REGIONAL INSTITUTE FOR POPULATION STUDIES (RIPS)

UNIVERSITY OF GHANA, LEGON

TYPE OF HOUSEHOLD FUEL USED FOR COOKING AND ACUTE RESPIRATORY INFECTION AMONG CHILDREN UNDER FIVE YEARS IN GHANA

BY

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ACCEPTANCE

Accepted by the College of Humanities, University of Ghana, Legon, in partial fulfillment of the requirement for Master of Arts in Population Studies.

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Signature                                      Date
DECLARATION

I ISAAC KWADWO YEBOAH, author of this dissertation, hereby declare that this dissertation is the result of my original work and that no part of it has been presented for another degree in this University or elsewhere.

Signed…………………………………………
Isaac Kwadwo Yeboah (Student)

Date……………………………………………
DEDICATION

I dedicate this work to the best mother in the whole world, Madam Theresa Akua Kyeremaa.

Thank you very much and may God equally reward you.
I wish to use this medium to duly acknowledge faculty, senior colleagues, family and friends who contributed in diverse ways to the success and completion of this dissertation. First and foremost, my sincere gratitude goes to my supervisor Dr. Fidelia Dake whose directions, patience and necessary comments have made this work possible. All the faculty and staff of the Regional Institute of Population Studies (RIPS) are also duly acknowledged. Second, I acknowledge with much gratitude the assistance I received from the PhD students especially Mr. Martin Agyekum Wiredu and Mr. Reuben Tetteh. Third, to my family: Professor Yaw Oheneba Sakyi, Ms. Theresah Akua Kyeremaa, Mrs Agnes Addai, Madam Vida Obeng Addai, Mr. Oppong Agyemang, Mr. Peter Ameyaw, Ms. Faustina Konama, and to my friends and loved ones for their love and support during the entire duration of my studies. May the almighty God richly bless and reward you all Amen!
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<tr>
<td>ALRI</td>
<td>Acute Lower Respiratory Infection</td>
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<tr>
<td>ARI</td>
<td>Acute Respiratory Infections</td>
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<tr>
<td>AURI</td>
<td>Acute Upper Respiratory Infection</td>
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<tr>
<td>BCG</td>
<td>Bacillus Calmette–Guérin</td>
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<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
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<td>DALYs</td>
<td>Disability-Adjusted Life Years</td>
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<tr>
<td>DPT</td>
<td>Diphtheria Pertussis Tetanus</td>
</tr>
<tr>
<td>EPI</td>
<td>Expanded Programme of Immunization</td>
</tr>
<tr>
<td>GDHS</td>
<td>Ghana Demographic and Health Survey</td>
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<td>GSS</td>
<td>Ghana Statistical Service</td>
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<td>HAP</td>
<td>Household Air Pollution</td>
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<td>ICD</td>
<td>International Classification of Diseases</td>
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<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
</tr>
<tr>
<td>LUS</td>
<td>Lancet Under Nutrition Series</td>
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<tr>
<td>MDGs</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>MEME</td>
<td>Multiple Exposures Multiple Effects</td>
</tr>
<tr>
<td>MOH</td>
<td>Ministry of Health</td>
</tr>
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<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>--------------</td>
<td>------------------------------------------------</td>
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<tr>
<td>NO₂</td>
<td>Nitrogen Dioxide</td>
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<tr>
<td>OR</td>
<td>Odds Ratio</td>
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<td>PAH</td>
<td>Polycyclic Aromatic Hydrocarbons</td>
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<tr>
<td>PHC</td>
<td>Population and Housing Census</td>
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<td>RC</td>
<td>Reference Category</td>
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<tr>
<td>SO₂</td>
<td>Sulfur Dioxide</td>
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<td>WHO</td>
<td>World Health Organization</td>
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ABSTRACT

Acute respiratory infection (ARI) is a major public health problem globally that require greater efforts for prevention through research and policy-making. It is reported that ARI is a leading cause of death, morbidity, and disability among children under-five years in many developing countries. Several studies have tried to link the association between biomass fuel use and respiratory infection, morbidity and mortality, yet the association of type of cooking fuels and incidence of ARI in Ghana is largely unknown. This study, therefore, seeks to assess the association between the type of cooking fuels used by households and ARI among children under-five in urban and rural areas of Ghana. Data from the 2014 Ghana Demographic and Health Survey (GDHS) was analyzed using SPSS IBM version 20 software. Pearson Chi-square analysis was used to test for the association between ARI and type of cooking fuels and other independent variables. Binary logistic regression was used to test for the influence of type of cooking fuel on ARI. The study population involved 5,491 children under-five years.

Findings of the present study show that 6.4% children under five had symptoms of ARI during the last two weeks preceding the survey. The univariate analysis showed that a little more than half (52.4%) were males, about 1 in 5 (20.9%) children were below age one, and more than half (56.9%) of the children had completed the recommended doses of childhood vaccination. Also majority (79.9%) of the households use different types of biomass fuels as their main source of cooking fuel compared to 20.1% of households who use different types of non-biomass fuel. Biomass fuel was not statistically associated with incidence of ARI at p=0.05 level. However, the present study revealed that type of place of residence was significant in predicting incidence of ARI among children under-five in Ghana. Children from urban areas were less likely to experience the symptoms of ARI as compared to children from rural areas. Further studies, however, are needed for concrete policy recommendations.
CHAPTER ONE
INTRODUCTION

1.1 Background

Acute Respiratory Infections (ARIs) continue to be the topmost cause of morbidity and mortality among children under-five in developing countries (Victora, 1989; WHO, 1999; WHO, 2000; Kieny, 2005; Mizgerd, 2006; & Williams, 2002). Generally, ARI alone accounts for more than six percent of the global burden of illness and mortality among the entire population (Ezzati, 2001). Globally, 13 million children under five die before reaching their fifth birthday. Out of this number 95% are from developing countries including Ghana and one third of these deaths are attributed to ARI (Taksande and Yeole, 2015).

Studies have shown that contact with smoke from biomass fuel such as wood, charcoal, dung and crop residue increases the risk of respiratory disorders such as persistent cough in adults (Bruce et al. 1998) and acute lower respiratory infection (ALRI) in children under-five (Ezzati and Kammen, 2001; Mishra, 2003). This is because with respect to combustion efficiency and cleanliness, biomass fuels are at the base of the energy ladder. Most of these pollutants it emits include suspended particulate matter, 1,3 butadiene, carbon monoxide (CO), benzene, nitrogen oxides, formaldehyde, polycyclic aromatic hydrocarbons (such as benzo[a]pyrene), and many other toxic organic compounds from smoke due to burning of biomass fuels are very harmful to human health. For instance concentration of these air pollutants tends to be massive indoors where people stay longer indoors for hours. Most of these pollutants cause air pollution and it is usually used by the poor (WHO, 2006). In developing countries such as Ghana, Kenya and Ethiopia, in majority of households, solid (or biomass) fuel is the main source of energy. Biomass fuels are used for space heating and cooking (Mishra, 2003). Severe respiratory illness and mortality are associated with exposure to pollution from incomplete wood combustion stoves.
for indoor heating and cooking (Johnson and Aderele, 1992). According to the 2010 Ghana population and housing census report, biomass use for cooking is about 79.5% consisting 42.7% wood and 35.8% charcoal, 0.9% crop residue and 0.1 saw dusts (Ghana Statistical Service, 2010).

ARI has been classified into two main categories: upper respiratory infection (URI) and lower respiratory infection (LRI). This classification is based on whether the disease affects the lower or upper respiratory tract (Simeos et al., 2006). Examples of URI include colds, ear infections, and sore throats. Infections of the epiglottis, trachea, bronchi, bronchioles, and lungs (pneumonia) among others constitute LRI (Addico, 2000). URI and LRI are further classified based on the duration of the infection as acute or chronic. The acute type of ARI lasts approximately a week while chronic ARI lasts three months or more. Clinical signs of ARI include nasal and lungs congestion, runny nose, cough, sore throat, body aches, fatigue, difficulty in breathing, loss of consciousness and dizziness (Addico, 2000).

ARI is a common health problem that affects both males and females of all ages. However, even though ARI can affect everybody regardless of age, some age groups are more susceptible to ARI than others. Apart from the fact that ARI is common among children under-five and the elderly, Khalek and Abdel-Salem (2016) report that children under-five and the elderly suffer the most severe form of ARI complications. ARI clinical reports reviewed so far reports respiratory arrest and respiratory failure as the two most severe forms of complications. Whereas respiratory arrest happens when the lungs stop functioning properly, respiratory failure happens when there is a rise in carbon dioxide ($CO_2$) in the blood resulting in malfunctioning of lungs and subsequently in congestive heart failure. ARI is considered one of the topmost
contributors to children under-five mortality in the sub-Saharan Africa (Ezzati and Kammen, 2001; Boadi & Kuitunen, 2006).

ARI among children under-five in developing countries have been found to be associated with risk factors such as low birth weight, malnutrition (e.g. stunting and wasting), lack of breast feeding, defects in immune system, overuse of antibiotics and immunization status. Co morbid illness such as Human Immunodeficiency Virus (HIV), measles, malaria and diarrhea increases susceptibility. Environmental risk factors such as overcrowding, poor sanitation, indoor and outdoor air pollution and socioeconomic factors— poverty, access to preventive and curative health services et cetera are also named as major risk factors of ARI (Murray et al., 2012; Choube et al., 2014; Maharjan et al., 2017).

Interventions to prevent ARIs among children under-five include four preventive measures: immunization against specific pathogens, early diagnosis and treatment of disease, improvement in nutrition and safer environment (Simeos, 1999; and Guade, 2016). According to Guade (2016), the first ARI preventive measures: immunization and appropriate case management falls under the domain of health–system while the last two: malnutrition and environmental factors require what Gaude (2016) describe as ‘multi-sectoral involvement’.

Studies suggest that an effective universal treatment for ARI appears impossible. Chen et al. (2014), for example, explain that antibiotics are only effective against some bacterial infections even without considering that in some developing countries especially rural areas, antibiotics are hard to access. Meanwhile, ARI is caused by a diversity of micro-organisms (pathogens, e.g. viruses). There is also a deficit in diagnosis by about 30 percent. Furthermore, Murray et al. (2012) adds that most pathogens that cause ARI are not vaccine preventable, even
so, those that are vaccine preventable are underutilized in developing countries where the disease is prevalent. Talaat (2010) and other researchers interested in ARI assert that hand washing could decrease ARI among children however maintaining adherence to hand washing is a big challenge even in countries where resources are available.

It presupposes then that as far as ARI is concerned the identification of risk factors for ARI among population is important for developing effective policies and strategies to interrupt transmission and improve health outcomes (Chen, Williams & Kirk, 2014,p1.). To solve this problem, recent studies in developing countries have focused on identification of the risk factors Ezzati and Kammen (2001); Mishra (2003); Akunne, Louis, Sanom and Saueurborn (2006); Kilabuko and Nakai (2007); Boadi and Kuitunen (2006); Jean-Daniel (2016); Jangua, Mahmood, Dharma, Sathiaikumur and Kkan (2012). Existing studies on environmental risk factors generally focuses on indoor air pollution. These studies (Ezzati & Kammen, 2001; Mishra, 2003; Akunne, Louis, Sanon & Saueurborn, 2006; Kilabuko & Nakai, 2007) have examined the impact of cooking fuel type on ARI.

In Ghana, most women are primary cooks and care givers (care of young children is not limited to one person). Most often women have their children under five with them while cooking. Consequently, women and their children under-five are exposed to the negative impacts that come from the use of biomass fuels (der kroon, 2013). One would have thought that ARI studies should, as it were, focus on the influence of biomass on the prevalence of ARI in Ghana considering the afore mentioned factors. Accentuated by the fact that an appreciable number of ARI studies in developing countries theorize that type of fuel use has a positive association with prevalence of ARI among children under five years. However the association between type of
cooking fuel and ARI in Ghana is largely unknown, yet, existing ARI literature surveyed so far considered indoor air pollution from the use of biomass fuels.

Furthermore, ARI studies have looked at case management, thus, early diagnosis and treatment, care seeking and home management strategies (Addico, 2000; Dan & Rachel, 2015). Manu (2014) focused on ARI risk factors but without a critical assessment of biomass in Ghana even though the study used the 2008 GDHS—nationally representative population data. Therefore, it could be tentatively concluded that in the Ghanaian context, the influence of type of cooking fuel on ARI among children under-five is largely unknown. Though, Boadi and Kuiten (2006) did study type of fuel among others and ARI prevalence, their study as reported early on, was limited to the then Accra metropolitan assembly with only 950 women-respondents. This present study examines the association between household cooking fuel use and incidence of ARI among children under-five in Ghana using the latest nationally representative population data, 2014 Ghana Demographic Health Survey (GDHS) collected by Ghana Statistical Service (GSS).

1.2 Statement of the problem

Over a decade into the third millennium, many Ghanaians households rely on firewood, charcoal and agricultural residue as their main source of energy for space heating and cooking at home (Mishra, 2003). It is reported that majority of biomass fuel users live in rural areas, hence biomass fuel use is a rural phenomenon (Jean-Daniel 2016). Moreover, the rate of biomass fuel use varies greatly between regions and within countries (Jean-Daniel, 2016). It is reported that more than 50% of children under-five spend much time each day with their mothers in dense smoky and toxic haze arising from combustion of inefficient, air polluting fuels used for cooking and heating homes (Torres-Duque et al. 2008). Undoubtedly, biomass fuels such as wood,
charcoal, dung and crop residues burned in traditional stoves or open fires release health-damaging pollutants such as nitrogen dioxide (NO$_2$), particulate matter, polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO), sulfur dioxide (SO$_2$), and other volatile organic compounds (Samet et al. 1991; Smith et al., 2000). These harmful chemical compounds deeply penetrate the lungs leading to respiratory disorder (WHO, 2014). Figure 1.1 below shows that particles greater than 10 microns rarely make it past the upper airways, whereas fine particles smaller than 2 microns can make it as far as the alveoli.

The use of wood as cooking fuel not only harms the inhabitants health but it also recognized as a factor in deforestation, soil erosion, loss of soil fertility and ecosystem imbalance. According to estimations by the World Health Organization in 2014 more than three billion people constituting 43% of the population worldwide rely on biomass fuels for cooking. For instance this result in household air pollution (HAP) which caused a little over four million deaths annually (WHO, 2016). With most of the deaths taken place in south-East Asia, Western Pacific and Africa. The situations presently in these countries are very serious (WHO, 2016). For
instance, more than half of these deaths were associated with pneumonia among children under five years of age, making biomass air pollution combustion the greatest risk factor for children under-five pneumonia (WHO, 2016). The need to switch from biomass cooking fuels to non-biomass cooking fuel is not an option now but rather a necessity in improving child health worldwide. A number of international initiatives such as the global alliance for clean cook stoves, national institute of environmental health science and thrasher research fund have been launched in recent years to move this issue up on the world's agenda yet many countries are failing to act globally (WHO, 2016).

In Ghana, ARI is a major cause of morbidity and mortality among children under-five and this poses a lot of challenges to our health care system and public health as a whole. This is because 270 million children around the world including Ghana live in what amounts to a health care desert-lacking access to even the most basic health care provisions (UNICEF, 2004). According to WHO estimations in 2010, 14.9 million episodes of severe ALRIs among children under-five resulted in hospital admission and the use of health centers for treatment and medication worldwide (WHO, 2013). ARI adds to health care cost due to frequent hospital attendance, excessive hospitalization, and deaths of children under five. Ghana lags behind in terms of achieving the health objectives of the Millennium Development Goal 4. Comparatively the conditions of the health status of children under-five in Ghana are worse than an average condition around the globe (Agyemang, 2013). According to the World Health Organization the occurrence of children under-five mortality in Ghana as at 2009 was 69 per 1000 live birth whilst the global average value was 60 per 1000 live births that same year (WHO, 2011). It is regrettable when one considers the fact that more children suffer and die from ARI which are easily preventable.
Child mortality is experienced globally; with many countries such as Angola, Central African Republic, Sierra Leone, Chad, Somalia, Democratic Republic of Congo, Mali, Nigeria, Lesotho, Equatorial Guinea, Cote d'Ivoire recording higher (Reidpath, & Allotey, 2003) compared to developed countries. However, on average it is estimated that about six million young children die annually before they celebrate their fifth birthday meanwhile some of these deaths are preventable and treatable. Among this number, it is estimated that about three million children under-five still die from environment related causes with developing countries recording the highest. ARI under five child mortality stands at 1.6 million. Interestingly, sixty percent of ARI are attributable to biomass fuel combustions in household (WHO, 2016).

In Ghana ARI is the leading cause of death among children under-five (GDHS, 2014; MI, 1999; GSS et al. 2003; GSS et al., 2009). Therefore protecting children from exposure to biomass fuels requires the need to understand the association between ARI and type of fuel use for cooking in households. Studies that have investigated the relationship between biomass fuels and ARI among children under-five are scanty and have focused mainly on environmental factor specifically indoor air pollution and outdoor air pollution. In view of the above, the present study seeks to address the following research questions.

1.3 Research questions

1. What is the association between type of cooking fuel and ARI among children under-five in Ghana?

2. What is the association between place of residence-rural and urban and ARI among children under-five in Ghana?
3. What is the association between mother's education and ARI among children under-five in Ghana?

4. What is the association between household wealth index and ARI among children under-five in Ghana?

1.4 Rationale for the Study

In some developing countries like Bangladesh, Ethiopia, Tanzania, Cameroon, Gabon, Zimbabwe, Kenya and India studies have shown that exposure to harmful air pollutants especially the types of fuel labelled as biomass has significant association with morbidity and mortality among children. In the fore-mentioned developing countries, wood, kerosene, coal, and animal dung are the main fuel used for cooking and heating homes. The gamut of ARI research on indoor air pollution and type of fuel use makes the claim that biomass fuel use emits air pollutants that cause ARI and other health related problems (Robin, Winget, Steinhoff, Moulton, Santosham & Correa, 1996; Ezzati & Kammen, 2001; Smith, Mehta, & Maeusezahl-Feuz, 2004; Akunne, Louis, Sanon & Sauerborn, 2006; Flintwood–Brace, 2016).

However, the case of Ghana remains largely unknown. A lot of studies in Ghana have identified risk factors of ARI (Boadi & Kuitunen, 2005; Agyemang, 2013 Manu, 2014). Boadi and Kuitunen (2005) examined the impact of indoor air pollution from cooking fuel and place of cooking on prevalence of respiratory symptoms in Accra. Findings of their study indicate that there is a positive association between the type of fuel used and place of cooking, and the presence of children during cooking and incidence of ARI symptoms among children. However, Boadi and Kuitunen's study is limited in the sense that the study involved only 960 female respondents in Accra, hence findings cannot be generalized. Manu's (2014) study identified factors influencing ARI among children under five in Ghana using data from 2008 GDHS.
Manu’s study could be thought as exploratory. However, to the authors’ knowledge, studies have not been conducted in Ghana to assess the association between type of fuel use and incidence of ARI among children under-five. As such this present study, therefore, seeks to assess the association between the type of cooking fuel used by households and ARI among children under-five in Ghana paying particular attention to both the rural and urban areas.

A study of the Ghanaian context is necessary because it would provide a base line data for better understanding of the magnitude of indoor air pollution induced by biomass fuel. Additionally, it would provide understanding into biomass use and ARI prevalence among children under five in Ghana. The study will guide policymakers in the area of policy interventions to prevent ARI illnesses among the vulnerable age groups-children under five. In essence, a critical account of ARI and type of fuel used for cooking risk determinants will ensure appropriate targeted interventions for ARI in Ghana. Controlling ARI among children under-five, according to WHO reports on health, will go a long way to reduce significantly the fourth sustainable development goal which calls for a two-third reduction in the mortality of children under five in Ghana and the world at large. Finding of the present study also has implications for further research that will add to the existing pool of knowledge on ARI risk factors in general. Finally, this study will create awareness regarding the use of biomass fuel and incidence of ARI in Ghana.

1.5 Objectives of the study

The general objective of the study is to examine the association between type of household fuel used for cooking and ARI among children under five in Ghana. Specifically, the study seeks to:
1. Examine the association between type of fuel used for cooking and ARI among children under-five in Ghana.

2. Examine the relationship between place of residence—urban and rural and ARI among children under-five years in Ghana.

3. Find out the relationship between mother's education and ARI among children under-five in Ghana.

4. Examine the influence of household wealth status on ARI among children under-five in Ghana.

1.6 Organization of work

The study is organized in five chapters. Chapter one presents the background of the study, states the problem, the research questions, the rationale for the study, and the objectives of the study as well as the outline of the study. Chapter two reviews relevant literature, and presents the conceptual framework and the study's hypotheses. Chapter three, which is the methodology chapter covers issues relating to source of the data, sample design, methods of data analysis, measurement variables, and limitations of study. Chapter four presents the results and discussion. The fifth and final chapter summarizes the results and conclusions of the study and makes recommendations for further research and policy intervention.
CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews energy sources used for cooking in the households and their association with ARI. The energy sources are classified into biomass fuel and non-biomass fuel based on combustion efficiency in the energy ladder. Socio-demographic factors such as maternal education, wealth index, occupation, and place of residence are reviewed. Moreover, household characteristics such as main floor material and main wall material are also reviewed to see whether it has influence on both type of fuel use in households or ARI among children under-five. The chapter review risk factors of ARI burden in the developed and developing countries. The chapter also presents the theoretical/conceptual framework used for the study.

2.2 The burden of acute respiratory infections (ARI) in developed and developing countries

The Lancet Under nutrition Series (LUS) defines “burden” of ARI as all morbidity, deaths and disability-adjusted life years (DALYs) lost due to acute respiratory infections (Roth et al., 2008). The burden of ARI ranges from health implications such as discomfort due to morbidity, premature death to economic burden of health care. For instance, the burden includes acute lower respiratory infection (ALRI), disability-adjusted life years (DALYs), low birth weight (LBW), hospital admission and intrauterine growth restriction (IUGR). ARI is the third leading cause of global burden of disease after heart disease and stroke. It is the leading cause of death among children under five in less developed and developing countries (Major, 2010). New figures show that acute respiratory infections (ARI) such as pneumonia, flu and respiratory syncytial virus accounts for 4.25 million deaths globally (Mayor, 2010). It is estimated that about 44% neonatal deaths/DALYs are attributable to ALRI and 20% of postnatal deaths and disability
adjusted life years lost are also attributable to suboptimal breastfeeding in the LUS analysis (Roth, 2008).

The World Health Organization in the year 2000 estimated that in developing countries, 1,619,000 young children die every year from acute respiratory infections worsened by indoor biomass smoke exposure (Ezzati & Kammen, 2002) and this figure has over the years steadily increased (Belkin, 2018).

In developed countries, studies have focused on the health effects biomass smoke has on households that cook with cooking stove with chimneys in an enclosed place (Samet et al. 1991). Research has documented that the decline in mortality due to acute respiratory infections (ARI) attracted much attention in the developed countries for instance in Europe the life expectancy after the industrial revolution decreased by 7.5 years (Mishra, 2001). ARI accounted for the highest proportion compared to all other infectious diseases. Particularly among children under-five, ARI was the leading cause of childhood mortality. Some studies have found that when life expectancy declined below 45 years, 25% of the mortality was due to ARI among children under-five, compared to 4% when life expectancy increased to 70 years (Mishra, 2001). This shows that ARI mortality in developed countries is declining due to improved living conditions and the discovery of antibiotics since 1950s (Mishra, 2001). With increasing mortality due to ARI in developing countries, much effort is needed to control the occurrence of ARI in these countries as well (Mishra 2001).

Studies in developing countries have indicated that acute respiratory infection is the leading cause of mortality among children under-five years old. Results from WHO (1990) estimated that ARI contributes to 4.3 million deaths among children under five globally.
However it has decrease to 567,000 annually in 2016 (WHO, 2016). According to Madhi and Klugman (2006) ALRI childhood mortality is estimated at between 1.9 million to 2.2 million each year (Madhi et al. 2006). In 2010 Vashishtha found that ARI mortality rate for each year has increased to 3.9 million globally but importantly in developing countries (Vashishtha, 2010). For example in sub-Saharan Africa, ALRI caused 190,400 neonatal deaths, 402,000 infants and 248,000 deaths between age one and age four in 2010 (Rehfuess et al. 2013). Four years later, studies by Selvaraj et al. (2014) found that mortality due to ARI burden among children under-five has decreased from 3.9 million to 2.04 million yearly. Two years later, studies by Ramani et al., (2016) saw almost double increase from 2.04 million to 4 million in childhood mortality due to ARI. On the other hand the prevalence rate of acute respiratory tract infection (mainly pneumonia associated) accounts for 20% of deaths among children under-five in low income countries. However the prevalence rate of mortality burden increased from 20% to 35-45% when neonatal pneumonia is included in the pool. More so in less developed countries, every ten deaths that occur in children under-five, seven out of the ten is due to ARI (Smith et al., 2000; Bassani et al., 2010).

2.3 The environmental conditions and occurrence of ARI

Acute respiratory infection has been linked to environmental conditions and the main environmental conditions that predispose people to the risk of ARI are air pollution. Air pollution has been associated with health problems globally (Hong, 1996; Murray & Lopez, 1996; Cohen et al. 2004; Smith et al., 2004 and Annette, 2004). However, studies over the years have focused on so much on outdoor air pollution. Historically, the impact of the global burden of disease from air pollution was solely estimated from outdoor sources (Hong, 1996; Murray & Lopez, 1996 & Annette, 2004). Studies continues to emphasize outdoor air pollution as the main
cause of ill-health problems the world over, due to the increasing rates of vehicular and industrial 
emissions in urban areas of both developed and developing countries. Nevertheless, indoor air 
pollution induced by biomass fuel using in rural daily life is not given much needed attention. 
However, the health risk associated with indoor air pollution far exceeds that of the outdoor air 
pollution (Desai et al. 2004).

Research from many countries shows that exposure to indoor sources of pollutants can be 
greater than exposure to pollutants from outdoor sources (Smith, 1993; Desai et al. 2004). The 
energy ladder theory postulates that in terms of combustion efficiency, biomass fuels are at the 
base of the ladder and at the high end in terms of air pollution (Smith & Liu, 1994; Mishra, 
2001). In the same way, many less developed countries rely on biomass fuels as their primary 
source of energy for cooking and heating and this reduces as household income increases 
(Mishra, 2001).

Research has shown that biomass smoke contains harmful substances such as respirable 
particulates, carbon monoxide, nitrogen oxide, formaldehyde, and poly aromatic hydrocarbons 
including benzo [a] pyrene (WHO, 1992; Smith, 1993; Mishra, 2001). Consequently high 
exposure to these harmful components causes serious health problems such as tuberculosis, acute 
respiratory infections, blindness, chronic obstructive lung disease and lung cancer (Fullerton et 
al., 2008; Mishra, 2003; Alemayehu et al., 2014; Inkoom & Crentsil, 2015; Smith et al., 2004; 
Dherani et al., 2008). In addition, studies have linked exposure to cooking smoke to pregnancy 
outcomes, including low birth weight and perinatal death (Mishra, 2001). On the whole, several 
studies from global estimation show that combustion of biomass household fuels accounts for 
about 2.5 million premature deaths every year (WHO, 1997; Mishra, 2001). Smith et al. (1999) 
reported that about 25-33 percent of the global burden of disease can be attributable to
environmental risk factors and that indoor air pollution is the highest factor compared to malnutrition, water/hygiene/sanitation (Mishra, 2001).

In addition to these environmental risk conditions, research has shown that type of building materials—bamboo, stone, mud, cement blocks, bricks, earth sand, dung for building a house influence the occurrence of ARI among children under-five. In Ethiopia Alemayahu et al. (2014) reported that incidence of the symptoms of ARI was highest in children who lived in mud houses compared to children who lived in houses constructed with bricks. Additionally, in Uganda, Bbaale (2011) reported similar findings and added that houses built with bricks compared to mud reduce the occurrence of ARI by seven percent. Again in Uganda, Bbaale (2011) reported that households that have cement floors compared to dirt floors decreases the incidence rate of ARI among children who lived in the household by seven percent.

Mishra (2003) conducted a study in Zimbabwe with the aim of investigating the association between household use of biomass fuels for cooking and acute respiratory infections among pre-school age children below five years. The study found that almost two-thirds (66%) of children lived in households that use biomass fuels and sixteen percent experienced the symptoms of ARI two weeks prior to the survey (Mishra, 2003). Children within the age group 6-23 months were more likely to have experienced the symptoms of ARI compared to children below 6 months of age or older children. Generally children within this age bracket start taking another food aside from breastfeeding around sixth months of their age which predisposes them to consuming contaminated foods and removes the protection provided by breast milk (Mishra, 2003). Additionally children start crawling around that same age group-6-23 months and could be carried outside which exposes them to infections (Mishra, 2003).
2.4 Type of cooking fuels and incidence of ARI

Research has shown that types of energy for cooking is influenced by the type of food cooked, the meals cooked, household size, the specific combination of energy source and cooking equipment used. For example type of stove and cooking pans (Kim et al. 2011). In less developed countries majority of household rely on biomass fuel for their daily cooking. Biomass fuels often come from forest, agricultural residues and cow dung. In Ghana wood is the most common example but the use of charcoal and crop residue is widespread in different households especially in the rural areas, where they have access to these agricultural residue. The traditional home-made (three stones) cooking stove does not burn the wood completely and it emits some harmful pollutants in the environment (Kim et al. 2011). Studies have shown that there is a strong association that exits between biomass fuel and prevalence of ARI. Moreover studies conducted in Tanzania reported 11% prevalence of ARI among children living in households where biomass fuel was used. Particularly, children living in households where biomass fuel was used had a higher incidence of ARI and also three times more likely to experience the symptoms of ARI compared to children living in households where non-biomass fuel was used. Study conducted in Addis Ababa, the capital of Ethiopia revealed that the prevalence of ARI was 29.9% in households that use biomass fuel compared to households that use non-biomass (Sanbata et al. 2014). Also study in Zimbabwe reported that children in households using animal dung, firewood, or straw for cooking were more than twice as likely to experience symptoms of ARI as compare to children living in households where LPG or electricity were used (Mishra, 2003; Sanbata et al. 2014). A study conducted in Ghana showed that children living in households where biomass fuel was used reported a higher occurrence of the symptoms of ARI.
compared to children living in households where non-biomass fuel was used (Manu, 2014). ARI episodes were highest among children living in households that used wood and crop residues.

2.5 Maternal characteristics

Mother’s characteristics such as age of the mother, educational attainment of the mother, occupation of the mother and wealth status of the mother have been revealed to be associated with incidence of ARI among children under five. Studies have shown that children whose mothers are older are more likely to experience the symptoms of ARI compared to children from younger mother’s (Manu, 2014). This could be that the experience of the older mothers acquired in terms of childcare may be greater than the younger ones. Results from Bangladesh showed a significant association between mother’s age and incidence of ARI among children under-five years old. However, children whose mothers were below 20 years reported a greater proportion of symptoms of ARI. It was noted that mothers who were in the age brackets of thirteen and nineteen concentrate on their pleasure and that of their partners than their child’s wellbeing (Manu, 2012). Prietch et al., (2008) also found out that maternal age has a protective effect for children. This is especially so for mothers who were above thirty years at the birth of their children. Additionally, children whose mothers have attained some level of education up to primary reported higher occurrence of ARI than children whose mothers had no formal education (Mishra, 2001). Maternal education is one of the factors found to be associated with the risk of ARI and other childhood infections. The enlightenment acquires through formal education influences the prevention, treatment and management of an infection at an early stage as soon as they occur.
2.6 The burden of acute respiratory infection (ARI) in Ghana

ARI was ranked second in a study by Songsore et al., as the most common disease in Ghana next to malaria. ARI is second but has reduce from 9 percent in 1991 to 7.2 percent in 2004 based on health facilities data (Songsore, 1993). Although there is a reduction of ARI case in Ghana, prevalence rate continues to be high and unacceptable.

In 2007, WHO estimate that exposure to biomass fuels in Ghana was linked to about 2.2 percent of the national burden of disease. For instance 5,600 death that occur in that year was due to the use of biomass fuels for cooking in households (WHO, 2007). However the incidence rate of acute lower respiratory infections (ALRI) among children under-five years accounted for more than two thirds (3,960) of the total deaths attributable to the use of biomass fuels. Consequently, ARI (ALRI & AURI) does not only cause child morbidity and mortality but also lead to chronic respiratory disease later in the child’s life if not treated in the early stage of the child. Even though the information on the burden of ARI in Ghana is scanty, the GDHS (2008) report shows that ARI is the leading cause of death among children under five in Ghana.

2.7 Theoretical framework

2.7.1 The Multiple Exposures Multiple Effects (MEME)

This model provides the conceptual and theoretical basis for the development, collection, and use of children’s environmental health indicators. It emphasizes the divergent, multiple links between exposure and health effects. On the environmental side, it recognizes a spectrum of exposures, from more proximal to more distal, which can occur in a number of different settings – in the case of children, at home, community and the wider, ambient environment. On the health side it recognizes that health effects may be expressed in different ways, and at different levels of severity (e.g. as morbidity or mortality). In addition, it recognizes that both exposures and health
outcomes may be affected by more remote, contextual factors, such as social conditions, demographic and economic development that influences the susceptibility of the population to environmental health effects (Briggs & WHO, 2003.p11).

Figure 2.1: Multiple exposure multiple effects model


The MEME model further explains the 4 components necessary for examining of children under-five environmental wellbeing. These include contextual indicators, exposure indicator, health outcomes indicator and actions indicator. Consequently the MEME hypothesized that poverty is linked to the use of biomass fuel hence the health outcome is mortality due to acute respiratory infection. And mortality due to ARI is attributable to mean annual PM$_{10}$ exposure of children living in homes using biomass fuels. Actions can be targeted at reducing exposures or at reducing the severity of health outcomes (Briggs 2003).
Figure 2.2 Multiple exposure multiple effects model 2

**Context**
Children living in poverty

**Exposure**
- Children living in homes using biomass fuels
- Mean annual PM$_{10}$ exposure of children

**Health outcomes**
Mortality rate for children aged 0-4 years due to acute respiratory illness

**Causes**
Attributable to

**Actions**
- Provide public education
- Improve ventilation in housing
- Use fuel efficient stove
- Provide access to medical treatment and facilities
- Use antibiotics or other

Source: Adapted from WHO, 2003.
2.7.2 Energy ladder theory

The ‘energy ladder’ is a theory used to explain the manner in which households will transition from biomass to more refined or non-biomass fuels as household income increases. The ‘energy ladder’ theory postulates that as household income improves, households that use biomass fuel move from the use of biomass fuels to the use of non-biomass fuels. The ‘energy ladder’ transition is in three stages according to Hosier and Dowd, 1987. The first stage shows a total reliance on biomass fuels such as wood, cow dung, and agricultural residues. At the second stage, due to factors such as increase in income and changes in socioeconomic factors like urbanization and industrialization, households switch from biomass use to kerosene, coal, and charcoal. The last stage is where households switch to the use of non-biomass fuels such as natural gas, LPG and electricity. Hosier and Dowd (1987) reported that income drives the transition from the usage of biomass to non-biomass fuel. However other studies reported otherwise (Mesera et al., 2000). For instance Mesera et al. (2000) reported that, despite income influences the choice of fuel used for cooking, mostly accessibility and availability determine if households will switch to the use of non-biomass. This presupposes that income alone does not determine the use of biomass or non-biomass. Additionally, factors such as age of the household head, place of residence, educational level, sex and others have been reported to influence the choice of fuels use by households (Helberg, 2003; Ouedraogo, 2006).
Figure 2.3 Energy ladder

Source: WHO, 2006

2.8 Conceptual framework

Figure 2.4 shows the conceptual framework of the study. It was adopted from multiple exposures multiple effects model (figure 2.2). It indicates the association between the main independent variable-type of cooking fuels, other independent variables-maternal characteristics and household characteristics, and the dependent variables-ARI. The measures in the conceptual framework in figure 2.4 are based on variables available in the 2014 Ghana Demographic Health Survey data set. Based on the multiple exposures multiple effects (MEME) theory the conceptual
framework of this study is divided into two main facets. Main independent variables, other independent variables which are further divided into two- the maternal characteristics and household characteristics; and the dependent variable. The framework suggests that maternal characteristics and household characteristics influences the choice of cooking fuel type used in households. The type of cooking fuel which is the main independent variable is categorized into two main groups: (1) biomass fuels- wood, charcoal, straw/shrubs/grass, agriculture crops, coal and lignite; (2) non-biomass- electricity, kerosene, LPG, and natural gas. Maternal characteristics herein referred to as age of the mother, educational level of the mother, place of residence, region of residence, occupation, and wealth of the mother predict the choice of cooking fuels used by households and the type of cooking fuel also predicts the incidence of ARI.

Cooking fuel transition is driven by income, education, employment, technology, infrastructure access and fuel prices (Liao et al., 2016). Mothers who are older are more likely to choose biomass fuels as cooking fuel than mothers who are little younger while the younger mothers are also likely to choose non-biomass fuels as cooking fuel than the older mothers. This is supported by Mensah & Adu (2013) which found that age has a significant negative effect on the probability of using clean and efficient fuels over the inefficient fuels.

The educational level of the mother is strongly related to the use of non-biomass fuels as cooking fuels. The higher the level of education of the mother the more likely it will be for the household to choose non-biomass as cooking fuels (Ouedraogo, 2006; Heltberg, 2003). Education comes with a number of benefits such as higher skill levels and possible employment, greater self-esteem and socio-economic status and more understanding of health implications associated with the use of biomass fuels (Esime, 2015).
People who dwell in rural areas are more likely to resort to traditional fuels such as wood and dung (Wichmann, 2006) compared to urban dwellers. The opposite is likely to be a probability. This is because rural dwellers have access to firewood and several other biomass fuels compared to people who live in urban cities and towns.
MAIN INDEPENDENT VARIABLE
Type of cooking fuels
Biomass (wood, charcoal, straw/shrubs/grass, agriculture crops and coal, lignite)
Non-biomass (electricity, kerosene, LPG, and natural gas)

OTHER INDEPENDENT VARIABLES
Maternal Characteristics
Age
Educational level
Occupation
Wealth index

Household characteristics
Main wall material
Main floor material
Type of place of residence
Region of residence

Control variables
Child characteristics
Age
Sex
Size at birth
Immunization

DEPENDENT VARIABLE
Acute Respiratory Infection (ARI)
Yes
No

Source: Author’s construct, 2017.
Households with higher wealth status are more likely to choose non-biomass fuels as cooking fuel while on the other hand households with low wealth status are more likely to choose biomass fuels as cooking fuel. This is explained by the energy ladder theory which states that as household income increases, households move from the use of traditional fuels to modern fuels. Income is considered as the single most determinant of household fuel choices (Liao et al., 2016). Other independent variables such as main wall materials and main floor materials, type of place of residence and region of residence could influence the choice of cooking fuels type that households used as cooking fuel hence incidence of ARI.

2.9: Hypotheses

1. Households that use biomass fuels are more likely to have their children experience symptoms of ARI than households that use non-biomass fuels.

2. Children living in urban areas are less likely to be exposed to biomass fuels smoke as compare to children living in rural areas hence children living in urban areas are less likely to experience the symptoms of ARI compared to children living in rural areas.

3. Mothers with higher educational attainment are less likely to have their children experience symptoms of ARI than mothers with no formal education.

4. Children from households in the poorest wealth quintile are more likely to experience the symptoms of ARI than children from the richest households.
CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter presents the methods that were used in carrying out the study. It includes the source of data, sampling design, measurement of variables, methods of data analysis and limitation of the study.

3.2 Source of data

The study utilized information from the 2014 Ghana Demographic Health Survey (GDHS). The survey is conducted mainly to collect demographic and health information across the country (representative) in less developing countries within a specified time period. This survey is undertaken each 5 years in Ghana since 1988 and 2014 is the sixth series and most current one.

The main purpose of the 2014 GDHS was to gather and supply new reliable broad representative knowledge on the demographic and health state of affairs in Ghana with relevant and elaborate data on fertility, birth control, infant and child mortality, maternal and child health, and nutrition. Additionally the survey contains knowledge on household size, age, sex, and occupation of household members, educational attainment, type of place of residence and religion.

3.3 Description of the design

The 2014 GDHS used an updated sampling frame from the 2010 Ghana population and housing census provided by the Ghana Statistical Service (GSS 2013b). Unsettled and institutional populations include persons in hotels, barracks, and prisons were not included in the survey. The surveyed used a two-stage sample procedure. At the first stage, sample points
(clusters) consisting of enumeration areas from the 2010 PHC were selected. A total of 427 clusters were selected and out of that 216 were from the urban areas while 211 were from rural areas. At the second stage, a systematic sampling was used to select 30 households from each cluster to constitute a total sample size of 12,831 households. Questionnaires were administered by field staff. In all, three set of questionnaires were used and these include the households, women’s and men’s questionnaires. The questionnaires were first prepared in English; they were then translated into Akan, Ga, and Ewe.

The survey involved 9,396 eligible women age 15-49 years who were identified for individual interviews throughout the country. Women with surviving children born in the last five years preceding the survey responded to questions on topics such as respondent’s background, reproduction, antenatal and delivery care, breastfeeding, immunization, health and nutritional status and occurrence of disease symptoms such as cough, short rapid breathe and other disorders. A file was created by GSS with household variables and that of the women’s characteristics was included in a file known as the Childs’ file. The study included a total number of 5,884 under five children.

3.4 Measurement of variables

3.4.1 Independent variable

The independent variable being examined in this study is the type of cooking fuel. This is used as a proxy to measure exposure to smoke. Cooking smoke exposure was obtained indirectly by the type of fuel household used for cooking. “What type of fuel does your household mainly use for cooking” (GDHS, 2014) was the question asked and the responses included the main cooking fuels commonly used in Ghana. These include electricity, LPG/natural gas/biogas, kerosene, charcoal, wood, straw/shrubs/grass, and agricultural crop. This was grouped into two
categories and was recoded as 0=biomass and 1 as non-biomass fuel. Thus for this study, biomass fuels are made up of wood, charcoal, straw/shrubs/grass, agriculture crops and kerosene while non-biomass fuels are electricity, LPG, and natural gas. This is based on the energy ladder theory where the inefficient fuels are at the bottom of the energy ladder while the clean fuels are at the top (WHO, 2006).

3.4.2 Outcome variable

Acute respiratory infection (ARI) is the outcome variable in this study. In the data set the following questions were asked to the child’s mother to determine whether the child has ARI or not: “Has (Name) had an illness with cough at any time in the last 2 weeks?” the response was yes and no, and the follow up question was “When (Name) had illness with a cough did he or she breathe faster than usual with short, rapid breaths or have difficulty breathing?” The response was yes and no. If the mother answered yes to these two questions it means the child exhibited symptoms of ARI. So the child was coded as having ARI in the last two weeks preceding the survey. If the mother answered no to the two questions it means the child does not have ARI. And if the mother answered yes to the first question and no to the second question it means the child does not have ARI. The first question was not enough to classify someone to have suffered from ARI based on the WHO guidelines. So there was the need for the second question. The responses have been coded into a discrete binary variable as “1” if the child had ARI and “0” if otherwise.
3.4.3 Other independent variables

Other independent variables in this study include maternal characteristics and household’s characteristics. They are measured and defined as follows:

3.4.3.1 Mother’s characteristics

The age of the mother was categorized into seven distinct groups with 5 year intervals. Categories are as follows 1=15-19, 2=20-24, 3=25-29, 4=30-34, 5= 35-39, 6=40-44, 7=45-49. Educational attainment of the mother was coded as 1=No education, 2= primary education, 3= secondary and 4= higher. Occupation of the mother was recoded into 1=not working, 2=professional, technical and managerial, 3= sales, service and clerical, 4= agriculture and 5= manual occupations. Additionally, the wealth index was coded as 1 and 2 as being poorest and poorer respectively, 3 as middle, 4 and 5 being richer and richest respectively. Type of place of residence of the mother was described as rural and urban based on the definition of urban and rural localities used in the survey. According to the 2010 Population and Housing Census (PHC) report, localities with a population of more than 5,000 are classified as urban and rural when total population is less than 5,000. Therefore type of place of residence was coded as 1 being urban and 2 rural. The type of place of residence is a key factor that enables the mother to have access to better basic social amenities such as electricity, portable drinking water, improved toilet facilities, hospitals, and better schools; clean modern fuels and cooking facilities. The distribution and access to these facilities vary by place of residence.

Again the regional distributions of the respondents were based on their region of residence during the survey. Ghana is divided into 10 administrative regions, these include 1=Western, 2=Central, 3= Greater Accra, 4=Volta, 5=Eastern, 6= Ashanti, 7= Brong Ahafo, 8=Northern, 9= Upper East, and 10= Upper West.
3.4.3.2 Child characteristics

The child’s age were categorized into months and was grouped as 1= 0-11 months, 2= 12-23 months, 3= 24-35 months, 4=36-47 months and 5= 48-59 months. The sex of child was coded as 1 and 2, for males and females respectively. In addition the size of the child at birth was included in the framework and was coded as 1 being small, 2= average and 3= large. With the expectation that immunization would play an important role in childhood incidence of ARI, immunization status of the children was included in the study. This was coded as 1 not immunized at all, 2= partial and 3= complete. If a child received all the recommended dosages of 1 dose of BCG, 1 dose of measles, 3 doses of DPT and 3 doses of polio the child is to have complete immunization however if the child had not taken all the doses but has ever been vaccinated, the child is classified as partially immunized. Also, if the child had not taken any of those doses before it means the child was not immunized at all.

3.4.3.3 Household characteristics

The main wall material of the household the child lives in were coded as 1=unimproved (constructed with cane/palm/trunks, dirt, bamboo with mud, stone with mud, uncovered adobe, plywood, reused wood and wood planks/shingles) and 2= improved (constructed with cement, stone with lime/cement, brick, cement blocks, covered adobe). In addition, household main floor material was coded as 1= unimproved and these include earth sand, dung, wood planks and parquet while vinyl, asphalt strips, cement, ceramic/marble/porcelain tiles/terrazzo, woolen carpet/synthetic carpet and linoleum/rubber carpet were coded as improved =2.

All the variables were weighed to check for over sampling of respondents in all the categories in the study design.
3.5 Methods of data analysis

The analysis was carried out using Statistical Package for Social Sciences software version 20 (SPSS, 20). The analysis was in three stages: first stage was univariate, second stage bivariate and the third stage multivariate. These are explained as follows:

3.5.1 Univariate analysis

The univariate analysis was done to describe all the variables being included in the study. Frequencies and percentages were used to describe each variable.

3.5.2 Bivariate analysis

The second stage of analysis was the bivariate analysis. The bivariate analysis was performed to evaluate the risk factors associated with the outcome variable (ARI). The main independent variable- type of cooking fuel and other independent variables- age of the mother, educational level, type of place of residence, region of residence, occupation, wealth index, child’s age in months, size of child at birth, sex of child, immunization status, wall material and floor material were cross-tabulated against the dependent variable: ARI (Yes or No). This shows the extent to which each of the variables was associated with the outcome variable (ARI). All variables are categorical so chi-square analysis was used to test for the associations. The chi-square test was set at $\alpha=0.05$ to indicate the significance of the associations between the main independent variable and other independent variable as against the dependent variable.

3.5.3 Multivariate analysis

At this stage, two models were used to determine the factors associated with ARI among children under-five in Ghana. The first model measured the effect of cooking fuel on ARI without taking into account other independent variables. For model two, the main independent and other independent variables were put into one model. This was done to determine the extent
to which maternal characteristics influence the incidence of ARI. More specifically, the study focuses on the extent to which type of households cooking fuel has an association with incidence ARI among children under-five. The binary logistics regression reports the odds ratio, which explains the significance of the association between the independent variable and the dependent variable in the presence of other variables. The odds ratios (OR) were analyzed for statistical significance for type of cooking fuel and ARI. The binary logistic regression model was used for the analysis because the dependent variable is dichotomous variable (yes and no). Such dependent variable with two categories can only take on two values 0 or 1, and the predicted probability ranges between 0 and 1. Thus the logit transformation model is used and the equation for the model is stated as follows:

\[
\text{Logit } P = \ln\left(\frac{P}{1-P}\right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \beta_n X_n
\]

Where P is the probability that a child experienced ARI

1-P is the probability that a child did not experience ARI

\(\alpha\) is a constant

\(\beta_1, \beta_2, \beta_3\) and \(\beta_n\) are the regression coefficients.

\(X_1, X_2, X_3\) and \(X_n\) are the main independent variables which are type of cooking fuels and control variables such as place of residence, mother’s age, and the sex and the age of the child.

The logistic regression model can be given as the log odds of an event occurring in terms of the independent variable and an error term. Odds ratio greater than one (OR>1) shows a greater chance of the event occurring while an odds ratio less than one (OR<1) shows a lesser
chance of the event occurring and if an odds ratio of one (OR=1) is observed, it means the absence of relationship between predictor variable and the outcome variable.

3.6: Limitations

While this study has advantage of using a large national representative sample. The following limitations have to be kept in mind. One major limitation of this study is its cross sectional design that precludes the ability to disentangle cause and effect. The study relies on self-reported symptoms without laboratory or radiographic evidence. Thus possibility of misclassification may occur, hence the result should be considered as such.

Children in this study were grouped based on whether the children were living in homes cooking on biomass or non-biomass fuels. Such groupings of children without more information on children from homes using a combination of mix fuels may lead to different effects values. Also fuel type is not the best measure to use as estimation of exposure to smoke.

Lastly, variables such as climate, seasonality and house ventilation were not found in the data set.
CHAPTER FOUR

BACKGROUND CHARACTERISTICS OF RESPONDENTS

4.1 Introduction

This chapter presents the results obtained from univariate, bivariate and multivariate analysis of the present study, together with discussion and interpretation of the results. Firstly, this section starts with only the description of results of the univariate analysis of all the variables that was included in the analysis. Secondly, the bivariate analysis describes the relationship between household characteristics such as type of fuel use for cooking and maternal characteristics. Lastly the multivariate analysis is in two models (model one and model two).

4.2 Acute respiratory infection (ARI)

Table 4.1 shows the percentage of children under-five years that reported ARI. Majority (93.6%) of the mothers reported no, implying that their children did not experience the symptoms of ARI. However, 6.4% of the mothers reported that their children experienced these symptoms which include cough accompanied by short, rapid breathing.

Table 4.1: Percentage distribution of ARI

<table>
<thead>
<tr>
<th>ARI</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>5137</td>
<td>93.6</td>
</tr>
<tr>
<td>Yes</td>
<td>354</td>
<td>6.4</td>
</tr>
<tr>
<td>Total</td>
<td>5,491</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Generated from 2014, GDHS.
4.3 Household characteristics

From Table 4.2, majority (79.9%) of the mothers in the sample reported using biomass fuel as the main source of energy for cooking while 20.1% of mothers reported using non-biomass as the main energy source for cooking at home.

The results from Table 4.2 show that a greater proportion of children lived in Ashanti region representing 18.4 percent followed by Greater Accra representing 15.6 percent and Northern region constituted 12.6 percent while small proportion of the children lived in Upper West and Upper East regions constituting 2.7 percent and 4.0 percent respectively.

Again, the results indicate that majority (54.9%) of the children’s mother lived in rural areas compared to 45.1% women who lived in urban areas. With regards to household floor material, the majority (91.4%) of mothers and children lived in households built with improved floor material while 8.6% of children lived in households built with unimproved floor material.

On household wall materials, majority (71%) of mothers and children lived in houses built with improved wall materials which included cement, stones with lime/cement, brick, cement blocks and covered adobe while 29% of children lived in households built with an unimproved wall material (constructed with cane/palm/trunks, dirt, bamboo with mud, stone with mud, uncovered adobe, plywood, reused wood and wood planks/shingles).
Table 4.2: Percentage distribution of type of cooking fuels and household characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency (N=5,491)</th>
<th>Percent (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of cooking fuel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>4389</td>
<td>79.9</td>
</tr>
<tr>
<td>Non-biomass</td>
<td>1102</td>
<td>20.1</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>542</td>
<td>9.9</td>
</tr>
<tr>
<td>Central</td>
<td>602</td>
<td>11.0</td>
</tr>
<tr>
<td>Greater Accra</td>
<td>858</td>
<td>15.6</td>
</tr>
<tr>
<td>Volta</td>
<td>430</td>
<td>7.8</td>
</tr>
<tr>
<td>Eastern</td>
<td>515</td>
<td>9.4</td>
</tr>
<tr>
<td>Ashanti</td>
<td>1009</td>
<td>18.4</td>
</tr>
<tr>
<td>Brong Ahafo</td>
<td>473</td>
<td>8.6</td>
</tr>
<tr>
<td>Northern</td>
<td>693</td>
<td>12.6</td>
</tr>
<tr>
<td>Upper East</td>
<td>222</td>
<td>4.0</td>
</tr>
<tr>
<td>Upper West</td>
<td>147</td>
<td>2.7</td>
</tr>
<tr>
<td><strong>Place of residence</strong></td>
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<td></td>
</tr>
<tr>
<td>Urban</td>
<td>2476</td>
<td>45.1</td>
</tr>
<tr>
<td>Rural</td>
<td>3015</td>
<td>54.9</td>
</tr>
<tr>
<td><strong>Main floor material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unimproved</td>
<td>472</td>
<td>8.6</td>
</tr>
<tr>
<td>Improved</td>
<td>5019</td>
<td>91.4</td>
</tr>
<tr>
<td><strong>Main wall material</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unimproved</td>
<td>1590</td>
<td>29.0</td>
</tr>
<tr>
<td>Improved</td>
<td>3901</td>
<td>71.0</td>
</tr>
</tbody>
</table>

Source: Generated from 2014, GDHS

4.4 Maternal characteristics

Firstly, the results indicate that less than 5% of mothers were between the ages of 15-19 and 45-49. A greater proportion of mothers were between the ages of 30-34 which constituted 25.2%. In Ghana, larger proportion of women is in the youthful age. Hence women in this age bracket are at the peak of their child bearing years. This probably explains why a greater proportion of women fall between this age brackets. Secondly the results show that 1,524 of mothers had no education, which constitutes 27.8% of the total respondents. Mothers with primary education constitute 20%. A higher proportion (47.8%) of the mothers had secondary
education while 4.5 percent of mothers had higher education. Nine hundred and fifty five of the mothers were not working and this constitutes 17.4 percent. A higher proportion of the mothers were in the sales/service/clerical occupation which constitutes 38.6 percent while less than 5% were in the professional/managerial/technical occupation category. The results from Table 4.3 indicate that half of the mothers fall within the poorest and poorer wealth category. Children from the poorest households in the sample were 22.6% while the children from the poorer households were 20.8%. Again the results from Table 4.3 show that less than forty percent of the children are from richer and richest households’ wealth category.

Table 4.3: Percentage distribution of maternal characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency (N=5,491)</th>
<th>Percentage (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age of the mother</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-19</td>
<td>194</td>
<td>3.5</td>
</tr>
<tr>
<td>20-24</td>
<td>918</td>
<td>16.7</td>
</tr>
<tr>
<td>25-29</td>
<td>1349</td>
<td>24.6</td>
</tr>
<tr>
<td>30-34</td>
<td>1382</td>
<td>25.2</td>
</tr>
<tr>
<td>35-39</td>
<td>1030</td>
<td>18.8</td>
</tr>
<tr>
<td>40-44</td>
<td>478</td>
<td>8.7</td>
</tr>
<tr>
<td>45-49</td>
<td>141</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Educational attainment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No education</td>
<td>1524</td>
<td>27.8</td>
</tr>
<tr>
<td>Primary</td>
<td>1098</td>
<td>20.8</td>
</tr>
<tr>
<td>Secondary</td>
<td>2624</td>
<td>47.8</td>
</tr>
<tr>
<td>Higher</td>
<td>245</td>
<td>4.5</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not working</td>
<td>955</td>
<td>17.4</td>
</tr>
<tr>
<td>Professional/managerial/technical</td>
<td>234</td>
<td>4.3</td>
</tr>
<tr>
<td>Sales/service/clerical</td>
<td>2120</td>
<td>38.6</td>
</tr>
<tr>
<td>Agricultural</td>
<td>1482</td>
<td>27.0</td>
</tr>
<tr>
<td>Manual</td>
<td>700</td>
<td>12.7</td>
</tr>
<tr>
<td><strong>Wealth index</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poorest</td>
<td>1239</td>
<td>22.6</td>
</tr>
<tr>
<td>Poorer</td>
<td>1142</td>
<td>20.8</td>
</tr>
<tr>
<td>Middle</td>
<td>1068</td>
<td>19.4</td>
</tr>
<tr>
<td>Richer</td>
<td>1025</td>
<td>18.7</td>
</tr>
<tr>
<td>Richest</td>
<td>1017</td>
<td>18.5</td>
</tr>
</tbody>
</table>

Source: Generated from 2014, GDHS
4.5 Household characteristics and incidence of ARI

The results depict that there is no association between type of fuel use for cooking and incidence of ARI among children under-five in Ghana. This means that children from households that cooked with biomass fuels are not at high risk compared to children from households that cooked with non-biomass and the opposite is also true. Region of residence is associated with incidence of ARI among children under five years old in Ghana. The Pearson chi-square revealed that region of residence is statistically significant ($\chi^2=19.324$, $p=0.023$). The results show that children who lived in Asanti region had the highest proportion of children reporting of ARI (9.9%) compared to children who lived in the northern region reported the least incidence of ARI (4.2%). This could be as a result of the numbers.

There was no association between type of place of residence and the occurrence of ARI among children under-five ($x^2= 3.789$, p-value=0.052). However, even though statistical significance was not attained, the results show that children who lived in rural areas recorded the highest proportion of incidence of ARI (7%) compared to children who lived in urban areas.

The results from Table 4.4 depict that the p-value indicates there is no association between main floor material and incidence of ARI among children under-five in Ghana ($p=0.138$). However children from households with unimproved main floor material reported the highest occurrence of ARI (8.1%) compared to children from households with improved main floor material (6.3%). There was no statistically significant association between main wall material and incidence of ARI among children under five ($p=0.431$).
Table 4.4: Percentage distribution of type of cooking fuels and households characteristics by ARI

<table>
<thead>
<tr>
<th>Variables</th>
<th>ARI</th>
<th>chi-square</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
<td>Yes</td>
<td>(CI, 95%)</td>
</tr>
<tr>
<td><strong>Type of cooking fuels</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>93.6</td>
<td>6.4</td>
<td>0.017</td>
</tr>
<tr>
<td>Non-biomass</td>
<td>93.5</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western</td>
<td>93.5</td>
<td>6.5</td>
<td>19.324</td>
</tr>
<tr>
<td>Central</td>
<td>93.9</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Greater Accra</td>
<td>92.9</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Volta</td>
<td>92.8</td>
<td>7.2</td>
<td></td>
</tr>
<tr>
<td>Eastern</td>
<td>90.1</td>
<td>9.9</td>
<td></td>
</tr>
<tr>
<td>Ashanti</td>
<td>93.6</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>Brong Ahafo</td>
<td>95.8</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Northern</td>
<td>95.4</td>
<td>4.6</td>
<td></td>
</tr>
<tr>
<td>Upper East</td>
<td>93.7</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>Upper West</td>
<td>94.6</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td><strong>Place of residence</strong></td>
<td></td>
<td></td>
<td>3.789</td>
</tr>
<tr>
<td>Urban</td>
<td>94.3</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>93.0</td>
<td>7.0</td>
<td></td>
</tr>
<tr>
<td><strong>Main floor material</strong></td>
<td></td>
<td></td>
<td>2.203</td>
</tr>
<tr>
<td>Unimproved</td>
<td>91.9</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>93.7</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td><strong>Main wall material</strong></td>
<td></td>
<td></td>
<td>0.621</td>
</tr>
<tr>
<td>Unimproved</td>
<td>94.0</td>
<td>6.0</td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>93.4</td>
<td>6.6</td>
<td></td>
</tr>
</tbody>
</table>

Source: Generated from 2014 GDHS. Confidence interval= (CI)
4.6 Maternal characteristics and incidence of ARI

The maternal characteristics include the mother’s age, educational attainment, occupation, and wealth index. The Pearson chi-square value for mothers age and ARI indicates a significant association between mother’s age and ARI (χ²=13.259, p=0.039). This means that mother’s age has an association with the incidence of ARI among children under five years. Table 4.5 shows the percentage distribution of mother’s age in 5 year groups and the incidence of ARI among children under-five in Ghana. The results in the table indicate that a greater proportion of children who experienced symptoms of ARI two weeks prior to the survey belonged to mothers who were aged between 44-49 years while 4.3% which is the least proportion of incidence of ARI among children who belonged to mothers aged between 35-39 years.

The results from table 4.6 also indicates that a greater proportion of mother’s with higher educational attainment reported the highest incidence of ARI (8.2%) among their children under-five compared to the smaller proportion of mother’s with no education who reported the least incidence of ARI (6.0%) among their children under five. This association is however not significant. Pearson chi-square test indicates that there is no significant association between mother’s educational attainment and incidence of ARI among children under five (p=0.541).
Table 4.5: Percentage distribution of maternal characteristics by ARI

<table>
<thead>
<tr>
<th>Variables</th>
<th>ARI</th>
<th>chi-square (95%, CI)</th>
<th>P-value (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother’s age</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>15-19</td>
<td>93.3</td>
<td>6.7</td>
<td>13.259,</td>
</tr>
<tr>
<td>20-24</td>
<td>93.8</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td>92.2</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td>30-34</td>
<td>93.4</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>35-39</td>
<td>95.7</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>40-44</td>
<td>93.5</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>45-49</td>
<td>91.5</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>Educational attainment</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>No education</td>
<td>94.0</td>
<td>6.0</td>
<td>2.153,</td>
</tr>
<tr>
<td>Primary</td>
<td>93.8</td>
<td>6.2</td>
<td>0.541</td>
</tr>
<tr>
<td>Secondary</td>
<td>93.3</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>91.8</td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td>No</td>
<td>Yes</td>
<td>7.169</td>
</tr>
<tr>
<td>Not working</td>
<td>92.3</td>
<td>7.7</td>
<td>0.127</td>
</tr>
<tr>
<td>Professional/managerial/technical</td>
<td>95.3</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Sales/service/clerical</td>
<td>93.1</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Agriculture</td>
<td>94.1</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>Manual</td>
<td>94.9</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td>Wealth index</td>
<td>No</td>
<td>Yes</td>
<td>17.018</td>
</tr>
<tr>
<td>Poorest</td>
<td>94.5</td>
<td>5.5</td>
<td>0.002</td>
</tr>
<tr>
<td>Poorer</td>
<td>93.6</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>91.0</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>Richer</td>
<td>95.0</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Richest</td>
<td>93.5</td>
<td>6.5</td>
<td></td>
</tr>
</tbody>
</table>

Source: Generated from 2014, GDHS. Confidence interval (CI) =95%; P-value = 0.05.

Similarly, the Pearson chi-square test shows that there was no statistically significant association between mother’s occupation and incidence of ARI among children under-five. But even though statistical significance was not achieved, the results show that children born to mothers who are not working recorded the highest proportion of incidence of ARI (7.7%) compared to children whose mothers worked in the professional, managerial and technical occupations who had the least incidence of ARI (4.7%) among children under-five.
The wealth index of the household the children belonged to was found to be statistically related to incidence of ARI. The results were however opposite of what was expected. The results revealed that children from middle wealth household category recorded the highest incidence of ARI, constituting 9.0% of the total sample of respondents compared to children from the richer wealth household category (5.0%). Meanwhile children belonging to the richest households had 6.5% incidence of ARI compared to 5.5% incidence of ARI of children belonging to the poorest wealth category.

4.7 Child’s characteristics and incidence of ARI

The results from Table 4.6 depict the association between child’s age and incidence of ARI. A statistically significant association was found between age of the child and occurrence of ARI. Children aged 12-23 months reported the highest proportion of symptoms of ARI compared to children aged 48-59 months who had the lowest proportion reporting of symptoms of ARI representing 4.7%. In addition, sex of child has no significant association with symptoms of ARI. This means that females are not at high risk compared to male and vice versa.

There is no association between size of the child at birth and incidence of ARI as the p-value for the chi square test (p=0.575) is higher than 0.05. The results however show that children of average size at birth reported the highest proportion of incidence of ARI representing 6.8% while children who were of large size at birth experienced the least symptoms of ARI compared to those of small size at birth. A statistically significant association between immunization status and incidence of ARI ($\chi^2 = 25.553$, $p = 0.000$) was realised. However, the result was contrary to expectation as children who were reported to have complete immunisation recorded a higher proportion of children with symptoms of ARI (7.1%) compared to 0.5% of children who were not immunized.
Table 4.6: Percentage distribution of child’s characteristics by ARI

<table>
<thead>
<tr>
<th>Variables</th>
<th>ARI</th>
<th></th>
<th>chi-square (CI, 95%)</th>
<th>P-value (0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child’s age in months</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-11</td>
<td>93.1</td>
<td>6.9</td>
<td>18.552</td>
<td>0.001</td>
</tr>
<tr>
<td>12-23</td>
<td>91.3</td>
<td>8.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24-35</td>
<td>93.4</td>
<td>6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36-47</td>
<td>95.0</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48-59</td>
<td>95.3</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex of the child</td>
<td></td>
<td></td>
<td>0.012</td>
<td>0.913</td>
</tr>
<tr>
<td>Male</td>
<td>93.6</td>
<td>6.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>93.5</td>
<td>6.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of the child</td>
<td></td>
<td></td>
<td>1.108</td>
<td>0.575</td>
</tr>
<tr>
<td>Small</td>
<td>93.5</td>
<td>6.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>93.2</td>
<td>6.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>94.3</td>
<td>6.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immunization status</td>
<td></td>
<td></td>
<td>25.553</td>
<td>0.000</td>
</tr>
<tr>
<td>No immunization</td>
<td>99.5</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial</td>
<td>93.4</td>
<td>6.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>92.9</td>
<td>7.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Generated from 2014, GDHS; Confidence interval (CI).

4.8 Factors predicting acute respiratory infection among children below five years

The model generated an $R^2=0.043$ which shows that, all the independent and control variables in the model accounted for 4.3% of the variation in ARI. Hence 95.7 percent of the incidence of ARI among children under five is explained by other factors that were not considered in this present study.

The results in Table 4.7 indicate that four of the independent variables in the model showed statistical significance with the occurrence of ARI among children under-five. These variables were place of residence, occupation, wealth status, child's age in months and immunization status.
In model one, contrary to expectation, type of cooking fuels did not show any significant relationship with incidence of ARI among children under-five in Ghana. The hypothesis that households that use biomass fuel are more likely to have their children suffer from ARI than households that use non-biomass fuel was not supported. However, children from households that use non-biomass fuels for cooking were found to be 1.045 times as likely to suffer from incidence of ARI compared to children from households that use biomass as the main source of energy for cooking. This is however not statistically significant.

Results from Table 4.7 show that age of the mother is not significantly related with incidence of ARI among children below five years. However, children of mothers of all age group categories except 20-24 years and 35-39 years categories were more likely to suffer from ARI compared to children of mothers between 15-19 years. In contrast, children of mothers between age groups 20-24 years and 35-39 years were less likely to suffer from ARI compared to children of mothers between 15-19 years. There was no significant relationship between educational attainment of the mother and incidence of ARI among their children. However the results show that children whose mothers had attained primary and secondary education were less likely to develop ARI compared to children whose mothers had no formal education.

Children from middle wealth household category were the only wealth category that appeared to have a statistical relation with incidence of ARI. Thus, children from middle wealth category households were more likely as children from poorest households to suffer from incidence of ARI. The type of place of residence was statistically associated with incidence of ARI among children under-five in Ghana. The results show that children under-five from households in urban areas are less as likely as children from households in rural areas to suffer from incidence of ARI. Region of residence of the children were not significantly related to incidence of ARI.
However, children from households in all the regions except Ashanti region were more likely to suffer from ARI compared to children from households in the upper west region.

Mothers’ occupation was statistically associated with incidence of acute respiratory infection in the model. Children whose mothers worked in professional, managerial, and technical occupations were less likely as those children whose mothers were not working to suffer from ARI. Sex of the child was not significant with incidence of ARI indicating that males are not at higher risk compared to females and vice versa. The age of the child and incidence of ARI were statistically significant. Children in the age group 48-59 months category were less likely as children between age group of 0-11 months to suffer from ARI. Also, children aged 36-47 months were less likely as children less than a year to suffer from incidence of ARI. Immunization status of children was significantly associated with the occurrence of ARI among children under-five in Ghana. Results show that children who were partially immunized were more likely as children with no immunization to suffer from ARI. In fact children who were completely immunized were even more likely to suffer from incidence of ARI than children who were not immunized at all.

Main floor material was not significant with incidence of ARI among children under five at 95% confidence level. Additionally, main wall material was not significantly associated with incidence of ARI among children under-five.
Table 4.7: Binary logistic regression model showing the relationship between household types of cooking fuels, selected control variables, and incidence of ARI among under-five children in Ghana.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
</tr>
</thead>
<tbody>
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<td><strong>Child's age in months</strong></td>
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<td>0-11 months (RC)</td>
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<td>12-23 months</td>
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<td>36-47 months</td>
<td>0.044</td>
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48-59 months  0.020  0.617

Size of child at birth

Small (RC)  1.000
Average  0.862  1.022
Large  0.428  0.874

Main floor material

Unimproved (RC)  1.000
Improved  0.088  0.705

Main wall material

Unimproved (RC)  1.000
Improved  0.422  1.141

Immunization of child

Not immunized (RC)  1.000
Partial  0.000  12.993
Complete  0.000  14.711

<table>
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<th>Model</th>
<th>R^2</th>
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<tr>
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<td>-2log likelihood</td>
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RC= Reference Category, sig =significance, CI=confidence interval, N=5,491

4.9 Discussion

A lot of studies have shown that biomass fuels are associated with the occurrence of ARI among children under five (Smith, 2000; Alemayehu et al. 2014; Abd-Elfarag & Langoya, 2016). The results from the bivariate and multivariate analysis show that some aspect of child’s characteristics, mother’s characteristics and household characteristics significantly influence incidence of ARI among children under-five years in Ghana but not the type of cooking fuel.
This is attributable to the fact that fuel type is not an ideal measure of exposure to cooking smoke. Also the data set (GDHS, 2014) did not show exposure to cooking smoke because we use the main type of cooking fuel used in household as a proxy for exposure to cooking smoke (Mishra, 2001). At the bivariate level, results from chi-square analysis show that mother’s characteristics such as age and wealth were associated with the incidence of ARI. Children whose mothers were in the age category 45-49 years reported the highest (8.5%) proportion of incidence of ARI, however at binary regression analysis mother’s age did not show significance with incidence of ARI.

The association between mother’s educational attainment and incidence of ARI was not significant. Even though this was not statistically significant it was opposite to what was hypothesized. Instead of children of mothers with higher educational attainment experiencing less symptoms of ARI, a reverse association was realized. For example children of mothers with primary education category were less likely as children of mothers with no education to develop ARI. In contrast, children of mothers with higher educational attainment were rather more as likely as children of mothers with no educational attainment to suffer from ARI. Educated mothers are more likely to be employed and thus will result in their children being left alone or in the care of someone whose lifestyle may influence or intensify likely of symptoms of ARI. Another possibility is an underestimation of the occurrence of ARI prevalence due to recall bias of the event, ARI prevalence have been fully understood by uneducated mothers, or because the children of uneducated mothers have a higher likelihood of dying from ARI and thus being excluded from this study. Therefore the hypothesis that children of mothers with higher educational attainment are less likely to suffer from ARI than children of mothers with no educational attainment was not accepted. This is because children of mothers with higher
educational attainment developed a higher incidence of ARI by a factor of 1.904 compared to children of mothers with no educational attainment. This is in line with a pilot study from Indonesia, which found that a mother’s education level had an indirect effect on childhood pneumonia and respiratory illness (Adesanya et al, 2016).

The results from bivariate analysis indicate that wealth was significantly related to incidence of ARI. Children from the middle wealth category reported the highest proportion (9.0%) of children who experienced ARI while children from the richer wealth category reported the lowest (5%). Studies by Manu (2014) in Ghana, Bbaale (2011) in Uganda and Azad (2009) in Bangladesh made similar observations. Children from the middle wealth household’s category were significantly related to incidence of ARI at the binary regression.

Occupation of the mother specifically professional, managerial, and technical was the only occupation that was significantly related to incidence of ARI. However, results from the regression indicate that children of mothers in all occupation categories were found to be less likely to experience the symptoms of ARI compared to children of mothers not working. Maternal employment gives some indication of their income that they earned hence it influences child feeding practices and thus reflects child’s nutritional status. There is also an evidence to suggest that mothers who work may lack the time to adequately breastfeed or prepare nutritious meals for their young children or to make use of public service designed to improve child nutrition (Glick, 2002). On the other hand income earnings are essential to child health.

Region of residence was found to be statistically related to incidence of ARI at the bivariate analysis. Generally the expectation was that children from the northern region will suffer the highest occurrence of symptoms of ARI, however, the results of the bivariate analysis
indicate that ARI was high (9.9 percent) among children who were living in the Eastern region and Volta region 7.2%. Also mothers living in Brong Ahafo reported the lowest ARI prevalence (4.2%) among their children. Meanwhile in the binary regression model, the results indicated that region of residence did not show significance with incidence of ARI. However children from Ashanti region were less likely to suffer from incidence of ARI as compared to children from upper west region.

Also, with the expectation that type of place of residence may play an important role in the incidence of ARI among children under-five, this study sought to assess the association between type of place of residence and occurrences of ARI among children under-five years. Type of place of residence was found to be statistically related to occurrence of ARI. Children from households in urban areas were less likely to experience symptoms of ARI compared to children from households in rural areas. The results are consistent with literature and support one of the hypotheses of this study. This hypothesis states that children who live in urban areas are less likely to suffer from ARI than children who live in rural areas. The hypothesis was supported because children who live in urban areas are less likely to suffer from ARI (OR=0.668; p-value 0.012) compared to children who live in rural areas. Again the results from the univariate analysis showed that there were more women in rural areas than in urban areas. And people who reside in rural areas were more likely to use biomass fuel such as wood and charcoal as their main source of cooking fuel due to its availability and accessibility.

All the environmental factors were not statistically significant with the occurrence of ARI among children under-five in Ghana both at the bivariate and binary logistic regression analysis. This could be that other equally important factors were not considered in this present study. This include type of cooking stove, cooking area (kitchen closed to the living room or far from the
living room) and whether the child is with the mother while cooking during the use of biomass fuel has been reported as risk factors of incidence of ARI in other studies. However since this present study used a secondary data from 2014 GDHS which did not have all the key information which could have influenced the results, the study did not considered them in the analysis and this constitute a limitation to the current study. Additionally, the price of the non-biomass fuel such as electricity is expensive compare to biomass fuel like wood or charcoal.

Child’s characteristics such as sex of the child and size of the child at birth did not show significant association with incidence of ARI. However age in months and childhood immunization status showed statistically significant association with occurrence of ARI. Results from bivariate analysis indicate that children between age categories 12-23 months reported the highest (8.7%) incidence of ARI while children between 48-59 months reported the lowest proportion (4.7%) of incidence of ARI. Findings from Ethiopia, Nigeria, and Ghana (Alemayehu et al.2014; Ujunwa & Ezeonu 2014; Manu, 2014) found similar observations that children between the ages of 6 and 23 months old had higher incidence of ARI. However results from the binary regression also indicate that children in all age categories with the exception of children in the 12-23 months were less likely to experience symptoms of ARI compared to children in the age category of 0-11 months. Also, children who were in the age categories of 36-47 months and 48-49 months were less likely to experience symptoms of ARI. This could mean that children after they are weaned begin to take nutritious meals and because their immune system is developed it may reduce the risk of infection hence less the likelihood of experiencing ARI at that age categories.

Childhood immunization remains an important strategy for the reduction of illness and death from common preventable infections like ARI. With regards to immunization status by the
child, the results showed that immunization status was significantly related to the occurrence of ARI. The Pearson chi-square showed that (7.1 percent) of children who had been completely immunized reported the highest symptoms of ARI while (0.5 percent) of children who had received no vaccinations at all reported the least symptoms of ARI. In contrast binary regression results showed that children who had been partial and completely immunized are more likely to experience the symptoms of ARI. In fact this was not expected however it could also mean that other factors have equally important influence on ARI than just completion of the childhood immunization. Moreover in the 2014 GDHS data set used for the analysis, information on vaccination status was collected from health cards (weighing card) shown to the interviewer and from mother’s verbal reports if no card was available so this could affect the results.
CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter summarizes the key findings and conclusion from this study. The chapter finally ends with recommendation for further studies to reduce the incidence of ARI among children under five in Ghana.

5.2: Summary

In order to understand the association between type of cooking fuel and acute respiratory infections (ARI) in Ghana, the present study was undertaken with the main objective of examining the types of cooking fuel used in Ghana and incidence of ARI among children under-five. Specifically, the present study sought to investigate household’s characteristics and maternal characteristics which influence the type of fuel use for cooking by households hence incidence of ARI. In addition child’s characteristics were also employed in the study. All variables were selected and included in the study based on existing literature.

The study used data from the 2014 Ghana Demographic and Health Survey. The results showed that 6.4 percent of the children under-five had symptoms of acute respiratory infection two weeks prior to the survey. In addition, the majority of the respondents 79.9 percent relied on biomass fuels (wood, charcoal, agricultural crops and straw, grass, shrubs) as their main source of fuel for cooking in the house. One fourth of mothers were in the 30-34 age category. More than seventy percent of mothers had varied levels of education. Meanwhile more than 30% were into sales, service, and clerical occupation. Consequently the results showed that 20.8 percent of the children were from poorer households. More than half of the total samples were males and majority of children were below three years. With regards to size at birth more than fifty percent
of the children were large. Also majority of the children had received complete immunization and 7.2% had not been immunized at all. There were more than half of the children in rural areas. Higher proportion of the children was from the Ashanti region. Furthermore the results revealed that majority of children lived in household built with improved floor material. In addition more than 70% of the children lived in households built with improved wall material.

Cross tabulation and Pearson chi-square test were used at the bivariate analysis to ascertain the association between the main independent variable, other independent variables and the outcome variable. The results showed that mother’s age, wealth index, region of residence, child’s age in months and childhood immunization were significantly related to incidence of ARI among children under-five.

Binary logistic regression was used at the multivariate analysis with significance set at 5% to determine which of the variables were statistically significant in predicting the incidence of ARI among children under-five. The results from model 1 show that type of cooking fuel does not predict incidence of ARI among children under-five. In addition results from model 2 show that child’s age in months, occupation of the mother, specifically professional, managerial, and technical, middle wealth index, place of residence and childhood immunization were found to be significant predictors of incidence of ARI among children under-five years old.

The study hypothesized that households that use biomass fuel are more likely to have their children suffer from ARI than households that use non-biomass fuel. Secondly children in urban areas are less likely to experience symptoms of ARI as compared to children in rural areas. Thirdly mothers with higher educational attainment are less likely to have their children experience symptoms of ARI than mothers with no educational attainment. Furthermore children
from poorest households were more likely to suffer from ARI than children from richest households. The hypotheses that were not confirmed by the results of the analysis include households that used biomass fuels are more likely to have their children experience the symptoms of ARI than households that used non-biomass fuels, mothers with higher educational attainment are less likely to have their children experience symptoms of ARI than mothers with no formal education and children from households in the poorest wealth quintile are more likely to experience the symptoms of ARI than children from the richest households. However the hypothesis that children in urban areas are less likely to experience symptoms of ARI as compared to children in rural areas was confirmed by the results of this present study.

5.3 Conclusion

Indoor air pollution is a major cause of ill-health such as ARI in low-middle countries such as Ghana. It is mostly due to the burning of biomass fuel such as wood, cow dung, charcoal etc. ARI is classified into two: URI and LRI. ARI is not age selective neither gender selective. However children under five are more likely to suffer from ARI. Globally 13 million premature death occurs every year due to the use of biomass fuel and around 95% of these deaths occur in developing countries. The use of wood as cooking fuel not only harms the inhabitants health but it also recognized as a factor in deforestation, soil erosion, loss of soil fertility and ecosystem imbalance. In 2014 more according WHO more than 3 billion people rely on biomass fuel for cooking and other activities.

Based on the study findings, the study concludes that type of cooking fuel does not have an influence on incidence of ARI among children under five in Ghana. There are several factors that could explain this conclusion. Firstly, cooking fuel was use as proxy for exposure to cooking smoke meanwhile fuel type is not an ideal measure of exposure to smoke. On the other hand
household in Ghana use combination of cooking fuels, whereas we have information only on the primary cooking fuel. A mix of biomass fuels and cleaner fuels is actually used by many households instead of biomass fuels alone.

There is also a possibility of underreporting of ARI due to lack of awareness that the child had the disease during the two weeks reference period use during the data collection. Underreporting due to lack of awareness may be greater among children under five living in households using biomass fuels.

Lastly reports of ARI symptoms by mothers are not as accurate as clinical measures of the disease. Hence there is the possibility that misclassification may occur.

However, child’s characteristics such as child’s age in months, childhood immunization, child’s place of residence, region of residence and mother’s characteristics such as age of the mother, occupation of the mother and household characteristics such as wealth were found to be important factors that influence the occurrence of the symptoms of ARI. It is worthy to mention that all the variables that were included in the binary logistics regression model explained only 4.3 percent of the variation in occurrence of ARI. However as mention earlier other variables that could possibly influence the incidence of ARI among children under five were excluded from this study due to data limitations. This explains why the main independent variable (biomass fuel for cooking) did not show significant association with the incidence of ARI, hence the study failed to achieve its objectives. Further research is needed to establish the influence of type of cooking fuel on prevalence of ARI among children under-five.
5.4 Recommendations

Based on the findings and conclusion of the study these are the suggested recommendations:

The study findings concerning the association between the type of cooking fuels and incidence of ARI among children under-five in Ghana gives credence to the claim that ARI is not a result of biomass smoke alone. Countless factors beyond the environmental conditions influence incidence of ARI. For example type of place of residence, age of the child, childhood immunization, occupation of the mother and wealth have significant influence on ARI among children under-five as was found in the present study. In the quest to prevent and reduce the occurrence of ARI among children under-five in Ghana, there is the need for serious interventions both short and long term. Although biomass fuel did not show any significant association with ARI, but there is a line evidence that exposure to biomass fuel can lead to increased risk of disease including respiratory infections. Therefore the health education associated with indoor air pollution and biomass fuel use for cooking is necessary. Also there should be promotion of the use of clean stoves for cooking by raising public awareness of the benefits and important role of clean cook stoves. Lastly health education campaign should not end at health benefits of the use of clean cook stove but they should be community education to teach residents especially the rural people how to use the improved stoves correctly.

The binary logistic regression model for incidence of ARI for this study showed the advantage urban children have over rural children in terms indoor air pollution. Therefore there should be enforcement of rural energy policy for clean cooking. More also there should be an age policy to
restrict children below eighteen years from going near the place of cooking especially kitchen as is been done in some developed countries.

Also in other to prevent childhood illness, the ministry of health should make sure there is an increase in the coverage of immunization during the early childhood stage. The immunization helps prevent a lot of diseases.

The socio-economic status of mothers should be improved by creating jobs for mothers who are not engaged in any meaningful work. Hence mothers will be financially independent so incase the child is sick the mother will take the child to the health center for treatment.
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