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FACTORS INFLUENCING THE USE OF "AHOTOR" OVEN AMONG FISH SMOKERS IN GHANA.

BY

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THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PUBLIC HEALTH DEGREE

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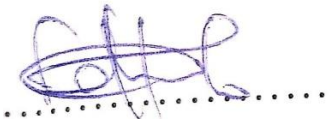
DECLARATION

This is to declare that this work is a result of my own research under the supervision of Dr. Reginald Quansah. Other academic works that have been cited have been duly acknowledged. This work has never been submitted to this or any other university for any degree.



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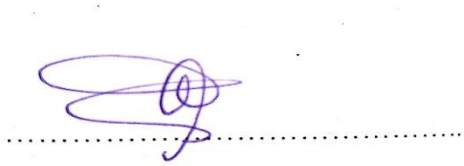

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DR. REGINALD QUANSAH — DATE

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DEDICATION

This work is dedicated to my mother Mrs. Martina Afi Agbemabiese - Danoo for her immense support throughout my study. God bless you mom.

ACKNOWLEDGEMENT

I thank God for how far he has brought me. Grateful to my supervisor for his assistance throughout this study. Also to my friends and family especially my husband Mr. Sena Komla Hotor for being patient and understanding at all times. My course mates Innocent, Charles and Ackah Blay, God bless you for all the support.

ABSTRACT

Background: Household air pollution (HAP) is a leading cause of morbidity and mortality worldwide. This occurs from combustion of biomass fuel which is commonly used around the world, especially in developing countries for cooking and other domestic and commercial purposes. Large amounts of pollutants are emitted when these fuels are combusted therefore contributing significantly to HAP. These pollutants include particulate matter, carbon monoxide, hydrocarbons, oxygenated and chlorinated organic compounds among others depending on the fuel type used. To limit HAP exposure and environmental degradation associated with biomass fuel combustion whiles using traditional ovens to smoke fish, programs and initiatives have been underway to disseminate improved smoking technologies which have health, socio-economic and environmental benefits.

In one of these interventions, an improved fish smoking technology known as "Ahotor" oven was introduced. It is known to reduce levels of polycyclic aromatic hydrocarbons (PAH); a known carcinogen, in smoked fish. However, major challenges have been reported pertaining to the use of these disseminated "Ahotor" ovens. Identifying and understanding factors that lead to these challenges will help formulate solutions to improve its use.

Objectives: The purpose of this study was to assess factors that influence the use of "Ahotor" oven in Ghana.

Methods: A mixed method approach involving surveys using questionnaires, focus group discussions and interviews were employed. These were applied to 109 users of "Ahotor" oven in Ghana to elicit individual and household characteristics, fuel and oven characteristics, knowledge on health and safety benefits of "Ahotor" oven and cultural and traditional factors that influence "Ahotor" oven use. Data from questionnaires were analyzed using descriptive

statistics and logistic regression whiles data from focus group discussions were transcribed verbatim and analyzed by content thematic analysis.

Results: Age of participants, improved quality of smoked fish (i.e. better colour, taste, texture) and participants' knowledge on health and safety benefits of "Ahotor" oven were the main factors that influenced the use of "Ahotor" oven in this study. Cultural factors were not found to have an influence on use of "Ahotor" oven. The most reported barrier to "Ahotor" oven use especially among the low users was its inability to smoke fish as fast as the traditional oven did whiles the most reported facilitator of its use was its property of emitting reduced amounts of smoke compared to the traditional oven. "Ahotor" oven was also found to have a high user rate compared to the traditional ovens.

Conclusion: "Ahotor" oven as an improved oven has a high user rate (60%) due to the numerous positive characteristics it possesses. However, in order to increase or achieve total participant use, it has to be made more affordable and turn over time for fish smoking must be improved.

Key words: Improved cookstoves, traditional cookstove, biomass fuel, smoked fish, HAP, PAH.

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LIST OF ABBREVIATIONS

BaP	Benzo (a) pyrene
FAO	Food and Agriculture Organization of the United Nations
FGD	Focus Group Discussion
FTT	FAO Thiaroye Processing Technique
HAP	Household air pollution
ICS	Improved cookstove
PAH	Polycyclic Aromatic Hydrocarbons
LPG	Liquefied Petroleum Gas
SFMP	Sustainable Fisheries Management Project
SNV	Stichting Nederlandse Vrijwilligers (Foundation of Volunteers)
USA	United States of America
USAID	United States Agency for International Development

DEFINITION TERMS

Biomass fuel - This refers to burned plant or animal materials; wood, charcoal, dung and crop residues.

Carbon monoxide (CO) - Carbon monoxide is a colorless, odorless, tasteless gas produced by burning gas, wood, propane, charcoal or other fuel burning with limited oxygen

Household air pollution (HAP) - Household air pollution refers to chemical, biological and physical contamination of indoor/household air.

Improved cook stove – A cook stove that is more efficient, emits less emissions or is safer to use than the traditional cook stoves.

Particulate matter (PM) - Particulate matter also known as particle pollution or PM is a complex mixture of extremely small particles and liquid droplets suspended in air, many of which are hazardous.

Pollutants - A pollutant is a substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Exposure to household air pollution (HAP) from cooking practices such as fish smoking is known to be a major risk factor for health. In the 2013 Global Burden of Disease Study (GBD). HAP was ranked as the single most significant environmental health risk factor globally. It is responsible for about 3 million to 4 million premature deaths annually (Patel, Chisholm, Dua, Laxminarayan and Medina-Mora, 2015).

In 2015 alone, nearly three million deaths were associated with household air pollution (HAP) (Wolf, Mäusezahl, Verastegui, & Hartinger, 2017). Similarly, diseases such as pneumonia and asthma in children, chronic obstructive lung disease, cardiovascular diseases, lung cancer and vision related conditions like cataracts in adults have been linked to exposure to HAP (Bruce et al., 2014). It has furthermore been shown to have negative socioeconomic and environmental impacts. These socioeconomic impacts manifest in the time spent especially by women in collecting wood in the forest and extra money spent in treatment of diseases acquired from exposure to HAP. Impacts on the environment include contribution to outdoor air pollution, deforestation and climate change (Wolf et al., 2017).

Moreover, an estimated 70% of the world's poorest population; many of whom are in developing countries, rely on use of biomass fuel in the form of firewood, crop residues and charcoal often burned in traditional and inefficient cookstoves (Person et al., 2012). Among these are women and children who are at a higher risk of health effects of exposure to HAP since they spend more time in the cooking process and within the kitchen environment. In most parts of the developing world fish smoking relies ostensibly on use of biomass fuel.

Generally, fish serves as a main source of income for several millions of people worldwide (FAO, 2012). As well as serving as a main source of animal protein to about 3 billion people worldwide (FAO, 2014).

There are several methods for preserving fish; including refrigeration, salting, smoking, drying and canning (Ugochukwu, 2017). Smoking and drying are the main traditional methods employed mostly to preserve and process fish for consumption and storage. Fish smoking prolongs shelf life and enhances flavor therefore increasing utilization in soups and sauces. It also reduces wastage that could have occurred during bumper seasons thereby allowing storage for the lean season (Akande & Adeyemi, 2016).

However, the traditional fish smoking method has consequences that should be addressed in order to significantly improve air quality and the livelihood of people in the fish supply chain. Smoke, especially wood smoke contains polycyclic aromatic hydrocarbons (PAH), which are known to be carcinogenic. Meanwhile, food safety is of growing concern globally and presence of PAH residues in smoked fish above recommended levels is unquestionably of public health concern (Tongo, Ogbeide, & Ezemonye, 2017).

It is therefore critical to promote use of efficient ovens and clean fuels for smoking fish especially in low and middle-income countries in order to improve health of women, children and the environment at large. Several interventions have been implemented in the past to reduce PAH content in smoked fish. The introduction of FAO Thiaroye Processing Technique (FTT-Thiaroye) (FAO, 2015) and “Ahotor” ovens which are improved fish smoking techniques known to reduce PAH associated health risks have faced several challenges.

There is therefore a need to understand key drivers of adoption and sustained implementation of improved ovens. Moreover, there is a significant gap in the research to understand determinants of adoption and sustained use of cleaner fuels in rural poor communities(Kumar, Dhand, Tabak, Brownson, & Yadama, 2017). It is against this backdrop that this study is being carried out to delve into factors that promote and limit the use of the "Ahotor" oven which is an improved oven.

1.2 Problem Statement

The adverse effects of household air pollution pose a major challenge to mankind and the environment as a whole. To mitigate these negative impacts, efforts are being made worldwide to promote the adoption of clean cookstoves. However, programmes put in place to promote these clean cookstoves have faced difficulties with adoption and use. In line with this, numerous researches are ongoing in various parts of the world including Africa to discover factors that influence the adoption and use of these improved cook technologies.

According to a research by the Ghana Council for Scientific and Industrial Research (CSIR), fish smoked with the traditional "Chorkor" oven contains very high levels of polycyclic aromatic hydrocarbons (PAHs). These PAHs are known to be carcinogenic (CSIR, 2018). Based on this knowledge, several interventions have been implemented over the past years to reduce PAH content in smoked fish. However, improved fish smoking technologies such as the one introduced by FAO, Thiaroye Processing Technique (FTT-Thiaroye) (FAO, 2015) and "Ahotor" oven which are both known to reduce health risks associated with PAH have all faced several challenges. This study concentrates specifically on challenged with "Ahotor" oven only.

"Ahotor" oven is an improved oven which operates at lower temperatures and produces less smoke thereby significantly reducing levels of PAH in the smoked fish. Reduced consumption of

PAH lowers the risk of cancer and creates a safer, comfortable and healthy work environment for the fish smokers who are mainly women and children (Torell, E., Owusu, A., and Okyere Nyako, 2017).

In 2013, a ban was placed on smoked fish exportation from Ghana to the European Union due to detection of high levels of PAH in exported fish (Dogbevi, 2015). In an attempt to reduce PAH levels in smoked fish produced in the country, Stichting Nederlandse Vrijwilligers (SNV), a foundation of volunteers from a Netherlands development organization together with the Fisheries Commission in Ghana developed an improved oven known as "Ahotor" oven under the Sustainable Fisheries Management Project (SFMP). The oven was designed to reduce PAH levels in fish as well as to be more energy efficient compared to the existing traditional smoke ovens currently in use in the country. The Ministry of Fisheries and Aquaculture Development and the Fisheries Commission, working closely with the USAID/Ghana SFMP have disseminated "Ahotor" ovens to fish smokers in some regions in Ghana. In spite of these reported beneficial uses of the "Ahotor" oven, there has been reports of user apathy among some fish smokers in Ghana.

There has been several studies done on the factors that influence the use of improved cookstoves but there is no literature on improved ovens. Therefore, this study seeks to determine the factors that promote and inhibit the use of the "Ahotor" oven (an improved oven) from the perspective of the adopters.

1.3 Conceptual framework

The conceptual framework below shows the relationship between "Ahotor" oven use and individual and household characteristics, fuel and oven characteristics, cultural and traditional factors and knowledge of "Ahotor" oven. This conceptual framework was based on existing literatures on related technology (i.e. improved cookstoves and cleaner fuels) due to lack of research and literature on "Ahotor" oven use. It shows how these factors may possibly influence the use of "Ahotor" oven.

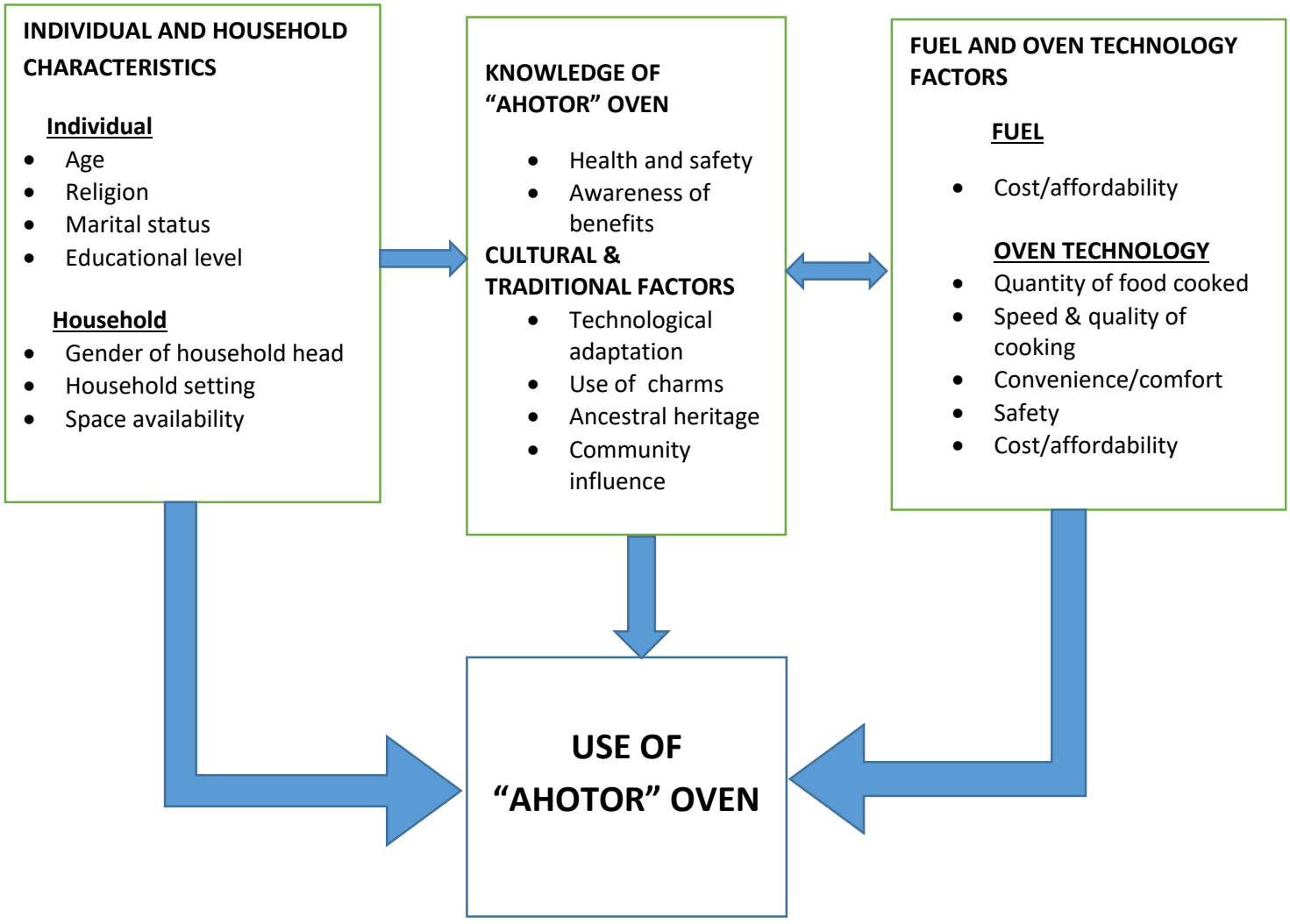

Figure 1.1: Conceptual framework of the factors that influence the use of "Ahotor" oven.

The dependent variable is use of "Ahotor" oven whiles the independent variables are individual and household characteristics, knowledge of "Ahotor" oven, fuel and oven technology characteristics and cultural and traditional factors.

One's age may influence their use of "Ahotor" oven. Lewis and Pattanayak, (2012) found that age of household head did not influence adoption of improved cookstoves while a study by Gebreegziabher et al., (2010) found age to positively influence the decision to adopt an improved cookstove. They reported that the younger household heads were more likely to use improved cookstoves.

Level of education may also determine whether one decides to use "Ahotor" oven or not. A review by Inayat (2011) argued that people with higher educational level are likely to be aware of benefits of improved cookstoves and therefore will be more likely to purchase it.

The religious background of a person may influence the decision to use "Ahotor" oven. Narasimha and Reddy (2007) found that households in rural India with Islamic religion were less likely to use LPG (a cleaner fuel) compared to fuelwood.

One's marital status may play a role in their decision to use "Ahotor" oven. Single women according to Damte and Koch (2011) were found to be more likely to adopt improved cookstove compared to married ones.

Another factor that may influence "Ahotor" oven use is the household size of respondents. It was found to be positively associated with adoption of improved cookstove by Lewis and Pattanayak (2012). Larger households were found to be more likely to adopt improved cookstove.

Gender of household head .i.e. whether the family is headed by female or male may influence the use of "Ahotor" oven. In traditional settings, a woman's decision-making power is usually limited because of a man's ability to exercise a greater budget control. Gender-specific preferences with respect to stove attributes also exists; with women valuing health benefits whiles the men value fuel efficiency and monetary savings (Rehfuess et al., 2014).

Household setting i.e. whether household is located in a rural or urban setting may also influence "Ahotor" oven use. According to a study by Narasimha and Reddy (2007) people living in larger cities or metropolitans are at a higher probability of choosing cleaner fuels as compared to those in smaller cities.

Space availability for installment of more "Ahotor" oven may be found to have an influence on its adoption and use (Pine et al., 2011). Households with more spaces available are more likely to adopt more improved cookstoves.

The knowledge on the appropriate use, the health benefits of "Ahotor" oven and whether it is safer to use compared to the traditional oven, how clean it is to use and any cultural beliefs or taboos pertaining to fish smoking practices may influence the use of the oven. This was evidence in studies by Troconso et al. (2007) and Axen (2012).

The fuel and oven technological characteristics of "Ahotor" oven may influence its use. According to Mekane (2007) and Levine et al., (2013), the thermal efficiency of an improved cookstove; in terms of quantity of food that can be cooked within a given time, speed and quality of smoking, whether it is easier and convenient to use, how affordable it is, all influence their use.

Furthermore, individual and household characteristics such as age and level of education may determine how knowledgeable a person may be concerning the benefits associated with using an improved oven (i.e. "Ahotor" oven for that matter) and thereby influencing their perception and its use. (Axen, 2012).

Knowledge and awareness of health and safety benefits of "Ahotor" oven including the knowledge and awareness of its fuel and oven technology characteristics may influence its use. These fuel and oven technology characteristics have been found to depend on one's cultural perception and therefore one's decision to acquire an improved cookstove. Concurrently, the presence of beneficial fuel and oven characteristics will increase its appeal and subsequently increase its use (Makane, 2007).

1.4 Justification

Household air pollution is one of the main avoidable causes of disease and death globally (WHO, 2014). It occurs from combustion of biomass fuel worldwide, especially in developing countries for cooking and other domestic and commercial purposes. During these processes large amounts of pollutants are emitted therefore contributing significantly to HAP. Introduction of "Ahotor" oven, an improved oven will help mitigate adverse effects associated with HAP. This study will help to understand the factors that promote and inhibit the use of the "Ahotor" oven. A better understanding of these factors will help tackle issues that prevent its use and formulate solutions to improve its use. It will also create awareness among project implementers (i.e. those who disseminated the "Ahotor" oven) (see section 1.2) and oven producers on factors which affect the use of the oven and therefore propose and implement effective interventions for its success. If successful, all households and their communities at large will benefit from reduced air pollution

which contributes generally to a better quality of life. The study will also contribute to the empirical literature on factors that determine the use of "Ahotor" oven in Ghana.

1.5 Objectives

1.5.1 General objectives

The general objective of this study is to assess factors that influence the use of "Ahotor" oven among fish smokers in Ghana.

1.5.2 Specific objectives

i. To identify individual and household characteristics that influence the use of "Ahotor" oven.

ii. To identify fuel and oven technology factors that influence the use of "Ahotor" oven.

iii. To identify fish smokers' knowledge on health, safety and awareness of benefits of "Ahotor" oven.

iv. To explore cultural and traditional factors that influence the use of "Ahotor" oven.

v. To determine the proportion of high oven users among "Ahotor" oven users.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Scope of the review

"Ahotor" oven has been used in Ghana among fish smokers since 2015. However, no single literature exists on this oven. For this reason, the literature review here focuses on related technology; that is improved cookstove and cleaner fuels. Also, it is worth noting that the smoke generated by both of these technologies (i.e. "Ahotor" oven and improved cookstove) are solely from combustion of biomass fuel. Therefore, this review looks at a general description of "Ahotor" oven. It further looks at various determining factors such as individual and household characteristics, fuel and oven characteristics, knowledge on health and safety benefits and cultural and traditional factors, and their association with adoption and use of improved cookstoves and cleaner fuels. Other factors known to influence the adoption and use of cleaner fuels are also mentioned.

2.2. General Description of "Ahotor" oven.

"Ahotor" oven is an improved version of the existing "Chorkor" oven (a traditional oven). It is made up of a combustion chamber fitted centrally to a Chorkor or Morrison-like outer shell with fish processing trays above it. It can either be a retrofit or a new-build, with the latter made from sandcrete blocks and cement. It can also be built as a single or double unit. Above the combustion chamber is a fat collecting tray which is fitted to allow the hot gases to flow up through to the fish while preventing any fat from falling back down onto the fire. There is a primary air inlet which allows oxygen into the combustion chamber to enhance efficient combustion of the firewood. A secondary air inlet located on top of the firewood entrance

introduces cool air into the smoking chamber to meet with heat from combustion chamber, to enable even circulation of air and heat in the smoking chamber. The grate located underneath the combustion chamber improves combustion by elevating the firewood and allowing for better heat circulation. There is a fat exit behind the oven through which fat collected during smoking is drained (Avega, 2015). The "Ahotor" oven is energy efficient i.e. reduces firewood consumption by 32%, emits less smoke compared to the "Chorkor" oven and produces smoked fish with 36% less content of PAH_4 and Benzo (a) pyrene (BaP). A PAH analysis carried out by Ghana Standard Authority (GSA) on smoked fish with skin recorded PAH_4 levels of 23µg/g for "Ahotor" oven compared to 200 µg/g for "Chorkor" oven whiles for smoked fish without skin, PAH_4 levels were 9 µg/g and 69 µg/g for "Ahotor" and "Chorkor" ovens respectively. BaP levels for smoked fish with skin were 4 µg/g and 36 µg/g for "Ahotor" and "Chorkor" ovens respectively whiles for smoked fish without skin, BaP levels were respectively 2 µg/g and 10 µg/g for "Ahotor" and "Chorkor" ovens. All the smoked fish samples from "Ahotor" oven recorded BaP levels lower than the EC limit of 5ug/g but PAH_4 levels in smoked fish with skin were higher than the EU limit of 12 µg/g whiles lower in smoked fish without skin (Amponsah et al., 2018). Below are images of "Ahotor" and "Chorkor" ovens.

Figure 2.1 External view of “Ahotor” oven (Double unit)

Figure 2.2 Fat collecting tray of "Ahotor" oven.

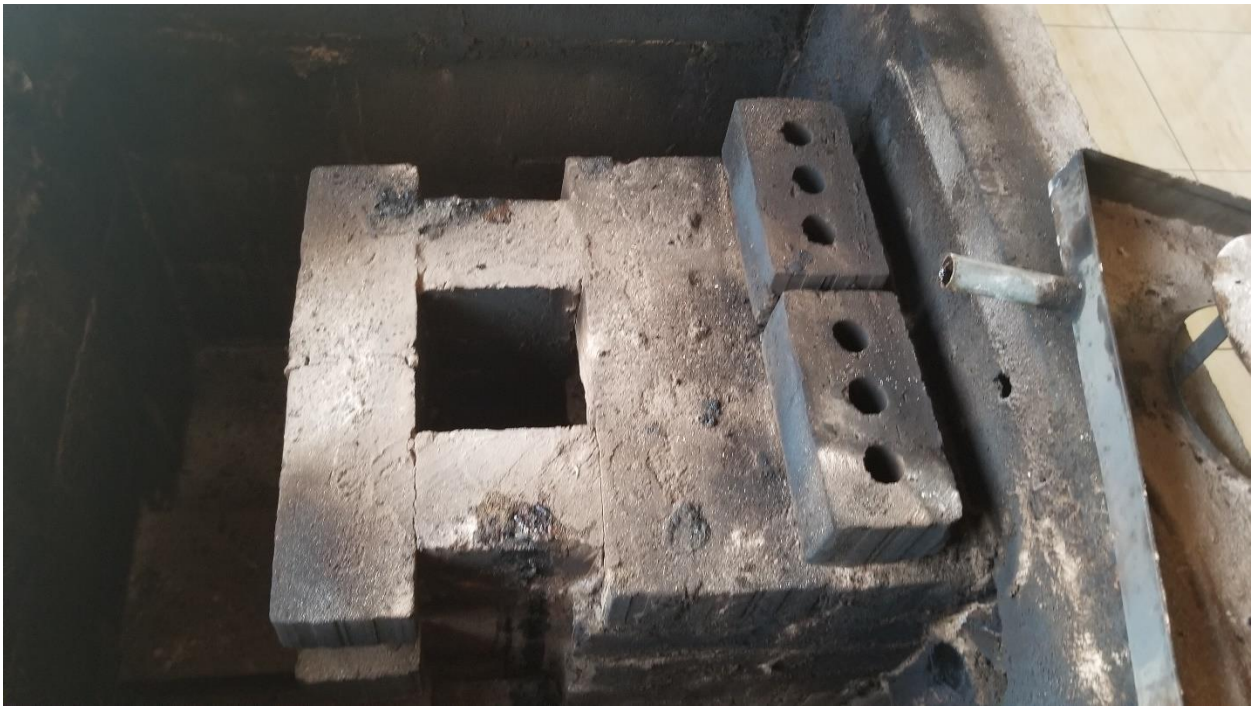

Figure 2.3 Internal view of "Ahotor" oven showing combustion chamber made of sandcrete blocks.

Figure 2.4 Fat exit of "Ahotor" oven.

Figure 2.5 "Chorkor" oven with firewood in combustion chamber and mounted fish trays..

2.3 Factors affecting adoption of cleaner fuel.

There are a range of factors that affect the adoption of cleaner fuels in rural households. They include household characteristics, fuel and stove technology characteristics, policy and standards, market development, finances and subsidies, awareness and perception, support and emphasis from the local government, publicity, after-sale service among others(Shen et al., 2015). Rehfuess et al (2014), in their systematic review of enablers and barriers to large-scale uptake of improved solid fuel stoves, found that meeting the needs and expectations of the user , providing valued savings on fuel, durability, higher socio-economic status, presence of a kitchen house, knowledge on the relative benefits of improved cookstoves, early adopters' success, support to initial users, developing a proficient and dependable network of suppliers/retailers, providing financial access were some of the important factors that influence the adoption of improved cookstoves. The sections below discuss into details some of these factors based on the objectives and conceptual framework of this study.

2.3.1 Individual and household characteristics

Families who live in concrete structures prefer to use cleaner high-quality energies like electricity and solar energy compared to families living in houses made of brick-wood structure (Zhang et al., 2011).

The location of a house will determine the availability and accessibility of various types of fuels. Families living in remote areas tend to rely on traditional fuels like firewood. The transport of cleaner fuels like coal briquette and LPG are difficult and generally expensive. This prevents them from using these fuels in their everyday lives (Gao, 2009, Wu et al., 2012)

Generally, as house income increases, the adoption of cleaner high-quality fuels increases. (Wang and Hu, 2010) found that consumption of electricity had a positive correlation with house income. Pine et al (2011) and Inayat (2011) found that household income is a determinant of household's decision to adopt improved cookstoves. The works also revealed that household income is statistically significant in determining household adoption decision.

Clean fuel adoption may be directly or indirectly impacted by family size, age and gender of members of a household. The older members may prefer to use traditional solid fuels compared to younger members (Wu et al., 2012). In a larger family, there would be enough people to generate cleaner fuels like biogas. Due to the scale effect, the energy consumption per person usually decreases with an increase in the number of family members. Fei and Yu (2011) also reported that females are more enthusiastic to change to the cleaner high-quality fuels compared to males.

The presence of adults in the household, large household size, occupation of household head, household income and non-rainy season were found to be statistically significant positive factors that influence adoption of improved biomass stoves (Pine et al., 2011).

Conversely, household head's age, household size, landholding and knowledge of open fire hazards were found to be statistically insignificant factors in determining improved cookstoves adoption (Inayatullah et al., 2017).

Potential customers who are educated are more likely to be privy to the benefits of improved cookstoves as compared to uneducated or less educated ones (Inayatullah, 2011).

2.3.2 Fuel and stove technology

Fuel characteristics such as supply, price, convenience and effects on air quality influence adoption and use. Lou et al., (2008) found that in Sichuan electricity was in high demand because of its convenience, cleanliness, stable supply and affordability. Though other fuel sources like biogas can meet the household energy requirement and keep the environment clean, its adoption may be low if there are no policies and financial support from the government. In remote areas, using natural gas is costly compared to coal which is abundant and cheaper and therefore widely preferred thus making the use of natural gas very scarce. Normally, low cost is the main consideration for choice of fuel. Asides that, the convenience in use and benefits on air quality are also considered. Electricity, LPG and biogas are convenient compared to others fuels like coal, straw and wood. These fuels produce much less pollutants than traditional solid fuels therefore their adoption would be of benefit to both environment and human health. In a study by Levine et al (2018) it was found that poor's inability to pay for the improved cookstoves was one of essential barriers to their decision to adopt. Axen (2012) also argues that the price of improved stoves and households' perception on the price have effect on the probability of the households adoption decision.

2.3.3 Knowledge of cleaner fuels

The knowledge and awareness of the energy-saving characteristics of cleaner fuels and their role in environmental protection affect adoption behavior. A field study in Fujian province it was found that the local residents though willing to adopt cleaner high-quality fuels, knew very little about these fuels (Liu et al., 2013). According to Wang et al., (2011) limited knowledge about cleaner fuels is an important barrier in their utilization and sustained use.

A person's educational level affects their knowledge and perception (Wu et al., 2012; Fei and Yu, 2011). Usually, people with comparatively higher education prefer to use cleaner high-quality fuels. Wu et al., (2012) reported a significant impact of education on household energy choice. The use of biogas increased significantly with increasing level of education. (Wu et al., 2012)

Influence from peers such as friends and neighbors outside of the household exceeded all other major facilitating and impeding factors to adoption of the improved cooking system. For adopters, positive peer feedback were reduced expenses, cooking time, increased cleanliness whiles among non-adopters, negative peer feedback included damage to cooking pots and overcooked food, the two most-frequently reported barriers to adoption(Seguin, Flax, & Jagger, 2018).

2.3.4 Tradition and Cultural factors that affect adoption of improved cookstoves.

Troncoso, Castillo, Masera, & Merino(2007) studied socio-economic, cultural and environmental factors affecting improved cookstoves adoption in rural Mexico. The socio-economic level, cultural tolerability and lack of free access to open forest were found to have a positive correlation with the adoption of ICs, there was no correlation between IC adoption and level of educational, stove benefits, household head age and cost of the stove.

Women who headed households were found to be more likely to adopt improved cookstoves compared to their married women with male heads counter parts (Damte & Koch, 2011; Inayat, 2011). They argue that traditionally, since the husband has more power to make economic decisions in male-controlled societies, married women's improved cookstoves purchasing decision therefore is determined by the willingness of their spouse. Nguyen et al. (2017)

identified cultural barriers to change in behavior which explains why some households even though had bought or been gifted improved cookstoves were still not using them. Lack of patience, difficulty to self-train and to learn how to use a new cooking technology were some of the cultural issues identified. In Nigeria, a recent study by Akintan et al. (2018) highlighted that "ethnic-specific" traditional norms and taboos influenced fuel choice and cooking habits. However, there was little evidence found by Thurber et al. (2014) in relation to the taste of food cooked on traditional stoves being a significant barrier to adoption of improved cookstove. Bensch et al. (2015) also found no evidence pointing to the fact that preference for traditional cooking methods might be responsible for the adoption of improved cookstove.

2.3.5 Other factors affecting cleaner fuel adoption.

Other factors that influence clean fuel adoption include financial support, market development, policies, regulations and standards. The cost of fuel affects its effective use. It is expected that if local government supports financially, fuel deployment would be encouraged and successfully developed. There is an upsurge in development of cleaner fuels in many rural areas when there are investments through programs of national debt, public facilities grants, loan from world blank among others (Tian, 2013).

A study by (Levine, Beltramo, Blalock, Cotterman, & Simons, 2018) identified that factors such as information, liquidity and presence of biased term of payment impeded the adoption of improved cookstoves in Uganda. From the study it was found that a customer's liquidity constraint, inadequate information, absence of confidence in the new stove's fuel saving capacity and uncertainty about its durability were essential barriers to improved cookstoves adoption.

There is a need to have national standards on fuels and stoves. Standards like measurement of stove thermal efficiency, biogas pool building technology and technical guidelines for production of compressed biofuels. This will help to control fuel quality as well as corresponding stoves and subsequently ensure the adoption and sustainable use (Shen et al., 2015).

Industrialization of commercial cleaner fuels and programs enable the development of rural fuel energy. Tian (2013) evaluated the development status and future trend of Chinese rural energy and concluded that the development and industrialization process of biogas, biofuels and solar energy had been successful.

Publicity and demonstrations on new fuel technologies to residents would give them a better understanding of the fuel and its potential benefits when adopted. Increased their knowledge and perception on environmental protection and fuel efficiency through the publicity and demonstration will create passion and enthusiasm (Shen et al., 2015).

Extensive trainings and instructions about the correct use of new technologies influence dissemination. This can be done through communication mediums such as posters, text messages or radio and television advertisements to inform users of stove's operations and correct use. (Seguin et al., 2018).

CHAPTER THREE

3.0 METHODS

3.1 Study design

A descriptive cross sectional study which employed both quantitative and qualitative methods of data collection and analysis was used in this study. Quantitative data on individual and household characteristics, fuel and oven characteristics, knowledge of "Ahotor" oven and use of "Ahotor" oven were collected using structured questionnaire whiles the qualitative data was obtained through focus group discussions and interviews on cultural and traditional factors that influence the use of "Ahotor" oven. The qualitative data helped to augment and enhance the quantitative data which was obtained using the questionnaires.

3.2 Study area

The study was carried out in selected communities in the Volta, Central and Greater Accra regions of Ghana where users of "Ahotor" oven were identified. Study was conducted in their homes or places of work i.e. where fish is smoked or "Ahotor" oven is located.

The names of districts and communities where study was conducted are summarized in Table 3.1 in section 3.3 below.

3.3 Study population

A list of one hundred and twenty four (124) "Ahotor" oven users in Ghana was obtained from Ghana Fisheries Commission and SNV Ghana. Contact was made with these "Ahotor" oven users. However, the population for this study included only one hundred and nine (109) "Ahotor" oven users (see Table 3.1) who met the eligibility criteria (section 3.4).

Table 3.1: Number of study participants and their locations.

REGION	DISTRICT/MUNICIPAL	COMMUNITIES	NUMBER OF USERS
VOLTA	Keta Municipal	Abortiakorpe, Vodza, Woevia, Dzita,Akplorwutorkor	6
	Ketu South Municipal	Xedzranawo, Aflao, Adina	4
	South Dayi District	Dzemeni, Agordeke, Fantekorpe	26
	TOTAL		36
CENTRAL	Gomoa West District	Mumford, Apam	11
	Awutu Senya West District	Senya Bereku	8
	Mfantiman Municipal	Biriwa, Ainiyi, Abandze, Amissanu, Ankaful	32
	Gomoa East	Gomoa Feteh	8
	KEEA Municipal	Nyiaye, Elmina, Moree, Bantuma	9
	TOTAL		68
GREATER ACCRA	Ga West District	Tsokomey, Bortianor	5
		TOTAL NUMBER OF PARTICIPANTS	109

3.4 Study variables

3.4.1 Dependent variable (Outcome variable)

The main outcome of interest is "Ahotor" oven use which is defined here as the total number of times in a month "Ahotor" oven was used compared to the traditional oven within the last 6 months (Tigabu et al., 2016). Women who have never used their "Ahotor" oven were grouped as

non-users, those who used it less than 50% of the time were grouped as low users, those who used it between 50-75% of the time were grouped as moderate users and those who used the oven more than 75% of the time were grouped as high users (see appendix B). These were later re-categorized into two groups: low users (comprising of 32 non-users and 11 low users) and high users (comprising of 15 moderate and 44 high users) due to the few numbers obtained initially.

3.4.2 Independent variables (Exploratory variables)

The independent variables were the factors that influenced the use of "Ahotor" oven. These included:

1) Individual and household characteristics such as;

   Age: Refers to participant's age in years.

   Religion: Refers to participant's system of faith and worship.

   Marital status: Refers to participant's state of being single or married.

   Educational level: Refers to participant's last level attained on the educational ladder.

   Gender of household head: Refers to whether the house is headed by self (female) or husband (male).

   Household setting: Refers to whether house is located in a rural or an urban area.

   Family size: Refers to total number of people in the household.

   Availability of space: Refers to whether the participant had space in the house for installment of more "Ahotor" ovens.

2) Fuel and oven technology characteristics such as:

   Amount of firewood used in smoking a given amount of fish.

   Quantity of fish smoked per given time.

Speed & quality (colour, taste, texture) of smoking per given time

Convenience: Refers to how easy and comfortable it is to use the oven

Safety: Refers to how safe it is to use oven in order to prevent accidents.

Cost: Refers to how affordable the fuel and oven are.

3) Knowledge of the "Ahotor" oven refers to participants' knowledge on whether the "Ahotor" oven is healthy and safe to use and their awareness of its health benefits.
4) Cultural and traditional factors: These explore whether there are any issues of technological adaptations, community influence, use of charms/voodoo or ancestral heritages that influence the use of the "Ahotor" oven.

3.5 Inclusion and exclusion criteria

Women who had in their possession the "Ahotor" oven for at least six (6) months, 18 years of age and above and willing to follow the study protocol were included in the study. Women who exclusively use traditional ovens, those below the age of 18 years and "Ahotor" oven users unwilling to take part in study protocol were excluded from the study.

3.6 Sampling method

Quantitative method:

The total number of women who were identified to have in their possession the "Ahotor" oven in Ghana as per information obtained from Ghana Fisheries Commission and SNV Ghana was 124. However, only 109 of them, who were contacted, met the eligibility criteria. Therefore only this number were recruited for the study. Sample size was not calculated because all "Ahotor" oven users who met eligibility criteria were sampled for the study.

Qualitative method:

Three (3) focus group discussions (FGD) were supposed to have been conducted in each region, each group comprising at least five (5) people. But due to the distances between some of the communities, it was very difficult gathering the women in some districts for a discussion. In view of this, two (2) FGDs were conducted in the Volta region, two (2) in the Central region and one (1) in the Greater Accra region. Each FGD group comprised of 5 study participants who were randomly selected from the list of names and contacted (i.e. Volta and Central region). Greater Accra had exactly 5 study participants therefore random selection was not done. Transportation fares were provided to enable them travel from their communities and converge at a designated location for the FGD.

3.7 Data collection

The study was conducted using both quantitative and qualitative data collection methods. Questionnaires were used for quantitative data collection whiles focus group discussions were used for qualitative data collection. The qualitative data was collected to give an in-depth explanation to results obtained from the quantitative data. Two research assistants were trained a week to commencement of data collection at the University of Ghana, School of Public Health auditorium. They were trained to understand the content of the questionnaire and what each question required, they were equipped with ethical principles and skills required to conduct data collection, informed consent, focus group discussions and data management.The principal investigator and research assistants met some opinion leaders and the leaders of fish smokers unions in their communities to inform them and seek permission to carry out the project. Once approval was given, all the fish smokers who had the “Ahotor” oven were contacted and

informed about the project. Data collection tools were not pre-tested due to time constraints and late commencement of the study.

3.7.1 Quantitative data collection

Data was collected using structured questionnaires. This was done by the principal investigator and trained research assistants after obtaining informed consent from each participant. The questionnaire ascertained information on age, sex, religion, ethnicity, marital status, level of education, gender of household head, household setting, space availability, knowledge of "Ahotor" oven and fuel and oven characteristics. Questionnaires were filled face-to-face and participants who could not read or write English had oral translations of questionnaire. Each questionnaire was filled in an average of 20 minutes. Data collection period lasted for about two (2) months due to the data being collected from three (3) different regions. Data collected were coded and entered into EpiData version 3.0 software by principal investigator. A sample of the questionnaire that was used can be seen in appendix B.

3.7.1.1 Questionnaire

The questionnaire for the study participants was in five (4) parts; Part I to Part IV. Part I of the questionnaire was made up of open and closed ended questions on individual and household characteristics. These included age, sex, tribe, marital status, level of education, religion, head of household, household setting, space availability for extra ovens, total family size, type of toilet facility and source of drinking water. Part II contained questions on the use of "Ahotor" oven. It sought to know the type of oven normally used to smoke fish, ownership of "Ahotor" oven, how it was acquired, how long participant has had and used the oven, how often they use the oven, whether they have stopped using the oven and why, and advantages and disadvantages of the oven. Part III was used to assess the participants' knowledge on health and safety benefits of

"Ahotor" oven and presence of any cultural and traditional influences on use of the oven. Part IV sought to compare fuel and oven technological characteristics of traditional oven and "Ahotor" oven and whether participants will be willing to purchase more "Ahotor" ovens in the future. The fuel and oven characteristics included; how fast the oven smokes fish, how well it smokes fish (colour, consistency, taste), which oven consumes less firewood, which oven is less expensive or affordable and which oven is more convenient (less effort and easy) to use.

3.7.2 Qualitative data collection

Focus group discussion (FGD) and interviews were conducted by the principal investigator and research assistants. The focus group discussion sought to explore any cultural and traditional influences on use of "Ahotor" oven and also explore and deeply understand the barriers and facilitators of the "Ahotor" oven that were mentioned in the quantitative study. Communities where it was possible to gather 5 or more people for the discussion were used. It was conducted at a designated location usually one of the participant's house where open ended questions were asked to enable participants to describe their experiences in details and in their own words. (FGD guideline can be seen in appendix C). For communities where participants couldn't be gathered, interviews were conducted individually using the same guideline. Discussions were recorded using a Samsung tablet voice recorder and later transferred unto a password guarded laptop for transcription later. Participants were given a token of appreciation in the form of call credits for their time and energy.

3.8 Record Storage and Protection

All records and data pertaining to the research were protected against inappropriate use, disclosure, malicious or accidental loss or destruction in order to safeguard the confidentiality of study subjects. Data was locked with restricted access and there were restrictions on copying

study-related materials. Data will be appropriately and safely destroyed by shredding and burning paper documents, destroying pen drives, deleting audio files and ensuring erasure of study-related electronic media after study is concluded and results reviewed by all appropriate bodies.

3.9 Data processing and analysis

3.9.1 Quantitative data analysis

The questionnaires were cross checked for completeness and internal consistency. The data was then cross checked to identify missing values and to correct any inconsistencies. Data entry was done using EpiData software version 3.0 and transferred into Stata 15 version (Stata Corporation, Texas, USA) for analysis. Sample proportions were used to describe categorical and numerical data. This was presented in the form of frequency distribution tables, pie charts and bar graphs. Some variables were re-categorized;

i) Age of participants was regrouped into [18-29, 30-39=18-39 and [40-49, 50 and above =40 and above].

ii) Marital status was regrouped into [never married, widowed, divorced separated=single] and [married and living together=married].

iii) Level of education was regrouped into [no education, nursery=lower education] and primary, junior high school, senior high school, tertiary=higher education].

iv) Religion was regrouped into [Christian=Christian, Muslim, traditionalist, no religion=others].

v) Family size was regrouped into [1-3, 4-6=1-6] and [7-9, 10 and above=7 and above].

For inferential analysis, Pearson's Chi-square test was used to test for the strength of association between the independent variables and dependent variable but in instances where the 2x2 cell contained less than 5 items, Fisher's exact test was used. Logistic regression using odds ratios was further employed to test the strength of association between significant factors and the dependent variable. The results were presented as percentages and ratios. A p-value of less than 0.05 was considered to be significant at a confidence level of 95%.

3.9.2 Qualitative data analysis

A thematic analysis approach was used to analyze the qualitative data. This was facilitated by NVIVO software version 11. All focus group discussions and in-depth interviews were transcribed verbatim from the voice recorder and translated into English from Twi, Fante, Ewe and Ga. After these, data analysis was done. Scripts were read several times so as to become familiar with the data. Meaningful major themes were identified based on the study objectives and coded. Codes were compared and all generated codes collated into potential subthemes. Subthemes were defined and grouped. Vivid, compelling examples (extracts) were then selected to substantiate the created themes.

3.10 Quality Control

The following measures were undertaken to ensure that the data collected was of superior quality so as to ensure its validity: two research assistants received training in questionnaire administration. Meetings were held daily after collection of data to identify any challenges and propose subsequent solutions to them. There was no pretesting of questionnaires due to the supposed elaborate nature of the study.

3.11 Ethical Consideration

Ethical clearance was sought from Ghana Health Service Ethical Review Committee. Ethical review number: GHS-ERC 014/03/19. Permission was also sought from regional coordinating councils of Volta, Central and Greater Accra regions.

3.11.1 Privacy/ confidentiality

Anonymity and confidentiality was assured. Information about participants' identity was not collected nor retained. The records of this study was kept strictly confidential. Any information that would make it possible to identify participants in any report that may be published was not included. They were made known that every information sought is for academic research purposes and was not be shared with people outside the research team. An informed consent form was provided to participants to ensure their voluntary choice in participating in study

The study is to inform health policy makers about the factors that influence the use of "Ahotor" oven and the necessary actions that ought to be taken to improve its use. There are no risks associated with participating in this study. Symbolic incentives were awarded to study participants in appreciation of time and energy spent to partake in the study. Therefore benefits of this study outweigh any potential risks.

Participation in this study were voluntary and participants can choose not to answer any individual question or all questions. Participants were at liberty to withdraw from the study at any time.

3.12 Informed consent

Permission was sought from the leaders of the community and the leaders of the local fish smokers association. A meeting was held with the fish smokers where the objectives and details

of the study were clearly explained to each participant. A translator was employed to help out with those who could not read and write English. It was made clear to them that participation in the study is voluntary and they are free to withdraw from the study at any point in time they wished to.

3.13 Benefits and Risks

The study when completed would inform health policy makers about the factors that influence the use of "Ahotor" oven and the necessary actions that ought to be taken to improve its use. There are no risks associated with participating in this study. Time spent in taking information (averagely 20 minutes) from participants may be of some discomfort to them. At the end of the session, participants were given a token in the form of call credits to show appreciation for their time and energy.

3.14 Conflict of Interest

The principal investigator had no particular interest in this study other than for academic purposes and its relevance in public health.

3.15 Dissemination of findings

The findings of this research was finally submitted to the school of Public Health, University of Ghana in partial fulfilment of requirements for the award of Master in Public Health Degree. The population will later be made aware of the key findings. Subsequently, an article will be published in a reputable journal.

CHAPTER FOUR

4.0 RESULTS

4.1 Individual and household characteristics of study participants.

All the 109 "Ahotor" oven users who met the eligibility criteria participated in the study. Of the 109, 33% resided in the Volta region, 62% in Central region and 5% in Greater Accra region. Locations of the study participants are represented in Table 4.1a. All participants were females with a greater portion of them (71.6%) being 40 years and above whiles the remaining (28.4%) were below 40 years. Fifty two (52%) were Akans, thirty three (33%) Ewes, fourteen (14%) Gas and one (1%) Dagbani. Majority of them were married (71.6%) and 52.8% of them had higher education. Christians made up 89% of the participants whiles the rest (11%) belonged to other religions. Majority of them (97.3%) resided in rural settings with 74.3% of them with available space in the household for future installment of extra ovens. Majority of study participants (76.5%) had improved drinking water sources whiles as much as 84% of them used unimproved toilet facilities. Table 4.1b illustrates other individual and household characteristics of the study participants.

Table 4.1a: Distribution of "Ahotor" oven users in Ghana (n=109).

Region/District/Community	Frequency (n)	Percentage (%)
VOLTA REGION		
South Dayi District		
Agordeke	9	8.3
Fantekope	10	9.2
Dzemeni	7	6.4
Keta Munucipal		
Vodza	1	0.9
Abutiakope	1	0.9
Woevia	1	0.9
Dzita	2	1.8
Akplorwutorkor	1	0.9

Table 4.1a continued.

Region/District/Community	Frequency (n)	Percentage (%)
Ketu south Municipal		
Aflao	2	1.8
Adina	1	0.9
Xedzranawo	1	0.9
CENTRAL REGION		
KEEA District		
Bantuma	5	4.6
Elmina	1	0.9
Moree	1	0.9
Nyaiaye	2	1.8
Gomoa West District		
Apam	6	5.5
Mumford	5	4.6
Awutu Senya West District		
Senya Bereku	8	7.3
Mfantiman Municipal		
Ainiyi	2	1.8
Ankaful	8	7.3
Biriwa	2	1.8
Abandze	10	9.2
Amissanu	10	9.2
Gomoa East District		
Gomoa Feteh	8	7.3
GREATER ACCRA REGION		
Ga West District		
Tsokomey	2	1.8
Bortianor	3	2.8

KEEA: Komenda Edina Eguafo Abirem

Table 4.1b: Individual and household characteristics of study participants (n=109).

Variables	Frequency (n)	Percentage (%)
Age in years		
18-29	5	4.6
30-39	26	23.9
40-49	46	42.2
50 and above	32	29.4
Marital Status		
Never married	9	8.3
Married	73	67.0
Living together	5	4.6
Widowed	11	10.1
Divorced	5	4.6
Separated	6	5.5
Level of education		
No education	46	42.6
Nursery	5	4.6
Primary	31	28.7
Junior high school	19	17.6
Senior high school	6	5.6
Tertiary	1	0.9
Religion		
Christian	97	89.0
Muslim	1	0.9
Traditionalist	3	2.8
No religion	8	7.3
Family size		
1-3	10	9.3
4-6	42	38.9
7-9	35	32.4
10 and above	21	19.4
Household setting		
Rural	106	97.3
Urban	3	2.8
Space availability		
Yes	81	74.3
No	28	25.7
Household head		
Husband(male)	73	67.0
Self(female)	36	33.0
Drinking water source		
Improved	83	76.5
Unimproved	26	23.5
Toilet facility		
Improved	17	15.6
Unimproved	92	84.4

4.2 Fuel and oven characteristics of "Ahotor" and traditional ovens.

Of the 109 participants, 103 responded to questions on fuel and "Ahotor" oven characteristics. The remaining 6 participants were yet to use their "Ahotor" oven because they were either awaiting training on its use or due to incomplete installation of the oven. More than half of them (60.2%) reported the traditional oven as being faster in smoking fish but 80.6% said "Ahotor" oven smokes the fish better in terms of colour, taste and texture. Majority (94.2%) said less firewood was required when using "Ahotor" oven compared to traditional oven, whiles 66% said the traditional oven was more affordable. Table 4.2 below shows the responses of the participants.

Table 4.2: Fuel and oven characteristics (n=103).

Variables	Frequency (n)	Percentage (%)
Smokes fish faster		
Traditional oven	62	60.2
"Ahotor" oven	41	39.8
Smokes fish better (colour, taste, texture)		
Traditional oven	20	19.4
"Ahotor" oven	83	80.6
Uses less firewood		
Traditional oven	6	5.8
"Ahotor" oven	97	94.2
Less expensive		
Traditional oven	68	66.0
"Ahotor" oven	35	34.0
More convenient		
Traditional oven	17	15.7
"Ahotor" oven	86	84.3

4.3 Knowledge on health and safety benefits of "Ahotor" oven.

This was ascertained through questions on health benefits of 'Ahotor" oven and its safety. As shown in Table 4.3a, 86.2% of study participants had good knowledge on benefits of the oven. Tables 4.3b shows the health benefits they reported. More than half of them (56%) reported less emission of smoke as an important health benefit of the oven, 16.5% reported reduced eye disease whiles 15% could not report any health benefits at all. Also, 90.8% of participants had good knowledge on safety of the "Ahotor" oven whiles the remaining 9.2% had poor knowledge. This is represented in Table 4.3c.

Table 4.3a Knowledge on health benefits of "Ahotor" oven reported by participants (n=109).

Health benefits of "Ahotor" oven	Frequency (n)	Percentage (%)
Good knowledge	94	86.2
Poor knowledge	15	13.8

Table 4.3b Health benefits reported by participants (n=109).

Health benefits	Frequency (n)	Percentage (%)
Reduced heart diseases	6	5.5
Reduced eye diseases	18	16.5
Less heat	3	2.75
Less smoke	61	56.0
Reduced cough	6	5.5
No response	15	13.8

Table 4.3c Knowledge on safety of "Ahotor" oven reported by participants (n=109).

Safety of "Ahotor" oven	Frequency (n)	Percentage (%)
Good knowledge	99	90.8
Poor knowledge	10	9.2

4.4 Cultural and traditional influences on use of "Ahotor" oven

The influence of culture and tradition on use of "Ahotor" oven was assessed through focus group discussions (qualitative study). Results obtained have been presented as quotes and supports the results from the quantitative study.

None of the study participants reported being influenced culturally or traditionally to use "Ahotor" oven. Some of the statements they made when interviewed are stated below.

A study participant said:

"*There are no cultural influences, it is because of the lack of fish during this season that we don't use the oven. When we harvest enough fish, we surely use it"*. (Woman, FGD 1)

Another reported:

"No. it is not because of anything. No cultural practice prevents me from using it and how to use it is not difficult because we were taught, yes they taught us. Did you say juju, me I am a Christian so I don't use juju". (Woman, FGD 2)

One other participant also indicated:

"Oooh as for those things (referring to cultural practices)*, no, it is not because of that. We came to meet it. Yes! But that is not why we will not use the new one* (referring to "Ahotor" oven) *because it is very good".* (Woman, FGD 5)

4.5 Use of "Ahotor" oven by participants.

Use of "Ahotor" was defined as the number of times "Ahotor" oven was used compared to traditional oven, out of the total number of times fish was smoked in the last 6 months. Low users were those who used it less than 50% of the time while high users were those who used it 50% or more of the time (see definition in section 3.5.1). Of the 109 study participants, 60% of them fell in the category of high users whiles 40% fell into the category of low users. As stated in section 3.5.1, non-users (29%) and low users (11%) were re-categorized and combined into low users making up the 40% whiles moderate users (16%) and high users (44%) re-categorized and combined into high users making up the 60%.

n=109

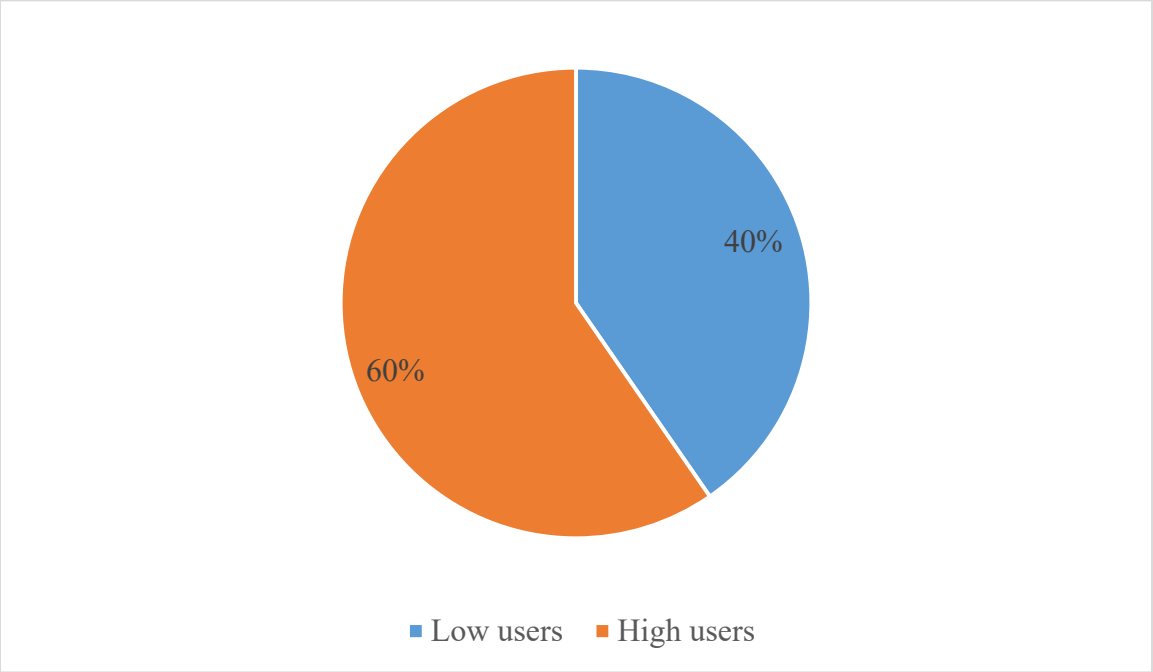

Fig 4.5: Proportion of use of "Ahotor" oven by participants.

4.6 Factors that promote the use of "Ahotor" oven as reported by study participants.

Figure 4.6 shows factors that encourage participants to use the "Ahotor" oven compared to the traditional ovens. Twenty eight (28.2%) of them reported less smoke emission by "Ahotor" oven as their main facilitating factor. Nineteen (19.4%) said the fish tasted better whenever "Ahotor" oven was used to smoke it. Fuel saving characteristic of "Ahotor" oven i.e. less amount of firewood used by the oven was also reported by 18.5% of participants as a facilitating factor. One respondent said:

"When I use it for smoking of my fish there is less smoke produced which is good for my health. So I don't have any problem with sickness or any disease". (Woman, FGD 4)

Another respondents also reported:

"The difference is that the "Ahotor" oven doesn't emit a lot of smoke, it is fast and also doesn't burn the fish". (Woman, FGD 1)

Considering less burns as a facilitator, a participant stated:

"When using the old one (referring to "Chorkor" oven)*, the fire comes out of the oven to burn us sometimes, but with this one* (referring to "Ahotor" oven) *there is no problem with it".* (Woman, FGD 3)

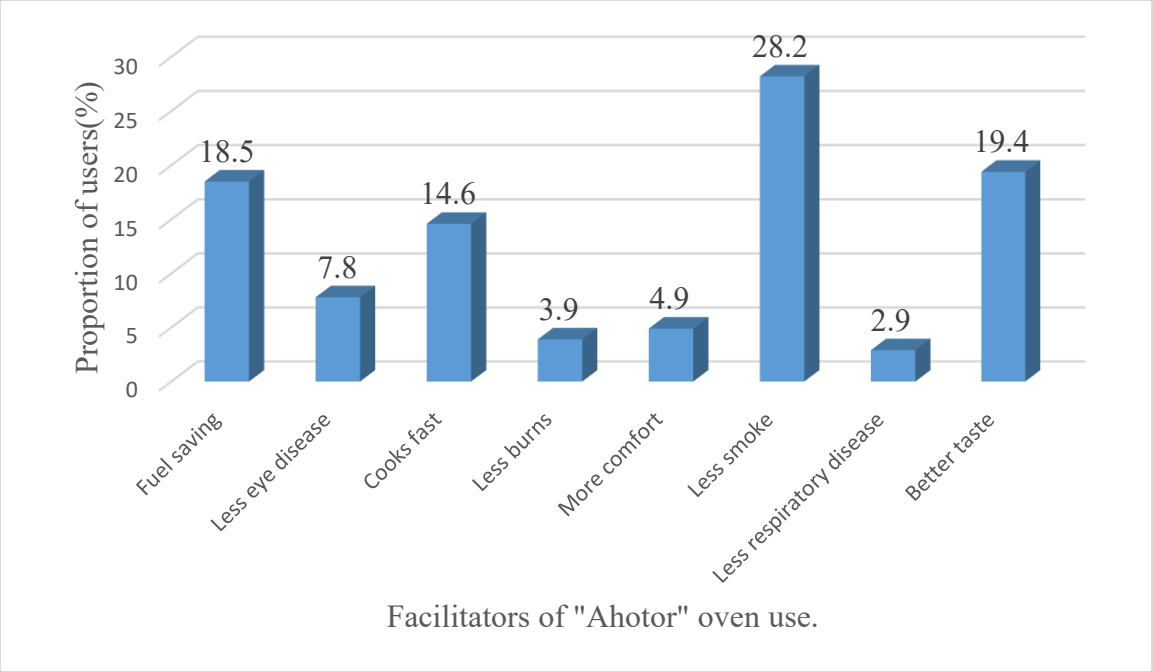

Fig 4.6 Facilitators of "Ahotor" oven use.

4.7 Barriers to the use of "Ahotor" oven by study participants.

Figure 4.7 shows the disadvantages of "Ahotor" oven observed and reported by the participants. More than half of them (59.3%) said it took a longer time to smoke fish compared to traditional oven and 27.8% of them said it did not smoke fish properly i.e. colour, taste and texture. The other participants (7.4% and 5.6%) said it was difficult to maintain and expensive respectively.

One fish smoker complained:

"When using "Ahotor" oven to work, it doesn't smoke fast at all. So it will be good if they can do something about it because the fish we smoke is plenty; it is not the kind of fish that can be taken to small markets". (Woman, FGD 3)

Another said:

*"The old one (*referring to *"*Chorkor" oven*) cooks all parts of the fish but the new one* (referring to "Ahotor" oven) *smokes only the middle part of the fish so it does not get well cooked. That is the problem".* (Woman, FGD 5)

Regarding cost, a participant said:

"The "Ahotor" oven is expensive. I wasn't lucky enough to be part of any of the programs that did it for free but I heard it was good so I decided to do it with my own money. I had to borrow some of the money from friends too". (Woman, FGD 1)

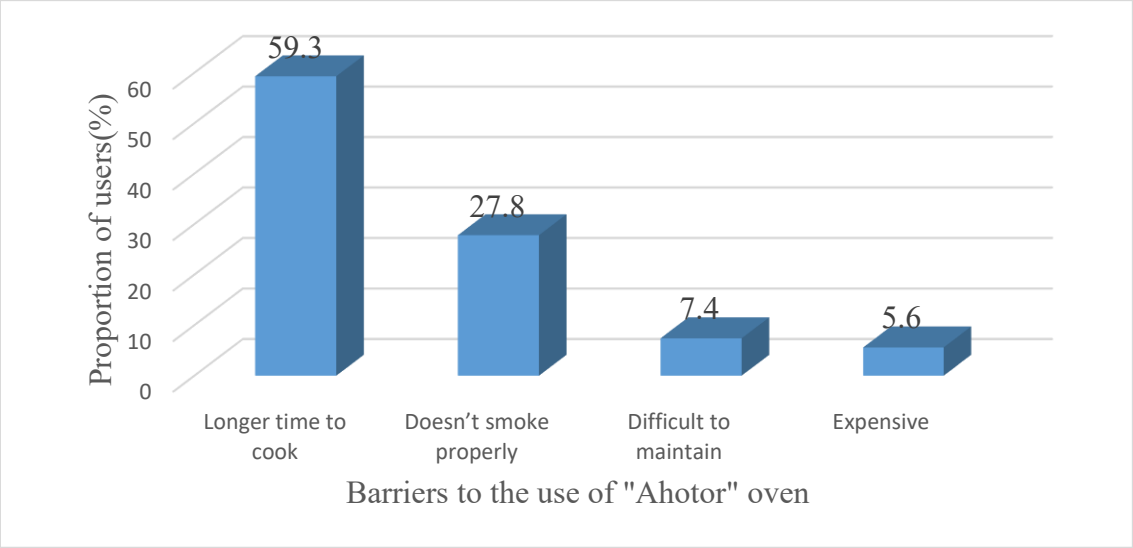

Fig. 4.7 Barriers to the use of "Ahotor" oven.

4.8 Association between individual, household, fuel and oven characteristics, knowledge on health and safety benefits of "Ahotor" oven and use of "Ahotor oven.

Table 4.8a, 4.8b and 4.8c show results from Chi-square analysis. Significant associations were observed between use of "Ahotor" oven and factors such as age of participant [$X^2(109)=13.6$, $p=0.00$], space availability [$X^2(109)=11.8$, $p=0.001$], gender of household head [$X^2(109)=5.2$, $p=0.02$], the oven which smokes fish faster [$X^2(103)=17.8$, $p=0.00$], smokes fish better [$X^2(103)=5.7$, $p=0.017$], cost [$X^2(103)=4.8$, $p=0.028$], convenience[$X^2(103)=8.7$, $p=0.003$] and knowledge on health [$X^2(109)=4.9$, $p=0.025$] and safety [$X^2(109)=7.7$, $p=0.005$] benefits of "Ahotor" oven all at a significance of $p<0.05$. As mentioned earlier, only 103 participants responded to questions on fuel and oven characteristics in the study (see section 4.2). Values from the Fisher's exact test were represented with (^).

Table 4.8a: Test of association between individual and household characteristics of participants and use of "Ahotor oven (n=109).

Variables	Use of Ahotor oven				X^2	p value
INDIVIDUAL AND HOUSEHOLD CHARACTERISTICS	**Low Users**		**High Users**			
	n	**%**	**n**	**%**		
Age in years					13.6	**0.000**^
18-39	4	12.9	27	87.1		
40 and above	40	51.3	38	48.7		
Marital status					1.2	0.282¥
Single	15	48.4	16	51.6		
Married	29	37.2	49	62.8		
Level of education					1.0	0.601¥
Lower education	19	37.2	32	62.8		
Higher education	24	42.1	33	57.9		
Religion					3.1	0.339^
Christian	42	43.3	55	56.7		
Others	2	16.7	10	83.3		
Total family size					0.5	0.477¥
1-6	23	44.2	29	55.8		
7 and above	44	40.7	64	59.3		
Household setting					2.1	0.271^
Rural	44	41.5	62	58.5		
Urban	0	0.0	3	100		
Space availability					11.8	**0.001**¥
Yes	25	30.9	56	69.1		
No	19	67.9	9	32.1		
Household head					5.2	**0.020**¥
Husband (male)	24	32.9	49	67.1		
Self (female)	20	(55.6	16	44.4		

- **p** = significant at $p<0.05$, X^2=chi square
- p¥ = p value from Chi square test
- p^ = p value from Fisher's exact test
- Marital status (Single = never married, separated, divorced, widowed. Married = married and living together)
- Level of education (Low education = no education, nursery, primary. High education = Junior high, senior high and tertiary)
- Religion (Others = Muslim, traditionalists and no religion)

Table 4.8b: Test of association between fuel and oven characteristics of participants and use of "Ahotor oven (n=103).

Variables FUEL/OVEN CHARACTERISTICS	Use of Ahotor oven Low Users		High Users		X^2	p value
	n	%	n	%		
Smokes fish faster					17.8	**0.000**¥
Traditional oven	33	53.2	29	46.8		
"Ahotor" oven"	5	12.2	36	87.8		
Smokes fish better					5.7	**0.017**¥
Traditional oven	12	60.0	8	40.0		
"Ahotor" oven"	26	31.3	57	68.7		
Uses less firewood					0.03	1.000^
Traditional oven	2	33.3	4	66.7		
"Ahotor" oven"	36	37.1	61	62.9		
Less expensive					4.8	**0.028**¥
Traditional oven	20	29.4	48	70.6		
"Ahotor" oven"	18	51.4	17	48.6		
More convenient					8.7	**0.003**¥
Traditional oven	11	68.8	5	31.2		
"Ahotor" oven"	26	30.2	60	69.8		

- **p** = significant at $p<0.05$, X^2=chi square
- p¥ = p value from Chi square test
- p^ = p value from Fisher's exact test

Table 4.8c: Test of association between knowledge on health and safety benefits of "Ahotor" oven by participants and use of "Ahotor oven (n=109).

Variables	Use of "Ahotor" oven				X^2	P value
KNOWLEGDE ON HEALTH AND SAFETY OF "AHOTOR" OVEN	**Low Users**		**High Users**			
	n	**%**	**n**	**%**		
Health					4.9	**0.025**[¥]
Poor knowledge	10	66.7	5	33.3		
Good knowledge	34	36.2	60	63.8		
Safety					7.7	**0.005**[¥]
Poor knowledge	5	50	5	50		
Good knowledge	39	39.4	60	60.6		

- **p** = significant at $p<0.05$, X^2=chi square
- $p^{¥}$ = p value from Chi square test

4.9 Association of individual, household, fuel and oven characteristics, knowledge on health and safety of "Ahotor" oven and use of "Ahotor" oven.

Table 4.9a, 4.9b, 4.9c below show results from the logistic regression. Significant associations were observed between use of "Ahotor" oven and age, space availability, gender of household head, ability to smoke fish faster, ability to smoke fish better, cost, convenience and knowledge on health and safety benefits at $p<0.05$. After adjusting for possible confounders, only age, ability to smoke fish better and knowledge on health and safety benefits remained independently associated with use of "Ahotor" oven.

Study participants aged 18-39 years were four (4) times more likely to use "Ahotor" oven compared to those aged 40 years and above and this difference was statistically significant [Adjusted OR=0.2, 95% CI=0.05 0.94, p=0.041]. Also, respondents were five (5) times more likely to use Ahotor oven compared to traditional oven because it smokes fish better (colour, taste, texture). [Adjusted OR=4.59, 95%CI=0.17 0.98, p=0.016].

Results also showed that participants were three (3) times more likely to use "Ahotor" oven if they have good knowledge on its health benefits [Adjusted OR=2.9, 95%CI=0.85 9.8, p=0.032] and two (2) time more likely to use it if they have knowledge on its safety benefits [Adjusted OR=1.7, 95%CI=0.03 2.60, p=0.018]. As mentioned earlier in section 4.2, only 103 participants responded to questions on fuel and oven characteristics

.

Table 4.9a: Association of individual and household and use of "Ahotor" oven (n=109).

Variables	Crude (OR)	(95% CI)	P value	Adjusted (OR)	(95% CI)	P value
Age in years						
18-39	1.00			1.00		
40 and above	0.14	(0.05 0.44)	**0.001***	0.2	(0.05 0.94)	**0.041***
Space availability						
Yes	1.00			1.00		
No	0.21	(0.08 0.53)	**0.001***	0.38	(0.12 1.15)	0.087
Household head						
Husband (male)	1.00			1.00		
Self (female)	0.39	(0.17 0.88))	**0.025***	0.61	(022 1.71)	0.345

*significant at p<0.05, OR=Odds ratio, CI=Confidence Interval

Table 4.9b: Association of fuel and oven characteristics and use of "Ahotor" oven (n=103).

Variables	Crude (OR)	(95% CI)	P value	Adjusted (OR)	(95% CI)	P value
FUEL & OVEN CHARACTERISTICS						
Smokes fish faster						
Traditional oven	1.00			1.00		
"Ahotor" oven	8.19	(2.84 23.65)	**0.000***	0.72	(1.32 15.93)	0.647**0**
Smokes fish better						
Traditional oven	1.00			1.00		
"Ahotor" oven	3.28	(1.20 9.00)	**0.021***	4.59	(0.17 0.98)	**0.016***
Less expensive						
Traditional oven	1.00			1.00		
"Ahotor" oven	0.39	(0.17 0.91)	**0.03***	0.41	(0.14 1.17)	0.094
More convenient						
Traditional oven	1.00			1.00		
"Ahotor" oven	5.07	(1.6 16.1)	0.006	1.89	(0.44 8.07)	0.389
Good knowledge	0.25	(1.12 2.48)	**0.012***	1.7	(0.03 2.60)	**0.018***

*significant at p<0.05, OR=Odds ratio, CI=Confidence Interval

Table 4.9c: Association of knowledge on health and safety benefits of "Ahotor" oven and use of "Ahotor" oven (n=109).

Variables	Crude (OR)	(95% CI)	P value	Adjusted (OR)	(95% CI)	P value
KNOWLEGDE ON HEALTH AND SAFETY OF "AHOTOR" OVEN						
Health						
Poor knowledge	1.00			1.0		
Good knowledge	0.30	(0.09 0.90)	**0.020***	2.9	(0.85 9.80)	**0.032***
Safety						
Poor knowledge	1.0			1.0		
Good knowledge	0.25	(1.12 2.48)	**0.012***	1.7	(0.03 2.60)	**0.018***

*significant at p<0.05, OR=Odds ratio, CI=Confidence Interval

CHAPTER FIVE

5.0 DISCUSSION

5.1 Main Findings

This study sought to determine the factors that influence the use of "Ahotor" oven in Ghana. To reiterate, no study has been conducted to the best of my knowledge on "Ahotor" oven prior to this, therefore literature reviews were based on studies on improved cookstoves and cleaner fuels worldwide. Factors that were considered were individual and household setting characteristics of participants, fuel and oven characteristics of "Ahotor" oven, knowledge on health and safety benefits of "Ahotor" oven and cultural and traditional factors.

The main findings in the study showed that 60% of participants were high users of "Ahotor" oven whiles 40% constituted low users. The main factors that were found to influence the use of "Ahotor" oven are age of participant, ability to smoke fish better (colour, taste, texture) and knowledge on its health and safety benefits. From the qualitative study, no cultural and traditional factor was found to influence the use of "Ahotor" oven. The characteristic of reduced smoke emission compared to the traditional oven and inability to smoke fish faster compared to the traditional oven were the most reported advantage (facilitator) and disadvantage (barrier) to the use of the "Ahotor" oven respectively.

Details of the results with respect to the objectives are discussed below.

5.2 Methodological validity

This study has a number of strengths and limitations. The strengths include the fact that it is the first of its kind in Ghana. There has been researches on improved cookstoves but none on improved cook oven such as the "Ahotor" oven.

The study also happened to use a mixed method approach (both quantitative and qualitative methods). The qualitative method enhanced the understanding of findings from the quantitative study.

During data analysis, all confounding factors were controlled for to minimize any possible confounding bias.

One major limitation of this study was that, data collection time coincided with a time when there was a ban on fishing in Central region of Ghana. This affected the frequency of fish smoking among most of the women during the stipulated 6 months prior to this study.

Secondly, because participants had to recall the number of times they used or how often they used the ovens in the last 6months, their responses may have lacked some accuracy and completeness.

Sample size for study was relatively small because only a few number of people possessed "Ahotor" oven. This was as a result of it being a new improved oven technology that had recently been introduced and was being piloted in Ghana.

Another limitation was that, only few focus group discussions were conducted. This was as a result of relatively long distances between various communities making it difficult for the women to travel from their respective communities to converge at a designated point for the discussions. Therefore, only women who could be remunerated agreed to travel for the FGDs.

5.3 Individual and household factors influencing the use of "Ahotor" oven.

In this study, use of "Ahotor" oven was significantly associated with age of participant. The participants in the higher age groups of 40 and above were found to be 80% less likely to use "Ahotor" oven compared to those in the lower age group of 18-39 years. This may be explained by the fact that the younger generation are more technologically inclined and likely to accept new technologies compared to the older generation. The older generation who have used the traditional oven for a longer period of time, and expected to have suffered the consequences and therefore expected to appreciate the improved technological features of the "Ahotor" oven rather fell among the low users. This observation may be explained by the fact that older people are relatively less receptive to new technological ideas or have low technological adaptability. A study by Wu et al., (2012) reported that age could directly or indirectly impact clean fuel adoption. They reported that older people may prefer to use traditional fuels compared to younger people which was consistent with this study. Conversely, Pine et al., (2011) in their study reported that the presence of adults in a household had a positive influence on adoption of improved biomass stoves. Inayatullah et al., (2017) also reported that age of household head was found to be a statistically insignificant factor in determining improved cookstoves adoption.

5.4 Fuel and oven factors influencing the use of "Ahotor" oven.

The oven characteristic that was found to be significantly associated with use of "Ahotor" oven was its ability to smoke fish better in terms of colour, taste and texture compared to when the traditional oven is used. Thus, participants preferred to use "Ahotor" oven which is an improved oven because they believe it gives the fish a better taste compared to fish from the traditional oven.

This is inconsistent with a study by Masera, Saatkamp & Kammen (2000) who reported that taste of food produced by traditional stoves negatively influenced adoption of improved stoves. Even though the people had access to and could afford an improved stove they did not purchase them because they preferred the better taste of food produced by the traditional stove.

Participants also reported that there was reduced emission of smoke when "Ahotor" oven was used which is beneficial to their health and the environment as a whole. This is in agreement with a study by Lou et al., (2008) who found that demand for cleaner fuel was high because of its convenience, cleanliness, production of less pollutants and affordability.

The participants who purchased the 'Ahotor" oven themselves and even some who were gifted by various government and non-governmental agencies reported that the oven was expensive and pleaded that the price be reduced to allow them to purchase more in the future. This finding was consistent with that of Levine et al. (2018) who reported that inability to pay for improved cookstoves was one of the essential barriers to the decision to adopt.

5.5 Knowledge on health and safety benefits of "Ahotor" oven.

Based on the responses by participants on their knowledge on health and safety benefits of "Ahotor" oven, it was deduced that awareness of these benefits was associated with its use. Those who had good knowledge on health and safety benefits were more likely to use the oven compared to those who had poor knowledge. According to Wang et al., (2011) limited knowledge about cleaner fuels is an important barrier in their utilization and sustained use. This view is in line with findings of this study. Inayatullah (2012) also reported that lack of knowledge of health and environmental hazards associated with inefficient biomass use was a barrier to adoption of improved cookstoves.

5.6 Cultural and traditional factors influencing the use of "Ahotor" oven.

In this study, culture and tradition were found to be insignificant determinants of "Ahotor" oven use. All participants denied the influence of cultural practices such as ancestral heritage, use of charms embedded in traditional ovens, difficulty adapting new technology and community influence on their decision to use "Ahotor" oven. This contradicts a recent study by Akintan et al. (2018) who highlighted that "ethnic-specific" traditional norms and taboos influenced fuel choice and cooking habits.

In the qualitative study, all participants interviewed denied any cultural influence on their use of "Ahotor" oven. Participants did not report any difficulty learning new technologies and said they were trained on how to use the "Ahotor" oven after its installment. Nguyen et al. (2017) identified factors such as lack of patience, difficulty to self-train and learn how to use a new cooking technology as some of the cultural barriers to adoption of improved cookstoves. Their finding is inconsistent with this current study where the older group of participants (40 years and above) were only assumed to be less adaptable to technology and therefore fell in the category of low users of "Ahotor" oven even though none of them specifically reported it as an influential factor.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

Overall, majority of "Ahotor" oven users were found to be high users. Age of participants, the ability of the "Ahotor" oven to smoke fish better (colour, taste, texture) and participants knowledge on health and safety benefits of "Ahotor" oven were the main factors that influenced the use of "Ahotor" oven in this study. Cultural factors were not found to have an influence on use of "Ahotor" oven. The most reported barrier to "Ahotor" oven use especially among the low users was its inability to smoke fish as fast as the traditional oven did whiles the most reported facilitator of its use was its property of emitting less amount of smoke compared to the traditional oven. "Ahotor" oven as an improved oven had a high user rate (60%) compared to traditional oven due to the numerous positive characteristics it possesses. However, in order to increase or achieve total (100%) participant use, it has to be redesigned to allow it to smoke fish faster and also should be made more affordable by reducing the price so that all fish smokers in Ghana can acquire it. Replacing traditional ovens with |Ahotor" oven will ameliorate health associated indoor air pollution in Ghana especially among women and children.

6.2 Recommendations

Based on these findings, it is recommended that;

1. Awareness programs be organized by Ghana Fisheries Commission and SNV Ghana under Sustainable Fisheries Management Project (SFMP) to educate fish smokers especially those in older age groups on the positive benefits of "Ahotor" oven so as to increase its adoption and use.

2. There should be occasional trainings for "Ahotor" oven users by experienced technicians, on how to maintain it and also maximize its use. These technicians should always be available especially via phone calls to attend to faulty or broken down ovens.
3. The engineers and designers of "Ahotor" oven should develop more advanced technologies to enhance the oven's speed of smoking fish so as to allow larger amounts of fish to be smoked within a given period of time.
4. Government should put in place policies to promote the sole use of "Ahotor" oven by all fish smokers in Ghana in tandem with adequate financial support to those who cannot afford it so as to increase adoption and use of the "Ahotor" oven.

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APPENDIX A: INFORMED CONSENT

Title of study: Factors influencing the use of "Ahotor" oven among fish smokers in Ghana.

Introduction

My name is Edwina Seyram Danoo, a student of the School of Public Health, University of Ghana, Legon. I am conducting a study on the factors influencing the use of "Ahotor" oven in Ghana and I would like to invite you to partake in this study.

Background of study

Household air pollution (HAP) is a leading cause of morbidity and mortality worldwide. To limit HAP exposure and environmental degradation from biomass fuels used during traditional cooking practices, programs and initiatives have been underway to disseminate improved cookstoves which have health, socio-economic and environmental benefits. In one of these interventions, an improved fish smoking technology using the "Ahotor" oven was introduced. It is known to reduce levels of polycyclic aromatic hydrocarbons (PAH); a known carcinogen in smoked fish. However, major challenges have been reported pertaining to the less regular use or even abandonment of the disseminated "Ahotor" ovens. Identifying and understanding factors that lead to these challenges will help formulate solutions to improve its use.

This study therefore seeks to understand the factors that promote and limit the use of the "Ahotor" oven among fish smokers in Ghana.

Nature of study

The study will involve answering closed and open ended questions in the form of a questionnaire and partaking in focus group discussions. Though you are under no obligations to participate in the study, it will be appreciated if you could. This is purely an academic research which forms part of my work for the award of a Master Degree in Public Health.

Participant's involvement

You will be required to answer questions in the questionnaire. Each questionnaire takes about 30-40minutes to complete. After this, a group discussion will be held. This discussion will be recorded and some pictures of participants will also be taken.

Benefits and Risks

The study when completed would inform health policy makers about the factors that influence the use of "Ahotor" oven and the necessary actions that ought to be taken to improve its use. There are no risks associated with participating in this study. Time spent in taking information (at least 30 -40minutes) from you may be of some discomfort to you. At the end of the session, you will be given a token to show appreciation for your time and energy.

Confidentiality

Anonymity and confidentiality is assured. We will not be collecting or retaining any information about your identity. The records of this study will be kept strictly confidential. We will not include any information in any report that may be published that would make it possible to identify you.

Voluntary participation and withdrawal

Participation in this study is voluntary and you can choose not to answer any individual question or all questions. You are at liberty to withdraw from the study at any time. However, I will encourage you to fully participate in the study since your answers are much needed.

Outcome and feedback

After data analysis and obtaining results, feedback will be given to participants on all findings through the contact numbers provided.

Funding

Study is being sponsored by my supervisor who is a lecturer at the School of Public Health, University of Ghana.

Sharing of data

The information generated is solely for academic purposes. But findings will be shared with stakeholders for policy implementation. Data may also be published in a reputable journal in the near future.

Data security

All data collected from study will be locked out in safe cabinets with restricted access and restrictions on copying study-related materials. Data will be appropriately and safely disposed/destroyed by shredding/burning paper documents, destroying pen drives, deleting audio files after transcription and ensuring erasure of study-related electronic media.

Provision of Information and consent

A copy of the information sheet and consent forms will be given to you after it has been signed or thumb-printed to keep.

Who to contact for additional information on study:

Edwina Seyram Danoo

Mobile: 0205334708

Email: seddas8@yahoo.com

For ethical issues and your right as a participant:

Madam Hannah Frimpong

Administrator

GHS-Ethics Review Committee

P.O.Box MB 190, Accra

Mobile: 0507041223

Email: hannah.frimpong@ghsmail.org

CONSENT FORM

STUDY TITLE: Factors influencing the use of "Ahotor" oven in Ghana.

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the purpose and contents of the Participants' Information Sheet read and all questions have been satisfactorily explained to me in a language I understand (English [ ]/Twi [ ]/Ewe[ ]). I fully understand the contents and any potential implications as well as my right to change my mind (i.e. withdraw from the research) even after I have signed this form.

I voluntarily agree to be part of this research.

Name or Initials of Participant…….. ID Code ……..

Participants' Signature ……OR Thumb Print…… OR Mark (Please specify)…….

Date……

INTERPRETERS' STATEMENT

I interpreted the purpose and contents of the Participants' Information Sheet to the afore named participant to the best of my ability in the (Ewe[ ]/Twi[ ]) language to his/her proper understanding.

All questions, appropriate clarifications sort by the participant and answers were also duly interpreted to his/her satisfaction.

Name of Interpreter……

Signature of Interpreter…….. Date……

Contact Details

STATEMENT OF WITNESS

I was present when the purpose and contents of the Participant Information Sheet was read and explained satisfactorily to the participant in the language he/she understood (English [ ]/Twi [ ]/Ewe).

I confirm that he/she was given the opportunity to ask questions/seek clarifications and same were duly answered to his/her satisfaction before voluntarily agreeing to be part of the research.

Name……..……..

Signature……. OR Thumb Print ……..... OR Mark (please specify)……..

Date……

INVESTIGATOR STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study. All questions and clarifications raised by the participant have been addressed.

Researcher's name…….

Signature ……

Date……

APPENDIX B: QUESTIONNAIRE

SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA LEGON

HOUSEHOLD QUESTIONNAIRE

TITLE: FACTORS INFLUENCING THE USE OF "AHOTOR" OVEN IN GHANA.

I am a student of the University of Ghana pursuing a Master's Degree in Public Health. I am carrying out a research to determine the factors that prevent you from using the Ahotor oven and factors encourage you to use it. You may help us complete the questionnaire by answering a few questions below. Your participation is vital to the success of this study. The study is purely for academic purposes and every information provided will therefore be treated with confidentiality. Thank you.

Date……

Start time of interview…… End time of interview……

Serial No……..

Contact No…… Alternative contact No…….

Region……

District…… Town/ Village……

	Item/Question	Response [√]
Part I: Socio-demographic Characteristics		
1	Tribe	1 Akan [ ] 2 Ga [ ] 3 Ewe [ ] 4 Gonja [ ] 5 Dagbani [ ] 6Bimoba [ ] 7Konkomba[ ] 8 Mampruli [ ] 9)Other[ ]
2	Sex	1 Male [ ] 2 Female [ ]
3	Age	1 18-29 [ ] 2 30-39 [ ] 3 40-49 [ ]

		4 50 and above [ ]
4	Marital status	1Never married [ ] 2Married [ ] 3Living together [ ] 4Widowed [ ] 5Divorced [ ] 6Seperated [ ]
5	Level of education	1 No education [ ] 2 Nursery [ ] 3 Primary school [ ] 4Junior High School [ ] 5Senior High School [ ] 6Tertiary
6	Religion	1 Christian [ ] 2Muslim [ ] 3Traditionalist/spiritualist [ ]

		4No religion [ ] 5Others (specify)
7	Occupation	
8	Who is the head of the household?	1Husband [ ] 2Self [ ] 3 Other
9	What setting is the house located?	1 Rural [ ] 2 Urban [ ]
10	Do you have available space for more Ahotor ovens?	1Yes[ ] 2No[ ]
11	Total family size	1 1-3 [ ] 2 4-6 [ ] 3 7-9 [ ] 4 >10 [ ]
12	What kind of toilet facility do members of your household usually use?	1Flush or pour flush [ ] 2Pit latrine [ ] 3Bucket toilet [ ] 4No toilet facility/bush/field [ ]

		5Other
13	Is this toilet facility shared with other households?	1Yes [ ] 2No [ ]
14	What is the main source of drinking water for your household?	1Pipe water [ ] 2Public standpipe [ ] 3Dug well [ ] 4Surfacewater(river/lake/dam) [ ] 5Sachet wáter 6 Bottled wáter
15	Where is the water source located?	1Own house [ ] 2 Own yard/compound [ ] 3 Elsewhere [ ]
Part II: The Use of Ahotor oven		
16	What type of oven do you normally use to smoke fish?	1Round clay oven [ ] 2Metal drum [ ]

		3Rectangular mud oven 4Traditional kiln 4Chorkor [ ] 5Ahotor [ ] 6LPG Gas Burner [ ] 7Other [ ]
17	Are you the owner of the Ahotor oven?	1Yes 2 No 3Others (specify)
18	How was the Ahotor oven acquired?	1Purchased outright 2Purchased on credit 3Constructed by household 4Gifted by individual 5Gifted by NGO 6Gifted by Fisheries Commission 7Gifted by other government agency 8Other

19	How long have you had the Ahotor oven?											
20	How long have you been using the oven?											
21	In the last 6 months, which of the ovens did you use to smoke fish?						TICK AS APPROPRIATE IN BOX BELOW[√] TRA- TRADITIONAL OVEN AHOT- AHOTOR OVEN					
	JUNE		MAY		APRIL		MARCH		FEBRUARY		JANUARY	
	TRA	AHOT	TRA	AHOT	TRA	AHO	TRA	AHOT	TRA	AHOT	TRA	AHOT
WEEK 1												
WEEK 2												
WEEK 3												
WEEK 4												
22	Have you stopped using the Ahotor oven?						1Yes [ ] 2No [ ]					

23	If yes, why?	
24	What advantage do you see in using Ahotor oven? (tick as mentioned by participant)	1Fuel saving [ ] 2Less eye disease [ ] 3Cooks fast [ ] 4Less burns/accidents[ ] 5More comfort [ ] 6Reduced smoke [ ] 7Less respiratory disease [ ] 8Better taste of fish [ ] 9Other(specify)
25	Do you see any disadvantage of Ahotor oven?	1 Yes [ ] 2 No [ ]
26	If yes, what are they? (tick as mentioned by participant)	1Takes more time to cook [ ] 2Not possible to sit around fire [ ] 3Produces a lot of heat and smoke[] 4Doesn't smoke fish properly [ ] 5Difficult to maintain [ ] 6Expensive [ ]

		7Other(specify)
Part III: Knowledge of "Ahotor" oven.		
KNOWLEGDE ON HEALTH AND SAFETY BENEFITS OF "AHOTOR" OVEN		
27	Do you know any health benefits of using 'Ahotor" oven?	1Yes [ ] 2No [ ]
28	If yes, what are they?	
29	Is the Ahotor oven safer to use compared to traditional oven(s)?	1Yes [ ] 2No [ ]
30	Why?	
31	What are the effects of smoke on health?	1Red eye [ ] 2Sore throat[ ] 3Cough [ ] 4Lung cancer [ ] 5Cataract (blindness) [ ] 6Heart diseases [ ]

		7 Hypertension [ ] 8 Stroke [ ]	
CULTURAL & TRADITIONAL FACTORS			
32	Are there any cultural practices that affect your use of Ahotor oven?	1 Yes [ ] 2 No [ ]	
33	What are these practices?		
Part IV: Fuel and stove technology			
	Which of the ovens……. (tick as applied)	TRADITIONAL OVEN	AHOTOR OVEN
34	Smokes fish faster?		
35	Smokes fish better? (colour, taste, texture)		
36	Consumes less firewood?		
37	Less expensive/affordable?		
38	More convenient to use?(easy to use)		
39	Will you be willing to purchase Ahotor oven in the	1Yes[ ] 2No[ ]	

	future?	
40	Why?	

APPENDIX C: FOCUS GROUP DISCUSSION GUIDE

1. WHAT ARE THE CUSTOMS OR CULTURAL VALUES THAT INFLUENCE YOUR USE OF "AHOTOR" OVEN?

   EXAMPLES;

- The traditional oven represents the fundamental part of their customs.
- Ancestral heritage (i.e. used by their forefathers with no adverse effects).
- Born into it (i.e. came to meet it and still in use so many years down the line).
- Almost the entire area uses this type of traditional oven.
- Traditional ovens prepare the food properly and yield the right flavors/taste.
- Charms/voodoo buried under traditional ovens to boost business.
- Difficulty in learning how to use new technology

2. CAN YOU DESCRIBE HOW THE AHOTOR OVEN IS DIFFERENT FROM THE TRADITIONAL OVEN?
3. IN WHAT WAYS CAN WE OVERCOME THIS CHALLENGE AND IMPROVE ITS USE?
4. OF EVERYTHING THAT HAS BEEN DISCUSSED, WHAT DO YOU THINK IS THE MAIN REASON WHY YOU KEEP USING THE AHOTOR OVEN?
5. GIVE A SUMMARY OF THE MAIN QUESTIONS AND MAIN IDEAS THAT HAVE BEEN DISCUSSED.
6. IS THERE ANYTHING WE HAVE MISSED OR YOU WANT TO ADD TO THE DISCUSSION?