

**HOUSEHOLD FUEL CHOICES AND THE RISK OF COOKING-RELATED BURNS  
AMONG TWO RIPARIAN COMMUNITIES ALONG THE LOWER RIVER VOLTA OF  
GHANA**

**BY**



**SCHOOL OF PUBLIC HEALTH**  
**COLLEGE OF HEALTH SCIENCES**  
**UNIVERSITY OF GHANA**



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AMONG TWO RIPARIAN COMMUNITIES ALONG THE LOWER RIVER VOLTA OF  
GHANA**

**BY**

**COURAGE GIDIGLO  
(10521381)**

**THIS DISSERTATION IS SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH,  
UNIVERSITY OF GHANA IN PARTIAL FULFILLMENT FOR THE AWARD OF THE  
MASTER OF PUBLIC HEALTH (MPH) DEGREE.**

**MAY 2022**

**DECLARATION**

I, Courage Gidiglo, do declare that this dissertation is the result of my original work and that all literature used have been duly acknowledged. This study, either in whole or in part has been submitted to any other university for the conferral of another degree.

Courage Gidiglo



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23 /06 /2022

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(Date)



This study is dedicated to the loving memory of Mr. Stanley Korshie Gidiglo.



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## ABSTRACT

### Background

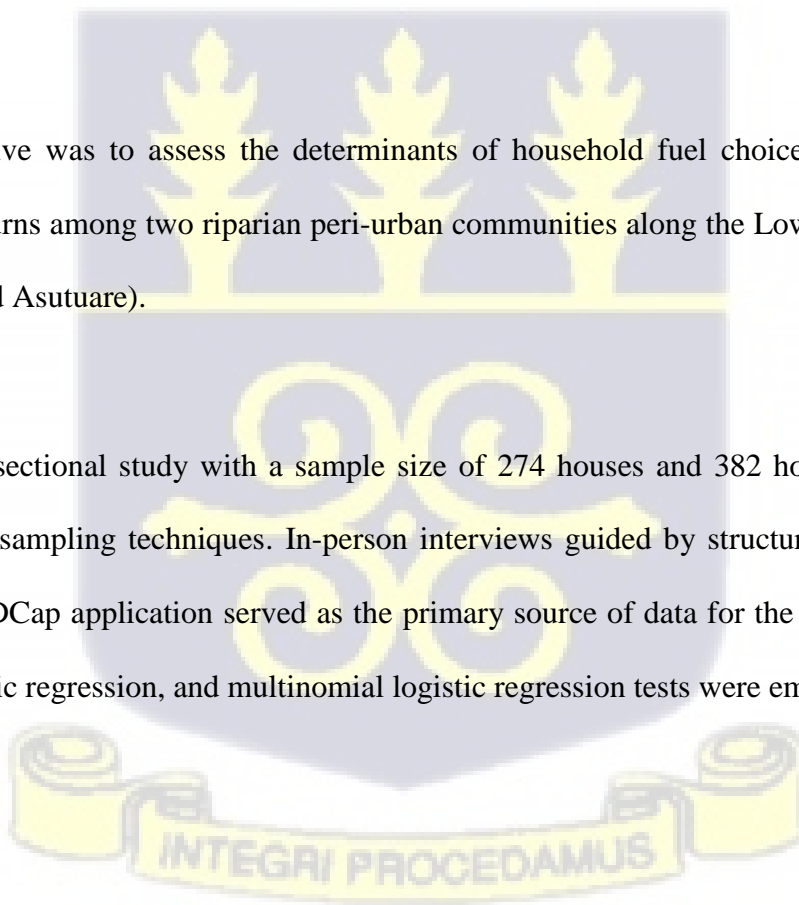
Each day, about three (3) billion people globally prepare their food using biomass fuels. The majority of households in sub-Saharan Africa depend largely on solid biomass fuels such as firewood, and charcoal as their primary source of energy for cooking and heating. In Ghana, more than 90% of the rural population depend on biomass fuel whilst about 70% of the urban and peri-urban population rely on traditional wood fuels (Quansah et al., 2017). Approximately, 30,000 people suffer burns and cooking-related injuries worldwide each day (Albertyn et al., 2012; Mehta et al., 2020). This equates to a staggering estimate of about 11 million fresh burns annually (WHO, 2017). Cooking-related burns are directly associated with the use of biomass and fossil fuels in households, and the burden of cooking-related burns is predominant among residents of low-and middle-income countries (LMICs) with women and children extremely vulnerable.

### Objective

This study objective was to assess the determinants of household fuel choices and the risk of cooking-related burns among two riparian peri-urban communities along the Lower River Volta of Ghana (Kpong and Asutwae).

### Methods

This was a cross-sectional study with a sample size of 274 houses and 382 households selected through clustered sampling techniques. In-person interviews guided by structured questionnaires hosted on the REDCap application served as the primary source of data for the study. Chi-square tests, binary logistic regression, and multinomial logistic regression tests were employed to analyse the data.



## Results

From the findings, 93.19% of the participants were females while 6.81% were males. The study findings disclosed that majority of the riparian households depended largely on charcoal (64.99%), 15.12% used wood fuel while 19.89% consumed LPG as their primary cooking fuel. 31.50% of the primary cooks interviewed reported ever suffering cooking-related burns in the past year. Charcoal (P-value = 0.004), wood fuel (P-value = 0.038) were household fuels that showed statistical significant association with cooking-related burns. Educational levels, income levels, household ownership status, marital status of household heads, sex of household heads, household dwelling type, and occupational status of household heads were the factors that significantly determined household fuel choices. In contrast, it was observed that households did not completely switch from biomass fuel consumption to cleaner fuels as hypothesized by the energy ladder theory, instead they combined multiple fuels for domestic purposes.

## Conclusion

It is recommended that the Government of Ghana through the National Petroleum Authority (NPA), the Energy Ministry, the Ministry of Environment, Science, Technology & Innovation, and the Ministry of Health collaborate, and leverage on the National LPG Promotion Programme, and the Rural LPG Promotion policy to motivate households to switch from the use of traditional fuels to LPG by increasing LPG access to rural consumers through private investor subsidies and tax rebates to construct more LPG stations at safer, easily accessible locations, and organize advocacy education campaigns on best LPG safety practices, and innovations to prevent or minimize potential LPG-related hazards.

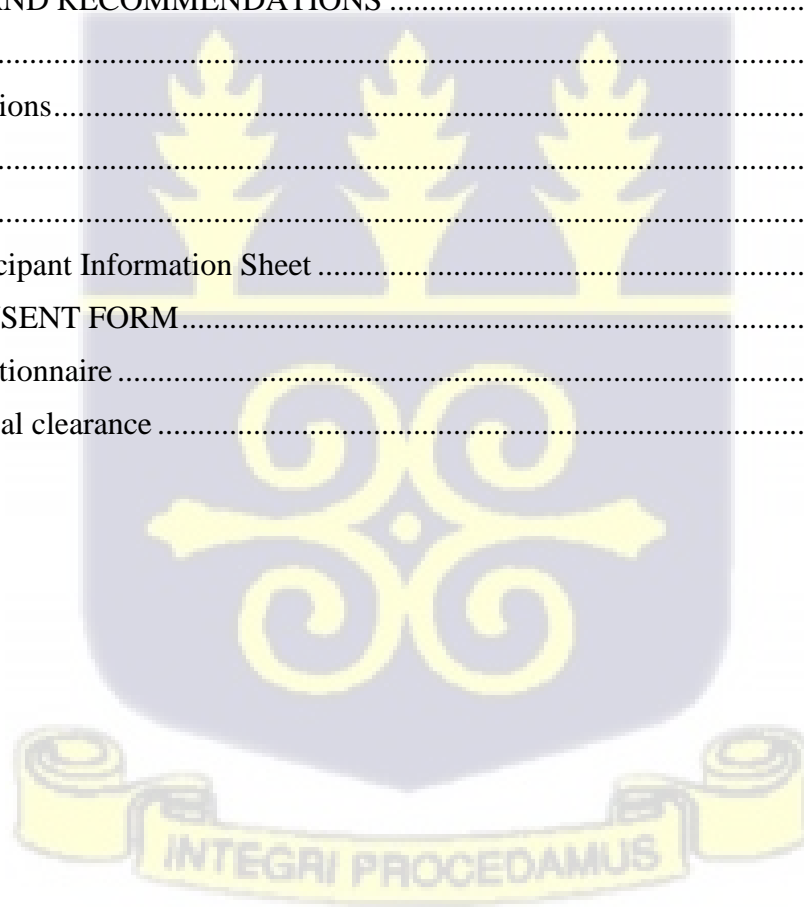


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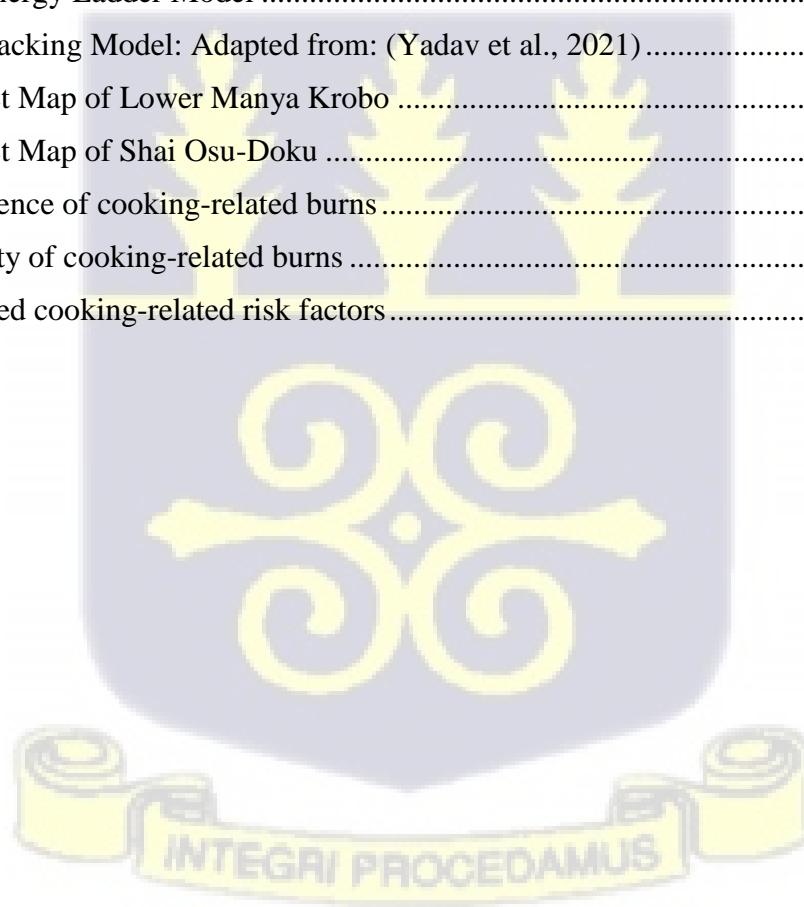
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## LIST OF ABBREVIATIONS

**ALRI:** Acute Lower Respiratory Infections

**ARI:** Acute Respiratory Infection

**CI:** Confidence Interval

**CO:** Carbon Monoxide

**COPD:** Chronic Obstructive Pulmonary Diseases

**Covid-19:** Corona Virus 19

**GBD:** Global Burden of Disease

**GHS:** Ghana Health Service

**GSS:** Ghana Statistical Service

**HAP:** Household Air Pollution

**IEA:** International Energy Agency

**IER:** Integrated Exposure Response

**LMICs:** Low- and Middle-Income Countries

**LPG:** Liquefied Petroleum Gas

**OR:** Odds Ratio

**PI:** Principal Investigator

**PM<sub>2.5</sub>:** Particulate Matter

**NO:** Nitrogen Oxide

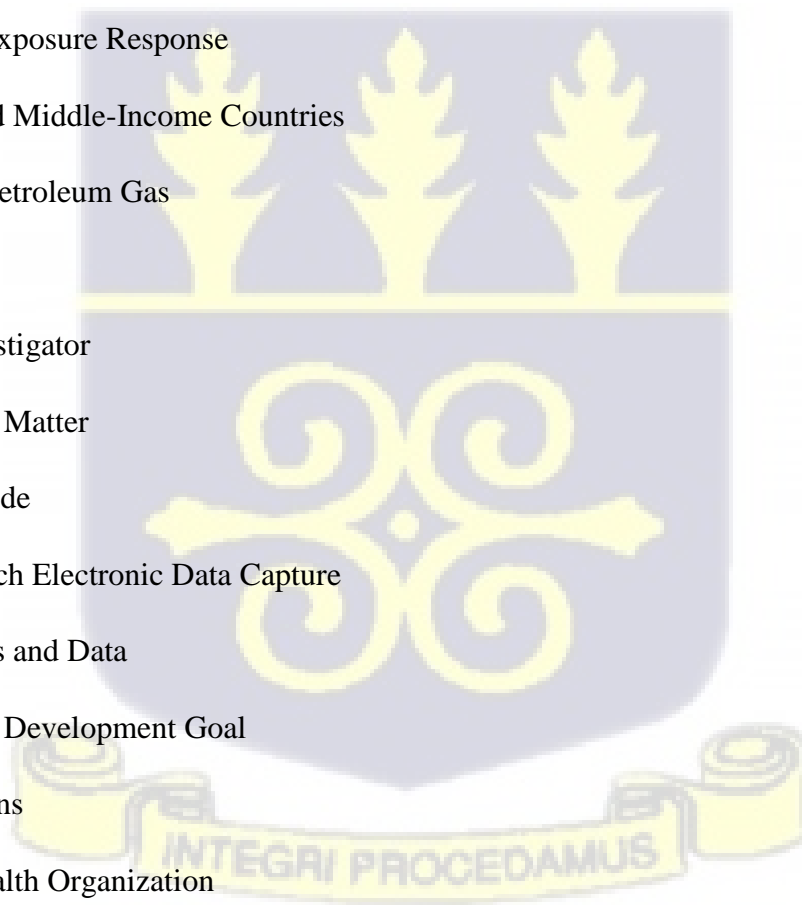
**REDCap:** Research Electronic Data Capture

**STATA:** Statistics and Data

**SDG:** Sustainable Development Goal

**UN:** United Nations

**WHO:** World Health Organization



## CHAPTER ONE

### INTRODUCTION

#### 1.1 Background of the study

Man's discovery of fire has had an incredible impact on present-day development. It revolutionised cultures and introduced new fuel sources for cooking, lighting, and other human activities. Each day, about three (3) billion people globally prepare their food using traditional fuels (Jagger & Das, 2018). The majority of households in sub-Saharan Africa depend largely on solid biomass fuels such as firewood, and charcoal as their primary source of energy for cooking and heating because they are relatively cheaper and readily available in comparison to most alternative fuels and are easily accessible (Rehfuss et al, 2006, Smith et al, 2004, Boahene, 2008). The use of traditional fuels give rise to certain respiratory health issues, cancers of the lung, and environmental problems such as deforestation, global warming, and reduction in the air quality index. These fuels emit large amounts of criteria pollutants including particulate matter, black carbon, and carbon monoxide due to incomplete combustion, resulting in household air pollution (Pope and Dokcery, 2006; Burwen & Levine; 2012, Adane et al., 2021). Exposure to these pollutants poses adverse health consequences to vulnerable groups in the population including women as it is their responsibility for household cooking, and infants (Schlag & Zuzarte, 2008). Every year, about 4.3 million people die prematurely from illnesses associated with biomass fuel consumption, and it is the 6<sup>th</sup> foremost cause of mortality among females between the ages of 15 – 29 (Wong et al., 2014). Far more people who evade burn-deaths are either saddled with lifelong scars and disability or are plunged into abject poverty and isolation (Dans et al., 2017). The domestication of fires came along with destructions, pollution, pain, and burns. Burns are a major public health worry in the developing world. Millions of residents in Africa and Southeast Asia suffer from the risk of burns (Mehta et al., 2020). Infants are the most vulnerable group at risk of burns. It is estimated that approximately 17 million children in Africa are at risk of burns annually. Of this figure, an estimated 18,000 to 30,000 infants die from their burns

((Bartlett, 2002; Van N. A, 2007). Burns are directly associated with the use of biomass and fossil fuels in households. Regardless of the sparse data on cooking-related-burns in the developing world, they are still recognised and considered major public health hazards and threats. (Ahuja & Bhattacharya, 2004; Toon et al., 2011) posited that burn injuries accounted for the lengthiest clinical admissions for injuries. Approximately, 30,000 people suffer burns and cooking-related injuries worldwide on daily basis (Albertyn et al., 2012; Mehta et al., 2020). This equates to a staggering estimate of about 11 million fresh burns annually (WHO, 2017). The burden of burns is predominant among residents of low-and middle-income countries (LMICs). Over 90% of these burns occurring in homes.



## 1.2 Problem Statement

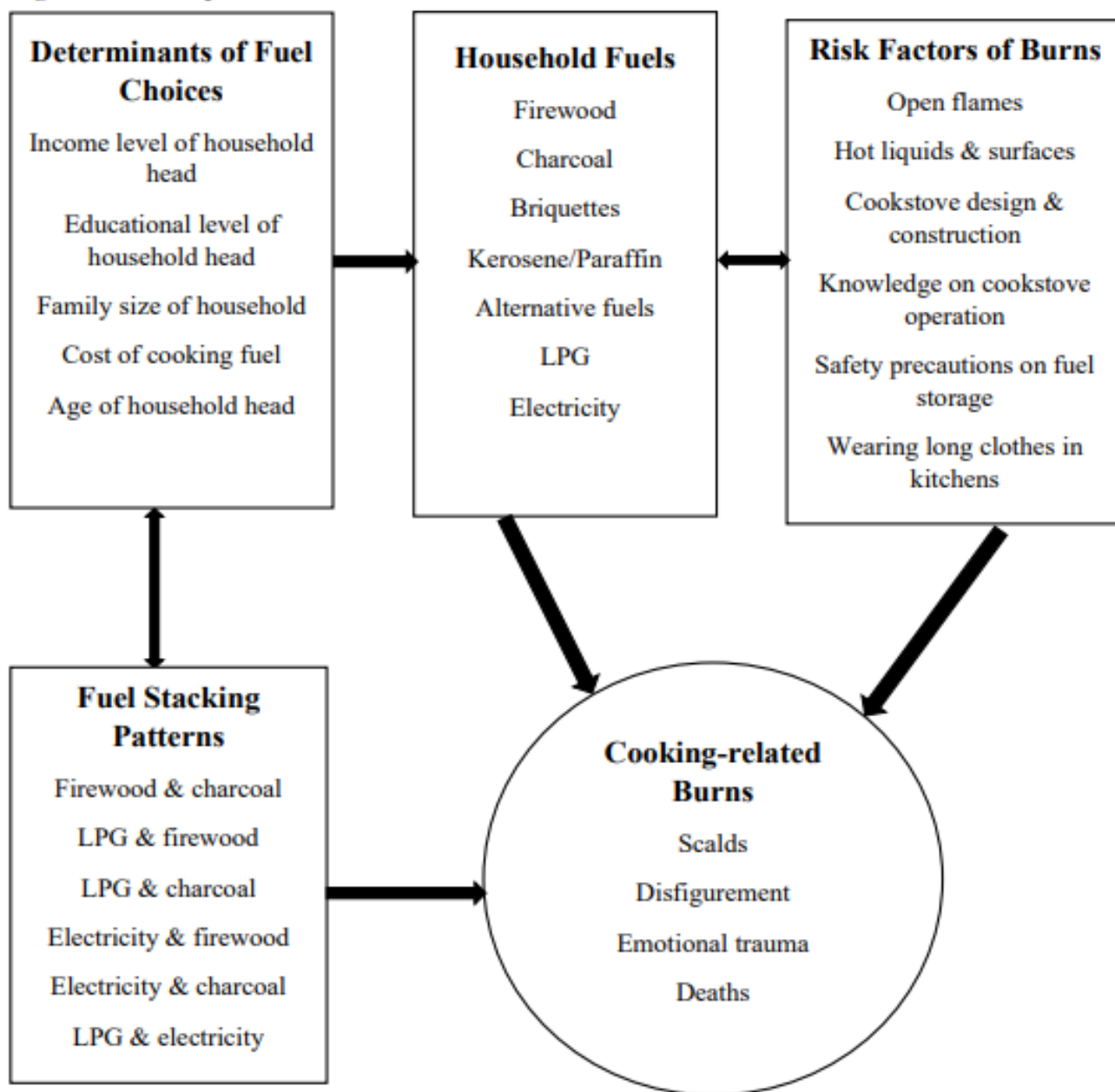
The domestication of fires came along with destructions, pollution, trauma, and burns. Over 81% of Sub-Saharan African households cook with solid biomass fuels (fuelwood, charcoal, crop residues) (Jagger & Das, 2018). Biomass fuels emit large amounts of criteria pollutants including particulate matter, black carbon, and carbon monoxide due to incomplete combustion leading to household air pollution (Pope & Dockery, 2006; Burwen & Levine, 2012). Every year, household air pollution causes 16,600 deaths and the loss of 502,000 disability adjusted life-years (GSS, 2014; Ahunu, 2015; Asante et al., 2018). In Ghana, more than 90% of the rural population depend on biomass fuels whilst about 70% of the urban and peri-urban population rely on traditional wood fuels (Quansah et al., 2017). According to WHO, 2017, air pollution from the use of biomass fuels for household cooking is a top priority global risk factor for respiratory, cardio-vascular, ocular diseases and burns, and about 4.3 million people die prematurely from illnesses associated with biomass fuel usage annually.

In a bid to curb this situation, successive governments in developing countries have adopted policies and programmes to promote the consumption of modern clean fuels by households (Karimu et al., 2016). The Ghanaian government launched the Rural LPG Promotion Program in 2013 as part of its efforts to reduce biomass fuel consumption and increase LPG access to 50% by 2020 (Bruce et al., 2018; Bediako & Amorin, 2018). LPG is commonly stored under pressure, as such, it has a proclivity to leak from any improperly sealed connection. LPG is risk-free when used properly. However, due to some of its properties, LPG usage has been linked to a number of incidents, including fires, explosions, and the loss of lives and property due to improper handling. Between 2007 and 2017, approximately 96 people were killed and 486 were injured in only nineteen (19) reported cases involving gas station, and domestic LPG explosions in Tema, Atomic Junction, Kasoa, Labadi and other parts of the country (Ghanaweb.com; Myjoyonline.com; Graphiconline.com; Citifmonline.com; Aaron 2016). Millions of people in Africa and Southeast Asia are exposed to the risks of burns on daily basis (Van N. A, 2007). Burns are one of the leading

causes of injury worldwide (Mehta et al., 2020). Nearly 95% of burn injuries occur in LMICs, the majority of which are avoidable (Mehta et al., 2020). A staggering number of people who evade burn-deaths are either saddled with lifelong scars, and disability or are plunged into abject poverty and isolation (Dans et al., 2017).

### 1.3 Conceptual Framework

**Figure 1.0 Conceptual Framework**



**Figure 1.0: Conceptual Framework on Determinants of Household Fuel Choices and Burns.**

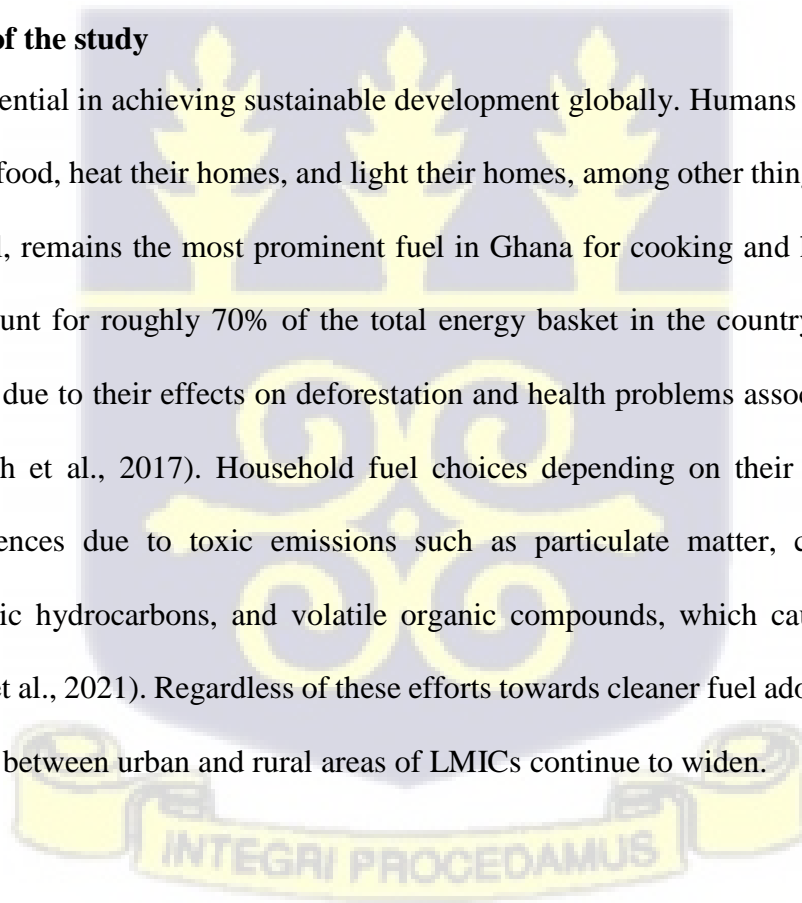
#### 1.4 Description of Conceptual Framework

The figure 1.0 above is a conceptual framework on the study depicting the relationship between the independent variables (household fuels, determinants of household fuel choices, cooking-related risk factors), and the outcome variable (cooking-related burns) among rural and peri-urban communities. The relationship suggests that household characteristics influence fuel choices. Empirical studies have identified that household income levels influence fuel choice for cooking and other household activities. As household income levels increase, households switch from biomass fuels (firewood, charcoal) to alternative, and modern fuels (Heltberg, 2003). The educational status of household heads influence fuel consumption choices. Education level affects a household head's social exposure in relation to cooking fuels and the existence of modern fuels (LPG, electricity), their comparative advantages over biomass fuels, thus, influencing fuel consumption choices (Suliman, 2010; Heltberg, 2003). Household size refers to the number of occupants in a particular household. A household with a larger family size requires more energy for cooking, heating, and lighting. This increased demand for fuel is accompanied by increased expenditure on fuels. Thus, family size determines household fuel consumption patterns (Suliman, 2010). *Ceteris paribus*, the cheaper the fuel source, the higher its demand. A relatively expensive household fuel is likely to deter rational consuming households thereby decreasing their demand. Access and availability of household fuels on the market influences household fuel choices (Masera et al., 2000). Access to modern fuels (LPG and electricity) in developing countries is very erratic for several reasons. The insecurity of modern fuels affects household adoption behaviours, thus, compelling households to combine both biomass fuels and modern fuel sources instead of switching fuels (Masera et al., 2000). Households in rural and peri-urban settlements are able to resort to traditional fuels (wood, charcoal, dung) as compared to urban dwellers with limited access to wood fuel and other biomass fuels (Wichmann, 2006). Cooking-related risk factors are diverse and vary between age groups, sexes, regions, and countries (Atiyeh et al., 2009). The wearing of traditional loose clothes by women in the kitchen in developing

countries is a great source of cooking-related burns. The risk of burns in the kitchen as a result of open fires at floor levels catching the hems of their clothing exposes these women to burns (Mock et al., 2008). Cookstove designs and construction quite often expose cooks, and households to burns. Using biomass fuels and fossil fuels in poorly designed and constructed cookstoves results in explosions and uncontrolled fires (Govender et al., 2020). Knowledge on the appropriate operation of cookstoves, and fuel storage affects the risk of burns. Cookstoves at ground levels where children can easily tumble over and poor storage of these fuels at inappropriate locations are judgmental errors attributable to the lack of education which may result in explosion and burns (Peck et al., 2008). Despite being a safe alternative to traditional fuels, LPG explosions poses devastating consequences for households. Lack of maintenance, improper storage, weak safety standards result in gas leakages and explosions that expose human lives to life-threatening burns, scalds, emotional traumas, disfigurement, and deaths (Arturson, 1987; Aaron 2016).

### **1.5 Justification of the study**

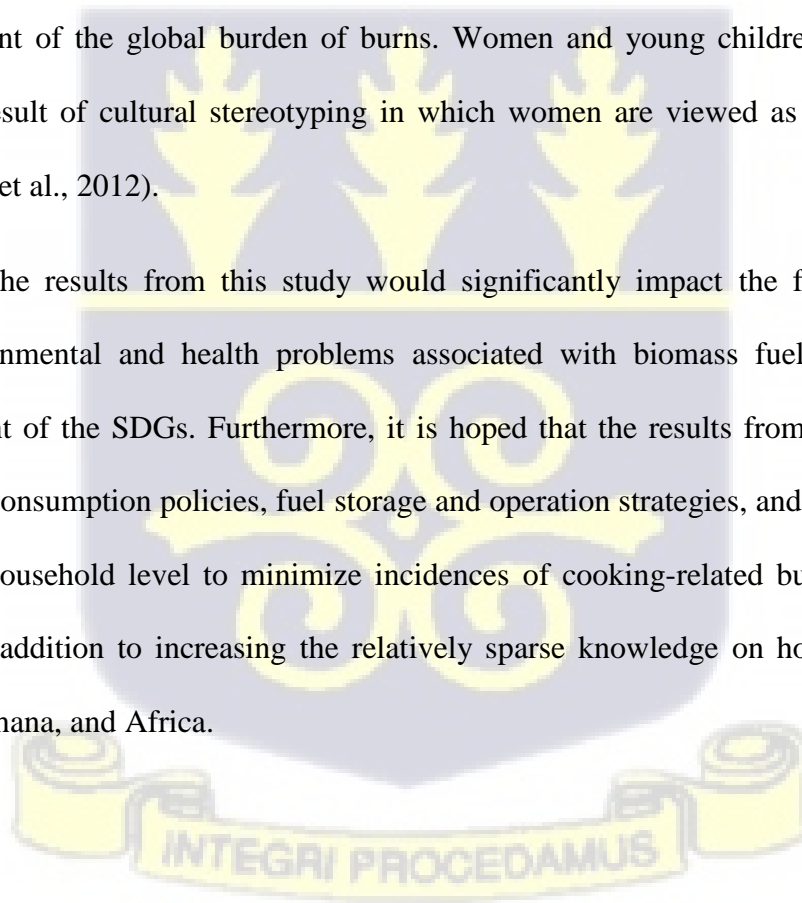
Energy is very essential in achieving sustainable development globally. Humans require household energy to prepare food, heat their homes, and light their homes, among other things. Biomass in the form of wood fuel, remains the most prominent fuel in Ghana for cooking and heating. Firewood and charcoal account for roughly 70% of the total energy basket in the country and are a major source of concern due to their effects on deforestation and health problems associated with indoor pollution (Quansah et al., 2017). Household fuel choices depending on their quality, can pose negative consequences due to toxic emissions such as particulate matter, carbon monoxide, polycyclic aromatic hydrocarbons, and volatile organic compounds, which cause household air pollution (Adane et al., 2021). Regardless of these efforts towards cleaner fuel adoption, the modern energy access gap between urban and rural areas of LMICs continue to widen.



Ghana has seen a number of plans, policies, and programmes aimed at increasing LPG access and adoption as primary household fuels. A steady progress towards LPG consumption in urban areas particularly in the Ashanti and Greater Accra Regions have been achieved. Despite these initiatives and interventions, LPG adoption rates continue to plunge and even worse in rural areas (Kemausuor et al., 2011).

Unfortunately, the domestication of fires ushered in devastation, pollution, and injuries. Consequently, burns are now a worldwide issue, particularly for those living in low- to middle-income countries (LMICs). The use of biomass and fossil fuels is directly associated with burns. It is estimated that increasing modern fuel access by LMICs could prevent up to 4000 burn-related deaths per year. But the exact number of burns in the developing world remain sparse, but considered a major public health issue (Van Niekerk, 2007). In addition to high mortality rates, burns may result in disfigurements, pain, and emotional trauma. Millions of vulnerable people in Africa and Southeast Asia bear the brunt of the global burden of burns. Women and young children are particularly vulnerable as a result of cultural stereotyping in which women are viewed as custodians of the kitchen (Albertyn et al., 2012).

It is hoped that the results from this study would significantly impact the fuel supply chain, addressing environmental and health problems associated with biomass fuels, and contribute towards attainment of the SDGs. Furthermore, it is hoped that the results from this study would influence energy consumption policies, fuel storage and operation strategies, and education on safe measures at the household level to minimize incidences of cooking-related burns and domestic adoption LPG in addition to increasing the relatively sparse knowledge on household cooking-related burns in Ghana, and Africa.



## 1.6 Research Objectives

The general objective of this study was to assess the determinants of household fuel choices and the risk of cooking-related burns among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana.

## 1.7 Specific Objectives

- To assess the determinants of household fuel choices among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana.
- To establish the association between household fuel choices, and socio-demographic characteristics of households and risk factors of cooking-related burns among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana.
- To establish the association between household fuel choices and cooking-related burns among two-riparian peri-urban settlements along the Lower Volta Basin of Ghana.
- To determine the household fuel stacking patterns among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana.

## 1.8 Research Questions

- What are the factors influencing household fuel choices among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana?
- Is there an association between household fuel choices, and socio-demographic characteristics of households and risk factors of cooking-related burns among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana?
- Is there an association between household fuels and the risk of cooking-related burns among the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana?
- In what proportion do residents of the two-riparian peri-urban settlements along the Lower Volta Basin of Ghana combine household fuels domestic activities?

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter provides a summary of household fuel choices, and the risk of burns among riparian dwellers along the River Volta of Ghana (Kpong, and Asutsuare). Literature for this study was obtained through searches in various databases (Pubmed, Google Scholar, Science Direct, University of Ghana database, Jstor, Emerald, Sci-hub, and the Balme Library) using key terms such as household fuels, energy sources, and cooking-related burn injuries. The review thus focuses on household fuel use patterns, the energy ladder theory, fuel stacking behaviours, risk factors, and burns to household primary cooks.

#### 2.2 Energy Consumption in Ghana

The significance of energy cannot be underestimated. Energy generation and consumption are important prerequisites for livelihood and national economic growth (Massoud et al., 2020). In this modern era, the requirement for large amounts of energy is on the rise. In the developing world, large biomass fuel sources are used to meet these increasing energy demand. The continuous availability and sustainability of these fuel sources are not guaranteed. In Ghana, more than 90% of the rural population depends on biomass fuel whilst about 70% of the urban and peri-urban population rely on traditional wood-fire. Wood fuels account for over 70% of the primary energy supply in Ghana, thus putting pressure on the Ghanaian forest (Quansah et al., 2017). The dominant methods and states of cooking in Ghana include; wood fire, charcoal, LPG, electricity, kerosene, and crop residue. Using biomass fuel (wood, charcoal, animal dung) for cooking, lighting, and heating produce and increases the concentration of carbon monoxide (CO), Hydrogen (H), nitrogen oxide (NO<sub>2</sub>), and hydrocarbons in the environment (Naeher et al., 2007).

Household fuel consumption patterns are generally mediated by socioeconomic status, welfare, and cultural practices. An increase in socio-economic status displaces solid fuels (firewood and charcoal)

to liquid fuel (paraffin), which is in turn displaced by LPG or electricity as the desirable forms of energy (Uhunamure et al., 2017). Households move up the energy ladder (biomass fuel to paraffin to LPG or electricity) in correspondence to improved socio-economic statuses. According to Sepp, (2014), many households use wood fuel for cooking and water heating, whilst heating water with either wood fuel or electricity, and others use kerosene and LPG for cooking. Households headed by lower-level employees use more biomass fuels as compared to executives and middle-level employees who employ cleaner fuels (Reddy, 2003). Attention on household fuel consumption patterns and the transition from traditional fuels to modern fuels in developing countries stems from the quest to understand the relationship between household fuel choices and its impacts on humans and the environment. Firewood collection and charcoal production as fuel sources stress the natural ecosystem, thus, resulting in environmental degradation (Chidumayo and Gumbo, 2013). In a bid to mitigate these challenges, successive governments in developing countries have implemented policies and programmes to promote the use of alternative fuels and clean fuel sources by households (Karimu et al., 2016). According to the World Health Organization (WHO 2016), household air pollution is a leading cause of death globally. The United Nations' Sustainable Energy for all goal under the Sustainable Development Goal seven (SDG 7) aims at enhancing access to affordable, reliable, sustainable, and modern energy for all and advocating for energy in development policies (Chomert et al, 2017). Resorting to renewable sources of energy offers an efficient strategy to tackle these problems (Kumar et al., 2020).

In the past, household fuel choices and patterns were assessed and analysed in relation to the energy ladder model which assumes that as household income levels rise, they switch to modern energy sources like LPG and electricity (Van der Kroon et al, 2013). However, many households adopt a mixture of both modern and traditional fuels and each fuel is for a specific end-use such as large cooking with wood fuel and heating with LPG. Fuel substitution and the transition is not always applicable in developing countries (Hoffman et al, 2015). Increasing evidence supports the

conception that households simultaneously employ multiple fuel choices in cooking, heating, and lighting. In rural settlements, fuels are not completely displaced or abandoned even in situations where cleaner fuels and cooking technologies are introduced. Rather, multiple fuel stacking is employed for cooking and heating. Since the 1990s, successive Ghanaian governments have implemented policies and programmes to promote the use of alternative fuels and clean fuel sources by households. Notable among these policies is the National Liquefied Petroleum Gas (LPG) programme aimed at enhancing access to LPG through price subsidizing, the Cylinder Recycling Model which aims to increase household access to cleaner fuels irrespective of their socioeconomic status (Martey et al., 2021). Despite these efforts, access and switching remain low. Only about twenty-three percent (23%) of Ghanaian households have transitioned towards the adoption of alternative sources of energy for cooking, lighting, and heating which occurs in a context of significant fuel stacking.

Excessive reliance on biomass fuel for household activities including cooking and heating in low-income countries has given rise to a considerable hike in carbon emissions and forest depletion, leading to adverse impacts on humans and the environment (Geist and Lambin, 2002). According to (Kamila et al., 2014), respiratory diseases, premature deaths, lung cancer, physical injury, and burns are associated with biomass fuel consumption by households in Ghana. Household consumption of biomass fuels or fossil fuels occasionally threatens the health and safety of individuals due to severe injuries and loss of lives (Albertyn et al., 2012).

Fire-related injuries and burns have exerted a toll on humanity since antiquity. Despite its reputation as the most powerful tool in human history, fire leaves its scars. Burns and smoke inhalation significantly contribute to the global mortality burden (Peck et al., 2008). The use of biomass fuels and fossil fuels is directly related to preventable burns at an alarming frequency. Women and infants are extremely vulnerable and highly exposed group of cooking-related burns in the household as they are responsible for cooking and spend much time in the kitchen (Bartlett, 2002).

### **2.3 Household Fuels**

Fuels are indispensable components of every home's consumption basket. Household energy sources vary from traditional biomass fuels (firewood, charcoal, briquettes, dung, crop residue) to cleaner fuels (LPG, electricity). The majority of households in the least and middle-income countries (LMICs) largely depend on biomass fuel for cooking and heating. In Ghana, wood and other solid fuels are the commonly consumed energy sources especially in rural settlements (Abdul-Wakeel Karakara & Dasmani, 2019). The Ghanaian economy is a solid fuel-based economy. Fewer than 1% of Ghanaian households adopt electricity for cooking whilst about 20% consume LPG and other natural gases. In contrast, 76% of Ghanaian households consume biomass fuels (GDHS, 2014). The situation is not different in other Sub-Saharan countries. In a study conducted by Mekonnen and Kohlin, (2008), the use of biomass fuels (wood fuel, charcoal, dung) was common in urban Ethiopia. Furthermore, the use of charcoal is predominant in countries high endowed with fossil fuels such as Angola, Gabon, and Nigeria. Firewood and charcoal are the dominant household fuel choice in Ghana with 84% and 13% consumption rates respectively in rural settlements (GDHS, 2014). According to the International Energy Agency (IEA, 2014), an estimated 730 million dwellers in sub-Saharan rely on biomass fuel (firewood, charcoal, crop residue, dung) for cooking.

### **2.4 Determinants of Household Fuel Choices**

Energy consumption is a significant determinant of the socio-economic status of people globally. The consumption of modern and cleaner energies illustrates the living standards within a country. Humans rely on energy for cooking, heating, lighting, movement, production, and preservation (Ado et al., 2016). Reasons for a household's preference for a particular fuel have been explained in literature referencing the energy ladder theory. According to the energy ladder theory, households transition energy as their income levels increases (Farsi et al., 2007). Households with lower income, uneducated lag at the base of the ladder consuming traditional fuels (wood, dung, straws). Middle-class households, households at the upper echelon in society consume transitional fuels and modern

(cleaner) fuels (charcoal, briquettes, kerosene, LPG, electricity). Nevertheless, households adopt multiple fuels, consuming more than one fuel. This behaviour in rural, urban, and peri-urban societies violates the energy consumption pattern advanced by the energy ladder theory (Ogwumike et al., 2014; Nnaji et al, 2012).

#### **2.4.1 Household Location**

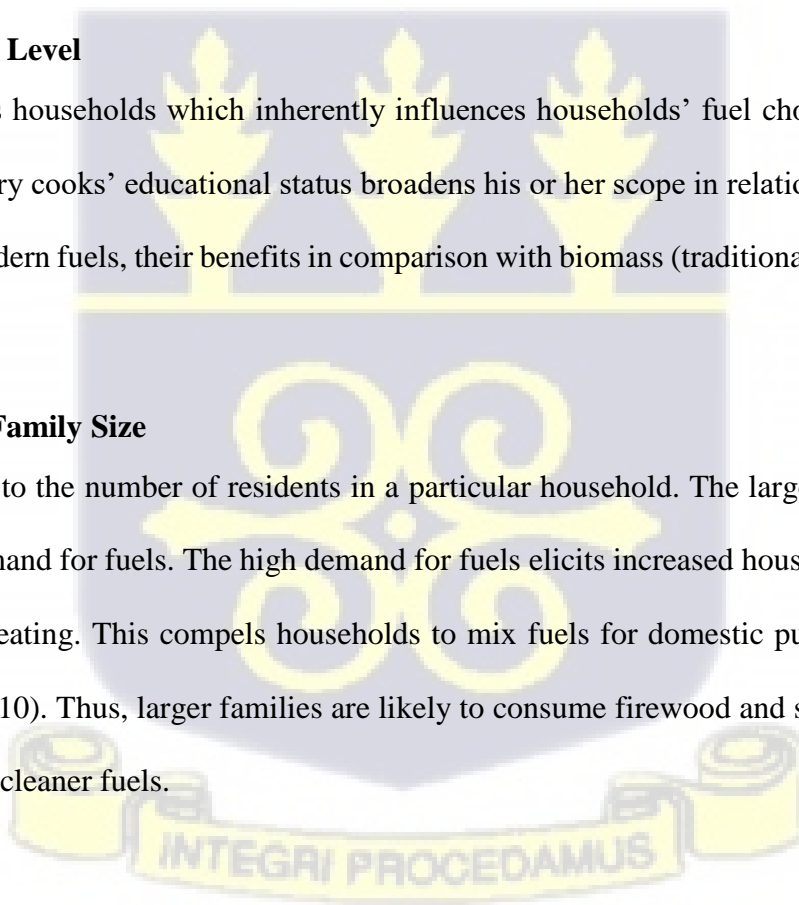
The geographical location of a household is a key determinant of its energy choice due to access and supply. Households sharing facilities such as kitchens and compounds with other dwellers are more likely to adopt modern fuels and transitional fuels than traditional fuels that require larger storage space, are associated with incomplete combustion, and emit indoor pollutants than rural dwellers (Mensah & Adu, 2015). Urban, peri-urban households tend to adopt alternative fuels (charcoal, briquettes) and modern fuels (LPG, electricity) compared to rural households who rely extensively on traditional fuels (firewood, straws).

#### **2.4.2 Educational Level**

Education exposes households which inherently influences households' fuel choices for domestic purposes. A primary cooks' educational status broadens his or her scope in relation to the existence of transitional, modern fuels, their benefits in comparison with biomass (traditional) fuels (Hertberg, 2003).

#### **2.4.3 Household Family Size**

Family size refers to the number of residents in a particular household. The larger the family size, the greater the demand for fuels. The high demand for fuels elicits increased household expenditure for cooking and heating. This compels households to mix fuels for domestic purposes (Hertberg, 2003; Suliman, 2010). Thus, larger families are likely to consume firewood and solid fuels relative to transitional and cleaner fuels.



#### **2.4.4 Household Income Levels**

This refers to the earners of the breadwinner of the household. The income level of a breadwinner determines the standards of living and buoyancy of the house. The energy ladder theory suggests that income levels influence fuel choices of households, thus, as income levels rise, households switch from traditional biomass fuels (firewood, dung, straws) to transitional fuels (charcoal, briquettes, kerosene) to modern (cleaner) fuels such as LPG and electricity and vice versa (Hertberg, 2003).

#### **2.4.5 Fuel Access and Availability**

Access and availability of a fuel source on the market influence a household's consumption of that particular fuel. An erratic supply of a fuel type due to inadequate generation, and distance to source influences its consumption level. Fuel supply insecurity ultimately impacts the consumption behaviour of households (Masera et al., 2000).

#### **2.4.6 Cost and Affordability**

The cost of purchasing a fuel type determines a households' consumption choice in relation to that particular fuel. The probability of a household adopting a particular fuel decrease with a higher cost of the fuel. The relatively higher cost of modern fuels (LPG, electricity) serves as a disincentive for poor households who are constrained by cost, thus preferring the less expensive traditional fuels (Mekonnen & Kohlin, 2008; cited in Mensah & Adu, 2015).

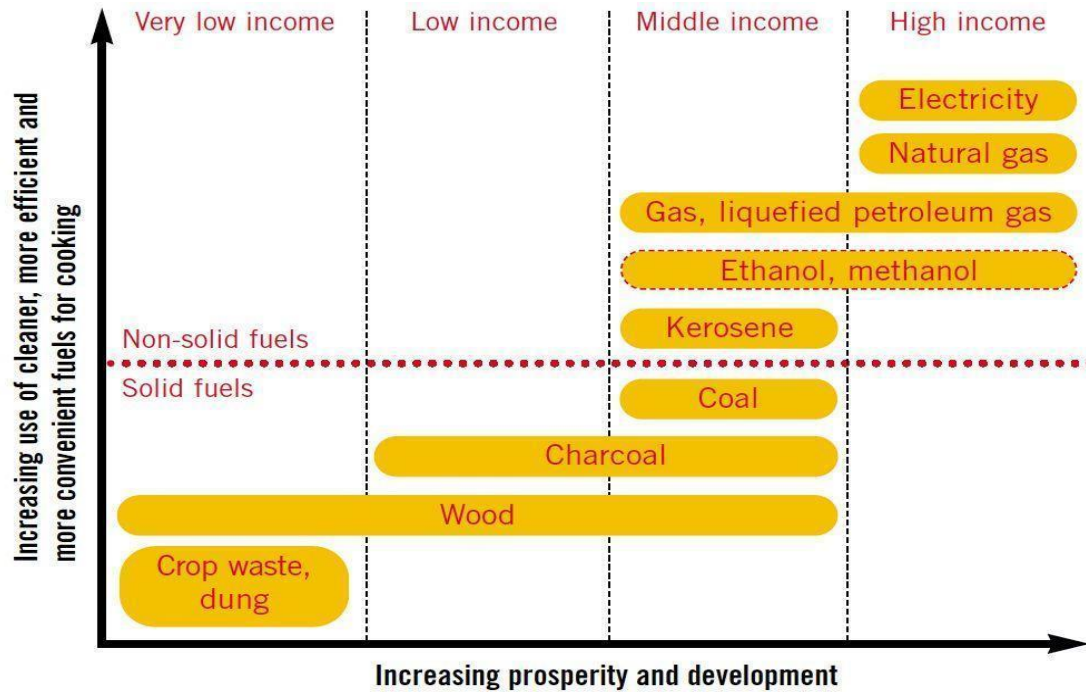
#### **2.4.7 Age of Household Head**

the probability of adopting modern and alternative fuels for household application decreases as the household head advances in age. Households with relatively older heads (primary cooks) are less likely to consume transitional and modern fuels in comparison to younger primary cooks. This fuel adoption behaviour is attributable to the reluctance and conservatism by older heads who perhaps have become comfortable using traditional fuels as such less inclined to switch to modern fuels (Mensah & Adu, 2015).

### 2.4.8 Cook Time

The duration for cooking a specific food influences the fuel choice adopted for that purpose. Foods perceived to take a longer time to be cooked will be prepared with less expensive biomass fuels rather than available modern fuels such as LPG or electricity (Ouedraogo, 2006).

### 2.5 The Energy Ladder Theory



**Figure 2.0: The Energy Ladder Model**

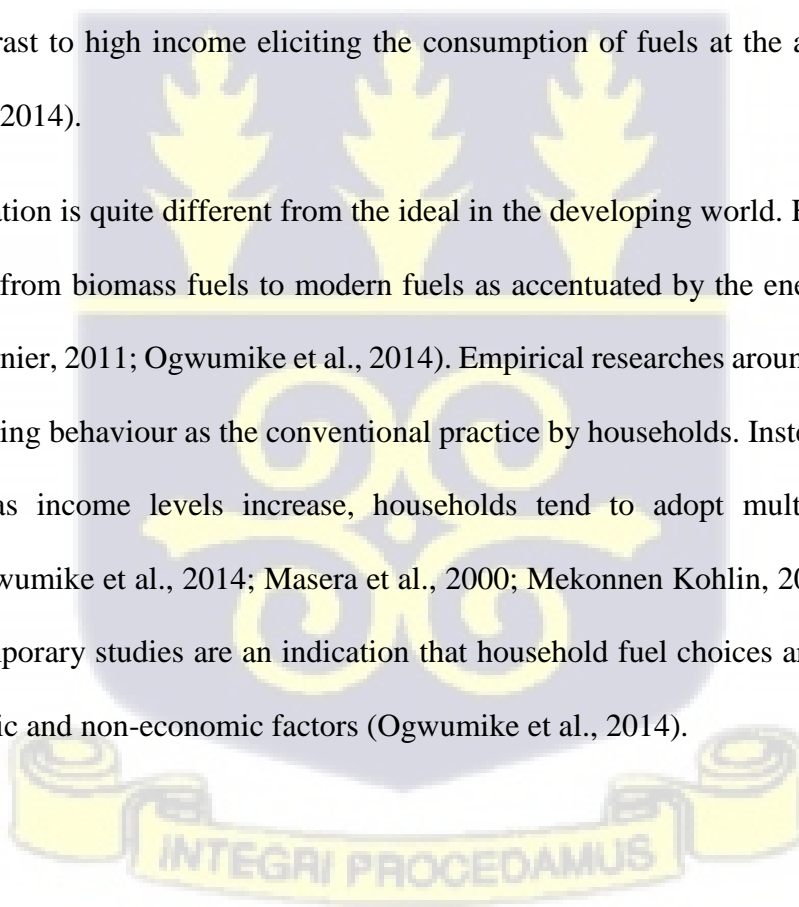
**Source: (WHO 2006 as cited in Ado et al., 2016)**

The energy ladder model is a basic framework employed by scholars and energy experts globally to explain households’ fuel transition behaviours. Households’ transition from biomass fuels to modern fuels follows a pattern illustrated by this model. The energy ladder concept emerged in the 1980s designed to depict a hierarchical relationship between households increased economic status and fuel choice for cooking and heating (Smith, 2000; Treiber, 2012). As a household’s income level improves, it switches from dirty fuels (biomass) to intermediate fuels (charcoal, kerosene) and finally adopts cleaner and modern fuels (Smith, 2000). As households’ standards of living and socio-economic improves, they tend to ditch dirty fuels for modern, cleaner, and energy-efficient sources (Muller & Yan, 2018), thus illustrating a linear relationship. The energy ladder hypothesis assumes

that households ascend the energy ladder with a surge in income level. The model revolves around households' income dictating their fuel pattern and choice for cooking and heating. Thus, household fuel adoption is income reliant (Heltberg, 2004). The model classifies households into three distinct categories of energy consumption. Households in the first category (base of the ladder) completely depend on biomass, the second category (middle class) of households depend on transitional fuels (charcoal, briquettes, kerosene). The third category consists of households at the apex of the ladder (affluent households) who switch to cleaner and modern fuels (Leach, 1992; Barnes et al., 2002).

The consumer behaviour concept rationalizes household fuel choices. Households are rational consumers seeking to maximise their utility (Varian, 2010). As income levels increase, households abandon traditional fuels for cleaner, modern, and efficient fuels. This behaviour indicates the inferiority of traditional fuels, concurrently perpetuating modern fuels as normal economic goods (Demurger & Fournier, 2011). Low income elicits the consumption of dirty fuels at the base of the ladder in contrast to high income eliciting the consumption of fuels at the apex of the ladder (Ogwumike et al., 2014).

However, the situation is quite different from the ideal in the developing world. Households do not linearly transition from biomass fuels to modern fuels as accentuated by the energy ladder model (Demurger & Fournier, 2011; Ogwumike et al., 2014). Empirical researches around the world report energy (fuel) stacking behaviour as the conventional practice by households. Instead of abandoning traditional fuels as income levels increase, households tend to adopt multiple fuel sources preferentially (Ogwumike et al., 2014; Masera et al., 2000; Mekonnen Kohlin, 2008). The findings from these contemporary studies are an indication that household fuel choices are influenced by a myriad of economic and non-economic factors (Ogwumike et al., 2014).



2.5.1 The Fuel Stacking Concept

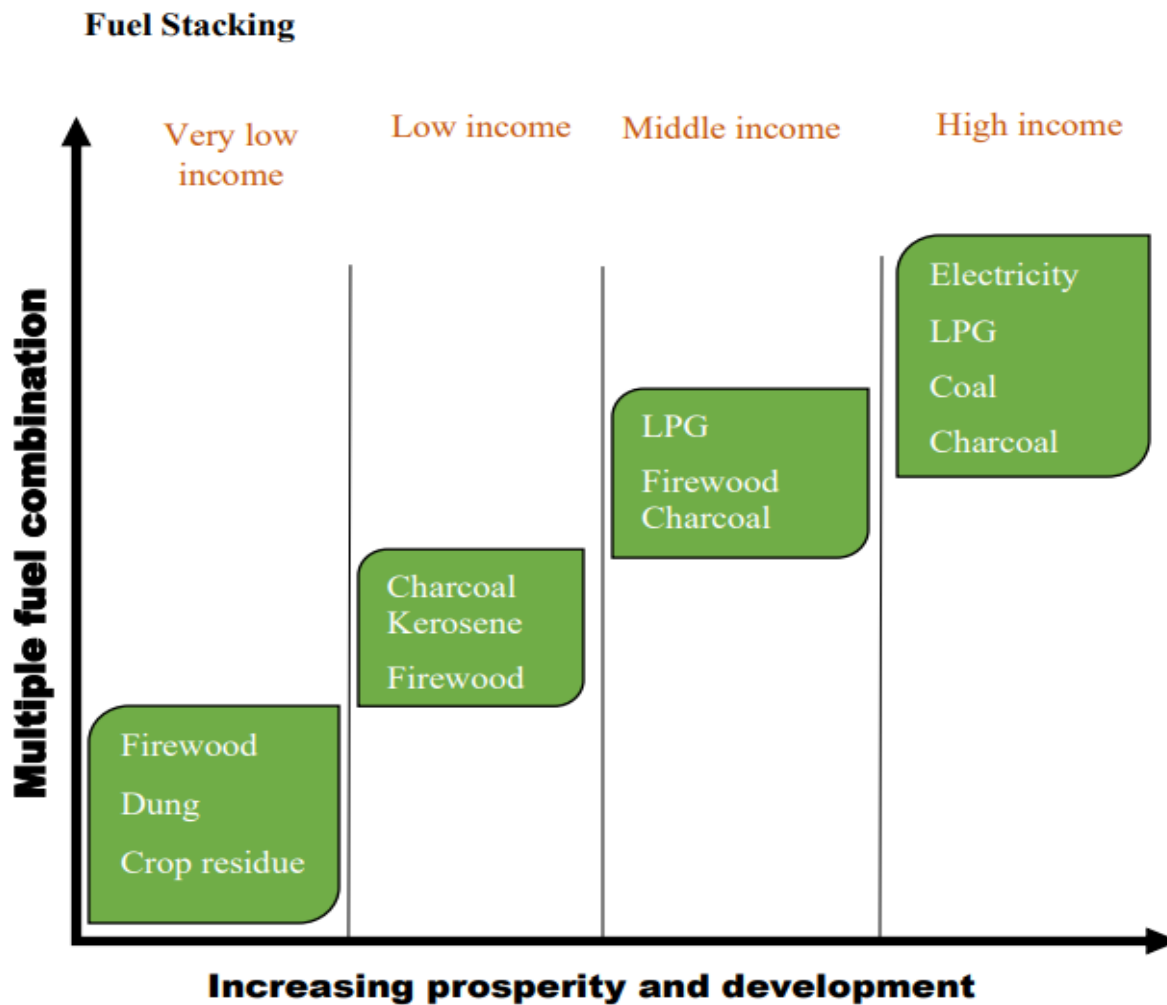


Figure 2.1 Fuel Stacking Model: Adapted from: (Yadav et al., 2021)

The energy stacking concept was propounded by Masera and Navia, (1997) as a critique of the energy ladder theory. In a study on household energy switch patterns in rural Mexico conducted by Masera and Navia, a new trend in fuel consumption patterns by household's contrary to the energy ladder hypothesis was observed. The fuel stacking concept (multiple fuel use strategy) hypothesizes that fuel switch conforms to the adoption of multiple fuel sources where modern fuels are added to traditional fuels without necessarily abandoning the latter (Masera et al., 2000). According to the fuel stacking hypothesis, household fuel consumption seldomly adhere to a linear transition pattern as income levels increased as propounded by the energy ladder theory (Masera & Navia, 1997; Treiber, 2012). In a study on agriculture mechanization in developing countries, it was observed that

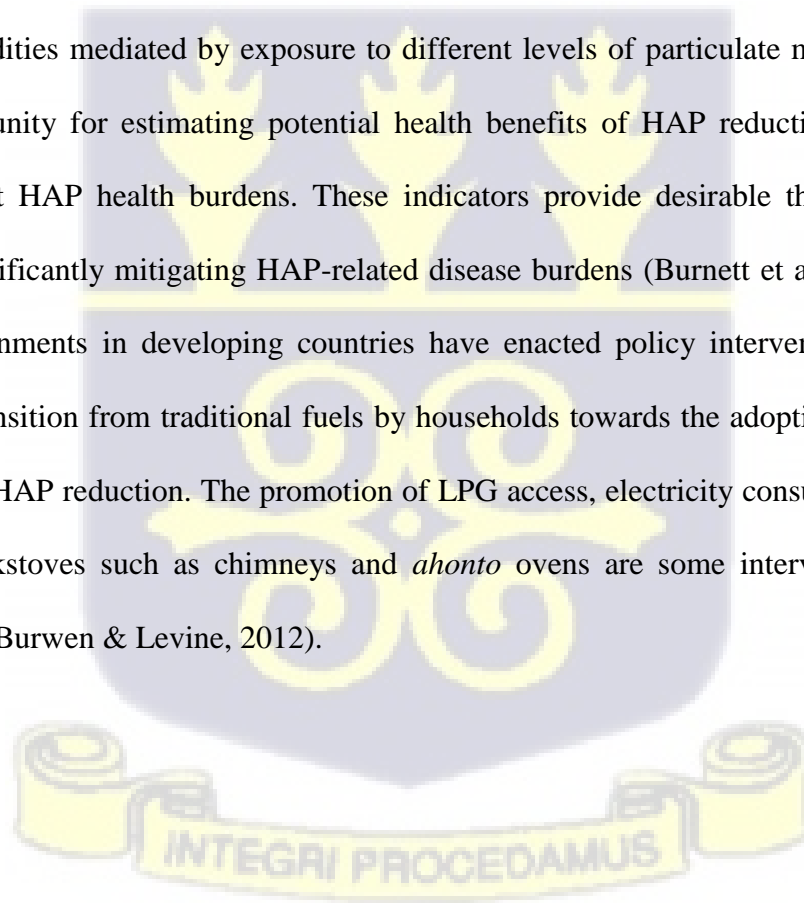
farmers shifted from animal power to adopt tractors without abandoning the animals for certain farming activities (Biswanger, 1984). Critics of the energy ladder hypothesis argue that the model is exaggeratively basic. Inasmuch as it suggests a complete abandonment of traditional fuels due to improved socio-economic status and adoption of modern fuels, households do not completely switch from traditional fuels in developing countries. Instead, modern fuels are consumed alongside traditional fuels (Heltberg, 2004; Akpalu et al., 2011). In sharp contrast, the energy stacking concept posits that households do not necessarily transition from one fuel to another. Rather households consume multiple fuels (Van der Kroon et al., 2013; Heltberg, 2004; Leach, 1992; Masera et al., 2000). Hence households choose from the fuel bundle constrained by income, and preference. Dependence on biomass as supplementary sources is necessitated by the erratic supply of cleaner fuels (LPG and electricity) and socio-cultural practices. Many urban communities in sub-Saharan Africa combine LPG and charcoal for cooking due to frequent shortages of LPG. In events of LPG shortage, charcoal comes in handy (Mekonnen & Kohlin 2008). Households in Mexico support LPG with wood fuel, but seldomly abandon firewood (Masera et al., 2000). Energy switch or transition basically illustrates the retardation of a least preferred fuel for better alternatives (Van der Kroon et al., 2013). The determinants of household choices are dynamic and multi-faceted ranging from cultural factors, socio-economic factors, environmental influences, and availability (Masera et al., 2000).

## **2.6 Health Risks Associated with Biomass**

The dependence on dirty biomass fuels (firewood, charcoal, crop residue, straws, kerosene) for cooking and heating is a major source of household air pollution (HAP) globally. This phenomenon is significantly associated with respiratory and cardiovascular morbidities widening the global mortality burden (WHO, 2016). Major health issues mediated by biomass consumption include; acute lower respiratory infections (ALRI), lung cancer, stroke, chronic obstructive pulmonary diseases (COPD), and premature deaths. Household air pollution emanating from the incomplete

combustion of wood fuel for cooking and heating poses major health risks to households in developing countries in addition to environmental impacts (Duflo & Greenstone, 2008). Exposure to particulate matter (PM<sub>2.5</sub>) concentration from smoke (black carbon) emission in relation to solid fuel consumption gives rise to obstructive pulmonary diseases and acute respiratory infection (ARI) in children and adults.

In addition to acute respiratory infections (ARI), traditional cooking fuel is significantly associated with burn injuries (Shankar et al., 2020). In low- and middle-income countries, poorly constructed cookstoves and open fires give rise to about 95% of the 300,000 global cooking-related mortalities annually (Gallagher et al., 2016). The burden of firewood collection and processing significantly reside on women and children in the developing. This cultural practice wastes time in addition to reducing opportunities for women's engagement in beneficial economic endeavours (Ndiritu & Nyangena, 2011). The Integrated exposure-response (IER) model employed to estimate the relative risk for co-morbidities mediated by exposure to different levels of particulate matter constituents offers the opportunity for estimating potential health benefits of HAP reduction in addition to estimating current HAP health burdens. These indicators provide desirable thresholds of HAP reduction for significantly mitigating HAP-related disease burdens (Burnett et al., 2014; Bruce et al., 2015). Governments in developing countries have enacted policy interventions focused on promoting the transition from traditional fuels by households towards the adoption of cleaner and modern fuels for HAP reduction. The promotion of LPG access, electricity consumption, adoption of improved cookstoves such as chimneys and *ahonto* ovens are some interventions aimed at decreasing HAP (Burwen & Levine, 2012).



### **2.6.1 Cooking-related Burns**

Burns are of great public health concern globally. Cooking-related burns refer to any injury caused by fire (flame burns), contact with hot liquids (scalds) or hot surfaces (contact burns), and exposure to substances capable of damaging the skin (Mehta et al., 2020). Also, burns are defined as damage to the skin or living tissues instigated by thermal trauma (Govender et al., 2020; Story, 2008). They occur when a cell or some cells in the skin and tissues are damaged by hot surfaces, flames, or hot liquids. Burns to a large extent affect the skin, resulting in functional disability, contractures, and scars of exposed body parts (Agbenorku, 2013; Norman and Judkins, 2004). These injuries occur as a result of skin contact with hot liquids (scalds), open flames, heat, radiation, and hot surfaces (Jabir et al., 2013). The problem of burns is disproportionate between developing and the developed nations owing to socioeconomic and cultural disparities. Burns account for the fourth most excruciating trauma trailing only road traffic accidents, falls, and deliberate violence with about 90% of them occurring in Low- and Middle-Income Countries (WHO, 2004; Peck & Pressman, 2013).

### **2.7 Classification of Burns**

Burns are classified in relation to their depth as first degree, second degree, or third-degree burns. Contemporary, inhalation burns resulting from breathing smoke and hot flames have been added to this classification (Wise & Levine, 2015). First-degree burns affect the outer layer of the skin causing a change in colour (redness in whites, darkness in black persons), dryness, and swelling. First-degree burns (superficial) usually heal with three (3) to six (6) days. Second-degree burns (partial thickness) destroy both the skin's outer layer and the layer beneath it, causing excruciating pain and swelling. Second-degree burns heal within a time frame of two (2) to three (3) weeks. Third-degree burns also referred to as full-thickness burns destroy the full thickness of the skin. Third-degree burns cause extensive destruction to the tendons and bones, blood vessels, and major body organs. Due to nerve damages, the victim may not experience any pains (Torpy, 2009). Furthermore, burns may be classified as scalds (caused by hot liquids, steam, and spill from cooking vessel), contact burns

(caused by hot surfaces such as cooking utensils), flame burns (caused by flames or incandescent fires), chemical burns (exposure to reactive chemicals), inhalational burns (a significant cause of deaths in fire-related burn patients) as a consequence of inhaling heated gases, hot liquids or steam, poisonous products of incomplete combustion (Saffle et al., 1995)

### **2.7.1 Cooking-related Risk Factors**

Burn risk factors vary globally between age groups, and sexes (Atiyeh, Masellis & Conte, 2009). Young women in LMICs are exposed to burns in the kitchen, the use of unsafe cooking appliances, open flames at ground level, wearing loose clothing significantly expose young women to the risk of cooking-related burns (Mock et al., 2008). Adult males are exposed to the risk of burns at their workplace, faulty electrical wiring, and open flames (Duke et al., 2012; Smolle et al., 2017). Children and infants (pediatrics) are at risk of burns in homes in the kitchen as a result of inadequate supervision (WHO, 2017).

### **2.7.2 Knowledge of Fuel Storage and Operation**

Liquefied Petroleum Gas (LPG), a mixture of butane and propane gases is a fossil fuel that is stored as a liquid under high-pressure tanks and is widely consumed domestically, and industrially. Governments globally are promoting the consumption of LPG for it being a cleaner fuel due to its propensity to burn easily and completely (Murugkar et al., 2006). However, the immediate and sudden explosion of LPG tanks and cylinders due to fuel leakage and fire source can cause extensive damage, serious burns, and mortality (Bozkurt et al., 2008).

### **2.7.3 Open Fires (flames)**

Open flames used for cooking and heating are major risk factors for burns. Open flames can easily escape from the cookstove as well as under the cooking pot, ignite clothes, endanger those nearby. Children easily access burning sticks under cooking pots by pulling them out for playing or may end up falling into an unprotected fire in the kitchen and getting disfigured or burnt (Albertyn et al., 2012).

### 2.7.2 Cookstove Design

Cooking or heating on open fires at ground level and unenclosed cookstoves are very hazardous and pose significant threats to household inhabitants, especially women and children. Easy access to these cooking appliances when cooking by children endangers their lives and increases the risk of burns (Daisy et al., 2001). Infant (toddlers) during their learning process become curious about their surroundings, thus exploring their environment thereby coming into contact with hot surfaces including cooking pots, and cooking equipment (Van Niekerk et al, 2013). Young children grab pots, to open lids, overturn heated content on themselves causing severe burns and scalding (Govender et al., 2020).

### 2.8 Preventive and Safety Measures

The experience of high-income countries confirms that it is possible to reduce burn mortality and morbidity through a combination of measures aimed not only at reducing the likelihood of a fire but also at decreasing the severity and impact of burn injuries. While such strategies have been successful in much of the developed world, they have not been so successful in low- and middle-income countries where burn-related deaths are still exceedingly high. The effectiveness of such interventions varies, but notable successes have been logged in many cases. It is possible to reduce the health risks associated with biomass and fossil fuel use in developing countries. Intervention strategies, such as smoke detectors and sprinkler systems, that have been shown to be effective in high-income countries, are not widely used in low- and middle-income countries. Similarly, advancements in burn care including improved resuscitation capability of burn victims, and improved burn wound care (skin grafting) have contributed to a reduction in burn-related mortality and morbidity in high-income countries (Mock et al., 2008).

Overcoming barriers to the development and implementation of burn prevention, care, and recovery programs around the world to remedy this inequality and decrease the global rates of death, disability, and disfigurement from burns is a major challenge for governments and international

organizations. Improving home appliance quality, improved cookstove design, and education have been identified as some effective intervention strategies for mitigating the risk factors of cooking-related burns injuries for LMIC (Albertyn et al., 2012).

### **2.8.1 Education and Advocacy**

As a primary intervention strategy for burns, community programs to ensure good supervision of children, particularly those with disabilities, to educate parents and policymakers about burns, and to advise against the storage of flammable substances in homes have been proposed (Forjuoh, 2006). It has been demonstrated that educating parents about the use of safety equipment results in increasing knowledge. Educating people about the health risks associated with the use of household fuels and appliances should be the focus of burn prevention initiatives. The most important aspect is education about the safe use of cookstoves and fuel storage. It is critical that manufacturers of cooking appliances provide users with accurate information regarding safe and effective applications (Albertyn et al., 2012). There is a lack of understanding among policymakers and donors about the scope and cost of the burn problem. There is also a lack of understanding that current high rates of burn death, disability, and disfigurement could be reduced through affordable and sustainable improvements in prevention and care. Educational programs in schools and communities are effective in increasing knowledge about burns among young children (Kendrick, 2007).

### **2.8.2 Improved Cookstove Designs**

Many low- and middle-income countries use fossil fuels in their lamps and stoves for lighting and heating (Peck et al., 2008). These lamps and stoves are frequently associated with child burns. Creating safe stoves and relocating them outside and off the ground will decrease the number of burns sustained by children in addition to a reduction in their exposure to indoor fumes. The safety of users should be emphasised when designing cookstoves. Improving household cooking appliances is a critical component in burn prevention. New designs should prioritize smoke

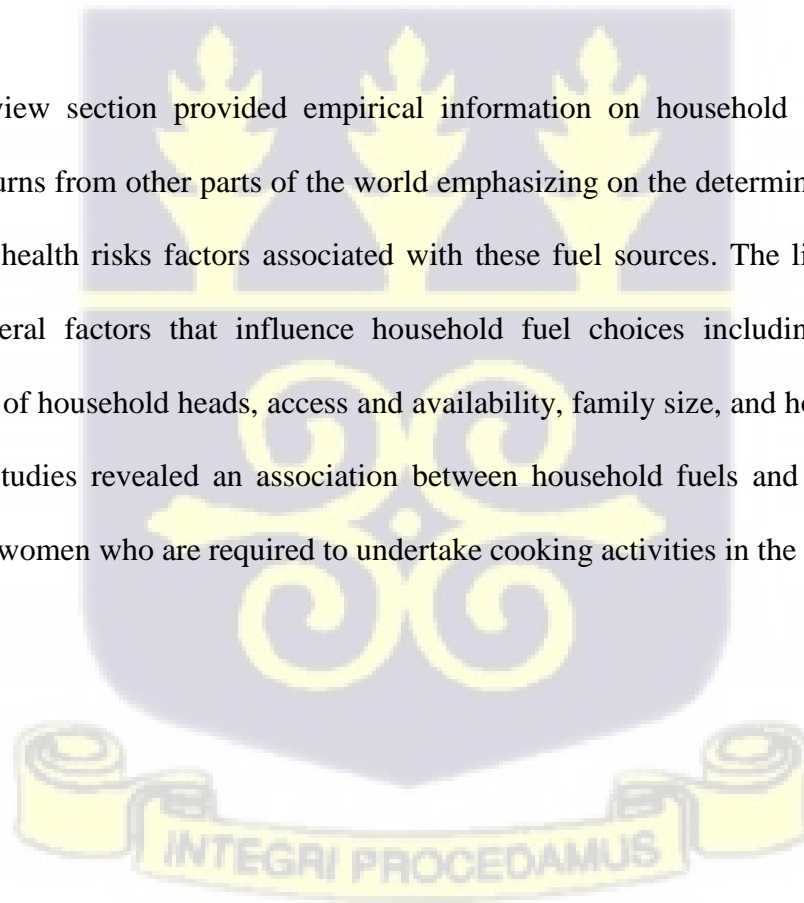
reduction, improved fuel combustion, and elevation above-ground levels. This measure will reduce both acute lower respiratory infections and cooking-related burns (Bawa et al., 2000).

### **2.8.3 Laws and Policy Regulation**

Laws and regulations are one of the most effective means of encouraging people to adopt safe behaviours. In addition to legislation requiring smoke detectors, which has proven effective in many high-income countries, three other measures appear to be effective: laws governing the temperature of hot-water taps bans on fireworks, and child-resistant lighter standards (Peck et al., 2008). Many of these strategies that have contributed to the reduction of burn deaths in high-income countries have been implemented through policy changes. However, many low- and middle-income countries have yet to develop burns policies, as well as put action plans, legislation, or regulations in place to address the situation. In situations where burn policies have been enacted, enforcement is frequently insufficient (Albertyn et al., 2012).

### **2.9 Conclusion**

The literature review section provided empirical information on household fuel choices, and cooking-related burns from other parts of the world emphasizing on the determinants of household fuel choices, and health risks factors associated with these fuel sources. The literature reviewed demonstrated several factors that influence household fuel choices including income levels, educational status of household heads, access and availability, family size, and household location. Likewise, many studies revealed an association between household fuels and the risk of burns especially among women who are required to undertake cooking activities in the developing world.



## CHAPTER THREE

### METHODS

#### 3.1 Study Design

This was a cross-sectional study employing quantitative techniques to assess households' consumption of cooking fuels, determinants of household fuel choices, and the risk of cooking related burns. The cross-sectional nature of the study allowed for data to be collected, and analysed on households' exposure to cooking fuels, and the risk of burns to primary cooks within the two riparian communities simultaneously. Also, it assisted in comprehending the prevalence of burns, and the determinants of household fuel choices within the selected communities. The data for this study was obtained from an ongoing randomized control trial into the Utilization of Invasive Aquatic Weeds for Biomass Briquettes Production and its Public Health Impact on two riparian peri-urban communities along the Lower River Volta of Ghana in the Greater Accra region (Asutwaa), Eastern region (Kpong) purposively selected. Notable communities along the Lower River Volta of Ghana include; Akosombo, Kpong, Akuse Asutwaa, Adidome, Sogakope, Jemeni, Kpando, and Ada Foah. Kpong and Asutwaa were selected for this study due to the presence of large populations of invasive aquatic weeds colonizing those sections of the River Volta's banks.

#### 3.2 Study Location

##### 3.2.1 Kpong Area and Asutwaa Area Councils

The Kpong municipality is located in the Eastern Region of Ghana between latitudes 6.05N and 6.30N and longitudes 0.08W and 0.20W, at an elevation of 457.5m above sea level. Upper Manya Krobo District borders the municipality on the North-West, Asuogyaman District on the North-East, North Tongu District on the South-East, and Yilo and Dangme West District on the South-West. The district's population primarily consists of Krobos. However, they coexist with Ewes, Akans, Hausas, and other groups. The district is diversified in terms of culture, and religion. Christians, Moslems, and traditionalists are the major religious groups within the Kpong township. The people

of Kpong depend largely on the River Volta for their livelihood and economic development. They are noted for fishing, fish mongering, farming, sale of *abolo*, *one-man-thousand*, and other freshwater crustaceans such as shrimps, crabs, oysters, prawns, crayfish, and krill (Ghana Statistical Service, 2014). The Shai-Osudoku District is located in the Greater Accra Region of Ghana in the south-eastern part of the country. The district encompasses a total land area of approximately 968.361 square kilometers with Dodowa as its district capital. It borders the North Tongu District to the North-East, the Yilo and Lower Manya Districts to the North-West, the Akwapim North District to the West, the Kpone Kantamanso District to the South-West, the Ningo Prampram District to the South, and the Ada West District to the East. The Volta River washes the district's north and east sides. The two major dialects spoken within the district are Dangme and Ga with its indigenous people divided into four (4) traditional groups. The people of Asutuare largely depend on the River Volta for their livelihood. They are noted for fishing, fish mongering, and banana farming among others. (Ghana Statistical Service, 2010).



3.2.2 District Maps of Lower Manya Krobo and Shai Osu-doku

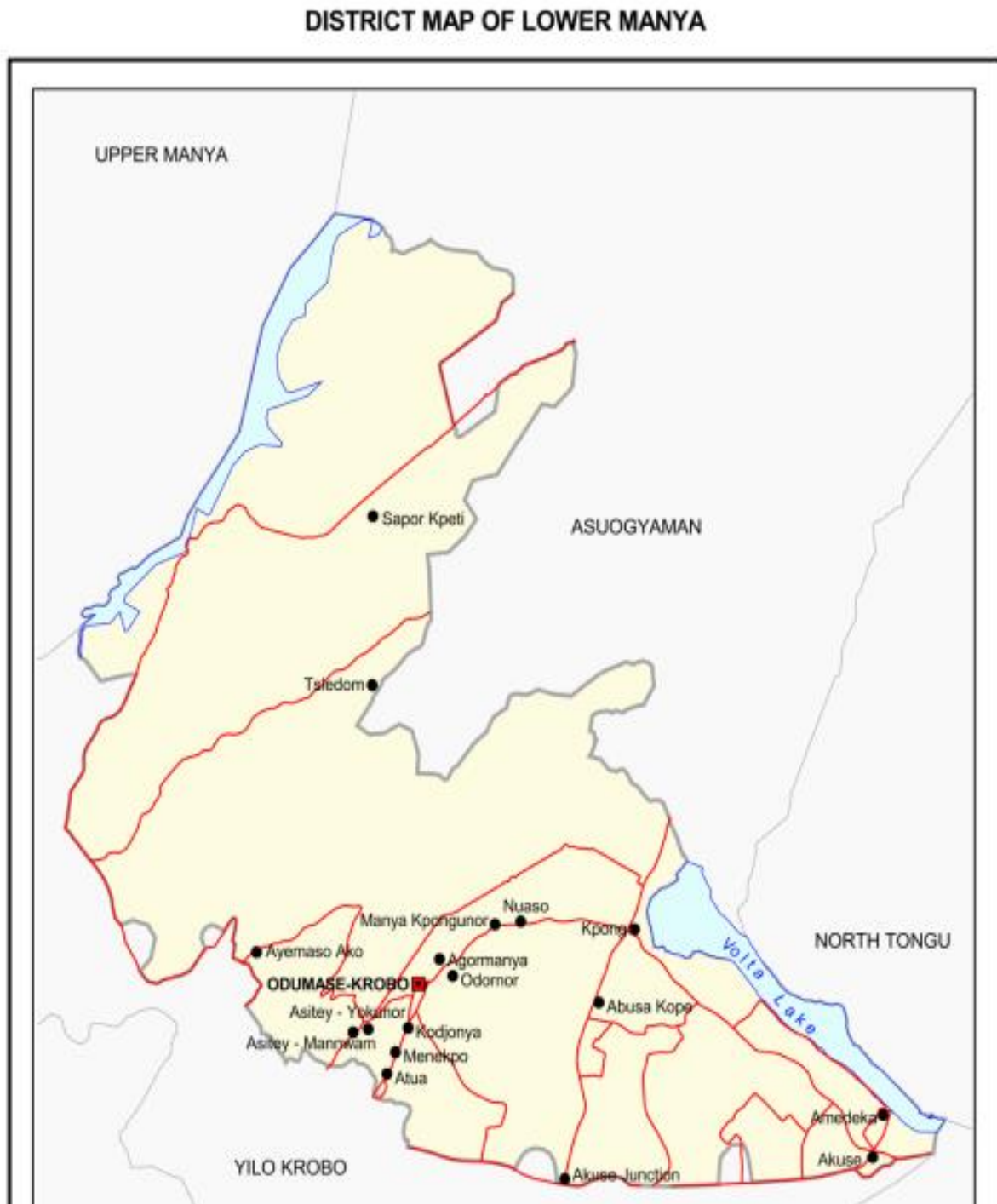
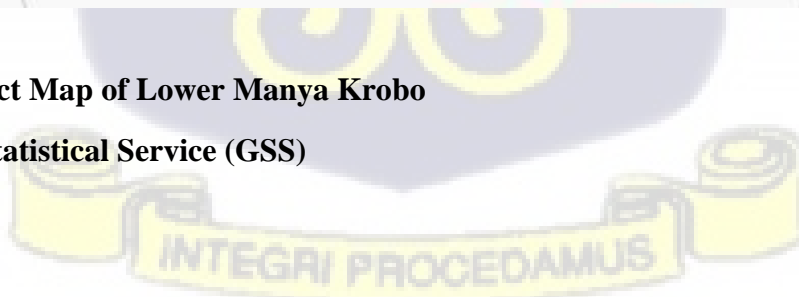
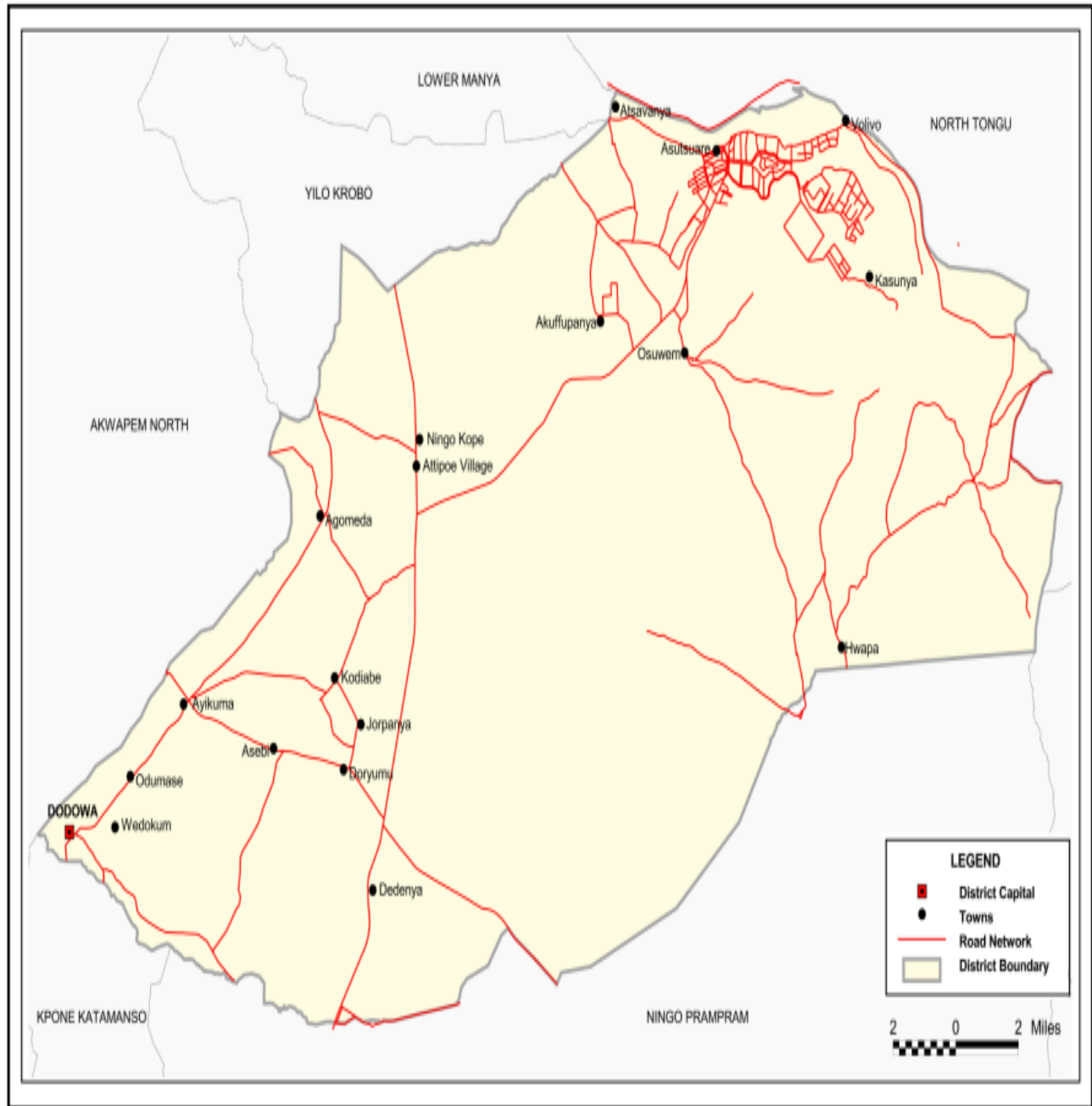


Figure 3.1: District Map of Lower Manya Krobo

Source: Ghana Statistical Service (GSS)



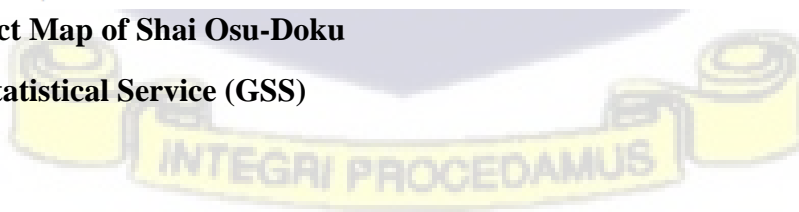
DISTRICT MAP OF SHAI OSU DOKU



Source: Ghana Statistical Service, GIS

**Figure 3.2: District Map of Shai Osu-Doku**

Source: Ghana Statistical Service (GSS)



### 3.2 Study Population

The source population included all primary cooks (males and females) in the Asutuare, and Kpong townships of Ghana consuming household fuels in the kitchen for domestic purposes. 382 households at baseline participated in this study (see Table 4.1).

#### 3.2.1 Sample Size and Sampling

The sample size was determined in reference to previous studies (Fedak et al., 2019; Fedak et al., 2019; Adane et al., 2021). To adjust for the clustering effect of the community, houses, and intraclass correlation, an intra-cluster correlation of 0.25 and an intra-class correlation coefficient of 0.1 are assumed. The variability of the account is assumed to be 359 and an assumed confidence interval of 95%, a type I error rate of 5%, and a power of 80%. A sample size of 232 houses and a 15% non-response and attrition rate obtained a minimum sample of 274 houses. Sampling for this study was conducted in five phases at the community level where each household had an equal chance of participation via clustered sampling. Phase (i) community entry and stakeholder engagement, Phase (ii), housing census (counting and numbering of houses in the two districts), phase (iii) household recruitment and demarcation, phase (iv) training of research assistants, phase (iv) data collection.

$$N = \frac{2 \times \sigma^2 \left( Z_{\alpha} + Z_{\beta} \right)^2 \text{def}f_1 \times \text{def}f_2}{\delta^2}$$

Where;

- $\sigma^2$  is the variability of  $PM_{2.5}$
- $\alpha$  is the type I error rate
- $(1 - \beta)$  is the power to detect a difference
- $\delta$  is the effect size (expected difference in  $PM_{2.5}$  between intervention and control group)
- $sdef f_1 = (m_1 - 1) * ICC$  is the design effect associated with clustering.
- $def f_2 = (m_2 - 1)\rho$  is the design effect due to repeated measurement.
- $m_1$  and  $m_2$  are the cluster size and number of repeated measurements, respectively.

- $ICC$  and  $\rho$  are intra-cluster and intra-class correlations, respectively.

To obtain the final sample size, the attrition, and missing rate,  $\gamma$  is determined by inflating  $N$  as follows:

$$N_f = \frac{N}{(1-\gamma)}$$

**Table 3.1 Proportion to sample calculation**

District	Communities	Houses	Households
<b>All households</b>			
Kpong	16	1730	8349
Asutsuare	6	177	476
<b>Houses with at most 4 households</b>			
Kpong	16	947	2611
Asutsuare	6	157	356

### Allocation and Sampling

Sample size,  $n = 274$

Number of houses to be a sample from Asutsuare (proportional to size):  $\frac{157}{157+947} \times 274 = 39$

Number of houses to be sampled from Kpong (proportional to size):  $\frac{947}{157+947} \times 274 = 235$

### 3.3 Inclusion Criteria

The study was limited to households that consumed at least one of biomass fuels or modern fuels, had four (4) or fewer families permanently residing in the participating communities qualified as study participants. Additionally, the household head or the next in command consented to participate in the study and adhere to the research protocols, and guidelines. In this study, a house refers to a building habited by humans while a household refers to a family occupying a house.

### **3.3.1 Exclusion Criteria**

Households that engaged in commercial consumption of fuels, temporal residents, pregnant women, and precluded communities were exempted from the study.

### **3.4 Study Variables:**

#### **3.4.1 Dependent Variable**

In this study, two (2) relationship are investigated. Factors influencing household fuel choices and the association between household fuels and cooking-related burns. The primary outcome was household fuel choices defined as the energy sources used for cooking and heating in the home. Household fuels are classified as solid biomass fuels (firewood, charcoal, dung, crop residue, coal, briquettes) or cleaner fuels (cooking gas/LPG, electricity).

The secondary outcome was cooking-related burns defined as burns ever experienced by a participant. Burns are classified as first-degree (superficial) burns, second-degree (partial thickness) burns, or third-degree (full-thickness) burns. The surface area of a participant's palm was used to classify the various sizes of cooking-related burns.

#### **3.4.2 Independent Variables**

The independence variables (see section 3.4.1) for the primary outcome are; income levels of household heads, educational levels of household heads, cost or affordability of fuels, age of household head, sex of household heads, marital status of household heads, household ownership status, house dwelling type, occupational status of household head, religion of household head, and ethnicity of household head. The independence variables (see section 3.4.1) for the secondary outcome are; contact with hot cooking surfaces, open fire or flames, hot liquids or steam, knowledge on fuel storage and operation.

#### **3.4.3 Potential Confounders**

The confounders for the secondary outcome (see section 3.4.1) were the sociodemographic factors of the participant (age, sex, religion, marital status, ethnicity, education, income levels, type of

dwelling, household ownership status, source of drinking water, toilet facility, waste disposal)

(Story, 2008; Albertyn et al., 2012; Govender et al., 2020; Stewart et al., 2021).

### **3.5.1 Community Entry and Stakeholder Engagement**

The research team (supervisor, principal investigator) met with the community chiefs, assemblymen, and opinion leaders to notify them on the project, and obtained authorization to engage their subjects.

A succinct presentation was made on the purpose of the project, the study objectives, methodology, procedures, and timelines. A request was made on the chiefs for community representatives with extensive knowledge on the community boundaries, who were fluent in English and the native dialects of the people to lead the research team during the housing census, and introduction of the team to the community members.

### **3.5.2 Housing Census**

Each individual house and household in the participating communities were counted with assistance from the community representatives and other volunteers. The houses were given unique identification codes. A mop-up exercise was conducted by the PI and the study supervisor to confirm household eligibility.

### **3.5.3 Household Recruitment**

A simulated random number generator was used to sample eligible households in the target communities. These selected households were demarcated and numbered with predefined codes using oil paints for easy identification, protection against unfavourable weather conditions, and rains. Residents of the selected houses were extensively briefed on the study protocols, timelines, objectives, and procedures. Excluded houses were duly notified.

### **3.5.4 Training of Field Assistants**

The recruited research assistants four (4) were given a one-week thorough training on the study protocols, guidelines, objectives, data collection procedure, and the data collection tool (REDCap) at Kpong from 1<sup>st</sup> to 6<sup>th</sup> October 2021. The training sessions were held twice daily (mornings and

afternoons). Each session lasted for three (3) hours with intermittent breaks. The PI with guidance and assistance from the supervisor moderated the in-person training sessions.

### **3.6 Data Collection**

The data collection tool (structured questionnaire) was categorized into six sections (informed consent, sociodemographic characteristics, the home environment, household fuels, cooking-related burns, water, sanitation and health). The data was obtained through an in-person interview using a structured questionnaire developed in the English language and hosted on REDCap (Research Electronic Data Capture) application on Android smartphones hosted at the University of Ghana. The PI aided by the research assistants visited all selected households to interact and obtain data on their demographic characteristics, household fuels, determinants of household fuel choices, cooking-related risk factors, and exposure to burns, water, sanitation and health. Based on the community dynamics, majority of the participants predominantly farmers and petty traders, arrangements were made to conduct the interviews at specific time periods (mornings, evenings, weekends) based on community characteristics. The process lasted for six weeks (11<sup>th</sup> November to 23<sup>rd</sup> December 2021).

### **3.7 Data Processing and Analysis**

Data collected was exported from REDCap to a statistical software package (Statistics and Data – STATA 16) for analysis. The analyses were conducted in three phases (univariate analysis, bivariate analysis, and multinomial logistic regression analysis) at a confidence level of 95% and a 5% level of precision (P-value = 0.05). The univariate analyses were performed on the study variables using tables, percentages, graphs, and frequencies for descriptive purposes. The bivariate analyses were performed to determine an association between the independent variables and the outcome variables using binary logistic regression, and Pearson Chi-square test of independence to determine an association between the independent and dependent variable. Finally, variables that were statistically significant at the bivariate level were analysed with multinomial logistic regression to determine

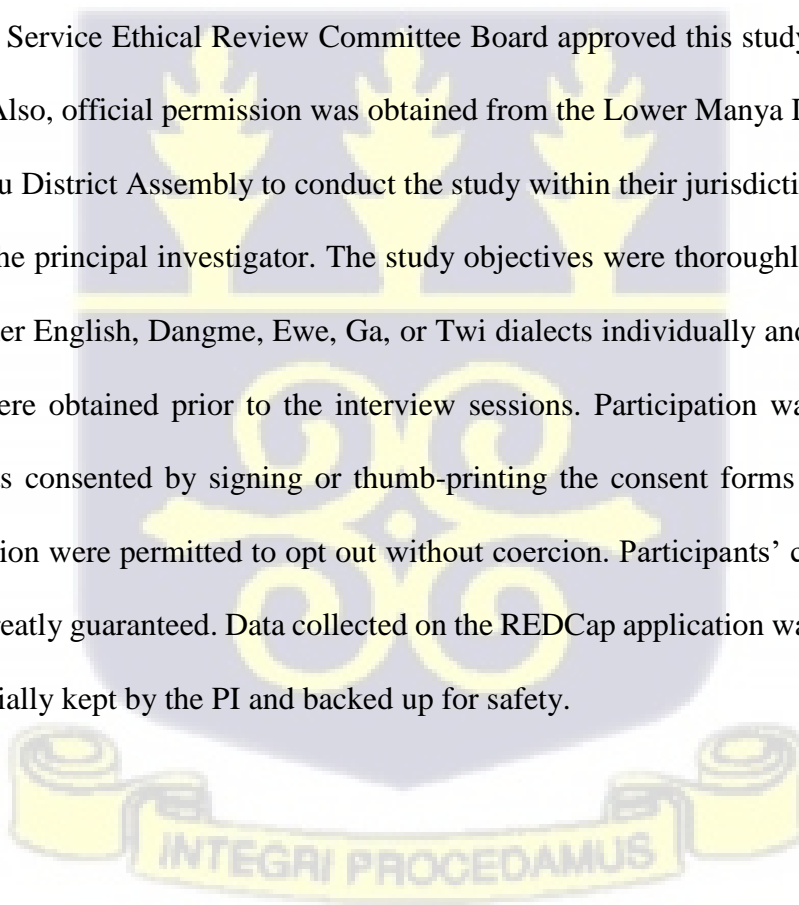
variables strongly associated with household fuels choices. Variables with p-values less than 0.05 at 95% confidence interval (CI) significantly influenced fuel choices and the risk of coking-related burns.

### **3.8 Quality Control**

Precautions were taken to ensure the reliability and validity of the data. The questionnaire was adopted from the WHO harmonized survey questions for monitoring household energy use (Group, 2019). Only research assistants with in-depth knowledge of the selected communities and native dialects were recruited and adequately trained on the study protocols. The questionnaire was edited by the study supervisor for completeness, errors, omissions, and mistakes prior to uploading onto the REDCap application. The tool was pre-tested on 10 primary cooks during the training sessions to test its efficiency, validity, and reliability.

### **3.9 Ethical consideration**

The Ghana Health Service Ethical Review Committee Board approved this study numbered GHS-ERC 048/09/21. Also, official permission was obtained from the Lower Manya District Assembly, and Shai Osu-Doku District Assembly to conduct the study within their jurisdiction. The study was solely funded by the principal investigator. The study objectives were thoroughly explained to the participants in either English, Dangme, Ewe, Ga, or Twi dialects individually and their unqualified written consent were obtained prior to the interview sessions. Participation was voluntarily, the willing participants consented by signing or thumb-printing the consent forms whilst those who declined participation were permitted to opt out without coercion. Participants' confidentiality and anonymity were greatly guaranteed. Data collected on the REDCap application was passworded and the code confidentially kept by the PI and backed up for safety.



## CHAPTER FOUR

### RESULTS

#### 4.1 Sociodemographic Characteristics of Participants

Data for this study was obtained from 274 houses and 382 households in the Kpong and Asutuare townships of Ghana. Of the participating households, 6.81% of the primary cooks were males whereas 93.19% were females. 48.90% of the participants fell between the age ranges 16-35 years, 46.34% were between 36 – 59 years, and 5.76% were 60 years and above. Majority of the participants representing 56.78% had high school education, 27.54% attended primary school and 12.30% had no education whilst 3.74% had tertiary education.

The Ewe/Anlo with 56.43% were the dominant ethnic group, the Ga/Adamgbe with 20.73% were the second largest ethnic group with the Krobos and Akan ethnic groups constituting 9.97% and 4.72% respectively. 11.40% of the household heads earned less than or equal to Ghc 250.00 monthly while 62.07% of the household heads earned between Ghc 251.00 to 1000.00 monthly. 26.53% earned greater than or equal to Ghc 1001.00 monthly on the average. In terms of occupation, 29.55% of the household heads engaged in petty trade, 12.67% were farmers, 27.18% were artisans, 18.97% were employed, and 11.61% were unemployed. 97.66% of the households had access to improved water sources, while 2.34% accessed unimproved water. Regarding waste disposal, 90.06% of the households improperly disposed of their wastes, 9.94% safely disposed their wastes. 28.50% had access to improved toilet facilities, whilst 71.49% accessed unimproved toilet facilities.

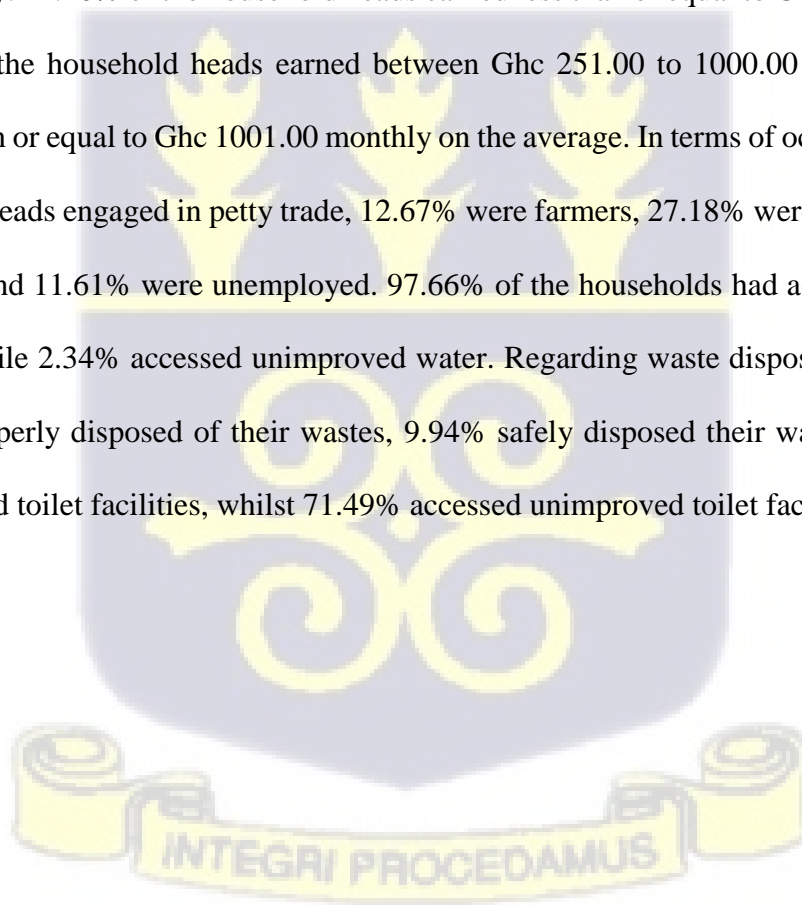


Table 4.1a Sociodemographic characteristics of study participants (n=382)

Variable	Frequency (n)	Percentage (%)
<b>Sex primary cooks</b>		
Male	26	6.81
Female	356	93.19
<b>Age - primary cook</b>		
16 – 35 years	183	47.91
36 – 59 years	177	46.34
60+ years	22	5.76
<b>Education - primary cooks</b>		
No education	46	12.30
Primary	103	27.54
<sup>1</sup> High school	211	56.78
Tertiary	14	3.74
<b>Religion - primary cooks</b>		
<sup>2</sup> Christians	353	92.65
Muslims	21	5.51
<sup>3</sup> Agnostic	7	1.84
<b>Marital status</b>		
Single	120	31.42
Currently married	188	49.21
<sup>4</sup> Ever married	74	19.37
<b>Ethnicity - primary cooks</b>		
Adamgbe	79	20.79
Ewe/Anlo	215	56.58
Krobo	37	9.74
Akan	18	4.74
<sup>5</sup> Other	31	8.16
<b>Sex - household head</b>		
Male	257	66.75
Female	128	33.25

<sup>1</sup>High school: junior high and senior high. <sup>2</sup>Christian: catholic, Protestant, Pentecostal/Charismatic.

<sup>3</sup>Agnostic: Atheists, traditionalists, prefer not to say. <sup>4</sup>Ever married: divorced, widowed, separated but not divorced. <sup>5</sup>Other: Ga, Guan, Mole-Dagbani, Zarma.

Table 4.1b Sociodemographic characteristics of study participants (n=382)

Variable	Frequency (n)	Percentage (%)
<b>Education - household head</b>		
No education	50	13.09
Primary	92	24.08
<sup>1</sup> High school	213	55.76
Tertiary	27	7.07
<b>Occupation household head</b>		
<sup>6</sup> Farmer	87	22.96
Artisan	64	16.89
Trader	112	29.55
<sup>7</sup> Employed	72	19.00
<sup>8</sup> Unemployed	44	11.61
<b>Income levels</b>		
≤ Ghc250	27	7.16
Ghc 251 – 1000	234	62.07
≥ <sup>9</sup> Ghc 1001	100	26.53
Reluctant	16	4.24
<b>Type of dwelling</b>		
Single household occupancy	132	34.55
Multiple household occupancy	209	54.71
Enclosed dwelling	41	10.73
<b>Household ownership</b>		
Sole ownership	101	26.79
Family house	108	28.64
Rented	166	44.27
<b>Source of drinking water</b>		
<sup>10</sup> Improved water source	374	97.66
<sup>11</sup> Unimproved water source	8	2.34
<b>Toilet Facility</b>		
<sup>12</sup> Improved facility	108	28.50
<sup>13</sup> Unimproved facility	271	71.49
<b>Waste disposal</b>		
<sup>14</sup> Safe disposal	38	9.94
<sup>15</sup> Improper disposal	344	90.06

<sup>6</sup>Farming: farm own land, fishing, day labourer. <sup>7</sup>Employed: government employee, business employee. <sup>8</sup>Unemployed: retired, other, run household, unemployed. <sup>9</sup>≥ Ghc 1001: Ghc 1001 – 3000.

<sup>10</sup>Improved water source: piped into home, public tap, enclosed well, sachet water.

<sup>11</sup>Unimproved water source: stream/river. <sup>12</sup>Improved toilet facility: WC, private pit latrines.

<sup>13</sup>Unimproved toilet facility: shared/public KVIP, open fields, bucket latrines, other. <sup>14</sup>Safe disposal: pickup by waste management company, burn at designated sites. <sup>15</sup>Improper disposal: open dumping, burning on own compound, burning outside own compound, dumping along river/lake bank, open dumping on own compound.

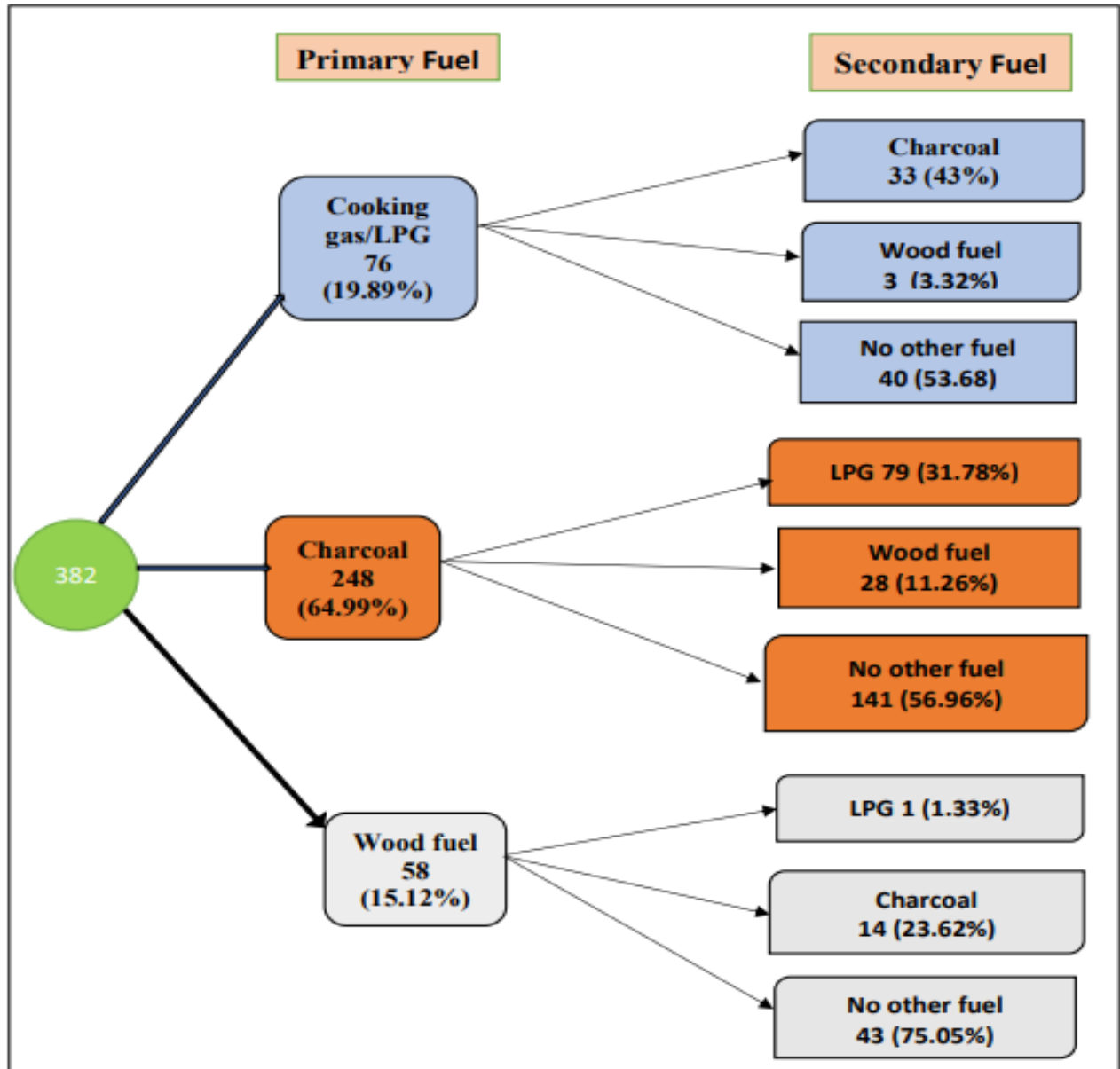


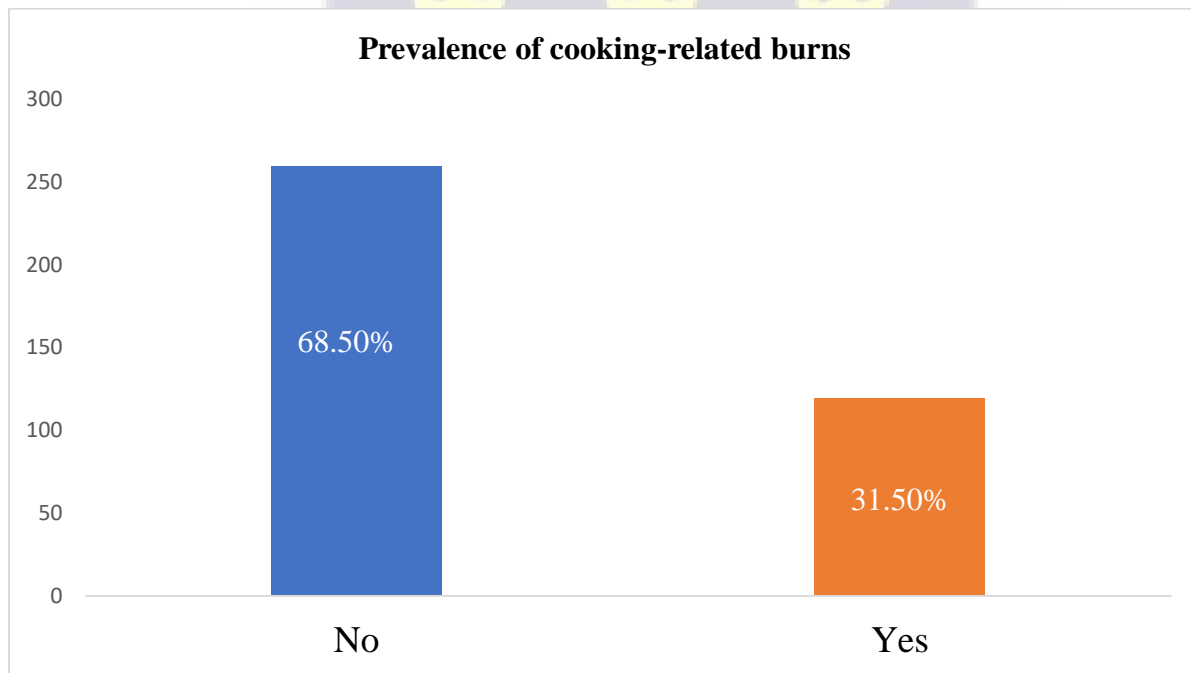
Figure 4.1: Household fuel choices and the patterns of fuel stacking behaviours among the two riparian communities



Figure 4.1 illustrates the different categories of primary household fuels consumed in the selected communities for domestic purposes including cooking, and heating. Unprocessed charcoal (64.99%) was the dominant cooking fuel consumed by the selected households. Cooking gas/LPG (19.89%) was the second most consumed primary fuel while wood fuel consumption accounted for 15.12% of the communities cooking fuel basket.

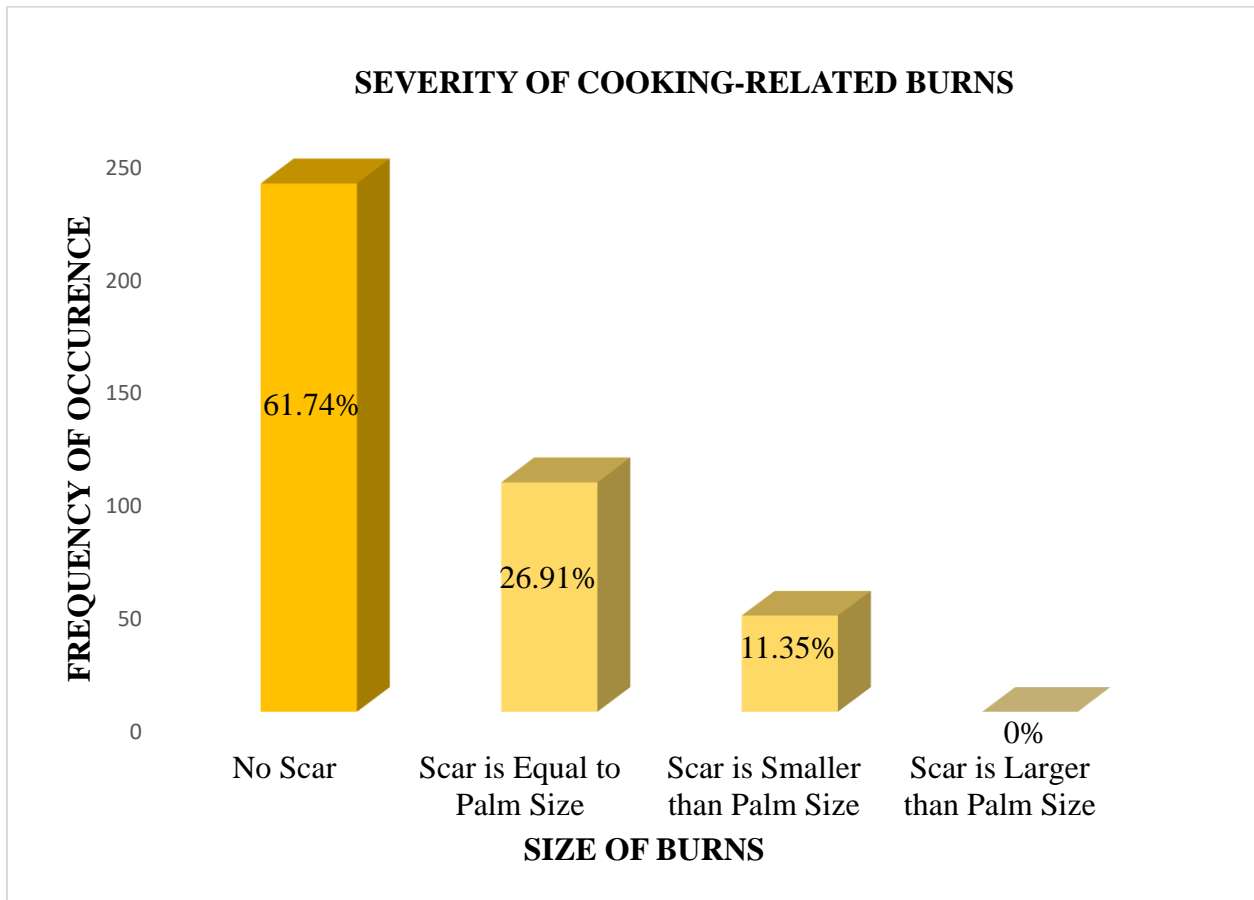
Fuel stacking behaviours were observed among the selected households. Among the households consuming charcoal as their primary fuel, 31.78% reported combining it with cooking gas/LPG, 11.26% combined it with wood fuel while 56.96% exclusively consumed charcoal. Participants who primarily consumed wood fuel, 23.62% combined it with charcoal, 1.33% combined it with cooking gas/LPG, and 75.05% exclusively consumed wood fuel. Households who consumed cooking gas/LPG as their primary cooking fuel, 43% reported combining it with charcoal, 3.32% combined it with wood fuel while 53.68% consumed LPG exclusively.

### 4.3 Cooking-related burns



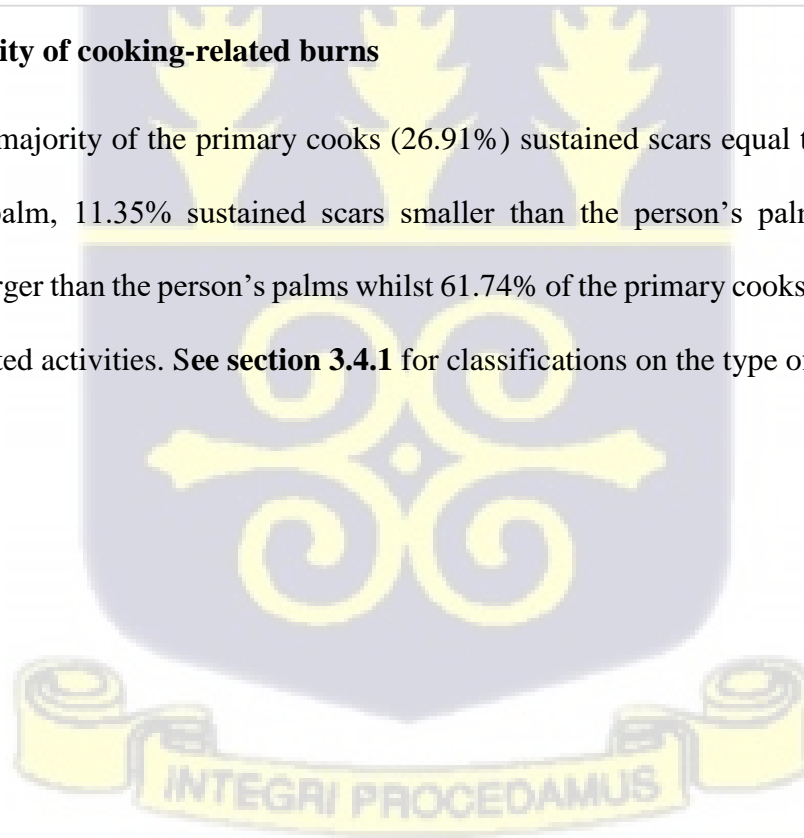
**Figure 4.2: Prevalence of cooking-related burns**

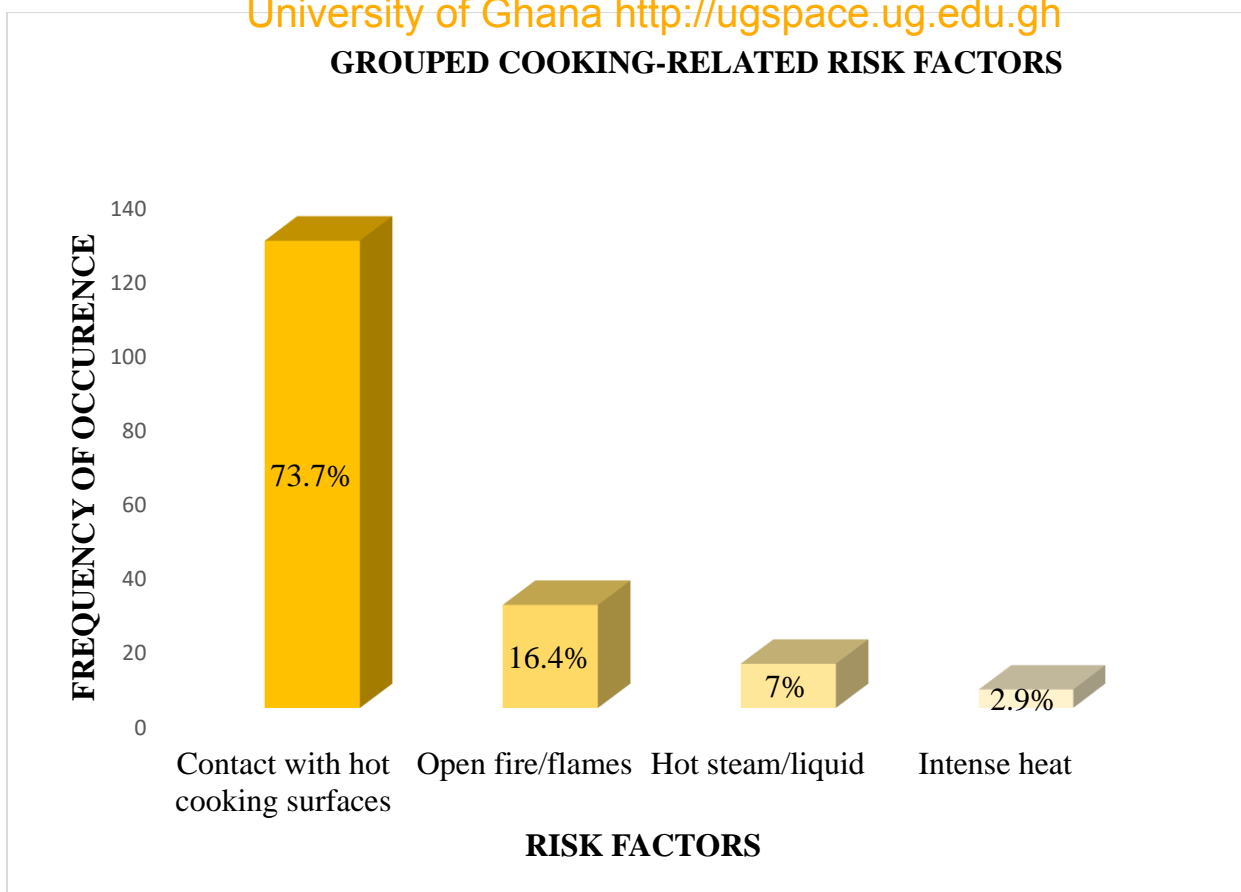
Among the primary cook participants, 31.50% suffered one form of burn or the another, while 68.50% reported not suffering any cooking-related burns.



**Figure 4.3: Severity of cooking-related burns**

From Figure 4.3, majority of the primary cooks (26.91%) sustained scars equal to the surface area of the person’s palm, 11.35% sustained scars smaller than the person’s palm. No participant sustained burns larger than the person’s palms whilst 61.74% of the primary cooks had no scars from their cooking-related activities. See section 3.4.1 for classifications on the type of burns.



**GROUPED COOKING-RELATED RISK FACTORS****Figure 4.4: Grouped cooking-related risk factors**

Contact with hot surfaces accounted for 73.70% of the total cooking-related burn cases, 16.40% of the burns occurred due to open fire/flames, 7% of the burns occurred due to hot steam/liquid while 2.90% of the cooking-related burns arose due to intense heat emitted during cooking.

#### **4.5 Logistic Regression Model on the association between household fuels and the risk of cooking-related burns**

From Table 4.2, the unadjusted logistic regression model, unprocessed charcoal (P-value = 0.004), wood fuel (P-value = 0.038) were household fuels that showed statistical significant association with cooking-related burns at 95% confidence interval. From the adjusted logistic regression model, unprocessed charcoal (P-value = 0.024), wood fuel (P-value = 0.014) were household fuels that showed statistical significant association with cooking-related burns.

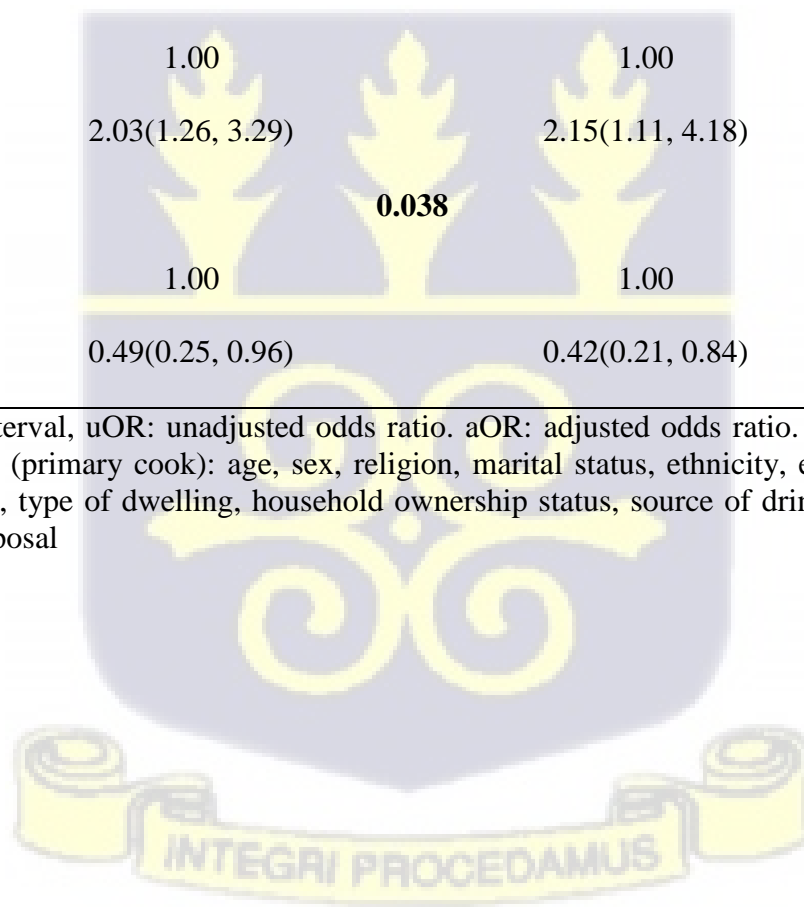
The odds from the adjusted model of household fuel consumption, charcoal unprocessed, and wood fuel (aOR: 2.15, 95% CI: [1.11, 4.18]) and (aOR: 0.42, 95% CI: [0.21, 0.84]) respectively showed

that charcoal users were 2.15 times more likely to experience cooking-related burns in comparison to wood fuel users who had 0.42 less chance of experiencing cooking-related burns in the household. These results indicate that majority of the cooking-related burns suffered were associated with biomass fuel (charcoal, wood) usage. Cooking gas/LPG fuel unadjusted (P-value = 0.079), and adjusted (P-value = 0.811) were statistically insignificant with cooking-related burns.

**Table 4.2: Association between household fuel choices and cooking-related burns**

<b>Cooking-related burns</b>	<b>Unadjusted logistic regression model uOR (95% CI)</b>	<b>P-value</b>	<b>Adjusted logistic regression model aOR (95% CI)</b>	<b>P-value</b>
<b>LPG</b>		0.079		0.811
No	1.00		1.00	
Yes	0.59(0.32, 1.06)		1.10(0.49, 2.50)	
<b>Charcoal</b>		<b>0.004</b>		<b>0.024</b>
No	1.00		1.00	
Yes	2.03(1.26, 3.29)		2.15(1.11, 4.18)	
<b>Wood fuel</b>		<b>0.038</b>		<b>0.014</b>
No	1.00		1.00	
Yes	0.49(0.25, 0.96)		0.42(0.21, 0.84)	

CI: confidence interval, uOR: unadjusted odds ratio. aOR: adjusted odds ratio. OR (95% CI) for adjusted variables (primary cook): age, sex, religion, marital status, ethnicity, education, income levels, occupation, type of dwelling, household ownership status, source of drinking water, toilet facility, waste disposal



**Table 4.2.1: Association between household fuel choices and risk factors of cooking-related burns**

	<u>Unadjusted logistic regression model</u> uOR (95% CI)	P-value	<u>Adjusted logistic regression model</u> aOR (95% CI)	P-value
<b>Burn risk factors</b>				
Open flames	1.00		1.00	
Hot steam/liquid	3.67(0.17, 77.55)	0.404	10.94(0.31, 380.14)	0.186
Contact hot surface	6.61(0.60, 73.40)	0.124	15.74(1.05, 235.73)	<b>0.046</b>
<b>Sex</b>				
Male	1.00		1.00	
Female	2.30(1.25, 4.25)	<b>0.008</b>	1.60(0.17, 14.77)	0.678
<b>Occupation</b>				
Trader	1.00		1.00	
Farmer	1.36(0.61, 3.07)	0.453	1.61(0.09, 28.42)	0.745
Artisan	0.71(0.33, 1.56)	0.397	1.30(0.06, 26.26)	0.864
Employed	0.43(0.21, 0.87)	0.018	0.37(0.02, 5.75)	0.475
Unemployed	0.88(0.35, 2.20)	0.776	2.05(0.05, 82.17)	0.703
<b>Income level</b>				
<= GHC 250	1.00		1.00	
GHC 251 – 1,000	0.54(0.16, 1.88)	0.333	3.43(0.22, 53.73)	0.380
>= GHC 1,000	0.35(0.10, 1.26)	0.109	5.67(0.23, 138.53)	0.287
Reluctant	1.88(0.18, 19.72)	0.601	0.25(0.01, 9.36)	0.452

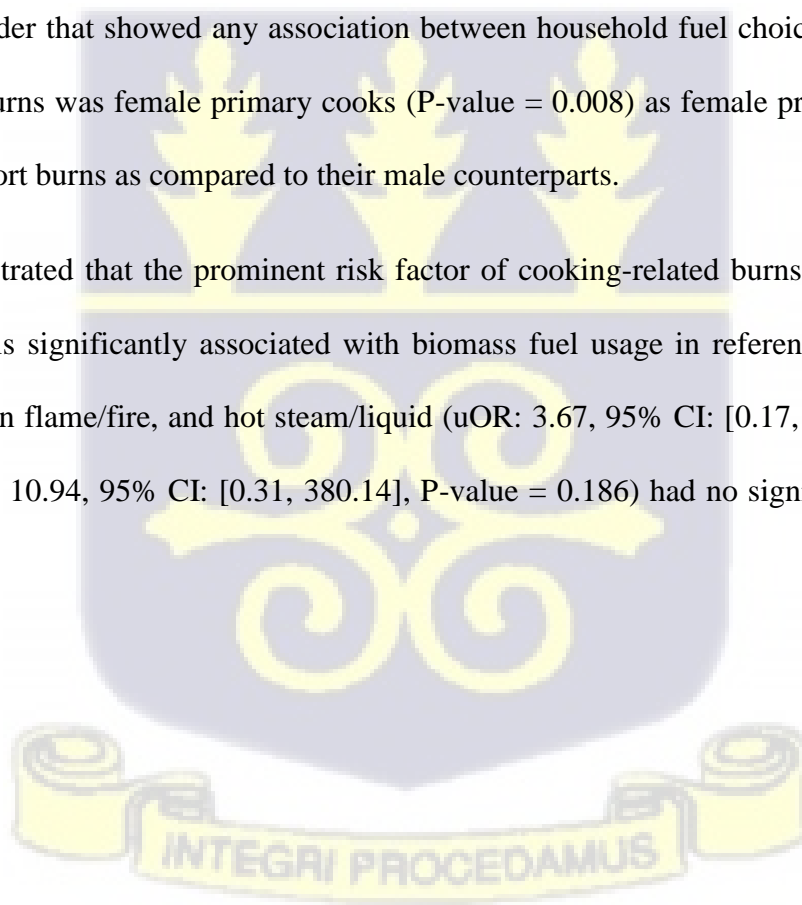
**Base Outcome: LPG.** CI: confidence interval, uOR: unadjusted odds ratio. aOR: adjusted odds ratio. OR (95% CI) for adjusted variables (primary cook): age, religion, marital status, ethnicity, education, type of dwelling, household ownership status, source of drinking water, toilet facility, waste disposal.

From Table 4.2.1, the unadjusted logistic regression model, hot steam/liquid (P-value = 0.404), and contact with hot surfaces (P-value = 0.124) showed no statistical significance as cooking-related burn risk factors of biomass fuel relative to LPG usage at 95% confidence interval. From the adjusted logistic regression model, hot steam/flame (P-value = 0.186) likewise showed no statistical significant association as a cooking-related burn risk factor of biomass fuel relative to LPG usage at 95% confidence interval. Contact with hot cooking surfaces (P-value = 0.046) had a statistical significant association with cooking-related risk factors biomass fuels relative to LPG usage at 95% confidence interval.

The odds from the unadjusted model of the cooking-related burn risk factors of females (uOR: 2.30, 95% CI: [1.25, 4.25]) demonstrated that female primary cooks were 2.30 times more exposed to the risk of cooking-related burns emanating from biomass fuel usage relative to the male primary cooks.

The only confounder that showed any association between household fuel choices and the risk of cooking-related burns was female primary cooks (P-value = 0.008) as female primary cooks were more likely to report burns as compared to their male counterparts.

These results illustrated that the prominent risk factor of cooking-related burns (contact with hot cooking surface) is significantly associated with biomass fuel usage in reference to cleaner fuel (LPG) usage. Open flame/fire, and hot steam/liquid (uOR: 3.67, 95% CI: [0.17, 77.55], P-value = 0.404), and (aOR: 10.94, 95% CI: [0.31, 380.14], P-value = 0.186) had no significant association with LPG usage.



#### 4.6 Chi-square test of Association between the Determinants and Households' Primary Fuel Choices.

From table 4.3, age of household heads, religion, and ethnicity were the determinants with no statistical significant influence on a household's choices of cooking fuels.

Sex of household heads (Pearson's  $\chi^2 = 7.64$ , P-value = 0.022), marital status (Pearson's  $\chi^2 = 10.19$ , P-value = 0.037), educational levels of household heads (Pearson's  $\chi^2 = 38.11$ , P-value = <0.001), dwelling type (Pearson's  $\chi^2 = 25.84$ , P-value = <0.001), household ownership status (Pearson's  $\chi^2 = 19.76$ , P-value = 0.001), income levels of household heads (Pearson's  $\chi^2 = 14.71$ , P-value = 0.023), and the occupational status of household heads (Pearson's  $\chi^2 = 25.17$ , P-value = 0.001) were the factors that statistically influenced a household's primary cooking fuel choices.

**Table 4.3 Chi-square test of association between the Determinants and Household Fuels Choices.**

Variable	n (382)	$\chi^2$ Stat	df	P-value	Cramer's V
<b>Age range of household head</b>		3.62	4	0.460	0.069
16 – 35 years	180				
36 – 59 years	176				
60+ years	20				
<b>Sex household head</b>		7.64	2	<b>0.022</b>	0.143
Male	251				
Female	125				
<b>Marital Status of household head</b>		10.19	4	<b>0.037</b>	0.116
Married	185				
Single	117				
<sup>4</sup> Ever married	74				
<b>Educational level of household head</b>		38.11	6	<b>&lt;0.001</b>	0.225
No education	50				
Primary	92				
<sup>1</sup> High school	207				
Tertiary	27				

<b>Home dwelling type</b>		25.84	4	<0.001	0.185
Single occupancy	132				
Multiple occupancy	203				
Enclosed dwelling	41				
<b>Household Ownership</b>		19.76	4	0.001	0.164
Sole ownership	100				
Family house	106				
Rented	163				
<b>Income levels of household head</b>		14.71	6	0.023	0.141
≤ Ghc 250.00	27				
Ghc 251 – 1000.00	229				
<sup>9</sup> ≥ Ghc 1001.00	99				
Reluctant	16				
<b>Occupational of household head</b>		25.17	8	0.001	0.184
Trading	108				
<sup>6</sup> Farming	86				
Artisan	64				
<sup>7</sup> Employed	72				
<sup>8</sup> Unemployed	43				
<b>Religion of household head</b>		2.93	4	0.569	0.063
<sup>2</sup> Christians	348				
Muslims	21				
<sup>3</sup> Agnostic	7				
<b>Ethnicity of household head</b>		13.48	8	0.096	0.134
Adamgbe	76				
Ewe/Anlo	214				
Krobo	37				
Akan	18				
<sup>5</sup> Other	30				



#### 4.7 Multinomial Logistic Regression Analysis on the Determinants and Household Fuel Consumption Choices

Table 4.4a illustrates the relative risk ratio of LPG preference in relation to wood fuel when all other variables are held constant. Females were statistically less likely 0.83 (95% CI: 0.23, 3.08), and [P-value = 0.785] to prefer LPG as their primary fuel source compared to their male counterparts.

Ever-married status, and being single; 0.35 (95% CI: 0.09, 1.37), P-value = 0.132), 0.60 (95% CI: [0.22, 1.66], P-value = 0.326) respectively had no statistical significant influence on the choice of LPG as primary fuel relative to the currently married group. Also, participants with primary education 0.80 (95% CI: [0.17, 3.37], P-value = 0.777), high school education 3.11 (95% CI: [0.77, 12.66], P-value = 0.112), tertiary education 8.21 (95% CI: [0.59, 114.57], P-value = 0.117) had no significant preference for LPG as their primary fuel source relative to those with no education. Participants residing in rented homes on the average were statistically more likely 3.64 (95% CI: [1.22, 10.83], P-value = 0.020) to consume LPG as their main source of cooking fuel for household activities in comparison to households residing in homes solely owned by household heads. Furthermore, participants residing in multiple occupancy homes, enclosed or walled homes 4.34 (95% CI: [1.63, 11.55], P-value = 0.003), 7.05 (95% CI: [1.12, 44.22], P-value = 0.037) respectively were more likely to consume LPG as their primary fuel choice for domestic activities including cooking, and heating as compared to participants residing in single occupancy homes.

Households with income levels between Ghc 251 – 1,000.00,  $\geq$  Ghc 1,001.00, and those reluctant in disclosing their average monthly income 0.70 (95% CI: [0.12, 4.05], P-value = 0.694), 1.64 (95% CI: [0.22, 12.48], P-value = 0.633), and 0.13 (95% CI: [0.01, 2.61], P-value = 0.184) respectively demonstrated statistically insignificant preference for LPG relative to households with income levels  $\leq$  Ghc 250.00. Additionally, the occupational status of the selected participants: farmers, artisans, the employed, and the unemployed 0.33 (95% CI: [0.09, 1.18], P-value = 0.088), 0.83 (95% CI: [0.19, 3.54], P-value = 0.799), 1.13 (95% CI: [0.24, 5.36], P-value = 0.878), and 0.82 (95% CI:

[0.18, 3.64], P-value = 0.791) respectively statistically had no influence on their likelihood of adopting LPG as primary fuel relative to the traders.

**Table 4.4a: Multinomial Logistic regression on determinants and household fuel choices**

Variable	Cooking gas/LPG OR (95% CI)	P-value
<b>Sex of household head</b>		
Male	1.00	
Female	0.83 (0.23, 3.08)	0.785
<b>Marital Status of household head</b>		
Married	1.00	
Single	0.60(0.22, 1.66)	0.326
<sup>4</sup> Ever married	0.35(0.09, 1.37)	0.132
<b>Educational level of household head</b>		
No education	1.00	
Primary	0.80(0.17, 3.73)	0.777
<sup>1</sup> High school	3.11(0.77, 12.66)	0.112
Tertiary	8.21(0.59, 114.57)	0.117
<b>Household dwelling type</b>		
Single occupancy	1.00	
Multiple occupancy	4.34(1.63, 11.55)	<b>0.003</b>
Enclosed dwelling	7.05(1.12, 44.22)	<b>0.037</b>
<b>Household Ownership</b>		
Sole ownership	1.00	
Family house	1.36(0.41, 4.49)	0.612
Rented	3.64(1.22, 10.83)	<b>0.020</b>
<b>Income levels of household head</b>		
≤ Ghc 250.00	1.00	
Ghc 251 – 1000.00	0.70(0.12, 4.05)	0.694
<sup>9</sup> ≥ Ghc 1001.00	1.64(0.22, 12.48)	0.633
Reluctant	0.13(0.01, 2.61)	0.184
<b>Occupation of household head</b>		
Trading	1.00	
<sup>6</sup> Farming	0.33(0.09, 1.18)	0.088
Artisan	0.83(0.19, 3.54)	0.799
<sup>7</sup> Employed	1.13(0.24, 5.36)	0.878
<sup>8</sup> Unemployed	0.82(0.18, 3.64)	0.791

**Base outcome:** wood fuel. OR: odds ratio

Table 4.4b depicts the relative risk ratio of charcoal consumption relative to wood fuel when all other variables are held constant. Female participants 1.39 (95% CI: [0.48, 4.00], P-value = 0.539) statistically had no significant relationship with charcoal consumption as primary fuel relative to the male participants.

The ever-married participants 0.30 (95% CI: [0.10, 0.88], P-value = 0.028) were statistically less likely to consume charcoal as their primary fuel for cooking, and heating as compared to participants who were currently married. Participants residing in rented homes 2.68 (95% CI: [1.11, 6.46], P-value = 0.028) were more likely to prefer charcoal as their main source of cooking fuel for household activities relative to households residing in homes solely owned by the household heads. Furthermore, participants residing in multiple occupancy homes 2.15 (95% CI: [1.02, 4.55], P-value = 0.045) were more likely to consume charcoal as their primary fuel for domestic purposes as compared to those residing in single occupancy homes.

Participants with primary education 0.77 (95% CI: [0.29, 2.03], P-value = 0.593), high school education 1.33 (95% CI: [0.51, 3.50], P-value = 0.562), tertiary education 0.93 (95% CI: [0.08, 10.45], P-value = 0.950) had no significant preference for charcoal as their main fuel relative to those with no educational status.

Households with income levels between Ghc 251.00 – 1,000.00,  $\geq$  Ghc 1,001.00, and those who were reluctant to disclose their earnings 0.40 (95% CI: [0.11, 1.45], P-value = 0.163), 1.36 (95% CI: [0.28, 6.52], P-value = 0.698), and 0.34 (95% CI: [0.05, 2.34], P-value = 0.272) respectively statistically had no significant influence on the preference of charcoal as main cooking fuel relative to households with income levels  $\leq$  Ghc 250.00. Additionally, farmers, artisans, the employed, and the unemployed participants 0.43 (95% CI: [0.16, 1.14], P-value = 0.091), 0.82 (95% CI: [0.23, 2.86], P-value = 0.750), 1.08 (95% CI: [0.27, 4.33], P-value = 0.916), and 0.53 (95% CI: [0.16, 1.78], P-value = 0.307) respectively statistically had no significant association on charcoal consumption as their primary cooking fuel relative to the traders.

Table 4.4b: Multinomial logistic regression on determinants and household fuel choices

Variable	Charcoal Unprocessed OR (95% CI)	P-value
<b>Sex of household head</b>		
Male	1.00	
Female	1.39(0.48, 4.00)	0.539
<b>Marital status of household head</b>		
Married	1.00	
Single	0.68(0.30, 1.56)	0.366
<sup>4</sup> Ever married	0.30(0.10, 0.88)	<b>0.028</b>
<b>Educational status of household head</b>		
No education	1.00	
Primary	0.77(0.29, 2.03)	0.593
<sup>1</sup> High school	1.33(0.51, 3.50)	0.562
Tertiary	0.93(0.08, 10.45)	0.950
<b>Household dwelling type</b>		
Single occupancy	1.00	
Multiple occupancy	2.15(1.02, 4.55)	<b>0.045</b>
Enclosed dwelling	4.30(0.84, 21.81)	0.079
<b>Household ownership status</b>		
Sole ownership	1.00	
Family house	1.55(0.63, 3.85)	0.340
Rented	2.68(1.11, 6.46)	<b>0.028</b>
<b>Income levels of household head</b>		
≤ Ghc 250.00	1.00	
Ghc 251 – 1000.00	0.40(0.11, 1.45)	0.163
<sup>9</sup> ≥ Ghc 1001.00	1.36(0.28, 6.52)	0.698
Reluctant	0.34(0.05, 2.34)	0.272
<b>Occupation of household head</b>		
Trading	1.00	
<sup>6</sup> Farming	0.43(0.16, 1.14)	0.091
Artisan	0.82(0.23, 2.86)	0.750
<sup>7</sup> Employed	1.08(0.27, 4.33)	0.916
<sup>8</sup> Unemployed	0.53(0.16, 1.78)	0.307

**Base outcome:** Wood fuel. OR: odds ratio.

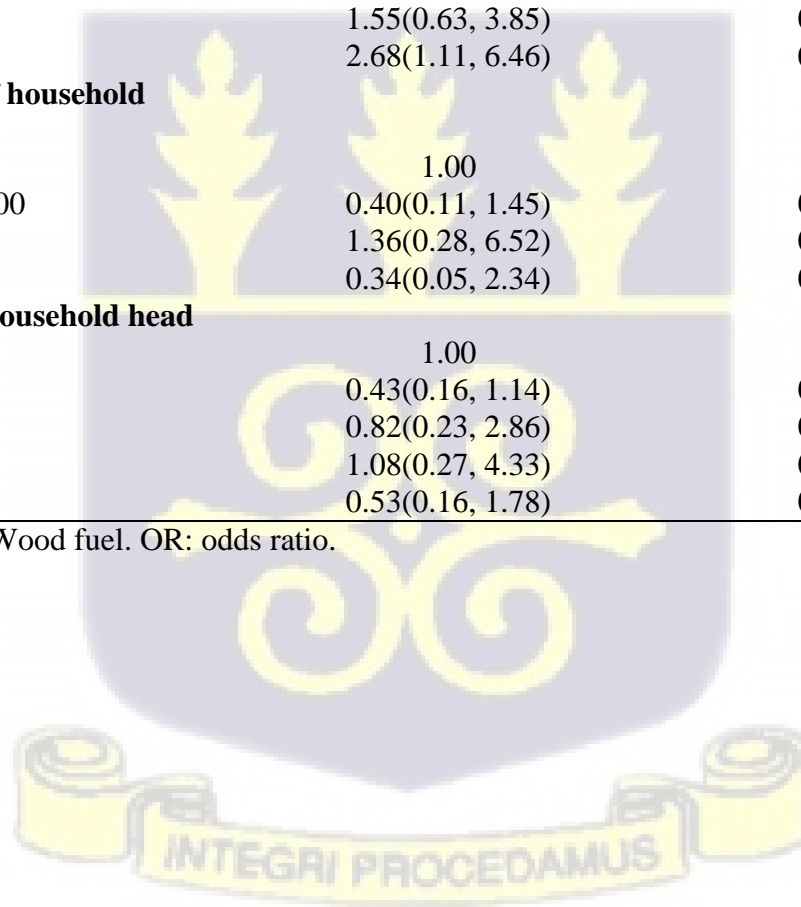


Table 4.4c illustrates the likelihood of households preferring LPG as their primary cooking fuel in relative to biomass fuels. The results from this study indicated that the sex of household heads, marital status of a household head, household ownership status, income levels of household heads, and the occupational status of household heads had no statistical significant influence on a household's choice of LPG as its primary cooking fuel relative to biomass usage.

Furthermore, household heads with tertiary educational background 9.04 (95% CI: [2.05, 39.90], P-value = 0.004), and households dwelling in multiple occupancy homes 2.29 (95% CI: [1.09, 4.85], P-value = 0.030) were more likely to prefer LPG (clean fuel) as their primary source of fuel for cooking food, and heating water relative to solid biomass fuels.



**Table 4.4c: Multinomial Logit regression on determinants and household fuel choice**

Variable	Cooking gas/LPG OR (95% CI)	P-value
<b>Sex of household head</b>		
Male	1.00	
Female	0.63 (0.25, 1.59)	0.330
<b>Marital Status of household head</b>		
Married	1.00	
Single	0.83(0.40, 1.72)	0.619
<sup>4</sup> Ever married	0.98(0.35, 2.69)	0.964
<b>Educational level of household head</b>		
No education	1.00	
Primary	1.02(0.28, 3.75)	0.979
<sup>1</sup> High school	2.46(0.79, 7.67)	0.120
Tertiary	9.04(2.05, 39.90)	<b>0.004</b>
<b>Household dwelling type</b>		
Single occupancy	1.00	
Multiple occupancy	2.29(1.09, 4.85)	<b>0.030</b>
Enclosed dwelling	1.95(0.69, 5.52)	0.207
<b>Household Ownership</b>		
Sole ownership	1.00	
Family house	0.96(0.39, 2.39)	0.929
Rented	1.57(0.71, 3.43)	0.259
<b>Income levels of household head</b>		
≤ Ghc 250.00	1.00	
Ghc 251 – 1000.00	1.57(0.41, 6.03)	0.509
<sup>9</sup> ≥ Ghc 1001.00	1.21(0.28, 5.26)	0.795
Reluctant	0.35(0.03, 4.06)	0.402
<b>Occupation of household head</b>		
Trading	1.00	
<sup>6</sup> Farming	0.65(0.25, 1.70)	0.384
Artisan	0.99(0.40, 2.44)	0.976
<sup>7</sup> Employed	1.03(0.42 2.53)	0.954
<sup>8</sup> Unemployed	1.41(0.47, 4.25)	0.540

**Base outcome:** Biomass fuel. OR: odds ratio



## CHAPTER FIVE

### DISCUSSIONS

#### 5.1 Main findings

This study was conducted on 274 houses and 382 households in the Kpong Area Council and the Asutuare Area Council of the Lower Manya Krobo district, and the Shai Osudoku district. 31.50% of the primary cooks reported ever experiencing cooking-related burn injuries. Majority (73.70%) of these burns occurred due to contact with hot cooking surfaces. Unprocessed charcoal (P-value = 0.004), wood fuel (P-value = 0.038) were household fuels that showed statistical significant association with cooking-related burns. Charcoal users were 2.15 times more likely to experience the risk of cooking-related burns as compared to wood fuel users who were 0.42 times less exposed to the risk of cooking-related burns in the household. Marital status (P-value = 0.037), education (P-value = <0.001), sex of household head (P-value = 0.022), household dwelling type (P-value = <0.001), household ownership status (P-value = 0.001), income (P-value = 0.023), and occupation of household head (0.001) were the determinants that statistically influenced household fuel consumption choices.

The selected households exhibited fuel stacking behaviours. 43% of primary LPG users combined it with charcoal, 3.32% combined it with wood. 31.78% of primary charcoal consumers combined it with LPG, 11.26% used it in conjunction with wood. 1.33% of primary wood consuming households combined it with LPG while 23.62% combined it with charcoal.

#### 5.2 Methodological Validity

This study adopted the clustered sampling method in selecting the eligible households to guarantee equal chance of participation by each household. This technique helped to minimize selection bias. During the data collection process, the original language of the questionnaire was translated into the native dialect of the participants with no or limited knowledge of the English language. Additionally,

both the interviewer and primary cook had no prior knowledge of the association of interest regarding the study. This helped combat information bias.

Pilot interviews were conducted on the data collection tool in ten selected homes at Kpong on two occasions to enhance correctness and reduce interviewer bias. The study was limited by possible underreporting of cooking-related burns ever experienced. However, related studies on a similar objective reported similar prevalence of cooking-related burns.

### **5.3 Comparison of findings with previous studies**

#### **5.3.1 Cooking-related burns**

The findings from this study showed a high prevalence of cooking-related burns due to the consumption of biomass fuels (charcoal, firewood). Only a few of the cooking-related burns occurred due to clean fuel (LPG) consumption. These findings support the study conducted by (Albertyn et al., 2012; Van Niekerket al., 2013; Kimemia et al., 2014; Govender et al., 2020) that household burns are directly associated with the consumption of biomass fuels in poor and developing countries.

#### **5.3.2 Cooking-related burn risk factors**

Contact with hot cooking surfaces: overwhelming, 73.70% of the cooking related burns sustained by the primary cooks emanated from contact with hot surfaces (cookstoves). This result supports the findings of (Panday et al, 2007; Albertyn et al., 2012; Dans et al., 2017; Kimemia et al., 2014; Govender et al., 2020) that cookstoves constructed close to ground levels increased the risk of scald and burn injuries.

Open fire or flames: open fire was the second leading (16.40%) risk factor that contributed to burn injuries. This result confirms the findings of (Panday et al, 2007; Albertyn et al., 2012; Dans et al., 2017) that cooking and heating on open flames significantly contributed to burns in low- and middle-income countries. Escaping sticks under a 3-stone stove easily destabilize the remaining woods and expose the primary cook to the risk of burns.

Hot steam or liquid: from this study, 7% of the primary cooks reported suffering burns due to incidents involving hot liquids or steams. These burns are a consequence of hot soup spillage, hot beverage, hot water, or hot food spillage due to pot overturn in the kitchen. This confirms the findings of (Van Niekerket al., 2006; Govender et al., 2020 ) that hot liquids or steam exposed and increased the vulnerability of primary cooks and infants to scalds.

Intense heat radiation: results from the study (2.90%) of the primary cooks reported suffering burns from excessive and intense heat emitted during cooking and heating activities. Empirical studies reported that intense heat radiation is one of the risk factors associated with cooking-related burns (Drago, 2005; Govender et al., 2020).

### **5.3.3 Household fuels**

Results from this study showed excessive reliance on biomass fuel for domestic activities. Unprocessed charcoal dominated the cooking fuel basket in the selected communities. These results support the findings of (Albertyn et al., 2012; Mensah & Adu, 2015 Martey et al., 2021) that majority of households in LMICs largely depend on traditional fuels for cooking, and heating. Only a few households exclusively relied on LPG (modern fuel) for cooking and heating.

### **5.3.4 Determinants of household fuel choices**

Income levels of household heads: the chi-square test ( $\chi^2 = 14.71$ , P-value = 0.023) for household head's income levels demonstrated that income levels and choice of primary fuels were significantly associated. Wood fuel consumption as main cooking fuel decreased as income levels rose. Inversely, the use of charcoal and LPG increased as income levels increased. This finding suggests that richer households preferred transitional fuels (charcoal), and modern fuels (LPG) relative to poorer households who largely favoured traditional fuels. These results support other findings that a statistical significant association exists between cleaner fuel consumption and household income levels (Mekonnen & Köhlin, 2008; Kwakwa et al., 2013; Mensah & Adu, 2015; Ado et al., 2016; Paudel et al., 2018; Mbaka et al., 2019; Wassie et al., 2021).

Educational status of household head: the chi-square test ( $\chi^2 = 38.11$ , P-value  $<0.001$ ) for educational level showed a statistically significant relationship between a household head's educational status and the choice of primary fuel for cooking. Household heads with high school, and tertiary experience were more likely to consume transitional fuels (charcoal, LPG) as their main source of cooking fuel relative to household heads with no education. This indicates that as a household head's educational status improves, they become increasingly likely to transition from traditional fuels to cleaner fuels as primary cooking fuels. These findings corroborate the works of (Hertberg, 2003; Suliman, 2010; Kwakwa et al., 2013; Mensah & Adu, 2015; Ado et al., 2016; Paudel et al., 2018;) that education influences the choice of cooking fuel since it exposes household heads to the existence of cleaner fuels and their advantages over biomass fuels.

The occupation of household heads: the chi-square test ( $\chi^2 = 25.17$ , P-value = 0.001) for occupation disclosed that a statistically significant relationship exists between a household head's occupation (source of income) and their choice of primary fuel for cooking. Household heads who engaged in farming activities were more likely to consume biomass fuels. Likewise, household heads formally employed were more likely to consume charcoal and cooking gas relative to the unemployed household heads. These findings support similar findings by (Kwakwa et al., 2013; Adeyemi et al., 2016; Wassie et al., 2021) that formal employment status influenced a households choice of modern fuel consumption.

Household dwelling type: the chi-square test ( $\chi^2 = 25.84$ , P-value  $<0.001$ ) for household dwelling status disclosed that dwelling type and choice of primary fuel were significantly associated. Households residing in multiple occupancy homes (P-value = 0.003), and those residing in walled or enclosed homes (P-value = 0.037) were more like to use cleaner fuels (LPG) as their primary cooking fuel relative to households residing in single occupancy homes. Additionally, households living in multiple occupancy homes (P-value = 0.045) were more likely to consume charcoal relative to wood fuel. These results confirms the findings of (Paudel et al., 2018; Martey, 2019) that

households residing in wealthier homes, and those sharing their dwelling places with other families were more likely to consume cleaner fuels.

**Household ownership status:** the chi-square test ( $\chi^2 = 19.76$ , P-value = 0.001) for household ownership status disclosed that household ownership status and the choice of primary fuel for cooking were significantly associated. Households residing in rented homes (P-value = 0.020) had statistically significant probability of adopting modern fuels (LPG) as compared to households residing in homes solely owned by the household head. Similarly, households residing in rented homes (P-value = 0.028) had higher chances of adopting transitional fuels (charcoal) for domestic applications as compared to household heads residing in their own homes. This finding corroborates the work of (Paudel et al., 2018) that households residing in rented homes were more likely to save portions of their income, attain higher educational status, and engage in income generating ventures, thus, more likely to invest on cleaner fuels.

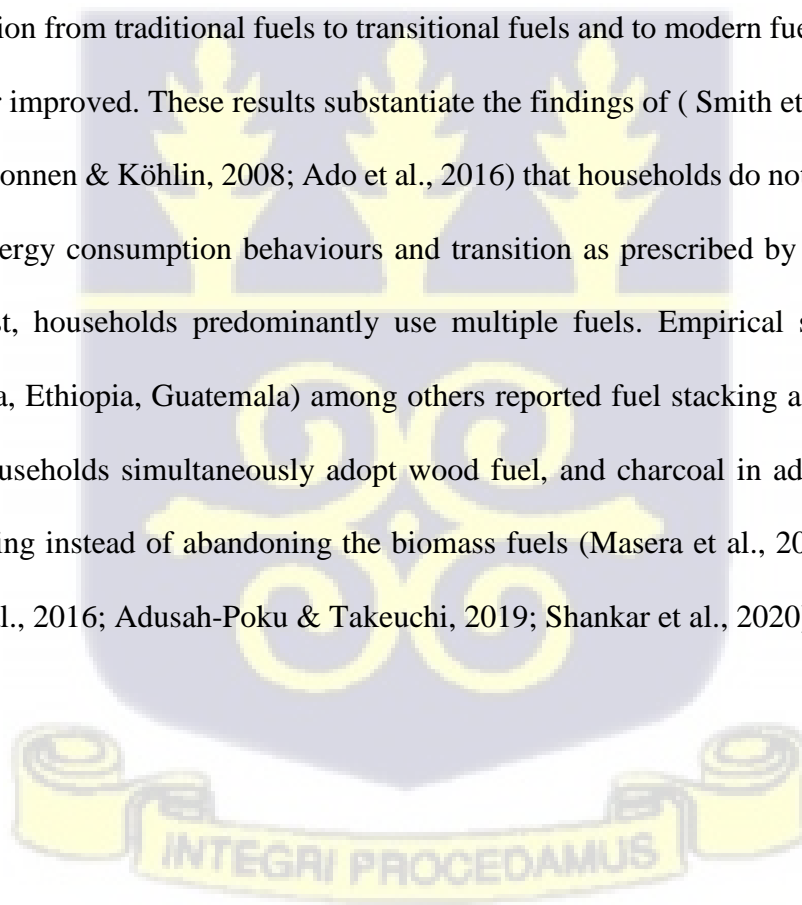
**Sex of household head:** the chi-square test for sex ( $\chi^2 = 3.62$ , P-value = 0.022) showed a significant relationship between a household head's sex and the choice of fuel for domestic purposes. Female headed households were less likely to consume modern fuels (LPG) in comparison to households headed by males. Also, female headed households exhibited no significant association with the choice of charcoal as their primary fuel relative to male headed households. These results confirm the findings of (Kohlin et al., 2012; Mbaka et al., 2019; Wassie et al., 2021) that female headed households in rural developing sub-Saharan Africa were more likely to consume biomass fuels as compared to male headed households since they are more disadvantaged in income generation.

**Marital status of household head:** the chi-square test ( $\chi^2 = 10.19$ , P-value = 0.037) for marital status showed a statistically significant relationship between a household head's marital status and the choice of primary fuel for cooking. Household heads who were ever married (P-value = 0.028) were less likely to use charcoal as their primary fuel relative to household heads currently married. This

finding supports the research of (Paudel et al., 2018) in Afghanistan that married household heads inclined towards the consumption of cleaner fuels relative to ever married household heads.

### **5.3.5 Household fuel stacking behaviours**

From this study, it was observed that households use cooking fuels in varied combinations. The households adopted at least a secondary fuel source in addition to their primary sources. Irrespective of their socioeconomic status, the selected households did not completely discard biomass fuels for cleaner fuels. Instead, they added them to their existing fuels. Each household exhibited similar fuel stacking behaviours. Households that consumed LPG as their primary fuel source had 43% of them combining it with charcoal, 3.32% combined it with wood fuel. Among the primary charcoal consuming households, 31.78% consumed it in conjunction with LPG, 11.26% in conjunction with wood fuel. 1.33% of primary wood fuel users combined it with LPG while 23.62% used it simultaneously with charcoal. This contradicts the energy ladder hypothesis which assumes that households transition from traditional fuels to transitional fuels and to modern fuels as their income levels increased or improved. These results substantiate the findings of ( Smith et al., 1994; Elias & Victor, 2005; Mekonnen & Köhlin, 2008; Ado et al., 2016) that households do not adhere to a linear pattern in their energy consumption behaviours and transition as prescribed by the energy ladder theory. In contrast, households predominantly use multiple fuels. Empirical studies conducted elsewhere (Nigeria, Ethiopia, Guatemala) among others reported fuel stacking as the predominant practice where households simultaneously adopt wood fuel, and charcoal in addition to LPG for cooking, and heating instead of abandoning the biomass fuels (Masera et al., 2000; Ogwumike et al., 2014; Ado et al., 2016; Adusah-Poku & Takeuchi, 2019; Shankar et al., 2020).



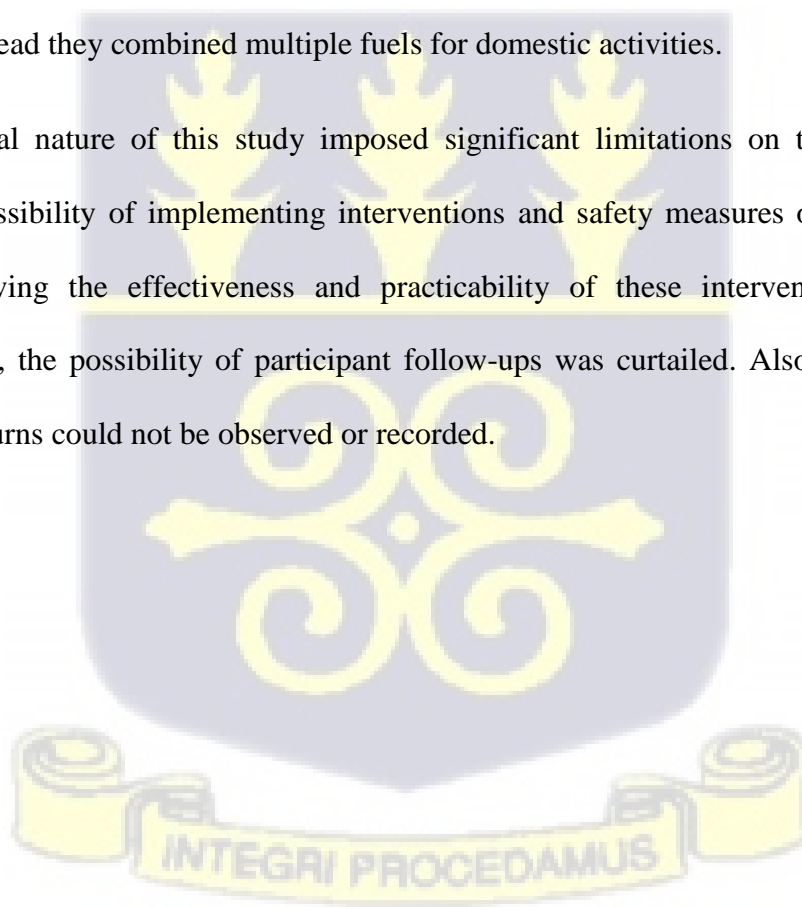
## CHAPTER SIX

### CONCLUSION AND RECOMMENDATIONS

#### 6.1 Conclusion

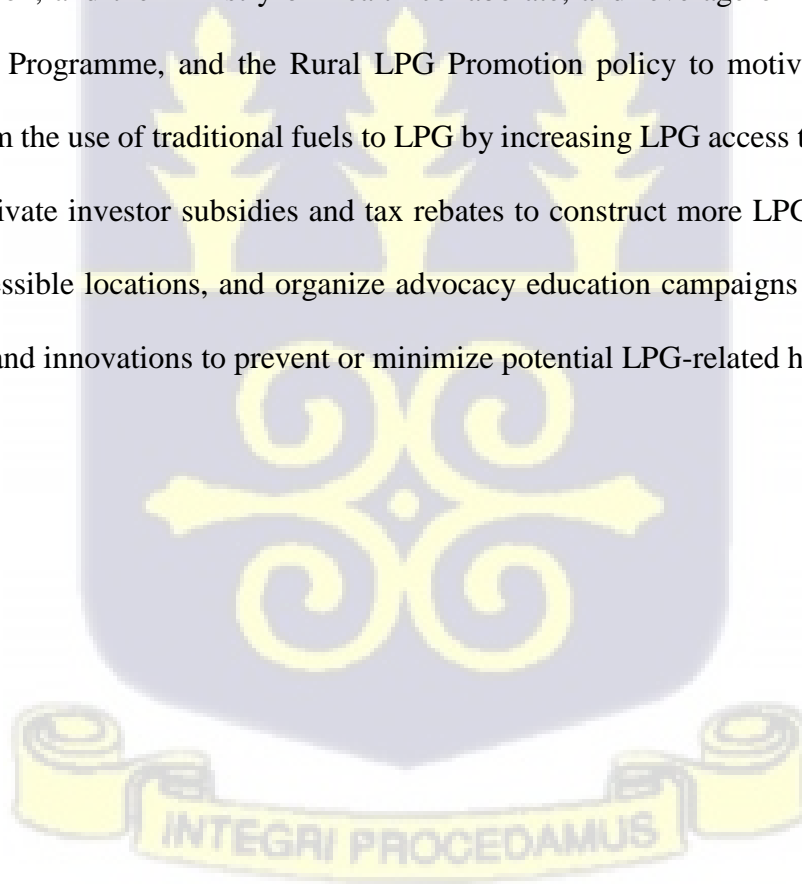
The significance of household cooking fuels is invaluable. The Ghanaian cooking fuel basket is largely dominated by wood fuel, charcoal, LPG, and electricity. The goal of this study was to evaluate the determinants of household fuel choices and the risk of cooking-related burns. The study findings disclosed that educational levels, income levels, household ownership status, marital status of household head, sex of household head, household dwelling type, and occupational status of household heads were the factors that significantly influenced a household's fuel consumption choices. Additionally, majority of the cooking-related burns suffered by the primary cooks were associated biomass fuel consumption. Furthermore, it was determined that households did not completely switch from traditional fuel consumption to cleaner fuels as hypothesized by the energy ladder theory, instead they combined multiple fuels for domestic activities.

The cross-sectional nature of this study imposed significant limitations on the study since it eliminated the possibility of implementing interventions and safety measures on household fuel usage and observing the effectiveness and practicability of these interventions among the participants. Thus, the possibility of participant follow-ups was curtailed. Also the incidence of cooking-related burns could not be observed or recorded.



## 6.2 Recommendations

- It is recommended for the Government of Ghana to encourage, and create an enabling environment through its Energy Ministry, and the Ministry of Environment, Science, Technology & Innovation to promote charcoal cookstove redesign and modification technologies similar to the *Gyapa* improved cookstove initiative incorporating modern insulative features that shield the metallic outer surface from excessive heating, in addition to safety education campaigns in the mass media on safe kitchen practices, at relatively moderate costs to the users. These interventions will protect and safeguard domestic biomass charcoal users and the general public against incidences of contact burns due to hot metallic inductive cooking surfaces.
- It is further recommended that the Government of Ghana through the National Petroleum Authority (NPA), the Energy Ministry, the Ministry of Environment, Science, Technology & Innovation, and the Ministry of Health collaborate, and leverage on the National LPG Promotion Programme, and the Rural LPG Promotion policy to motivate households to switch from the use of traditional fuels to LPG by increasing LPG access to rural consumers through private investor subsidies and tax rebates to construct more LPG stations at safer, easily accessible locations, and organize advocacy education campaigns on best LPG safe practices, and innovations to prevent or minimize potential LPG-related hazards.



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## APPENDICES

### Appendix 1: Participant Information Sheet

Title: Household fuel choices and burn injuries among residents along the river volta (kpong and Asutuare)

#### Introduction

I am Courage Gidiglo, a Master of Public Health (MPH) student at the School of Public Health, University of Ghana, Legon. My email addresses are [gidiglocatore@gmail.com](mailto:gidiglocatore@gmail.com) / [cgidiglo001@st.ug.edu.gh](mailto:cgidiglo001@st.ug.edu.gh) and my telephone number is 0543201579. I am student and self-employed.

#### Background of the study

The Volta River is the world's largest artificial lake and runs through Ghana from Bobo- Dioulasso highlands of Burkina Faso. It serves as a source of power generation, livelihood, irrigation for agriculture activities and some form of employment for the riparian communities. Household fuels serve as sources of energy for cooking, lighting, heating, and other human activities. Majority of households in sub-Saharan Africa depend largely on solid biomass fuels such as firewood, and charcoal as a source of energy for cooking and heating because they are cheaper than most alternatives and easily accessible, but these fuels emit large amounts of criteria pollutants such as particulate matter, black carbon, and carbon monoxide. Exposure to these pollutants poses adverse health consequences to vulnerable groups in the population including women and infants including acute respiratory infections, cancers of the lung, burn injuries, and environmental problems such as deforestation, and reduction in the air quality index.

#### Nature of study

This is a quantitative research study that focuses on factors influencing household energy consumption choices and the risk of burn injuries in communities at the lower Volta basin at the Manya Krobo district (Kpong) and Shai Osudoku district (Asutuare) of the Eastern and Greater Accra Regions of Ghana. It is a cross-sectional study adopting quantitative techniques to assess households' exposure to fuels, household fuel choices, and burns adapting structured questionnaires developed in the English language and hosted on the REDCap (Research Electronic Data Capture) application

### **Participant Involvement**

I would be grateful if you participate in this study because you reside within the study location (Kpong or Asutsuare) and consume household fuels for cooking activities. I trust that you can assist me by providing the suitable answers.

### **Duration**

It is a one-time study and as such, participants will only be required to respond to a questionnaire once.

### **Potential risks**

This research will cause no harm to the participants. It is hoped that the findings from this research will aid policy makers, health and environment oversight bodies of the riparian communities along the River Volta for informed choices. Given the risk posed by the COVID 19 pandemic, all safety directives protocols about COVID-19 as recommended by the Ghana Health Service and the National COVID-19 control team to avoid the risk of being infected with the virus will be strictly adhered to. All field workers and participants of the study are required to socially distance of at least 6 feet while waiting to be participate in the study, observe hygiene practices such as hand washing with soap under running water and the use of alcohol-based hand sanitizer as well as wearing of facemask.

### **Benefits**

There would be no direct or indirect profits from this study. However, your responses would be useful in policy planning and the formulation of recommendations to appropriate authorities regarding household fuels and the risk of burns among rural and peri-urban dwellers.

### **Costs**

Participation in this study is free. No monetary rewards or incentive will be awarded for participation.

### **Compensation**

No financial or material compensations will be given to participants of this study.

### **Declaration of Conflict of interest**

The principal investigator (PI) has no interest in this research.

### **Privacy/Confidentiality**

Participant details will not be required, but the information provide will be coded and will be preserved with utmost confidence. Please, be assured that I will maintain your confidentiality. Only the PI and the supervisor for this study will access the information provided. Data analysis will be

performed at the aggregate level to guarantee anonymity. The data will be coded such that no information will be traced to you. Data files will be kept for 3 years, and discarded afterwards.

### **Voluntary Participation and withdrawal**

This study's participation is entirely voluntary. Participants are free to choose whether or not to participate in this study. Furthermore, you have the right to withdraw your consent at any time, without explanation and without repercussions.

### **Outcome and feedback**

The information gathered will be used to improve policy formulation on household fuel consumption and the risk of burns among rural and peri-urban residents.

### **Feedback to participants**

There will be no individual feedback, but a report will be shared with the various stakeholders involved in policy formulation in the Kpong and Asutsuare districts.

### **Funding information**

All costs relating to this study will be borne solely by the Principal Investigator.

### **Sharing of participants Information/Data**

Data gathered will be kept in the possession of the principal investigator and this information will not be shared with any other organization(s) or individuals. It will only be for usage.

### **Storage of samples**

Data files will be kept for 3 years, and discarded afterwards.

### **Provision of information and consent form for participants**

A copy of the consent form and the information sheet will be given to each participant after signing or thumb-printing for safe keep.

### **Who to contact for further clarification or questions**

In the event for further enquires and any challenge concerning the study please contact the principal investigator, Courage Gidiglo on 0543201579. Also, the Ghana Health Service Ethics Review Committee Administrator Madam Nana Abena Apatu may be contacted on 0503539896 or [ethics.research@ghsmaail.org](mailto:ethics.research@ghsmaail.org) for more information on ethical issues and their rights of participants if necessary.

**Appendix 2: CONSENT FORM**

**HOUSEHOLD FUEL CHOICES AND BURN INJURIES AMONG RESIDENTS ALONG THE RIVER**

**PARTICIPANTS' STATEMENT**

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

I voluntarily agree to be part of this research.

Name of Participant.....

Participants' Signature .....OR Thumb Print.....

Date:.....

**INTERPRETERS' STATEMENT**

I interpreted the purpose and contents of the Participants' Information Sheet to the afore named participant to the best of my ability in the (Ewe, Krobo, Ga, Dangme, Akan) language to his proper understanding.

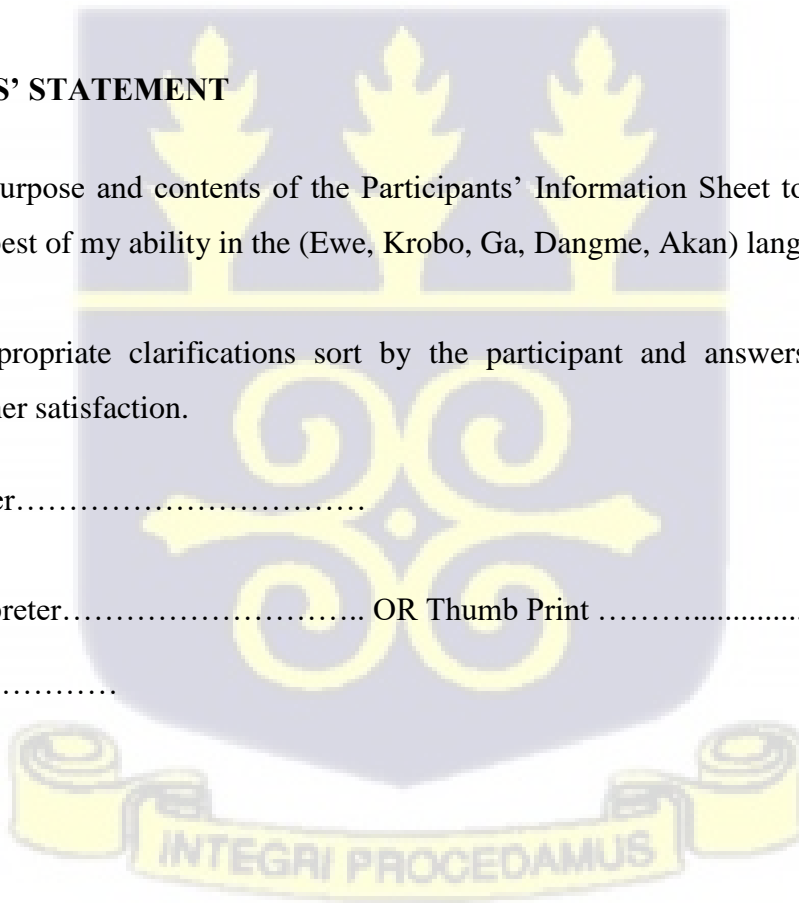
All questions, appropriate clarifications sort by the participant and answers were also duly interpreted to his/her satisfaction.

Name of Interpreter.....

Signature of Interpreter..... OR Thumb Print .....

Date:.....

Contact Details



**STATEMENT OF WITNESS**

I was present when the purpose and contents of the Participant Information Sheet was read and explained satisfactorily to the participant in the language, he/she understood (English, Ewe, Krobo, Ga, Dangme, Akan)

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

Name.....

Signature..... OR Thumb Print .....

Date.....

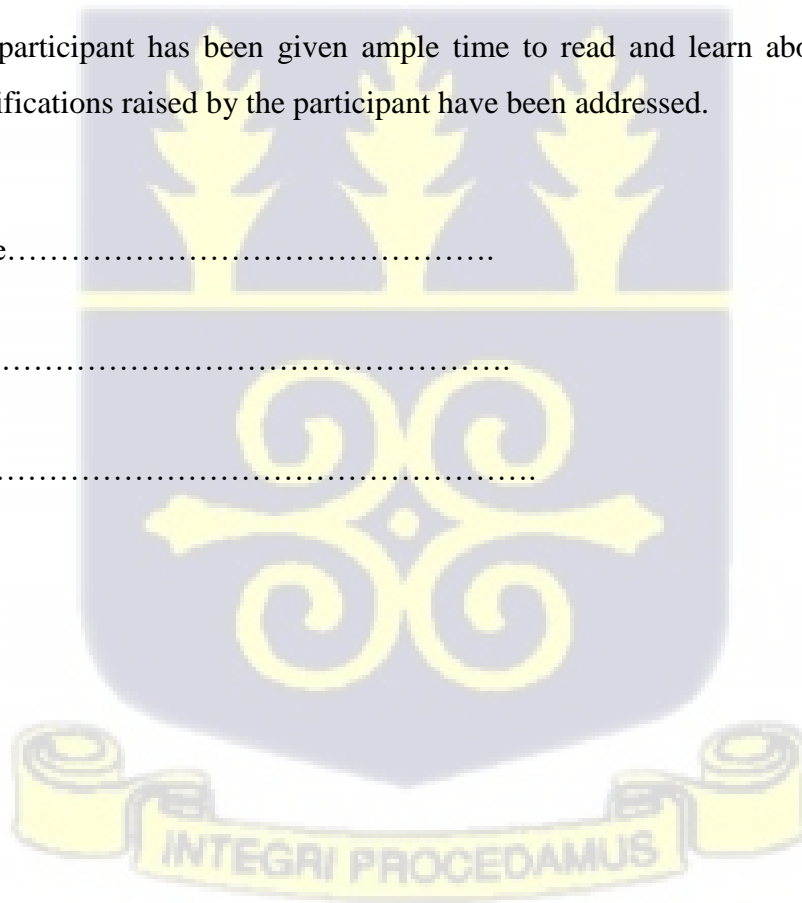
**INVESTIGATOR STATEMENT AND SIGNATURE**

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

Researcher's name.....

Signature .....

Date.....



Appendix 3: Questionnaire

**MODULE A: BASIC INFORMATION**

<p>A1: Participant's ID (<i>studyID</i>)/ House Id _____</p> <p>A2: Participant's Tel: _____</p> <p>A3: Region _____</p> <p>A4: District _____</p> <p>A5: Electoral Area _____</p> <p>A6: Community _____</p> <p>A7: Team _____</p>	<p>A8: Field worker code: _____</p> <p>A9: Date of Interview: _____ (dd-mm-yyyy)</p> <p>A10: Start time of Interview _____</p> <p><b>A11 GPS of household</b> Longitude..... Latitude..... Altitude.....</p>
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**MODULE B: INFORMED CONSENT AND VERIFICATION**

B1	Did participant consent to partake?	<p>[0] No, why? [01] Not interested [02] Family against participating [03] Afraid [04] Personal reasons [5] Other <b>(End interview)</b></p> <p>[1] Yes</p>	
B2	Did the participant consent to allow information taken to be stored and used for future studies?	<p>[0] No [1] Yes</p>	
B3	Do you agree to record some part of the interview?	<p>[0] No [1] Yes</p>	

B4	Are you planning to move out of your community for more than 3 weeks in the next 10 months?	[0] No [1] Yes	
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Instruction: Please Tick (✓) appropriate response or write in the empty space provided.

**MODULE C: PRIMARY COOK CHARACTERISTICS AND SOCIODEMORGRAPHIC INFORMATION**

No.	Question	Response	
C1	Are you the main primary cook of the house?	[0] No – stop the interview and reschedule for when the main cook is at home. [1] Yes, continue with interview	
C2	Participant's Age (years).	_____	
C3	Participant's sex	[0] None [1] Male [2] Female	
C4	Are there other cooks in the house aside the main cook?	[0] No [1] Yes, if yes, how many? .....	
C5	What is the relationship of the primary cook to the household head?	[0] I don't know/ not sure [1] Head of the house [2] Married to HH head [3] Partner (Not-Married) of HH head [4] Daughter of HH head [5] Step-daughter of HH head [6] Son of HH head [7] Step-son of HH head [8] Other relative of HH Head [9] Other relationship with HH Head [10] House-help	

C6	Highest Level of Education	[0] None [1] Primary [2] JHS [3] SHS [4] Tertiary	
C7	Religion	[0] None [1] Orthodox [2] Protestant [3] Charismatic [4] Muslim [5] Traditionalist/ spiritualist [6] Agonist [7] Other, (Please [8] Specify) .....	
C8	Tribe	[1] Adagmbe [2] Ewe/ Anlo [3] Krobo [4] Akan [5] Ga [6] Guan [7] Mole-Dagbani [8] Grusi [9] Mande	
C9	Which of the following best describes your profession	[0] None [1] Fisherman/ fish monger [2] Trader [4] Farmer [5] Artisan [6] Professional [7] Other, (Please Specify) .....	
C10	How much do you earn in a month?	[ 1 ] less than GHC 250.00 [ 2 ] GHC 1,001 -2,000 [ 3 ] GHC 2,001 – 3,000 [ 4 ] More than GHC 3,000	

C11	Which of the following best describes your marital status?	[ 1] Single [ 2] Married [ 3] Widowed [4] Divorced [5] Separated but not divorced [5] Other (Specify) .....	
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**MODULE D: HOME ENVIRONMENT**

No.	Question	Response	
D1	Roof type	[ 1] Straw [ 2] Aluminum [ 3] Tile	
D2	Which statement best describes your home?	[1] Single household occupancy [2] Multiple occupancy house [3] Enclosed/walled house [4] multi-storied house [5] Other (specify) .....	
D3	What is the ownership status of your house?	[1] Household head has sole ownership [2] It is a family house [3] It is a rented house [4] It is provided rent free	
D4	Number of people in the house.	[ 1] 1-6 [ 2] 7 and above	
D5	Household Head	[ 0] Not sure [1] Male [1] Female	
D6	Highest educational level of household head	[0] None [1] Primary [2] JHS [3] SHS [4] Tertiary	
D7	Age of household head in years	.....	

**MODULE E: HOUSEHOLD FUEL**

No.	Question	Response	
E1	Is any food or drink consumed by household members cooked or prepared at the household	1 = Yes 0= No ( <b>Skip to Section F</b> )	

	dwelling using a cookstove, fire or other cooking device?		
		<b>a. Primary/main cookstove</b>	<b>b. Secondary cookstove</b>
E3	What does this household use for cooking <b>most of the time</b> , including cooking food, making tea/coffee, boiling drinking water? Please tell me the <b>primary</b> cookstove or device that is used for the most time.	[1] Electric: Hotplate [2] Kerosene stove [3] Electric: Induction [4] Electric: Rice Cooker [5] Gas: Liquefied petroleum gas (LPG)/cooking gas stove [6] Solid Fuel: Manufactured [7] Solid Fuel: Traditional (not manufactured) [8] 3-stone stove/open fire [9] Charcoal stove [999] Other specify.....	[1] Electric: Hotplate [2] Kerosene stove [3] Electric: Induction [4] Electric: Rice Cooker [5] Gas: Liquefied petroleum gas (LPG)/cooking gas stove [6] Solid Fuel: Manufactured [7] Solid Fuel: Traditional (not manufactured) [8] 3-stone stove/open fire [9] Charcoal stove [999] Other specify.....
E4	<b>MAIN FUEL:</b> During this season what type of fuel or energy source does this household use <b>most of the time</b> in this cook stove or device for cooking food, making tea/coffee and boiling drinking water?	[1] Electricity [2] Kerosene [3] Cooking gas/LPG [4] Charcoal unprocessed [5] Charcoal briquettes/pellets [6] Wood [7] Kerosene [8] Agricultural or crop residue/grass/straw/shrubs/corn cobs [9] Animal waste/dung [10] Processed biomass pellets/briquettes [11] Woodchips [12] Garbage/plastic [13] Sawdust Plastic	[1] Electricity [2] Kerosene [3] Cooking gas/LPG [4] Charcoal unprocessed [5] Charcoal briquettes/pellets [6] Wood [7] Kerosene [8] Agricultural or crop residue/grass/straw/shrubs/corn cobs [9] Animal waste/dung [10] Processed biomass pellets/ briquettes [11] Woodchips [12] Garbage/plastic [13] Sawdust

		[999] Other, specify..... [0] No other fuel	Plastic [999] Other, specify..... [0] No other fuel
E5	How long does it take to buy or gather fuel for cooking in a day or on a single trip?	[1] 1-2 hours [2] 2-3 hours [3] 3-4 hours [4] More than 4 hours [99] Not sure/ doesn't know	
E6	On a single trip to collect or buy fuel, how long (distance) does it take one to go and bring fuel to the house?	[0] None [1] 0-1 km [2] 2-3km [3] 4-5km [4] 5-6km [5] 7km and over	
E7	Do you obtain any cooking fuel for free?	[0] No, if no, skip next question [1] Yes, if yes, move to next question	
E8	In the past 12 months, how often was this fuel <b>unavailable</b> in the quantity you desired?	[0] Never (always available) [1] Often (more than once a month) [2] Sometimes (4-12 times a year) [3] Rarely (less than 4 times a year) [999] Don't know/ Unsure	
E9	In the past 12 months, did anyone get <b>injured</b> from fetching or using the fuel you usually use?	[ 0] None [ 1] Burns [ 2] Fire in house [ 3] Death [99] other	
E10	Primary stove used	[ 1] Traditional clay stove/VCSCS [ 2] Coal Pot [ 3] Both 1& 2 [ 4] Burner	
E11	Time spent gathering fuel in a day	[ 1] 30min-1 hour [ 2 ]1 hour and above	
E12	Fuel stacking behaviours,	[ 1] Use one fuel at a time [ 2] Mix fuel use at a time	

E13	Characteristics of fuel	[ 1] Convenient [ 2] Cheaper [ 3] Cooks fast [ 4] Food taste better	
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**MODULE F: MODULE I: WATER, SANITATION AND HEALTH**

No.	Question	Response	
F1	What is the source of water for cooking, drinking and bathing in your house?	[0] Not sure [1] River/ Stream [2] Borehole/ well (underground water) [3] Tap water [4] Rain water [5] Water truck, tanker [6] Dugout/ pond [7] Sachet/ bottled water [8] Other, specify please /.....	
F2	To what extent do you agree or disagree with waste segregation in your community?	[0] Not sure [1] Agree [2] strongly agree [3] Disagree [4] Strongly disagree	
F3	Which kind of waste do you generate at home? tick	[0] Not sure [1] Bio waste or food crops [2] Plastics [3] Paper [4] Glass [5] Textiles [6] Metals [7] Wood [8] Hazardous substances [9] Other, please specify.....	
F4	How do you dispose your waste?	[0] Not sure [1] Burying [2] Burning	

		<p>[3] Throwing</p> <p>[4] Pick up for recycling by waste management workers</p> <p>[5] Other, specify.....</p>	
F5	<p>In the past 12 months, did any harm or injury happen from using this cookstove, device or fuel? (Circle all that respondent mentions.)</p>	<p>[0] None</p> <p>[1] Burn injury</p> <p>[2] Fire in house</p> <p>[3] Poisoning</p> <p>[3] Death</p> <p>[4] Other</p>	
F6	<p>Do you have a toilet facility in the house or compound?</p>	<p>[0] No</p> <p>[1] Yes</p>	
F7	<p>What type of toilet facility do you have?</p>	<p>[1] Water closet/ septic tank/ modern toilet</p> <p>[2] Water sealed/ slab latrine</p> <p>[3] Open pit latrine</p> <p>[4] Hanging latrine</p> <p>[5] Open space</p> <p>[6] Other, please specify.....</p>	
F8	<p>Has any harm or injury or burn ever happened from using the cookstove, device or fuel? (Select all that respondent mentions.)</p>	<p>[0] No scar</p> <p>[1] First degree burn</p> <p>[2] Second degree burn</p> <p>[3] Third degree burn</p> <p>[4] Scald</p> <p>[5] Death</p> <p>[999] Other, specify _____</p>	<p>[0] No scar</p> <p>[1] First degree burn</p> <p>[2] Second degree burn</p> <p>[3] Third degree burn</p> <p>[4] Scald</p> <p>[5] Death</p> <p>[999] Other, specify _____</p>
F9	<p>What was the reason for the injury?</p>	<p>[0] None</p> <p>[1] Flames / fire</p> <p>[2] Hot liquid, steam</p> <p>[3] Contact with a hot surface</p> <p>[4] Electrical burn</p> <p>[5] Intense heat radiation</p>	<p>0 None</p> <p>[1] Flames / fire</p> <p>[2] Hot liquid, steam</p> <p>[3] Contact with a hot surface</p> <p>[4] Electrical burn</p> <p>[5] Intense heat radiation</p>

Appendix: 4 Ethical clearance

**GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE**

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



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Ghana Health Service  
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Email: [ethics.research@ghsmail.org](mailto:ethics.research@ghsmail.org)  
25<sup>th</sup> November, 2021

My Ref. GHS/RDD/ERC/Admin/App 121/50  
Your Ref. No.

Courage Gidiglo  
C/O Margaret Jones,  
P.O. Box, C/7 8363 – Tema

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

GHS-ERC Number	<b>GHS-ERC: 048/09/21</b>
Study Title	Household Fuel Choices and Burn Injuries among Residents along the River Volta (Kpong and Asutuare)
Approval Date	25 <sup>th</sup> November, 2021
Expiry Date	24 <sup>th</sup> November, 2022
GHS-ERC Decision	<b>Approved</b>

**This approval requires the following from the Principal Investigator**

- Submission of a yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

**You are kindly advised to adhere to the national guidelines or protocols on the prevention of COVID -19**

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

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

SIGNED...  .....  
Dr. James Akazili  
(Head, Ethics & Research Management Department)

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

