

UNIVERSITY OF GHANA

COLLEGE OF HUMANITIES

**FACTORS INFLUENCING HOUSEHOLD COOKING FUEL CHOICE IN THE
NSAWAM-ADOAGYIRI MUNICIPALITY OF GHANA**

COMFORT ADUBEA YEBOAH

INSTITUTE OF STATISTICAL, SOCIAL AND ECONOMIC RESEARCH

APRIL 2021



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NSAWAM-ADOAGYIRI MUNICIPALITY OF GHANA



**THIS DISSERTATION IS SUBMITTED TO THE UNIVERSITY OF GHANA IN
PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF
MASTER OF ARTS IN DEVELOPMENT STUDIES**

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APRIL 2021

DECLARATION

I, Comfort Adubea Yeboah, affirm that this dissertation is my work under the supervision of Dr. Aba Crentsil, and does not contain any previously published work by any individual, except where due acknowledgment has been made in the text and at the end of the work.

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ABSTRACT

There is heavy dependence on biomass fuels like firewood and charcoal which contribute to deforestation in Ghana. In Ghana, a majority of households (34.1%) use charcoal for their cooking needs. Others also use other types of cooking fuel like LPG. However, many households use a particular type of cooking fuel based on many reasons, including the price of cooking fuel and household average income. Therefore, this study sought to identify factors influencing household cooking fuel choice, specifically in the Nsawam-Adoagyiri Municipality. This study adopted a cross-sectional design to examine relationships between variables and a quantitative method approach was employed in the collection of primary data. A questionnaire was administered to 246 households in the Municipality. Data obtained from the field was coded and analyzed using STATA software. The study discovered that LPG was the most desired cooking fuel among households in the municipality. Also, the study revealed age, family size, educational level, age of household head, price of fuel, and indoor air pollution as the statistically significant factors that influence households' choice of cooking fuel in the Nsawam-Adoagyiri Municipality. The analysis of the study helped make some recommendations such as subsidization of LPG prices, public education on the effects of the various cooking fuels, as well as free distribution of cylinders and burners to help achieve the SDG Goal 7, which seeks to achieve widespread access to affordable and reliable energy by the year 2030. It will also contribute to Ghana's goal of transitioning 50% of households to the use of relatively clean cooking fuels such as LPG and biogas.

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To my mom, Kingsley, and Jonas, I couldn't have come this far without your support. *ABOVE ALL, I GIVE GLORY TO GOD.*

DEDICATION

I dedicate this work to my lovely mom, Rosemary Animah. I love you, mom.

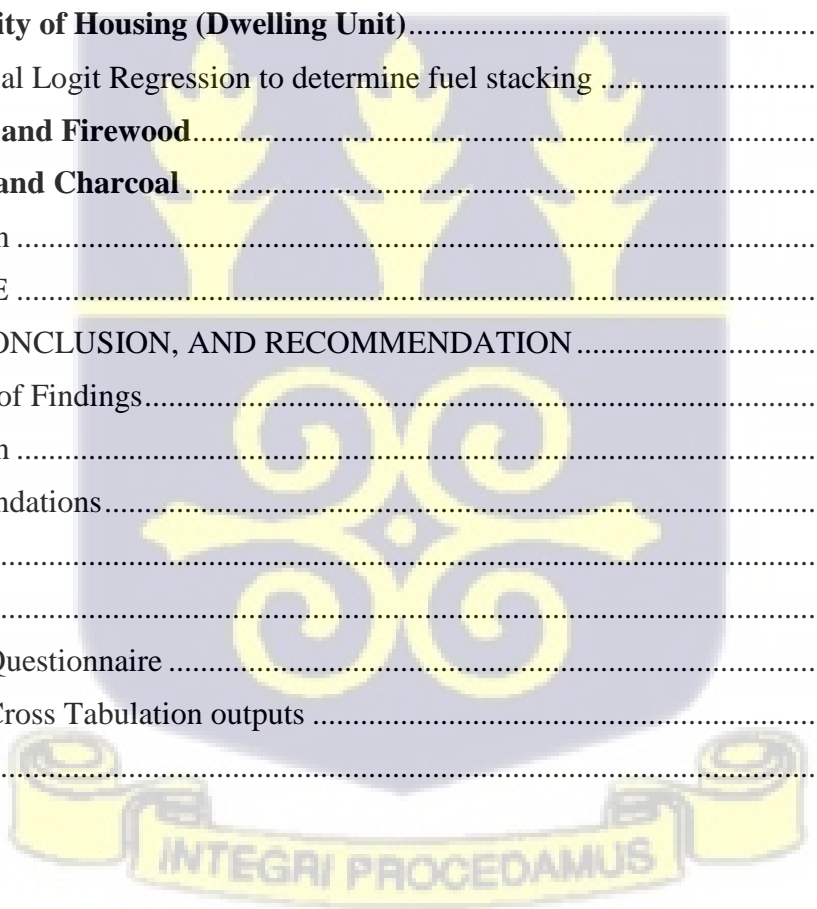


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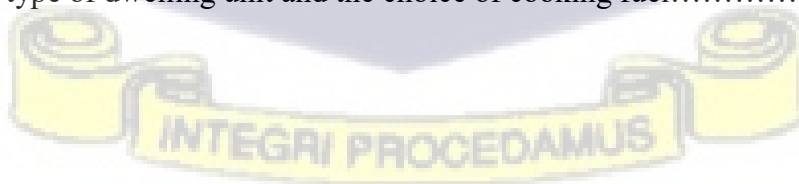
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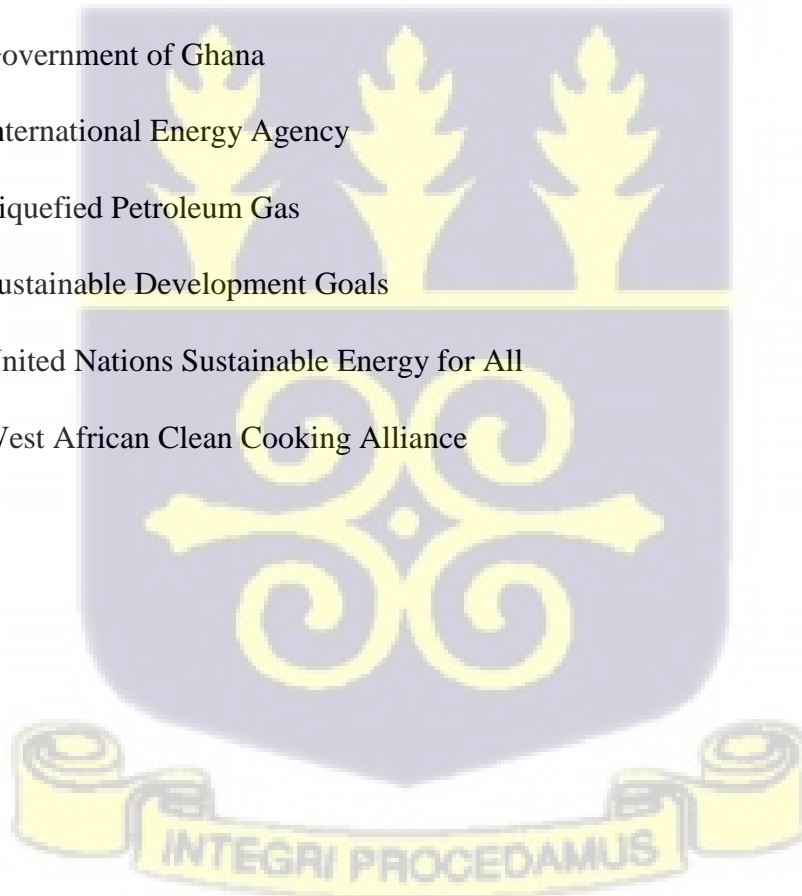


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ACRONYMS

ACCES	Africa Clean Cooking Energy Solutions
EAP CSI	East Asia and Pacific Clean Stove Initiative
ECREEE	Ecowas Centre for Renewable Energy and Energy Efficiency
EFA	Eco-Fuel Africa
ESMAP	Energy Sector Management Assistance Program
GACC	Global Alliance for Clean Cookstoves
GLPGP	Global LPG Partnership
GoG	Government of Ghana
IEA	International Energy Agency
LPG	Liquefied Petroleum Gas
SDG	Sustainable Development Goals
UNSEA	United Nations Sustainable Energy for All
WACCA	West African Clean Cooking Alliance



CHAPTER ONE

STUDY BACKGROUND

1.1 Introduction

Cooking fuel is crucial in every home as it assists in cooking activities. Cooking energy comes in many forms and so households decide on the suitable type for their homes based on several reasons such as availability of cooking fuel and household characteristics (Nielsen, 2017). In many instances, the cooking fuel choice of a household depends on income, price, and a household head's level of education (Pundo & Fraser, 2006). However, households also make choices under several constraints which propel them to use either 'traditional' cooking fuels such as firewood and charcoal or 'modern' cooking fuels such as Liquefied Petroleum Gas (LPG) and electricity, and for some households, a mixture of both (Truneh, 2014).

Presently, the world is striving to achieve Sustainable Development Goal 7 (SDG 7) which aims to ensure universal access to reliable, affordable, and modern energy by 2030 (Franco, Power, & Whereat, 2020). The United Nations Environment Programme (2019) reports that in 2016, over three billion people worldwide, especially in Asia and Africa depended on biomass fuels – wood, leaves, crop waste, dung, etc. for their daily cooking needs. About 1.3 billion folks worldwide did not have access to electricity, and 2.6 billion people relied on traditional biomass (fuelwood, charcoal, dung, and agricultural residues) for cooking largely in rural areas in Africa and Asia as of 2011 (International Energy Agency (IEA), 2013). This indicates a decrease in the number of households who depended on biomass fuel in 2006 as reported by the World Health Organization. Literature suggests that an increase in income, taste and preference, as well as level of education, account for the decrease in biomass fuel usage (Atanassov, 2010; Berhe, 2014; Karimu, 2015).

As opined by Zhang & Hassen (2017), an increase in well-being and income in developed countries like China leads to a shift from traditional cooking fuels like firewood to LPG and electricity. Similarly, in Ghana, a rise in income, the level of education of household heads, access to modern infrastructure, among others contribute to the choice of cooking fuel in homes (Heltberg, 2004; Kwakwa, Wiafe, & Alhassan, 2013; Karimu, 2015). It is reported that charcoal is the most used cooking fuel (34.1 percent) by households in Ghana. The next most used cooking fuel is firewood, accounting for 33.3 percent, followed by LPG with a household percentage usage of about 25 percent (Ghana Statistical Service, 2019). However, preference for cooking fuel types differs between households in urban areas and rural areas.

The Ghana Statistical Service (2019) reports that while charcoal and LPG are the most used cooking fuels in cities, firewood is rather preferred among rural households. Among the determining factors that influence this disparity, Karimu et al., (2016) assert that homes choose a cooking fuel type based on socio-economic factors. For example, Karimu (2015) and Alhassan (2018) cite the level of income, level of education of household head, and price of cooking fuel as notable socioeconomic factors that affect a family's cooking fuel choice. Also, Nyankone & Waithera (2016) and Makonese, Ifegbesan & Rampedi (2018) discover that most households in rural areas prefer solid cooking fuels such as firewood and charcoal due to their availability and easy access. They further reveal that most households collect firewood freely from their farms and those who do not have trees on their farms either receive them as gifts from their neighbors or purchase them at relatively low prices.

Dry and semi-arid areas in the country contain most of the forests and are good sources of biomass, hence this provides easy access to firewood and charcoal for residents in those areas. According to the UNFAO (2010), Ghana's rate of deforestation is 3 percent per annum and is estimated to

increase over time. In the year 2000, annual wood production was about 30 million tons, and about 18 million tons were used as wood fuel. This practice continues to harm the country's forest reserves although the exploitation of wood resources is not the major cause of deforestation in the country (Trossero, 2002).

In current times where the world is consistently experiencing negative consequences of climate change, it is important to implement safe, effective, and renewable energy use among municipalities in Ghana to enhance environmental sustainability (Bawakyillenuo & Agbelie, 2015). Households are, therefore, encouraged to use relatively safe cooking fuels like biogas. Unfortunately, many households prefer other alternatives because biogas (fecal gas), due to its nature, is not attractive to households, especially Muslims in livestock rearing areas in the Northern part of Ghana (Ahiokpor, Antwi, Bensah, & Ribeiro, 2015c). Consequently, to better understand household cooking fuel choice in a given geographic location, it is important to incorporate the sources of energy that provide households with their cooking and heating needs (Wiesmann, Azevedo, Ferrão & Fernandez, 2011; Soltani, Rahmani, Pour, Ghaderpour, Ngah & Misnan, 2019).

1.2 Problem Statement

There is a rise in urbanization across Sub-Saharan Africa and this makes urban household energy a critical issue for developing countries as there is heavy dependence on biomass fuels which contribute to deforestation (Adeyemi & Adereleye, 2016). According to IEA (2019), biomass fuels such as firewood and charcoal are widely used among households in sub-Saharan Africa. The available literature on household cooking fuel usage reverberates the conception that urbanization and lifestyle changes cause households to use modern fuels than traditional fuels. However, in Sub-Saharan Africa, many countries, including Ghana still rely on biomass fuels and are adopting

modern fuels such as LPG at a slower pace (Barnes, Krutilla & Hyde, 2005; Mokennen & Kohlin, 2008; Truneh, 2014).

The heavy reliance on solid fuel by urban households in developing countries is due to complex economic and cultural restraints (World Bank, 2011). Socio-economic factors such as education and income as stated by Karimu (2015), also affect the choice of households' cooking fuel. Where the income of a household is relatively low, the household would opt for cheaper cooking fuels like firewood and charcoal (Alhassan, 2018; Nlom & Karimov, 2015). Underprivileged households burn large amounts of firewood and charcoal with inefficient stoves to meet their cooking needs. This exposes those involved in cooking for households, particularly women, to high levels of air pollution. The combustion of biomass fuels such as firewood and charcoal is known to produce high levels of pollutants, including carbon monoxide, nitrogen dioxide, particulate matter, and other organic compounds that threaten respiratory health and the environment (Fullerton, Bruce, & Gordon, 2008). Despite the numerous disadvantages such as the emission of smoke and less heat associated with biomass fuels, lots of Ghanaians, especially those in rural areas still use firewood, cow dung, and charcoal for cooking (Ahiokpor, Antwi, Bensah & Ribeiro, 2015).

Cognizant of the fact that poverty influences the choice of household cooking fuel, the Government of Ghana (GoG) has made efforts to make alternative cooking fuels accessible to many households all over the country. Thus, the government has resorted to diversifying cooking fuel sources among households by introducing Liquefied Petroleum Gas (LPG) onto the market some years back. The LPG promotion project sells both cylinder and stove to support consumers who until then used to buy the cylinder and stove separately (Amissah-Arthur & Amonoo, 2004). The program, however, has not helped the ordinary Ghanaian who does not have a regular flow of income, hence

depending on solid fuel for cooking. Additionally, some households who can afford modern fuels still prefer traditional cooking fuels like firewood and charcoal.

To this effect, identification of the factors that influence the choice of household cooking fuel in Ghana would be helpful because this will assist policy-makers in designing sustainable intervention mechanisms to enhance the adoption of environmentally friendly cooking fuels to help combat climate change. Several gaps still exist, as few studies by Ahiekpor, Antwi, Bensah & Ribeiro (2015) and Karimu (2015) have focused on peri-urban areas in Ghana. Therefore, this study examines cooking fuel at the household level and factors influencing choices among peri-urban households in the Nsawam-Adoagyiri Municipality.

1.3 Objectives

The key objective of the study is to examine factors that influence the choice of household cooking fuel in the Nsawam-Adoagyiri Municipality.

The specific objectives are to:

1. Identify the kinds of cooking fuel choices available to households and their preferences in the Nsawam-Adoagyiri Municipality.
2. Examine different socio-economic factors influencing household cooking fuel choice in the Nsawam-Adoagyiri Municipality.
3. Determine the environmental factors influencing household cooking fuel choice in the Nsawam-Adoagyiri Municipality.

1.4 Research Questions

The study seeks to answer the following research questions;

1. What are the kinds of cooking fuel choices available to households and what are their preference in the Nsawam-Adoagyiri Municipality?
2. What are the socio-economic factors influencing household cooking fuel choice in the Nsawam-Adoagyiri Municipality?
3. What are the environmental factors influencing household cooking fuel choice in the Nsawam-Adoagyiri Municipality?

1.5 Scope of Study

This study is limited to Nsawam-Adoagyiri Municipality in the Eastern Region of Ghana. This area is chosen for the study because of the limitation imposed by the Institute of Statistical, Social and Economic Research (ISSER) concerning designated areas of study and partly due to the peri-urban nature of the area. The focus of the study is on the factors that influence household cooking fuel choice in the municipality. Also, Nsawam-Adoagyiri is cosmopolitan with

1.6 Justification of the study

A growing body of literature such as (Aberilla, Gallego-Schmid, Stamford & Azapagic, (2020) and the Food and Agriculture Organization of the United Nations (2010) have noted various types of cooking fuels as significant contributors to climate change. For Ghana to achieve its national goal of clean energy, policymakers must be abreast with the various kinds of cooking fuels being adopted at the household level and their related determinants. This, therefore, gives rise to the need for information on the types of cooking fuels used in various municipalities in Ghana. The study will contribute insight into the major sources of cooking fuel as well as factors influencing households' choices. These factors can help stakeholders and policymakers to design strategies that will increase peoples' awareness of alternative and cleaner energy cooking fuels. Again, the discoveries of the study would be important for future cooking fuel-related studies. Thus,

individuals and groups interested in conducting similar research work could refer to this work as a source of literature.

1.7 Limitation of the Study

The study focused on household cooking fuel choice and does not address other units such as restaurants. Also, the unit of analysis was limited to households in the Nsawam-Adoagyiri Municipality in the Eastern Region of Ghana. Therefore, the setting of the study may not lead to a generalization of the findings across the country. Again, there was limited time and financial resources to undertake the study. Under these limitations, the researcher put in much effort to ensure that the quality of the research was not negotiable. The aforementioned limitations, which the researcher had no control of, may impact the level of generalization of this work.

1.8 Organization of the Study

This research consists of five chapters. The first chapter gives a background to the study, explains the problem, and states the objectives of the research and the questions it seeks to answer, followed by the scope, limitation, and significance of the study. Chapter Two reviews relevant literature and provides theoretical and conceptual insights into factors affecting household cooking fuel choice. Chapter Three also explains the methodology for the research and includes a description of the study area, research design, data type and source, sampling procedure, data instruments and collection, data collection procedure, the definition of variables, and processing of data. Chapter Four describes the demographic profile and socio-economic background of the sample respondents. Additionally, it analyses data and highlights findings from this research, and presents results. This chapter also introduces discussion points based on the results. Lastly, Chapter Five concludes the study and presents recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examines existing literature on cooking fuel and factors affecting households' choices. The first section of the chapter introduces the kinds of cooking fuels, followed by fuel programs, factors influencing the choice of household cooking fuel, theoretical review, and then a conceptual framework to help answer the research questions.

2.2 Kinds and Samples of Cooking Fuel

Different terms are used in describing household cooking fuel types based on their characteristics. According to Malla & Timilsina (2014), household cooking fuels can be characterized into "traditional" (animal dung, agricultural residues, and fuelwood), "intermediate" (wood pellets, charcoal, briquettes, coal, and kerosene), and "modern" (LPG, solar, biogas, natural gas, electricity, plant oils, and dimethyl ether) based on the level of energy development. In Central America, Wang, Franco, Masera, Troncoso & Rivera (2013) assert that nearly 20 million people use biomass, mainly fuelwood for cooking. Furthermore, coal is a popular household cooking fuel in China, animal dung in India, charcoal in Sub-Saharan Africa, kerosene in Djibouti, and electricity in South Africa (Smith et al., 2012). According to the Ghana Statistical Service (2014), some common types of cooking fuel in Ghana include firewood, charcoal, kerosene, LPG, and sometimes, electricity.

2.2.1 Firewood

Firewood is the commonest cooking fuel in most African countries and South East Asia. It is estimated that about 60 percent of households in these regions cook with solid fuels such as

firewood and charcoal (Bonjour, Adair-Rohani, Wolf, Bruce, Mehta, Prüss-Ustün ,...& Smith, 2013). In Ghana, wood fuel provides about 71 percent of the total annual energy demand (Mason, 2008). Firewood is burned in open stoves, usually traditional three-stone stoves and mud stoves. This produces low energy density and low efficiency on combustion, between 10 to 20 percent (Bailis, 2004). Again, due to the open spaces in the stoves, it is difficult to control the level of heat.

2.2.2 Charcoal

About 17 percent of all the wood used worldwide as fuel is converted to charcoal. There has been an increase in the production of charcoal in recent times as demand has grown among urban populations and enterprises predominantly in parts of Asia, Sub-Saharan Africa (SSA), and South America (Jones & Challinor, 2019). In the US for instance, people use charcoal for grilling due to the flavors it imparts to grilled food (Kammen & Lew, 2005). Charcoal is a solid residue that is produced from the carbonization of wood (Afrane & Ntiamoah, 2011a). In Ghana, charcoal production is popular in the transition belt between the tropical forests of the south and the savanna woodlands where fresh wood is harvested for processing. It is also produced from the harvesting of live trees and wastes generated from logging and sawmills' operation and is often packaged in sacks for distribution by trucks from the production site to wholesalers and retailers (Obiri, Nunoo, Obeng, Owusu & Marfo, 2014). Many urban households in developing countries prefer charcoal to firewood because it has higher energy density and burns more cleanly with less smoke (Schlag & Zuzarte, 2008).

2.2.3 Kerosene

Kerosene is a microscopic concentrate of petroleum. It is a combination of hydrocarbons – 12-18 carbon atoms per molecule and it boils between 190-250°C (Amakiri, Owen & Iboh, 2009). Some households in Sub-Saharan Africa use kerosene as their main source of cooking fuel and as an

insect repellent because of its odor (Amakiri, Owen & Iboh, 2009; Adeyemi & Adereleye, 2016). According to Bailis (2004), wick stoves and pressurized stoves are used for cooking with kerosene and both are easy to use.

2.2.4 Biogas

Biogas is a mixture of carbon dioxide (CO_2) and methane (CH_4) and is produced from the process of anaerobic digestion of organic wastes like fecal matter (Feroskhan & Ismail, 2016). The availability of inputs like manure and water influence the use of bio-digesters for cooking at home. China and India are widely known for the use of bio-digesters and the spread of the technology to other parts of the world (Odoi-Agyarko, 2009).

2.2.5 Liquefied Petroleum Gas (LPG)

LPG is a mixture of hydrocarbon compounds made up of propane (C_3H_8) and butane (C_4H_{10}) (Oyelami & Bolaji, 2015). According to the World Liquefied Petroleum Gas Association (2004), LPG demand grew from 200 million tonnes in the year 2000 to 237 million tonnes globally with Asia being the largest consumer with about 60 million tonnes. Many households in developing countries recorded an increase in LPG consumption by 5% between 1990 and 2011. In Ghana, LPG is produced by the country's only refinery, the Tema Oil Refinery, and sometimes imported from Nigeria (Afrane & Ntiamoah, 2011). LPG is filled into steel cylinders at LPG fuel stations and later connected to a cookstove for use at home. According to the Ghana Statistical Service (2019), about 25% of households use LPG for cooking.

2.2.6 Electricity

A very small percentage of Ghanaian households (less than 1 percent) depend on electricity for their cooking needs (World Health Organization, 2018). Out of this percentage, it is mostly high-

income households with a relatively small household size that uses electricity for cooking (Ahiokpor, Antwi, Bensah & Ribeiro, 2015). According to Malla & Timilsina (2014), households that use electricity for cooking are usually urban dwellers. In some urban areas in South Africa, Gabon, and Cameroon, electricity is common among households that can afford grid connections (Blimpo & Postepska, 2017). However, grid-based electricity is not a feasible source of cooking fuel in rural areas of Sub-Saharan Africa where electrification is not common and where transmission distances are large (Puzzolo, Zerriffi, Carter, Clemens, Stokes, Jagger,... & Petach, 2019). On average, it is estimated that a household in Africa uses about 8kWh per day and 3232 kWh per year for cooking (Kammila, Kappen, Rysankova, Hyseni & Putti,2014).



Images of some cooking fuels

A: charcoal

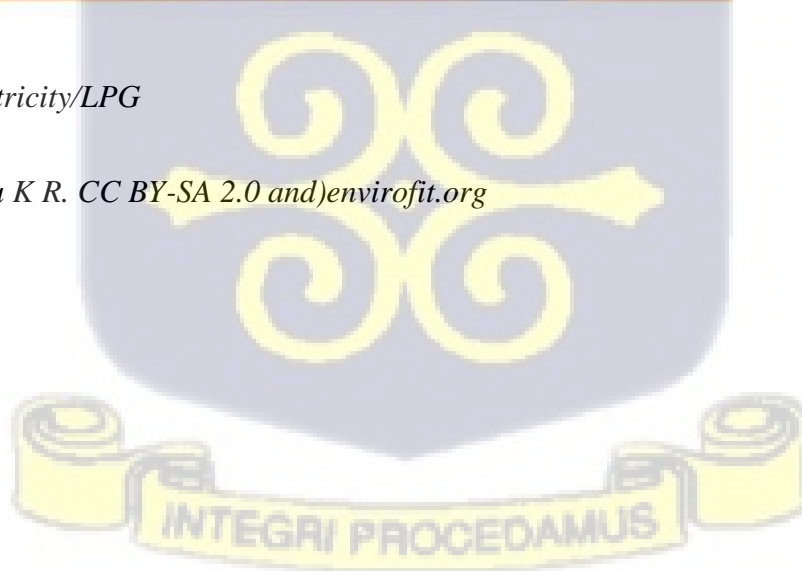
Source: africa-energy-portal.org

B: Electricity/LPG



Figure 2.1. Electricity/LPG

Source: (Harsha K R. CC BY-SA 2.0 and)envirofit.org



C: Animal dung



Figure 2.2: Animal Dung

Source: www.alamy.com

D: Firewood



Figure 2.3: Firewood

Source: (Harsha K R . CC BY-SA 2.0 and)envirofit.org

2.3 Cooking Fuel Programs

Firewood, charcoal, cow dung, and crop waste are predominant cooking fuels in many households in developing worlds, including Sub-Saharan Africa. The use of solid fuels and potentially harmful fuels like kerosene causes major public health problems (ESMAP & GACC, 2015). Lambe, Jürisoo, Wanjiru & Senyagwa, (2015) reveal that the usage of inefficient fuels for cooking also levies major expenses on governments. While this may be worrying, it is worth noting that there would come a time that the world will adopt transformative measures to improve the cooking sector.

Programs aimed at embracing relatively safer fuels such as LPG and renewable energy alternatives like biomass pellet fuels and biogas must be intensified to facilitate a high rate of adoption to save the environment and improve the health of individuals in households. Countries like Ghana, China, Bangladesh, and Peru have united with organizations and programs such as the United Nation's Sustainable Energy for All (UNSEA), Global Alliance for Clean Cookstoves (GACC), Global LPG Partnership (GLPGP), Africa Clean Cooking Energy Solutions (ACCES), and East Asia and Pacific Clean Stove Initiative (EAP CSI) to deliver an enabling environment for clean cooking solutions (ESMAP & GACC, 2015).

Most developing countries are faced with the problem of implementing improved cooking solutions to avoid the widespread harmful effects of smoky fuels. Available data from the Energy Sector Management Assistance Program (ESMAP) and Global Alliance for Clean Cookstoves (GACC) indicate that in 2010, only 10 percent of households in Sub-Saharan Africa had access to renewable fuels and advanced biomass solutions with few countries managing to introduce clean and improved ways of cooking on a broader scale to combat the effects of inefficient cooking fuels (ESMAP & GACC, 2015; Gold Standard, 2016). According to GACC (2011), poverty and lack of

awareness among households in developing countries about the benefits of clean cooking fuels may also be the reason for the reliance on unclean cooking fuels.

2.3.1 Cooking Fuel Programs in Africa

Several households in Africa rely on unclean and inefficient cooking fuels in their homes. About 80 percent of households in Sub-Saharan Africa use solid fuels such as charcoal and firewood for their basic cooking needs (Kumie, Emmelin, Wahlberg, Berhane, Ali, Mekonnen & Brandstrom, 2009; Gold Standard, 2016). Meanwhile, the use of solid fuel in developing countries has been identified as a major source of black carbon, contributing about one-fourth of total global emissions, second only to open burning of forests, savanna, grasslands, et cetera (Bond, Streets, Yarber, Nelson, Woo & Klimont, 2004). This has posed several threats to health and the environment and has triggered the conception of various interventions to minimize the effect.

Impact Carbon, a partner of Global Alliance for Clean Cook Stoves (GACC), joined forces with BioLite in Uganda to implement a full-scale product launch of BioLite's Home Stove, a fan stove that reduces household air pollution when used together with charcoal. Eco-Fuel Africa (EFA) also produces green charcoal from locally sourced biomass waste as an alternative to traditional wood fuel for Ugandans. The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) also established the West African Clean Cooking Alliance (WACCA) in 2012 to encourage the enactment of policies on clean cooking initiatives in the ECOWAS region (ECREEE, 2013). According to ECREEE, this initiative is to ensure that by 2030, all households in the ECOWAS region would have access to modern cooking fuels and devices. All these programs are aimed at reducing the effects of unclean cooking fuels.

2.3.2 Cooking Fuel Programs in Ghana

Ghana's improved cooking fuel program can be traced back to the 1990s when the Government of Ghana initiated the Liquefied Petroleum Gas (LPG) promotion program. This program was aimed at encouraging households that used charcoal and firewood for cooking to rather adopt LPG for cooking (Quaye-Foli, 2002). As part of the program, 14.5kg and 5kg cylinders were distributed to the general public, and consumers were given free cylinders upon request or cylinders with LPG where they paid for only the gas (Ahunu, 2015). This initiative resulted in an upsurge in LPG usage from 5,267 MT in 1989 to 32,000MT in 1996 (Quaye-Foli, 2002). Before this, only about 6.5 percent of the population in urban areas used LPG, while no households in the rural areas used LPG (Quaye-Foli, 2002).

According to the Ghana Statistical Service (2014), firewood and charcoal were the main cooking fuels in Ghana in 2013. About 34.1 percent of households used charcoal and 33.3 percent of households used firewood for their cooking needs. According to the report, LPG usage among households was just about 22 percent. This informed the Energy Ministry to reduce the use of wood fuel to 50% by 2020 through nationwide dissemination of clean and efficient cooking stoves and alternative cleaner cooking fuels such as LPG (Tettey, 2014). The LPG cookstove dissemination program aims to encourage the usage of cleaner fuels for cooking in both rural and urban areas. The Rural LPG promotion program was also launched in 2013 to increase LPG usage in rural areas and also reduce the usage of biomass fuel which has proven to be a major cause of respiratory diseases in Ghana (Asante, Afari-Asiedu, Abdulai, Dalaba, Carrión, Dickinson,...& Jack, 2018).

In 2016, a total of 2000 sets of LPG stoves and accessories were distributed in ten districts, including Atebubu, Bole, Jirapa, Krachi West, Nanumba South, Nkoranza South, Nkwanta North

& South, Pru, and West Gonja. The rural LPG promotion program is aimed at increasing the adoption of LPG usage among rural and peri-urban households from 5.5 percent to 50 percent by 2030 (Global Alliance for Clean Cookstoves, 2014; Tettey, 2014). The Council for Scientific and Industrial Research (CSIR) in collaboration with Plan Ghana (an NGO) also developed and distributed improved firewood stoves to about 1000 households in Tumu District in the Upper-East Region in the same year. Despite the increasing usage of LPG, many rural communities in Ghana are still reluctant to adopt it (Broni-Bediako & Amoritin, 2018).

2.4 Factors Affecting the Choice of Cooking Fuel

For many households around the world, the choice of a particular cooking fuel depends on several factors. Such factors include socio-economic, cultural, and environmental conditions (Pundo & Fraser, 2006). Household characteristics also vary from country to country and so the factors may not necessarily be universally applicable.

2.4.1 Socio-Economic Factors

Socio-economic factors such as household income, home-ownership, price of cooking fuel, and the educational level of a household head can all affect a household's choice of cooking fuel (Berhe, 2014; Karimu, 2015; Soltani, Rahmani, Pour, Ghaderpour, Ngah & Misnan, 2019). In finding the driving factors of the choice of household cooking fuel, Bansal, Saini & Khatod (2013) and Nlom & Karimov (2015) also discover that household income is a contributory factor in the choice of cooking fuel in rural India and Northern Cameroon respectively. A household with a higher level of income will prefer modern cooking fuels like LPG and electricity whereas a low-income household would choose traditional fuels such as firewood and charcoal for cooking (Stephen 2011). In Ghana, similar studies by Karimu (2015) and Alhassan (2018) reveal that

income determines whether a household should use traditional, intermediate, or modern cooking fuels.

In addition to income, education also influences the preference for a particular type of household cooking fuel. For example, Pandey & Chaubal (2011) find that in rural India, several educated females between the age bracket of 10 and 50 years use clean cooking fuels as compared to their counterparts with no level of education. Using data from Kisumu in rural Kenya, Pundo & Fraser (2010) also assert that though firewood is by far the preferred cooking fuel for many households in the study area, the level of education of the wife determines the choice of cooking fuel in a household. The authors claim that it is possible for an educated wife in a household to use charcoal or kerosene for cooking instead of firewood because household heads who are educated are well-informed about the side effects of cooking fuels. Additionally, Adeyemi & Adereleye (2016) realize that in Nigeria, a household head who is educated is more likely to use liquid fuel instead of solid fuel for cooking. This, they believe education informs people about fuel characteristics, thereby increasing the preference for better cooking fuels.

Many households in Sub-Saharan Africa also consider price when choosing a particular cooking fuel. It has been noted that households prefer cooking fuels that are less expensive and tend to use the alternative of expensive fuels (Ahiekpor, Antwi, Bensah & Ribeiro, 2015; Nlom & Karimov, 2015). Therefore, households that perceive LPG to be expensive prefer charcoal for cooking. According to Tettey (2014), since the price of cooking fuel is one of the major determinants of cooking fuel preference, the majority of households in Ghana use relatively cheaper cooking fuels such as charcoal. The occupation of a household head is also found to be a factor in the choice of cooking fuel. Thus, household heads who are employed in white-collar jobs prefer LPG while

those employed in blue-collar jobs prefer solid fuels like firewood and charcoal for cooking (Heltberg, 2005; Eakins, 2013).

2.4.2 Environmental Factors

It is widely known that environmental factors such as the availability of freely gathered fuel, accessibility, cleanliness of cooking fuel, and cooking location, determine the choice of cooking fuel (Rehfuess, Mehta & Prüss-Üstün, 2006). For instance, a study by Nyankone & Waithera (2016) in Kenya reveals that the majority of Thuti residents have trees on their farms from which they source their firewood and those without trees on their farms can buy from those that grow them. Thus, getting firewood for energy is not difficult in Thuti-Kenya. The accessibility of cooking fuels also contributes to their preference. In Nigeria, Nielsen (2017) asserts that most households purchase cooking fuel in bits and so prefer to use the ones that are easily accessible in their neighborhoods. Karimu (2015) also asserts that in Ghana, access to points of sale where cooking fuel can be purchased influences a household's choice. In the study, he discovers that LPG usage was popular among households that had easy accessibility to LPG within their communities. Preference of any of the cooking fuels may also depend on the type of dwelling unit of a household and cooking location. Karimu (2015) remarks that in Ghana, households living in modern apartments rarely use solid fuels but prefer modern fuel types such as LPG for cooking. Again, households whose kitchens are separated from their apartments prefer solid fuels such as charcoal but those with their kitchens located in their apartments prefer to use modern fuels like LPG to reduce the amount of indoor pollution.

Community physiognomies are also considered important in cooking fuel preference among households. For instance, Suliman (2013) asserts that residents in an urban area may have a preference for LPG instead of charcoal or firewood for their cooking needs. Moreover, studies by Kwakwa, Wiafe, & Alhassan (2013) and Francis, Geoffrey & Gemma (2014) reveal that residence in a rural community increases the usage of solid fuels and kerosene for cooking but reduces the use of LPG and electricity for cooking and heating. They also discover that households in urban centers use modern cooking fuels such as LPG and sometimes electricity, while those in rural areas prefer traditional and intermediate fuels like biomass and kerosene for cooking.

Correspondingly, families who live in modern infrastructure prefer LPG for cooking than households that live in other structures (Barnes, Krutilla & Hyde, 2005). In Ghana, Karimu (2015) draws a similar conclusion that households who have access to electricity usually use non-solid fuels such as LPG and electricity for cooking and warming their foods. Consequently, household units are also proven to influence the choice of cooking fuel. For example, Olugbire, Aremu, Opute, Ojedokun, Olawale & Adisa (2016) reveal that in Nigeria, the choice of cooking fuel is dependent on the nature of a household's dwelling place. Households with single-unit dwellings usually use charcoal or kerosene because there is not enough space for a cylinder and a cooker at the same time. However, LPG is more suitable for households living in spacious apartments.

In some cases, households consider the cleanliness of cooking fuels when making a choice. A study by Selvakkumaran & Ahlgren (2019) reveals that urban households prefer clean cooking fuels that reduce pollution and are environmentally friendly. Thus, many households in this area prefer cooking fuels that emit no or less smoke.

2.4.3. Cultural and Behavioural Factors

Food tastes and cooking practices are among the factors that influence household energy choices (Heltberg, 2005; IEA, 2006). As proof, a study by Masera et al. (2000) in rural Mexico revealed that although people can afford modern fuels, they are still using traditional biofuels to cook dishes because of the convenience of cooking traditional dishes over direct flames. Correspondingly, IEA (2006) found that Indian households prefer to use traditional wood stoves to bake bread.

Heltberg (2005), and Guptaa & Kohlin (2006) both revealed in their studies that cultural and lifestyle choices influence household fuel decisions. For instance, findings from Heltberg (2005) showed that indigenous ethnic tribes in Guatemala have unique energy portfolios due to cultural differences. In addition, other studies, for example, Masera et al. (2000) and Xiaohua & Zhenmin (2003) indicated that households make decision on cooking fuel choice based on their status, thus, a higher income household is most likely to opt for a modern trend of cooking fuel source.

2.4.4. Policies and Market Regulation characteristics

Government policies on energy distribution and regulation ultimately affects households decision on the type of energy to use (Barnes et al. 2005). Kowsari & Zerriffi (2011) mention that government intervention policies have mostly increased the availability of contemporary fuels. Interventions such as government energy subsidies have made it possible for poorer households to afford modern energy fuels (ESMAP, 2000, 2004). While the intent of government subsidies is to provide a cushion for the poor, research has revealed that most government subsidies on energy end up benefitting the middle-class and the rich rather than the poor (ESMAP, 2000). Aside subsidy having a conflicting outcome in some cases, it is found to be a drain on government's coffers hence, most governments now resort to other market strategies such as regulation rather than subsidization policies (ESMAP, 2000; Elias et al. 2005; Victor & David, 2009).

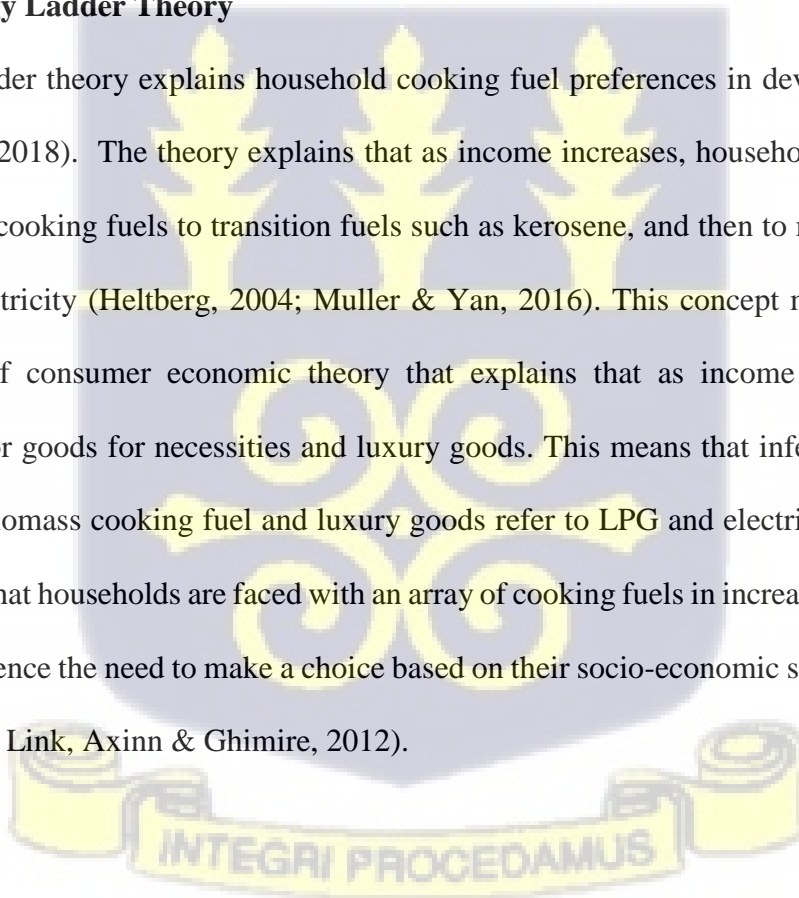
Regulatory policies on production and distribution affects household choices on energy, thus, the availability and access to energy choices to households are influenced by regulation. For example, in China, Jiang & O'Neill (2004), recorded that respondents chose coal as the main source of fuel because there is a ban on traditional biofuel. Further, Barnes et al. (2005) found in a study that government's policies has facilitated households choice cooking fuel from woodfuel to LPG.

2.5 Theoretical and Conceptual Framework

The energy ladder theory and fuel stacking theory are considered for this work. The conceptual framework, therefore, is based on the assumptions of these theories.

2.5.1 The Energy Ladder Theory

The Energy Ladder theory explains household cooking fuel preferences in developing countries (Muller & Yan, 2018). The theory explains that as income increases, households tend to switch from traditional cooking fuels to transition fuels such as kerosene, and then to modern fuels such as LPG and electricity (Heltberg, 2004; Muller & Yan, 2016). This concept mimics the typical income effect of consumer economic theory that explains that as income rises, consumers substitute inferior goods for necessities and luxury goods. This means that inferior goods in this model refer to biomass cooking fuel and luxury goods refer to LPG and electricity. Besides, this model assumes that households are faced with an array of cooking fuels in increasing technological sophistication, hence the need to make a choice based on their socio-economic status (Chambwera & Folmer, 2007; Link, Axinn & Ghimire, 2012).



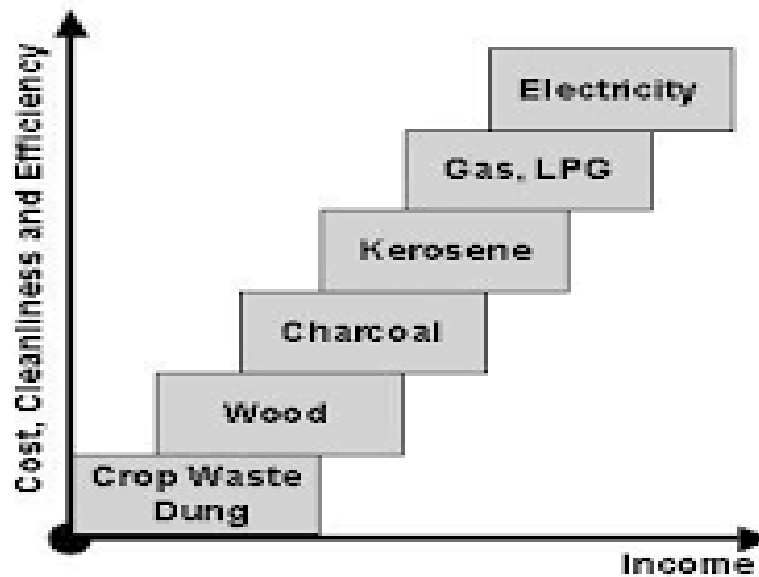


Figure 2.4: The Energy Ladder

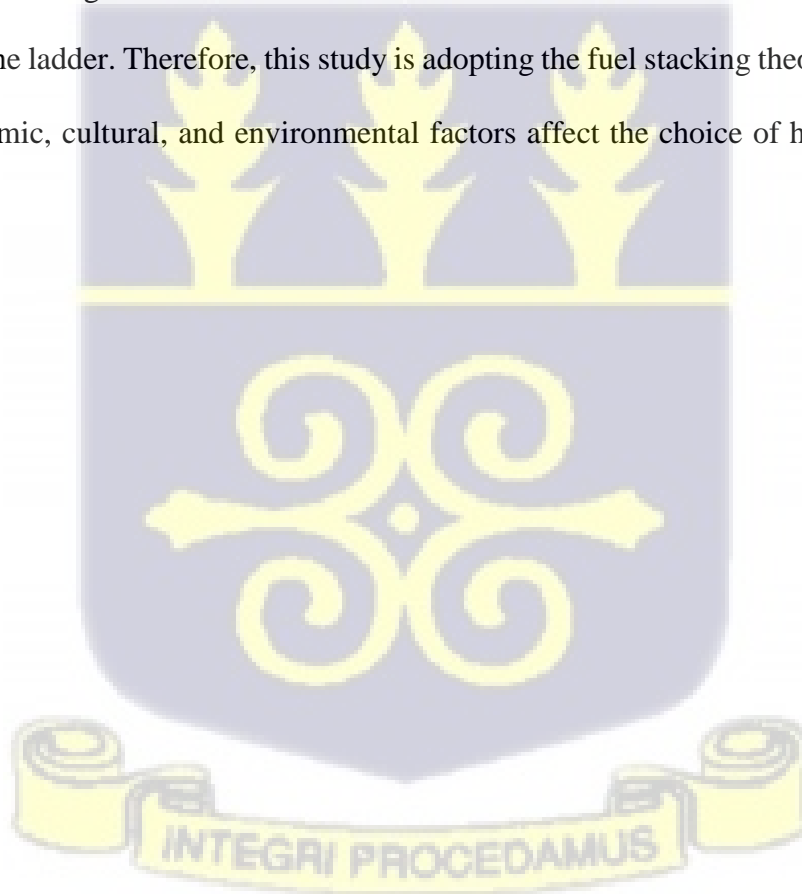
Source: (Schlag, N. & Zuzarte, 2008)

In this theory, cooking fuels are ordered on a ladder according to a family's preference based on characteristics such as efficiency, cleanliness, and speed (Hiemstra- van der Horst & Hovorka, 2008). Although not universally applicable, this theory explains the relationship between income and the choice of household cooking fuel in developing countries. In Sub-Saharan Africa, many households prefer traditional and intermediate fuels to modern fuels (Njiru & Letema, 2018). Thus, households with lower incomes cannot afford modern cooking fuels like electricity and LPG. The energy ladder theory is used in this work to show how households' income affects their choice of cooking fuel. In essence, while the energy ladder theory postulates that moving up the ladder denotes an abandonment of lower level fuels, other studies (Hosier et al. 1987; Masera et al. 2000; Leiwen & O'Neill, 2003; Heltberg, 2004) showed that energy choices are not linear. This indicates that the energy ladder theory is limited in reality. For example, Kowsari & Zerriffi (2011) pointed out that the energy ladder is efficient in explaining energy choice, particularly in urban

areas, thus, there is a limitation in the application of this theory in rural, and peri-urban communities.

2.5.2 The Fuel Stacking Theory

This theory is a critique of the energy ladder theory where Masera, Saatkamp & Kammen (2000) argue that the former cannot adequately represent the dynamics of household cooking fuel choice. This theory assumes that multiple interactive socioeconomic, cultural, and environmental factors determine the choice of cooking fuel (Masera, Saatkamp & Kammen, 2000). The proponents assert that fuel stacking is common in both urban and rural areas of developing countries and relates to many cooking fuel usages where households select a combination of fuels from both upper and lower levels of the ladder. Therefore, this study is adopting the fuel stacking theory to help explain how socioeconomic, cultural, and environmental factors affect the choice of household cooking fuel.



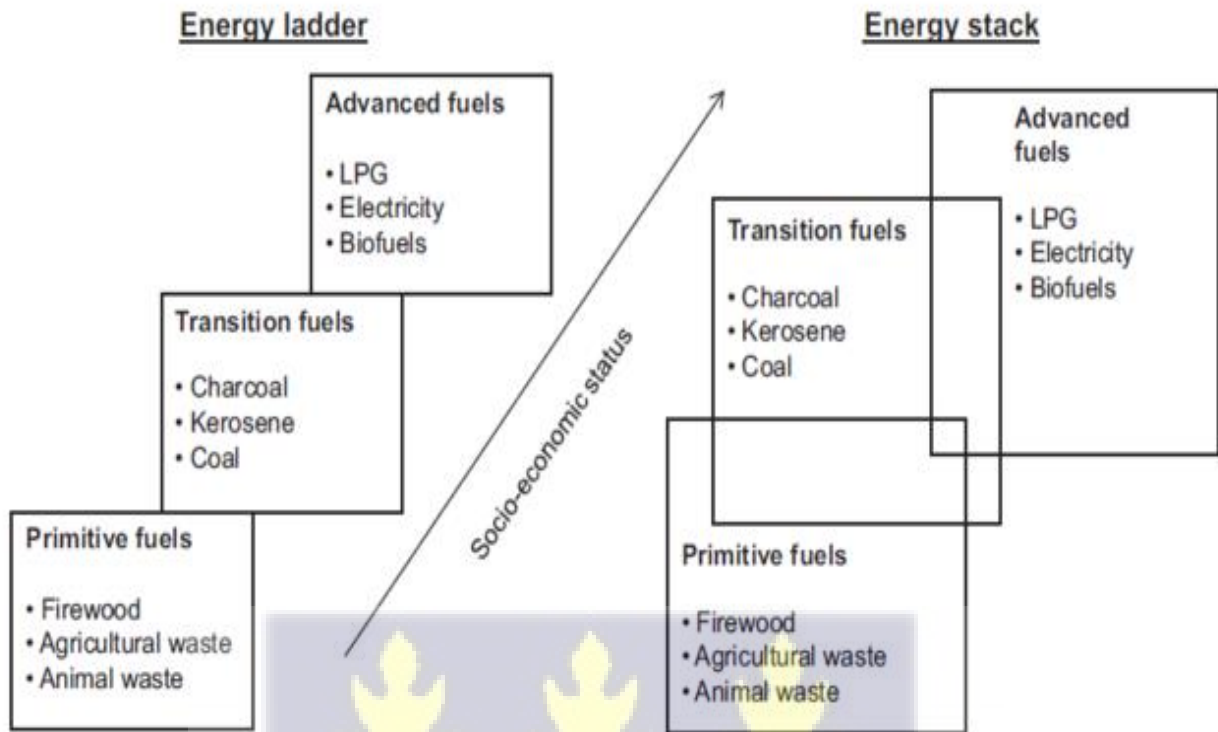


Figure 2.5 : Energy Ladder to Fuel stacking

Source: (Van der Kroon, Brouwer & Van Beukering, 2013)

The fuel stacking theory posits that there are no substitutes for cooking fuels and a particular cooking fuel is often chosen for specific tasks. Therefore, instead of just switching between cooking fuels as income increases, households use different cooking fuels at the same time depending on needs, budget, and preferences (ESMAP, 2003; Leiwen & O'Neill, 2003; Kowsari & Zerriffi, 2011). Based on this notion, if a family switches to a modern type of cooking fuel, traditional fuels and devices are normally kept and households only partially switch to use them when need be (Kowsari & Zerriffi, 2011). Nonetheless, Victor (2002) counter the universal heirachcy concept of the stacking theory with the premise that household energy transition is not a step-like progress.

2.6 Conceptual Framework

A conceptual framework is an interrelated set of ideas (theories) about how a particular phenomenon operates or is related to its parts. The framework serves as the basis for understanding the causal or correlational patterns of interconnections across ideas, observations, concepts, knowledge, and interpretations (Svinicki, 2010). Thus, the conceptual framework influences how an event is interpreted. Also, the ideas that constitute a conceptual framework support one another, express their respective phenomenon and establish a framework-specific philosophy (Jabareen, 2009).

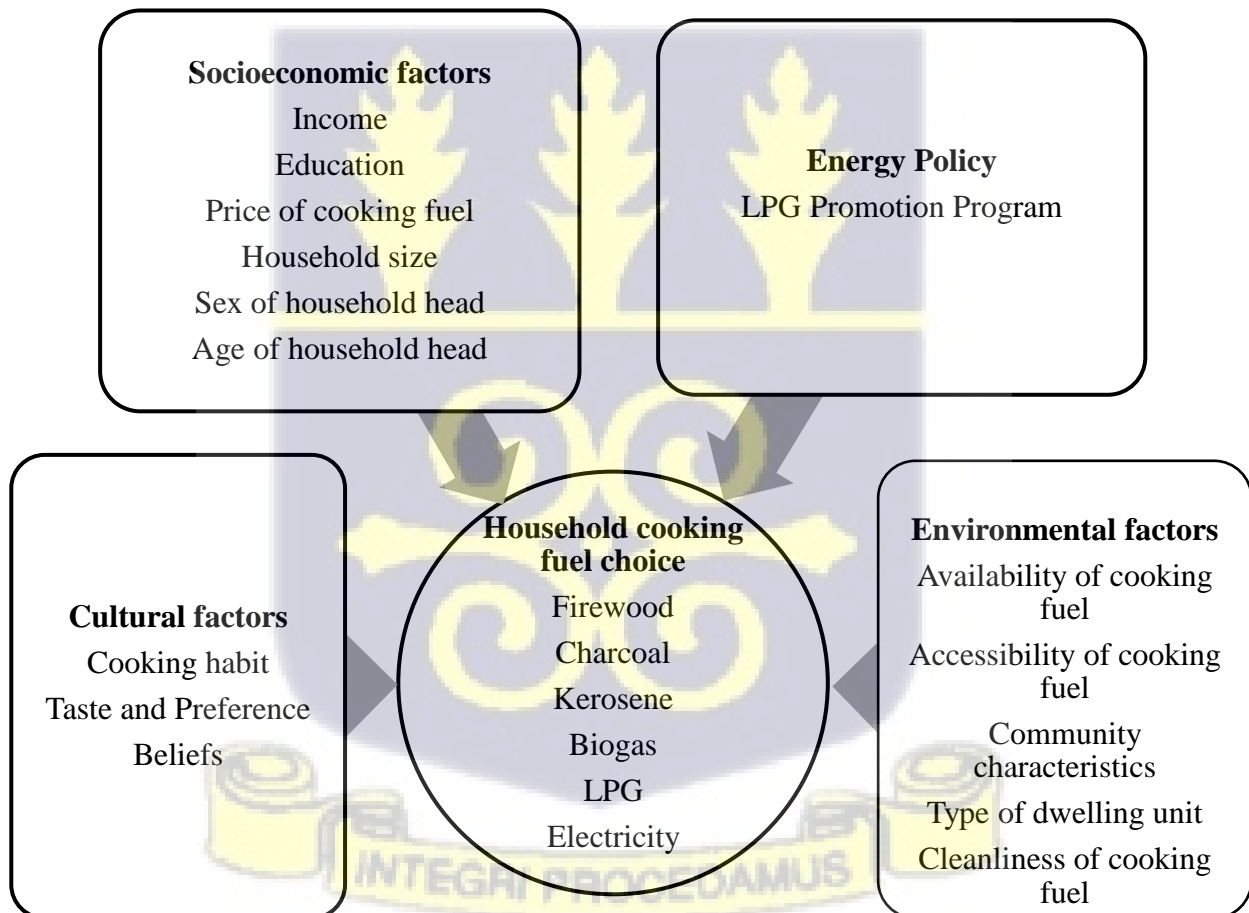


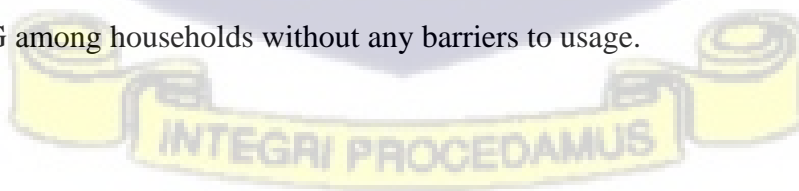
Figure 2.6: Conceptual framework

Source: (author's construct, 2020)

Based on findings from the literature, a conceptual framework is designed to help answer the research questions. The conceptual framework above demonstrates the elements of cooking fuel choice. The preference for a particular cooking fuel stems from socioeconomic factors such as education, income, Price of cooking fuel, et cetera. (Berhe, 2014; Karimu, 2015; Soltani, Rahmani, Pour, Ghaderpour, Ngah & Misnan, 2019). According to the literature, household heads who have at least secondary education prefer cleaner cooking fuels to traditional fuels.

Cultural factors such as beliefs, cooking habits, and taste and preferences are also impelling factors in the selection of household cooking fuel. Some households choose a cooking fuel that would add taste to their meals and others make a decision based on their place of abode. Also, the conceptual framework has drawn a link between environmental factors such as availability and accessibility of cooking fuel, community characteristics, and cleanliness of cooking fuel and how they affect the choice of cooking fuel.

Many low-income households have adopted their coping strategies. They opt for less expensive cooking fuels such as firewood and charcoal instead of expensive cooking fuels like LPG and electricity. However, the government has also designed some interventions to make LPG more accessible and less expensive to users by disseminating clean sets of LPG stoves and accessories to both rural and urban locations across the country. This is aimed at increasing LPG usage and also reducing the usage of biomass fuel. Therefore, this intervention strategy is aimed at achieving the usage of LPG among households without any barriers to usage.



2.7 Conclusion

The works of literature reviewed indicate that different socio-economic and environmental factors affect the choice of household cooking fuel. Ghana has recently realized an appreciable increase in the percentage of LPG users from 22.3 percent in 2014 to 24.5 percent in 2017 (Ghana Statistical Service, 2019). The reasons for the increase in the number of LPG users are unknown. Therefore, the fuel stacking theory is adopted for the study to explain the factors that influence cooking fuel preference among households.



CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

The research methodology is a way of systematically solving a research problem through the steps adopted by a researcher (Kothari, 2004). This chapter focuses on the research design, study area, sources of data, sampling procedure, instruments used for data collection, and analysis.

3.1 Research Design

The study used a cross-sectional design to examine relationships between variables. The quantitative method of gathering data was also used. Quantitative research is concerned with quantities and measurements aimed at making scientific generalizations and predictions in research activity (Biggar, 2008). It is also an approach for testing objective theories by examining the relationship among variables (Creswell, 2014). These variables, in turn, can be measured, typically on instruments, so that numbered data can be analyzed using statistical procedures and results presented in the form of graphs and tables. The results derived from quantitative data are usually presented in tables, bar graphs, and pie charts. In essence, since the study is not focusing on a specific class/type of household, quantitative method was employed for the purposes of providing numerical representation as well as to capture the variations of households and their choice of cooking fuel.

3.2 Profile of the Study Area

The study was conducted in the Nsawam-Adoagyiri Municipality in the Eastern Region of Ghana. The choice of the study area was partly due to its peri-urban nature and limited research works conducted on the choice of cooking fuel among households in that area. The Nsawam-Adoagyiri

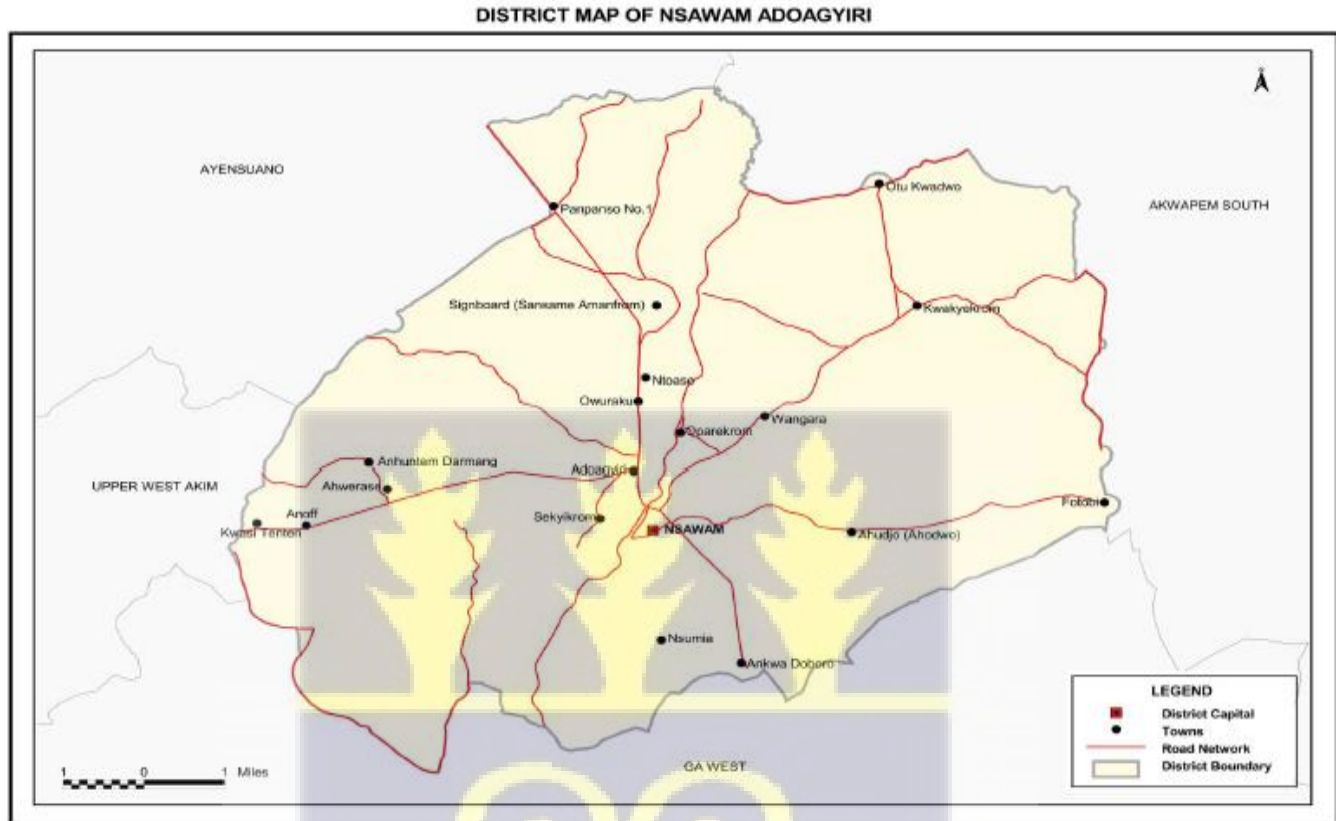
Municipality is about 24km from the national capital, Accra, and covers an area of approximately 175 square kilometers. The area is situated in the southeastern part of the Eastern Region of Ghana between latitude 5°.45 N and 5°.58 N and longitude 0.07°W and 0.27° W (Ghana Statistical Service, 2014).

Weather conditions in the Municipality are generally cool due to its location in the wet semiequatorial climate, coupled with the double maxima rainfall, which records an average annual rainfall of between 125cm and 200cm. The first rainy season is usually between May to June, with the heaviest rainfall experienced in June and a second rainy season between Septembers to October. This usually account for an entire year farming practice. The highest 2 temperatures averaging 30°C are recorded between March and April. With the lowest average temperature of 26°C recorded in August.

The Nsawam-Adoagyiri Municipality has a population of 86,000 representing 3.3 percent of the Eastern Region's total population (2,633,154) (Ghana Statistical Service, 2014a). Out of the total population, 49.7 percent are males and 50.3 percent are females, with more than half of the population living in urban communities. The area also has a household population of 79,402 representing 92.3 percent of the municipality's total population of 86,000 with an average household size of 4.1 persons per household.

In this area, about 64 percent of the total population can speak and understand English and a Ghanaian Language. The economy of the area is predominantly agrarian with other economic activities in the area including manufacturing, craftsmanship, forestry and fishery, and services and sales. The housing stock of the Nsawam Adoagyiri Municipality is 9,953 with the two main sources of lighting in dwelling units in the municipality being electricity (68.5%) and kerosene

lamp (20.9%). The major sources of cooking fuel in the area are wood fuel, charcoal, and LPG (Ghana Statistical Service, 2019).



Source: Ghana Statistical Service, GIS

Figure 3.1: Map of Study Area

Source: (Ghana Statistical Service, 2014)

3.3 Study population

The study population involved households in the Nsawam-Adoagyiri Municipality. The respondents of the study were members of households who are eighteen years or older and did the cooking in their homes. This was to guarantee the ability of participants to provide enough information about their cooking fuels.

3.4 Sample Size and Sampling Technique

According to the Ghana Statistical Service (2014), the Nsawam-Adoagyiri municipality has a total population of 86,000 and an urban population of 50,864. Since the unit of analysis of the research involves households in a peri-urban area, the research population is the total number of households in urban areas in the Nsawam-Adoagyiri Municipality, which is 12,406. In determining the sample size and sampling procedure, the population of the study area, settlement, and diversity of household characteristics were some important factors considered.

The Sample size for the study was calculated using the Taro Yamane formula (Yamane, 1973) with a 95% confidence level. The sample size is given as:

$$n = \frac{N}{1+N(e)^2}$$

Where n = sample size, N = Total population, and e = Error tolerance (0.05).

$$\text{Therefore, } n = \frac{12406}{1+12,406(0.05)^2} = 388 \text{ sample size.}$$

The sampling technique adopted for the study was systematic random sampling. The researcher divided the population size by the sample size to obtain the interval for the systematic sampling procedure.

$$\text{Sample interval} = \frac{12406}{388} = 31.9 \sim 32.$$

This means that every 32nd household in the population was chosen for the survey. Therefore, the researcher identified a starting point by randomly choosing number 26 which falls between 1 and

the sample interval of 32. Hence, any 32nd household after household number 26 was selected for the survey. Subsequently, all other participating households were selected following the systematic random sampling procedure. This sampling method was appropriate for the study because it costs less and is simple to use.

3.5 Type and Sources of Data

Two major sources of data were employed in the study: the primary source of data from the field and secondary data from books, journals, and newspapers were used to gather information. Primary data is a first-hand data source that a researcher uses to answer the study objectives and research questions. This type of data is usually obtained through interviews, surveys, observation or experiment, and focus group discussion (Salkind, 2010).

Secondary data is also data that already exists and can be used by others other than the original collector and sometimes for a purpose other than it was originally intended (Salkind, 2010). This source of data can be accessed in books, newspapers, journals, and online. The primary data used for the research was obtained through the questionnaires administered to the participants. Secondary data was also obtained from the Institute of Statistical, Social and Economic Research and Regional Institute of Population Studies Library, journals, online sources, and books.

3.6 Data Collection Method

In this research, data was collected using a semi-structured questionnaire (see Appendix 1) designed by the researcher which contained questions related to demography and also captured information about households such as the type of cooking fuel they use. The questionnaire was also used to elicit information such as factors influencing the type of cooking fuel used by households, their level of income, etc. To keep the flow of information, the questions were divided into four major parts.

The first part was aimed at knowing the demographic background of the respondents, and the second part sought to gather information about households' cooking fuel choice and kinds of fuels used, amount of fuel used for cooking, and monthly fuel expenditure. The third part of the questionnaire solicited information about households' cooking practices. This was to enable the researcher to know about the cooking norms and local cultural practices of the households in the study area. Subsequently, the fourth part covered questions about households' socio-economic and cultural characteristics.

The questionnaire was pre-tested with selected households in the La Nkwantanang-Madina Municipality to assess the appropriateness of the design, clarity, and relevance of the questions before the data was collected. All necessary modifications were made after the pre-test to solicit relevant information related to the study objectives.

3.7 Data Analysis

Data obtained from the field was coded and entered into STATA software for processing. Two types of analysis, descriptive and econometric analyses were used in analyzing the data.

3.7.1 Descriptive Analysis

Descriptive statistical analyses were performed on the sample to obtain a clear understanding of the demography of the population. Measures of central tendency (means and other percentiles) were also computed and presented in tables to provide clear characteristics of the study population. Consequently, cross-tabulations were performed to test the level of association between the dependent variable (cooking fuel choice) and the independent variables (income, age, the gender of household decision-maker, and the type of dwelling unit of households).

3.7.2 Econometric Analysis

The data was analyzed using a Multinomial Logit model to achieve the objectives of the study. This model was chosen because it performs better with discrete choice studies (Lutkepohl, Judge, Hill, Griffiths & Lee, 1985). The Multinomial Logit Model was chosen because there was more than one cooking fuel alternative available to households. In the Nsawam-Adoagyiri Municipality, the popular cooking fuels available are firewood, charcoal, LPG, and electricity. It was assumed that households choose a particular cooking fuel to maximize their satisfaction. Therefore, if a household selects j at a time, then Y^*_{ij} is the maximum option utilized among the other sources of cooking fuel. The fuel category is also defined as a vector ($Y_i = [Y_{ij}]$) of three dummy categories and the probability that j will be in the choice set of ' i ' is $P(Y^*_i > 0)$. The model is also expressed as follows;

$$Pr(Y_{i=j}) = \frac{\exp(\beta_{ij}X_i)}{\sum_{j=0}^m \exp(\beta_{ij}X_i)} \quad (1)$$

Where:

$Pr [Y_i = j]$ represents the probability of choosing any of the cooking fuels like charcoal, kerosene, LPG, biomass, or electricity. With firewood being the reference cooking fuel set,

- m is the number of cooking fuels in the choice set,
- $j = 0$ (firewood)
- x_i is a vector of the exogenous variables
- β_i is also a vector of the estimated parameters.

The above equation can be rearranged algebraically as follows;

$$P_i = \frac{e^{(b_0 + b_1x_1 + \dots + b_yx_y)}}{1 + e^{(b_0 + b_1x_1 + \dots + b_yx_y)}} \quad (2)$$

The following equation was also used to estimate the coefficient;

$$\ln\left[\frac{P_i}{1-P_i}\right] = b_0 + b_1 x_1 + \dots + b_v x_v \quad (3)$$

The quantity $P_i/(1-P_i)$ in the above equation (3) represents the odds ratio. The P-value also determines if a change in the predictor variable has a significant effect on the logit at the level of acceptance. Also, if the P-value is higher than the accepted confidence level, then there is not enough evidence to support that a change in the predictor variable affects the choice of cooking fuel.

The dependent variable in the model is the choice of cooking fuel (firewood, charcoal, or LPG) with firewood being the reference choice. In the logit model, estimated coefficients measure the likely change in the predictor variable while holding all other predictor variables constant. A positive estimated coefficient indicates an increase in the possibility of a household choosing an alternative fuel. A negative estimated coefficient also specifies that the possibility that a household will change to alternative fuel is low. Table 1, therefore, represents a matrix of the explanatory variables which are described in table 2. Due to time constraint in the collection of data, other explanatory variables captured in the conceptual framework including energy policy were left out in the analysis.



Table 3.1: Description of dependent variables

<i>Dependent variable/cooking fuel</i>	<i>Variable description</i>
Liquified Petroleum Gas (LPG)	A relatively cleaner cooking fuel as per the energy ladder to fuel stacking theory. It is the preferred output for this work since it is relatively safe.
Charcoal	This is produced from the harvesting of live trees and wastes generated from logging and sawmills. It produces less smoke as compared to firewood.
Firewood	This is woody biomass energy that is mostly collected on farms and burned in open stoves, usually a traditional three-stone stove and mud stove to produce heat for cooking. It produces lots of smoke in the process of burning. Indiscriminate tree cutting for use as firewood also leads to deforestation.
<i>Quality of housing</i>	<i>Description</i>
Traditional	A type of house whose designs differ in origin and Sometimes built to portray the culture of a household. This type of house is usually built with wood, clay, and brick.
Modest	A type of house with similar designs around its location. It is usually built with cement blocks and has simple designs.
Modern	This type of house usually has a confiscated design made by an architect. Such a house is usually built using the latest designs and quality building materials.

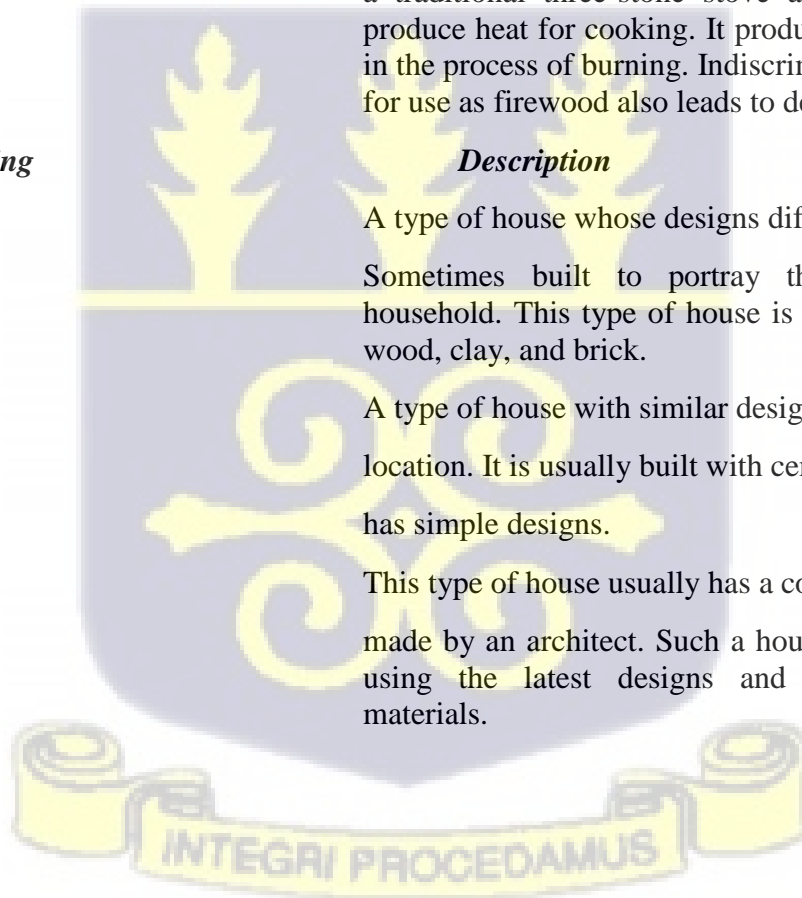


Table 3.2: Explanatory variables used in the Multinomial Logit Regression and the expected effect on the choice of cooking fuel

Variable	Variable description	Observations (N)	Expected effect on choice of cooking fuel	Mean
logHh	(Log) of household head (proportion of women to men)	245	+	0.779
Age	age of household head	245	+	37.8
Fsize	Family size	246	+	3.82
Lev_educ	Highest level of education of household head	246	+	1.26
Dec_fel	Decision maker of the type of cooking fuel	245	+	2.17
Hh_income	log per average monthly Household income	246	+	3.21
Housn_qulty	Quality of housing	246	+	1.04
Fel_cost	Cost of fuel	246	+	59.66
Kit_typ	Type of kitchen	246	-	0.26
Tas_pref	Taste and preference	245	-	0.31
Fel_clen	Cleanliness of fuel	245	+	0.318

3.8 Ethical Consideration

Approval was obtained from the Municipal executives of the Nsawam-Adoagyiri Municipality to research the area. The researcher also sought the consent of the participants and made them aware of their right to refuse to participate, assured them of anonymity and confidentiality, and the use of the information being collected. The objective and drive of the study were explained to the

responders (mainly household heads) in a clear language and their cooperation was also sought without any financial or material reward for participating.



CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

This chapter concentrates on data analysis, interpretation, and presentation of results by utilizing the multinomial logit regression model to draw the relationship that exists between the choice of cooking fuel and some household characteristics. The survey instructed the respondents to specify the type of fuel used by their households for cooking. The listed types of cooking fuel included firewood, charcoal, kerosene, LPG, biogas, and electricity. However, kerosene, biogas, and electricity were dropped from the analysis because none of the households interviewed used them.

4.2 Demographic Characteristics of Sample

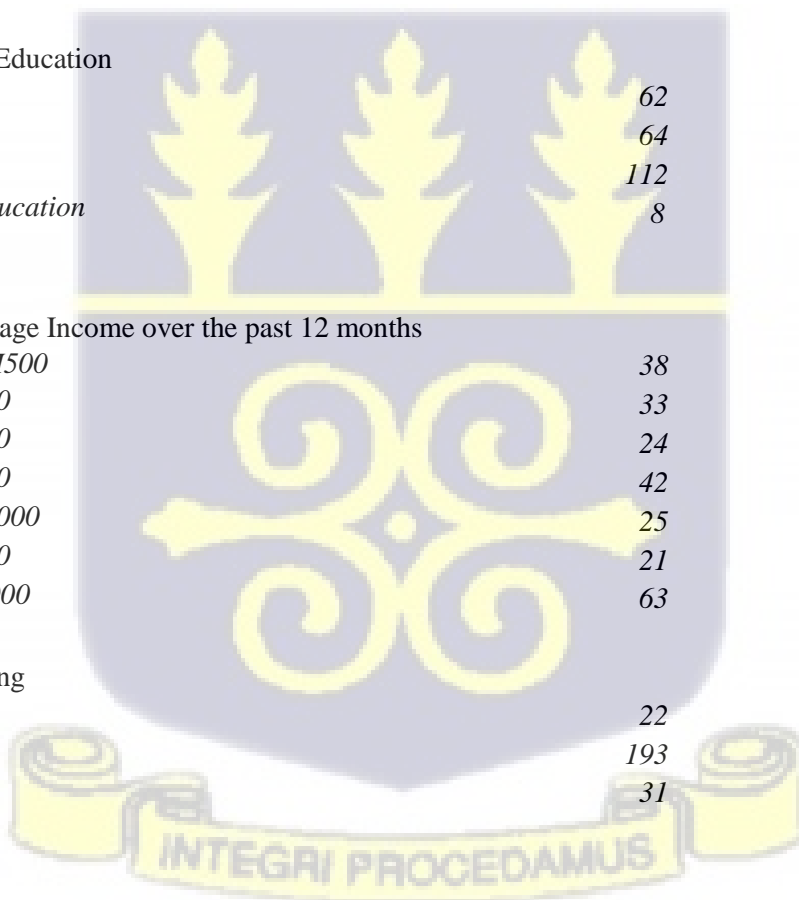
A total of 388 respondents were sampled for the survey. However, 246 responded, representing a response rate of 63.92%. This rate of response was achieved due to the strategy of visiting respondents on weekends and evenings on weekdays when household heads or their spouses are available. Table 4.1 below describes the demographic characteristics of the respondents while Table 4.2 presents the frequencies and percentages of the explanatory variables.

4.2.1 Sex of Respondents

A majority of the respondents were females (77%). This was expected since females are traditionally more involved in cooking decisions at home. Males constituted 23% of the total number of respondents.

Table 4.1: Descriptive Characteristics

Variable	Frequency	%
Cooking Fuel		
<i>Firewood</i>		
<i>Charcoal</i>	9	3.66
<i>LPG</i>	97	39.43
	140	56.91
Sex		
<i>Male</i>	57	23
<i>Female</i>	189	77
Highest level of Education		
<i>Tertiary</i>	62	25.20
<i>Secondary</i>	64	26.02
<i>Primary</i>	112	45.53
<i>No Formal Education</i>	8	3.25
Household Average Income over the past 12 months		
<i>Less than GH500</i>	38	15.25
<i>GH500-GH1000</i>	33	13.41
<i>GH1001-GH2000</i>	24	9.76
<i>GH2001-GH3000</i>	42	17.07
<i>GH3001-GH4000</i>	25	10.16
<i>GH4001-GH5000</i>	21	8.54
<i>More than GH5000</i>	63	25.61
Quality of Housing		
<i>Traditional</i>	22	8.94
<i>Modest</i>	193	78.46
<i>Modern</i>	31	12.60
Type of Kitchen		
<i>Private</i>	208	84.55
<i>Shared</i>	11	4.47
<i>No Kitchen</i>	27	10.98



Decision maker for the type of fuel to purchase

<i>Wife</i>	67	27.35
<i>Husband</i>	73	29.80
<i>Joint</i>	72	29.39
<i>Daughter</i>	17	6.94
<i>Son</i>	11	4.49
<i>Others</i>	5	2.04

Source: Author's field data, September 2020

Table 1.2 : Mean values for the explanatory variables

Variable	Description	Mean Values
Cooking Fuel	<i>Firewood = 0</i> <i>Charcoal = 1</i> <i>LPG=2</i>	1.53
Sex	<i>Male= 1</i> <i>Female = 0</i>	0.779
Age	<i>18-83 years</i>	37.8
Family Size	<i>1-11 members</i>	3.82
Highest level of Education	<i>Tertiary= 0</i> <i>Secondary=1</i> <i>Primary =2</i> <i>No Formal Education=3</i>	1.26
Household Average Income over the Past 12 months	<i><GHS500=0</i> <i>GHS500-1000=1</i> <i>GHS1001-2000=2</i> <i>GHS2001-3000=3</i> <i>GHS3001-4000=4</i> <i>GHS4001-5000=5</i>	3.21

Quality of Housing	>GHS5000=6 Traditional=0 Modest=1 Modern=2	1.04
Type of Kitchen	Private=0 Shared=1 No Kitchen=2	0.26
Decision maker for the type of fuel to purchase	Wife=0 Husband=1 Joint=2 Daughter=3 Son=4 Others=5	2.07
Price	GH0 – GH200	GH59.66

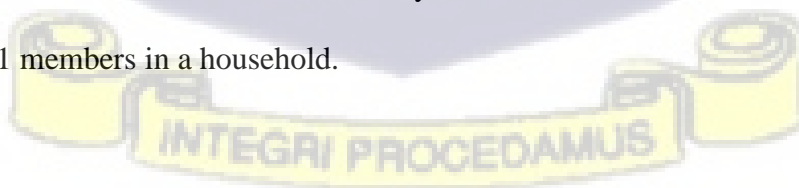
Source: Author’s field data, September 2020

4.2.2 Age of Respondents

Out of the 246 households surveyed, the minimum age among the respondents was 18 years, while the maximum age was 83 years, and the mean age of respondents being 38 years.

4.2.3 Family Size of Household

From the survey, households had a mean family size of 4. The minimum size was 1 and the maximum was 11 members in a household.



4.2.4 Price of Various Cooking fuels

According to the survey, Table 4 shows that the mean price for all cooking fuels examined was GH¢59.66. This means that on average, many households spend about GH¢60 on cooking fuel every month.

4.2.5 Type of Kitchen

The type of kitchens surveyed included private kitchens where the kitchen was utilized exclusively only by members of the household and shared kitchens where households living in compound houses would collectively share a common kitchen. The survey indicates that most households use a private kitchen. The majority of households, representing 84.55%, use private kitchens whilst 4.47% and 10.98% share and use no kitchens respectively.

4.2.6 Household Decision Maker for Cooking Fuel

The decision-maker for the choice of fuel used in the household includes either the husband or wife or both husband and wife or daughter or son. The result from Table 4 indicates that the average household decision-maker for the choice of fuel was 2.07 which represents joint, thus both husband and wife decide on the type of cooking fuel.

4.2.7 Level of Education of Household Head

Out of the total number of households surveyed, 45% had attained basic education as their highest level of education while 3.5% had no formal education. This indicates that close to 67% of the households were literates. This is in line with the statistics provided by the Ghana Statistical Service (2014), which indicates that about 86 percent of the population aged 11 years and older in the municipality are literate with about two thirds (63.7%) of the literate population being literate in English and a Ghanaian language and 24 percent being literate in the English language.

4.2.8 Average Income of Households

Out of the total sample, 29% of the households had their collective average income between GHS 500 and GHS1000, 27% had their income between GHS1001 to GHS 3000, 19% of households had their average income between GH3001 to GHS5000, and 25% had an average monthly income more than GH5000 over the past 12 months. This is illustrated in Figure 4.1.

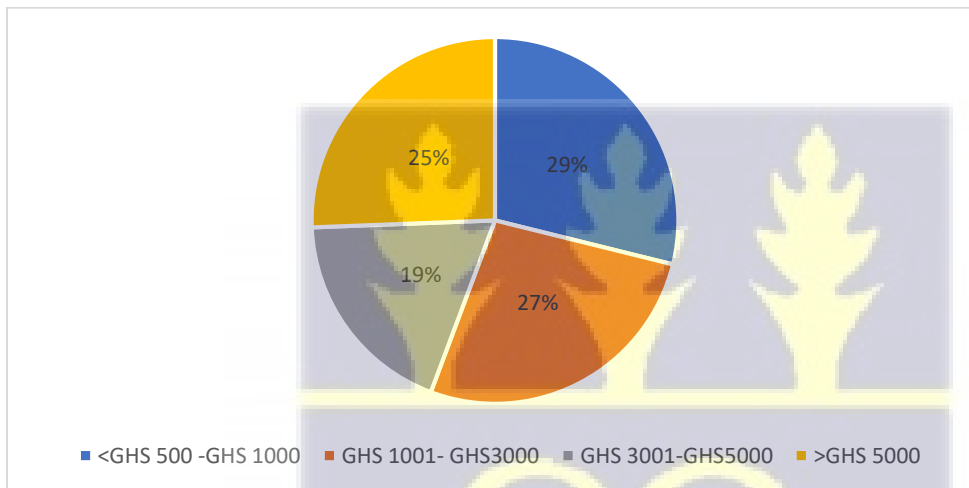


Figure 4.1: Distribution of the average monthly income of households

Source: Author's field data, September 2020

4.2.9 Quality of Housing

Approximately 79% of the households lived in modest homes, 12.1% lived in modern homes, while 8.94% lived in a traditional setting. In chapter 3, a modest home was described as a house that is not large nor expensive. Also, modern homes were described as houses with complicated architectural designs made by an architect. Such houses are usually built using the latest designs and quality building materials. Lastly, traditional settings are homes constructed with clay, bricks, and wood.

4.2.10 Preference for Cooking Fuel

From Figure 4.2, it can be seen that 57% of the total number of households prefer LPG as their cooking fuel, 39% of the households prefer Charcoal as their cooking fuel, and 4% use Firewood. This development is possible because of the rapid modernization in the area. Again, since more than 50% of the respondents have received some form of education, they are more likely to select LPG over charcoal and firewood as their source of cooking fuel owing to its efficiency. This is in agreement with Pandey & Chaubal (2011) and Adeyemi & Adereleye (2016) assertion that education can influence the choice of cooking fuel.

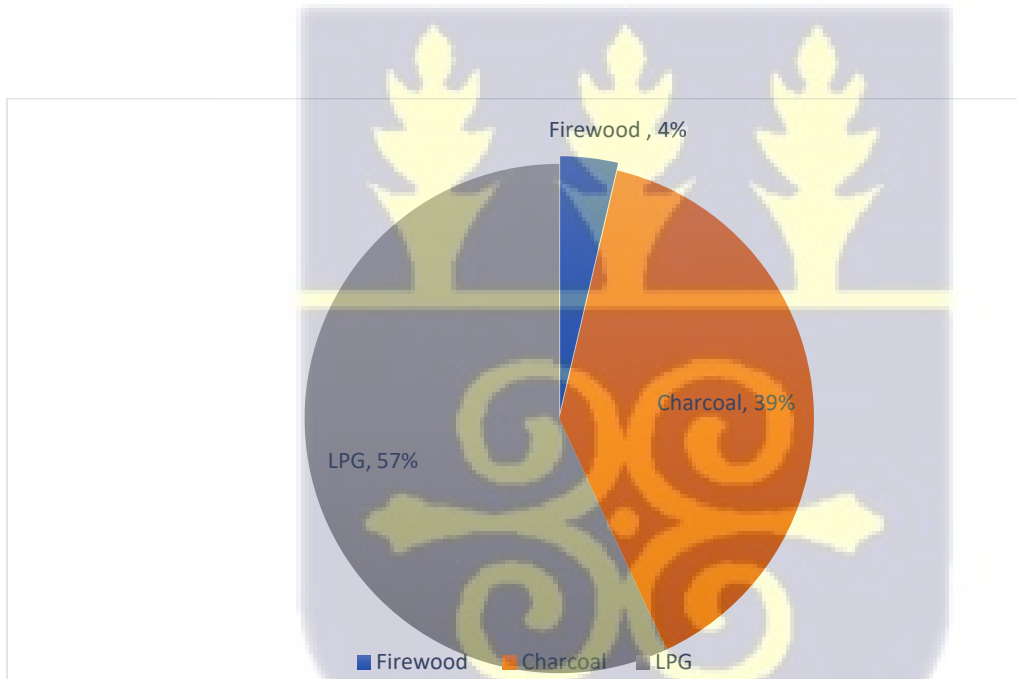


Figure 4.2: Choice of Cooking Fuel

Source: Author's field data, September 2020

4.2.11 Sources of Cooking Fuel

As depicted in Figure 4.3, there were diverse means by which households accessed cooking fuels. Specifically, about 88% of households purchased these cooking fuels, 11% self-collected, and 1% received cooking fuels as a gift.



Figure 4.3: Source of Cooking Fuel

Source: Author's field data, September 2020

4.2.12 Household Cooking task and Fuel consumption

As illustrated in Figure 4.4 below, about 71% of households indicated that cooking stew or soup consumed more fuel while another 27% observed that cooking solid foods consumed more fuel. Further, about 2% of households agreed that boiling water consumes more fuel. None of the households used the cooking fuel options to bake.

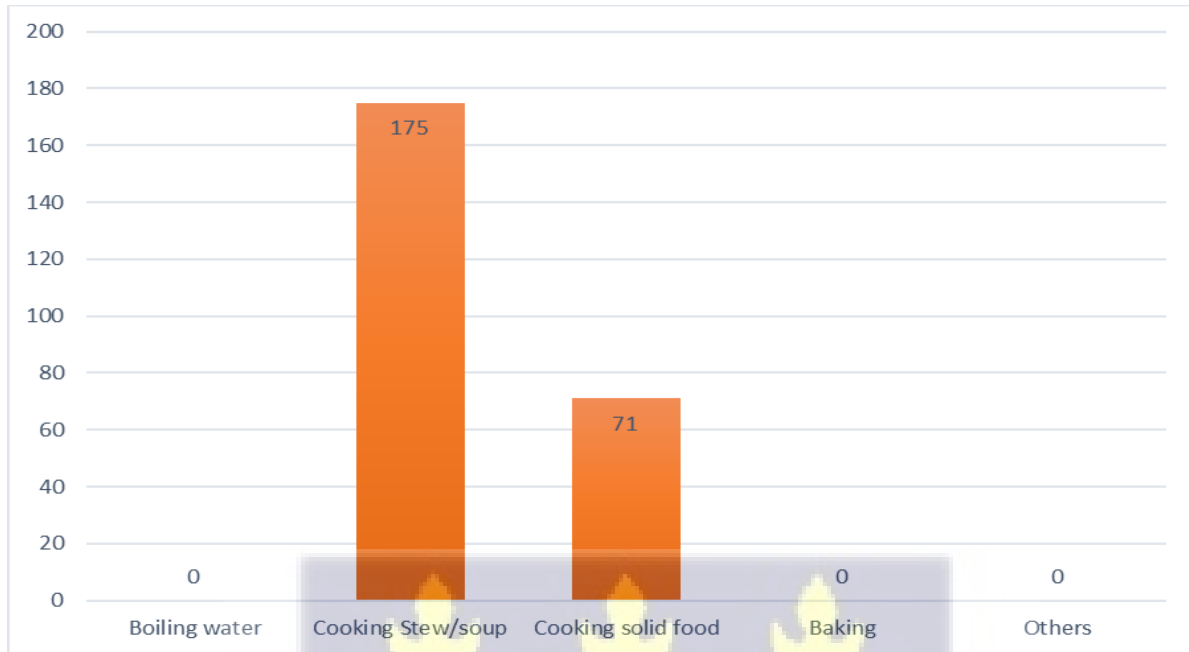


Figure 4.4: Household cooking task and fuel consumption

Source: Author's field data, September 2020

4.2.13 Reasons for a Household's Choice of Fuel

Many households prefer a particular cooking fuel to others based on many reasons. From Figure 10 below, many households (47%) in the study area cited efficiency as the reason behind their cooking fuel choice. The other underlying reasons - cleanliness, safety, convenience, cheap price, and availability were represented in the following respective percentages 24%, 14%, 7%, 4%, and 3%. Furthermore, 1% of the households indicated that their choice of cooking fuel was dependent on the cooking fuel's contribution to the taste of food.

Price of fuel and household income have been discovered to influence households' choice of cooking fuel (Stephen, 2011; Bansal, Saini & Khatod, 2013; Berhe, 2014; Tettey, 2014; Karimu,

2015; Nlom & Karimov, 2015; Alhassan, 2018; Soltani, Rahmani, Pour, Ghaderpour, Ngah & Misnan, 2019).

Environmental factors such as efficiency, convenience, safety, and cleanliness have also been demonstrated to affect the choice of cooking fuel (Rehfuess, Mehta & Prüss-Üstün, 2006; Karimu, 2015; Nyankone & Waithera, 2016; Nielsen, 2017). Additionally, research shows that the effect cooking fuel has on the taste of food is relevant in the choice of fuel (Atanassov, 2010; Kwakwa, Wiafe, & Alhassan, 2013; Suliman, 2013; Malla & Timilsina, 2014; GACC & GAC 2017; Zhang & Hassen, 2017; Makonese, Ifegbesan & Rampedi, 2018).

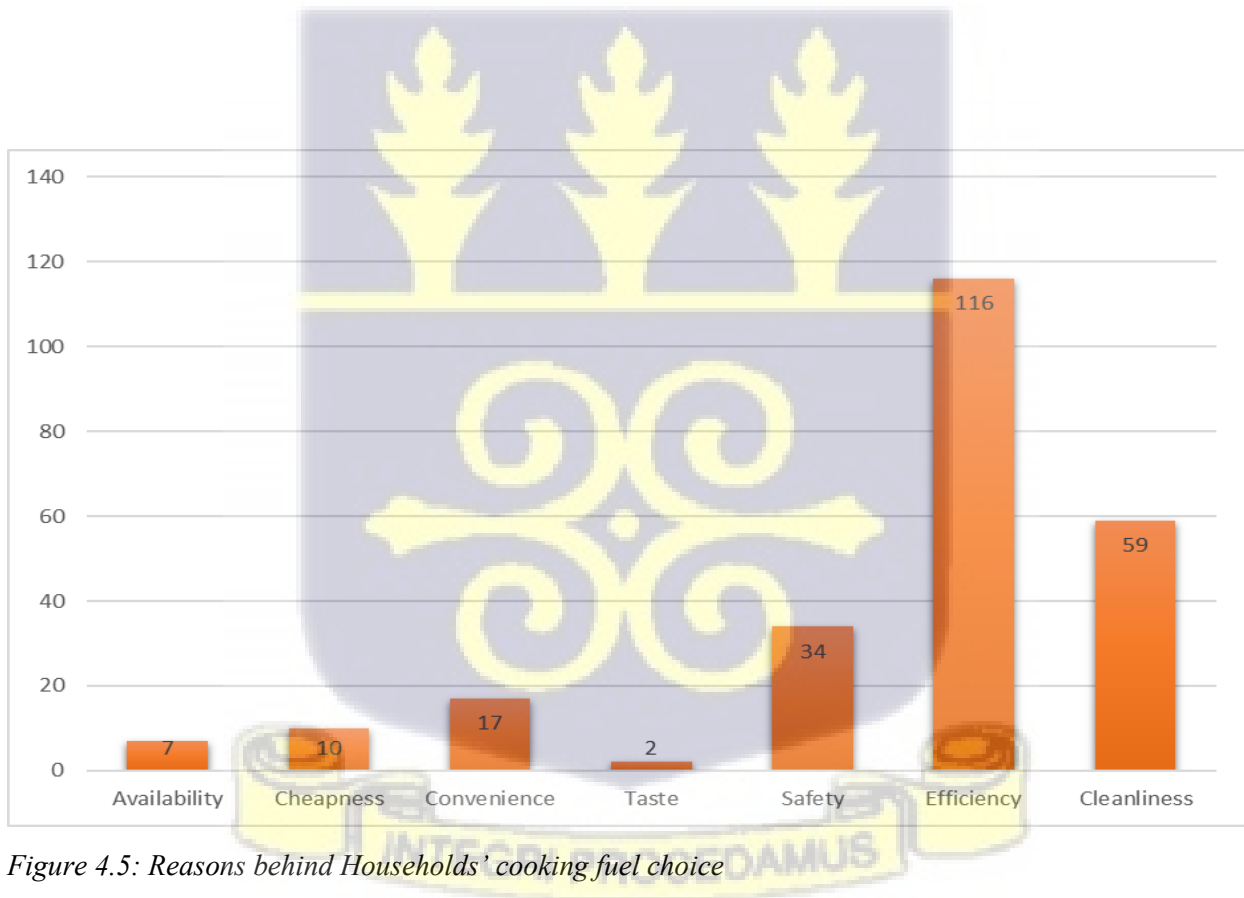


Figure 4.5: Reasons behind Households' cooking fuel choice

Source: Author's field data, September 2020

4.3. Socio-Economic Factors Influencing the Choice of Cooking Fuel

4.3.1 Income level of a household

Bansal, Saini & Khatod (2013) and Nlom & Karimov (2015) have shown that the level of household income is key in determining the choice of cooking fuel. In Ghana, the level of income of a household influences household cooking fuel choices. This means that the likelihood of a family choosing LPG or electricity over firewood and charcoal increases with a higher level of household income (Stephen, 2011; Alhassan, 2018). Since convenient, clean, and efficient fuel is relatively more expensive, its usage is expected to increase with higher income per the Energy Ladder and Fuel Stacking theories. According to the energy ladder and fuel stacking theories, the use of cleaner, convenient, and efficient fuels increases with income.

For household income, the higher the family size, the greater the likelihood of a household choosing charcoal as a cooking fuel relative to LPG. This can be attributed to larger families having lower household income per head and yet requiring more cooking fuel for relatively more quantities of meals at home. Hence, large families will resort to cheaper cooking fuel to save costs.

The Pearson chi-square test presented in Table 4.3 suggests a positive relationship between the income level of households and the choice of cooking fuel (chi-square = 42.1841, df = 12, $p < 0.05$). This means that a household with a relatively higher income would choose LPG over charcoal and firewood. The results from the regression analysis also indicate that households who earn relatively higher incomes are likely to choose LPG over charcoal and firewood.

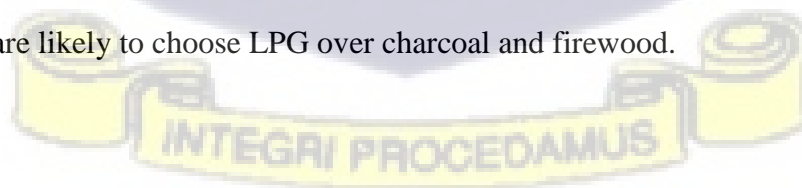


Table 4.3: Cross-tabulation of average household income over the past 12 months and choice of cooking fuel

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.1841	12	0.000
Likelihood Ratio	44.6847	12	0.000

Note DF = degree of freedom

4.3.2 Gender of Household Decision-maker and Choice of Fuel

The gender of a family’s decision-maker impacts the choice of cooking fuel (Pundo & Fraser, 2006). The data revealed that male decision-makers are more likely to use LPG than charcoal as compared to female household decision-makers who prefer firewood and charcoal to LPG. Figure 12 depicts the distribution of gender roles in household decision-making and its influence on the choice of cooking fuel.

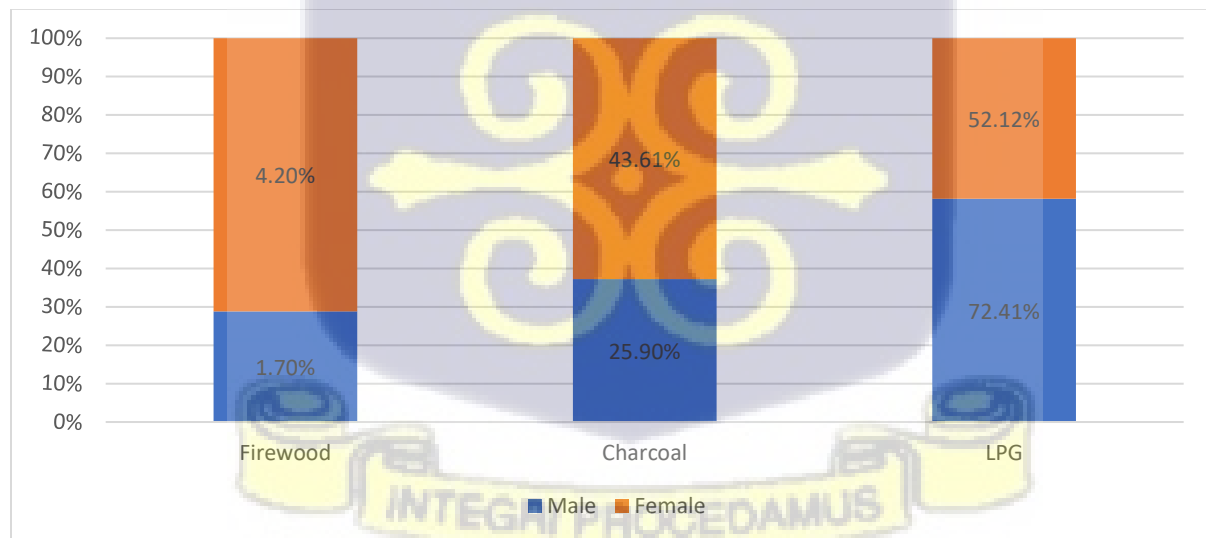


Figure 4.6: Influence of gender role in household decision making on choice of Cooking fuel

Source: Author’s field data, September 2020

From Figure 4.6, it can be seen that male decision-makers prefer LPG as cooking fuel to charcoal and firewood. Female decision-makers on the other hand prefer charcoal and firewood to LPG. This could likely be attributed to low-income levels among females which makes them unable to afford LPG. A study by Kwasi Fredua (2012) indicated that women are poorer compared to men in Ghana, and this further shows that economic inequality between men and women will likely have a negative rippling effect on issues related to the environment as women have equally important roles in maintaining a clean environment.

The results from the Pearson chi-square test presented in Table 4.4 indicate a positive correlation between the gender of a household decision-maker and the choice of cooking fuel (chi-square = 7.52, df = 2, $p < 0.05$). The test reveals that male decision-makers are more likely to use LPG than charcoal as compared to female household heads who prefer firewood and charcoal to LPG. This is likely because a majority of men do not have the experience in lighting up charcoal or firewood for cooking unlike majority of women who possess such experience through upbringing.

Table 4.4: Chi-Square Test result for Gender Role in Household Decision-making and Cooking Fuel Choice

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.52	2	0.023
Likelihood Ratio	7.83	2	0.020

Note DF = degree of freedom

4.3.3 The Age of Household Head

The age of a household head influences the choice of cooking fuel. According to Truneh (2014), older household heads prefer solid fuel like charcoal for cooking as against LPG. It is further explained that aged household heads are more conversant with traditional fuels like firewood and cow dung and are keener to preserve norms and traditions. Older household heads prefer solid fuels like charcoal for cooking as against LPG. Figure 12 illustrates the correlation between the age of a household head and the choice of cooking fuel.

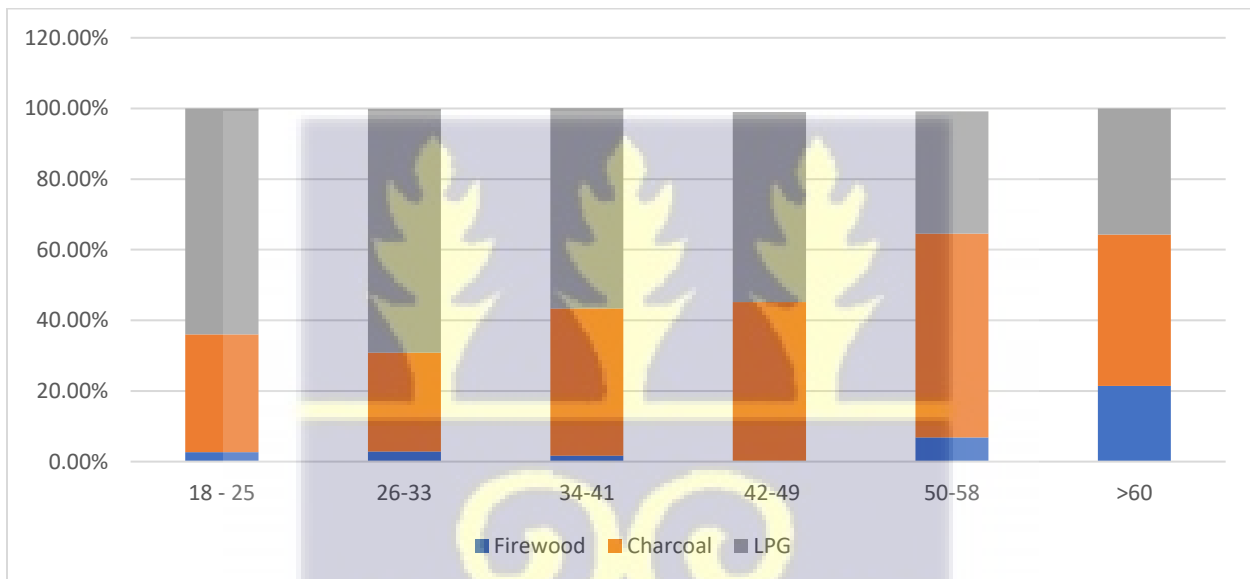


Figure 4.7: Age of household head and the choice of cooking fuel

Source: Author's field data, September 2020

The result presented in figure 4.7 shows that aged household heads prefer charcoal and firewood to LPG. This is in agreement with the findings by Truneh (2014).

The results from Table 4.5 are an affirmation of the narrative in figure 12. Table 7 below shows that there is a significant relationship between age and the choice of household cooking fuel, indicating that the age of a household head or a household decision-maker is a significant factor in determining the choice of cooking fuel

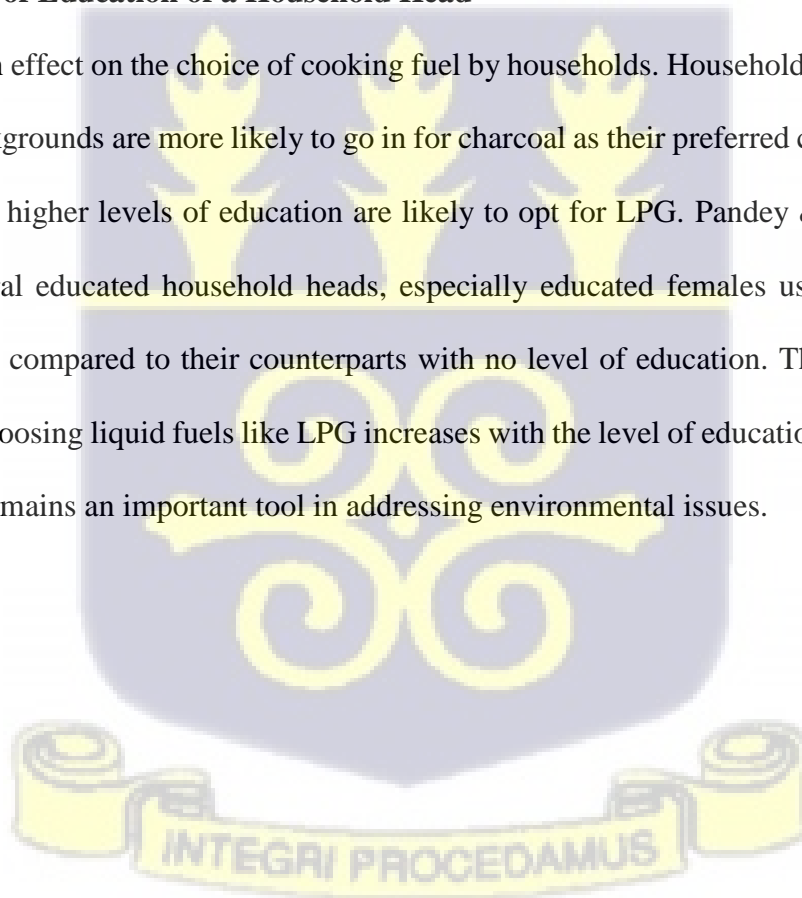
Table 4.5: Chi-Square Test result for household cooking fuel choice and age of household head

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	142.5741	100	0.003
Likelihood Ratio	129.3690	100	0.026

Note DF = degree of freedom

4.3.4 The Level of Education of a Household Head

Education has an effect on the choice of cooking fuel by households. Households with no or lower educational backgrounds are more likely to go in for charcoal as their preferred cooking fuel while households with higher levels of education are likely to opt for LPG. Pandey & Chaubal (2011) assert that several educated household heads, especially educated females use relatively clean cooking fuels as compared to their counterparts with no level of education. This means that the probability of choosing liquid fuels like LPG increases with the level of education, further proving that education remains an important tool in addressing environmental issues.



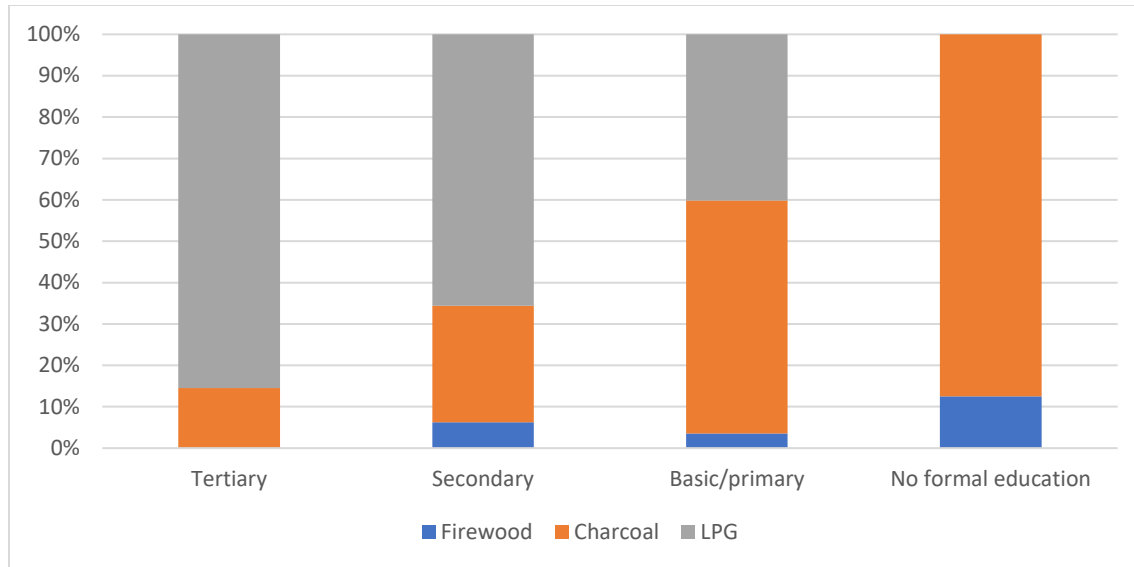


Figure 4.8: Level of education of household head and the choice of cooking fuel.

Source: Author's field data, September 2020

The figure above shows that the level of education of a household head influences the choice of cooking fuel. Household heads who have at least basic education prefer LPG to charcoal and firewood as compared to household heads with no formal education who prefer charcoal and firewood to LPG.

Table 4.6 below shows the impact of educational level on the choice of cooking fuel. It was discovered that education has an effect on the choice of cooking fuel by households. The results revealed that there is a significant effect of the level of education of a household head on the choice of cooking fuel (chi-square = 49.5238, df = 6, $p < 0.05$). Households with no or lower educational levels are more likely to cook with charcoal while households with higher educational levels are likely to opt for LPG. This corresponds to an assertion by Pandey & Chaubal (2011) which indicated that several educated household heads, especially females prefer relatively clean cooking fuels as compared to their counterparts with no level of education

Table 4.6: Cross-tabulation of the level of education of household head and the choice of cooking fuel

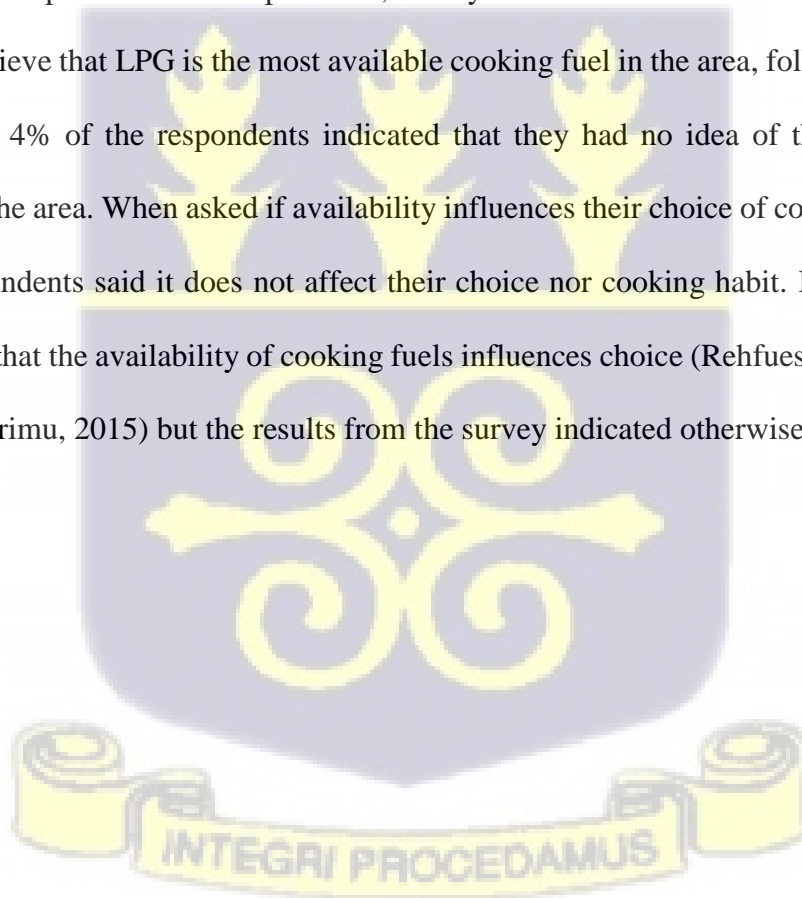
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	49.5238	6	0.000
Likelihood Ratio	56.0794	6	0.000

Note DF = degree of freedom

4.4. Environmental Factors influencing the choice of cooking fuel

4.4.1. Availability

With an 80% response from respondents, many households in the Nsawam-Adoagyiri Municipality believe that LPG is the most available cooking fuel in the area, followed by charcoal (9%). However, 4% of the respondents indicated that they had no idea of the most available cooking fuel in the area. When asked if availability influences their choice of cooking fuel, a great number of respondents said it does not affect their choice nor cooking habit. In the literature, it was established that the availability of cooking fuels influences choice (Rehfuess, Mehta & Prüss-Üstün, 2006; Karimu, 2015) but the results from the survey indicated otherwise.



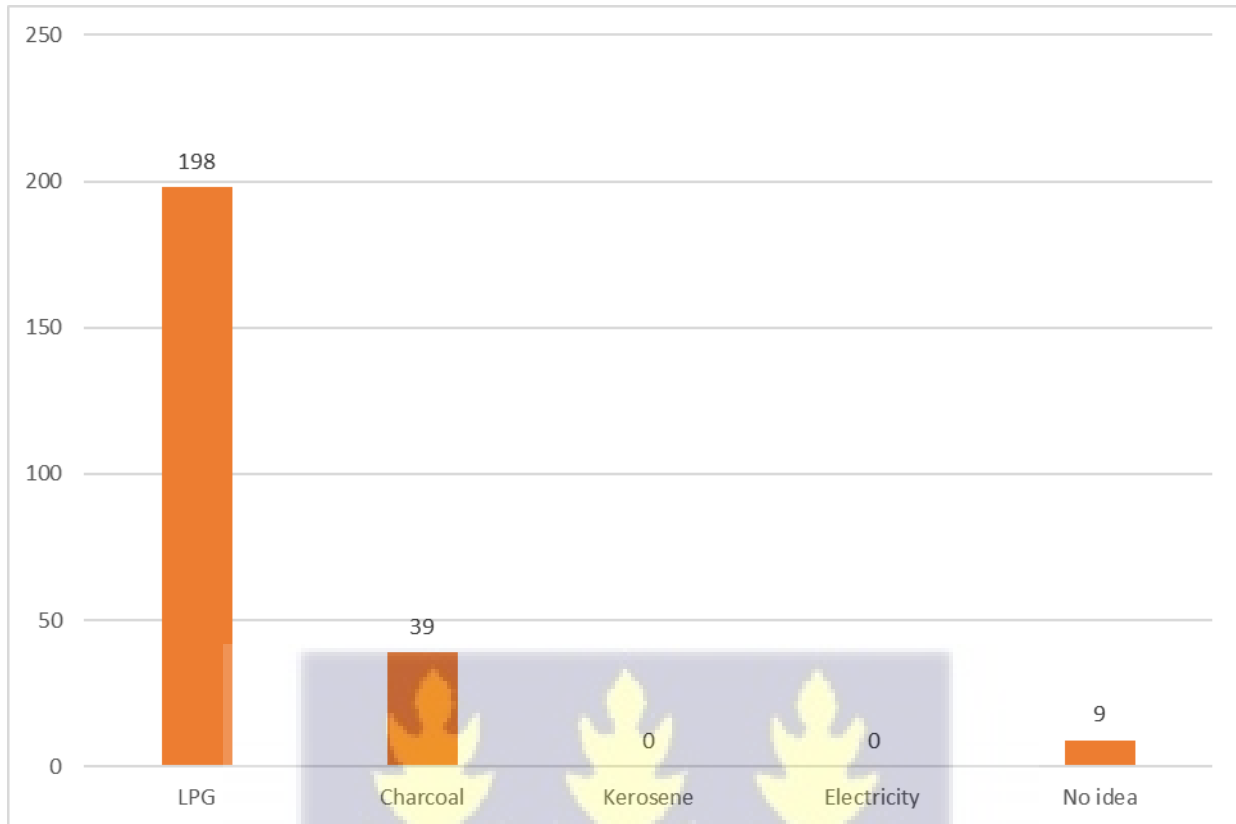


Figure 4.9: Knowledge on cooking fuels availability

Source: Author's field data, September 2020

4.4.2. Quality of Housing (Dwelling Unit)

The results from the chi-square analysis in Table 4.7 below revealed that there is a significant relationship between a household's dwelling unit and the choice of cooking fuel (chi-square = 37.0438, df = 4, $p < 0.05$). The study found households in modest and modern structures opted for LPG over charcoal in comparison to households in traditional structures who prefer charcoal or firewood. This finding is similar to that of Karimu (2015), where households in modern homes

were found to likely use modern fuel types such as LPG for cooking. Figure 4.10 illustrates the various types of dwelling units and their distribution of cooking fuel choices. ¹

Table 4.7: Cross-tabulation of Dwelling Unit and the Choice of Cooking Fuel

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	37.0438	4	0.000
Likelihood Ratio	27.6126	4	0.000

Note DF = degree of freedom

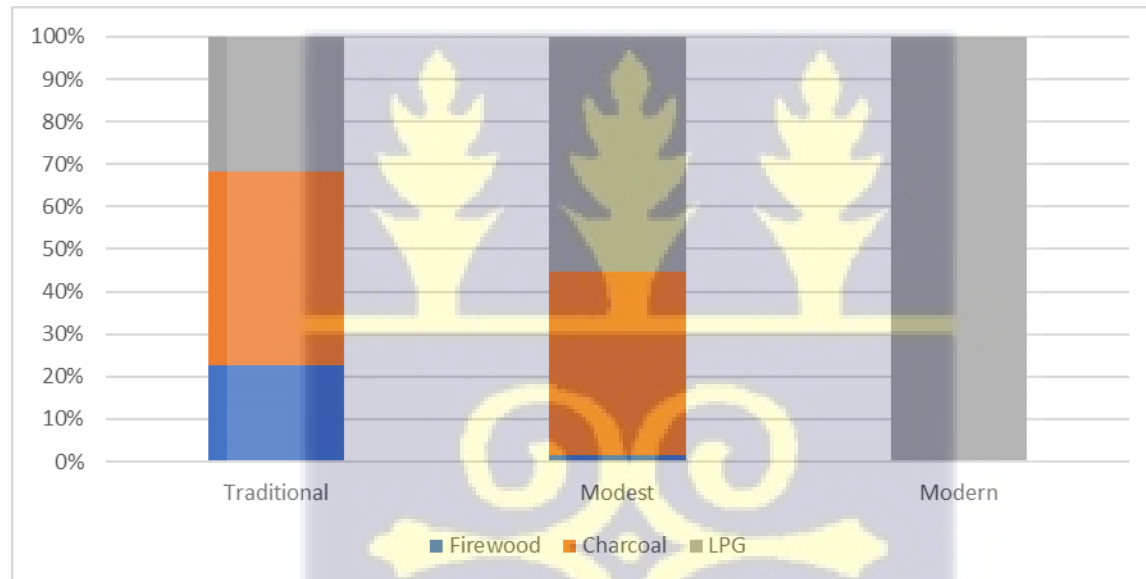


Figure 4.10: The Type of Dwelling unit and the Choice of cooking fuel

Source: Author's field data, September 2020



¹ **Traditional structure:** This type of house is usually built with wood, clay, and brick.

Modest structure: A type of house usually not large or expensive and has simple designs.

Modern structure: A modern house is a house that conforms to the principles of modern architecture and has sophisticated designs.

4.4.3. Indoor air pollution

Out of the 246 households surveyed, 24% of the respondents cited cleanliness and low level of smoke emission as a major cooking fuel characteristic affecting their choice after efficiency. Households who believe that some cooking fuels are not clean and can cause pollution are likely to choose LPG over firewood and charcoal as their preferred type of cooking fuel. This is due to the health implications of indoor air pollution.

4.5 Multinomial Logit Regression to determine fuel stacking

To understand the factors that influence the choice of each household cooking fuel, a multinomial logit regression was utilized. Multinomial logit regression is used when dealing with nominal dependent variables and in this case, it is the choice of household cooking fuel where the log odds of the outcomes are modeled as a linear combination of the independent variables. As a result, the two dependent variables focused on are firewood and LPG, and charcoal and LPG. The multinomial logit regression seeks to maximize the chance of households choosing a type of cooking fuel. Given the nature of the cooking fuels, LPG was used as the baseline category. Hence, the other cooking fuels (Firewood and Charcoal) were analyzed relative to LPG. From the output, the model was statistically fit at a 1% significance level. This was determined using the likelihood ratio chi-square test. It compares the fit of the model with a complete set of predictors against a model with an intercept only. Thus, the null model has no predictors. Since the model has a $\text{Prob} > \chi^2$ to be less than 0.01, then it can be established that at least one population slope is non-zero.

Based on the McFadden pseudo-R-square, it can concur that this model represents a 39.2% improvement in the fit relative to the null model. This statistical measure serves as an index of the proportionate improvement in a given model relative to its null model (Pituch & Stevens, 2016).

Table 4.8 below illustrates the multinomial logit regression on the determinants of cooking fuel choice in the Nsawam-Adoagyiri Municipality.

Table 4.8: Multinomial Logit Regression on the determinants of cooking fuel choice

Cooking Fuel	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Firewood &LPG							
Sex	-.913	2.354	-0.39	.698	-5.527	3.701	
Age	.078	.055	1.42	.156	-.03	.186	
Family size	.182	.395	0.46	.646	-.593	.957	
Education	.706	.993	0.71	.477	-1.241	2.653	
Average Income	-.309	.385	-0.80	.422	-1.065	.446	
Cost of Fuel	12.817	1674.456	0.01	.994	-3269.057	3294.69	
Decision maker	-2.025	1.663	-1.22	.223	-5.285	1.235	
Quality of house	.38	1.213	0.31	.754	-1.997	2.758	
Type of kitchen	-.046	.98	-0.05	.962	-1.966	1.874	
Pollution	1.475	1.689	0.87	.383	-1.836	4.786	
Cleanliness	17.295	974.574	0.02	.986	-1892.834	1927.425	
Carbon emissions	-16.398	3781.65	-0.00	.997	-7428.296	7395.5	
Constant	-34.088	1937.422	-0.02	.986	-3831.365	3763.189	
Charcoal & LPG							
Sex	-.013	.44	-0.03	.977	-.875	.849	
Age	.035	.015	2.30	.021	.005	.065	**
Family size	.205	.098	2.09	.037	.013	.397	**
Education	1.047	.249	4.20	0	.559	1.535	***
Average Income	-.028	.087	-0.32	.746	-.198	.142	
Price	.878	.437	2.01	.045	.022	1.734	**
Decision	.119	.117	1.02	.31	-.111	.348	

maker							
Quality of house	-.226	.448	-0.50	.615	-1.104	.653	
Type of kitchen	.122	.285	0.43	.668	-.436	.681	
Pollution	-.767	.341	-2.25	.024	-1.435	-.099	**
Cleanliness	-.205	.392	-0.52	.601	-.973	.563	
Carbon emissions	1.805	.785	2.30	.021	.267	3.343	**
Constant	-4.379	1.284	-3.41	.001	-6.895	-1.863	***
Mean dependent var		1.525	SD dependent var			0.561	
Pseudo r-squared		0.321	Number of obs			219.000	
Chi-square		112.561	Prob > chi2			0.000	
Akaike crit. (AIC)		290.463	Bayesian crit. (BIC)			378.579	

*** $p < .01$, ** $p < .05$, * $p < .1$

4.5.1. LPG and Firewood

From table 4.8, out of the 12 explanatory variables, none was significant in the determination of the choice of cooking fuel between firewood and LPG. This could be attributed to the low number of households that chose firewood as their source of fuel. The catchment area of the study is considered to be a peri-urban area, hence most of the households would prefer modern cooking fuels like LPG as against traditional fuels like firewood. Research shows that the type of settlement influences the choice of cooking fuel, with urban settlements preferring LPG whereas rural settlements tend to favor firewood and charcoal (Kwakwa, Wiafe, & Alhassan, 2013; Suliman, 2013; Francis, Geoffrey & Gemma, 2014). The result further indicates that households, irrespective of their socio-economic and socio-cultural status, use LPG or Firewood based on their discretion.

4.5.2 LPG and Charcoal

From the table 4.4, out of the 12 independent variables were significant in the determination of the choice of charcoal as a cooking fuel (relative to LPG). The age of the respondent was statistically

significant at 5%. For a one-year increase in age, the log-odds of the respondent choosing charcoal relative to LPG as a cooking fuel increase by 0.035. This suggests that older respondents are more likely to select charcoal as their household cooking fuel against LPG. This is in agreement with the assertion made by (Truneh, 2014). The author explains that aged household heads are more conversant with familiar fuels like firewood, and cow dung and are keener to preserve norms and traditions. Further, this result raises questions as to whether older people are not targeted sufficiently when it comes to education on safe cooking fuel sources, hence their preference for the conventional practices they have been exposed to.

The family size of the household was also statistically significant at a 5% level in the determination of the choice of cooking fuel. For every one-unit increase in the family size, the log-odds of a household selecting charcoal as against LPG increases by 0.205. Thus, the higher the family size, the greater the chance of a household choosing charcoal as a cooking fuel relative to LPG. This can be attributed to the cheap nature of charcoal against LPG and the household income implications of larger household sizes. The importance of household income is explained in earlier sections. The larger the family size, the lower the household income per head, and the more cooking fuel will be required. Hence, large families will resort to cheaper cooking fuel to save costs.

The multinomial logit regression also revealed that educational level in a household plays a crucial role in the determination of the type of cooking fuel to be used by that household. From the output in Table 10, households with basic education being their highest form of education (relative to tertiary education) were more likely to choose charcoal as their cooking fuel relative to LPG. Thus, the log-odds of those households choosing charcoal as against LPG increases by 1.047. This posits that households with lower educational levels are more likely to go in for charcoal as their preferred

cooking fuel. This is confirmed in studies by Pandey & Chaubal (2011) and Adeyemi & Adereleye (2016). From this result, there are questions as to whether people with low educational backgrounds may be excluded targets when it comes to public education on the choice of safe cooking fuel source.

The price of cooking fuel was also found to be statistically significant in determining the choice of cooking fuel by households. It has a statistically significant level of 1% which means that for every one-unit increase in the price of cooking fuel, the log-odds of selecting charcoal relative to LPG decreases by 0.878. Tettey (2014) and Nlom & Karimov (2015) demonstrated that lower prices of fuel resulted in households choosing more efficient and cleaner fuel. This study result shows that a reduction in the price of cooking fuel increases a household's willingness to pay for relatively safe cooking fuel. Thus making cleaner fuel cheaper may result in households preferring to spend on cleaner fuel and hence keeping the environment clean.

Finally, some environmental factors such as pollution and the emission of carbon into the atmosphere were significant in the determination of the choice of cooking fuel. Thus, the log-odds of a respondent selecting charcoal (relative to LPG) decrease by 0.767 for respondents who believe that cooking fuels cause pollution as against those who do not. Thus, respondents who believe that cooking fuels can cause indoor air pollution would prefer to cook with LPG in their homes. This is statistically significant at 5%. Selvakkumaran & Ahlgren (2019) showed that households in urban settlements tend to prefer LPG due to the advantage it provides of lower emission and less pollution. Interestingly, an inverse relationship exists for respondents who believe that cooking fuels increase carbon emissions. These respondents are likely to choose charcoal as their preferred cooking fuel against LPG. This result affirms that diverse factors are interrelated when it comes to

cooking fuel choice. Awareness and education must interrelate with other factors such as availability and good economic well-being to influence the choice of clean cooking fuel.

4.6 Conclusion

The majority of households in the Nsawam-Adoagyiri municipality preferred LPG to charcoal and firewood for cooking. There were four main socioeconomic factors considered in the study of choice of fuel – household income, gender of household head, age of household head, and educational level of the household head. Households with higher income preferred LPG to firewood and charcoal. Older and female household heads were likely to choose firewood and charcoal whereas younger and male household heads preferred LPG. Household heads with no or lower educational levels preferred charcoal and firewood but those with higher education opted for LPG.

Two environmental factors were investigated on the choice of cooking fuel – availability of fuel and quality of household housing structure. Many respondents indicated that LPG was the most available cooking fuel compared to charcoal and firewood. Additionally, households in modest and modern housing structures opted for LPG whilst those in traditional homes preferred charcoal and firewood.

The findings from the multinomial logit model revealed that all independent factors studied on the choice of firewood relative to LPG were all statistically insignificant. This was largely due to the low usage of firewood within the study area. For charcoal relative to LPG, 6 of the independent factors were statistically significant. These factors were: Age, Family size, Education, Price of fuel, Pollution, and Carbon emissions. It was discovered among households in the area that the level of income, education, price of fuel, quality of housing, among others influence households' decision to use either LPG, charcoal, or firewood.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATION

5.1. Introduction

This is the final chapter of the work and it gives a summary of the findings of the research, draws conclusions, and makes recommendations. The conclusion and recommendations were given to address the aim of the research, which was to identify factors influencing household cooking fuel among households in the Nsawam-Adoagyiri Municipality.

5.1 Summary of Findings

The study sought to identify factors influencing the choice of household cooking fuel in the Nsawam-Adoagyiri Municipality. The succeeding paragraphs provide a summary of the findings. Majority of households in the Nsawam-Adoagyiri municipality preferred LPG to charcoal and firewood for cooking. The four main socioeconomic factors considered in the study of household cooking fuel choice were household income, gender of household head, age of household head, and educational level of the household head. Households with higher income preferred LPG to firewood and charcoal. Older and female household heads were more likely to choose firewood and charcoal whereas younger and male household heads preferred LPG. Household heads with no or lower educational levels preferred charcoal and firewood but those with higher education opted for LPG.

Two environmental factors were investigated on the choice of cooking fuel – availability of fuel and quality of household housing structure. Majority of the respondents indicated that LPG was the most available cooking fuel compared to charcoal and firewood. Additionally, households in

modest and modern housing structures opted for LPG whilst those in traditional homes preferred charcoal and firewood.

The findings from the multinomial logit model revealed that all independent factors studied on the choice of firewood relative to LPG were all statistically insignificant. This was largely due to the low usage of firewood within the study area. Concerning charcoal relative to LPG, 6 of the independent factors were statistically significant. These factors were: Age, Family size, Education, Price of fuel, Pollution, and Carbon emissions. It was discovered among households in the area that the level of income, education, price of fuel, quality of housing, among others influence households' decision to use either LPG, charcoal, or firewood.

- **Household cooking decisions**

The study found that the majority of household cooking decisions are made by women, hence they have a greater influence on the choice of cooking fuel. This is because they mostly prepare meals with the various fuels and know the effects or consequences of using either LPG, charcoal, or firewood.

- **LPG is the most preferred cooking fuel**

The first objective of the study was to identify the kinds of cooking fuel choices available to households and their preference in the Nsawam-Adoagyiri Municipality. The study revealed that LPG was the most used and preferred cooking fuel among households in the municipality, followed by charcoal and, then firewood. This may be due to the peri-urban nature of the area under study.

- **The income of a household influences the choice of cooking fuel**

The study discovered a significant relationship between the average income of a household and the choice of cooking fuel. Thus, if the average income of a household is relatively higher, there is a likelihood of choosing LPG over charcoal or firewood. In the case of Nsawam-Adoagyiri Municipality, most of the households as revealed by the study, earn above GHC 500.00 monthly, hence most of them preferred LPG to charcoal and firewood.

- **The gender of a household head affects the choice of cooking fuel**

The gender of a household head also affects the choice of cooking fuel. The study revealed that male household heads prefer LPG while female-headed households prefer charcoal or firewood.

- **The age of a household head influences the choice of cooking fuel**

The study also found that the age of a household head is important in the choice of cooking fuel. Aged household heads prefer charcoal and firewood which they see as less harmful to LPG. However, younger household heads prefer LPG because it cooks faster and is convenient.

- **The level of education in a household influences the choice of cooking fuel**

The level of education in a household was also found to influence the choice of cooking fuel to use. While households with a low level of education were found to be more familiar with the use of charcoal, homes with higher educational backgrounds preferred LPG.

- **The type of dwelling unit influences the choice of cooking fuel**

The study established that households who live in a modern setting preferred LPG to charcoal and firewood while those who live in traditional settings prefer charcoal and firewood.

- **The price of cooking fuel does not influence the choice of cooking fuel**

It was also discovered that an increment in the price of cooking fuel does not necessarily influence households' choice of cooking fuel.

- **The availability of cooking fuel does not influence the choice of cooking fuel**

The study found that a majority of households disagreed that the availability of cooking fuels affects their choice of cooking fuel.

- **Taste and Preferences do not influence the choice of cooking fuel**

Taste and preference were touted to influence the choice of cooking fuel. However, this study found no proof of such an assertion. It rather revealed that taste and preference do not influence the choice of cooking fuel used by households.

5.2 Conclusion

Even though the Ghana Statistical Service identifies the major source of cooking fuel in Ghana as charcoal (34.1 percent), most urban households in the Nsawam-Adoagyiri Municipality use LPG which forms part of the nationwide usage of about 25 percent. This means that the use of LPG as cooking fuel is popular than charcoal and firewood in the area. The high preference for LPG to other solid fuels like charcoal and firewood is partly due to the availability of LPG, higher educational level of household heads, majority of the respondents being female and of a young age, and most households living in modest and modern housing structures.

The results from the study identified some statistically significant socioeconomic factors – education and age of household head, price of cooking fuel, family size. In terms of environmental factors, pollution and carbon emissions were statistically significant factors that influenced the

choice of cooking fuels among households in the Nsawam-Adoagyiri Municipality. The study revealed that a household with a relatively higher income, male household head, young household head, a household head with a high education level is more likely to choose LPG which produces little or no smoke as compared to charcoal or firewood.

5.3 Recommendations

Based on the findings of the study, the following recommendations are made:

1. Introduction of subsidies to increase the use of LPG

This study discovered that income and price influence the choice of cooking fuel. Given this, the municipality may consider subsidizing the price of LPG. This will make LPG affordable and many households would prefer it to other solid fuels. This will also help reach SDG Goal 7, which seeks to achieve universal access to affordable and reliable energy by 2030.

2. Free distribution of LPG cylinders and burners

The municipality can as well distribute free cylinders and burners to households that need them.

There have been similar initiatives since the 1990s but the government can make the distribution more frequent to households who need but cannot afford them. This is to promote the use of LPG which is relatively environmentally friendly than the other options available.

3. Education of Household on Benefits of Using LPG for Cooking

Public campaigns for clean cooking fuels must target the aged and the least educated. From the results, most household heads who are aged and also, those with lower educational backgrounds still resort to the traditional source of cooking fuel. Therefore, in creating public awareness of the

effects of various cooking fuels on health and the environment, stakeholders and policymakers must target these two groups of people who form a significant part of peri-urban communities.

4. Housing Planning by Municipalities Should Consider Impact of Housing on Choice of Cooking Fuel

The results indicate that the type of dwelling unit affects the choice of cooking fuel. Thus, traditional housing dwellers will opt for a traditional source of cooking fuel such as firewood while modern housing dwellers will likely use a clean cooking fuel. This makes the case for policymakers that building types in our communities should be planned hand-in-hand with policies on the usage of cooking fuel.



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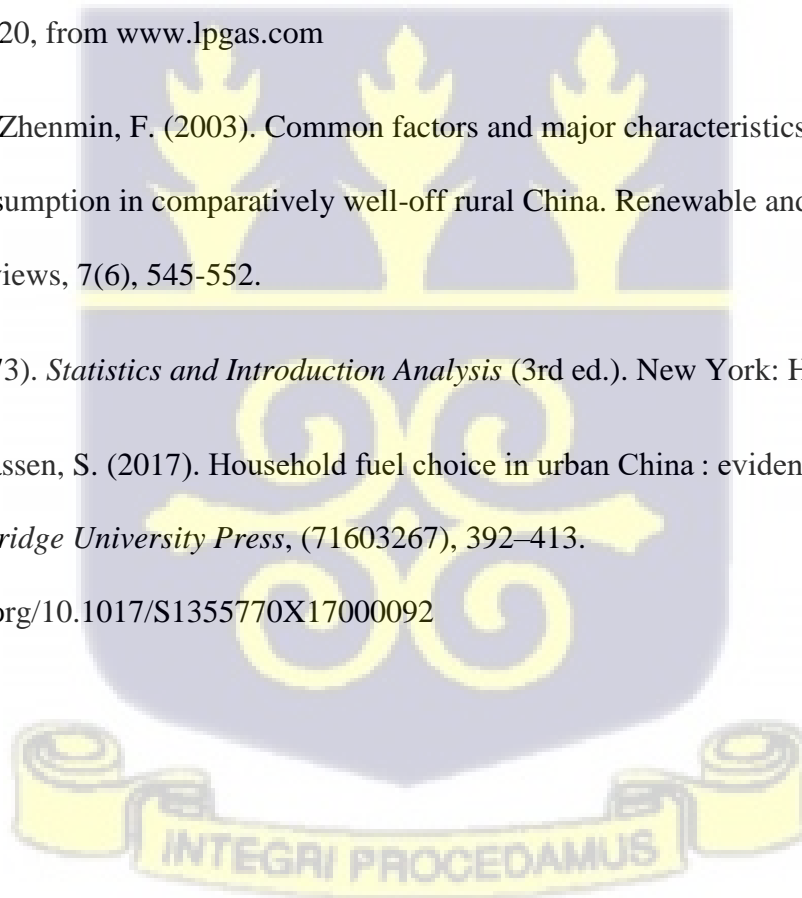
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Interviewer's full name: _____ Date of interview: _____

Name of city/town: _____ Time: _____ Questionnaire Number: _____

Introduction:

Dear respondent,

You are invited to participate in a survey as part of a research study that seeks to determine the factors influencing household cooking fuel choice in the Nsawam-Adoagyiri Municipality. This study forms part of the requirements for the completion of my Master's degree in Development Studies at the Institute of Statistical, Social, and Economic Research (ISSER), University of Ghana.

Please be assured that this research is for academic purposes only and that any information given will remain anonymous and treated with the utmost confidentiality. This survey is expected to last between 15-20 minutes and your participation would be appreciated.

Part I: Household Characteristics

1. Sex of the respondent: (0) Male (1) Female
2. Age of respondent _____ (in years)
3. Relationship of respondent to household head: (0) Household Head (1) Spouse (2) Son (3) Daughter (4) other (specify)
4. Marital Status of household head: (0) Married (1) Single (2) Divorced (3) Widowed (4) Cohabiting (5) Other (specify).....
5. Family size of the household _____
6. What is the household head's highest level of education? 0. Tertiary 1. Secondary level 2. Basic/ Primary 3. No formal education
7. How many people work (earn income) in the household? _____
8. Occupation of household head: 0. Employee 1. Self-employed/Petty trader 2. Unemployed 3. Other (specify) _____
9. What has been the household's average monthly income over the past 12 months? (0) Less than GHS 500 (1) GHS 500 - GHS 1000 (2) GHS 1001 to GHS 2000 (3) GHS 2001 to GHS 3000 (4) GHS 3001 to 4000 (5) GHS 4001 - GHS 5000 (6) more than GHS 5000
10. Does your household use electricity? (0) YES (1) NO
11. which of the following appliances does your household own? [Tick \surd more than one if applicable]

(0) Television (1) Radio (2) Fridge (3) Sofa (4) Car (5) Mobile phone (7) None

12. Who in your household makes decisions on...? (Please put the given code in the space provided): 0= Wife 1= Husband 2= Joint 3 = Daughter/Son 4 = other)

i. Buying food items: _____ ii. Buying the type of fuels to be used for cooking: _____

iii. Buying appliances (TV, fridge): _____ iv. Type of stove for cooking _____

v. Education and health expenses: _____

13. Does your household live in... (0) Rented house (1) own house (2) if other, specify _____

14. [Observe] quality of housing: (0) Traditional (1) Modest (2) Modern

15. Where is your kitchen/cooking place located? 0. inside the house 1. Outside the house

16. What is your kitchen type? (0) Private (1) Shared (2) I do not have a kitchen

OTHER

Part II: Cooking Practices

17. Who cooks for your household? 0.Wife 1.Husband 2.Daughter 3. Son 4. Other (specify) _____

18. On average, how many meals does your household prepare in a day? (0) 1 (1) 2 (2) 3 (3) 4 (4) Other (specify) _____

19. How many hours does the main cook in your household spend cooking per day?

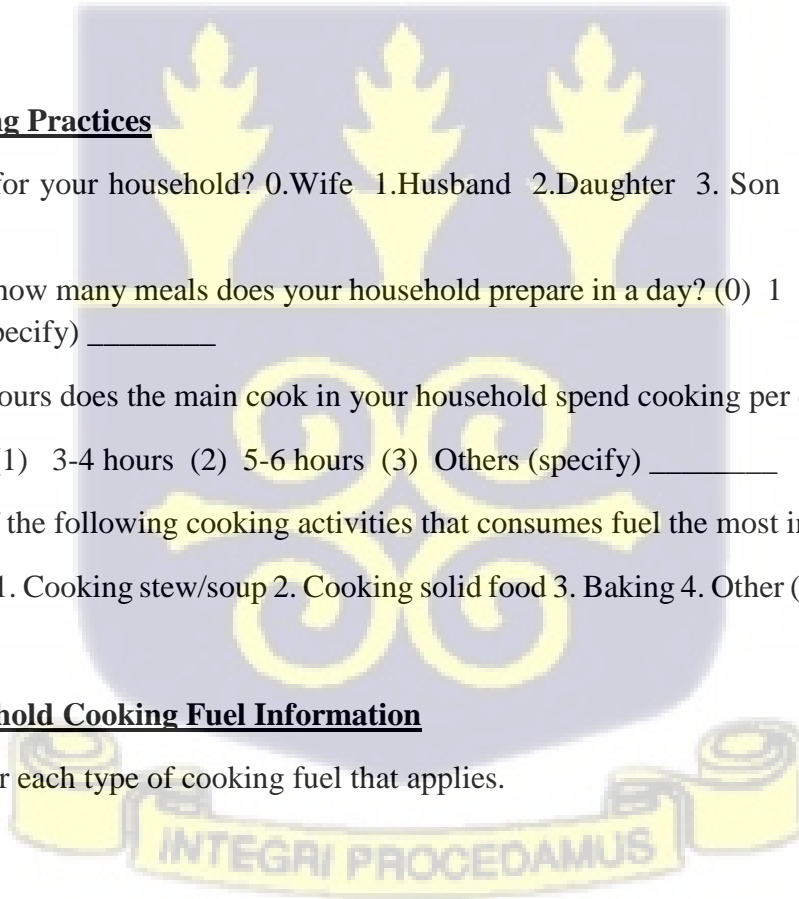
(0) 1-2 hours (1) 3-4 hours (2) 5-6 hours (3) Others (specify) _____

20. Select any of the following cooking activities that consumes fuel the most in your household

0. Boiling water 1. Cooking stew/soup 2. Cooking solid food 3. Baking 4. Other (specify) _____

Part III: Household Cooking Fuel Information

Please answer for each type of cooking fuel that applies.



Type of Cooking fuel	21. What type of cooking fuel does your household use for cooking? (Please rank in order of frequency: 1=most frequent...6= less frequent)	22. How much money does your household spend on cooking fuel monthly? Please state amount in GHS
Firewood		
Charcoal		
Kerosene		
LPG		
Biogas		
Electricity		
Other (specify)		

Please fill the following spaces provided in the table.

Type of cooking Fuel	23. What type of fuel does your household use for cooking the following: (Please select more than one if applicable)					
	Boiling water	Cooking soup/stew	Cooking rice/ampesi	Cooking Banku	Baking	Other (specify)
Firewood						
Charcoal						
Kerosene						
LPG						

Biogas						
Electricity						
Other(specify)						

Part IV: Household Cooking Energy Supply

24. What is the source of your cooking fuel?

(0) Self collected (1) purchased (2) Gift from relatives (3) Other _____

25. In your opinion, which of the following fuels are easily available in the Nsawam-Adoagyri Municipality? (Rank, with 1 being the most available and 5, the least available.

0. Firewood _____

1. LPG _____

2. Charcoal _____

3. Kerosene _____

4. Electricity _____

5. I do not know _____

26. Has the availability of any of the cooking fuels affected your cooking practice?

0. Yes 1. NO

(Skip if you don't know)

27. If unavailability of any of the cooking fuels has negatively affected your household, please indicate what strategies you have adopted to cope with the situation. (Tick \checkmark more than one if applicable)

(0) Obtain supplies in large quantities /_____/ (1) Collect wood freely instead of buying /_____/

(2) Reduce the number of meals prepared in a day /_____/

(3) Use fuels more frugally/economically /_____/ (4) Invest in energy-efficient cooking devices /_____/

(5) Shift to inexpensive but less desirable fuels /_____/ (6) Other (Specify) _____

Part V: Reasons for a Household's Choice of Fuel

28. Please indicate why you use the following types of cooking fuels (Tick more than one if applicable)

Possible Reasons	Firewood			Charcoal			LPG		
	Major	Minor	Not a reason	Major	Minor	Not a reason	Major	Minor	Not a reason
It is cheap									
It is readily available									
It is convenient to use									
Foods cooked with it taste better									
It is safer to use									
It cooks faster									

29. Please indicate if the following **Cooking Fuel Characteristics** influence your household's choice of cooking fuel (Please indicate **1** for YES and **2** for No).

- | | |
|------------------------|-------------------------------|
| 0. Safety _____ | 1. Availability _____ |
| 2. Price _____ | 3. Taste and preference _____ |
| 4. Cleanliness _____ | 5. efficiency _____ |
| 6. Easy to store _____ | |

END OF SURVEY

APPENDIX 2: Cross Tabulation outputs

Table 2: Cross tabulation of average household income over the past 12 months and choice of cooking fuel

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.1841	12	0.000
Likelihood Ratio	44.6847	12	0.000

(chi-square = 42.1841, df = 12, p<0.05)

Table 3: Chi-Square Test result for Gender Role in Household Decision-making and Cooking fuel Choice

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.52	2	0.023
Likelihood Ratio	7.83	2	0.020
(chi-square = 7.52, df = 2, p<0.05)			

Table 4: Chi-Square Test result for age of household head and cooking fuel choice

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	142.5741	100	0.003
Likelihood Ratio	129.3690	100	0.026
(chi-square = 142.5741, df = 100, p<0.05)			

Table 5: Cross tabulation of level of education of household head and the choice of cooking fuel

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	49.5238	6	0.000
Likelihood Ratio	56.0794	6	0.000
(chi-square = 49.5238, df = 6, p<0.05)			

Table 6: Cross tabulation of dwelling unit and the choice of cooking fuel

	Value	Df	Asymp. Sig. (2-sided)
--	-------	----	-----------------------

Pearson Chi-Square	37.0438	4	0.000
Likelihood Ratio	27.6126	4	0.000

(chi-square = 37.0438, df = 4, p<0.05)

APPENDIX 3

Table 7: Multinomial Logistic Regression Output

Cooking Fuel	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]	Sig
Firewood & LPG						
Sex	-.913	2.354	-0.39	.698	-5.527 3.701	
Age	.078	.055	1.42	.156	-.03 .186	
Family size	.182	.395	0.46	.646	-.593 .957	
Education	.706	.993	0.71	.477	-1.241 2.653	
Average Income	-.309	.385	-0.80	.422	-1.065 .446	
Cost of Fuel	12.817	1674.456	0.01	.994	-3269.057 3294.69	

Decision maker	-2.025	1.663	-1.22	.223	-5.285	1.235
Quality of house	.38	1.213	0.31	.754	-1.997	2.758
Type of kitchen	-.046	.98	-0.05	.962	-1.966	1.874
Pollution	1.475	1.689	0.87	.383	-1.836	4.786
Cleanliness	17.295	974.574	0.02	.986	-1892.834	1927.425
Carbon emissions	-16.398	3781.65	-0.00	.997	-7428.296	7395.5
Constant	-34.088	1937.422	-0.02	.986	-3831.365	3763.189

Charcoal & LPG

Sex	-.013	.44	-0.03	.977	-.875	.849	
Age	.035	.015	2.30	.021	.005	.065	**
Family size	.205	.098	2.09	.037	.013	.397	**
Education	1.047	.249	4.20	0	.559	1.535	***
Average Income	-.028	.087	-0.32	.746	-.198	.142	
Price	.878	.437	2.01	.045	.022	1.734	**
Decision maker	.119	.117	1.02	.31	-.111	.348	
Quality of house	-.226	.448	-0.50	.615	-1.104	.653	
Type of kitchen	.122	.285	0.43	.668	-.436	.681	
Pollution	-.767	.341	-2.25	.024	-1.435	-.099	**
Cleanliness	-.205	.392	-0.52	.601	-.973	.563	
Carbon emissions	1.805	.785	2.30	.021	.267	3.343	**
Constant	-4.379	1.284	-3.41	.001	-6.895	-1.863	***

Mean dependent var	1.525	SD dependent var	0.561
Pseudo r-squared	0.321	Number of obs	219.000
Chi-square	112.561	Prob > chi2	0.000
Akaike crit. (AIC)	290.463	Bayesian crit. (BIC)	378.579

*** $p < .01$, ** $p < .05$, * $p < .1$

