DEPARTMENT OF BEHAVIOURAL AND SOCIAL SCIENCES
SCHOOL OF PUBLIC HEALTH
UNIVERSITY OF GHANA

ACCEPTABILITY AND USE OF WATER FILTERS IN TWO RURAL COMMUNITIES IN SHAI-OSUDOKU DISTRICT OF GHANA

BY

AFUA MARFOAH OFORI
(10248753)

THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MSC APPLIED HEALTH SOCIAL SCIENCE DEGREE

SEPTEMBER, 2016

DECLARATION

I hereby declare that except for references to other people's work which have been duly acknowledged, this dissertation is the result of my own investigation carried out under the supervision of Dr. Collins Ahorlu of the Noguchi Memorial Medical Research Institute. I also declare that, to the best of my knowledge, this dissertation has never been presented in whole or part for another degree elsewhere.

……

Afua Marfoah Ofori

(Student)

……

Dr. Collins Ahorlu

(Supervisor)

ABSTRACT

Household water treatment can improve water and make it safe for drinking and may prevent diarrhoea diseases. The acceptability of an intervention is an important condition for its successful implementation. To study the acceptability and use of water filters in the study area, the study was designed to address the following objectives: a) to assess the sources of drinking water in the two communities. b) to assess the knowledge of the people on water filter and its usefulness c) to determine how frequent water filters are used d) to determine the level of acceptability and use of water filters and e) to assess diarrhoea related perceptions in terms of causes, treatment and prevention in the study communities. Quantitative and qualitative research techniques were employed for the study. Households were selected by using purposive sampling. Analysis was done on quantitative data using STATA software while content analysis was done on the qualitative data to determine relevant narratives for presentation. The results revealed high acceptance of water filters in the studied communities. Significant proportion of the study participants had knowledge deficits about causes and prevention of diarrhoea. There were no statistically significant relationship between independent (marital status, level of education and household size) and dependent variables (use of the filters). This study contributes to existing knowledge on acceptability and use of water filters as a means to control diarrhoea disease in Ghana.

DEDICATION

Glory! Glory to the Most High God!!

This dissertation is dedicated to my mother Alice Gyimah for your persistency in educating me and to all my siblings (Oforiwaa, Nyarkoa, Yeboaa and Takyiwaa).

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Dr. Collins Ahorlu of Noguchi Memorial Medical Institute, with indescribable appreciation. You trusted me from the onset and committed this project to my care. You made time through thick and thin to ensure that I do quality work. You have taught me excellence at different level. Thank you also for helping me secured the financial support for the study. My sincere appreciation goes to Dr. Reuben Esena (School of Public Health (SPH)) for your comments at the proposal level. Philip (SPH), the discussions we had from time to time were helpful.

The District Assembly, Chief Elders and residents of Apese and Amanfro for their warm reception and cooperation during the field work, I say *Akpenami*. I am particularly grateful to Adjei and William of Apese and Amanfro. I cannot forget the assistance I received from Mrs Cynthia Ahorlu. You have a special heart for people. I really appreciate all your efforts. Many thanks goes to Reginald and Stephanie for their tireless support. The teaching staff of the Department of Behavioural and Social Sciences did a great work in training me to be able to undertake this task. Of this I say thank you. I am grateful to all my course mates especially, Selina, Joyce Annor, Joyce Hommey, Lynn, Nardia, Patience, Jones and Michael. It was great working with you all!

I am deeply grateful to my husband Yaw and my children Nhyira, Nhyiraba, Ayeyi and Anuonyam; for your steadfast support during this period of study. Without your understanding and co-operation, it would have been very difficult to come this far. My sincere appreciation goes to my uncle Adofo and the rest of the family. I appreciate all your efforts! I would like to make a special mention of my friend Gloria and her family for the spiritual support. I am thankful.

May God bless you all!

This study was funded by SC Johnson through its 'Base of the Pyramid' programme in collaboration with Green World Health Net 307 Amherst Dr. SE Albuquerque, NM 87106, USA.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CHPS-Community-Based Health Planning and Services

GAPPD- global action plan to end preventable child deaths from pneumonia and diarrhoea

GSS-Ghana Statistical Service

HWT-Household Water Treatment

HWTS-Household Water Treatment and Safe Storage

IDI-Indepth Interviews

PET- Polyethylene terephthalate

POU- Point of Use

WHO-World Health Organization

UNICEF-United Nations Children's Fund

CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

Effective household water treatment can improve drinking water quality and prevent diseases if used correctly and consistently over time (Peletz et al., 2013). Worldwide statistics indicate that at least 1.8 billion people use drinking-water sources that are contaminated with faeces (WHO, 2015b). Unsafe drinking water is an important cause of diarrheal disease and water filters may be an effective public health intervention to prevent such disease. 842,000 deaths from diarrhoeal diseases each year could be prevented by improved water, sanitation and hygiene (WHO, 2015).

The definitive response to diarrhoeal problem would be the universal provision of piped, treated water, but because of insufficient resources, achievement of this goal remains remote. For this reason, a number of household water treatment technologies have been developed, tested, and disseminated to protect the health of populations lacking access to safe water (Clasen et al., 2007; Reller et al., 2003). One of these household water treatment technologies is filtration. Research has shown the need for consistent use of these interventions to make it effective (Brown & Clasen, 2012; Enger et al., 2012). The question has always been about whether household water treatment and safe storage (HWTS) interventions such as water filters are used correctly and consistently over in communities where it has been deployed of time (Hunter, 2009).

Overall, existing evidence suggests that HWTS use and health impact may decline over time (Clasen, 2008; Waddington & Snilstveit, 2009). That is why it has been recommended in some studies that there is the need to do research on acceptability and sustained use of these

interventions. The purpose of this study is to investigate the acceptability and use of water filters among households in the study area.

1.2 PROBLEM STATEMENT

Contaminated water can transmit diseases such as diarrhoea, cholera, dysentery, typhoid and polio About 842,000 deaths from diarrhoeal diseases each year could be prevented by improved water, sanitation and hygiene (WHO, 2015a).

Water filters are widely used technology for removing some microbes from water (WHO, 2015a). They are effective intervention control tool for diarrhoeal disease. Water filters have helped reduce the burden of diarrhoea in low income places (Clasen, 2005; Brown, 2008; Stauber, 2014). However the availability of water filters alone does not guarantee that a diarrhoea problem will be solved as the ability of water filters to control diarrhoea depends on their acceptability and use.

With all the benefits of water filters, some communities reduce the use or do not use them at all. In a study, it was found out that 24% of households (107/452) did not use filters distributed to them (Casanova, Walters, Naghawatte & Sobsey, 2012). Peletz et al. (2013) revealed in another study that five households (5.4%) did not have the filter set up for use at the time of visit; two households reported that they did not have time to filter their drinking water, one household head reported that she had been away from home, one filter was rendered unworkable by rats, and one household head had given the filter to a neighbour for safe keeping.

Filters could also not be accepted by individuals or communities. A study showed that uptake and use of the intervention is generally low among poor and uneducated people who are most at risk of diseases (Clasen, 2008). To address this, it was recommended by Schmidt (2009)

that acceptability studies are needed before household water treatment interventions are recommended to policy makers and implementers for adoption.

Ghana has made significant progress in bringing access to safe water to its marginalized regions. Nevertheless, an estimated 36% still lack such access in rural areas (UNICEF, 2007; WHO, 2006). While the delivery of safe and reliable water services is an essential goal, a World Health Organization (WHO)-sponsored literature review of existing research concluded that simple, acceptable, low-cost interventions at the household and community level are capable of dramatically improving the microbial quality of household stored water and reducing risks of diarrheal disease and death (WHO, 2011). All households unsure of their water safety should consider using HWTS. The main geographic areas of exposure to disease causing microbial agents in drinking water are developing countries with failing or absent water treatment infrastructure (WHO, 2007). However, HWTS is appropriate for vulnerable people in countries at all levels of socio-economic development, particularly in smaller communities (WHO, 2007).

Analysis of the current water and sanitation in the Shai-Osudoku district show that more effort is needed to meet the 85% water and sanitation coverage (Ghana Districts, 2015). On the basis of the National Community Water and Sanitation Standards of 600 people per stand pipe, 350 persons per borehole and 150 persons per hand dug well, the district has achieved about 66% coverage with 34% of the population lacking access to potable water supply (Ghana Districts, 2015).

Though, this has not been done before, water filters have been distributed among households in the study area, questions still remain, whether this useful intervention has been accepted and therefore being used as recommended? This study is therefore designed to determine the acceptability and use of water filters among the study participants and also assess their

perceptions on the usefulness of the water filters. The study also aimed to assess the perceptions of respondents on diarrhoea, its causes, treatments and preventions.

1.3 JUSTIFICATION

Improving household drinking water quality through household water treatment and safe storage (HWTS) has been shown to have the potential to considerably reduce diarrheal disease (Fewtrell & Colford Jr, 2005; Waddington & Snilstveit, 2009). However, research has shown the need for consistent use of these interventions to make it effective (Brown & Clasen, 2012; Enger, Nelson, Clasen, Rose & Eisenberg, 2012). The question has always been about whether HWTS interventions such as water filters are used correctly and consistently over in communities where it has been deployed of time (Hunter, 2009).

Overall, existing evidence suggests that HWTS use and health impact may decline over time (Clasen, 2008; Waddington & Snilstveit, 2009) .Use of water filters has previously proved effective in reducing diarrhoea in a number of studies (Clasen, 2005; Brown, 2008; Stauber, 2014). This study would contribute to existing knowledge on the acceptability and use of water filters to control diarrhoea disease in Ghana and Africa. It will also provide useful information that may be used for health promotion to enhance the acceptability and use of water filters in rural communities in Ghana. Such research is necessary to provide new insights for non-governmental organizations, donors, an. d policy makers in designing effective interventions to improve drinking water quality and reduce water-borne disease in Ghana.

1.4 RESEARCH QUESTIONS

This research seeks answers to the following questions:

- What is the level of acceptability and the use of water filters in two rural communities in the Shai-Osudoku district of Ghana?

- What are the diarrhoea related perceptions in terms of causes, treatments and prevention in the study population?

1.4 OBJECTIVES

The general objective is to determine the level of acceptability and the use of water filters in two rural communities in Shai-Osudoku district of Ghana.

The specific objectives are:

- To assess the sources of drinking water in the two communities.
- To assess the knowledge of the people on water filters and its usefulness.
- To determine how frequent water filters are used.
- To determine the level of acceptability and use of water filters.
- To assess diarrhoea related perceptions in terms of causes, treatment and prevention in the study communities.

1.5 CONCEPTUAL FRAMEWORK OF ACCEPTABILITY AND USE OF WATER FILTERS

The conceptual framework for this research was based on the Health Belief Model (HBM) propounded by Hochbaum, Kegels & Rosenstock (1952) as shown in Figure 1. The acceptability and use of water filters would be dependent upon the value placed by an individual on preventing diarrhoea and the individual's estimate of the likelihood that the use of water filters will prevent diarrhoea.

The HBM is based on the precept that people will take appropriate actions to modify their health, granted they see that negative effects could result from failure to change (Glanz, 2002). It is composed of six concepts namely perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action and self-efficacy. Each concept explains a possible behaviour change.

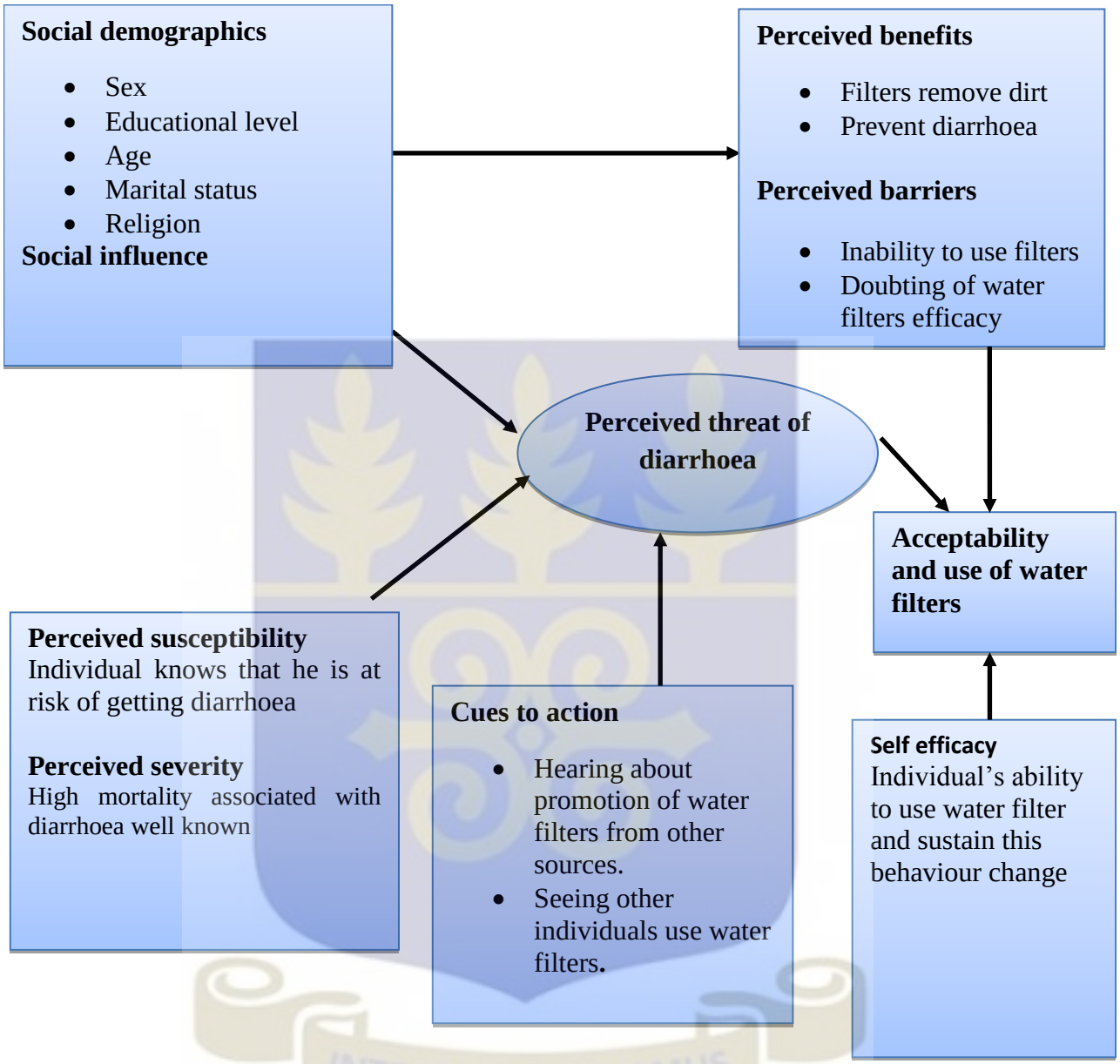


Figure 1: Health Belief Model (Modified from Hochbaum, Kegels & Rosenstock (1952).

Perceived barriers refer to potential obstacles, whether physical, mental or emotional that may prevent a people from taking an intervention or choosing to modify their own behaviour. Cues to action are prompts, whether tangible or intangible, that causes a person to act on behaviour change. Seeing an individual with diarrhoea disease prompts one to treat water before drinking to prevent diarrhoea.

Self-efficacy, which is a concept used in many behavioural theories and models, refer to one's perceived ability to make necessary behaviour change (Glanz, 2002). Self-efficacy in this study could refer to people's ability to prevent diarrhoea disease as well as their ability to treat their water with filter.

1.6 STRUCTURE OF THIS DISSERTATION

Besides this introductory chapter, the remainder of this written document is organised as follows: Chapter Two gives an overview of the literature review followed by a presentation of the systematic plan used in conducting this study in Chapter Three. Results of this study are presented in Chapter Four. The results are discussed in Chapter Five trailed by summary of findings, conclusion and recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1 SOURCES OF DRINKING WATER

Globally, 4.2 billion people now get water through a piped connection; 2.4 billion access water through other improved sources including public taps, protected wells and boreholes and 663 million people rely on unimproved sources, including 159 million dependent on surface water (WHO, 2015a). Contaminated drinking water is estimated to cause 502,000 diarrhoeal deaths each year. By 2025, half of the world's population will be living in water-stressed areas. In low- and middle-income countries, 38% of health care facilities lack any water source, 19% do not have improved sanitation and 35% lack water and soap for hand washing (WHO, 2015a). Universal access to safe drinking water is however called for in the Sustainable Development Goal 6 on water and sanitation which provides the targets and indicators for monitoring progress towards universal and equitable access to safe and affordable drinking-water, and to adequate and equitable sanitation and hygiene (WHO, 2016b).

An 'Improved' (piped water into dwelling, yard or plot, public tap or standpipe, tube well or borehole, protected dug well, protected spring and rainwater collection) and 'unimproved' (unprotected dug well, unprotected spring, cart with small tank or drum provided by water vendor, tanker truck provision of water, surface water-river, dam, lake, pond, stream, canal, irrigation channel, bottled water) drinking-water sources are known (WHO, 2011).

The improved drinking-water source is one that has been sufficiently protected from the source from outside contamination, in particular by faecal matter and has an underlying assumption that it is safe for drinking (WHO, 2011). It is however fascinating to note that 'improved sources' are not necessarily safe (WHO, 2015a). In the year 2015, WHO estimated

that at least 1.8 billion people use a drinking-water source that is contaminated with faecal matter (WHO, 2015a). Moreover, a significant proportion of water supplied through pipes is contaminated, especially where water supply is irregular or treatment is insufficient; and even where the source is good, water can be contaminated while being transported or stored, especially in environments where sanitation is inadequate (WHO, 2015a).

Many areas in developing countries lack access to safe drinking water. However, the majority (around 70%) of the global population without improved drinking water sources reside in rural areas (WHO & UNICEF, 2010). Rural communities are typically located far away from urban centres where the capacity to provide a centralized drinking water system is dramatically reduced; thus, rural populations commonly obtain water on an individual or household basis from nearby surface and groundwater sources where the microbial quality is often unknown (Ashbolt, 2004; Pronk et al., 2008; Peter-Varbanets, 2009). When improved drinking water supply infrastructure (e.g., boreholes with hand pumps) is available in rural areas, infrastructure sustainability is often limited by inadequate financial resources for operation and maintenance costs as well as the inability to obtain spare parts and necessary technical expertise (Lee & Schwab, 2005; Pronk et al., 2008).

Access to improved drinking water sources is unavailable to an estimated 13% of the world's population, and access to microbiologically safe drinking water sources is almost certainly unavailable to an even greater portion of the population (WHO, 2010). In a study by Jain et al. (2010), respondents reported that their water sources included water taps (95%), surface water (84%), wells (46%), rainwater (35%), and boreholes (25%); households typically used more than one source, depending on time of year.

In the case of Shai-Osudoku district where this study was conducted, Table 1 indicates the main sources of drinking water as follows; pipe-borne outside dwelling (37.3%), followed by

17.3% of households that use pipe-borne inside dwelling, while 16.1 percent of households use public tap or standpipe and 8.8 percent also use sachet water for drinking (Ghana Statistical Service, 2010).

Further on, 5.6 percent of households use bore-hole/pump/tube well, 4.6 percent of the households also depend on river/stream for drinking water whilst a further 3.6 percent get their source of drinking water from tanker supply/vendor provided. Ghana Statistical Service (2010), shows that a high proportion of pipe-borne water and borehole in the district is as a result of the Osudoku Water Project that helped in extending water into the district.

Table 1: Main sources of drinking water for household (Source: Ghana Statistical Service, 2010)

Sources of water	**Total country**	**Region**	**District**		**Urban**	**Rural**
			Number	**Percent**	**Percent**	**Percent**
Total	5,467,054	1,036,370	11,862	100.0	100.0	100.0
Pipe-borne inside dwelling	790,493	272,766	2,050	17.3	25.5	14.4
Pipe-borne outside dwelling	1,039,667	291,107	4,427	37.3	30.8	39.6
Public tap/Standpipe	712,375	103,356	1,915	16.1	9.0	18.7
Bore-hole/Pump/Tube well	1,267,688	15,989	661	5.6	6.4	5.3
Protected well	321,091	7,167	216	1.8	5.9	0.4
Rain water	39,438	1,833	187	1.6	1.5	1.6
Protected spring	19,345	3,513	37	0.3	0.3	0.3
Bottled water	20,261	10,952	52	0.4	0.6	0.4
Sachet water	490,283	290,342	1,038	8.8	18.7	5.2
Tanker supply/Vendor provided	58,400	29,843	429	3.6	0.2	4.8
Unprotected well	112,567	2,314	21	0.2	0.3	0.1
Unprotected spring	12,222	318	61	0.5	0.0	0.7
River/Stream	502,804	4,179	550	4.6	0.6	6.0
Dugout/Pond/Lake/Dam/Canal	76,448	1,677	218	1.8	0.2	2.4
Other	3,972	1,014	0	0.0	0.0	0.0

2.2 HOUSEHOLD OR POINT OF USE WATER TREATMENT

Household water treatment and safe storage (HWTS) or point-of use (POU) water interventions play significant role in protecting health of communities where existing water sources, including those supplied via a piped network or other improved sources, are untreated, are not treated well or become contaminated during distribution or storage (UNICEF & WHO, 2009). HWT systems are any of a range of technologies, devices or methods intended for the treatment of water at the household level or at the point of use in other sites, such as schools, health-care facilities and other community locations. (WHO, 2011). The use of these products is encouraged in places where there is no data on the specific pathogens in drinking-water or where piped supplies exist but are not safely managed (WHO, 2016a).

The perfect response to diarrheal problem would be the universal provision of piped, treated water, but because of inadequate resources, achievement of this goal remains remote (Jain et al., 2010). Until universal access to piped, treated water is attained, household water treatment (i.e., water purification at the point of consumption) has emerged as a cost-effective approach to protect the health of populations lacking safe water (Clasen et al., 2006; World Health Organization, 2008).

Treatment of drinking water at the POU has been documented to sufficiently reduce microbial pathogens (Clasen et al., 2008). Some techniques have had no effect on micobes as proven by a study on Sodium Dichloroisocyanurate Tablets for Routine Treatment of Household Drinking Water in Periurban Ghana by Jain et al. (2010) where the use, of the tablets had no impact on target population. According to Rosa & Clasen (2009) household treatment of water is not widely practiced among low-income populations of developing countries (other than boiling in a few nations) despite its findings.

Others have had positive effects as it was evident in a study by Brown et al. (2008) where the use of ceramic filters reduced 49% of diarrheal cases in Cambodia. A number of household water treatment technologies have been developed, tested, and disseminated to protect the health of populations lacking access to safe water (Clasen et al., 2007; Reller et al., 2003).

HWTS includes a wide array of treatment and storage techniques that are applied primarily at the point-of-use. Examples of household water treatment include boiling, filtration, chemical, solar and UV lamp disinfection, flocculation for the removal of turbidity, and other techniques (WHO, 2007).

Solar disinfection (SODIS) is the process by which polluted water is exposed to ultraviolet radiation to incapacitate pathogens (US CDC, 2015). Practically, it involves the filling of clear plastic bottles (PET bottles) with untreated water and exposing the filled bottles to direct sunlight for a number of hours (Dessie et al., 2014). SODIS is applicable only when the impacted region has intense solar radiation and due to its simplicity, it can be applied by individuals, households, and small communities during emergencies (Hindiyeh & Ali, 2010). Some noted drawbacks to this method include user acceptance issues such as length of time to treat the water and sustained behavior over a long period of time.

Boiling involves application of heat at high temperature (for instance, 105°C) to kill microbes such as bacteria and protozoa, and to get rid of inorganic chemicals (US EPA, 2015). This method is widely used and is associated with increased burns and scalds.

Chlorination is the process of adding chlorine or hypochloride to contaminated water (Gopal et al., 2007). One constraint of this alternative is that residual chlorine needs to be reduced to a safe post-treatment level before water can be consumed. The users of this substitute will need to be aware of the dangers involved in handling chlorine and how long to wait after

treatment before consuming the water. Prolonged exposure to these toxic by-products may form basis for liver and kidney diseases (Gopal et al., 2007).

Flocculation is a transport process which involves accumulation of coagulated particles to form flocs (Barajas & Pagsuyoin, 2015). Seeds of plants such as moringa can be used as flocculant. Moringa seeds are inexpensive natural flocculant and contain a protein that simultaneously enhances flocculation process and acts as an antibacterial agent against pathogens (Barajas & Pagsuyoin, 2015).

Several water filtration technologies have been innovated recently to resolve the scarceness of potable water (Sobsey et al., 2008). filtration techniques such as nano-membrane filtration, reverse osmosis technique, Pureit (HLL Ltd., Unilever Inc., India), organic additive based ceramic filters, Kanchan MIT arsenic filter and bio-sand filters are some of the most studied and surveyed techniques used around the globe for water purification (Brown et al. 2007; CDC 2008; Clasen et al. 2006; Clasen et al. 2007; Hillie et al. 2009; Duke et al. 2006; Ngai et al. 2006; Plappally et al. 2010; Sobsey et al. 2008).

Since 2014, WHO has been testing household water treatment products against WHO health based performance criteria through the WHO International 'Scheme' to Evaluate Household Water Treatment Technologies (WHO, 2015a). The aim of the Scheme is to ensure that products distributed protect users from the pathogens that cause diarrhoeal disease and to strengthen policy, regulatory, and monitoring mechanisms at the national level to support appropriate targeting and consistent and correct use of such products.

There exist a close collaboration between WHO and UNICEF in a number of areas concerning water and health (WHO, 2015). For example, the integrated global action plan to end preventable child deaths from pneumonia and diarrhoea (GAPPD) by 2025 sets out

several prevention and treatment targets, including achieving universal access to drinking water in health care facilities and homes by 2030 (WHO, 2015).

In line with WHO International Scheme to Evaluate Household Water Treatment Technologies (WHO, 2015) a product is evaluated if it is low-cost, appropriate for low-income settings, free standing and able to treat enough water to serve a limited number of individuals for a day. Products that meet these requirements are tested to see how well they remove microbiological contaminants, such as bacteria, viruses and protozoa, from drinking water to render it safe (WHO, 2016a). For this reason, the Round 1 report of the Scheme which is the first ever global assessment of HWT performance has been released and details of the results from a range of HWT technologies including solar, chemical, filtration and ultraviolet (UV) are presented in Table 2. Whiles a number of HWT products available were found to meet WHO recommended performance targets, others failed to meet the Scheme's minimum microbiological performance criteria (WHO, 2016a). Table 2 indicates that LifeStraw is among the top products for water filtration with high performance. LifeStraw is further discussed in Section 2.4.

In order to solidify the protection and management of water supplies, including at the household level, WHO and governments are taking steps to accomplish this goal (WHO, 2016c). In the case of Ghana where this research was conducted, WHO is currently working with the government to develop HWT performance standards and a certification and product labelling system to assist users in making informed purchases. Once launched, the certification programme will support the Government's National Strategy for Household Water Treatment and Safe Storage, aimed at reducing waterborne diseases by 2025 (WHO, 2016c).

Table 2: Performance classification of products found to meet WHO performance criteria in Round I (Source: WHO, 2016)

Technology	Product	Manufacturer	Performance Target Met	Performance Classification
Membrane ultrafiltration	LifeStraw Family 1.0	LifeStraw SA	***	Comprehensive protection: very high removal of bacteria, viruses
Membrane ultrafiltration	LifeStraw Community	LifeStraw SA	***	
Membrane ultrafiltration	LifeStraw Family 2.0	LifeStraw SA	**	Comprehensive protection: very high removal of bacteria, viruses
Flocculation-disinfection	P&G Purifier of Water	The Proctor & Gamble Company	**	
UV disinfection	Waterlogic Hybrid/ Edge Prifier	Qingdao Waterlogic Manufacturing Company	**	
Chemical disinfection	Aquatabs	Medentech Limited	*	Targeted protection: *removal of bacteria and viruses only*
Chemical disinfection	H2gO Purifier	Aqua Research LLC	*	
Solar disinfection	WADI	Helioz GmbH	*	Targeted protection: *removal of bacteria and viruses only*

***: removes at least 4 log10 of bacteria, at least 5 log10 of viruses and at least 4 log10 of protozoa
**: removes at least 2 log10 of bacteria, at least 3 log10 of viruses and at least 2 log10 of protozoa
*: meets the performance targets for at least 2-star (**) for *only two* classes of pathogens

The research presented in this dissertation focusses on filtration as a household or POU and determines the level of acceptability and the use of water filters in two rural communities in Shai-Osudoku district of Ghana. Water filtration system and types are presented in Section 2.3.

2.3 POINT OF USE OF WATER FILTRATION SYSTEM AND TYPES

There are numerous point-of-use water treatment systems available for various purposes and efficacy. Filtration is the most commonly used treatment process for removing hardness, and others to remove dissolved organics by adsorption filters (Clasen et al., 2006). Furthermore,

many point-of-use units remove turbidity, cysts and asbestos fibres by means particulate filtration (Clasen et al., 2006).

The practicality, ease of use, availability, accessibility and affordability of these filters vary widely and often depend on local factors (WHO, 2015; Oyanedel-Craver, 2014). Filtration of drinking water by POU systems is becoming increasingly popular (Ahmedna et al., 2004; Zhang & Oyanedel-Craver, 2013). For instance, ceramic water filters have been identified as one of the most promising and accessible technologies for treating water at the household level (Rayner, 2013; Abebe et al., 2014). Studies by Clasen (2004) shows that affordable ceramic water filters enable low-income households to treat and maintain the microbiologic quality of their drinking water.

Water filters have helped reduce the burden of diarrhoea in low income places (Clasen, 2005; Brown, 2008; Stauber, 2014). A number of studies about water filters attempt to evaluate the performance of the filters (El-Taweel & Ali, 2000; Oyanedel-Craver, 2014) whilst others focus on the compliance with use (Reichert & Binner, 1996; Rosa et al., 2014). The filtration process is a simple and an effective method of treating drinking water, and thus it is a suitable process to be used in point-of-use treatment systems. It is also easily adaptable to household-scale systems. These devices treat relatively small volumes of water typically only treat drinking and cooking water (WHO, 2015b). Various types are available for household or point-of-use treatment of water and have been summarised in table 3 and table 4 below.

Highly sophisticated filtration systems using processes such as membrane filtration are available in the market; however, the focus of this study is on the LifeStraw filter which was shared in the study communities.

Table 3: Filters and filtration media for treatment of household water: characteristics, advantages and disadvantages (Source: WHO, 2015b).

Type Of Filtration	Media	Availability	Ease of Use	Effectiveness (comments)	Cost
Granular media, rapid rate depth filter	Sand, gravel, diatomaceous earth, coal, other minerals	High	Easy to Moderate	Moderate (depends on microbe size and pre-treatment)	Low to moderate
Slow sand filter	Sand	High	Easy to moderate (community use)	High in principle but often low in practice	Low to moderate
Vegetable and animal derived depth filters	Coal, sponge, charcoal, cotton, etc.	Medium to high	Moderate to Difficult	Moderate	Low to moderate
Fabric, paper, membrane, canvas, etc. filter	Cloth, other woven fabric, synthetic polymers, wick siphons	Varies: some low; others high	Easy to moderate	Varies from high to low (with pore size and composition)	Varies: low for natural; high for synthetics
Ceramic and other porous cast filters	Clay, other minerals	Varies: high-low, with materials availability and fabrication skill	Moderate. Must be physically cleaned on a regular basis to prevent clogging and biofilm growth	Varies from high to low (with pore size and ceramic filter quality)	Moderate to high
Septum and body feed filters	Diatomaceous earth, other fine media	Varies	Moderate to difficult; dry media a respiratory hazard	Moderate	Varies

Table 4: Advantages and disadvantages of different granular medium filters for household use (source: WHO, 2015b).

Filter Design or Type	Advantages	Disadvantages
Bucket filter	Useable on a small scale at household level; simple; can use local, low cost media and buckets; simple to operate manually	May require fabrication by user; initial education and training in fabrication and use needed; requires user maintenance
Barrel or drum filter	Useable on a small scale at household or community level; relatively simple; can use local, low cost media and barrels or drums	Requires some technical know-how for fabrication and use; initial education and training needed; requires user maintenance
Roughing filter	Useable on a small scale at community level; relatively simple; can use local, low cost construction material and media; relative	Less amenable to individual household use because of scale; requires some technical know-how for construction and use

2.4 LIFESTRAW FAMILY FILTER

The Vestergaard Frandsen LifeStraw Family 2.0 which was used in this study is a portable point-of-use microbial water treatment system intended for routine use in low-income settings. LifeStraw is effective against waterborne diseases such as Escherichia coli (E.coli), Salmonella, Cryptosporidium parvum and Giardia lamblia. It transforms microbiologically contaminated water into safe, clean drinking water (LifeStraw, 2014). It filters water from any fresh water source, removes 99.99% of waterborne bacteria, 99.99% of waterborne protozoan parasites and removes 99.99% of waterborne viruses. Moreover, it reduces turbidity (muddiness), requires no power or batteries and replacement parts available and the Chlorine chamber has slow dissolving tablet (0.1 mg/l) to protect the membrane from bio-film formation (LifeStraw, 2014). The system is a table-top unit where the user pours untreated water through a 20 micron pre-filter into a 6 litre influent water tank. Water is then gravity-filtered through a 0.20 micron hollow-fibre ultrafiltration membrane into a 6 litre safe

storage container. Water can be dispensed from the safe storage container through a plastic tap, limiting recontamination. The filter is backwashed by squeezing a plastic bulb located on the opposite side of the tap. The membrane can filter up to 30,000 litres of water and is thus enough to supply a family of five with microbiologically clean drinking water for three to five years (LifeStraw, 2014). The system exceeds the 'highly protective' World Health Organization Standard for household water treatment technologies as indicated in a study by Naranjo & Gerba (2011). LifeStraw Water Filter is shown in Figure 2 with the essential parts.

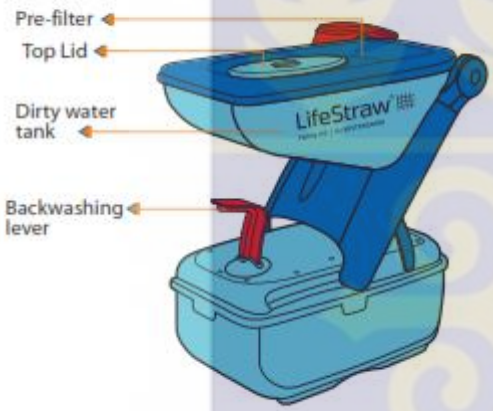


Figure 2: LifeStraw Water Filter showing important components (Source: LifeStraw, 2014).

Regarding use and acceptability, a study by Rosa et al., (2014) on assessing the impact of water filters and improved cook stoves on drinking water quality and household air pollution in Rwanda showed that Life Straw® Family 2.0 filter uptake among the intervention population was high, with filters being reportedly used in 89.2% of all household visited.

It was also revealing in Barstow et al. (2014) that there was a high uptake and sustained adoption of a water filter which was measured over a five-month period with indications of continued comparable adoption 16 months after the intervention. Households reported use of the filter had the highest adoption rate with 96.5% of households. An observational measure of use through presence of water in the filter showed a slightly lower adoption rate with 9 out

of 10 households having water in their filter at the time of household visit. Similar adoption rates as measured observationally were seen over the five follow up visits with the first follow up visit having the highest adoption rate of 92.6% and the lowest adoption rate reported as 86.4%.

An earlier version of the LifeStraw family 2.0 was shown to be highly effective in improving water quality and was protective against diarrhoea among HIV positive individuals, reducing longitudinal prevalence by over 50% (Peletz et al., 2012). Households were classified as reported users in 96% (596/620) of all household visits and as confirmed users in 87% (Peletz et al., 2012) after 12 months of the study.

Again, a study on assessment of the LifeStraw water filter revealed that some participants drank untreated water alongside the intervention tool. It was noted that 68% of the households used the filter whiles most (73% of adults and 95% of children) were reported drinking untreated water after 8 months of study. Over half of the respondents (56%) correctly demonstrated how to clean the filters. The pre-filter was cleaned at each use (40%) or once a day (41%), whereas the cartridge was generally backwashed once a day (67%). Overall, 36 (12.4%) of the 290 active filters tested were found damaged during visits, mainly due to rodents chewing on the soft hoses. Intervention households reported liking the filter due to improved aesthetics (88%), taste (92%), odour (56%) and health (35%). Reasons for dissatisfaction were slow flow rate (87%), small size of the top container (85%) and problems with rats (44%) (Boisson et al., 2010).

2.5 ACCEPTABILITY AND USE OF HWTS SYSTEMS

A WHO sponsored study on evaluating household water treatment options (WHO, 2011) suggested that one potential useful factor in verifying an intervention programme is acceptability to target population. A study showed that adoption and use of the intervention

is generally low among poor and uneducated people who are most at risk of diseases (Clasen, 2008). To address this, it was recommended that acceptability studies are needed before household water treatment interventions are recommended to policy makers and implementers for adoption (Schmidt & Cairncross, 2009). Lack of evidences on acceptability and scalability is an obstacle to promotion of HWT (Schmidt & Cairncross, 2009).

Social acceptability as indicated by (Santos & Pagsuyoin, 2015) is a measure of the society's willingness to adopt a system such as HWTS based on individual preferences. These preferences take into account aesthetic, health, economic, and environmental factors among others (Luby et al., 2008). Social acceptability can be tough to measure due to its subjective nature; however, evidence from field tests of HWTS systems has provided researchers some indicators (example visual improvement of water, taste and ease of maintenance) of the potential acceptability and long-term adaptability of HWTS devices (Luby et al., 2008; Loo et al., 2012). For example, the tastiness of water treated with chlorine is a key factor in defining the espousal of chlorination as a HWTS technology.

The acceptability of plastic bottles has also been identified as a critical consideration in employing community-scale solar disinfection (Meierhofer & Landolt, 2009). Again, challenges in the acceptability of and long term use of solar disinfection have resulted due to longer-term use, partly due to some resistance in gaining credibility among potential users, some inconvenience, its inability to deliver improvements in water aesthetics and its lack of aspirational appeal (WHO, 2009).

The guidelines used to evaluate acceptability according to Santos & Pagsuyoin (2015) are: perceived effectiveness (HWT shall be palatable and visually appealing to users), perceived health benefits (ability of HWT to reduce diseases) and perceived community-level economic benefit (system shall not interfere with pre-existing community livelihoods).

Without community acceptance, even sustainable programmes will be abandoned in the long term (Ogunyoku et al., 2011). The implementation of public health intervention tool is dependent on its acceptability and use. Acceptability and use of water filters are influenced heavily by perception, social influence and recommendability (MIT, 2015). Studies have been conducted on the acceptability and use of water filters. Some studies have measured user compliance and acceptance and also suggested there has been a little follow-up on initial positive results seen in randomised controlled trials disease (Roy et al., 2006; Arnold & Colford, 2007).

A meta-analysis by Hunter (2009) revealed that one of the major predictors of impact from HWT treatment was consistency in use of the intervention. There are varying rates of use with regards to point of use water treatment. It ranges from as low as 5% to as high as 98.1% for technologies such as biosand filtration (Aiken et al., 2011), ceramic filtration (Brown et al., 2008), solar disinfection (Rose et al., 2006), chlorination (Arnold & Colford, 2007) and coagulant flocculant disinfectant (Reller et al., 2003).

A study on use and performance of biosand filters (Duke et al., 2006) indicated that participants were generally satisfied with the performance of filters and continuous use was 98.1% (105 households out of 107 households) after they had been introduced to them. Peletz et al. (2013) revealed in another study that five households (5.4%) did not have the filter set up for use at the time of visit; two households reported that they did not have time to filter their drinking water, one household head reported that she had been away from home, one filter was rendered inoperable by rats, and one household head had given the filter to a neighbour for safe keeping.

Acceptability of HWT is an indicator for adopting these treatment systems regardless cost involved. This was evident in a study on four household treatment systems at Nkokonjeru, Uganda (Ogunyoku et al., 2011) where the implementation of chlorine treatment was rejected

though it was the most cost-effective among the four treatment interventions (Filtron clay pot filters, solar disinfection, chlorine treatment, and colloidal silver). Clay pot filters were preferred because of ease of use and physical particle removal capabilities. Ogunyoku et al. (2011) stated that filtron pots were the most expensive initial investment system of all water treatment systems implemented, but remained culturally acceptable because people could observe turbidity removal between the raw and finished water. In addition, families with the pots stated that they liked the idea of being able to show to family members, friends and neighbors a device that treated water.

High level of acceptability and a favourable perception was noticed among users in the first trial of candle-style ceramic filters (Clasen et al., 2004). All of the 24 intervention households interviewed reported that they liked the filter, and 96% of respondents would recommend it to others; 92% reported that they did not find using the filter inconvenient, 71% said that using the filter did not add significantly to their household duties, and 92% reported that since using the filter, they felt better. Filter acceptability and use were reported as being 94% and 96–100% respectively in a six weeks study. Only 46% of filters met recommended flow rate guidelines and 18% of filters broke during the study period; with overall satisfaction and reported use in the previous day (Lemons et al., 2016).

Disuse of HWT is also evident in some studies. In a study for instance it was found out that 24% of households (107/452) did not use ceramic filters distributed to them (Casanova et al., 2012). Filter disuse was due to breakage of the filters. Peletz et al. (2013) revealed in another study that five households (5.4%) did not have the filter set up for use at the time of visit; two households reported that they did not have time to filter their drinking water, one household head reported that she had been away from home, one filter was rendered inoperable by rats, and one household head had given the filter to a neighbour for safe keeping. Sobsey et al. (2009) highlights that HWT may be limited by decrease in use over time particularly when

water treatment is introduced through intervention programmes. In their study (Sobsey et al., 2009), there was a decrease rate of 2% per month after implementation of household water filtration device in Cambodia largely due to breakages.

In this study the level of acceptability and the use of water filters in two rural communities in Shai-Osudoku district of Ghana are assessed.

2.6 ATTITUDE TOWARD DIARRHOEA

Globally, at least 1.8 billion people use a drinking water source contaminated with faeces. Contaminated water can transmit diseases such diarrhoea, cholera, dysentery, typhoid and polio. Consumption of contaminated drinking water is an important cause of diarrhoea in developing countries, where safe water infrastructure is lacking. The consumption of untreated water can bring into the body various pathogens such as Salmonella, E. Coli, and Giardia (Karanis et al., 2007; Einarsson et al., 2015).

The spread of these pathogens can occur through direct ingestion, as in the instances of drinking or using contaminated water in food preparation, or through indirect routes resulting from one's failure to implement hygienic practices due to contaminated water (WHO 2013). Diarrhoea was listed among top 10 causes of death in Ghana (WHO, 2012). Diarrhoea is a symptom complex characterized by stools of decreased consistency and increased number. The clinical symptoms and course of the disease vary greatly with the age, nutritional status, and immunocompetence of the patient, and the aetiological agent infecting the intestinal system and interfering with normal adsorption (Clasen et al., 2006).

The definitive response to this problem would be the universal provision of piped, treated water, but because of insufficient resources, achievement of this goal remains far-off. For this reason, a number of household water treatment technologies have been developed, tested, and

disseminated to protect the health of populations lacking access to safe water (Clasen et al., 2007; Reller et al., 2003).

There is often absence of health risk perception and understanding of basic hygiene practices alongside technical and financial difficulties of supplying drinking water to rural communities (Sobsey, 2002). A study by Merga & Alemayehu (2015) reported that the knowledge and attitude of mothers, recognizing the danger sign of dehydration due to diarrhoea, and the prevention and management of childhood diarrhoeal diseases were not adequate. Information, education and communication strategy may help increase the knowledge and create positive attitude among mothers regarding the cause, prevention, and management of diarrhoea (Merga & Alemayehu, 2015).

It was also evident in another study on perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India there are gaps in the knowledge of the transmission pathways of diarrhoeal illnesses as well as changing perceptions over time (Francis et al., 2015). Yalew (2014) reported that majority of caregivers they studied had diverse misperceptions and malpractices on the causes and management of diarrhoea. Thus, urgent effective interventions that consider the local culture and resources should be designed.

In a cross-sectional study conducted among 280 mothers of under-five children in urban slums of Bengaluru (Rao et al., 2015), less than one-fourth (24.3%) knew the correct meaning of diarrhoea, with three-fourths (73.8%) of them not knowing the correct cause of diarrhoea. Only 44.3% mothers knew that diarrhoea can be prevented. Majority (88.7%) did not know how to look for signs of dehydration. Less than half of the mothers had heard of oral rehydration therapy (ORT). Oral rehydration salts (ORS) was found to be associated with the education of the mother proving that knowledge is better among those mothers with formal education.

Among other specific objectives, this study assesses diarrhoea related perceptions in terms of causes, treatment and prevention in the study communities.

CHAPTER THREE
METHODOLOGY

3.1 INTRODUCTION

This chapter presents a systematic plan used in conducting this study. The following aspects of the method are described including a descriptive profile of the study sites, population for the study, study design, sampling procedure, variables, data collection techniques, data processing and analysis, quality control, data security, ethical consideration, work plan and budget.

3.2 VARIABLES

The variables of the study are:

INDEPENDENT VARIABLES:

- Demographic factors of respondents (age, sex, marital status, religon and educational level.
- Social influence

DEPENDENT VARIABLE: Acceptability and use of water filter.

3.3 STUDY SITES

The study was conducted at Apese and Amanfro in the Shai-Osudoku (previously Dangme West District) District of Ghana, which is found in the south-eastern part of Greater Accra region. Like all districts in Ghana, the Shai-Osudoku district (Figure 3) was established in line with the decentralization policy of the Ghana Government. Between 1957 and 1988, efforts were made by successive Ghanaian governments to decentralize authority to the local level (Crawford, 2004). Decentralization was seen as a vital tool in governance and because

of this when it was introduced in 1988, it was based on governmental values such as empowerment (Crawford, 2004).

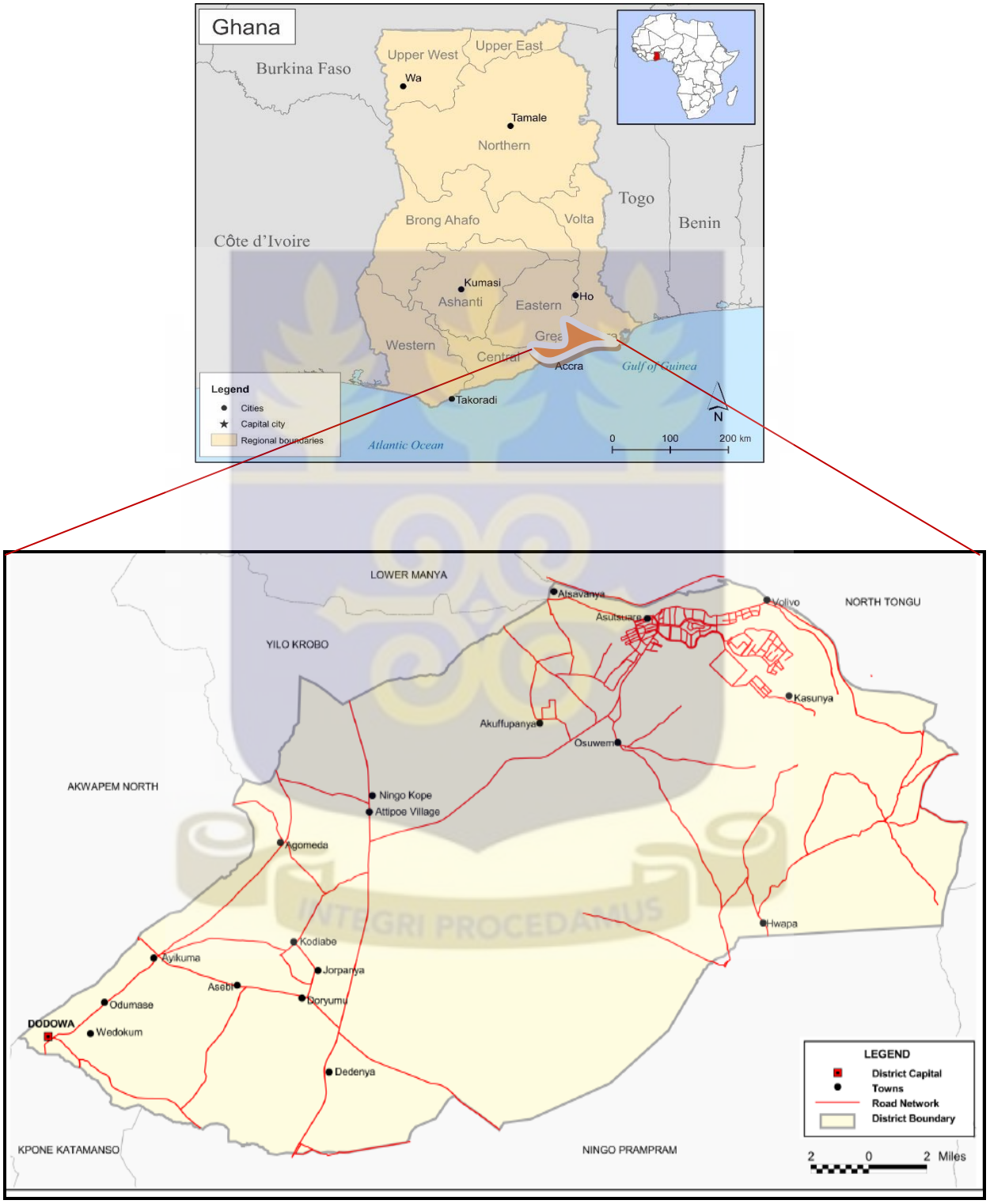


Figure 3: Map of Shai-Osudoku District in the Greater Accra Region showing the study sites (adapted from GSS, 2014)

The Shai Osudoku District is situated in the South eastern part of Ghana, lying between latitude 5° 45' south and 6° 05' North and Longitude 0° 05' East and 0° 20' West (Ghana Districts, 2015). The District has a total land area of 1,442 square kilometres, making it the largest in the Greater Accra Region. The land size represents 41.5% of the regional land area (Ghana Districts, 2015).

The district was carved out of the former District in 1988 as a result of a national redemarcation exercise carried out in relation to decentralization reforms in the country. The district shares boundaries with the Yilo Krobo District on the North-West, North-Tongu District on the North-East, Akwapim-North District on the West, Tema District on the South-West and Shai Osudoku District on the East. The north-eastern and the southern portions of the district are washed by the Volta River and the Atlantic Ocean respectively. The district has a coastline stretching over 37 kilometres.

3.4 STUDY UNITS /POPULATION

Shai-Osudoku district has a population of approximately 51,913 based on the 2010 census figures from the Ghana Statistical Service (GSS, 2012). Out of this figure, 25,272 (48.7%) are males and 26,621 (51.3) are females. The population of Shai-Osudoku District according to the 2010 Population and Housing Census is 51,913 and of this 48.7 percent are males and 51.3 percent are females. The district's population constitutes 1.3 percent of the region's population, with about 76.7 percent of the district's population residing in rural communities, a sex ratio of 95 and an age dependency ratio of 76.4 (GSS, 2014).

GSS (2014) indicates that the average household size in the district is 4.4 per household. Children constitute the largest proportion of the household members accounting for 39.3 percent, heads of households form 23.7 percent and spouse 10.1 percent. The target population for this study was be households in the selected two communities.

In the district, a little over 40 percent (40.7%) of the district population 12 years and older have never married, 39.8 are married (GSS, 2014); out of the married, 28.3 percent have no education, while 9.1 percent of the never married have no education. According to GSS (2014), over three- quarters (77.7%) of the married population are employed whiles only 38 percent of the never married are employed. The majority of never married are economically not active (57.3%). Water is important physiological need and vital for survival among all age groups. The household survey was limited to people in possession of the water filters, hence researcher came across different age groups.

3.5 STUDY DESIGN

Social theorists such as Emile Durkheim have suggested one idea which has been adopted for doing research in social sciences is that society exists in the minds of people, it has a reality that is unique to its existence (Coser, 2010). This idea indicates that the only way to gain insight into this reality, this collective conscience, is through sound data collection approaches. Three research approaches, namely, qualitative, quantitative, and mixed methods, are commonly used along with the various research designs when conducting research within the framework of each approach (Williams, 2011).

Nevertheless, there have often been debates about the one that is more appropriate in doing research. For instance, the quantitative approach is viewed by Creswell, (2003), as basic for assessing situations as a prerequisite for inferences and generalizations. Again it is concerned with conditions and interrelationships that exist, opinions that are held, processes that are on-going, effects that are evident and trends that are developing. Patton (2002) maintains that the quantitative researcher looks 'through a narrow lens at a specified set of variables'. The qualitative approach, on the other hand, is advocated as necessary when there is a new area to be explored (Creswell, 2003). It also allows research participants to express their views in an opened and relatively unconstrained way (Kumekpor, 2002). According to Patton (2002),

qualitative research is based on the idea that people can better air their views when they are asked to do so in an in-depth manner. To bridge the gap between the quantitative and qualitative approaches, mixed methods is used and they are viewed as complementing each other (Creswell, 2009)

In view of this cross-sectional study and its set objectives, a mixed method was adopted using both quantitative and qualitative techniques. A mixed method helped to arrive at vital information that might possibly not be obtained in one approach. It helped to generalise findings and gain an in- depth understanding of the study. The study involved a quantitative survey, in- depth interviews and observations.

3.6 SAMPLE SIZE

LifeStraw filters have been distributed to 60 households representing two-thirds of the population of the two communities (Apese and Amanfro). All the 60 households were studied in this research.

3.7 SAMPLING PROCEDURE

Purposive sampling was chosen for this study because a particular subset of the population was needful for the study. These participants were selected because they possessed characteristics and information relevant to the objectives of the study which was having received a water filter (Kumekpor, 2002). Convenient sampling was used for the qualitative study.

3.8 DATA COLLECTION TECHNIQUES

As indicated earlier, this study made use of both the quantitative and qualitative methods. The instruments for data collection were questionnaire and in-depth interview (IDI) guide. The questionnaire comprised of open-ended and closed-ended questions. The questionnaire had eight sections, namely, household information, demographics, diarrhoea related perceptions,

sources of drinking water, knowledge on use and usefulness of filter, acceptability of water filter and frequency in use of filter and social influence. Participating households had been given water filters and were interviewed accordingly. For the quantitative research approach, questionnaires were administered to 90 participants. Two persons in each household (male and female) of which one of them was the head of the household (his or her representative) was interviewed. In some cases only one person or none was available to be interviewed. For the qualitative approach, in-depth interview was granted to 8 heads of household whom the questionnaire had not been administered. Observations on specific activities, events and useful happenings of interest to the study were captured.

3.9 DATA PROCESSING AND ANALYSIS

The questionnaire was coded by assigning numbers to expected verbal responses. Data from the survey were first entered into Microsoft Access into a form easy for computation. It was later imported into STATA for processing (STATA, Version 13). In the case of the open ended questions, responses were grouped into one category till all possible categories were obtained to develop a nominal scale category for the variables under study. Data were then cleaned and edited to ensure that there was no, coding error and double entry. Tables have been used where appropriate in the presentation. Data obtained from the qualitative study were grouped into thematic areas and categorized with reference to the research objectives. Simple proportional analysis was done to present frequencies regarding acceptance and use of the intervention. Chi square test was used to test the relationship between the independent and dependent variables.

3.10 QUALITY CONTROL

There was a careful development of the questionnaire to provide a basis for validity. Researcher was part in data collection. Those involved in data collection were experienced in

in field work and it was reviewed that data have been entered correctly. Data were cleaned and edited to check for accuracy in data entry and all coding errors in the data entry. Results have been presented using descriptive statistics such as tables and frequency distributions where appropriate.

3.11 DATA SECURITY

Household survey data were collected and entered using password protected computers with customized entry screens, using personal external hard drive. A copy was kept in dropbox (https://www.dropbox.com/). All data forms and records collected during this research were uploaded into dropbox. Once data collection was complete, confidentiality of all respondents was ensured through the replacement of any personal information with unrelated unique identifiers as needed.

3.12 ETHICAL CONSIDERATION

The Code of Ethics of the American Anthropological Association (AAA, 2012) which is one of the most influential codes refers to three parties to whom a researcher bears responsibility: to the people (and animals) they study; to their discipline; and to the general public. With respect to the first party, principles of respect, safety, dignity or privacy of people as well as obtaining informed consent are advocated. The safety of respondents can also be ensured through privacy on one hand and anonymity on the other hand in order to ensure the protection of a participant's identity after information is gathered.

Neuman (2007) maintained that, even if a researcher cannot guarantee anonymity, he or she should always protect participant confidentiality. There is the risk of information being revealed unintentionally or negligently to third parties. Guided by these principles, ethical clearance was sought from Ghana Health Service-Ethical Review Committee (GHS-ERC) which provided a clearance before the study began (see Appendix D). Permission was sought

from the appropriate governmental and traditional authorities under whose jurisdiction the study community is sited. In addition, verbal informed consent was sought from participants from the beginning to the end of the study.

A written consent form was administered to all household within our sampling frame. This emphasized their agreement to take part in the study. Once signed, a second oral consent was also required by the household in order to demonstrate their approval to take part in the data collection process.

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

The chapter presents the results of the study. In order to address the objectives of the study, the presentation is structured into the following sections: social demographics, meaning of water and its value to y members, sources of drinking water, general use of water, perception about quality and what is considered good water, knowledge and frequency of use of water filters, level of acceptability of water filters, diarrhoea related perceptions in terms of causes, treatment and prevention in the study communities. The section ends with relationship between some independent and dependent variables.

4.2 SOCIAL DEMOGRAPHIC CHARACTERISTIC OF RESPONDENTS

The social demographic characteristics of the respondents are shown in Table 5.

Table 5: Socio- demographic characteristics of respondents.

Demographic Characteristics	**N = 90**
Sex (Freq (%))	
Female	44 (48.9)
Male	46 (51.1)
Age	
Mean age (years)	45.9
Standard deviation	15.97
Minimum age	17
Maximum age	106
Educational Level (Freq (%))	
No education/Primary	50 (55.56)
Junior High/Middle School	30 (33.33)
Senior high school Post-Secondary	10 (11.11)

Marital Status (Freq (%))	
Married	73 (82)
Single	9 (10.1)
Divorced	3 (3.4)
Widow/Widower	4 (4.5)
Religion (Freq (%))	
Christians	73 (81.1)
Muslims	5 (5.6)
Traditional	6 (6.7)
No Religion	6 (6.7)
Household size (Freq (%))	
1-5	62(68.9)
6-9	28 (31.1)

4.3 MEANING OF WATER AND ITS VALUE TO COMMUNITY MEMBERS

The meanings and values attached to water in the studied communities are captured in the qualitative narratives presented by respondents and representatives of such narratives are presented to clarify these.

Please water is important to me, even when the taps are closed it is a problem. When you are hungry and you see water you become happy and satisfied after drinking. If it had not been water I would have died. It helps me to urinate and urinate. When I drink water, it lessens my blood pressure (A grandmother with two grandchildren, Apese, IDI)

*I see water as very important you will die if your body is not getting water (*Middle aged woman, Amanfro, IDI)

*Water is so important, especially when taps are not flowing and it has not rained a while we go through challenges to get it because we can't do anything without it (*A young mother with one child, Apese, IDI*)*

*If you don't get water, what do you do? I just came from farm to bath, it's just not good to stay without water. Human beings especially women can sometimes have body odour and we need water all the time (*A married woman, Apese, IDI*)*

Water is very important because without it I can neither cook nor wash (An unmarried young woman, Amanfro, IDI)

4.4 SOURCES OF DRINKING WATER

In this section, the main sources of drinking water as well as the favourite sources for the communities are presented.

The main sources of drinking water reported were piped-borne water, 85 (94.4%) respondents and rain water, 44 (48.9%). The dominant positions of these sources were supported by the following representative narratives.

> *As for here we have pipe. We use rain water too but it does not rain every time. We use the pipe for drinking and cooking, rain water for washing clothes and bathing (*A mother with three children, Apese, IDI)
>
> *I get water to use from pipe and rain water. I use the pipe because it is closer and mostly available. For the pipe, we pay monthly. I consider how water free of dirt before choosing. I like the pipe (*A young woman, Amanfro, IDI*)*
>
> *I drink pipe and rain water. I use rain water for washing clothes and bathing* (A single mother, Apese, IDI)

Regarding favourite source of drinking water, 80 (89%) respondents preferred piped water whilst 8 (9%) preferred rain water (Figure 4). Out of the 80 respondents who claimed piped water as their main source of water, 67 (83.75%) attributed their choice to better quality and 12 (16.25%) mentioned availability and cost among others. These reasons are supported by

the following narratives when respondents were asked about their reasons for a preferred source of water.

> *I prefer pipe because there is no dirt in it (*A mother with two children, Apese,IDI*)*
>
> *I like pipe water because it has been treated (A grandmother, Apese, IDI)*
>
> *I like pipe water because it is not always that it rains (*A middle aged woman, Apese, IDI)

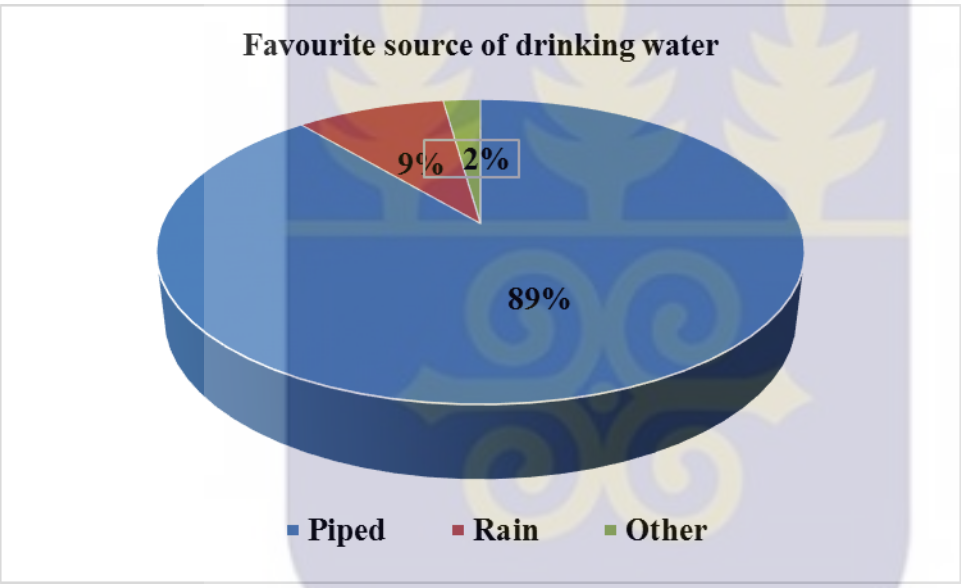


Figure 4: Favourite sources of drinking water.

4.5 WATER STORAGE

Community members reported various water storage means and these include small containers, ceramic pots, water filters among others. These positions were represented in the narratives below.

> *Smiles, I have two small containers that water for drinking is stored in them. I filter that water before drinking. I also have a big container that water is stored in for bathing and cooking* (A grandmother with two grandchildren, Apese, IDI)
>
> *I put water I drink in a ceramic container and cover it. At first, before I used to boil water before drinking, now I put the water in the filter we were given before drinking.*

> *I have the water for cooking in a covered container and the one for the animals in the big* (A grandmother, Apese, IDI)
>
> *When the pipe water is available, I store some in my big basin. I fetch water from it, put it in filter and drink it. I also use some for cooking, washing and bathing* (A young mother with two kids, Amanfro, IDI)

Some respondents who have access to and frequently used pipe borne water did not see the need to store water. This position was presented in the following narratives.

> *Mostly I use pipe water for cooking and bathing* (A married woman, Apese, IDI)
>
> *I use pipe water a lot, it's for drinking and cooking* (A single mother,Apese Medea, IDI)

Most respondents expressed satisfaction to the effect that the taps are closer to their homes and they do not have to cover a long distance to fetch it as presented in the following narratives:

> *Just a stone throw from here (*A middle aged woman, Apese, IDI)
>
> *Oh it's so close. We do not spend much time getting* water (A grandmother with two grandchildren, Apese, IDI)

The women normally fetch the water for household use according to the respondents.

4.6 PERCEPTION ABOUT QUALITY OR GOOD WATER

Respondents knew that there are bad and good water and believe that bad water can make one sick and therefore should be used only washing of cloths. They identify bad water to include, when people defecate into the water source and salty water. These positions were supported by the following narratives:

> *Good water is clean, bad water can make you sick. Bad water can be used for washing and good water is used for washing* (A mother with three children, Apese)
>
> *Bad water is the one that people have defecated inside and good water is pipe* (A young woman, Amanfro, IDI)

> *Bad water has salt in it and good water has no salt in it. Bad water makes you sick and good water makes you feel well* (A grandmother with two grandchildren, Apese, IDI)

Most respondents attributed pipe water to be the only good water, components don't matter. It was also evident in the way responses were given for which water they consider good for drinking.

> *Only pipe water is good for drinking* (A middle aged woman, Apese, IDI)

4.7 KNOWLEDGE ON WATER FILTER AND FREQUENCY OF USE

All the respondents (90) interviewed claimed to be aware that water filters have been distributed. They also confirmed having them in their possession. However, it was observed that 13 respondents from 11 households had not used the water filter. Two had given them away as gifts. One respondents claimed that the children will destroy the filter if it is set up, hence her decision not to use it. One other respondent claimed that rats had rendered the water filter inoperable. Seven respondents attributed the non-usage to lack of knowledge to setting up the water filter properly.

When asked about the purpose of using water filter, 77 (86%) respondents opined that it removes dirt or impurities from the water to make it clean (Figure 5). Interestingly one respondent claimed that it prevents malaria.

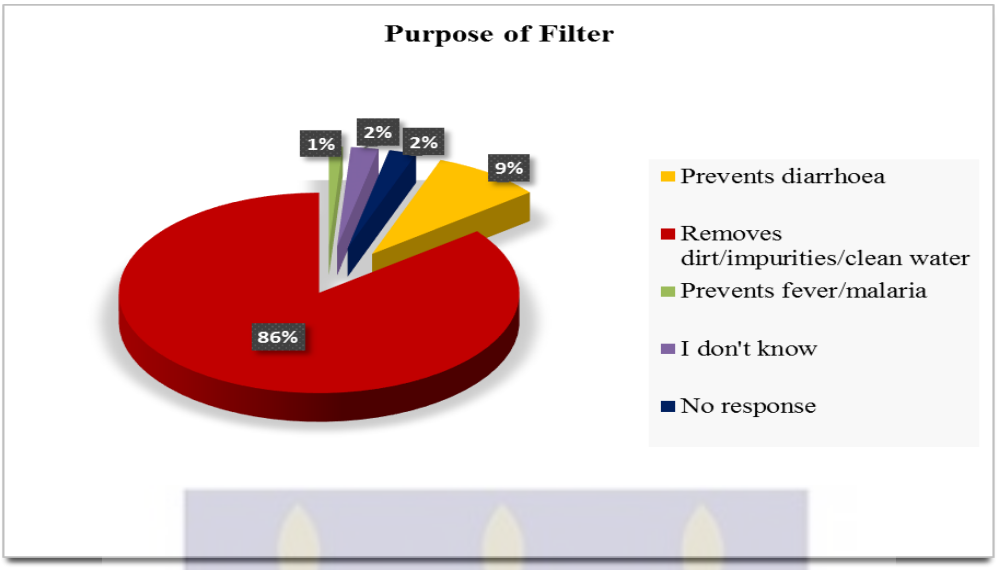


Figure 5: Knowledge of respondents on purpose of filter.

When asked concerning their awareness about water filters before the commencement of the project, 76 (84.4%) respondents answered that they were not aware of it until the project started while 14 (15.6%) respondents claimed that they knew about the use of water filters before the start of the project.

Regarding how to use LifeStraw water filter, majority of the respondents, 84 (93.3%) responded in affirmative. In terms of frequency of use of the water filter, majority (55.6%) of the respondents claimed that they fill it 1- 3 times in a day, while 30% filled it 1-3 times in a week and 14.4% was not using their filters at the time of data collection.

Regarding water treatment, 62 (69%) of respondents indicated that they treat all the water they drink and 15 (17%) claimed that they do not treat all the water they drink.

4.8 LEVEL OF ACCEPTABILITY OF WATER FILTERS

On acceptability, respondents were asked if they are happy with the water filters and whether or not they would recommend it to other people. Most, 77 (86%) of them said they were happy with the filters and a similar proportion (85%) of respondents said they would recommend the water filter to other people. Out of the 77 respondents who were happy with

the water filter, 40 (52%) were happy because the filter removes dirt to make the water clean (Figure 6).

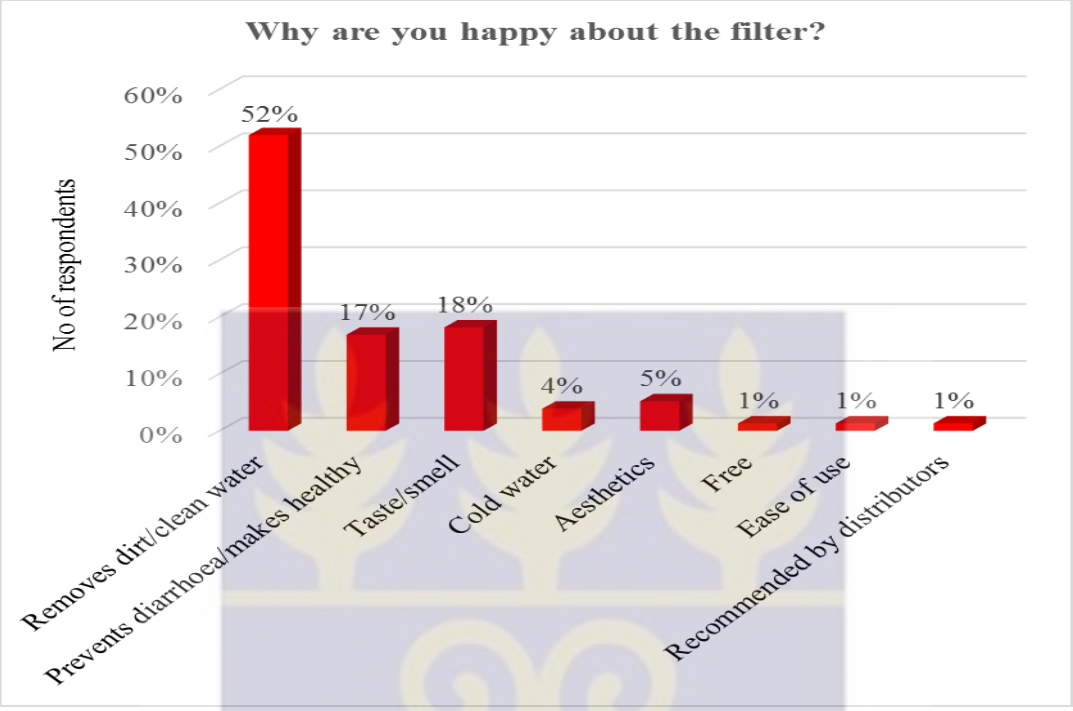


Figure 6: Why respondents were happy with the filter?

When asked about the taste of water after filtering, 71 (79%) claimed that the taste was better whilst 6 (7%) claimed it makes no difference, thus, the taste remained the same before and after filtration (Figure 7). In the same manner, majority 67 (75%) claimed that the smell is better (Figure 8).

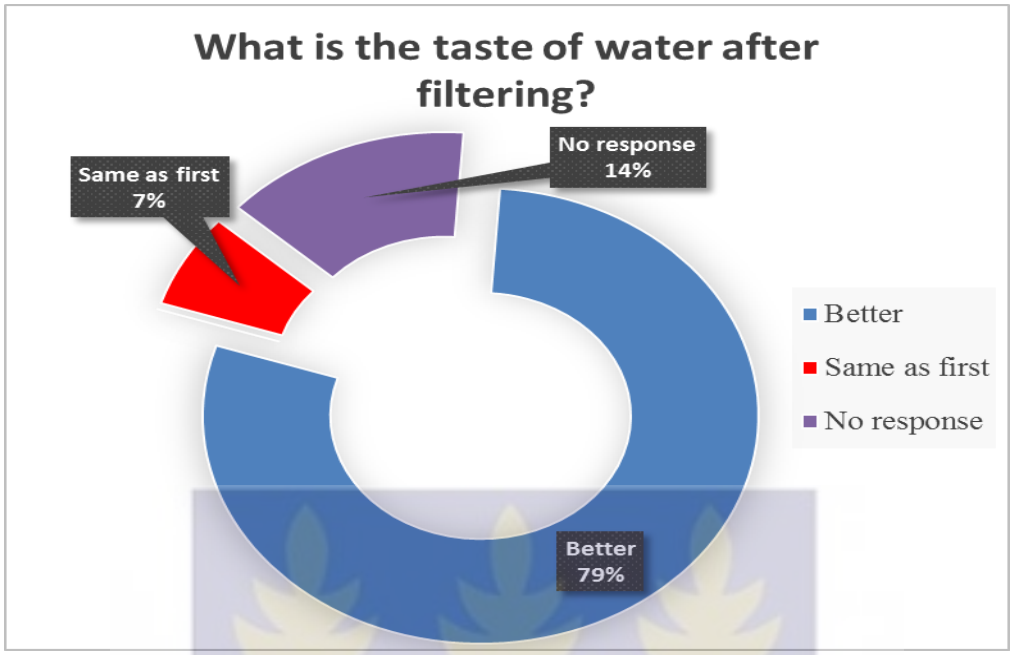


Figure 7: Respondents views about the taste of water before and after filtering.

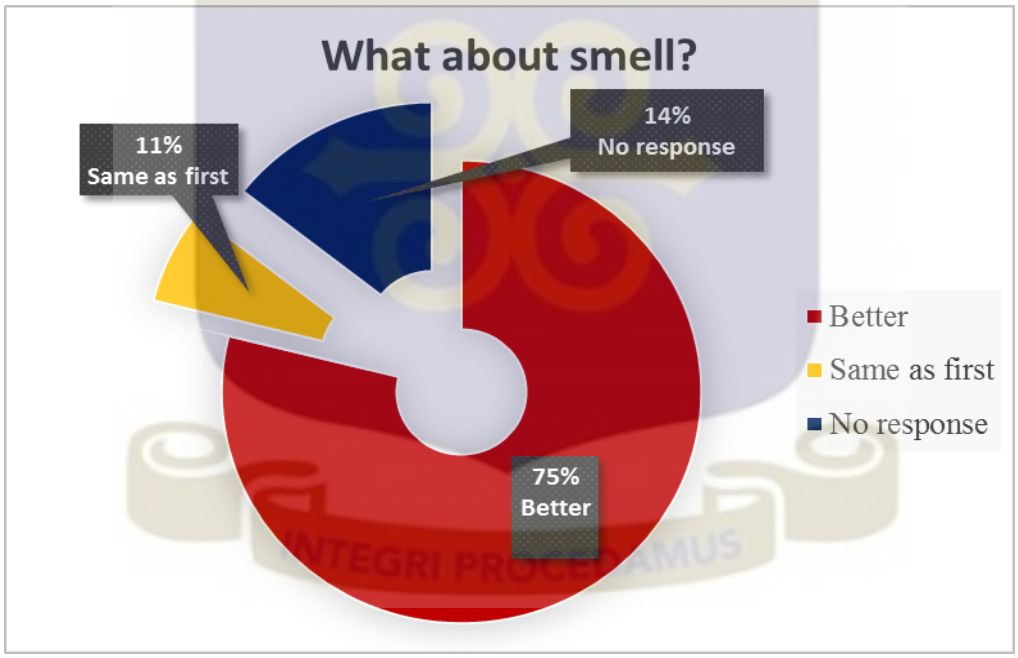


Figure 8: Respondents views about the smell of water before and after filtering

4.9 DIARRHOEA RELATED PERCEPTIONS

Respondents were asked if anyone got diarrhoea in the week before the survey and it came to light that 26 (29%) had someone with diarrhoea in their household in the past one week including the day of the interview. Respondents were further asked to indicate the causes of

diarrhoea and most, 46 (51%) of them attributed diarrhoea to intake of dirty water and poor food hygiene practices (Figure 9).

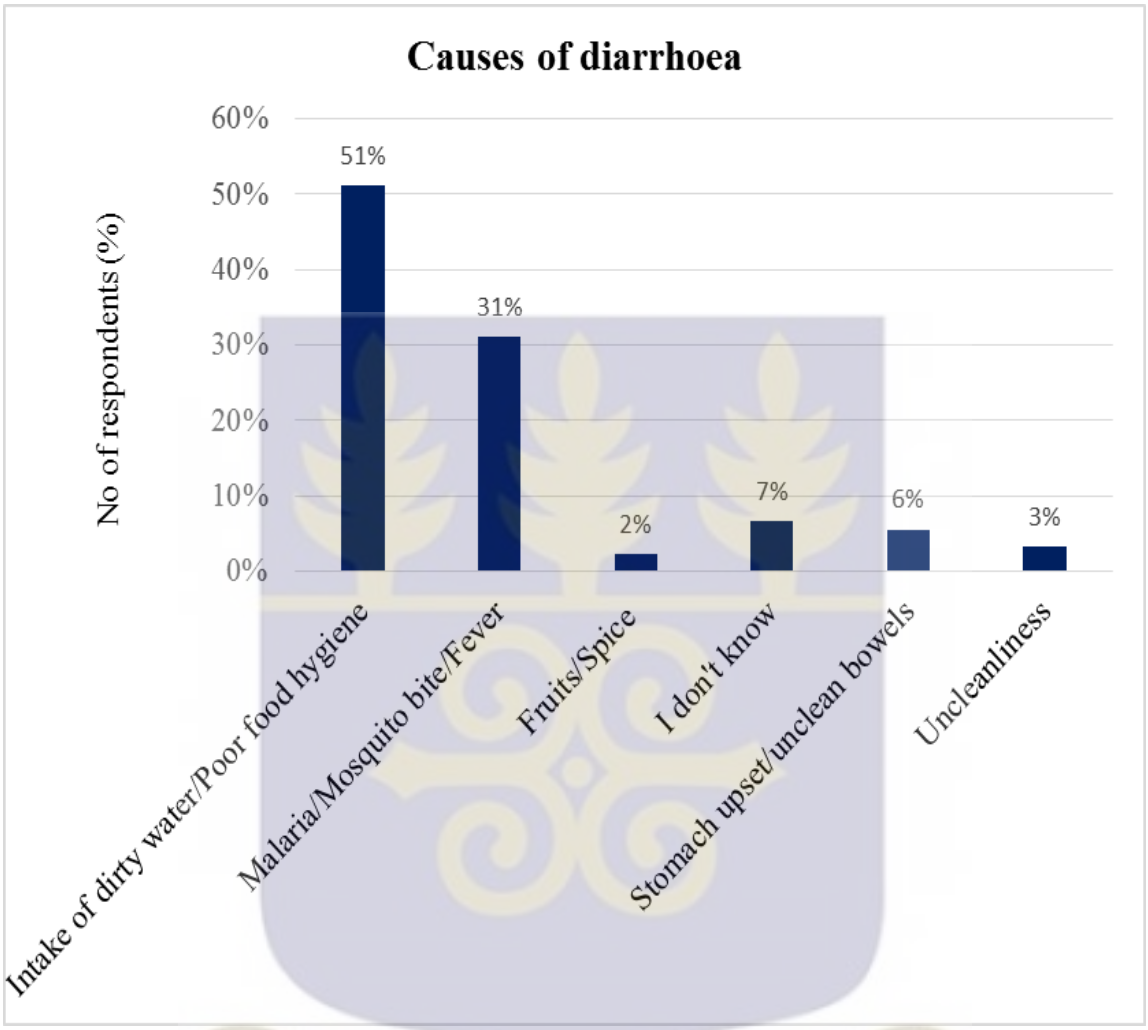


Figure 9: Perception about causes of diarrhoea.

With respect to diarrhoea prevention, 45 (50 %) of the respondents alluded to drinking of clean water and practicing food hygiene (Figure 10). The rest had misperceptions such as using medications and special foods to prevent diarrhoea.

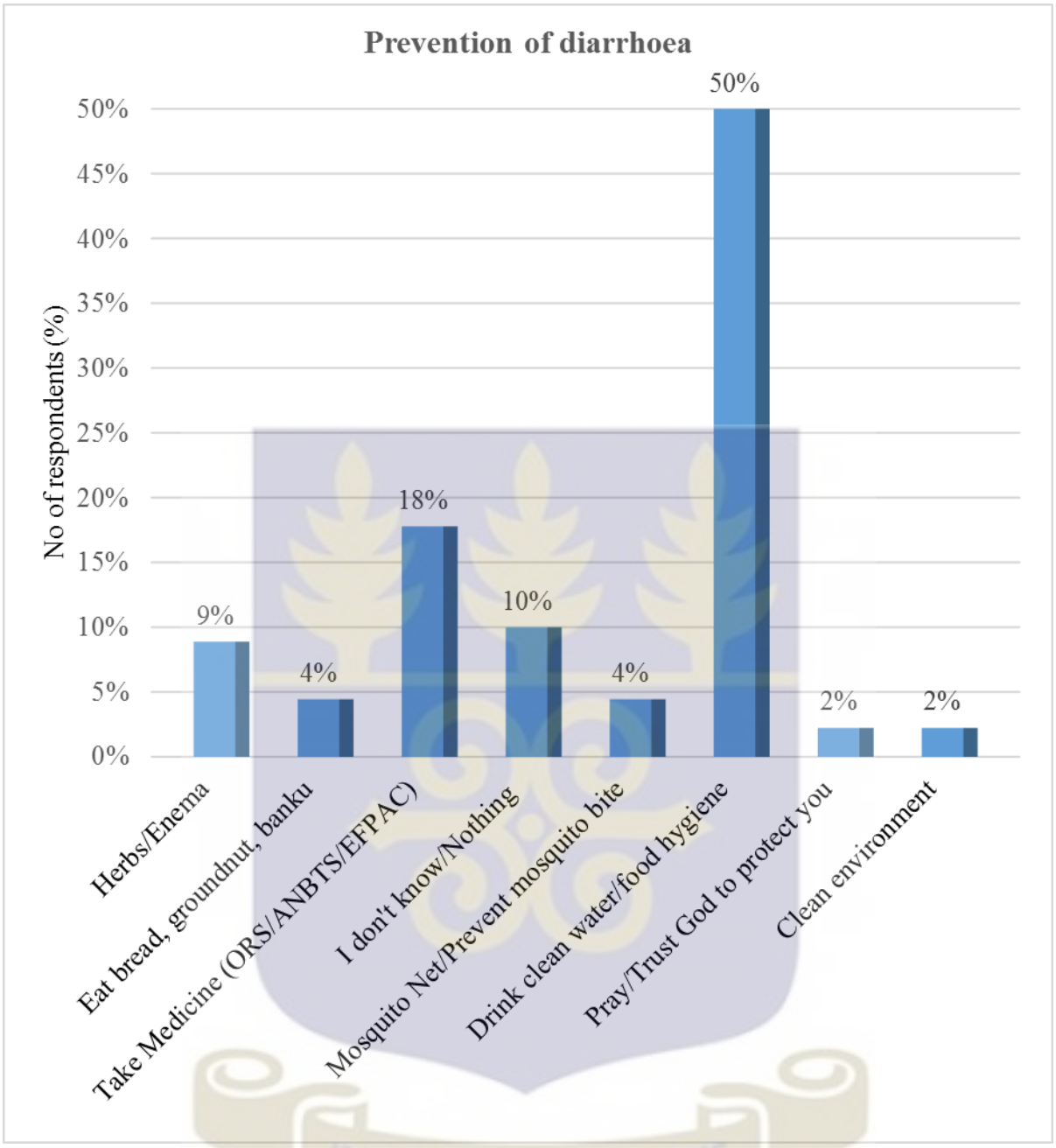


Figure 10: Perceptions about prevention of diarrhoea.

The results of a cross-tabulation between those who had diarrhoea in the week before the study and how often they fill the water filter (Table 6) reveals an interesting phenomenon. Out of 26 respondents who had diarrhoea, 24 were those who were using the filter and only 2 were those who were not using the filter. However, there was no significant relationship between diarrhoea episode in a household and how often the water filter was filled (p=0.086).

Table 6: Cross-tabulation: Did anyone get diarrhoea-How often do you fill the water filter?

Did anyone get diarrhoea in your household?	**Frequency N=90, Pearson chi^2 (2) = 4.9161, P = 0.086**			
	How often do you fill the water filter?			
	1-3 times in a day	1-3 times in a week	Not using now	Total
Yes	12	12	2	26
No	38	15	11	64
Total	50	27	13	90

Table 7 shows the results of education level and diarrhoea. From Table 7, with a chi-square value of 3 resulting in a p-value of 0.18, no statistically significant relationship exists between education level and diarrhoea in the studied communities.

Table 7: Education level and reported diarrhoea.

	Frequency N=90, Pearson chi2(5) = 3.4183, P = 0.181		
	Did anyone get diarrhoea in the past week?		
Educational level?	Yes	No	Total
No education/Primary	18	32	50
Junior High/Middle School	7	23	30
Senior high school/Post-Secondary	1	9	10
Total	26	64	90

4.10 RELATIONSHIP BETWEEN INDEPENDENT AND DEPENDENT VARIABLES

Associations were determined between some independent and dependent variables with chi-square test. From table 8, with a chi-square value of 1.8 resulting in a p-value of 0.780, the results was not statistically significant at the level of 95%. Therefore the level of education was not related to the frequency of filling the filters.

Table 8: Education level and frequency in filling the filters

	Frequency N=90, Pearson chi2(4) = 1.7597, P = 0.780			
	How often do you fill the water filter?			
Educational level?	1-3 times in a day	1-3 times in a week	Not using now	Total
No education/Primary	28	13	9	50
Junior High/Middle School	17	10	3	30
Senior high school/Post-Secondary	5	4	1	10
Total	50	27	13	90

Household size was not related to the frequency of filling the filters (Table 9). With a chi-square value of 2 resulting in a p-value of 0.468, no statistically significant relationship exists between household size and frequency in filling the filters.

Table 9: Household size and frequency in filling the filters.

	Frequency N=90, Pearson chi2(2) = 1.578, P = 0.468			
	How often do you fill the water filter?			
Household size	1-3 times in a day	1-3 times in a week	Not using now	Total
1-5	33	21	8	62
6-9	17	6	5	28
Total	50	27	13	90

The results of marital status and frequency in filling filters are displayed in Table 10. From Table 10, with a chi-square value of 3 resulting in a p-value of 0.78, no statistically

significant relationship exists between marital status and frequency in filling the filters in the studied communities.

Table 10: Marital status and frequency in filling filters.

	Frequency N=90, Pearson chi2(6) = 3.2493, P = 0.777			
	How often do you fill the water filter?			
Marital status	1-3 times in a day	1-3 times in a week	Not using now	Total
Married	42	22	9	73
Single	4	4	1	9
Divorced	2	0	1	3
Widow	2	1	1	4
Total	50	27	13	90

CHAPTER FIVE
DISCUSSIONS

5.1 INTRODUCTION

In this study the level of acceptability and the use of water filters in two rural communities namely; Apese and Amanfro in Shai-Osudoku district of Ghana was determined. The study also assessed the knowledge of the people on water filters and frequency of use. The level of acceptability and use of water filters as well as assessing diarrhoea related perceptions in terms of causes, treatment and prevention in the study communities were determined. In this section, the discussions of the results are presented below.

5.2 SOCIO-DEMOGRAPHICS

Out of the ninety interviewed, 46 (51.1%) were male and 44 (48.9%) were female. The mean age was 45.9 years with the youngest being 17 years and oldest being 106 years with a standard deviation of 15.97. The most reported educational level was those with no formal or primary education with 50 respondents (55.56). Most of the respondents 73 (82%) were married. The dominant reported religion was Christianity with 73(81.1%) of respondents. Majority, 62 (68.9%) of respondents had a household size of up to 5.

Sex is the biological make-up or characteristics of an individual (Krieger, 2003) and these characteristics match up with different roles. The sex distribution for the quantitative study shows that males made up 51.1% of the respondents. This is contrary to the differences in the gender composition of the Ghanaian population which, according to the 2010 Population and Housing Census, has the female population making up about 51.3% of the total population while males constitute 48.7% (GSS, 2010). It is however good because it is believed that the differences and inequalities between both genders influence how individuals respond to changes in water resources management (UN, 2014). Involvement of both women and men in

integrated water resources initiatives can increase project effectiveness and efficiency (UN, 2014).

The mean age for respondents was age was 45.9 years with the youngest being 17 years and oldest being 106 years. This reflects a large active population in the community. It also reflects the overall national population which has been observed to be, to a greater extent, youthful (GSS, 2012).

The data revealed that most reported educational level was those with no formal or primary education with 50 respondents (55.56). This group can to some extent be described as illiterates as they can neither read nor write the local and English language. This was obvious during data collection as questions had to be translated into Dangme and Eve, the predominant local languages in the town. Education has been recognized for many years as a critical factor in addressing environmental and sustainability issues and ensuring human well-being (ICSU & ISSC, 2015). This is reflected in policies of both national and international governments and agencies where the focus is geared towards widening access to quality education. The United Nations sustainable development goal 4, ensures inclusive and equitable quality education and promote life-long learning opportunities for all by 2030 is one such step towards quality education to curb such as evidenced in the study areas.

Marriage is a recognised institution for the establishment and maintenance of family life. From the data, 73 respondents were found to be married while 9 were single. Nukunya (2011) notes that marriage confers a number of rights, duties and obligations on people and these often reflect in their behaviour and roles they are expected to play in the society. For most adults, marriage plays a central role in their lives even compared to other social relationships. Therefore, this particular relationship has been given a great deal of importance in understanding the association with well-being. The high rate of married people in both

communities is significant. For instance, prior research suggests that married adults have lower rates of morbidity and mortality compared to unmarried adults (Holt-Lunstad et al., 2008).

Religion pervades every aspect of the life of community, like most Ghanaian the two communities are very religious. Majority (81.1%) of respondents were Christian. All the three religions were present which is consistent with the GSS (2010). Closely tied to culture are religious beliefs and practices. This was evident when respondents were asked about prevention of diarrhoea and some of the responses were that "pray " and "ask God for protection". Others also believed in taking herbs to prevent diarrhoea.

Majority, 62 (68.9%) of respondents had a household size of up to 5. The mean of household size was 4.5 compared to that of GSS (2012) which indicates an average household size of 4.5 for rural within the Shai-Osudoku District. This average of household size is the same as that of the census 2010 results. Further on the average household size within the study area is less than the optimal number of persons in a household required to use the filter. This means that on the average, the filters would serve household members as expected.

5.3 GENERAL USE OF WATER AND ITS VALUE

Uses of water ordinarily include drinking, personal sanitation, washing of clothes, food preparation, personal and household hygiene. Qualitative method was used to assess the general use of water and its value in the two communities and it was revealed how water is a fundamental need to humanity.

It is believed that the average distance that women in Africa and Asia walk to collect water is 6 kilometres. However, it was clear from the results and field observations that main source of water was physically accessible, contrary to the just mentioned belief. This access to clean water close to the home can dramatically reduce women's workloads, and free up time for

other economic activities. Everyone has the right to a water and sanitation service that is physically accessible within, or in the immediate vicinity of the household, educational institution, workplace or health institution. Whereas the water source has to be within 1,000 metres of the home and collection time should not exceed 30 minutes (UN, 2014), the two communities enjoy pipe water very close (some just in front of their homes) to them. This physical accessibility to water falls within the recommended 1,000 metre buffer. The women normally fetch the water for household use.

5.4 SOURCES OF DRINKING WATER IN THE TWO COMMUNITIES

Data on the sources of drinking water reveals that the major source of drinking water in the study area is pipe water. This main source of water also happens to be the favourite source of water for the two communities. The main reason for the choice of pipe water is the better quality. Majority of respondents attributed their choice of drinking water to better quality. Even though these are rural communities, well water is not one of the main sources of drinking water.

According to WHO (2011), it is assumed that improved sources of drinking water more likely to supply safe drinking-water than unimproved sources. Improved water supply technologies as summarized as: pipe water into dwelling, yard or plot, public tap or standpipe, tube well or borehole, protected dug well, protected spring and rainwater collection (WHO, 2011). Therefore all the major sources of drinking water in the study area are improved water supply. However, the problem is that water collected for domestic use often becomes re-contaminated or further contaminated by unsafe consumer storage and handling practices at the household level (Sobsey, 2002). Factors contributing to this problem are unsanitary and inadequately protected (open, uncovered or poorly covered) water collection and storage containers.

Furthermore, the use of unsanitary methods to dispense water from household storage vessels, including faecal contaminated hands and dippers, lack of protection against

contamination introduced by vectors (flies, cockroaches, rodents, etc.) and inadequate cleaning of vessels to prevent biofilm formation and accumulation of sediments and pathogens (Sobsey, 2002).

5.5 PERCEPTION ABOUT QUALITY OR GOOD WATER

A number of respondents said they consider clean water for drinking as generally observed from the qualitative interview. They however knew that there could be bad or good water. The consumption of safer drinking water is being championed by scholars as a panacea for numerous causes of ill health and death among the socio-economically ostracised in particular. It was mentioned that bad water makes one sick and this is worthy of note because perceived risk is associated with a household's decision to use good or bad water.

5.6 KNOWLEDGE ON WATER FILTER AND FREQUENCY OF USE

Data on the respondents' knowledge on water filter before the commencement of the project showed that most of the respondents did not know about use of water filter. Only fourteen respondents representing 15.6% claimed that they knew about use of water filters before the distribution of water filters. Majority of respondents knew the purpose of the water filter. Interestingly one respondent claimed that it prevents malaria. Regarding how LifeStraw water filter is used, majority of the respondents knew how to use the water filter.

The health belief model suggests a linear relationship of knowledge and behaviour. It assumes that a change in community knowledge will eventually lead to a change in behaviour. This change is glaring from this study as the behaviour of the majority of respondents was positively changed after the distribution. The knowledge about purpose and how to use the filter affected usability positively.

In terms of frequency of use of water filter, there are differences in the frequency of use. Whilst a sizeable proportion of respondents indicated that they fill it 1-3 times in a day, some

claimed that they fill 1-3 times on weekly basis. This means that those who are not filling it on daily basis are not complying with the exclusive use of the filter. It is the exclusive use which is necessary for prevention of diarrhoea. It has been observed that improving household drinking water quality through household water treatment and safe storage (HWTS) has been shown to have the potential to considerably reduce diarrheal disease (Fewtrell & Colford Jr, 2005; Waddington & Snilstveit, 2009) when used consistently.

Further on majority of respondents indicated that they treat all the water they drink but a significant number of respondents, 15(17%) claimed that they do not treat all the water they drink. This is consistent with a study by Moser et al (2005) where 42 reported that those in households reporting treated water still drank a considerable amount of untreated water with an average of 18.9%. However, research has shown the need for consistent use of these interventions to make it effective (Brown & Clasen, 2012; Enger et al., 2012). Clasen & Rosa (2010), however assert that raw water is sometimes drunk in addition to treated water in households classified as HWT users; it is unclear what the risk of waterborne diseases would be in these households.

As stated earlier in section 4.4, it was observed that 13 respondents from 11 households had not used the water filter. Reasons for disuse included: given away as gifts, children will destroy the filter if it is set up, rats had rendered the water filter inoperable. These reasons are similar to those presented by Peletz et al., (2012).

5.7 LEVEL OF ACCEPTABILITY OF WATER FILTERS

The results revealed that the LifeStraw was highly acceptable as a greater proportion, 77(86%) respondents were happy with the filters, 76 (84%) were willing to recommend the water filter to other people. Regarding the taste of water after filtering, majority 71 (79%) claimed that the taste is better. Similarly, 67 (75%) claimed that the smell is also better.

Overall respondents were very pleased with the performance of the filter. These results are in line with the guidelines used to evaluate acceptability according to Santos & Pagsuyoin (2015) are: perceived effectiveness (HWT shall be palatable and visually appealing to users), perceived health benefits (ability of HWT to reduce diseases) and perceived community livelihoods. More so answers to questions about why respondents are happy about the filters revealed some benefits ascribed to the water filter which possibly led to its acceptance according to the HBM model.

5.8 PERCEPTIONS ON DIARRHOEA

Respondent's perceptions about diarrhoea were assessed using quantitative method. With the ninety respondents, it was striking that 28 (31%) implicated fever, mosquito bite and eating spicy food as causes of diarrhoea. With respect to perceptions about prevention of diarrhoea, 45 (50%) of the respondents had misperceptions about the prevention of diarrhoea. Regarding causes and prevention, a notable number of respondents swap the causes of diarrhoea with causes of malaria. Similarly, responses such as using bread to prevent diarrhoea demonstrate low level of education. This indicates that further educational efforts with respect to prevention and causes of diarrhoea.

Out of 26 respondents who had diarrhoea, 24 were those who were using the filter and only 2 were those who were not using the filter. This means that though participants claimed to be using filters, it is possible that their reported behaviour does not reflect their actual behaviour. This could possibly be due to poor maintenance as it was proven from the responses given for cleaning of filter, 32 (41.5%) respondents clean filter once a week, 33 (42.9%) cleans it twice a week, 12 (15.6%) respondents cleans it every day.

5.9 RELATIONSHIP BETWEEN INDEPENDENT AND DEPENDENT VARIABLES

Associations were determined between some independent (age, sex, marital status, level of education and household size) and dependent variables (use of the filters) with chi-square tests. There were no statistically significant relationship between the independent (age, marital status, level of education and household size) and dependent variables (use of the filters). There was no association between levels of education with reported diarrhoea cases.

5.10 APPLICATION OF THE HEALTH BELIEF MODEL TO ACCEPTABILITYOF WATER FILTERS

In this section the constructs of the Health Belief Model which supported the conceptual frame work is applied to the acceptability of water filters. This explains explain how the HBM could be used to understand factors influencing acceptability and use of water filters. Individual characteristics which could affect perception were age, sex, marital status, religious background and level of education. Average age of respondents was 45 years and a significant number of the participants had no formal education.

In order to perceive a health risk related to the disease, a person must believe that he/she may get the disease and that consequences are negative. Participants commonly implicated dirty or contaminated water as leading cause of diarrhoea. Participants knew that drinking bad water would make one sick. Thus was associated with their decision to accept and use the water filter.

Perceived barriers in this study was few people who mentioned slow flow rate of the filter; meaning the benefits outweighed the perceived barriers for the behaviour change to occur. Answers to questions regarding general impressions about the filter, taste and smell after

filtering revealed some benefits associated to the water filter. When asked "Why they would buy new? ", they responded for health, to prevent diarrhoea among others.

External cues which were information from those who distributed the water filters served as reminders or triggered the respondents to engage in the water filtering.

Respondents successfully performed water filtering as reported by them and this behaviour had been sustained from the period they received the filters to the period researcher collected data. Hence self-efficacy also positively affected the use and acceptability.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 SUMMARY OF FINDINGS

The study was conducted in Apese and Amanfro in the Shai-Osudoku district of Ghana, which is found in the south-eastern part of Greater Accra region. The following are the findings:

- Even though Apese and Amanfro are rural communities, the major source of drinking water is pipe water contrary to general perceptions that pipe water is scarce in rural areas.
- All the major sources of drinking water in the study area are improved water supply.
- Data collected revealed that the LifeStraw water filter's use and acceptability were high.
- It was observed that some households practiced the filtering at a frequency that is unlikely to meet all the drinking water needs of the households.
- Some of those who possessed water filters were still having diarrhoea. Regarding diarrhoea perception, some participants had poor knowledge on causes and prevention.

6.2 CONCLUSION

The study determined the level of acceptability and the use of water filters in two rural communities in Shai-Osudoku district of Ghana. The specific objectives were to: assess the sources of drinking water, assess the knowledge of the people on water filters and its usefulness, determine how frequent water filters are used, determine the level of acceptability

and use of water filters and assess diarrhoea related perceptions in terms of causes, treatment and prevention in the study communities. Both quantitative and qualitative approaches were used. Questionnaires were used for the quantitative to collect data. In-depth study interview guide and observations were adopted for the qualitative aspect.

The results of this study revealed that acceptability rate is high. Results from respondents revealed that most of the study participants had knowledge deficits about diarrhoea causes and prevention. None of the participants could mention that hygiene-related factors such as regular hand and food washing could even prevent diarrhoea. Though participants claimed to be using the filters, it is possible that their reported behaviour does not reflect their actual behaviour since there were self- reported cases of diarrhoea from those who use the filters.

6.3 RECOMMENDATIONS

These recommendations are directed towards the communities, Ministry of Health, WHO and UNICEF.

- In chapter four, it was realised that a significant proportion of participants had poor knowledge with regards to causes and prevention of diarrhoea. Community health awareness on diarrhoea could be created by the district health directorate in collaboration with Community-Based Health Planning Services (CHPS) to throw more light on diarrhoea within the communities.
- The major source of water which is the pipe borne water is an improved water source however, further education should be conducted by health professionals in the afore mentioned organisations regarding transport and storage of the water.
- Participants should be well informed on the need to adhere to use of the water filter to achieve the health gains from it.
- The Ministry of Health in Ghana or World Health Organization should take up responsibility to have community outreach programmes focusing on hand washing

campaign in the two communities since none of the respondents made mention of it as a preventive measure for diarrhoea. Meanwhile studies have shown handwashing with soap to also have positive effect on diarrhea

- Future research should focus on diarrhoea prevention or diarrhoea.
- Research on filter use in same communities must be done to compare trend in use since literature reviewed suggest that there is decline in use years after introduction to such intervention tools.

6.4 LIMITATIONS

This is a study with a small sample size so findings cannot be generalised to all household water treatment users in the country.

REFERENCES

Abebe, L. S., Smith, J. A., Narkiewicz, S., Oyanedel-Craver, V., Conaway, M., Singo, A.,& Dillingham, R. (2014). Ceramic water filters impregnated with silver nanoparticles as a point-of-use water-treatment intervention for HIV-positive individuals in Limpopo Province, South Africa: a pilot study of technological performance and human health benefits. *Journal of water and health*, *12*(2), 288-300.

Ahmedna, M., Marshall, W. E., Husseiny, A. A., Rao, R. M., & Goktepe, I. (2004). The use of nutshell carbons in drinking water filters for removal of trace metals. *Water Research*, *38*(4), 1062-1068.

Aiken, B. A., Stauber, C. E., Ortiz, G. M., & Sobsey, M. D. (2011). An assessment of continued use and health impact of the concrete biosand filter in Bonao, Dominican Republic. *The American Journal of tropical medicine and hygiene*, 85(2), 309-317.

American Anthropological Association. (2012). Statement on Ethics: Principles of Professional Responsibilities. Arlington, VA: American Anthropological Association. Available at: http://www.aaanet.org/profdev/ethics/upload/Statement-on-Ethics-Principles-of-Professional-Responsibility.pdf

Arnold,B.F ,Colford, J.M. , (2007) . Treating water with chlorine at point-of-use to improve water quality and reduce child diarrhea in developing countries: a systematic review and meta-analysis. *Am J Trop Med Hyg* 76: 354 – 364 .

Barajas, J. R., & Pagsuyoin, S. (2015, April). Development of a low-cost water treatment technology using Moringa oleifera seeds. In *Systems and Information Engineering Design Symposium (SIEDS), 2015* (pp. 24-28). IEEE.

Barstow, C. K., Ngabo, F., Rosa, G., Majorin, F., Boisson, S., Clasen, T., & Thomas, E. A. (2014). Designing and piloting a program to provide water filters and improved cookstoves in Rwanda. *PloS one*, 9(3), e92403.

Boisson, S., Kiyombo, M., Sthreshley, L., Tumba, S., Makambo, J., & Clasen, T. (2010). Field assessment of a novel household-based water filtration device: a randomised, placebo-controlled trial in the Democratic Republic of Congo. *PLoS One*, 5(9), e12613.

Brown, J., & Sobsey, M. D. (2007). Use of ceramic water filters in Cambodia. Water and Sanitation Program, Cambodia Country Office.

Brown, J., & Clasen, T. (2012). High adherence is necessary to realize health gains from water quality interventions. *PLoS One*, *7*(5), e36735.

Brown, J., Sobsey, M. D., & Loomis, D. (2008). Local drinking water filters reduce diarrheal disease in Cambodia: a randomized, controlled trial of the ceramic water purifier. *The American journal of tropical medicine and hygiene*, *79*(3), 394-400.

Brown, J., Outlaw, T., Clasen, T., Wu, J., & Sobsey, M. (2009). Safe Water for All: Harnessing

the Private Sector to Reach the Underserved. *Washington, DC: International Finance Corporation/World Bank*.

Casanova, L. M., Walters, A., Naghawatte, A., & Sobsey, M. D. (2012). Factors affecting continued use of ceramic water purifiers distributed to tsunami-affected communities in Sri Lanka. *Tropical Medicine & International Health*, *17*(11), 1361-1368.

Center for Affordable Water and Sanitation Technology (CAWST) Document(2006). Project Implementer's Workshop Reference Manual.

Clasen, T. F., Brown, J., Collin, S., Suntura, O., &Cairncross, S. (2004). Reducing diarrhea through the use of household-based ceramic water filters: a randomized, controlled trial in rural Bolivia. *The American journal of tropical medicine and hygiene*, *70*(6), 651-657.

Clasen, T., Roberts, I., Rabie, T., Schmidt, W., & Cairncross, S. (2006). Interventions to improve water quality for preventing diarrhoea (review).*Cochrane Libr.*, *4*.
Clasen T, Schmidt WP, Rabie T, Roberts I, Cairncross S, (2007). Interventions to improve water quality for preventing diarrhea: systematic review and meta-analysis. *BMJ* 334: 782–791.

Clasen, T., Parra, G. G., Boisson, S., & Collins, S. (2005). Household-based ceramic water filters for the prevention of diarrhea: a randomized, controlled trial of a pilot program in Colombia. *The American journal of tropical medicine and hygiene*, *73*(4), 790-795.

Clasen, T.; Thao, D.; Boisson, S.; Shipin, O. Microbiological effectiveness and cost of boiling to disinfect water in rural Vietnam. *Environ. Sci. Technol.* **2008**, *42* (12), 4255–60

Coser, L. A. (2010). *Masters of Sociological Thought*. India: Rawat Publications.

Dessie A, Alemayehu E, Mekonen S, Legesse W, Kloos H, Ambelu A(2014) Solar disinfection: an approach for low-cost household water treatment technology in Southwestern Ethiopia. *J Environ Health Sci Eng* 12:25

Creswell, J. W. (2003) Research design: Qualitative, quantitative and mixed methods approaches, (2nd edition), Thousand Oaks: Sage.

Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches. SAGE Publications, Incorporated

Duke, W. F., Nordin, R. N., Baker, D., & Mazumder, A. (2006). The use and performance of BioSand filters in the Artibonite Valley of Haiti: a field study of 107 households. *Rural Remote Health*, *6*(3), 570.

Einarsson E, Svard S, Troell, K .(2015). UV irradiation responses in Giardia intestinalis. Exp Parasitol 154(25):25–32.

El-Taweel, G. E., & Ali, G. H. (2000). Evaluation of roughing and slow sand filters for water treatment. *Water, air, and soil pollution*, *120*(1-2), 21-28.

Enger, K. S., Nelson, K. L., Clasen, T., Rose, J. B., & Eisenberg, J. N. (2012). Linking quantitative microbial risk assessment and epidemiological data: informing safe drinking water trials in developing countries. *Environmental science & technology*, *46*(9), 5160-5167.

Francis, M. R., Nagarajan, G., Sarkar, R., Mohan, V. R., Kang, G., & Balraj, V. (2015). Perception of drinking water safety and factors influencing acceptance and sustainability of a water quality intervention in rural southern India. *BMC public health*, *15*(1), 731.

Fewtrell, L., & Colford Jr, J. (2005). Water, sanitation and hygiene in developing countries: interventions and diarrhea-a review. *Water Sci Technol*, *52*, 299.

Gopal K, Tripathy SS, Bersillon JL, Dubey SP (2007) Chlorination by products, their toxicodynamics and removal from drinking water. *J Hazard Mater* 140:1–6

Hillie T, Munasinge M, Hlope M, Deraniyagala Y,(2009) Nanotechnology, Water and Development, for the commissioned as Part of the Meridian Institute's Global Dialogue on Nanotechnology and the Poor: Opportunities and Risks, pp. 1-44. http://sites.merid.org/nano/water paper.

Hindiyeh, M & Ali, A.,(2010). Investigating the efficiency of solar energy system for drinking water disinfection. *Desalination* 259, 208e215.

Hochbaum, G., Rosenstock, I., & Kegels, S. (1952). Health belief model. *United States Public Health Service*.

Hunter, P. R. (2009). Household water treatment in developing countries: comparing different intervention types using meta-regression. Environmental science & technology, 43(23), 8991-8997.

Jain, S., Sahanoon, O. K., Blanton, E., Schmitz, A., Wannemuehler, K. A., Hoekstra, R. M., & Quick, R. E. (2010). Sodium dichloroisocyanurate tablets for routine treatment of household drinking water in periurban Ghana: a randomized controlled trial. The american journal of tropical medicine and hygiene, 82(1), 16-22.

Karanis P, Kourenti C, Smith, H. (2007) Water borne transmission of protozoan parasites: a worldwide review of outbreaks and lessons learnt. J Wat Health 5(1):1–38

Kumekpor, T. K. B. (2002). Research Methods and Techniques of Social Research, (3rd edition). Accra: Sonlife Press and Services.

Lemons, A., Branz, A., Kimirei, M., Hawkins, T., & Lantagne, D. (2016). Assessment of the quality, effectiveness, and acceptability of ceramic water filters in Tanzania. Journal of Water Sanitation and Hygiene for Development, washdev2016006

LifeStraw (2014). LifeStraw® Family 2.0 Clean & safe drinking water for households. LifeStraw.

Loo, S.L, Fane, A.G., Krantz, W.B., Lim, T.T. (2012). Emergency water supply: a review of potential technologies and selection criteria. *Water Res* 46(10):3125–3151

Luby, S. P. (2003). A randomized controlled trial of household-based flocculant-disinfectant drinking water treatment for diarrhoea prevention in rural Guatemala. *The American Journal of Tropical Medicine and Hygiene*, *69*(4), 411-419.

Luby S.P., Mendoza, C., Keswick, B.H, Chiller, T.M., Hoekstra, R. (2008). Difficulties in bringing point-of-use water treatment to scale in rural Guatemala. *Am J Trop Med Hyg* 78(3):382–387.

Massachusetts Institute of Technology (MIT), Sustainability Report (2015). MIT. Massachusetts.

Meierhofer R, Landolt G (2009) Factors supporting the sustained use of solar water disinfection—experiences from a global promotion and dissemination programme. *Desalination* 248:144–151

Merga, N., & Alemayehu, T. (2015). Knowledge, perception, and management skills of mothers with under-five children about diarrhoeal disease in indigenous and resettlement communities in Assosa District, Western Ethiopia. *J Health Popul Nutr*, *33*(1), 20-30.

Naranjo, J., & Gerba, C. (2011). Assessment of the LifeStraw Family Unit using the World Health Organization Guidelines for Evaluating Household Water Treatment Options: Health-based Targets and Performance Specifications. *University of Arizona*.

Neuman, L. (2007). Basics of Social Research: Qualitative and Quantitative Approaches. (2nd edition). New York: Pearson Education.

Ngai, T. K. K., Murcott, S., Shrestha, R. R., Dangol, B., & Maharjan, M. (2006). Development and dissemination of Kanchan™ Arsenic Filter in rural Nepal. *Water Science and Technology: Water Supply*, *6*(3), 137-146.

Ogunyoku, T. A., Nover, D. M., McKenzie, E. R., Joshi, G., & Fleenor, W. E. (2011). Point-of-use drinking water treatment in the developing world: Community acceptance, project monitoring and revision. *International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*, *6*(1), 14-32.

Oyanedel-Craver, V., Narkiewicz, S., Genovesi, R., Bradshaw, A., &Cardace, D. (2014). Effect of local materials on the silver sorption and strength of ceramic water filters.*Journal of Environmental Chemical Engineering*, *2*(2), 841-848.

Patton, M. (2002). *Qualitative Research and Evaluation Methods*, (3rd edition). London: Thousand Oaks.

Plappally, A., Soboyejo, A., Fausey, N., Soboyejo, W., & Brown, L. (2010). Stochastic modeling of filtrate alkalinity in water filtration devices: transport through micro/nano porous clay based ceramic materials. *Journal of Natural and Environmental Sciences*, *1*(2), 96-105.

Peletz, R., Simunyama, M., Sarenje, K., Baisley, K., Filteau, S., Kelly, P., & Clasen, T. (2012). Assessing water filtration and safe storage in households with young children of HIV-positive mothers: a randomized, controlled trial in Zambia. *PloS one*, *7*(10), e46548.

Peletz, R., Simuyandi, M., Simunyama, M., Sarenje, K., Kelly, P., & Clasen, T. (2013). Follow-up study to assess the use and performance of household filters in Zambia. *Am J Trop Med Hyg*, *89*(6), 1190-1194. doi: 10.4269/ajtmh.13-0054

Rainey, R. C., & Harding, A. K. (2005). Acceptability of solar disinfection of drinking water treatment in Kathmandu Valley, Nepal. *International journal of environmental health research*, *15*(5), 361-372.

Rao, A., Jadhav, J., Ranganath, T. S., & Dsouza, L. (2015). Awareness regarding diarrhea, its prevention, and oral rehydration therapy among mothers of under-five children in urban slums of Bengaluru. *International Journal of Medical Science and Public Health*, *4*(8), 1086-1089.

Rayner, J., Zhang, H., Schubert, J., Lennon, P., Lantagne, D., & Oyanedel-Craver, V. (2013). Effect of silver on the bacterial removal efficacy of locally-produced ceramic water filters. *Application of Silver Nanoparticles in Drinking Water Purification*, 104.

Reichert, J., &Binner, J. G. P. (1996). An evaluation of hydroxyapatite-based filters for removal of heavy metal ions from aqueous solutions. *Journal of materials science*, *31*(5), 1231-1241.

Reller, M. E., Mendoza, C. E., Lopez, M. B., Alvarez, M., Hoekstra, R. M., Olson, C. A.,&Rosa, G., Kelly, P., & Clasen, T. (2015). Consistency of Use and Effectiveness of Household Water Treatment Practices among Urban and Rural Populations Claiming to Treat Their Drinking Water at Home: A Case Study in Zambia. *The American journal of tropical medicine and hygiene*, 15-0563.

Rosa, G., Majorin, F., Boisson, S., Barstow, C., Johnson, M., Kirby, M. & Clasen, T. (2014). Assessing the impact of water filters and improved cook stoves on drinking water quality and household air pollution: A randomised controlled trial in Rwanda. *PloS one*, *9*(3), e91011.

Rosa, G., & Clasen, T. (2009). The global prevalence of boiling as a means of treating water in the home. *Brown, J., Outlaw, T., Clasen, T., Wu, J., Sobsey, M. Safe Water for All: Harnessing the Private Sector to Reach the Underserved*.

Rose A , Roy S , Abraham V , Holmgren G , George K , Balraj V , Abraham S ,Muliyil J. , Joseph A., Kang G. , (2006) . Solar disinfection of water for diarrhoeal prevention in southern India. *ArchDis Child* 91:139 – 141.

Schmidt, W.P. & Cairncross, S. (2009). Household water treatment in poor populations: is there enough evidence for scaling up now. *Environ Sci Technol* 43: 986 – 992.

Santos, J. & Pagsuyoin, S.A.(2015). A multi-criteria decision analysis framework for evaluating pointof-use water treatment alternatives. *Springer-Verlag* Berlin Heidelberg.

Sobsey, M. D., Stauber, C. E., Casanova, L. M., Brown, J. M., & Elliott, M. A. (2008). Point of use household drinking water filtration: a practical, effective solution for providing sustained access to safe drinking water in the developing world. *Environmental science & technology*, *42*(12), 4261-4267.

Sobsey M.D.,(2002). Managing Water in the Home: Accelerated Health Gains from Improved Water Supply. Available at: http://www.who.int/water_sanitation_health/dwq/wsh0207/en/.

Stauber, CE, et al. (2014). Evaluation of the Impact of the Plastic BioSand Filter on Health and Drinking Water Quality in Rural Tamale, Ghana. Int. J. Environ. Res. Public Health 2012, 9, 3806–3823. *International journal of environmental research and public health*, *11*(9), 9154-9155.

UNICEF & WHO.(2009). Diarrhoea: why children are still dying and what can be done. New York, United Nations Children's Fund; Geneva, World Health Organization. Available at: (http://whqlibdoc.who.int/publications/2009/9789241598415_eng.pdf).

UNICEF (2007). The State of the World's Children 2008: Child Survival. Available at: http://www.unicef.org/sowc08/.

United States Center for Disease Control (US CDC). (2015) Solar disinfection. http://www.cdc.gov/safewater/solardisinfection.html.

United States Environmental Protection Agency (US EPA). (2015) Emergency disinfection of drinking water. http://water.epa.gov/drink/emerprep/

United States Environmental Protection Agency (US EPA). (2015) Emergency disinfection of drinking water. http://water.epa.gov/drink/emerprep/

Waddington, H., & Snilstveit, B. (2009). Effectiveness and sustainability of water, sanitation, and hygiene interventions in combating diarrhoea. *Journal of development effectiveness*, *1*(3), 295-335.

Williams, C. (2011). Research methods. *Journal of Business & Economics Research (JBER)*, *5*(3).

World Health Organization. (2008). Water quality interventions to prevent diarrhoea: Cost and cost-effectiveness. Geneva.

World Health Organization (WHO) (2006). Mortality Country Fact Sheet 2006: Ghana. Available at: http://www.who.int/countries/gha/gha/en/.

World Health Organization. (2009). Scaling up household water treatment among low-income populations. Geneva.

World Health Organization (WHO). (2011a). Evaluating household water treatment options: Health-based targets and microbiological performance specifications. Geneva.

World Health Organization (WHO). (2011b). Guidelines for Drinking-Water Quality 4th edition. Available at: http://apps.who.int/iris/bitstream/10665/44584/1/9789241548151_eng.pdf

World Health Organization (WHO). (2013). Water quality and health strategy 2013–2020. Available at: http://www.who.int/water_sanitation_health/publications/2013/water_quality_strategy.pdf?ua=1.

World Health Organisation (WHO),(2015a). Drinking water. Available at: http://www.who.int/mediacentre/factsheets/fs391/en/

World Health Organisation (WHO),(2015b).Water Sanitation Health. Available at: http://www.who.int/water_sanitation_health/dwq/wsh0207/en/index5.html

World Health Organization (WHO). (2016a). Results of Round I of the WHO International Scheme to Evaluate Household Water Treatment Technologies. Geneva.

World Health Organization(WHO).(2016b). SDG Health and Health-related Targets. Available at: http://www.who.int/gho/publications/world_health_statistics/2016/EN_WHS2016_Chapter6.pdf

World Health Organization (WHO). (2016c) Putting Household Water Treatment to the Test . http://www.who.int/features/2016/household-water-treatment-test/en/ Available at

World Health Organization & UNICEF (2010). Progress on Sanitation and Drinking Water: 2010 Update. Available at: http://www.who.int/water_sanitation_health/publications/9789241563956/en/ index.html.

Yalew, E. (2014). A qualitative study of community perceptions about childhood diarrhea and its management in Assosa District, West Ethiopia. *BMC Public Health*, *14*, 975. doi: 10.1186/1471-2458-14-975

Zhang, H., & Oyanedel-Craver, V. (2013). Comparison of the bacterial removal performance of silver nanoparticles and a polymer based quaternary amine functiaonalized silsesquioxane coated point-of-use ceramic water filters. *Journal of hazardous materials*, *260*, 272-277.

APPENDIX A: INFORMED CONSENT FORM

RESEARCH TITLE: Acceptability and use of water filters in two rural communities in the Shai-Osudoku district of Ghana

Principal Investigator : Afua Marfoah Ofori

Principal Supervisor: Dr Collins Ahorlu

School of Public Health

General Information about the Research:

I am a student from the Department of Social and Behavioural Sciences, school of Public Health, College of Health Sciences, University of Ghana. I am in this community to carry out a study on acceptability and use of water filters in the Shai-Osudoku district of Ghana. This study will investigate and highlight issues related to unsafe drinking water, perception on diarrhoea and use of water filters in the community. There will be no right or wrong answers. The study is purely on academic research which forms part of my work for the award of a Master of Science in Applied Health and Social Science. I am indeed pleased to invite you to be part of my study. I would like you to read this consent so that you may decide if you wish to be part or not of the study. Accepting to be part of this study will take about 40minutes of your time to answer some questions. It's voluntary and you can withdraw from the study whenever you wish. There is no risk involved in this study and any information given will be treated with confidence such that only researcher and members of the ethics committee will have access to the information.

Possible Risks and Discomforts:

There are no foreseeable risks in participating in this study. However, any discomforts experienced by any respondent as a result of his or her involvement in the study will be dealt with accordingly.

Possible Benefits:

The possible benefit may be indirect but the results are likely to inform policy decision making that would shape the scope of household water treatment in Ghana in relation with water management with which the respondents may be beneficiaries.

Confidentiality:

Please be assured that no names or any other form of identity is required of you. Any information provided will be handled with care and used for academic purpose only.

Compensation*:*

There will be no material or direct compensation for participation in the study since the study will not take so much time and does not pose any danger to the respondents.

Voluntary Participation and Right to Withdraw:

Participation in this research is absolutely voluntary and you are under no compulsion to take part. You may withdraw as you so wish at any point in the study. You may also choose not to answer specific questions.

Contacts for Additional Information:

In case of any doubt or/and for additional information concerning the study you may contact the Principal Investigator, Afua Marfoah Ofori, School of Public Health, University of Ghana, Legon. Telephone: 0578189086 or email address: amoafua@gmail.com Or the administrator of Ghana Health Service Ethical Review Committee: Hannah Frimpong on 0243235225.

Your right as a participant:

This research has been reviewed and approved by the Ghana Health Service. If you have any questions about your rights as a research participant you can contact the Ghana Health Service.

VOLUNTEER AGREEMENT:

The above document describing the benefits and procedures for the research titled: "Acceptability and use of water filters in two rural communities in the Shai-Osudoku district of Ghana" has been read and explained to me. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

_____ _____

Date Signature or mark of participant

If volunteers cannot read the form themselves, a witness must sign here: I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_____ _____

Date Signature of witness

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____ _____

Date Signature of researcher

APPENDIX B: QUESTIONNAIRE

SCHOOL OF PUBLIC HEALTH

UNIVERSITY OF GHANA

ACCEPTABILITY AND USE OF WATER FILTERS IN TWO RURAL COMMUNITIES IN SHAI-OSUDOKU DISTRICT OF GHANA

QUESTIONNAIRE

QUESTIONNAIRE NO. ☐☐☐

NAME (OPTIONAL):_____

INTERVIEWER

I am a post graduate student undertaking a research to investigate the acceptability and use of water filters. I would be glad if you participate in this study by answering a few questions to enable the achievement of the objectives of this study. Your responses would be treated as confidential and used only for the purposes of this research. Your name is not required. Kindly respond as truthfully as possible. You can ask questions if you want.

Thank you.

A. HOUSEHOLD INFORMATION

No.	Question	Response
1	Date of survey	
2	Respondent's ID	
3	Name of community	
4	Signed consent form	
5	Role in family	
6	How many people live in this house?	

B. DEMOGRAPHICS

This section is intended to get information about yourself. Your responses will be treated confidential.

No.	Question	Response	Code
7	Gender	Male Female	1 2
8	What is your age?	……	
9	Marital status	Married Single Divorced Widow Others……..	1 2 3 4 99
10	Highest educational level	No education Primary JHS SHS Post-secondary Other, specify……..	1 2 3 4 5 99
11	Religious denomination	Muslim Christian Traditional No religion Other, specify…….	1 2 3 4 99

C. DIARRHOEA RELATED PERCEPTIONS

This section explores your knowledge about diarrhoea, including its causes, treatment and how it can be prevented

No.	Question	Response	Code
12	In your opinion, what causes diarrhoea?	…… …… …….. ……..	
13	Did anyone in your household have diarrhoea last week?	Yes…… No……	1 2
14	How many days did the diarrhoea last?	Person 1…… Person 2…… Person 3……	
15	Did they take any medication for the diarrhoea?	Yes…….. No……	1 2
16	If yes, what medication did they take?	ORS Herbal Medicine Prayers Other, specify_____	1 2 3 99
17	Did they see a doctor?	Yes…….. No……...	1 2
18	In your opinion, what can you do to prevent diarrhoea?	…… …… …… ……	

D. SOURCES OF DRINKING WATER

Here we would like to know your different sources of drinking water available in your community and your preferred ones.

No.	Question	Response	Code
19	What are your sources of drinking	Well	1

	water? (Tick more than one)	Piped Canal, river and stream Rain Other	2 3 4 99
20	What is your favourite source of drinking water?	Well Piped Canal, river and stream Rain Other ……	1 2 3 4 99
21	Why do you like your favourite source of drinking water?	Closer Better quality Like the taste Other (specify)……..	1 2 3 99

E. KNOWLEDGE ON USE AND USEFULNESS OF FILTER

This section seeks to explore your awareness about the use of the lifeStraw Family filter which was distributed by a group of people a year ago.

No.	Question	Response	Code
22	Are you aware that filters were distributed in this community?	Yes…….. No……	1 2
23	If yes, do you have one?	Yes…… No……..	1 2
24	Do you know of anyone who has one?	Yes…… No……..	1 2
25	In your opinion, what is the purpose of the filter?	…… …… …… ……	

26	Did you know about filter use before this project?	Yes…….. No……	1 2
27	Do you know how to use the LifeStraw filter?	Yes…….. No……	1 2
28	Have you taught your children or any member in this household how to use the filter?	Yes……. No……..	1 2

F. ACCEPTABILITY OF WATER FILTER

With this section, we would like to know your acceptance level and overall impression about the LifeStraw Familly filter.

No.	Question	Response	Code
29	Are you happy with the filter? (If No skip to question 31)	Yes…… No……	1 2
30	If Yes, why?	…… …… ……	
31	If No, why?	…… …… ……	
32	Are you satisfied with the overall performance of the filter?	Fully satisfied Satisfied Less satisfied Poor	1 2 3 4

33	What is the taste of water after filtering?	Better Worse Same as before filtering	1 2 3
34	What about its smell?	Better Worse Same as before filtering	1 2 3
35	Are there any problems with the filter?	Yes…… No……	1 2
36	Would you recommend the filter to others?	Yes…… No……	1 2
37	What is your general impression about the LifeStraw Family filter?	…… …… …… ……	

G. FREQUENCY IN USE OF FILTER

This section seeks to find out how the filter is maintained and the the number of times the filter is used.

No.	Question	Response	Code
38	How many times do you fill the filter in a day?	Always Sometimes Never	1 2 3
39	Do you treat all the water the household uses for drinking? (If Yes skip to question 41)	Yes…… No……	1 2

40	If No to question 39, why?	…… …….. ……..	
41	How long have you been using the filter?	…….. ……	1 2
42	How often do you clean the filter?	Once a week Twice a week Everyday Never	1 2 3 4
43	If this filter breaks down or stops working, will you buy a new one?	Yes…….. No……	1 2
44	If yes to question 43, why will you buy a new one?	…….. …….. …….. ……..	
45	Is the use of the filter important to you?	Yes …….. No ……	1 2
46	If No to question 45, why?	…… …… ……	

H. SOCIAL INFLUENCE

This section is intended to find out whether your decision to use the filter is influenced by others.

No.	Question	Response	Code
47	Who influences you to use the filter?	Self Health professional Friends Relatives Neighbours	1 2 3 4
48	Did anybody recommend the use of filter to you in the past?	Yes…… No……	1 2

APPENDIX C: IN-DEPTH INTERVIEW

SCHOOL OF PUBLIC HEALTH

UNIVERSITY OF GHANA

ACCEPTABILITY AND USE OF WATER FILTERS IN TWO RURAL COMMUNITIES IN SHAI-OSUDOKU DISTRICT OF GHANA

INDEPTH INTERVIEW

INTERVIEW NO. ☐☐☐

NAME (OPTIONAL):_____

INTERVIEWER

I am a master's student at the School of Public Health, University of Ghana, we are trying to understand the meaning and uses of water in our communities and you have been selected to respond to a few questions that I will ask you.

Thank you for agreeing to talk to me about water which is very important to all of us in many ways. However, we all see water differently and attach different meanings to it and how we use it in our daily lives. Please, know that in this interview, there is no right or wrong answers, whatever you say will be your view and understanding of the issues that we are discussing. I am here to learn from you so feel free to tell me things that I did not even ask you about regarding water and its uses in our communities.

Meaning of Water and Its Value to the Community

1. When we say water, what exactly do we have in mind? probe for water for bathing, drinking, washing and cooking; farming/gardening and other activities such as construction works
2. Do you regard water as important in this community? Why is it so important or not so important/what makes it important or unimportant?
3. Are there any beliefs about water and its uses in this community?
   (Probe for beliefs and uses of water)
4. How are we supposed to handle water in our homes? Probe whether water handled based on its uses- For example, how drinking water is handled, cooking water handled etc.
5. Could you tell me the types of water and their sources in this community? What do you consider before choosing a source of water for a particular use?
   (Probe for bathing, drinking, cooking and hand washing)

General Use of Water

6. What is the most frequently used water source by your household? Probe for pipe, well and stream; Probe for various uses
7. How long does it take to get to the most frequently used water source?
8. Who usually go to fetch water for your household use?
   (Probe for daughter, son, mother and father)

What Influences the Choice of Particular Source?

9. Among all the sources of water, which one do you prefer and why?
   (Probe reasons for pipe, well, steam and rain water)

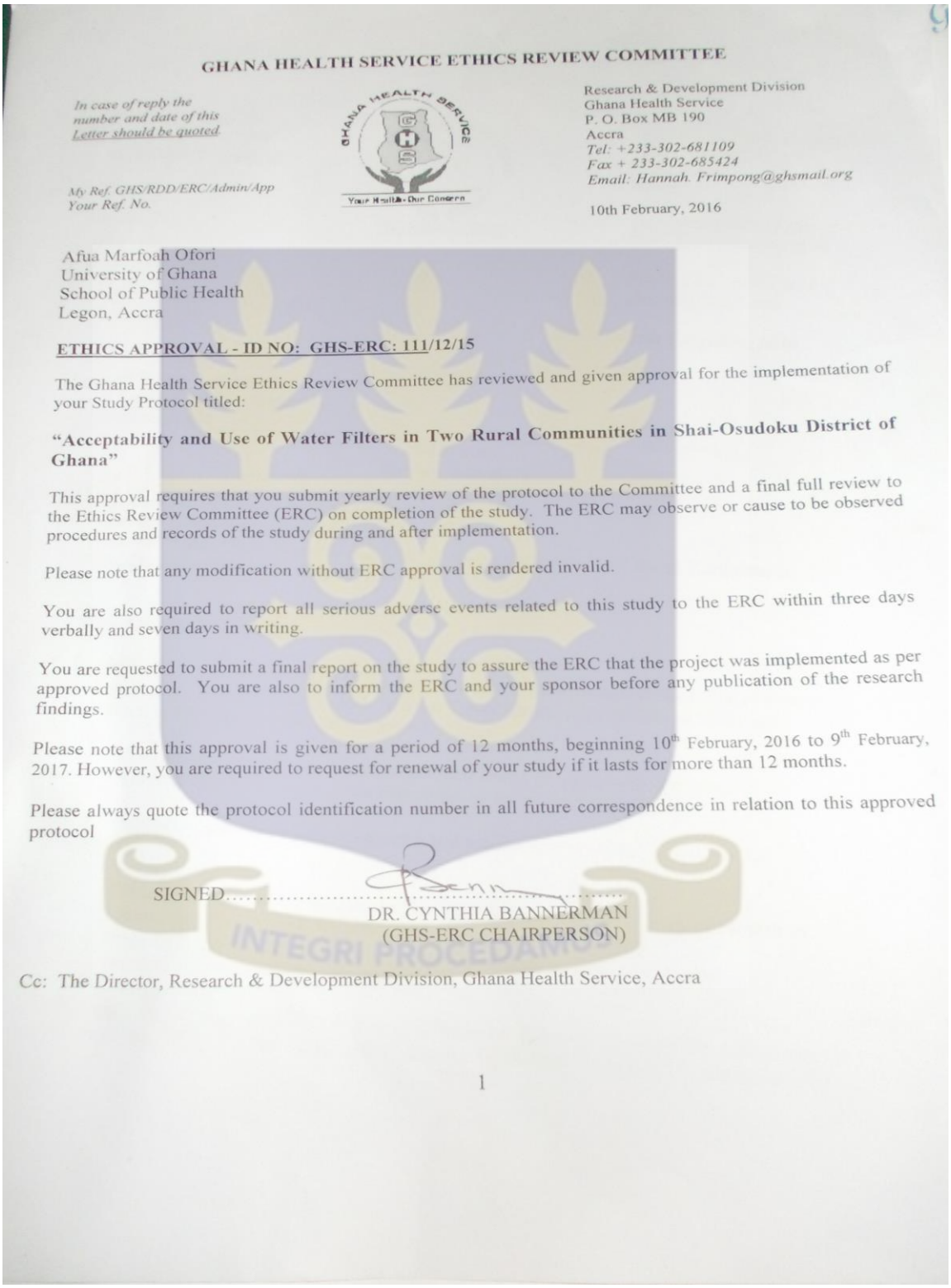
What Community Considers as Quality or Good Water?

10. Can we describe some water as good and others as bad?
11. How do you differentiate between good and bad water?
12. What water do you consider good for drinking?

13. If there is anything that you want to talk to me about water and I did not ask you, please feel free to tell me about it all. I am very interested to know more from you?

Thanks once again.

APPENDIX D: ETHICAL CLEARANCE LETTER



GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

My Ref. GHS/RDD/ERC/Admin/App
Your Ref. No.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: Hannah. Frimpong@ghsmail.org

10th February, 2016

Afua Marfoah Ofori
University of Ghana
School of Public Health
Legon, Accra

ETHICS APPROVAL - ID NO: GHS-ERC: 111/12/15

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol titled:

"Acceptability and Use of Water Filters in Two Rural Communities in Shai-Osudoku District of Ghana"

This approval requires that you submit yearly review of the protocol to the Committee and a final full review to the Ethics Review Committee (ERC) on completion of the study. The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Please note that any modification without ERC approval is rendered invalid.

You are also required to report all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.

You are requested to submit a final report on the study to assure the ERC that the project was implemented as per approved protocol. You are also to inform the ERC and your sponsor before any publication of the research findings.

Please note that this approval is given for a period of 12 months, beginning 10th February, 2016 to 9th February, 2017. However, you are required to request for renewal of your study if it lasts for more than 12 months.

Please always quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: The Director, Research & Development Division, Ghana Health Service, Accra

1