polluted drinking water in adjacent regions that are on the rise. *(*Akowanou *et al.,* 2016) estimate that even in developed nations, as high as 15-30% of community gastroenteritis can be tied to polluted municipal drinking water, despite the use of modern technology in water treatment, and no evidence of high microbial contamination levels.

Shifting focus back to Africa and Kenya is it commonplace for people to assume that clear and odorless water is clean. This dissertation furthers this assumption on the basis that most Kenyans assume water safety to mean 'clear and odorless' and not necessarily water that has been treated. Filtration, sedimentation and use of chlorine are the most common methods of water treatment in Africa (Kioko & Obiri, 2012). Boiling of water is not mostly used especially when the water is assumed to be 'clean'. The method of water treatment employed in different regions of the continent (Africa) is seen to vary depending on the water sources. However, as (Kioko and Obiri 2012) establish, chlorination is the most preferred method of water treatment in Kenya. River water (brown unclear water) is considered dirty thus filtration, boiling, and chlorinating water are the most preferred methods (Kioko & Obiri, 2012). The two microbiologists Kioko and Obiri established that 60% of the residents of Kakamega, one of Kenya's busiest townships, share the general assumption that the water they drink from piped connections is safe and that water from the river is not safe. This paper finds that this assumption showed some level of knowledge about sources of clean drinking water but also some level of ignorance regarding where and when water can be contaminated. Narrowing down to Yatta constituency, because of their ability to reduce evaporation rates and preserve water, people living near the sand dams are more likely to use the water without treating it further as it is usually clear and odorless. Consequently, the water is not only used for domestic purposes but as previously mentioned, for irrigation purposes, which, as this paper finds, brings to light the interplay between water and food contamination. The people in yatta constituency might assume dam water is clean since it is

sometimes clear and odorless thus does not need any treatment before using it. This assumption is ignorant since there are possible sources of rainwater contamination along the waterways. Instead of using boiling and chlorination treatment methods (most used), they drink, wash fruits and vegetables and cook using this untreated water (WHO/UNICEF, 2010). It could also be a result of the low-level of education of the caregivers.

Furthermore, given the dry conditions in Yatta constituency, residents residing close to the sand dams consider themselves lucky to have clear, odorless water for their daily use, hence there is a laxity when it comes to treating the water before use or even testing it for contamination before it is used for domestic or small-scale irrigation.

2.4 Microbial Risk Factors and Microbial Associated with Sand Dam Water

Animals graze and drink water from the sand dams which no fences around them. Frequently, the animals defecate on the surface of the sand dams and the feaces filtrate through the soil layers, and traces fecal coliforms would be find their way into the harvested water (Quinn et al., 2018). Fecal contaminants and dirt that is into the sand dams increase the likelihood of fecal coliforms getting into the water among other contaminants. This means of water harvesting is a risk factor to water contamination as traditional scooping method increase the likelihood of water contamination in addition to hand handling and exposure to animals (Neufeld et al., 2020). These findings correlate with those of Quinn who reported contamination of water through scoop holes (Quinn et al., 2018). *B.Cereas* is mostly found in soil which are the main building material of the sand dams and also is rainwater assumed to have been contaminated by dust from the air (Neufeld et al., 2020). Similarly, the pathogen is likely to be found in the sand dam water as effluent water is carried down the soil in the rainy season. Hence, Salmonella is of interest in this research. Water is the most indispensable natural resource yet is limited in quality and quantity in most countries.

2.5 Household Level Water Treatment Methods of Sand Dam Water

Worldwide, most people depend on on unsafe water sources, hence exposing themselves to waterborne diseases which are often fatal especially among the under-five year old's (WHO/UNICEF/JMP, 2015). Most people depend on unsafe water are in sub-Saharan Africa where there is high demand for quality water (WHO/UNICEF/JMP, 2015; WHO/UNICEF, 2010). Unluckily, this is not feasible for most people in developing countries, with slum

inhabitants and rural areas dwellers are the majority of the affected. This pushes this Populous to source water from vendors who may source the water from formal or informal sources, most of which do not follow strict water treatment and storage procedures. Informal water sources e.g., rivers and dams are mostly not treated thus exposing the consumers to illnesses (Mumbi *et al*., 2018). River water is mostly assumed to be dirty hence boiling and chlorination are the most preferred water treatment methods. (Kioko and Obiri, 2012) found 60% of the residents of Kakamega to have a general assumption of their water being safe with water from the river scoring the lowest score on the perception of being safe.

2.6 Knowledge Gaps

This study focused on establishing the occurrence of food and water-borne diseases in Yatta. The researcher sought to ascertain the methods of treatment and their frequency, regarding water found in the sand dams and whether this is an aspect that contributes to the occurrence of food and waterborne diseases in Yatta. More study is needed to investigate on which type of pathogens are present in dam water that causes diseases periodically specifically on rain seasons.

CHAPTER THREE: DETERMINATION OF FOOD-WATER HANDLING AND TREATMENT PRACTICES BY CAREGIVERS YATTA CONSTITUENCY, KENYA

Abstract

Yatta Constituency is in Machakos County in the lower Eastern part of Kenya. Yatta receives low rainfall due to high altitude. Furthermore, climate changes have resulted in reduced rainfall and increased temperatures in Yatta, which in turn causes recurrent droughts and dry spells in the area. There is thus an insufficient supply of water for domestic and agricultural use in Yatta. The aim of the study was assessment of caregivers' food-water handling practices, knowledge and prevalence of food-water borne diseases in children (1-5 years), Yatta constituency, Kenya. Structured questionnaires were used to collect data on knowledge, water handling and treatment practices. Questionnaires on knowledge, water handling, and treatment were used to collect data from the respondents/caregivers of 60 respondents. SPSS version 25 was used for statistical data analysis. Level of education could also be a contributor to some of the respondents not knowing how to treat dam water with 17.9% having gone up to primary education and less than 8.9% having not gone to school at all. Some of them had never heard information concerning water treatment methods (7.1%). It was found that the majority did not use any treatment on dam water, accounting to 39.3%, 35.7% use the chlorination method, 21.4% boiling, and about 3.6% allowed the water to settle. This was contributed by the lack of water handling knowledge and treatment practices of caregivers of children 1-5 years in the area of study. In conclusion, there is a lack of knowledge on water treatment, and this poses health risks to children 1-5 years considering the mode of harvesting dam water. There is also the need for government to plan for public education on the water treatment methods to employ and the dangers associated with not treating dam water.

3.1 Introduction

Worldwide, most people drink unsafe water exposing them to disease including waterborne diseases (WHO and United Nations Children's Fund, 2012). Most of the world populations reliant on poor quality drinking water are in sub-Saharan Africa (UNICEF and WHO, 2021; World Health Organization (WHO), 2019). There is an unrelenting quest for clean and quality water universally. Unluckily, this is not feasible for most people, particularly in developing countries where slum inhabitants and rural areas are the most affected. This drives this population to source water from sellers who draw their water from formal or informal sources, most of which do not follow strict water treatment and storage procedures. Informal water sources, e.g., rivers and dams, are generally not treated, thus risking users to communicable illnesses (Fengting *et al*., 2018).

Global Warming and other climatic changes, the rain patterns of the globe have changed, leading to water scarcity in some areas and flooding in others (Akowanou *et al*., 2016). Yatta constituency only has one permanent river. Therefore, constituents have no option to forage for miles, searching for clean water for household use (Mureithi *et al*., 2014). Given the current state of water quality in developing countries that are managed by municipal supplies (Akowanou *et al*., 2016) argue that for underserved city populations, point-of-use chlorination of water (at the household level) could act as a more effective and prompt means of shielding community from both water and foodborne diseases. However, as established, chlorination is the most preferred method of water treatment in Kenya. Study by reported that people stored water in uncovered containers with lids followed by narrow neck containers with lids. Knowledge of the application of water treatment is an important factor in affecting the efficiency of water treatment. For instance, Amoukpo *et al*., (2018) found that about 65.3% of the population in Kenya have knowledge on water treatment protocols using lemon oil, Aqua tabs, tablets, cresol, boiling, and palm branch among other approaches. Furthermore, given the dry conditions in Yatta constituency, residents residing close to the sand dams consider themselves lucky to have clear, odorless water for their daily use, hence there is laxity regarding treating the water before use or even testing it for contamination before it is used for domestic use. This study sought to assess water handling knowledge, treatment, and practices among care givers of children 1-5 years.

3.2 Materials and methods

3.2.1 Study area

This study was carried out in Yatta Constituency, Machakos County in Kenya (Figure 3.1). Yatta measures 1057 square kilometers and has a population of 147,579. The constituency has 5 wards; - Ndalani, Kithimani, Matuu, Katangi, and Ikombe. Being a semi-arid region, Yatta receives little rainfall. Yatta constituency only has one permanent river, coupled with multiple seasonal rivers that dry up quickly. Boreholes and sand dams are drilled by the county government. Again, there are also individual dams at homesteads. During the rainy season, channels are erected that funnel water to the sand dams, where it then stays to be used in the dry season.

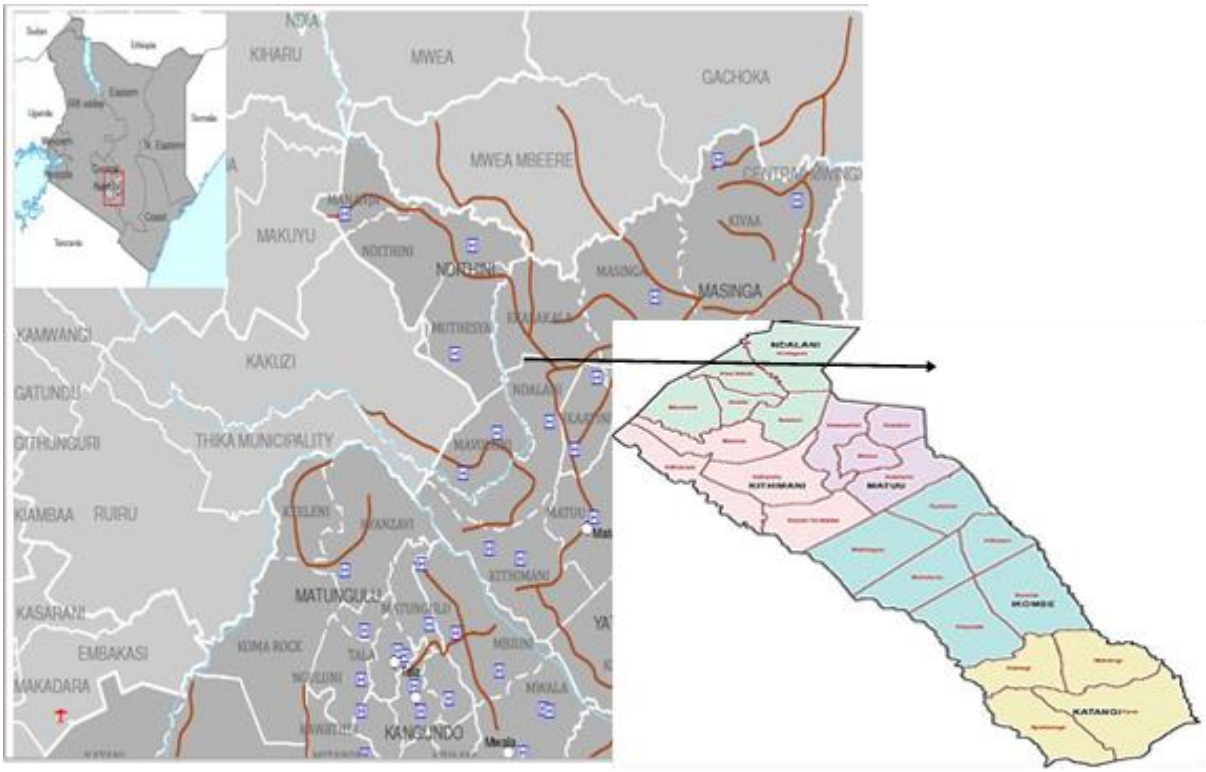

Figure 3.1: Map of Yatta Constituency Showing Yatta constituency (Source: Revised IEBC Boundaries, 2012)

3.2.2 Study population

This study targeted caregivers of children aged 1-5 years since children are the bulk of the population affected by water and foodborne diseases. Children in this category have low immunity compared to older ones. Since they are still under parental care, it was prudent to target their caregivers as a sample group as they gave insight into their water acquisition, treatment, and storage techniques.

3.2.3 Sampling

The sample size was arrived at using Fischer's formula, as illustrated below (Fisher Andrew; Laing John; Stoeckel John; Townsend John, 1991). To offset any inaccuracy that might have occurred from the missing data, an additional 10 respondents were necessary, hence arriving at a figure of 60 participants. It is only 56 out of the 60 respondents that filled the questionnaire by themselves or were assisted by the interpreter.

Fischer's (formula,

$$n = \frac{z^2 \ x \ p \ x \ q}{f2}$$

$$n = \frac{1.92^2 \ x \ 0.75 \ x \ 0.25}{(0.12)2}$$

= 50 respondents

By adding an attrition of 20% of the sample size

$\frac{50 \ x \ 20}{100}$ = 10 respondents

Thus total respondents =50+ 10

=60 respondents

N=Desired sample size

Z=Standard deviation responding to 95% confident interval

P=Proportion of eligible children in the study.

F=Degree of accuracy desired.

By combining an attrition rate of 0.2 (20%) with the sample size

3.2.4 Sampling procedure/technique

Non-Probability sampling technique involves a purposive sampling method which was used in obtaining the sample of the study. Purposive sampling is a type of sampling method that involves conscious selection of certain subjects or elements or events to be included in the study. While non-probability sampling technique is way by which not every element or every subject in a population has equal chances of election. The survey did not discriminate against caregivers by their age or level of education. Additionally, the sample size of 60 respondents was picked through purposive sampling from 4 wards; one ward was excluded as it was used in the pilot study.

3.2.5 Data collection methods and tools

A sample size of 60 respondents was issued with questionnaires. A notebook was used to note down other additional useful information. Questions such age of the respondent and the child, gender, level of education, water treatment methods, mode of carrying water from the dam, access to information on water treatment, and water storage methods were asked. SPSS version 25 was used to generate tables and figures as well as Microsoft Excel and a notebook to record any other important information in the study.

3.2.6 Inclusion criteria

This study focused on respondents who sought water from sand dams. All respondents who were caregivers to children and sourced their water for domestic use from a sand dam were included in the study.

3.2.7 Exclusion criteria

The study excluded caregivers of children above five years and those that fetched domestic water from other sources like boreholes and shallow wells.

3.2.8 Data analysis

This data was analyzed using SPSS, Graphs and charts were generated through Microsoft Excel. Charts and graphs easily presented statistical findings.

3.3 Results

3.3.1 Socio-demographic characteristics of caregivers and children 1-5 years

The study probed parameters such as sex of the caregivers, age of children, age of respondents/caregivers, and level of education in social demographic factors. Out of the 56 valid responses received, the majority (95%) were female while 5% were males. These statistics are indicative of the fact that the female parent is more available during active hours of the day or that most people with children between the years of 1 to 5 were single mothers (Table 1). The study shows that children in this age category are mostly under the care of their female parents. They gave insights on what was consumed by the children. The findings of this study showed that most caregivers who took part the study had children between the ages of 2 and 3 years old. This subset of caregivers accounted for 26.8%. There was also a percentage tie in ages 4 and 5 years that accounted for 16.1% each (Table 3.1) Minority had children aged 1 year (14.3%). Children under this age category get insights from their caregivers on what to consume. They are not able to make informed decisions, so they might not know what is not fit for their consumption. From the findings most of the respondents were between the ages of 20 and 30 years (55%). This was followed by respondents between the ages of 30 to 40 years which took 28% and those above 40 years accounted for 17% (Table 3.1). This could be a contributor to poor water handling and treatment practices, because those above 40 years might not receive information on water treatment methods as in most cases they stay at home. The findings of the study showed that the majority of the respondents had gone up to secondary level of education (55.4%), this was followed by those who had attained up to college level of education (23.2%) which was then followed by those who had attained up to primary level of education (17.8%) with the minority having not gone to school (3.6%), (Table 3.1). These findings showed that more exposure could mean that the respondents could be familiar with water treatment methods and safe handling.

Table 3.1: socio-demographic on gender, age of the child, age of the respondent and level of education in Yatta Constituency, Kenya.

Socio-demographic characteristic		**%N N=56**
Gender	Female	94.6%
	Male	5.4%
Age of children	1 year	14.3%
	2 years	26.8%
	3 years	26.8%
	4 years	16.1%
	5 years	16.1%
Age of respondents	20 – 30	55%
	30 – 40	28%
	Above 40	17%
Level of education	Primary	17.8%
	Secondary	55.4%
	Collage	23.2%
	None	3.6%

3.3.2 Point of access to dam water Yatta Constituency, Kenya

This section analyzed the characteristics of sand dams that the respondents of this study looked for when they went to source water from a sand dam. This question allowed multiple responses and the options availed; most respondents indicated that when they sourced water from sand dams, they looked for areas of the dam that the water was clear. This tied to the study's earlier assumption that people in Yatta constituency believed clear water to be pure water. Respondents in this category accounted for 73.2 %. The study found that a number of people (17.9%) believed the dam was safe for domestic use in areas where water was clear and there were no animals and many people. Others thought that water was safe in areas of the dam where there were no animals only (8.9%) (Figure 3.2). All these assumptions could lead to the population not treating dam water.

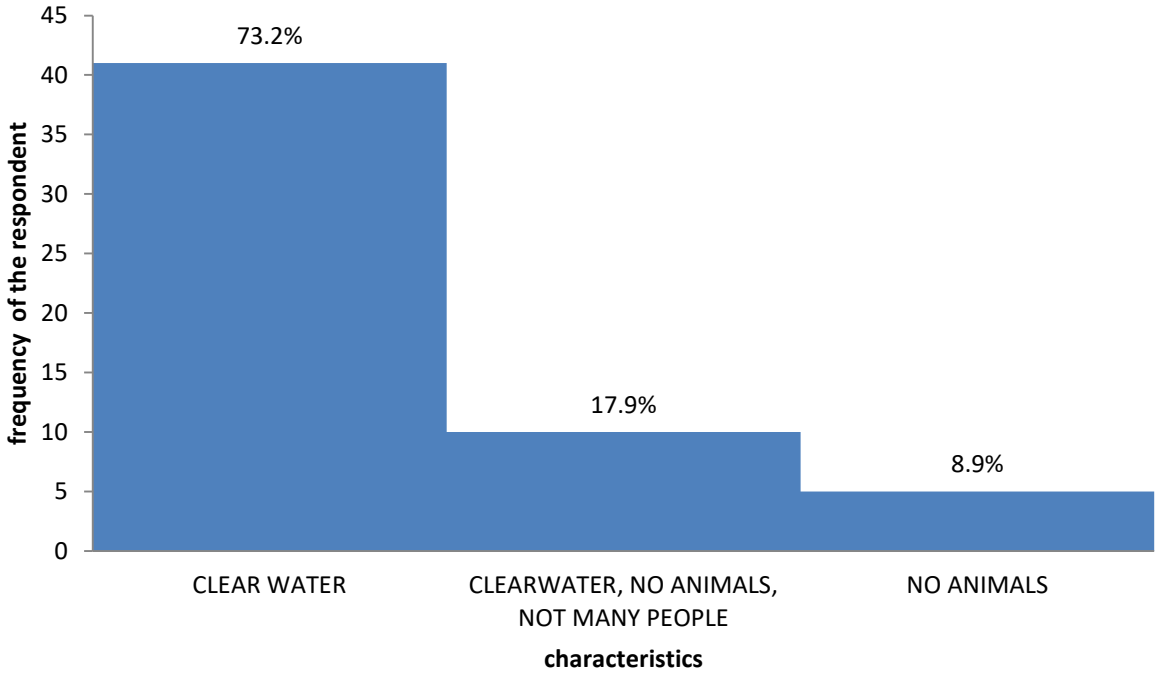

Figure 3.2: Point of access to dam water in Yatta Constituency, Kenya

3.3.3 Sand Dam Water Satisfaction in Yatta Constituency, Kenya

Majority (86%) reported to be satisfied with dam water quality because it is the most common source of water in the area while only 14% respondents were not satisfied with dam water quality (Figure 3.3). Majority 88% of the respondents said that municipality and county government were responsible for dam water treatment while 5% thought that it is individual's responsibility and lastly 7% thought no one was responsible since it's free water as shown in the (Figure 3.4).

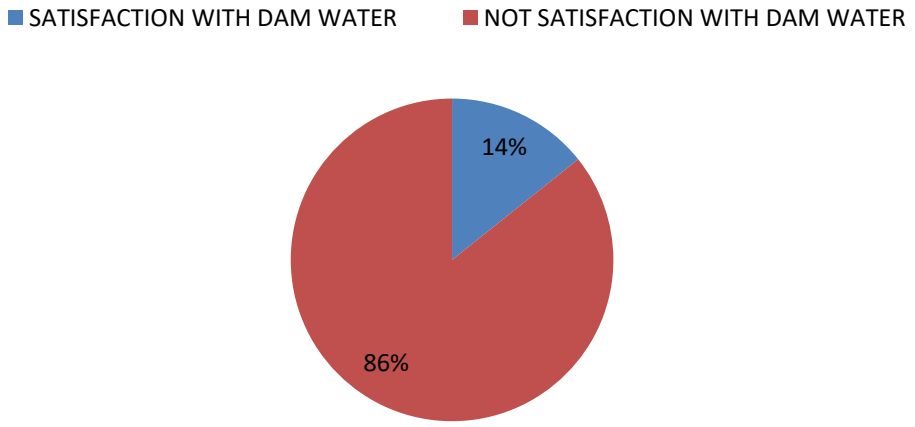

Figure 3.3: Level of respondent's satisfaction with dam water in Yatta Constituency, Kenya

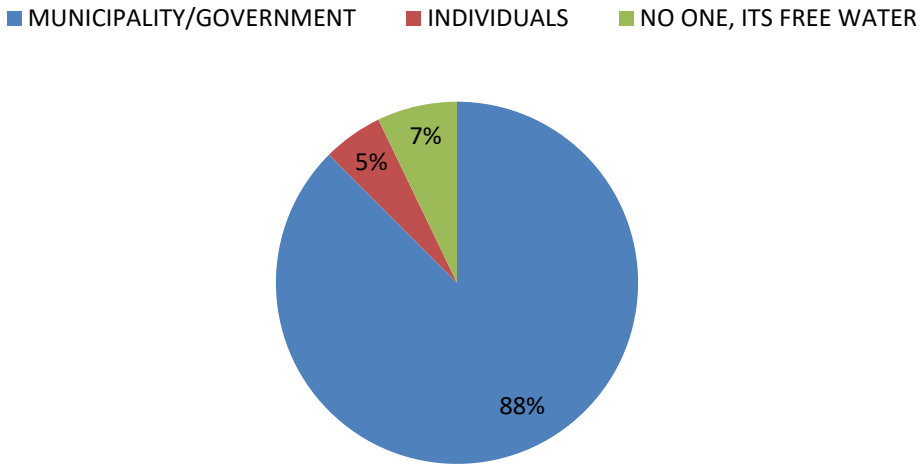

Figure 3.4: Responsibility for the purity of dam water in Yatta Constituency, Kenya

3.3.4 Water Treatment Procedures Used in Yatta Constituency, Kenya

The cluster chart shows the statistics gathered regarding access to information on water treatment procedures (Figure 3.5). This was important to assess the knowledge of caregivers regarding water handling and treatment procedures. Majority that accounted for 69.6% had heard information on water treatment more than a week ago, while 5.4% had heard about the same a week ago. Those that had heard information on water treatment methods two to three weeks ago accounted for 17.9%, while 7.1% had never. Those that had never heard information on water treatment (7.1%) could contribute to unsafe/poor water handling and treatment practice. Yatta Constituency who accessed sand dam water. Multiple choices were allowed, however, all respondents responded with singular choices. Upon further questioning, respondents revealed that they did so as using multiple methods was not necessary and was tedious. Hence, they only 'purified' water using one method. The findings were that most of the respondents (39.3%) did not take any steps to purify the sand dam water, especially if it was fetched in areas of the sand dam where the water was clear. A good number used chlorination method 21.4% used the boiling method of water treatment, and 3.6% did not treat water but allowed it to settle before use (Figure 3.6). However, it was evident that those that did not treat water posed a great challenge to children suffering from water and foodborne illnesses.

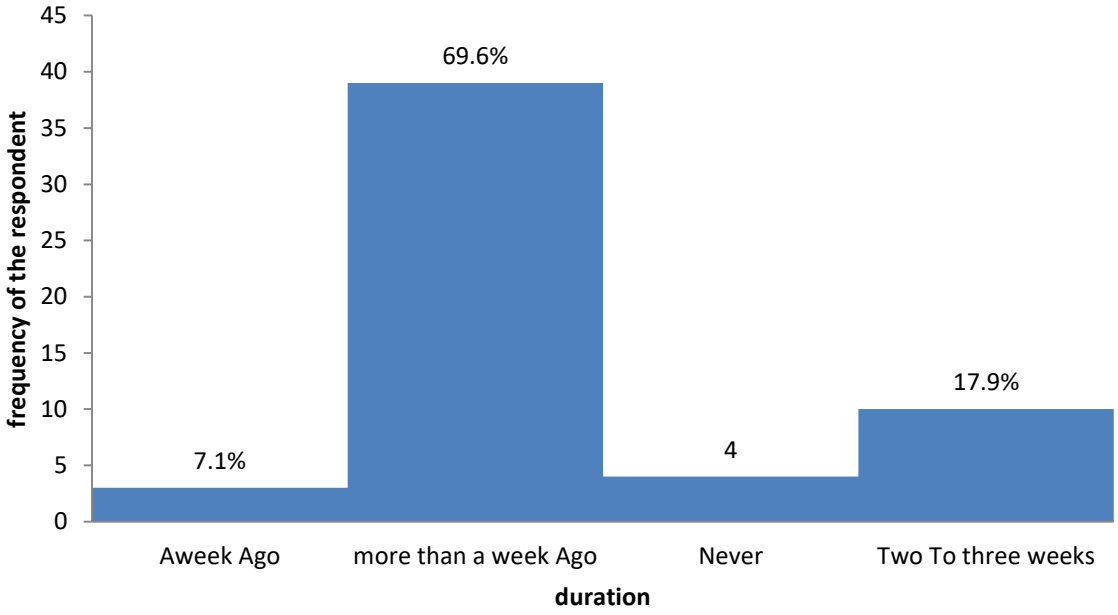

Figure 3.5: Respondents' frequency of access to information on Water Treatment practices in Yatta Constituency, Kenya

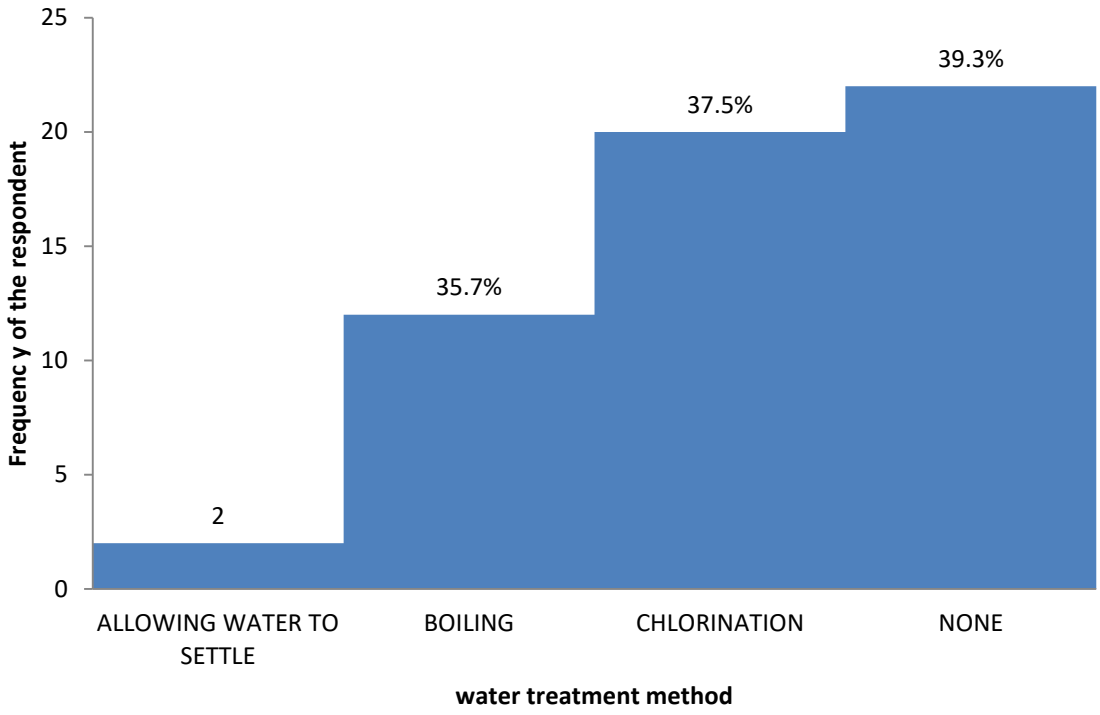

Figure 3.6: Water Treatment Procedures Used in Yatta Constituency, Kenya

3.3.5 Storage of Water in Yatta Constituency, Kenya

From the data collected, 66.1% respondents affirmed that they stored water in plastic containers with lids. This was because they needed to transport the water from the dam to the house and having open containers would mean significant spillage during transport. From the findings, 14.3% respondents carried water in plastic containers without lids and 19.6% respondents in metallic containers (Figure 3.7). Containers without lids could mean further environmental contamination of water. From the study 41.1% of the respondents used dam water within less than a day. A good number contributing to 10.7% stored for less than three days while a majority (48.2%) stored for more than a week (Table 3.2).

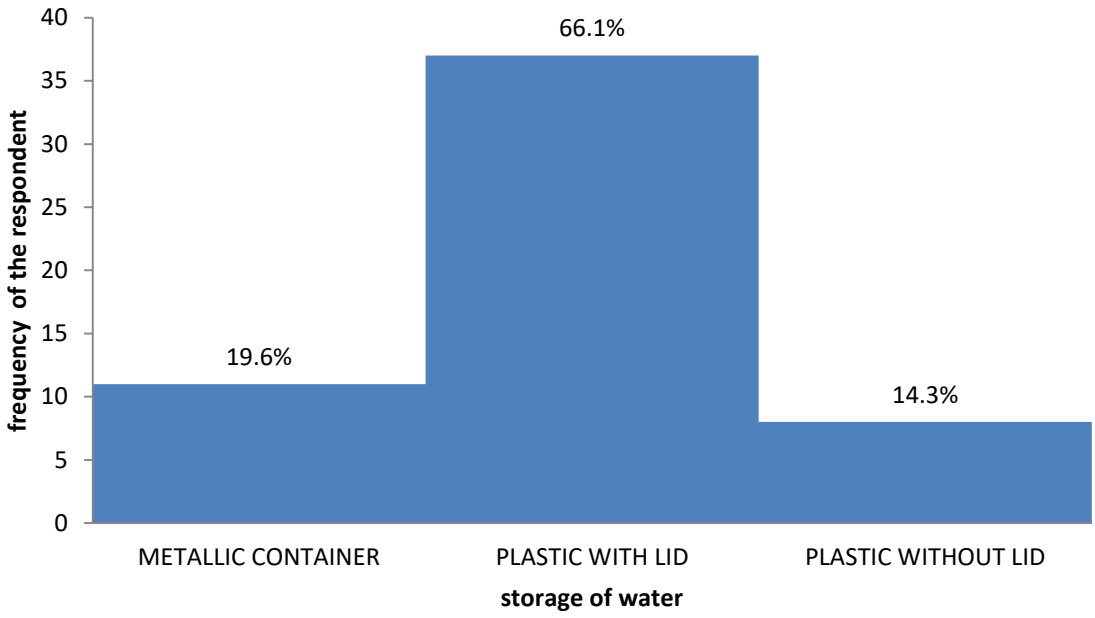

Figure 3.7: Storage equipment of Water in Yatta Constituency, Kenya

Table 3.2: Duration of dam Water Storage before use in Yatta Constituency, Kenya

	How long is water stored?	%N N=56
Storage duration	Less than a day	41.1%
	Less than three days	10.7%
	More than a week	48.2%

3.4 Discussion

3.4.1 Socio-demographic characteristics of caregivers and children 1-5 years

From the study, majority of the caregivers were women. This shows that women dominate in the society with the role of taking care of children (Polanen *et al*., 2017). Lower percentage of caregivers were forty years and above. This could contribute to some of them not treating dam water for domestic use because of lack of information on water treatment attributed to their busy schedules and lack of exposure (Moïse *et al*., 2019). There were some caregivers that had not gone to school at all while some had gone up to primary level. This posed a greater challenge because they lacked exposure and platforms where they can learn on methods of water treatment and safe handling of water (Maybud, 2015). A small number of caregivers had hardly heard of information concerning water treatment, but the majority had information. Those who had no information on water treatment were likely to have their children suffer from food and water borne illnesses (Ndunge *et al*., 2019).

3.4.2 Point of access to dam water Yatta Constituency, Kenya

Knowledge of points on where to fetch water in the dam was well captured in the study as the majority fetched water where it was clear and no animals and people were present (Polanen *et al*., 2017). This study established that the respondents rarely transferred water from one container to another after fetching the water from the dam. Hence, the container used to ferry water from the dam to the household was also used to store the water. This revealed a factor that was not anticipated by this study, that there is a possibility of infection stemming from contact with a container that was used to fetch sand dam water (UNICEF and WHO, 2021). Bacteria on the outside of the container can easily be transferred to children and adults via contact with the said container, The findings are supported by a study done by study by (Mkwate *et al*., 2016) who found that people stored water in open containers with lids followed by narrow neck containers with lids.

3.4.3 Sand Dam Water Satisfaction in Yatta Constituency, Kenya

Dam water quality cannot be guaranteed especially where there are no controls accessing the dam. The water is characterized by poor microbiological quality is likely to lead to infectious waterborne diseases, poor chemical quality may lead to short or long-term health effects and

poor physical quality which may affect its acceptability aspects (Moïse *et al*., 2019). Yatta dam is a multi-purpose dam which is used for drinking water, water for other domestic uses, watering animals and plants (Kioko and Obiri, 2012). Animals and people have uncontrolled use of the dam, accessing the dam water from all directions. This increases the risk of contaminating the water increasing the occurrence of water and food borne diseases in the area (Bakobie and Sukairazu, 2015). A small number (7.1%) were satisfied with the quality of dam water and did not see the need to treat water this could be due to lack of an alternative source of clean water hence having no other choice than accept the quality as it is. However, majority were not satisfied and felt the municipal is responsible for the water quality.

3.4.4 Water Treatment Procedures Used in Yatta Constituency, Kenya

As depicted in the funnel chart (Figure 3.5), there is certainly a high likelihood that many people in Yatta Constituency do not purify water from sand dams and use it directly by virtue of it being clear. Chlorination is the most preferred method of water treatment in Yatta constituency, followed by boiling and allowing water that has settled before use. The study concurs with a study done by *(Kioko and Obiri, 2012*) who established chlorination is the most preferred method of water treatment in Kenya. Given the current state of water quality in developing countries that are managed by municipal; (Akowanou *et al*., 2016) argue that for underserved city populations, point-of-use chlorination of water (at the household level) could act as a more effective and prompt means of shielding communities from both water and foodborne diseases. This assertion, as (Mkwate *et al*., 2016) found, has led to the prioritization of water sanitation and sanitation over hygiene. This paper, in agreement with (*UNICEF and WHO, 2021*) who argues that sanitation, e.g., keeping fecal matter away from hands, foodstuffs, and water, is vital to reducing the burden of infectious diseases nationally and globally. This 'subordination' of hygiene to water sanitation explains why community programs created to deliver clean water and sanitation have repeatedly not reaped the anticipated health benefits as one aspect undercuts the other (Faour-klingbeil, 2020). Where the previous weight has been on providing access to "clean water for all", it is increasingly being argued by scholars from different points that the key means to reducing the burden of water-borne diseases is to incorporate the promotion of hygienic practices e.g., washing hands and domestic water treatment and storage into programs for the provision of improved water supply and sanitation (Gwimbi *et al*., 2019). This finding also

supports the notion that many people in Yatta constituency are likely to suffer from waterborne diseases considering surface run-off might carry pathogens such as faecal coliforms, others that are caused by human activities like bathing in the dam and other pathogens in the soil.

3.4.6 Storage of Water in Yatta Constituency, Kenya

The quality of drinking water is a determinant to health. Household treatment and safe storage has been proven as a great intervention to safe drinking water and prevention of waterborne diseases (Pradhan *et al*., 2018). Water from the dam was packaged in plastic container and transported to the house; some used containers with lids while others had no lid. Containers without lid would lead to further environmental contamination during transport with dust, microorganisms, plant materials and other foreign matter (Spiridon *et al*., 2021). The duration of water storage could be a contributing factor to growth of microorganisms in the water which compromises the quality and safety of the water (World Health Organization, 2013). Microbial multiplication could occur during water storage and the longer the water stays the more it becomes lethal (Farkas *et al*., 2012). Water stored for longer periods would give microorganisms time to grow, thus further contamination compared with water stored for shorter periods before use (Farkas *et al*., 2012; Pradhan *et al*., 2018). People sourcing water from Yatta were found to have poor water treatment and storage practices. This could contribute to increased food and water borne diseases.

3.5 Conclusions

There is a lack of knowledge on water treatment, and this poses health risks to children 1-5 years considering the mode of harvesting dam water. There is a need for public education on the water treatment methods to employ and the dangers associated with not treating dam water.

3.6 Recommendation

There is need to create awareness on affordable methods of water treatment to reduce the risk of waterborne diseases.

CHAPTER FOUR: PREVALENCE OF FOOD AND WATER BORNE ILLNESSES AND THE RISK FACTORS AMONG CHILDREN AGED 1-5 YEARS IN YATTA CONSTITUENCY, MACHAKOS COUNTY, KENYA

Abstract

Yatta Constituency in Machakos County receives low rainfall and coupled with climate changes it has experienced reduced rainfall and increased temperatures. There is thus an insufficient supply of water for domestic and agricultural use in Yatta. The aim of the study was to determine the prevalence of food and water borne illnesses and the risk factors among children aged 1-5 years in Yatta constituency. Questionnaires were used to collect data on social demographic characteristics of caregivers and their children and the prevalence of food and water borne illnesses in the area. From the study sample of 60 respondents, greatest number of children experienced a running stomach after every three months accounted for 21.4 %. This was closely followed by those who experienced both a running stomach and vomiting, within three months which accounted for 19.6%. Most caregivers (89%) suspected the illnesses were as a result of untreated dam water while 11% did not. Furthermore, given the span/frequency in which the sickness occurred, it coincides with the rainfall patterns in the area (three-month periods), in which there are alternate dry and relative wet seasons, it is possible that *S. typhi* may be carried into the dam by surface runoff, by the washing of both human and animal feces among other sources of dam water contamination. Risk factors that contribute to contamination of dam water and food that lead to water and foodborne illnesses include poor sanitation and access to food and storage. Untreated water has been associated with occurrence of waterborne diseases in Yatta. There is need for training of caregivers on hygiene and water treatment to control water and foodborne diseases.

4.1 Introduction

Water is the most essential natural resource however, it is limited in quality and quantity in all locations (Mkwate *et al*., 2016; Moïse *et al*., 2019). Globally, more than 1 billion people cannot gain access to an adequate water source. Therefore, water-borne diseases like dysentery, cholera, diarrhea, and typhoid fever are occurring since most water sources are shared among people (World Health Organization (WHO), 2019). The dam water is considered of poor quality because dams are uncovered and unprotected increasing the risk of contamination from animals, processing, mining, and human waste among other contaminants (Liberacki, 2021). Consequently, people's health is compromised when they consume such water without proper treatment. They wind up suffering from acute microbial contamination or other long-term health effects, stemming from consuming chemically contaminated water (Lillini *et al*., 2020).

Moïse *et al*. (2019) study, established that 13% and 52% of water samples taken from shallow wells and scoop holes had microbial contaminants.

The World Health Organization, in a joint study with (Unicef/ WHO/The World Bank, 2019; UNICEF, 2015) established that approximately 3.2% of deaths (1.8 million people) and 4.2% of disability-adjusted life years (61.9 million people) worldwide can be attributable to unsafe water, poor sanitation, and hygiene. The study also established that of the deaths attributable to hazardous drinking water, deficient hygiene, and sanitation, 99.8% of which occur in developing countries andthatalmost90% of the fatalities are of children. For years, the global availability of safe water and sanitation has been at the helm in the effort to reduce the global prevalence of water and food-borne diseases (Unicef/ WHO/The World Bank, 2019). Despite these efforts, both WHO and UNICEF agree that almost 1.1 billion people globally, still cannot find clean drinking water like a protected well or a piped connection. The two bodies (WHO and UNICEF) further ascertain that majority of the remaining 5.2 billion people who have access to "improved" water sources, are still at risk, as the water they consume is very likely contaminated at the source, in the piping delivery system or because of unhygienic handling during transport or at home (Kioko and Obiri, 2012; Moïse *et al*., 2019). WHO and UNICEF, 2015 estimate that in Europe, 120 million people cannot access safe drinking water. The report continues to state that the consumption of unsafe water is still the key cause of diarrheal disease deaths.

According to (Ashbolt, 2004; Woodward, 2003) there exist three vital types of infectious diseases that can be aggravated by climate change: The first is water-borne illnesses; the second

is food-borne illnesses; and the third is vector-borne illnesses (Eder *et al*., 2018). Human contact with waterborne diseases occurs through contact with polluted drinking water, food, or recreational water. Water and food-borne illnesses are related to the consumption of pathogens via contaminated food or water, whereas vector-borne diseases are linked to the infections spread by arthropods e.g., mosquitoes. As aforementioned, (UNICEF and WHO, 2021) data on the burden of disease points to the fact that about1.8 million people (3.2% of global deaths) and 61.9 million (4.2% of global death) people of disability-adjusted-life years worldwide are linked to poor sanitation, hazardous water, and hygiene. This tally to 88% of diarrheal infections worldwide which is the attributable fraction of diarrhea caused by hazardous water supply and cleanliness in addition to the disease burden from hookworm disease, trachoma, ascariasis, schistosomiasis, and trichiniasis. Hald *et al*. (2016) indicate that food-borne diseases occur through the ingestion of foodstuffs (including water), that have been contaminated by chemicals or microorganisms. The researchers continue to argue that the risks of contamination, particularly in food, stem from the food chain found the estimation of food-borne disease burden to be complicated as most of the hazards causing food-borne diseases are not transmitted solely by food (Akowanou *et al*., 2016; Ashbolt, 2004; Faour-klingbeil, 2020). Food has numerous exposure means, consisting of transmission from animals, by humans, and via environmental routes, which includes water. In agreement with (UNICEF and WHO, 2021), (Hoffmann *et al*., 2017) find that water plays a major role in propagating food-borne diseases, hence, the separation of food and water as exposure vehicles is challenging, particularly at the community level.

4.2 Materials and methods

4.2.1 Study area

The study area is as per section 3.2.1

4.2.2 Study population

This study targeted caregivers of children aged 1-5 years since children are the bulk of the population affected by water and foodborne diseases. Children in this category have low immunity compared to older ones. Since they are still under parental/guardian care, it was

prudent to target their caregivers as a sample group as they take care of them and are aware of the symptoms experienced when they are sick.

4.2.3 Sampling

The sample size was arrived at using Fischer's (1991) formula, as illustrated below. To offset any inaccuracy that might have occurred from the missing data, an additional 10 respondents. Random sampling of respondents who reside and draw water from Yatta dam, a sample of 60 respondents were sampled for the study.

s

$$= \frac{z^2 \ x \ p \ x \ q}{f2}$$

$$n = \frac{1.92^2 \ x \ 0.75 \ x \ 0.25}{(0.12)2}$$

= 50 respondents

By adding an attrition of 20% of the sample size

$\frac{50 \ x \ 20}{100}$ = 10 respondents

Thus total respondents =50+ 10

=60 respondents

N=Desired sample size

Z=Standard deviation responding to 95% confident interval

P=Proportion of eligible children in the study.

F=Degree of accuracy desired.

By combining an attrition rate of 0.2 (20%) with the sample size

4.2.4 Sampling procedure/technique

Non Probability sampling technique involves a purposive sampling method which was used in obtaining the sample of the study. It involved conscious selection of caregivers to be included in the study. The survey did not discriminate against caregivers by their age or level of education. Additionally, the sample size of 60 respondents was picked through purposive sampling from 4 wards; one ward was excluded as it was used in the pilot study.

4.2.5 Data collection methods and tools

A sample size of 60 respondents was issued with questionnaires. A notebook was used to note down other additional useful information. Questions such age of the respondent and the child, gender, level of education, symptoms experienced by children and whether they suspected the illnesses were caused by untreated dam water food acquisition and storage were asked. SPSS version 25 was used to generate tables and figures as well as Microsoft Excel and a notebook to record any other important information in the study.

4.2.6 Inclusion criteria

This study, due to its topic, only focused on respondents who sought water from sand dams. To this effect, it was a requirement that a respondent must source their water for domestic use from a sand dam.

4.2.7 Exclusion criteria

The study excluded caregivers of children above five years and those that fetched domestic water from other sources like boreholes and shallow wells. The exclusion of other sources of water was done to narrow the scope of the study and enable it to prove whether the variables being investigated had a bearing on the objectives of the study or not.

4.2.8 Data analysis

This data was analyzed using SPSS to draw descriptive statistics, correlations and chi-square tests

4.2.9 Determination of prevalence

Prevalence =n/p (100)

Where: n is the number of sick children

p is the number of total children in the study

n=12, p=56

$\frac{12}{56}$x100= 21.4%

4.3 Results

4.3.1 Prevalence of food and waterborne illnesses in Yatta Constituency, Kenya

Most respondents in Yatta (87.5%) sourced drinking water from the dam (Figure **4.**2). Waterborne diseases were common in Yatta constituency with stomach being the most prevalent (21.4%) occurring at least three months among children (Table **4.**1). More than eight in every ten respondents (89.3%) suspected the illnesses to be caused by the dam water. Also, more than nine in every ten respondents (92.9%) cleaned food stuffs using still water in a basin. There was no significant association ($\chi^{2=}13.33^{a}$, p=0.771) between the source of water and the symptoms experienced by the respondents, however, these symptoms were significantly associated ($\chi^{2=}102.66^{a}$, p<0.001) with water treatment process. Additionally, water storage method was significantly ($\chi^{2=}49.85^{a}$, p<0.001) associated with the illnesses experienced by respondents with water stored in plastic containers without lids being the most suspected. Water storage time was significantly associated ($\chi^{2=}97.40^{a}$, p<0.001) with causing illnesses among respondents with water stored for more than a week being linked with causing running stomach and vomiting.

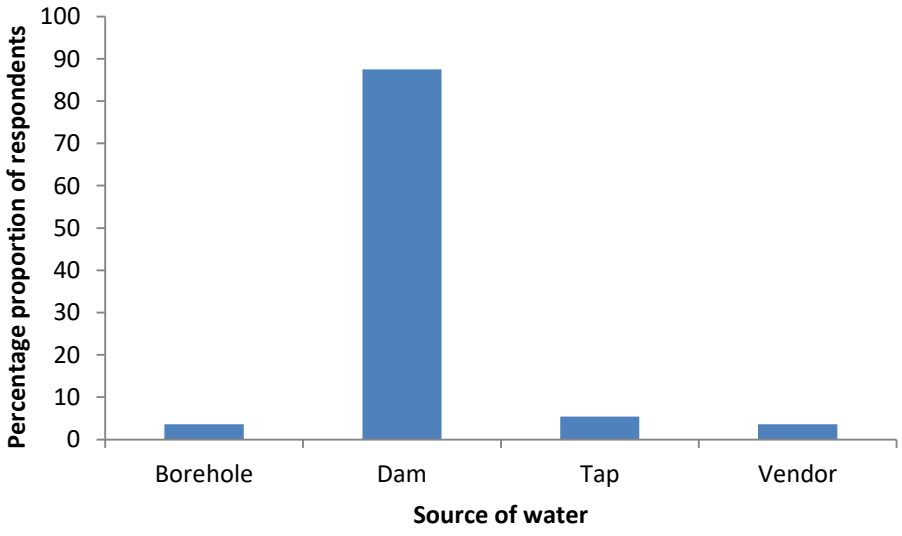

Figure 4.2: Source of water for residents of Yatta constituency

Table 4.1: Frequency of symptoms of experienced by children 1-5 years in Yatta Constituency- Kenya

Symptoms experienced	Frequency	Number of sick children	Percent Prevalence
Fever	Every three months	6	10.7
Headache	Every six months	1	1.8
Puking	Every month	5	8.9
Running stomach	Every month	5	8.9
Running stomach	Every three months	12	21.4
Running stomach	Rarely	4	7.1
Running stomach, headache	Every three months	2	3.6
Running stomach, puking, fever	Every six months	5	8.9
Running stomach, puking, fever	Every three months	5	8.9
Running stomach, puking	Every three months	11	19.6

4.3.2 Risk factors linked to contamination of dam water in Yatta

More than 51.8% of the respondents did not have animals. Majority of them (83.9%) did not bathe in the dams. These are risk factors associated with dam water quality. Other risk factors included lack of toilet facility in their homes and lack of access to information on water treatment, contamination of food at the marketplace poor hygiene during food preparation. Majority stored their foodstuff next to utensils and other kitchenware (71%) and others (23%) in open area in the house. More than seven in every ten respondents (73%) acquired food from the market. The source of food significantly associated ($\chi^{2=}60.98^{a}$, $p<0.001$) with the frequency of symptoms experienced by the respondents. Most people bought their food from open-air

markets and stored it next to utensils and other kitchen items. More than three quarters of the respondents (75.0%) washed their food stuff before cooking and almost all of them (92.6%) washed the food stuff using still water in a basin. Half of the respondents (50.0%) had indoor toilets while 33.6% were using pit latrines. Sanitation was significantly associated ($\chi^{2=}53.36^{a}$, $p<0.001$) with the symptoms experienced by respondents in Yatta. Several risk factors were associated with water contamination and disease symptoms (Table 4.2). Those who did not treat drinking water were at high risk of experiencing running stomach (Figure 4.3).

Table 4.2: Risk factors associated with water contamination and disease symptoms

	Risk Factor	χ^2
1	Water treatment process	102.66 **
2	Storage of water	49.85 **
3	Access to information	51.59 **
4	Sanitation	53.36 **
5	Place of bathing	23.36 **
6	Source of food	60.98 **
7	Cleaning of food	70.73 **
8	Storage of food	50.61 **

*correlation is significant at 0.05 level, **correlation is significant at the 0.001 level

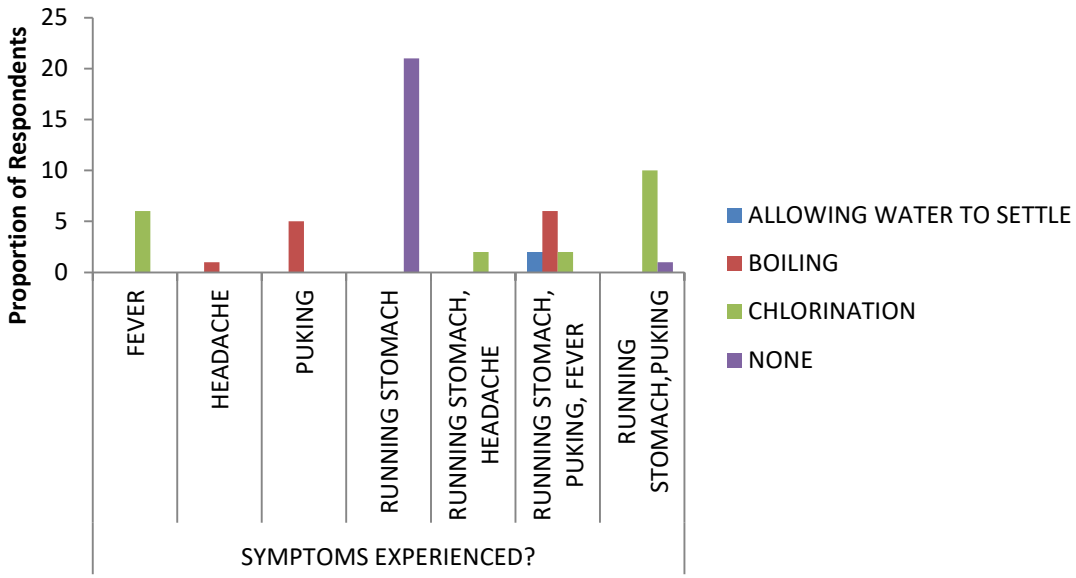

Figure 4.3: Method of water treatment and symptoms experienced by respondents

4.4 Discussion

4.4.1 Prevalence of food and waterborne illnesses in Yatta Constituency, Kenya

From the findings of the study the most prevalent symptoms were running stomach followed by running stomach together with puking after every three months. These are base symptoms for typhoid fever that is caused by the bacterium *Salmonella Typhi*. It is an indication that children in the mentioned age category suffered from water and foodborne illnesses. The study is supported by (Moïse *et al*., 2019; Ashbolt, 2004)) study, which indicated that water samples taken uncovered water sources was contaminated with microbes. The high microbial contaminants is due to deposition of these contaminants into the water by animals, rain water and humans (Kioko and Obiri, 2012).

From the findings of the study it was noted that most caregivers/respondents believed that illnesses were as a result of consuming untreated dam water (Akowanou *et al*., 2016; Cheraghi *et al*., 2014). Untreated dam water could be contaminated with microbial pathogens considering the mode of dam water harvesting (Ashbolt, 2004). Microorganisms find their way to the children body and cause illnesses. Studies done by (Hoffmann *et al*., 2017), state that food-borne diseases occur through the ingestion of foodstuffs (including water), that have been contaminated by chemicals or microorganisms. The researchers continue to argue that the risks of contamination, particularly in food, stem from the food chain (from food production to consumption) i.e., "from farm to fork", and involve the pollution of soil, water, or air. The researchers' found that the estimation of food-borne disease burden to be complicated as most of the hazards causing food-borne diseases are not transmitted solely by food (Hoffmann *et al*., 2017)argue that food has multiple exposure routes, consisting of transmission from animals, by humans, and via environmental routes, which includes water. In agreement with (UNICEF and WHO, 2021), find that water plays a major role in propagating food-borne diseases, hence, the separation of food and water as exposure vehicles is challenging, particularly at the community level.

4.4.2 Risk factors linked to contamination of dam water

Untreated water was associated with food and waterborne diseases in Yatta mainly as it is a medium for microbial growth (Gwimbi *et al*., 2019). Most people in Yatta were using untreated dam water loaded with microorganisms (Ndunge *et al*., 2019). Respondents reported fever, running stomach, headache and puking as a result of use of untreated dam water. This occurred

after a period of three months and considering that rains come after every three months, this could be the reason as to why water and food borne illnesses are prevalent during this period (WHO, 2019). Majority used boiling, chlorination while 24 did not use any method of water treatment (Moïse *et al*., 2019). A large number did not treat water and this could be the reason of the prevalence of waterborne and foodborne illnesses (WHO, 2019). Areas of the dam with access for both animals and people were suspected to contain microorganisms especially *Staphylococcus aureus* (Ashbolt, 2004). Dam water was used to clean foods that are eaten raw thus contamination of food was considered high in Yatta. Bacteria contamination of drinking water is a major problem in rural areas especially in the arid and semi-arid regions where access to clean water is a major challenge (Gwimbi *et al*., 2019). This could lead to ingestion of pathogens hence causing food and water borne illnesses (Ndunge *et al*., 2019; WHO, 2019).

Contamination of the dam water in Yatta can be attributed to open defecation, livestock faeces, infiltration of faecally contaminated water from nearby latrines, inadequate protection of water sources and unhygienic management of sources (Gwimbi *et al*., 2019). Contaminated drinking water has largely contributed to contamination of food increasing the prevalence of foodborne illnesses in Yatta. Water contaminated with *Campylobacter jejuni, enterotoxigenic Escherichia coli, Shigella spp. and Vibrio cholera* and other microbial species contribute to many gastrointestinal diseases (Ashbolt, 2004). Additionally, lack of toilet/latrine could be a contributing factor to water and food borne illnesses and water contamination due to open defecation and disposal of human feaces. This is because when the rain comes it carries with it human faeces collected from the bush where they probably go for long and short calls (Ndunge *et al*., 2019). Another contributing factor is lack of information on water treatment methods. Lack of awareness could also contribute to food and waterborne illnesses. Also, households stored water for more than a week before using which could create an environment for growth of pathogens contributing to more illnesses. Containers without lids expose the water in to environmental contamination such as dust.

4.5 Conclusion

Contamination of drinking water has increased the prevalence of food and waterborne diseases in Yatta. The residents lack knowledge on methods of water treatment and hygiene and sanitation

practices which could reduce the risk. The residents frequently suffer diarrhoea, typhoid, stomach aches and other gastrointestinal diseases.

4.6 Recommendations

The recommendations included; drilling of wells, boreholes, and supply of tapped water, frequent civic education on water treatment practices and establishment of formal food markets which comply with food handling standards. People should store water in covered containers and should not be stored for long. The community should avoid storing uncooked food alongside clean utensils and use of treated water to wash foods that are eaten raw.

CHAPTER FIVE: GENERAL CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Most people in Yatta constituency who source water from the different sand dams do not treat the water before consuming it or using it in the preparation of foodstuff. This leaves them vulnerable to water-borne diseases, which occur in spans of three months, given the rain patterns in the area alternate in three-month periods. The spread of information on water treatment in Yatta constituency seems to be sparse and sporadic. Most respondents in this study last heard of water treatment practices within a month and a good number of those who did still did not put them to practice, thus exposing themselves to waterborne and food borne illnesses. Most people in Yatta constituency access their foodstuff from open-air markets, which they then store in the kitchen area, next to utensils and other kitchenware. Additionally, they wash the food with still water (fetched from the dam and untreated) just before cooking the foodstuff. There is also possible contamination of foodstuff at the open-air markets or during storage. The most prevalent waterborne disease in Yatta was established to be Typhoid Fever, given the consistent symptoms of diarrhea and vomiting, which are consistent with the disease. The disease's frequency of occurrence (three-month spans) was also seen to tie to the occurrence of rain in the area. Surface runoff washes fecal matter, transferring the pathogen from the feces to the water, which is then used without treating, causing typhoid fever amongst other waterborne diseases, both in infants and their caregivers.

5.2 Recommendations

There is need for the county government to drill wells, boreholes, and supply of tapped water to reduce the chances risk of contamination with feacal matter and other possible contaminants.

Frequent civic education on water treatment practices-enhancing the quality and frequency of civic education regarding water treatment will greatly enrich the Population of Yatta by shifting more knowledge to their disposal.

Establishment of formal food markets which comply with food handling standards-formalizing open-air markets makes it easier to control the quality of food being sold in these areas or at the very least, how the foodstuff is handled.

Formulation of safe water policy-the ministry of water should come up with safe water policies which will enlighten the public on use of safe water for domestic use to curb water and foodborne illnesses.

REFERENCES

Akowanou, A.V.O., Aina, M.P., Groendijk, L., Yao, B.K., 2016. Household Water Treatment in Benin : Current / Local Practices. Eur. J. Sci. Res. 142, 246–256.

Amoukpo, H., Bachirou, Z.S., Diez, G., Akuesson, L., Lanignan, R., Degnonvi, H., Barogui, Y., Boni, G., Boko, M., Johnson, R.C., 2018. Knowledge , Attitudes and Practices of the Population of the District of Ahomadégbé (Municipality of Lalo) in Benin on Methods of Water Treatment at Home 251–265.

Ashbolt, N.J., 2004. Microbial contamination of drinking water and disease outcomes in developing regions. J. Toxicol. 198, 229–238.

Bakobie, N., Sukairazu, I., 2015. Assessment of dam water quality in three selected communities in Savelugu-Nanton municipality , Ghana 2, 225–231.

Cheraghi, Z., Okhovat, B., Irani, A.D., Talaei, M., Ahmadnezhad, E., Gooya, M.M., Soroush, M., Asl, H.M., Holakouie-naieni, K., 2014. Knowledge , Attitude , and Practice regarding Food , and Waterborne Outbreak after Massive Diarrhea Outbreak in Yazd Province , Iran , Summer 2013 2014.

Eder, M., Cortes, F., Teixeira, N., Filha, D.S., Vinícius, G., França, A. De, Degroote, S., Braga, C., Ridde, V., Maria, C., Martelli, T., 2018. Scoping review on vector-borne diseases in urban areas : transmission dynamics , vectorial capacity and co-infection 1–24.

Faour-klingbeil, D., 2020. Prevention and Control of Foodborne Diseases in Middle-East North African Countries : Review of National Control Systems 1–23.

Farkas, A., Dragan-Bularda, M., Muntean, V., Ciataras, D., Tigan, S., 2012. Microbial activity in drinking water-associated biofilms. Cent. Eur. J. Biol. 8, 201–214.

Fengting, Li, Mumbi, A.W., Fengting, L, Karanja, A., 2018. Sustainable treatment of drinking water using natural coagulants in developing countries: A case of informal settlements in Kenya Technology innovation for advanced treatment of coking wastewater View project

Use of Diatomaceous Earth for textile waste wa. Water Util. J. 18, 1–11.

Fisher Andrew; Laing John; Stoeckel John; Townsend John, 1991. Handbook for family planning operations research design. 2nd ed. TT -, 2nd ed. Population council, New York, USA.

Gwimbi, P., George, M., Ramphalile, M., 2019. Bacterial contamination of drinking water sources in rural villages of Mohale Basin , Lesotho : exposures through neighbourhood sanitation and hygiene practices 1–7.

Hoffmann, S., Devleesschauwer, B., Aspinall, W., Cooke, R., Corrigan, T., Havelaar, A., Angulo, F., Gibb, H., Kirk, M., Lake, R., Speybroeck, N., Torgerson, P., Hald, T., Washington, D.C., States, U., 2017. Attribution of global foodborne disease to specific foods : Findings from a World Health Organization structured expert elicitation 1–26.

Kioko, K.J., Obiri, J.F., 2012. Household attitudes and knowledge on drinking water enhance water hazards in peri-urban communities in Western Kenya 1–5.

Liberacki, D., 2021. The Water Balance in a Dam Reservoir -a Case Study of the Przeb ę dowo Reservoir The Water Balance in a Dam Reservoir – a Case Study of the Przeb ę dowo Reservoir.

Lillini, R., Tittarelli, A., Bertoldi, M., Ritchie, D., Katalinic, A., Pritzkuleit, R., Launoy, G., Launay, L., Guillaume, E., Tina, Ž., Modonesi, C., Meneghini, E., Amati, C., Salvo, F. Di, Contiero, P., Borgini, A., Baili, P., 2020. Water and Soil Pollution : Ecological Environmental Study Methodologies Useful for Public Health Projects . A Literature Review 256.

Maybud, B.S., 2015. Women and the Future of Work – Taking care of the caregivers.

Mkwate, R.C., Chidya, R.C.G., Wanda, E.M.M., 2016. SC. Phys. Chem. Earth.

Moïse, N., Kaluli, J.W., Home, P.G., 2019. Evaluation of sand-dam water quality and its suitability for domestic use in arid and semi-arid environments : A case study of Kitui-West

Sub-County , Kenya 11, 91–111.

Mureithi, S.M., Verdoodt, A., Njoka, J.T., Gachene, C.K.K., Warinwa, F., Ranst, E. Van, 2014. Impact of community conservation management on herbaceous layer and soil nutrients in a kenyan semi-arid savannah.

Ndunge, D., Mbuge, D.O., Omuto, C.T., 2019. Protocol for Evaluating Sand Dam Water Quality in Semi-Arid Areas : A Case Study of Makueni County International organization of Scientific Research 09, 1–14.

Polanen, M. Van, Colonnesi, C., Tavecchio, L.W.C., Fukkink, R.G., Polanen, M. Van, Colonnesi, C., Tavecchio, L.W.C., 2017. Men and women in childcare : a study of caregiver – child interactions 1807.

Pradhan, S.K., Sinha, U., Satapathy, D.M., Swain, A.P., Mishra, R.P., 2018. Assessment of household water treatment and storage practices. Int. J. Community Med. Public Heal. 5, 1060.

Spiridon, S.I., Ionete, E.I., Ionete, R.E., 2021. Household Water Treatment and Safe Storage. Adv. Sci. Technol. Secur. Appl. 495–522.

Unicef/ WHO/The World Bank, 2019. Levels and Trends in Child malnutrition - Unicef WHO The World Bank Joint Child Malnutrition Estimates, key findings pf the 2019 edition. Unicef 4.

UNICEF, 2015. for every child Annual Results Report Child Protection.

UNICEF and WHO, 2021. The measurement and monitoring of water supply, sanitation and hygiene (WASH) affordability: a missing element of monitoring of Sustainable Development Goal (SDG) Targets 6.1 and 6.2.

WHO, 2019. Surveillance and outbreak water-related infectious diseases water-supply systems.

Woodward, A., n.d. Climate change and human health Editors.

World Health Organization, 2013. Household Water Treatment and Safe Storage (Hwts) 267.

World Health Organization (WHO), 2019. Water, Sanitation, Hygiene and Health: A Primer for Health Professionals. World Heal. Organ. 1–40.

World Health Organization, United Nations Children's Fund, 2012. Global monitoring instruments for water, sanitation and hygiene 4.

APPENDICES APPENDIX I: PROPOSED BUDGET

PROPOSED OBJECTIVES	ACTIVITY	COST		
		Item	**Unit Cost**	**Total Cost**
Specific Objective 1: To determine knowledge, water handling, and treatment practices in Yatta constituency. **Specific Objective 2 (i)** To establish the prevalence of food and water-borne illnesses in Yatta constituency. **Specific Objective 2 (ii)** To evaluate microbial risk factors linked to contamination of dam water in Yatta constituency.	Questionnaire to respondents Enumerators (two for two days) **SUBTOTAL**	Realm of printing paper Printing cost Transport to and from the field Training Wages	500 50 500 1000 2500	500 3000 1000 2000 10,000 **16,500**

General Expenses	**Supervision** **Printing& Binding of thesis Printing and** **Binding of Dissertation** **Publication** **Miscellaneous**		**25,000** **1000** **1000**	**50,000** **10000** **5000** **20,000** **20,000** **105,000**
	Sub-Total			
GRAND TOTAL				**121,500**

APPENDIX II: TIMELINE OF THE STUDY

ACTION	**MONTH**											
	J	F	M	A	M	J	J	A	S	O	N	D
PROPOSAL WRITING												

PROPOSAL PRESENTATION												
PROPOSAL EDITING/CORRECTION												
SUBMISSION TO BOARD OF POST-GRADUATE STUDIES.												
RECONNAISANCE VISITAT THE FIELD.												
PREPARATION OF FIELD												
ASSISTANTS.												
PILOT STUDY/TESTING OF RESEARCH TOOLS.												

ACTUAL DATA COLLECTION.												
LAB TESTING.												
DATA ENTRY AND ANALYSIS.												
SUBMISSION OF DRAFT THESIS.												
CORRECTIONS/EDITING OF FINAL THESIS												
SUBMISSION OF FINAL THESIS.												
DEFENCE/ORAL PRESENTATION.												
REVISION OF FINAL												

DISSERTATION												
SUBMISSION												

Table 1.1 Chronology of Events

APPENDIX III: ASSENT FORM (CONSENT).

Greetings, I am a student pursuing a master's degree in food safety and Quality at the University of Nairobi. As part of the qualification for this degree, I am required to perform research relevant to my course. To this effect, I am conducting a study on the **assessement of caregivers' food-water handling practices, knowledge and prevalence of food-water borne diseases in children (1-5 years) Yatta, Kenya: (a case of sand dams).** Authorization to conduct out this study has been granted by the county government of Machakos and the authorities' inYatta Constituency. If you consent to it, I solemnly promise to treat any information you divulge as confidential and only use it for this study alone. Kindly consider taking part in this study as its findings shall serve in reducing the cases of and food-borne diseases in your ward/constituency and Kenya.

I…… consent to this study after reading the above information. I authorize Peris Mugendi, a Masters' student at the University of Nairobi, to use the data I divulge in the manner prescribed in this consent form.

SIGN…….. Date……

APPENDIX IV: RESEARCH QUESTIONNAIRE

Hello and thank you for agreeing to participate in this study. As indicated in the consent form, this is a study on assessing **caregivers' food-water handling practices, knowledge and prevalence of food-water borne diseases in children (1-5 years) Yatta, Kenya: (a case of sand dams).** Your input is again much appreciated, and the data will be kept confidential and within the confines of this research.

The questionnaire has three sections, kindly read carefully and answer to the best of your ability.

BIO-DATA

1.What is your gender?

a. Female

b. Male

2.How old are you?

a. 20-30
b. 30-40
c. Above 40

3.How old is your child?

a. 1-3 years
b. 3-5 years

4.What is your level of education?

i. Primary
ii. Secondary
iii. College
iv. None

SECTION I WATER

1. Where do you frequently get water for domestic use?
    i. Dam
    ii. Tap
    iii. Borehole
    iv. Bought water/from a vendor
    v. Rainwater
2. Other Source? Please state……..
3. If your answer above was dam water when you go to fetch water at the dam, what do you look for?
    a. Places where the water is clear.

b. I fetch water furthest from the shore.

c. I fetch water where there are no animals.

d. I fetch water where other people are washing/fetching water.

e. I fetch water when there aren't many people at the dam e.g., early in the morning.

4. What procedures do you follow to treat the water? (Multiple choices are accepted)

    a. Chlorination (water guard)

    b. Boiling

    c. Filtration

    d. Allowing the water to settle then separating it.

    e. None

5. After treating the water, how do you store it?

    a. In plastic containers with lids.

    b. In plastic containers without a lid (basin).

    c. In metallic containers.

    d. Other means? Please state…….

6. On average, how long do you store water before using it?

    a. Less than a day.

    b. Less than three days.

    c. More than a week.

7. When is the last time you heard or accessed information on water treatment?

    a. A day or two ago.

b. A week ago.

c. Two to three weeks ago.

d. More than a month.

e. Never.

8. Where do you go for long/short calls (choo)?

    a. Pit Latrine

    b. Indoor toilet

    c. Anywhere I can help myself

    d. I use a hole that I then cover with earth

9. Any other method? Please state…….

10. Are you satisfied with the quality of Dam water you use?

    a. Yes

    b. No

11. Where do you get water for your domestic animals if you have any? If you don't, please move to the next question.

    a. They are grazed and drink water in the fields

    b. They drink water from the dam.

    c. From a well/borehole.

    d. I do not source water for the animals.

12. Any other source? Please state……

13. Do you in some instances bathe in the Dam?

a. Yes

b. No

SECTION II FOOD

14. Where do you get most of your foodstuffs?

    a. Market

    b. Garden/Farm

    c. Trading with neighbours.

    d. Supermarket

15. Do you clean the foodstuff after purchase or before you cook?

    a. Just before cooking.

    b. After purchase.

    c. Both after purchase and before cooking.

16. How do you clean the food after buying it? (Where applicable)

    a. Using running water from a tap.

    b. Using still water in a basin.

    c. I do not clean the foodstuffs.

17. How do you store the foodstuff?

    a. In a granary

    b. In an indoor pantry

    c. Alongside utensils and other kitchenware.

    d. In an open area within the house.

18. In your opinion who should be responsible for water quality from the dam?

    a. Municipality

    b. Individual

c. No one, its free water

SECTION III ILLNESSES

19. Are there cases where you suspect your child or children fell ill because of taking untreated dam water? (e.g., diarrhea, cholera, typhoid)
    a) Yes
    b) No

20. If yes which signs and symptoms did the child portray? (Multiple choices allowed)
    a. Running stomach
    b. Puking (kutapika)
    c. Fever.
    d. Headache.

21. Other symptoms? Please State
22. On average, how often do you or your child fall ill from typhoid, cholera, dysentery, or diarrhea?
    a. Weekly
    b. Every two weeks
    c. Every month.
    d. Every three months.
    e. Every six months.
    f. Rarely.
23. Are there any diseases other than the above listed that you or your child frequently suffer from? If yes, please state it…….