UNIVERSITY OF GHANA, COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

NUTRITIONAL STATUS AND PNEUMONIA IN CHILDREN UNDER FIVE AT PRINCESS MARIE LOUISE CHILDREN'S HOSPITAL

BY

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DECLARATION

I, Hugette Naa Ayele Aryee hereby declare that apart from references to other people's works which have been duly acknowledged, this dissertation is as a result of my own independent work undertaken under supervision and has not been submitted for the award of any degree in any other institution.

STUDENT:

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Hugette Naa Ayele Aryee Date

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Dr. Adolphina Addo-Lartey Date

DEDICATION

This work is dedicated to God Almighty for guiding me through all these years and bringing me this far. I also dedicate this work to my beloved family, faculty, friends and loved ones for their immense support, love, care and prayers for me throughout this work. Lastly I dedicate this thesis to all children below age five.

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ABSTRACT

Background: Pneumonia is a form of acute respiratory infection. The epidemiology of childhood pneumonia is due to various risk factors such as malnutrition, substandard breastfeeding, exposure to biomass fuel for cooking and parental smoking and needs further investigation.

Objective: The aim of the study was to examine the relationship between pneumonia and nutritional status in children under five at Princess Marie Louise Children's hospital.

Method: An unmatched case-control design was conducted and 88 cases and 88 controls were consecutively sampled. Data was collected with semi-structured questionnaires and child anthropometry was taken. Data was entered and analysed in MS Excel 2016 software, WHO Anthro software version 3.2.2 and Stata software version 15. Chi square test and Wilcoxon rank sum test were used to test of association for categorical and continuous variables respectively. Logistic regression was run to assess the extent to which the significant independent categorical variables influenced pneumonia. All tests were two-sided and statistical significance was set at 0.05.

Results: In the study, majority (80) of the cases were children between the ages 2 months to less than 60 months. The bivariate analysis showed that categorized child's age, weaning age, main caretaker, religion, complementary feeding, source of drinking water, height-for-age z-score and weight-for-age z-score were statistically significant. Pneumonia had a positive effect among children who were stunted (aOR= 0.08, 95% CI: 0.01-0.89), not stunted (aOR= 0.10, 95% CI: 0.01-0.86) and who had a relative other than the mother as main caretaker (aOR= 0.19, 95% CI: 0.04-0.95) and were significantly associated with the disease. Furthermore, being a female child (aOR= 1.85, 95% CI 0.92-3.72)., underweight (aOR= 5.17, 95% CI: 0.88-30.59), not underweight (aOR= 1.4, 95% CI: 0.32-6.14), not started complementary feeding yet (aOR=2.12, 95% CI: 0.37-12.02) and those who had started complementary feeding before 6 months (aOR= 1.61, 95% CI: 0.77-3.38) had higher odds of getting pneumonia.

Conclusions: This study highlights being female, underweight, not starting complementary feeding and starting complementary feeding before 6 months as risk factors and thus a need for health policies and nutritional interventions in children below five years to provide a basis for reducing the burden.

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LIST OF ACRONYMS

ALRTI	Acute Lower Respiratory Tract Infections
AMA	Accra Metropolitan Area
aOR	Adjusted Odds Ratio
BAZ	Body Mass Index-for-age
CI	Confidence Interval
EBF	Exclusive Breastfeeding
FP	Family Planning
GAR	Greater Accra Region
GDHS	Ghana Demographic and Health Survey
GMP	Growth Monitoring and Promotion
HAP	Household Air Pollution
HAZ	Height-for-age z-score
HIV	Human Immunodeficiency Virus
LBW	low birth weight
LPG	Liquefied Petroleum Gas
OR	Odds Ratio
PML	Princess Marie Louise Children's Hospital
RTHC	Road to Health Chart
RCH	Reproductive and Child Health
RSV	Respiratory Syncytial Virus
SDGs	Sustainable Development Goals
Spp.	species

UNICEF	United Nations Children's Fund
URTI	Upper Respiratory Tract Infection
WAZ	Weight-for-age z-score
WHO	World Health Organization
WHZ	weight-for-height z-score

OPERATIONAL DEFINITION OF TERMS

Under- five: a child below exact age five years

Nutritional status: undernutrition and over-nutrition

Colostrum: first breastmilk produced by mother within 3-4 days after giving birth. Usually yellowish in colour.

Parity of mother: number of children delivered by mother

Preterm: a baby born before completion of 37 weeks of pregnancy

Religion: can be Christianity, Islam, Traditional or other.

Educational level of each parent: Can be no education, primary, Junior High School (JHS), Senior High School and Tertiary or it's equivalence

Exclusive breastfeeding: the practice of only giving an infant breastmilk for the first six months of life (excluding other foods, water, liquids or herbal preparation) except vitamins, mineral supplements or medicines.

Income level of each parent per month: less than ₵200, ₵200 to less than ₵400, ₵400 and above

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Pneumonia is an acute infection, caused mainly by the pneumococcal species of bacteria and it affects the upper respiratory system. The lungs are made up of small sacs (alveoli) which fill with air when a healthy individual breathes. However, when a person develops pneumonia, the alveoli are filled with pus and fluid, making breathing painful and restricts the intake of oxygen (WHO, 2016). Worldwide, acute lower respiratory tract infections (ALRTI) in young children are one of the chief causes of deaths in childhood (Fiave, 2014). Pneumonia killed over 920 000 children below 60 months of age globally in 2015, which amounts to 16% of children who are less than five years old and have died. This disease affects children and families everywhere, but is most prevalent in South Asia and sub-Saharan Africa.

In children, pneumonia can be prevented through optimal breastfeeding, immunisation, adequate complementary feeding, reducing household air pollution and with cost effective treatment (WHO, 2016). In 2015, close to 3 million deaths out of about 6 million deaths in children below five years was in neonates with the leading causes being complications from preterm delivery, pneumonia, and intrapartum-linked episodes consecutively (Liu et al., 2016). The maximum number of deaths caused by pneumonia (81%) happen in the initial 24 months of life (Madhi, Bamford, & Ngcobo, 2014) Vaccine-preventable pneumonia is most often caused by Streptococcus pneumonia (related to 18.3% of cases).

Morbidity and mortality from childhood pneumonia are decreasing, nonetheless, action is required to accelerate its reduction globally and at country level (Walker et al., 2013). Early diagnosis and treatment of the disease can prevent substantial morbidity and mortality, but are often challenging in resource-poor settings (Acácio et al., 2015). The epidemiology of childhood pneumonia is due to risk factors such as under-nutrition, substandard breastfeeding, and zinc deficit (Walker et al., 2013). One study reported that polluted air from meal preparation using biomass fuel, smoking by parents and overcrowding are risk factors of pneumonia (Karki, Fitzpatrick, & Shrestha, 2014).

Since pneumonia is a major contributor to infant mortality, preventing of infection in children is a very crucial part of strategies adopted to decrease childhood deaths and the most effective way is through vaccinations against Hib, pneumococcus, pertussis and measles (WHO, 2016). However, adequate diet is crucial in building immunity in children which begins with exclusive breastfeeding for the initial 6 months of childhood. Moreover, breastfeeding aids in reducing the duration of infection (WHO, 2016). Furthermore, promoting good hygiene in crowded homes and combating environmental factors such as household air pollution (with the provision of clean and affordable indoor stoves, for example) also reduces the number of children who develop pneumonia (WHO, 2016). Contact with an infected upper respiratory tract of a person and delay in seeking treatment are also risk factors associated with severe pneumonia (Onyango, Kikuvi, Amukoye, & Omolo, 2012).

Death from pneumonia is associated with intensity of infection, crowding, malnutrition, abject poverty, as well as insufficient immunizations, and areas where access to healthcare is poor. Thus, poor and hungry children, and living in areas that are difficult to reach suffer most. Suggesting a relationship between pneumonia mortality risk and inequity in access to healthcare (Adegbola, 2012).

1.2 Problem Statement

Pneumonia is one of the main public health issues in children below age five (Karki et al., 2014). It is also a public health problem in the tropics (Rurangwa & Rujeni, 2016). Pneumonia accounts for nearly a million deaths per year in infants (Adegbola, 2012). About fifty percent of global deaths owing to pneumonia in children below age five occur in Africa. The estimated proportion of deaths in children less than 5 years in sub-Saharan Africa accredited to pneumonia is between 17 and 26% (Onyango et al., 2012). Although there was a reduction in main causes of infections in sub-Saharan Africa between the year 2000 to 2015, pneumonia, diarrhoea and counterparts are still key and must be the main target for improving child survival (Liu et al., 2016). Moreover, it has been found to cause more deaths annually than HIV, malaria, and measles combined with majority of these deaths occuring in developing countries and mortality attributed to pneumonia appears to be on the rising (Acácio et al., 2015).

Nations are counselled to prioritise child survival policy and programs in the sustainable development growth (SDG) era according to its related cause of child mortality (Liu et al., 2016). By 2030, SDG target for child mortality aims to end preventable deaths of under-5 mortality to at least as low as 25 per 1,000 live births (WHO, 2017). Lui and colleagues (2016) stated that continued and enhanced efforts to scale up life-saving interventions that have been proven are desirable in the achievement of SDG child survival target.

According to Tette and colleagues (2016), pneumonia is the third leading cause of child mortality in under-fives (18.4%) in Ghana and is on the rise. Distinct risk factors that have been recognized in children below 5 years are malnutrition and diarrhoeal diseases (Ashraf, Hamidul Huque, Kenah, Agboatwalla, & Luby, 2013). This is currently 60 per 1000 live births in Ghana (GDHS, 2014) . Understanding the determinants of diseases like pneumonia in the Ghanaian paediatric population is very crucial (Tette, Neizer, Nyarko, Sifah, Nartey, et al., 2016). In Ghana, there is little information on the relationship existing between nutritional status and pneumococcal infection in children under five.

1.3 Research Questions

- What is the prevalence of pneumonia at the Princess Marie Louise Children's Hospital?
- What are the risk factors of pneumonia in children below age five?
- Are there nutritional factors that affect children under five with pneumonia?
- Does poor nutritional status affect children under five with pneumonia?
- Is there an association between nutritional status and pneumonia in children under five?

1.4 Conceptual Framework

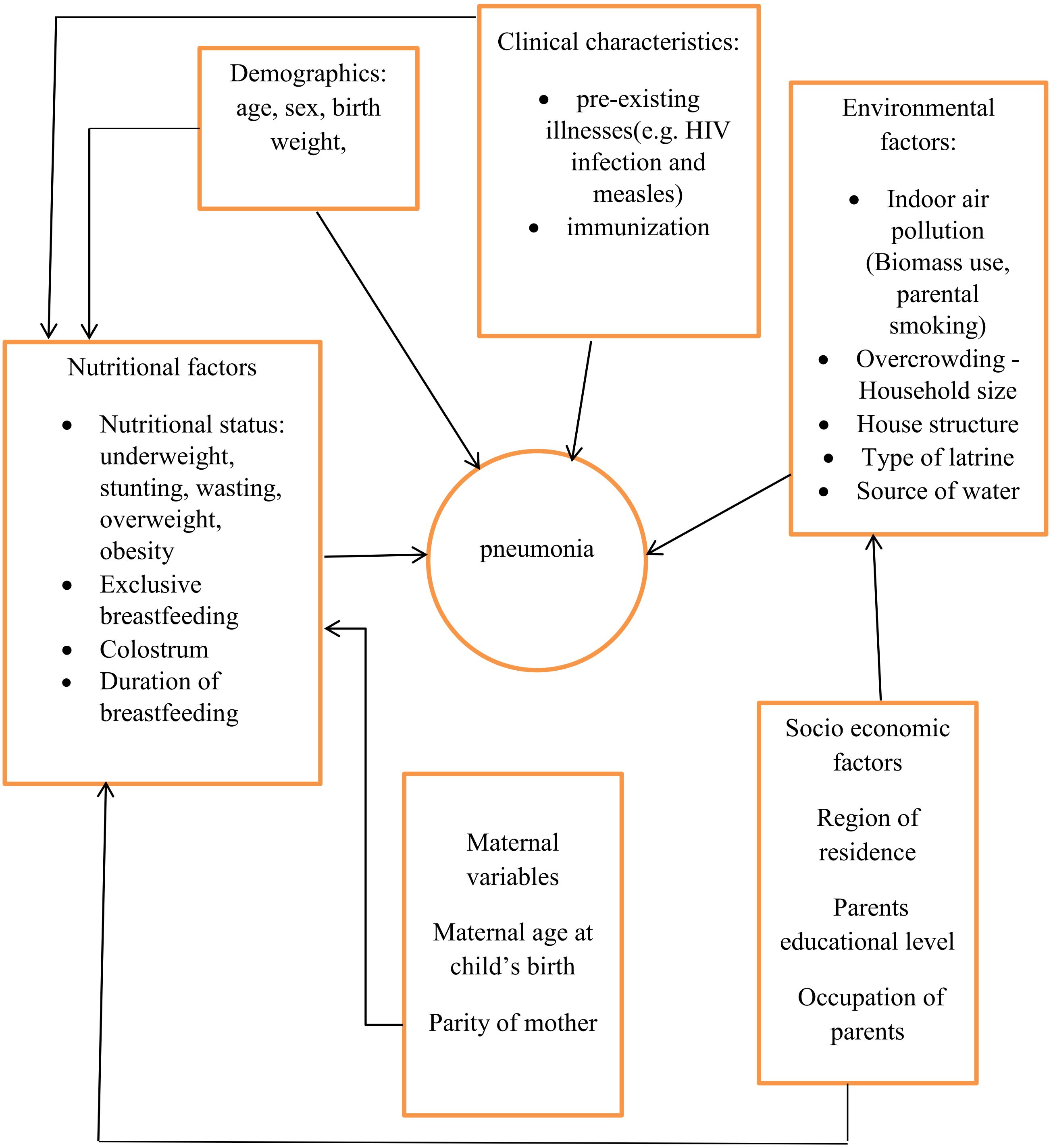

Figure 1: Conceptual framework

Narrative: Nutritional factors that have a direct effect on pneumonia in a child under five are nutritional status, exclusive breastfeeding, colostrum intake and duration of breastfeeding. Demographic characteristics such as age, sex, birth weight indirectly affect the outcome. Clinical characteristics including illnesses that already exist such as HIV infection and measles and immunization all have a direct effect on pneumonia. Environmental factors that have a direct effect on acquiring pneumonia include indoor air pollution from biomass use and tobacco smoking, overcrowding, house structure, type of latrine and water source. Maternal characteristics such as maternal age at child's birth, maternal Body Mass Index (BMI) and number of children affect the nutritional factors. Socio-economic factors, which are income of parents, educational level of parents, parents' occupations and region of residence, affect the environmental factors.

1.5 Justification

This research has particularly been necessitated, as there is little data on the relationship between nutritional status and pneumonia in children under five. As the number of children below 5 years with pneumonia keep increasing, compromised nutritional status will exacerbate its occurrence leading to more deaths from pneumonia in children under five, thus, child mortality rate would increase. This study will assess the association between nutritional status and pneumonia in children below 5 years. Data obtained from this study will add to existing knowledge and also help develop health policies in prevention and treatment of pneumonia in children under five in Ghana.

1.6 Objectives

1.6.1 General Objective

To examine the relationship between pneumonia and nutritional status in children under five at Princess Marie Louise Children's hospital

1.6.2 Specific Objectives

1. To determine socio-demographic factors associated with pneumonia among children under five at Princess Marie Louise Children's Hospital.

2. To examine the relationship between nutritional status and pneumonia in children under five at Princess Marie Louise Children's Hospital.

3. To determine other factors associated with pneumonia among children under five at Princess Marie Louise Children's Hospital.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Pneumonia

Pneumonia is a form of respiratory infection that is acute and affects the lungs (WHO, 2016). In pneumonia, one or both lungs made up of small sacs (alveoli) fill with air when a healthy human breathes (M. J. M. Hussein & Hamodi, 2017). When a person gets the disease, pus and fluid occupies the alveoli and this makes breathing painful and limits the intake of oxygen (Tong, 2013).

2.1.1 Pneumonia in Children Under-Five

Pneumonia is one of the leading cause of death in children below age five worldwide (Ginsburg et al., 2015; Onyango et al., 2012; Walker et al., 2013; WHO, 2014a). In Ghana, children below five account for 12% of the population of Greater Accra Region (GSS, 2012a). In 2011, an estimated 1.3 million children under the age of 5 years died of pneumonia, accounting for 18% of all deaths of children under 5 years of age worldwide (Walker et al., 2013). Furthermore, in 2015, pneumonia killed 920 136 (16%) children under five years old (Muppidathi, Boj, & Deivanayagam, 2017).

Pneumonia affects children and families everywhere, but is most prevalent in South Asia and sub-Saharan Africa (Rurangwa & Rujeni, 2016). Walker and colleagues (2013), estimated that 12% of pneumonia events advance to severity. The findings from one study suggested a global case-fatality ratio attributed to severe pneumonia of 8·9%.

Pneumonia accounts for millions of deaths in children below 60 months globally, of which 70% to 75% occur in infants (Ramezani, Aemmi, & Moghadam, 2015).

2.1.2 Prevalence and Incidence

The incidence of pneumonia varies between regions; adjusted for immunisation against S pneumoniae and H influenzae type b bacteria, it was highest in African and southeast Asia areas and lowest in the European area (Walker et al., 2013). Thus, the highest prevalence of severe pneumonia episodes is in the south-eastern part of Asia (39%) and African regions (30%). However, with childhood deaths, the highest numbers are in sub-Saharan Africa, with 43% of deaths occurring from pneumonia in 2011 (Walker et al., 2013) . Fifteen countries, including Uganda, account for 65% of total episodes of pneumonia with 64% for severe episodes (Walker et al., 2013). In Ghana, pneumonia accounts for 18.4% of annual under-five mortality. This means that as severity of outcomes increases, the global burden is mainly focussed in the countries of highest burden (Walker et al., 2013).

In one study, the prevalence of diarrhoea and pneumonia amongst children under 5 years of age with severe underweight, stunting and wasting was found to be 11%, 22% and 17% respectively; whereas the prevalence of pneumonia was found to be 53%. Also, the findings underscored the fact that even borderline malnutrition can predispose children to pneumonia (Rahman, Khatun, Azhar, Rahman, & Hossain, 2014).

2.1.3 Aetiology

A landscape analysis of recent pneumonia aetiology studies in children under 5 years of age in the developed and developing world revealed an array of case definitions, levels of health professionals participation, institution types, sample collection, and laboratory techniques (Gilani et al., 2012). It underpins the need for the calibration of methods and evaluation for present and future pneumonia aetiology studies in order to accurately describe the microbial causes of childhood pneumonia (Gilani et al., 2012). A Ghanaian cross-sectional study found acute lower respiratory tract infections (ALRTI) diagnosed among children under-five comprising majorly bronchopneumonia (55.5%) with the rest including lobar pneumonia, bronchiolitis, tuberculosis, non-specific ALRTI, bronchitis and respiratory distress (Adiku et al., 2015). Bacteria isolated included Staphylococcus pneumoniae, Streptococcus aureus and enteric bacteria, including Salmonella spp., Enterobacter spp and Klebsiella spp. and Respiratory Syncitial Virus (RSV) of subgroups A and B. (Adiku et al., 2015). The aim of a study by Fiave (2014), to detect and characterize human parainfluenza viruses in children that present with ALRTI at PML concluded that all four types of human parainfluenza viruses are in circulation in Ghana and were associated with ALRTI (Fiave, 2014).

2.1.4 Prevention and Treatment

Children can be protected from pneumonia which can be prevented using simple interventions, and treatment with cost effective medication and care (WHO, 2016). With regards to plummeting morbidities and mortalities associated with acute respiratory illnesses, reliable longitudinal studies, interventions, and educational programs in prevention targeting parents are essential (Karki et al., 2014). Public health programmes that prevent diarrhoea may also reduce the burden of respiratory illnesses (Ashraf et al., 2013). Moreover, prevention of pneumonia in malnourished children is essential. Hitherto, pneumonia presentation in the malnourished is not clear to see, and identifying those likely to die depends on general indicators of nutritional status (Ginsburg et al., 2015). Onyango and his fellow researchers, (2012), found out that receiving antibiotics at home was also protective and thus, recommend health education with regards to proper health seeking and community health workers engagement in the prevention, control and treatment of pneumonia.

2.1.5 Management of Pneumonia

A research done by Acácio and colleagues (2015) examining pneumonia management for children less than 5 years concluded that adherence to suggested management of severe pneumonia was suboptimal in health centres but high in a hospital outpatient department. Malaria diagnosis was the strongest risk factor for wrong management (Acácio et al., 2015). Nutritional interventions, smoking abstinence strategies and promoting mothers knowledge and practice about appropriate infant care are relevant strategies that can be adopted in pneumonia morbidity and mortality reduction in infants (Ramezani et al., 2015).

2.2 Risk Factors of Pneumonia

The World Health Organisation (2014) recounted risk factors of pneumonia include overcrowded homes, indoor air pollution from biomass fuel use in meal preparation and heating and parenting smoking are risk factors of pneumonia. In a one review and literature study, low birth weight, undernutrition, smoking tobacco, no breastfeeding, micronutrient deficiencies, maternal education and daycare were identified as the most essential risk factors affecting pneumonia rate in the developing world (Ramezani et al., 2015).

Findings from a case control study done among under-fives admitted in Dhulikhel Hospital in Nepal suggested a smoky chulo in a household and parental smoking as modifiable risk factors (Karki et al., 2014). It was also observed that among the children whose parents smoked tobacco, there was a rising trend of pneumonia. A western Kenyan case control study which sought to identify risk factors for severe pneumonia in children under-five revealed that comorbidity, delay in seeking treatment for three days or more and contact with upper respiratory tract infection were independent risk factors for severe pneumonia (Onyango et al., 2012). Results from a Pakistani study showed that the risk of pneumonia in children less than 5 years of age increased after a recent diarrhoeal disease (Ashraf et al., 2013). Yet in another study, having diarrhoea amidst the past 3 months was protective in children with pneumonia (Karki et al., 2014).

A Ghanaian study revealed age and having siblings with respiratory tract infections as risk factors significantly associated with the human parainfluenza viruses that present with ALRTI in children (Fiave, 2014). A randomized control trial in hospitalized children by Zhou and colleagues, (2015) found that improving micronutrient levels as a clinical nutritional intrvention can improve pneumonia status and reduce the number of days a patient spends in the hospital.

A case-control study in Gambia also revealed that sharing a bed with a person with a cough is an essential risk factor for severe pneumonia, which can easily be managed through intervention, whereas undernutrition prevails as a vital modifiable risk factor (Stephen R C Howie et al., 2016).

2.3 Other risk factors

There are other risk factors associated with pneumonia. These include low birth weight and suboptimal or no breastfeeding.

2.3.1 Low Birth weight

Duration of pregnancy, the pre-pregnancy weight and weight gained by the mother during gestation are all determinants of an infant's weight at birth (Mahan & Raymond, 2016). Women who are smallish have a higher risk of giving birth to an infant with low birthweight (LBW), contributing to the cycle of malnutrition affecting several generations since infants of retarded intrauterine growth have a tendency to be smaller in adulthood (WHO, 2010). Infants may lose approximately 7% of their weight in the initial days of life, nonetheless, they gain back their birth weight generally from day 7 to 10 (Mahan & Raymond, 2016). The weight of infants usually increases by times 2 by ages 4 to 6 months and triples about the time they turn a year old and the amount of weight gained during year two almost equals the infant's birth weight (Mahan & Raymond, 2016). A study in children less than 5 years in Bellary, India found a significant association between low birth weight and pneumonia with those with low birth weight having a 1.5 times higher odds compared to those with normal birth weight (Hemagiri et al., 2014).

2.3.2 Breastfeeding and Exclusive breastfeeding

Optimal breastfeeding practices, include breastmilk initiation within one hour of life, exclusive breastfeeding (EBF) for the first 6 months and continued breastfeeding for up to 2 years of age or beyond (WHO, 2014b). Breast milk comprises non-specific elements namely phagocytes, lysozymes, macrophages, lactoferrin, oligosaccharides, lactoperoxidase, bifidus factor, C3 and C4 complements as well as specific elements, which are secretory Immunoglobulin A (IgA), lymphocytes and antibodies, (Mahan & Raymond, 2016). These elements serves as protection against infectious diseases, especially against diarrhoea and acute respiratory illnesses, which are associated with infant mortality (Ramezani et al., 2015). Children who are not breastfed have an increased odd dying due to pneumonia. However, about 40% of babies below 6 months are exclusively breastfed (Ginsburg et al., 2015).

Exclusive breastfeeding is defined as the practice of only giving an infant breastmilk for the initial six months of life (excluding other foods, water, liquids or herbal preparation) except vitamins, mineral supplements or medicines (Hussein et al., 2015). Advantages of EBF include being a preventive intervention having the single largest possible influence on child mortality, thus, a basis of child health and survival (Bhutta et al., 2013). It gives the much needed and irreplaceable nutrition for growth and development serving as a child's introductory immunization subsequently serving as a defence from respiratory infections and other possible life-threatening diseases (WHO, 2014b). The initial breastfeeding in the first hour of birth, practice of exclusive breastfeeding up to the time of 6 months and the continuation of giving breast milk for one and half years or more is recommended for every child (Black et al., 2013). A systematic review suggested that breastfeeding a neonate on the first day of birth is protective against neonatal mortality (Debes, Kohli, Walker, Edmond, & Mullany, 2013).

2.4 Nutritional Status of Under-fives

Nutritional status is described as the balance between intake of nutrients and their expenditure in the processes of growth, reproduction, and health maintenance (Ghanbari, Khaleghparast, Ghadrdoost, & Bakhshandeh, 2014). Nutritional status of children is an indirect indicator for evaluating the health status of an entire population and also a key predictor of child survival (Bhandari & Chhetri, 2013). During the first 2 years of life, many changes (physical and immune development and social adjustment) happen affecting feeding and nutrient intake. The appropriateness of intake of nutrients for infants during these prime years affects how they relate to their environment. Healthy well-nourished infants are able to elicit responses to and learn from environmental stimuli as well as interact with their guardians in a way that encourages bonding and attachment (Mahan & Raymond, 2016).

2.4.1 Undernutrition

It is widely established that undernutrition and poor feeding practices in children remain an intractable public health problem in Ghana. Undernourished children can suffer several diseases from nutrient deficiencies (Black et al., 2013). Malnutrition increases the episodes and intensity of pneumonia infections beyond having a direct impact on mortality (Ginsburg et al., 2015). Even though the overall pattern of growth is genetically determined, it is significantly affected by nutrition. Socioeconomic status, nutritional knowledge and feeding practices among others are some of the reasons why children maybe undernourished (Eto, 2014). Though most Ghanaian mothers have knowledge concerning recommended feeding for children, the practice, particularly with complementary feeding, are below standard and thus support and counselling needs strengthening among mothers whose children receive complementary feeds (Gyampoh, Otoo, & Aryeetey, 2014). Under nutrition, especially in children, can lead to substantial problems in mental and physical development (Eto, 2014). Antenatal is the period where malnutrition is at its peak creating a vigorous cycle of malnutrition, low birthweight, and increased disease susceptibility in children (Ginsburg et al., 2015). Findings from a study by Eto, (2014) done among children of female head porters (kayayei) in Accra showed that most of their children were breastfed even though only less than 10% practiced exclusive breastfeeding. Furthermore, majority of the children were within normal WHO growth standards measures of weight-for-height (78.1%) and mid upper arm circumference (MUAC) of 67.1%, their consumption frequencies of the various food groups varied and most of them had adequate micronutrient levels (Eto, 2014).

When an infant is born, its growth is influenced by nutrition and heredity. Growth in infancy is scrutinised with the routine gathering and monitoring of anthropometric data, including weight, length, head circumference, and weight-for-length for age (Mahan & Raymond, 2016). These are plotted on the required World Health Organization (WHO) growth chart. Weight loss of more than 10% in neonates indicates the need for further assessment regarding adequacy of feeding. Growth subsequently continues at a speedy but declining rate (Mahan & Raymond, 2016). Infants increase their length by half during the initial year of life and by 48 months it gets doubled (Forbes & Watt, 2015). Conversely, total body fat in an infant increases for the initial 9 months and tapers off after and all through childhood (Mahan & Raymond, 2016). Furthermore, total body water reduces throughout infancy from 70% at birth to 60% at 1 year with almost all of the decrease in extracellular water (Suki & Massry, 2013). An infant's stomach volume increment is between 10 to 20 ml at birth to 200 ml by 12 months. This enable them to ingest more food at a given time; at less frequent intervals as they grow (Mahan & Raymond, 2016). In terms of gastric acidity, this decreases during the first weeks;

remaining lesser than that of older babies and grown-ups during the first few months. Emptying rate is comparatively sluggish, reliant on the amount and nutritional make-up of the meal (Mahan & Raymond, 2016). Children are constantly growing and developing body tissues and organs and for this reason eating an adequately varied and balanced diet with all essential nutrients proportionate to their size is important (Sardesai, 2003).

2.4.2 Assessment of Nutritional status

Child growth indicators are globally accepted vital population indicators of nutritional status and health in populations and are applied in the measurement of nutritional imbalance which causes undernutrition (i. e. wasting, stunting and underweight) and overnutrition (overweight and obesity) (WHO, 2010). The proportion of children with a low height-for-age (stunting) is reflective of the combined effects of gestational infections and undernutrition (WHO, 2011). Hence, stunted is inferred as a sign of meagre environment or long-term constraint of a child's growth potential (WHO, 2015). The proportion of children with low weight-for-age (underweight) can reflect ‘wasting’, which indicates acute weight loss, ‘stunting’, or both, thus making the interpretation of 'underweight'; a composite indicator (WHO, 2010).

2.4.3 Undernutrition and pneumonia mortality

Pneumonia pose significant morbidity and mortality of under five children and is further influenced by poor nutritional status of the affected child because of depressed immunity (Ginsburg et al., 2015). Deaths from pneumonia can be 15 times increased due to the presence of severe acute malnutrition (Roy et al., 2011). A cross sectional study conducted in a hospital in Bangladesh, evaluating nutritional status of children suffering from acute bronchiolitis and pneumonia showed overall nutritional status in terms of severe underweight (weight for age), microcephaly (OFC), low mid upper arm circumference (MUAC), severe wasting (weight for length) and severe stunting (length for age) in children having pneumonia was poor compared to those with bronchiolitis. (Shampa, Mollah, Bill, Kabir, & Saha, 2017). In Kenya, malnutrition in hospitalised children discharged is the key determining factor of mortality risk (Ginsburg et al., 2015).

2.4.4 Over-nutrition

The spectrum of malnutrition is not limited to undernutrition but also includes over-nutrition (Mahan & Raymond, 2016). Over-nutrition is malnutrition in which the intake of nutrients exceeds the amount required for normal growth, development, and metabolism (Bishnoi et al., 2016). In 2013, the WHO projected that more than 42 million children below 60 months were overweight worldwide with approximately 80% from the developing world (UNICEF/WHO/World Band Group, 2015). A retrospective study done in Bangladeshi children found an association between overweight and obese under-fives with pneumonia and hypoxemia (Shahunja et al., 2016).

2.5 Summary of the gaps in the literature

This study intends to address the gaps in literature pertaining to the Ghanaian context. Evidence on the association between pneumonia and certain risk factors in Ghanaian children less than 5 years is minimal.

CHAPTER THREE

3.0 METHODS

3.1 Study Design

This study was a case-control study conducted at the outpatient department (OPD) and inpatient department (emergency and admission wards) of Princess Marie Louise Children's Hospital (PML) in Greater Accra Region over a one-month period. This study was designed to help find causal relationship between the dependent variable and independent variables. A semi-structured questionnaire was used to collect data. Anthropometry was also measured.

3.2 Study location

The study was conducted at the Princess Marie Louise Children's Hospital which is a located in Greater Accra Region (GAR) within the Ashiedu Keteke sub-metro of the Accra Metropolitan Assembly and under the banner of Ghana Health Service. The Ashiedu Keteke sub-metro has an estimated population of 120,000 (GSS, 2012b). The-sub metro area share boundaries to the east with Osu Klottey sub- metro, to the south by the Gulf of Guinea, the west by Ablekuma South sub-metro and the north is bordered by Ablekuma Central sub-metro (The World Bank, 2010). Generally, PML is a specialist children's hospital and provides both primary and secondary care for paediatric patients from ages 1 day to 18 years old. The hospital delivers various services in clinical and healthcare including disease control, family planning, reproductive and child health as well as nutrition services (PML, 2017b). The total staff strength is 273 comprising six permanent doctors and 147 nurses. With a total bed capacity of about 84 beds, the medical service of the hospital is made up of an Out-patient Department (OPD), admission and **e**mergency wards**,** medical laboratory unit/Blood Bank**, a d**isease control unit, radiology department**,** diet-therapy department, environmental health unit among others (PML, 2017b). Out Patient Department attendance increased twofold from 45,000 in 1996 to nearly 73,000 per year till date (PML, 2017a). The hospital has the largest nutritional rehabilitation centre in the country. Admissions for malnutrition ranged from 2.4% to 7.3% of the total annual admissions from 2005 to 2013 (Tette, Neizer, Nyarko, Sifah, & Nartey, 2016).

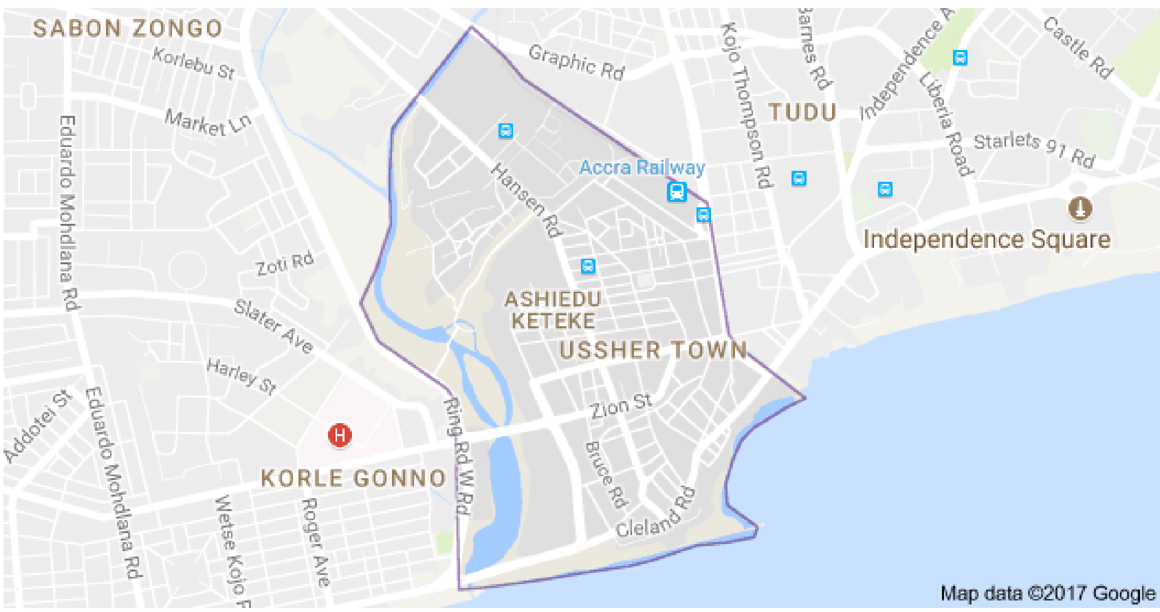

Figure 2: Map showing Ashiedu Keteke area

Source: Google map, 2017

3.3 Variables

3.3.1 Dependent Variable

- The dependent variable is pneumonia.

3.3.2 Independent Variables

- Socioeconomic and demographic characteristics: age, sex, location, educational level of caregiver, parents' occupations,
- Nutritional status: underweight, stunting, wasting, overweight, obesity

Other Factors:

- Maternal variables: maternal age at child's birth, parity of mother
- Anthropometry: weight, height
- Breastfeeding and Complementary feeding: colostrum, exclusive breastfeeding
- Environmental factors: cooking fuel usage, crowding, attendance at day-care

3.4 Study population

The study was done using children under five at the outpatient department and inpatient department of Princess Marie Louise Children's Hospital. Cases and controls were unmatched**.**

3.5 Study procedure

Cases were identified and selected by consecutive sampling and the corresponding control was recruited in the same facility. Data was collected on exposures using a questionnaire and taking anthropometry. Exposed and unexposed cases and controls were identified using the following criteria.

3.5.1 Case Selection

A case was a child below age 5 clinically diagnosed with pneumonia according to WHO (2013) criteria, admitted at the ward or seen to at the OPD of PML during the period of data collection. The case definition, inclusion and exclusion criteria were shown to Specialist or Resident Pediatricians and Medical Officers so that diagnosis of pneumonia will be made accordingly. Eligible patients with their caretakers were directed to the principal investigator and research assistants for briefing and participation in study.

The World Health Organization criteria for identifying children with pneumonia are as follows:

Table 3.1: Classification of the severity of pneumonia

Classification	**Sign or symptom**
Severe pneumonia	Cough or difficulty in breathing with: • Oxygen saturation < 90% or central cyanosis • Severe respiratory distress (e.g. grunting, very severe chest in drawing) • Signs of pneumonia with a general danger sign (inability to drink or breastfeed, lethargy or reduced level of consciousness, convulsions)

Pneumonia	• Fast breathing: ○ ≥ 60 breaths per min in a child: < 2 months old ○ ≥ 50 breaths per min in a child: 2-11 months old ○ ≥ 40 breaths per min in a child: 1-5 years old • Chest in drawing
No pneumonia: cough or cold	No signs of pneumonia or severe pneumonia

(WHO, 2013)

Case definitions

Suspected case**:** any child presenting with cough within the last 7 days accompanied by fever, fast breathing and/or chest in drawing according to the WHO guideline (table 1).

Confirmed case: any suspected case confirmed with an x-ray.

3.5.2 Control selection

A control was selected from the OPD. A control was a child under five without pneumonia or any chronic respiratory condition.

3.5.3 Inclusion Criteria

Study included any child

- below age five at the OPD or on ward admission at PML.

- under-five years who will meet the WHO criteria for pneumonia diagnosis
- whose mother or caretaker will agree to participate in the study.

3.5.4 Exclusion Criteria

Study excluded any child

- who was asthmatic, had sickle cell disease or immunosuppressed
- who was severely ill
- who was under nutritional therapy before and during the study.

3.6 Sampling

3.6.1 Sample Size

A minimum sample size was derived using the Fleiss equation

$$N_1 = \frac{\underline{Z_{\alpha/2}\,(r + 1)\, pq + Z_{1-\beta}\, rp_1q_1 + p_2q_2}^2}{r\,(p_1-p_2)^2}$$

N_1 = Number of cases

N_2= Number of controls

r = Ratio of cases to controls 1:1

P_1 = Proportion of cases with exposure

P_2 = Proportion of controls with exposure

$q_1 = 1-p_1$

$q_2 = 1-p_2$

Using the following parameters: proportion of controls with exposure of 57%, proportion of cases with exposure of 76.82% (Stephen R C Howie et al., 2016), a Confidence Interval (1-α) of 95% and a power (1-β) of 80%, minimal detectable odds ratio of 2.5 (Darkwa, 2012) and ratio of case to controls 1:1, a total of 88 cases and 88 controls was computed with Epi Info software.

3.6.2 Sampling Method

Consecutive sampling was adopted in recruiting both cases and controls. The Principal Investigator and assistants first approached the management of the hospital prior to the data collection period to introduce themselves and inform them of the purpose and procedure for the study. The hospital management took the team round the hospital and familiarized the team with the hospital staff. The caregivers of the patients were also informed of the study purpose, procedure and timeline for the data collection. Caregivers of patients, who were available at the time of the data collection period and agreed to participate in the study and met the selection criteria were recruited. A written consent was sought from the respondents before the questionnaire was administered. The questions were explained in the local language for those who do not speak English.

3.7 Data Collection Techniques/Method and Tools

A semi-structured questionnaire on socio-demographics, educational level of caregiver, breastfeeding status, environmental factors as well as nutritional status adopted from a study by Darkwa, (2012) were used to collect primary data via face-to-face interview. Anthropometry was taken; information on laboratory investigations from patient folder and other information from the road to health care (RTHC) document were sought.

3.7.1 Anthropometry

Weight was measured with a calibrated electronic Seca scale (Seca, Hamburg, Germany) to the nearest 0.1Kg for all children 2 years and above. Children stood barefooted on the platform of the scale in minimum clothing. Readings were taken with subjects standing upright, feet close together and knees and back straightened. For children below age 2, naked weights were measured with a calibrated Seca 374 scale.

Height was taken with a Seca stadiometer to the nearest 0.1 cm for 2-year olds and above. Children stood barefooted on the level platform. Their heights were measured without raising their heels and with their knees straightened. The lower eye sockets to the ear called the Frankfurt Plane were ensured to be perpendicular to the vertical board of the height measure. The sliding piece of the height measure was moved gently to the level of the crown of the subject's head before taking readings. Length was taken to the nearest 0.1cm with a Seca 210 baby length measuring mat for children below 2 years since they were unable to stand properly. Naked measurement of length was from the top of the head to the heels with the child lying on the calibrated part of the mat with a fixed piece on one side and a movable one on the other side (top of the head on the fixed part).

3.8 Data Quality control

Research Assistants were trained on the introduction to the objectives of the study, data collection processes involved in conducting one-on-one questionnaire, taking anthropometry and selecting relevant data from patient folders, translation of questionnaire into the local language, ethics and conduct of fieldwork. The Principal Investigator was part of the team during interviews to ensure that relevant information was collected. Data was checked for completeness and internal inconsistencies.

3.9 Data Processing and Analysis

Data collected was entered and cleaned in MS Excel 2016 before imported with WHO Anthro version 3.2.2 and Stata version 15.0 Software for analysis. Tables were used to summarize data and display figures. Descriptive statistics (median) was measured for continuous variables while proportions were calculated for categorical variables. Differences in proportions were tested using two-sided chi square tests. Continuous variables were tested for normality with their median reported and rank sum test conducted to check for significance. Association of each of the categorical variable with pneumonia was assessed with simple logistic regression analysis and their crude odds ratio (95% confidence interval) reported. Multiple logistic regression models were run for statistically significant variables to determine the significant independent risk factors. All tests were two-sided and statistical significance was set at 0.05.

3.9.1 Anthropometric Data

Z-scores for Height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ), BMI-for-age (BAZ) were derived from weight and height measurements and calculated using WHO Anthro version 3.2.2 and categorised with Stata 15.0 software. Nutritional status i.e. underweight, wasting, stunting, overweight and obesity were determined by comparing computed z-scores with the WHO child growth reference data (2007) for children below 5 years.

Table 3.2: World Health Organization classification of anthropometry nutritional conditions in children

Classification	Condition	Age: Birth to 60 months Indicator and cut-off
Based on body mass index (BMI)	Possible risk of overweight	BMI-for-age (or weight-for-height) >1SD to 2SD
	Overweight	BMI-for-age (or weight-for-height) >2SD to 3SD
	Obese	BMI-for-age (or weight-for-height) >3SD
	Stunted	Height-for-age <–2SD to –3SD
	Severely stunted	Height-for-age < –3SD
	Underweight	Weight-for-age <–2SD to –3SD
	Severely underweight	Weight-for-age <–3SD
	Wasted	Weight-for-height <–2SD to –3SD
	Severely wasted	Weight-for-height <–3SD

(De Onis, 2015)

3.10 Ethical Consideration/Issues

Approval was sought from the Ethical Review Committee of the Ghana Health Service (GHS) before commencement of the study. Documented proof of ethical approval and an introductory letter from the School of Public Health, University of Ghana, were delivered to the Municipal Health Directorate and management of the hospital to seek permission to carry out the study. The study objectives and procedures, as well as possible risks/ benefits associated with participating in the study were carefully explained in English and the local language to the caregivers of the participants before they were recruited. Persons eligible for the study were recruited after written informed consent was obtained from them. Questionnaires were administered on one-on-one basis. They were informed that they had the right to stop at any point in the study. All names used in the presentation of the results are pseudo names.

3.11 Privacy and Confidentiality

Consent of caregivers were sought before inclusion in the study and data collected was handled as confidential. Data will be used for academic or publication purposes. Data collected was stored under lock and key and was only accessible to principal investigator and supervisor. The data would be destroyed after ten years.

3.12 Potential Risks and Benefits

The study posed minimum physical or psychological risks to patients. Patients did not receive any direct benefit from the study.

3.13 Declaration of Conflict of Interest

The researcher had no conflict of interest with respect to the study.

CHAPTER FOUR

4.0 RESULTS

4.1 Demographic characteristics of participants

A total of 176 children under five years with their caretakers were enrolled in this study. There were 88 cases and 88 controls. After running the test of normality for the continuous variables, the Wilcoxon rank sum was run to test for significance since the variables were not normally distributed. The breakdown with regards to the median (interquartile range) are as follows: median age was 14.49 (6.95-25.53) months, weight was 8.5 (6.6-11.5) Kg, parity (M= 2, IQR: 1-3), number of people living in the house (M= 15, IQR: 8-25) and number of children below 5 years in the house (M= 3, IQR: 2-5). The median age of mothers was 30years (25-34) whereas the median age of the mothers at child's birth was 28 years (24-33). Of the 67 participants whose mothers reported they have been weaned off breastmilk, the median (interquartile) age in months was 18 months (13-20). Only 26 of participants reported people smoked in their house with an approximate median of 2 smokers (1-3). Of those who reported to have people coughing in their house (n= 49), the median was only 1 person (1-2).

With a total number of 46 children reported to have started daycare, the median starting age was one and half years or 18 months (16-24); time spent at daycare (M= 8 hours, IQR: 8-9) and number of students in the child's class (M= approximately 21, IQR: 15-28).

The lab investigations documented were platelet count (n= 90, M= 368 x 10^9/L, IQR: 255-485), white blood cells count (n= 91, M=11.9 x 10^9/L, IQR: 8.95-15.6) and hemoglobin levels (n= 91, M= 10.4g/dl, IQR: 9.2-11.4).

The median was statistically significant among cases and controls with regards to exact age of child, weight, height and number of children in child's daycare class ($p< 0.05$).

Table 4.1 Demographics of Cases and Controls

Continuous variables	n	Total Median (LQ-UQ)	Control Median (LQ-UQ)	Case Median (LQ-UQ)	Rank sum p-value
Exact age of child	176	14.49(6.95-25.53)	18.56(10.28-27.52)	12.16(4.42-24.07)	0.0052*
Weight (Kg)	176	8.5(6.6-11.5)	9.2(7.6-12.25)	7.75(6-10.2)	0.0034*
Height (cm)	176	76.25(67.25-88)	80.75(70.5-90)	72.75(62.25-84.5)	0.0036*
Current age of mother	176	30(25-34)	29(25-34)	31(25-35)	0.4588
Parity	176	2(1-3)	2(1-3)	2(1-3)	0.0640
Mother's age at child's birth	176	28(24-33)	27(24-33)	28.5(24-34)	0.2942
Weaning age	67	18(13-20)	18(14-21)	17(12-18)	0.0573
Number of people in house	175	15(8-25)	14(8.5-21.5)	15(7-26)	0.5570
Number of under-five in house	176	3(2-5)	3(2-4.5)	2(1.5-5)	0.2540
Number of people who smoke in house	26	1.5(1-3)	1(1-3)	2(1-5)	0.2106
Number of people who are coughing in house	49	1(1-2)	1(1-2)	1(1-2)	0.7941
Starting age of daycare attendance	46	18(16-24)	18(16-24)	18(16-24)	0.7057
Duration of time spent at daycare	46	8(8-9)	8(7.5-8)	8(8-9)	0.0710
Number of students in child's class	46	20.5(15-28)	25(20-30)	17(14-22)	0.0246*
Platelet	90	368(255-485)	395.5(287-476)	364(247-485)	0.6917
White blood cell	91	11.9(8.95-15.6)	11.1(8.93-14)	12.2(9-15.84)	0.4622
Hemoglobin	91	10.4(9.2-11.4)	10.65(9.8-11.35)	10.2(8.9-11.4)	0.2880

*** = statistically significant**

Table 4.2 Association between Child Socio-demographic factors and pneumonia

			Pneumonia status			
		Total (%)	Control (%)	Cases (%)	Chi-square	p value
Sex of child					1.4553	0.228
	Male	86(48.86)	47(53.41)	39(44.32)		
	female	90(51.14)	41(46.59)	49(55.68)		
Age categories of children					8.3742	0.015*
	<2months	10(5.68)	2(2.27)	8(9.09)		
	2- <12months	57(32.39)	23(26.14)	34(38.64)		
	12- ,<60months	109(61.93)	63(71.59)	46(52.27)		
Gestational maturity status					3.2195	0.073
	Mature (> 37 weeks)	164(93.18)	79(89.77)	85(96.59)		
	Preterm (< 37 weeks)	12(6.82)	9(10.23)	3(3.41)		
Birth weight					0.9556	0.328
	Low birthweight	20(11.43)	12(13.79)	8(9.09)		
	not low	155(88.57)	75(86.21)	80(90.91)		
Immunization status					0	1
	fully immunised	150(85.23)	75(85.23)	75(85.23)		
	partially immunised	26(14.77)	13(14.77)	13(14.77)		
DPT-Hepb-Hib1					0	1
	no	6(3.41)	3(3.41)	3(3.41)		
	yes	170(96.59)	85(96.59)	85(96.59)		
DPT-Hepb-Hib2					6.5425	0.011*
	no	21(11.93)	5(5.68)	16(18.18)		
	yes	155(88.07)	83(94.32)	72(81.82)		
DPT-Hepb-Hib3					4.9955	0.025*
	no	29(16.48)	9(10.23)	20(22.73)		
	yes	147(83.52)	79(89.77)	68(77.27)		
Pneumo 1					0	1
	no	6(3.41)	3(3.41)	3(3.41)		
	yes	170(96.59)	85(96.59)	85(96.59)		
Pneumo 2					6.5425	0.011*
	no	21(11.93)	5(5.68)	16(18.18)		
	yes	155(88.07)	83(94.32)	72(81.82)		
Pneumo 3					4.0183	0.045*
	no	30(17.05)	10(11.36)	20(22.73)		
	yes	146(82.95)	78(88.64)	68(77.27)		
Vitamin A supplement at 6 months					7.5344	0.006*
	no	46(26.14)	15(17.05)	31(35.23)		
	yes	130(73.86)	73(82.95)	57(64.77)		
Vitamin A supplement at 12 months					7.425	0.006*
	no	80(45.45)	31(35.23)	49(55.68)		
	yes	96(54.55)	57(64.77)	39(44.32)		
House structure					0.1146	0.735
	nuclear	48(27.27)	25(28.41)	23(26.14)		
	compound	128(72.73)	63(71.59)	65(73.86)		
Sleeping structure					0.059	0.808
	bed/cot	157(89.20)	79(89.77)	78(88.64)		

	mat/cloth	19(10.8)	9(10.23)	10(11.36)		
Exposure to smoking at home					1.0937	0.296
	no	149(84.66)	77(87.5)	72(81.82)		
	yes	27(15.34)	11(12.5)	16(18.18)		
Daycare attendance					0.4119	0.521
	no	129(73.71)	63(71.59)	66(75.86)		
	yes	46(26.29)	25(28.41)	21(24.14)		

*** = statistically significant**

Table 4.2 shows that majority of the cases were children between the ages 2 months to less than 60 months (91%), female (56%), lived in a compound house (74%) and slept on a bed or a cot (89%). Very few of the cases were preterm (3%) and low birthweight (9%). Furthermore, most (85%) of the cases were fully immunized. There was equal distribution of cases and controls with regards to immunization status for age. Immunization of pentavalent (DPT-Hepb-Hib) 1, 2 and 3 vaccines, Pneumococcal 1, 2 and 3 vaccines, and vitamin A supplementation at 6 months and 12 months were all significantly different among cases and controls ($p < 0.05$ and $p < 0.01$).

Table 4.3 Association between Child nutritional factors and pneumonia

		Total (%)	Pneumonia status Control (%)	Cases (%)	Chi-square	p value
Weaning age					7.5259	<0.01 *
	Inappropriate wean	5(7.46)	0(0)	5(17.86)		
	Appropriate wean	62(92.54)	39(100)	23(82.14)		
Complementary feeding					7.001	0.03*
	after 6 months	85(48.3)	51(57.95)	34(38.64)		
	before 6 months	68(38.64)	29(32.95)	39(44.32)		
	not yet	23(13.07)	8(9.09)	15(17.05)		
Child's main drinking source of water					6.0156	0.049 *
	bottled	82(46.59)	35(39.77)	47(53.41)		
	sachet	74(42.05)	45(51.14)	29(32.95)		
	none	20(11.36)	8(9.09)	12(13.64)		
Colostrum					2.0308	0.154
	no	20(11.36)	7(7.95)	13(14.77)		
	yes	156(88.64)	81(92.05)	75(85.23)		
Breastfeeding history during first 6 months					0.1432	0.705
	exclusive breastfeeding	87(49.71)	45(51.14)	42(48.28)		
	partial breastfeeding	88(50.29)	43(48.86)	45(51.72)		
Weaning status					1.3935	0.238

	no	107(61.14)	50(56.82)	57(65.52)		
	yes	68(38.86)	38(43.18)	30(34.48)		
Weight-for-height z-score					0.294	0.863
	severely wasted	22(12.50)	10(11.36)	12(13.64)		
	wasted	23(13.07)	11(12.50)	12(13.64)		
	not wasted	131(74.43)	67(76.14)	64(72.73)		
Height-for-age z-score					9.392	0.009 *
	severely stunted	11(6.25)	1(1.14)	10(11.36)		
	stunted	13(7.39)	9(10.23)	4(4.55)		
	not stunted	152(86.36)	78(88.64)	74(84.09)		
Weight-for-age z-score					6.1687	0.046 *
	severely underweight	12(6.82)	7(7.95)	5(5.68)		
	underweight	23(13.07)	6(6.82)	17(19.32)		
	not underweight	141(80.11)	75(85.23)	66(75)		
Body-Mass-Index for age z-score					1.941	0.379
	Not at possible risk of overweight	161(91.48)	83(94.32)	78(88.64)		
	At possible risk of overweight	8(4.55)	3(3.41)	5(5.68)		
	obese	7(3.98)	2(2.27)	5(5.68)		

*** = statistically significant**

Age at which child was weaned was separated into weaning at appropriate age and weaning at inappropriate age. Weaning of breastmilk at appropriate age was weaning started after the age of 12 months or not even started after 12 months whilst weaning started before age of 12 months as said to be weaning at inappropriate age. Out of those who had been weaned (n= 67), majority of cases had been appropriately weaned (82%). Most controls (58%) started complementary feeding later than cases (39%).

Out of the four nutritional status indicators which are Height-for-age z-score (stunting), weight-for-age z-score (underweight), weight-for-height z-score (wasting), BMI-for-age z-score (overweight and obese), only Height-for-age z-score (stunting) and weight-for-age z-score (underweight) were significantly different among cases and controls ($p< 0.01$ and $p< 0.05$ respectively).

Table 4.4 Association between Parent/Caregiver factors and pneumonia

			Pneumonia status			
		Total (%)	Control (%)	Cases (%)	Chi-square	p value
Current age of mother					1.3726	0.503
	<15-24years	33(18.75)	16(18.18)	17(19.32)		
	25-34years	101(57.39)	54(61.36)	47(53.41)		
	35-45years	42(23.86)	18(20.45)	24(27.27)		
Parity of mother					4.925	0.177
	1	63(35.8)	36(40.91)	27(30.68)		
	2	52(29.55)	28(31.82)	24(27.27)		
	3	44(25)	16(18.18)	28(31.82)		
	>4	17(9.66)	8(9.09)	9(10.23)		
Mothers age at child birth					1.9238	0.382
	<15-24years	50(28.41)	26(29.55)	24(27.27)		
	25-34years	95(53.98)	50(56.82)	45(51.14)		
	35-44years	31(17.61)	12(13.64)	19(21.59)		
Main caretaker of child					6.7277	0.009*
	Mother	163(92.61)	77(87.50)	86(97.73)		
	Other relation	13(7.39)	11(12.5)	2(2.27)		
Occupation of mother					1.8617	0.602
	none	20(11.36)	8(9.09)	12(13.64)		
	sales/services	117(66.48)	62(70.45)	55(62.50)		
	professional	32(18.18)	14(15.91)	18(20.45)		
	artisan	7(3.98)	4(4.55)	3(3.41)		
Employment status of mother					0.9219	0.631
	Full-time	61(34.66)	33(37.5)	28(31.82)		
	Self employed	83(47.16)	41(46.59)	42(47.73)		
	unemployed	32(18.18)	14(15.91)	18(20.45)		
Occupation of father					5.4297	0.066
	sales/services	101(57.71)	45(51.14)	56(64.37)		
	professional	48(27.43)	31(35.23)	17(19.54)		
	artisan	26(14.86)	12(13.64)	14(16.09)		
Employment status of father					2.5167	0.113
	Fulltime	89(50.86)	50(56.82)	39(44.83)		
	Self employed	86(49.14)	38(43.18)	48(55.17)		
Ethnicity					3.2404	0.356
	Akan	72(40.91)	38(43.18)	34(38.64)		

	Ga/Ga Adangbe	40(22.73)	18(20.45)	22(25)		
	Ewe	20(11.36)	7(7.95)	13(14.77)		
	Others	44(25)	25(28.41)	19(21.59)		
Religion					4.3153	0.038*
	Christianity	141(80.11)	65(73.86)	76(86.36)		
	Islam	35(19.89)	23(26.14)	12(13.64)		
Cooking fuel					0.3879	0.533
	LPG	110(62.5)	53(60.23)	57(64.77)		
	Biomass	66(37.50)	35(39.77)	31(35.23)		
Toilet facility					1.1494	0.563
	Water closet	87(49.43)	46(52.27)	41(46.59)		
	KVIP	29(16.48)	12(13.64)	17(19.32)		
	Public toilet	60(34.09)	30(34.09)	30(34.09)		

*** = statistically significant**

Majority (98%) of cases and controls (88%) had their mothers as their main caretaker. The occupations and employment statuses of parents were statistically insignificant. From the table, parents of cases and controls were either Christians or Muslims with majority being Christians. Their difference reached statistical significance ($p < 0.05$).

The bivariate analysis showed that categorized child's age ($p = 0.015$), weaning age ($p = 0.006$), main caretaker ($p = 0.009$), religion (0.038), complementary feeding (0.03), source of drinking water (0.049), height-for-age z-scores ($p = 0.009$) and weight-for-age z-scores ($p = 0.046$) had a significant association with pneumonia.

Table 4.5 Logistic Regression showing association between exposure factors and odds of pneumonia in children under-five

Case/control		Unadjusted Association		Adjusted Association	
		UOR (95% CI)	P-VALUE	AOR (95% CI)	P-VALUE
Sex					
	Male	ref		ref	
	female	1.44(0.8, 2.61)	0.228	1.85(0.92, 3.72)	0.086
Age categories of children					
	< 2months	ref		ref	
	2-11months	0.37(0.07, 1.9)	0.233	0.29(0.04, 2.04)	0.213
	12-60months	0.18(0.04, 0.9)	0.037*	0.22(0.03, 1.83)	0.161
Height-for-age z-score					
	Severely stunted	ref		ref	
	stunted	0.04(0, 0.48)	0.01*	0.08(0.01, 0.89)	0.04*
	not stunted	0.09(0.01, 0.76)	0.026*	0.1(0.01, 0.86)	0.036*
Weight-for-age z-score					
	Severely underweight	ref		ref	
	Underweight	3.97(0.91, 17.38)	0.068	5.17(0.88, 30.59)	0.07
	not underweight	1.23(0.37, 4.07)	0.732	1.4(0.32, 6.14)	0.657
Complementary feeding					
	After 6 months	ref		ref	
	before 6 months	2.02(1.06, 3.85)	0.034*	1.61(0.77, 3.38)	0.206
	not yet	2.81(1.08, 7.36)	0.035*	2.12(0.37, 12.02)	0.397
Main caretaker					
	Mother	ref		ref	
	Other relation	0.16(0.03, 0.76)	0.021*	0.19(0.04, 0.95)	0.044*
Cooking fuel					
	LPG	ref		ref	
	Biomass	0.82(0.45, 1.52)	0.534	0.97(0.47, 2.01)	0.93
Child's main drinking source of water					
	Bottled	ref		ref	
	Sachet	0.48(0.25, 0.91)	0.025*	0.55(0.25, 1.2)	0.135
	None	1.12(0.41, 3.02)	0.828	0.4(0.06, 2.44)	0.318
Religion					
	Christianity	ref		ref	
	Islam	0.45(0.21, 0.97)	0.041*	0.45(0.18, 1.17)	0.102

*** = statistically significant**

A logistic regression was run for continuous variables that were significant from the bivariate analysis and those known to be associated from literature (Table 4.3). After controlling for sex, categorized ages of children, immunization status, birthweight, breastfeeding history during first six months, cooking fuel, DPT-Hepb-Hib1: 2 and 3 immunizations, Pneumococcal 1; 2 and 3 immunizations, vitamin A supplementation at six and 12 months, weaning age, child's main caretaker, religion, complementary feeding, child's main drinking source of water, height-for-age z-scores, weight-for-age z-scores in the bivariate analysis, only children aged 12- <60 months (OR= 0.18, 95% CI: 0.04-0.9), stunted children (OR= 0.04, 95% CI: 0-0.48), not stunted (OR= 0.09, 95% CI: 0.01-0.76), had not started complementary feeding (OR= 2.81, 95% CI: 1.08-7.36) and those who had started complementary feeding before 6 months (OR= 2.02, 95% CI: 1.06 -3.85), having a relation other than mother as main caretaker (OR= 0.16, 95% CI: 0.03-0.76), child drinking mainly sachet water (OR= 0.48, 95% CI: 0.25-0.91) and being Muslim (OR= 0.45, 95% CI: 0.21-0.97) had a significant association with pneumonia.

After controlling for sex, children's ages, height-for-age z-scores, weight-for-age z-scores, complementary feeding, main caretaker, cooking fuel, main drinking source of water for child and religion, the independent risk factors for pneumonia in children below 5 years were as follows:

Female children were 1.85 times likely to have pneumonia compared to male children but the association was of no statistical significance (aOR= 1.85, 95% CI: 0.92-3.72). Children aged between 2 to 11 months were 71% less likely to have pneumonia compared to the other age groups but the association was not statistically significant (aOR= 0.29, 95% CI: 0.04-2.04). However, children 12- < 60 months were 78% less likely to have pneumonia compared to children younger than 12 months and this association was not statistically significant (aOR= 0.22, 95% CI: 0.03-1.83). Stunted children were 99.92% less likely to have pneumonia compared to those not stunted and this association was statistically significant (aOR= 0.08, 95% CI: 0.01-0.89). There was 99.9% less odds of having pneumonia among children who were not stunted compared to those stunted or severely stunted. This association was significant (aOR= 0.1, 95% CI: 0.01-0.86). In addition, underweight children were 5.17 times more likely to have pneumonia compared to children that were not underweight, yet, this association was statistically insignificant (aOR= 5.17, 95% CI 0.88-30.59). Moreover, children who were not underweight were 1.4 times more likely to have pneumonia compared to children that were underweight and this association was not statistically significant (aOR= 1.4, 95% CI: 0.32-6.14). Children who started complementary feeding before six months were 61% more likely to have pneumonia compared to children who started after 6 months or not yet. The association was statistically insignificant (aOR= 1.61, 95% CI: 0.77-3.38). Children who had not yet started complementary feeding were 2.12 times likely to have pneumonia compared to children who had started but this association was not statistically significant (aOR=2.12, 95% CI: 0.37-12.02). A child with a relation other than their mother being their main caretaker was protective (=aOR 0.19, 95% CI: 0.04-0.95) and the association was statistically significant. Compared to children who drink bottled water and none at all, children who mainly drink sachet water were 45% less likely to have pneumonia but this association was not statistically significant (aOR= 0.55, 95% CI: 0.25-1.2). Nevertheless, Children who were not given drinking water were 60% less likely to have pneumonia compared to those who drank but this association was not statistically significant (aOR= 0.4, 95% CI: 0.06-2.44). Children whose caregivers reported biomass as main cooking fuel were 3% less likely to have pneumonia. This association was not significant (aOR= 0.97, 95% CI: 0.47-2.01). There was a 55% less odds of having pneumonia among Muslim children compared to non-Muslims though this association was statistically insignificant (aOR= 0.45, 95% CI: 0.18-1.17).

Only height-for-age z-scores, i.e. stunted (aOR= 0.08, 95% CI: 0.01-0.89) and not stunted (aOR= 0.1, 95% CI: 0.01-0.86), and child having other relations as main caretaker (aOR= 0.19, 95% CI: 0.04-0.95) had a significant association with pneumonia after adjusting.

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CHAPTER FIVE

5.0 DISCUSSION

5.1 Discussions

The present study aimed at assessing various risk factors for pneumonia in children under five. In the study, majority (91%) of the cases and of the controls (98%) were children between the ages 2 months to less than 60 months. Findings from a study by Walker, et al (2013) showed that the burden of pneumonia was mainly in younger age groups with majority of deaths from pneumonia happening in children younger than age 2. This might be because the immune system of young children is not fully developed. The distribution of females with pneumonia was more than males (56% and 44% respectively) but this was not statistically different (p = 0.228). This finding differs from studies by Kwon et al., (2014) and Victoria et al., (1994) which have shown that ARI affects males more frequently than females overall.

In this study, using biomass in food preparation was found to be an insignificant risk factor for pneumonia (OR= 0.82, 95% CI: 0.45-1.52: p= 0.534). On the contrary, studies have shown that indoor air pollution by biomass fuels increases the risk of pneumonia (Murray et al, 2012: Afzal & Salman, 2014). Biomass fuels (charcoal, firewood, etc.) and others like kerosene generate poisonous products that harmfully affect the local defenses of the respiratory tract (specific and non-specific). This risk appears highest for mothers and young children due to longer stay in-door and closeness during cooking. In this study this risk may not have been established due to LPG being the predominant fuel for cooking and living in urban and peri-urban areas. Perhaps, biomass fuels were used outdoor where ventilation is optimum.

In terms of nutritional status, there was a 96% reduced odds of pneumonia among stunted children and this was statistically significant (aOR=0.08, 95% CI: 0.01-0.89: $p < 0.05$). Pneumonia had appositive effect among children who were stunted as opposed to a study by Howie et al, (2016) where stunting increased the risk of pneumonia. Also, among children who were not stunted, there was a reduced risk of pneumonia by 91%. This was also statistically significant (OR=0.09, 95% CI: 0.01-0.76: $p < 0.05$). Numerous studies by Ginsburg et al., (2015), Shampa, Mollah, Bill, Kabir, & Saha, (2017), and Howie et al., (2016) have shown consistent significant association between malnutrition and both incidence of, and mortality due to pneumonia in children. In a Gambian study, for instance, severely stunted children were 2.5 times more likely to develop severe pneumonia. This present study revealed underweight (WAZ <-2SD to -3SD) children had increased odds of having pneumonia but this was not significant (aOR=5.17, 95% CI: 0.88-30.59: p=0.07).

Children who are malnourished have malfunctioning cell mediated immunity secondary to thymus lymphatic depletion which leads to sepsis as well as severe gram negative infections (Chhina, 2013) and may also have qualitatively abnormal immunoglobulins, and impairment of key enzymes involved in bactericidal infection of leucocytes. Humoral immune function is also impaired because of decrease secretory IgA that acts as a first-line defense at the mucosal surfaces, including the respiratory tract. However, a study in Kolkata revealed undernutrition as the predictor of mortality in ALRI in children between 2 weeks and 5 years old (Kumar, Saha, Patra, & Chakraborty, 2011). Overall malnutrition increases mortality rate from acute lower respiratory infections by three-folds (Rice AL et al., 2000).

Majority (85%) of the cases were fully immunized. Fully immunized for age protects children against various respiratory infections like diphtheria, pertussis and complications of measles, thus, reduces the risk of development of these infections. Children who had started complementary feed before 6 months were 1.61 times more likely to develop pneumonia compared to those who started after 6 months (aOR= 1.61, 95% CI: 0.77-3.38: p= 0.206) but this was not statistically significant. There was also an increase in the odds of developing pneumonia in children who had not yet started complementary feed (aOR= 2.12, 95% CI: 0.37-12.02: p= 0.397) but had no statistical significance. Delayed and inappropriate complementary feed is a contributory factor of malnutrition (Rodriguez, Cervantes, & San, 2011) which in turn is a predictor of development of ALRI of which pneumonia is part. Poor complementary feeding practices have been extensively documented in countries of low and middle income (Kimani-murage et al., 2011).

In the present study, it was observed that, having a relative as main caretaker other than the mother was protective (aOR= 0.19, 95% CI: 0.04-0.95: p< 0.01) and this association was statistically significant. Most of the cases (98%) had their mothers as their main caretaker and this may be due to the cultural setting and the natural bond that exist between mothers and their young.

Children who drank sachet water had a 48% reduced odds of developing pneumonia as compared to those who did not drink sachet water (aOR= 0.55, 95% CI: 0.25-1.2: p= 0.135). Some mothers indicated that their children found the packaging attractive. A study in Vietnam showed that admission to hospital with pneumonia was also associated with drinking water other than tap water (Suzuki et al., 2009).

Muslim children had a reduced odds of 55% of developing pneumonia as compared to Christian children (aOR= 0.45, 95% CI: 0.18-1.17: p= 0.102). A Sierra Leonean study (Diaz et al., 2013) found majority of children from Muslim homes whereas in this present study majority of children were Christians (80%). A case-control study in Nepal showed that most of the cases belonged to the Hindu religion but having pneumonia showed no relationships with religion (Karki et al., 2014).

5.2 Limitations of the study

The study was limited to only one sampling site hence the study outcome may not reflect the true pneumonia situation in the entire country. There was likely admission bias as children from low-income households may be likely admitted since management of pneumonia at home would be difficult and consequently the population studied did not reflect the accurate target population. Although care was taken to minimize selection and information bias, recall bias is more likely since some of the questions were answered from recall although risk factors of most interest were not in the knowing of the interviewees. Some patients had multiple diagnoses and this may exacerbate severity of illness.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

In terms of nutritional status, height-for-age z-scores (stunted and not stunted) were protective and significantly associated with pneumonia. Having a relation other than child's mother as main caretaker was protective and had a significant association with pneumonia. The risk factors in children under-five with pneumonia are being female (socio-demographic factor), nutritional status, i.e. weight-for-age z-scores (underweight and not underweight), and not starting complementary feeding and starting complementary feeding before 6 months which fall under other factors. They had increased odds of getting pneumonia.

6.2 Recommendations

Emphasis should be placed on having other relatives of children helping with care. Immunization and child's birthweight should be well documented in the Road to health chart (RTHC) to improve monitoring. The district health directorate should endeavor to tailor public health efforts for frequent nutritional programs, campaigns, and education in the district targeted towards stunting and underweight in children below age five and appropriate complementary feeding as measures to decrease the risk of pneumonia. These findings would benefit from additional population-based research in other regions of Ghana and Sub-Saharan Africa.

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APPENDICES

APPENDIX A
Informed Consent

Title of study: Nutritional Status and Pneumonia in Children Under-Five at Princess Marie Louise Children's Hospital.

Introduction

I am a master student of the School of Public Health, University of Ghana, Legon. As part of the programme, we carry out research work. My work is on the association between nutritional status and pneumonia in children below five years. Poor nutritional status can exacerbate pneumonia occurrence in children below five years. It is hoped that the findings of this study will help identify the association between nutritional status and pneumonia in under-fives.

Voluntary participation

Participation is voluntary and you are free to withdraw from the study at any time without being penalized in any way.

Study Procedure

Your child is being invited to take part in this study and a short interview will be conducted to obtain some answers about the child. Some questions will be asked by a medical officer as well as examine child for diagnosis. Weight and height will also be taken.

Exclusion criteria

Persons with severe anaemia or very sick and those who are not willing or able to understand or comply with study procedures will not be allowed to be part of the study.

Risks and Benefits

The risk involved in your child's participation in this study is very low. Risk of cross contamination from measuring instrument surfaces will be avoided by ensuring strict hygienic practices by cleaning the length mat, standing and weighing scales with alcohol swabs before measuring weight and height. Nevertheless, this research will increase our understanding regarding the association between nutritional status and pneumonia in a child under five and will contribute to the content of health education programs both for caregivers and health-workers. A better understanding of this relationship may provide information to put in place treatment and preventive measures for under-fives with pneumonia.

Privacy and Confidentiality

The information you provide is totally confidential and will not be disclosed to any unauthorized persons. It will only be used for research purposes. No response you give will be specifically connected to you. Participants can opt to be interviewed in a location of their choice to increase privacy.

Declaration of conflict of interest

I, Huguette Naa Ayele Aryee (Principal Investigator), declare that, to the best of my knowledge, there is no conflict of interest that will or may arise as a result of my involvement with this study.

Who to contact

In case of further questions regarding the research, you can contact:

Huguette Naa Ayele Aryee, School of Public Health, University of Ghana, Legon. Mobile number: 0267360116, Email: hunaryee@yahoo.com

or

Nana Abena, Ethical Review Committee Administrator, Ghana Health Service, Adabraka – Accra. Mobile number: 0244712919

Before taking Consent

Do you have any questions you wish to ask about the study? Yes No

(If yes, please, indicate the questions below) ………………………………………….………...

…………………………………………………………………………………………

…………………………………………………………………………………………

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Statement of consent

I voluntarily consent to participate in this study

Signature/Thumbprint of participant.................................
Date.........../............../..........

Signature/Thumbprint of witness of participant………….
Date.........../............../..........

Name of person conducting interview…………………………………………………….

Date.........../............../..........

APPENDIX B

Study Questionnaire

	Date of interview (dd/mm/yyyy)	______/_____/_______	
	Interviewer's initials		
	Questionnaire code		
			Official use
No	**Questionnaire**	**Responses**	**Code**
SECTION A. SOCIO-DEMOGRAPHICS AND OTHER FACTORS			
1	Conditions:	1 = case 0 = control	**cse**
2	Date of diagnosis (dd/mm/yyyy)	______/_____/_______	**dd**
3	Is child currently on nutritional therapy?	1 = yes 0 = no	
4	Age of Child (months)		**age**
4b	Child's date of birth (dd/mm/yyyy)	______/_____/_______	**dob**
5	Sex	0 = male 1 = female	**sex**
6	Pre-term	1 = yes 0 = no	**preterm**
6a	Birth weight (Kg)		**bwt**
7a	Immunization status of child	0 = fully immunized 1 = partially immunized 2 = not immunized at all	**vaccine**
7b	DPT-Hepb-Hib1 DPT-Hepb-Hib2 DPT-Hepb-Hib1 Pneumo 1 Pneumo 2 Pneumo 3 Vit A suppl	1 = yes 0 = no 1 = yes 0 = no 1 = yes 0 = no 1 = yes 0 = no 1 = yes 0 = no 1 = yes 0 = no 1 = yes 0 = no	**vacctype**
8	Respondent's relationship to child		**resrelch**
9	Who is the main caretaker of this child?		**maincare**
10	Age of mother (years)		**agemoth**
11	Parity of mother		**parmoth**
12	Mother's age at child's birth (years)		**agemochbirt**
13	Current occupation of mother/caregiver	0 = none 1 = sales/services 2 = professional 3 = civil servant 4 = agricultural 5 = artisan	**occmoth**
13b	Current employment status of mother/caregiver	0 = full-time 1 = part-time 2 = self employed 3 = unemployed	**empmoth**

14	Current occupation of father	0 = none 1 = sales/services 2 = professional 3 = civil servant 4 = agricultural 5 = artisan	**occfath**
14b	Current employment status of father	0 = full-time 1 = part-time 2 = self employed 3 = unemployed	**empfath**
15	Ethnicity	0 = Akan 1 = Ga 2 = Ewe 3 = Dagomba 4 = Gonja 5 = other	**ethnicity**
16	Religion	0 = Christianity 1 = Islam 2 = Traditional 3 = other	**religion**
17	When did the child start complementary feeding?	1 = before 6 months 0 = after 6 months	**compfeed**
18	Colostrum	1 = yes 0 = no	**colostrum**
19	Breastfeeding history during first 6 months	0 = nil 1 = exclusive 2 = partial	**bfhx**
20	Has child been weaned off breastmilk?	1 = yes 0 = no	**weanbf**
20a	If yes, at what age (months) was child weaned off?		**ageweanbf**
21	Educational level of mother/ caretaker	0 = no education 1 = primary 2 = JHS 3 = SHS 4 = tertiary	**educmoth**
22	Educational level of father	0 = no education 1 = primary 2 = JHS 3 = SHS 4 = tertiary	**educfath**
23	Monthly income level of mother/ caretaker (Gh cedis)	0 < 200 1 = 200 – 400 2 > 400	**incomoth**
24	Monthly income level of father (Gh cedis)	0 < 200 1 = 200 – 400 2 > 400	**incofath**
SECTION B: ENVIRONMENTAL AND SOCIAL FACTORS			
1	Place of residence (town, region)		**place**

2	House	0 = nuclear 1 = compound	**house**
3	How many people live in your house?		**numberhse**
4	How many children in the house are under five?		**chifivehse**
5	How many people sleep in the same room with child?		**slpsamrm**
6	What does the child sleep on at home?	0 = bed/cot 1 = mat/cloth 2 = bare floor	**chslponhse**
7	Does anyone smoke in the house?	1 = yes 0 = no	**smoke**
7a	If yes, how many people smoke?		**numsmoke**
8	Is there anyone coughing in the house?	1 = yes 0 = no	**coughse**
8a	If yes, how many people are coughing?		**numcough**
8b	Do they sleep in the same room or bed with the child?	1 = yes 0 = no	**slpsamcough**
9	Main source of fuel for cooking	0 = gas 1 = charcoal 2 = firewood	**fuel**
10	Main source of drinking water for child	0 = bottled 1 = sachet 2 = tap water 3 = borehole 4 = well	**water**
11	Main toilet facility	0 = WC 1 = KVIP 2 = public toilet 3 = bucket/ pan 4 = no facility	**toilet**
12	Does your child attend a day-care centre?	1 = yes 0 = no	**daycare**
12a	If yes, at what age (months) did the child start?		**agestdcare**
12b	On average, how long does the child spend at the day-care centre per day?		**spendcare**
12c	What does the child sleep on at the day-care centre?		**chslpondcare**
12d	How many children are in the class (range)?		**numclass**
SECTION C: PHYSICAL EXAMINATION			
1	Weight (Kg)		**wt**
2	Height/ length (cm)		**ht**
3	Heart rate		**hrate**
4	Respiratory rate		**resprate**
5	Temperature		**temp**
6	Pallor	1 = present 0 = absent	**pallor**
7	Cyanosis	1 = present 0 = absent	**cyan**
8	Hydration status	0 = well hydrated	**hydstat**

		1 = dehydrated	
9	Glasgow Coma Scale		**gcs**
Sub-section (a) Symptoms			
1	Fever	1 = yes 0 = no	**fever**
2	Cough	1 = yes 0 = no	**cough**
3	Runny nose	1 = yes 0 = no	**nose**
4	Tachypnea	1 = yes 0 = no	**fastbrea**
5	Irritability/ altered sensorium	1 = yes 0 = no	**irrita**
6	Others	1 = yes 0 = no	**sympothr**
Sub-section (b) Nutritional status			
i.	Length/height-for-age (HAZ)		**haz**
ii.	Weight-for-age (WAZ)		**waz**
iii.	Weight-for-length (WLZ) or weight-for-height (WHZ)		**whz**
iv.	BMI- for-age		**bmi**
SECTION D: LABORATORY INVESTIGATION			
1	HB (current results)		**hb**
2	WBC (current results)		**wbc**
3	Platelet count		**platelet**
4	Sickling	1 = positive 0 = negative	**sickling**
SECTION E: X-RAY INVESTIGATION			
1	X-ray results	1 = positive 0 = negative	**xray**