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PNEUMONIA IN CHILDREN UNDER FIVE AT THE GREATER ACCRA REGIONAL HOSPITAL: 2016-2020

BY

ANSAH MAGDALINE YAA AMOAKOA

(10306998)

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DECLARATION

I, ANSAH MAGDALINE YAA AMOAKOA hereby declare that except for the references made to other peoples' work which I have duly acknowledged, this research which is my original work has neither in whole nor in part been presented to the University or elsewhere for another degree.

Date: 24TH February 2022

(ANSAH MAGDALINE YAA AMOAKOA)

(Student)

Date: 24TH February 2022

(DR ANTHONY DANSO-APPIAH)

(Supervisor)

DEDICATION

This work is dedicated to Mr. Benson Owusu for his unflinching support during my studies.

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ABSTRACT

Pneumonia continues to be a leading cause of severe morbidity and mortality among children under five globally. It is the third cause of death among children under five in Ghana despite effective ways of preventing this disease. This study assessed the trend of pneumonia among children under five at the Greater Accra Regional hospital between the years 2016-2020. Electronic hospital records of children under 5 who reported to the Greater Accra Regional Hospital with pneumonia was retrieved. The data was transferred from Microsoft Excel spreadsheet to STATA version 16, analysed in terms of time, age, place, gender, immunization status, and clinical outcomes of the disease, using time series to determine the trend. 1901 confirmed cases of pneumonia in children under five years reported from 2016 to 2020.There was a consistent comparatively reduced number of pneumonia cases over the first 4years(from 487 to 282)and a rise to 472 in 2020 in children aged especially less than 2years with males demonstrating an increased pneumonia risk, probably due to the emergence of COVID-19. Children living in peri-urban areas were more affected than those in urban areas. There was a decline in pneumonia mortality from 2016 to 2018 with a slight peak in 2019 and subsequent decline in 2020 as well as a statistically significant association between one's age ,place of residence, immunization status and developing pneumonia in under-fives with complete immunization reducing the risk for severe pneumonia. There is the need to intensify health education on immunization, enforce environmental health policies and modify healthcare practice in relation to pneumonia.

Keywords: Pneumonia, Children, Under-fives

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LIST OF ABBREVIATIONS

ALRI – Acute Lower Respiratory Infection

AOR -- Adjusted Odds Ratio

ARI – Acute Respiratory Infection

CHPS - Community-Based Health Planning and Services

CMH – Cochran-Mantel -Haenszel

CMV – Cytomegalovirus

COR -- Crude Odds Ratio

COVID-19 -- Corona Virus Infectious Disease-19

GARH – Greater Accra Regional Hospital

GHS -- Ghana Health Service

Hib – Hemophilus influenza type B

HIV/AIDS – Human Immune Deficiency Virus /Acquired Immune Deficiency Syndromes.

ICD-10 -- International Classification of Diseases-10

IGME – Inter Agency Group for Child Mortality Education.

IVAC – International Vaccine Access Length

JHBSPH – John Hopkins of Bloomberg School of Public Health.

PCV -- Pneumococcal Conjugate Vaccine

SARS-COV2 --Severe Acute Respiratory Syndrome-Corona Virus 2

SSA ---- Sub-Saharan Africa

UN --- United Nations

UNICEF - United Nations International Children's Education Fund

WHO --- World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

The Global Picture of Pneumonia in under five children

Despite the significant decrease in child mortality in the past 30 years, with mortality in under-fives down by over 60% since 1990, the global burden of child and adolescent fatalities remains enormous. About 7.4 million children, adolescents, and teenagers died in 2019, the majority from preventable or treatable causes (Sharrow et al.,2020). Contrary to the Sustainable Development Goal (SDG) 3, which underpins ‘’healthy lives and well-being for all ages’’, there are needless under five deaths.(Aheto, 2019). Globally, in 2017, pneumonia killed 809,000 children under five years (Dadonaite, 2019), translating to over 2,200 deaths daily (Dadonaite, 2019). The highest frequencies are in South Asia (2,500 cases per 100,000 children) and West and Central Africa (1,620 cases per 100,000 children) with pneumonia killing a child every 39 seconds (UNICEF, n.d).

Children across countries of Sub-Saharan Africa and South Asia are at higher risk of death from pneumonia (see Figure 1 for the global burden of pneumonia in children under 5). Nigeria, the Democratic Republic of Congo, Ethiopia, India and Pakistan in 2017 together accounted for 50% of childhood pneumonia for all deaths (WHO, 2020). A nation’s income shares strong association with pneumonia-associated child deaths (Dadonaite, 2019).

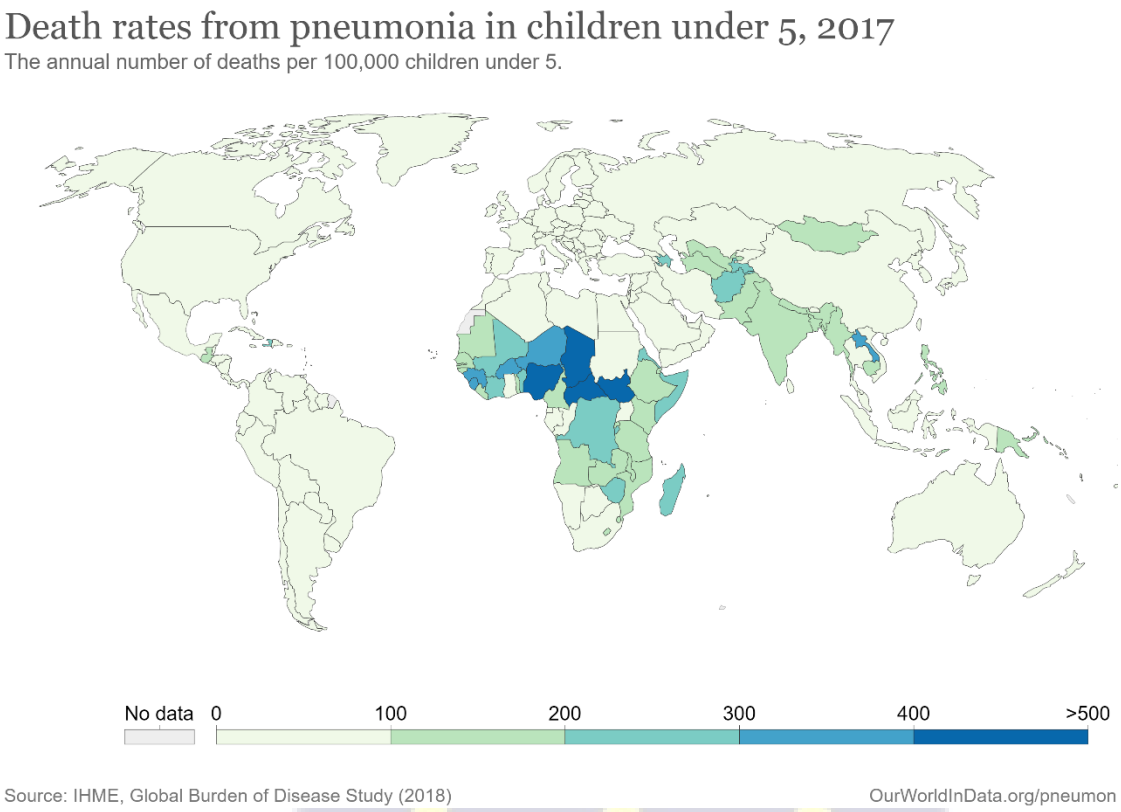


Figure 1.1: Global trends of death rates from pneumonia in children under 5

Common causes of under 5 mortality in Sub-Saharan Africa

Most frequent rates of child mortality occur in sub-Saharan Africa (SSA) with one out of eight children dying before age 5 as compared to developed regions which is 1 in 67(UNICEF, 2021b). Six conditions: acute lower respiratory infections, mostly pneumonia (18%), diarrhea (18%), malaria (9%), HIV/AIDS (2%), measles (1%) and a group of neonatal conditions put together including, pre-term, infections and birth asphyxia (37%) account for about 70% of all child deaths in SSA (Faijer et al., 2011). Thus, more children under 5 are killed by pneumonia than malaria, measles and AIDS combined, yet not much attention has been given compared to the latter conditions (UNICEF, 2021b). Pneumonia has been identified as the major "forgotten killer of children" (Wardlaw et al., 2006).

Under 5 pneumonia in SSA

Pneumonia is an acute respiratory tract infection (ARTI) involving the lungs, characterized by a combination of cough and rapid breathing with set values for increased respiratory rate. Scott in 2008 simply defined it "as an illness usually caused by infection, where the lungs become inflamed and congested, thus reducing oxygen exchange and leading to cough and breathlessness" (Scott et al., 2008). Classification of pneumonia includes community acquired, aspiration, ventilator associated pneumonia and hospital acquired pneumonia (Normandin, 2019).

Risk factors

Deaths associated with childhood pneumonia are strongly linked to under nutrition, inadequate access to potable water and healthcare, poor sanitation and air pollution (UNICEF, 2021a). Air pollution plays crucial role, accounting for 50% of all childhood pneumonia deaths (WHO-Africa, n.d.). Other risk factors include compromised immune status of the child such as seen in cases of low birth weight, malnutrition, pre-existing co-morbid conditions like HIV, cancer and environmental factors like household air pollution from use of biofuel, living in overcrowded homes, parental smoking (Karki et al., 2014).

Aetiology

Bacteria, viruses and fungi are aetiological agents of pneumonia. In children, the pathogens responsible for pneumonia include streptococcus pneumoniae (most common) followed by Hemophilus influenzae type b (Hib) which are bacterial in origin, respiratory syncytial virus (RSV) (most common viral cause) and in infants with Human Immune Deficiency virus (HIV), pneumocystis jivoreci is the most common cause resulting in at least 25% mortality in infants with

HIV (WHO 2019, 2020; Nathan et al., 2020). In infants less than 3 weeks, gram negative enteric bacteria, group B streptococci, cytomegalovirus (CMV) and listeria monocytogenes are common causes. For those aged 3 weeks to 3 months, chlamydia trachomatis, RSV, parainfluenza virus 3, streptococcus pneumoniae, Bordetella pertussis and staphylococcus aureus are the major causes. Also, RSV, influenza, haemophilus influenza, parainfluenza viruses, adeno and rhinoviruses , streptococcus pneumoniae ,mycoplasma pneumonia and mycobacterium tuberculosis cause infection in children aged 4 months to 4 years.(Ning et al., 2017; Vong et al., 2013).

Pathophysiology

Pneumonia is transmitted through inhalation of infected droplets from a cough or sneeze of an infected person or inhalation of normal flora in the nasal passages of the child. During and shortly after delivery, an infant may also get infected through the blood. When a person has pneumonia, there is limited oxygen intake and breathing is distressful as pus and fluid fill the alveoli in the lungs. It is responsible for mortality in children globally as the single largest cause (Nga Tong, 2013; WHO, 2019). The most consequential result of acute respiratory infection (ARI) is pneumonia and it claims around 2,200 lives of children under 5 every day (UNICEF, 2018).

Clinical Presentation

In a review for the Journal of Clinical Microbiology in 2018, Rodrigues and Groves stated that children with community acquired pneumonia could present at varying stages of illness ranging from mild to moderate with clinical features difficult to differentiate from other paediatric conditions (Rodrigues & Groves, 2018). These include fever, poor feeding, cough, respiratory distress (evident by nasal flaring grunting or chest recession or abdominal breathing), wheeze,

chest or abdominal pain, lethargy, vomiting, headache, tachycardia, hypoxia, crackles, altered state of consciousness(Harris et al., 2011; Rodrigues & Groves, 2018; WHO, 2014).

Diagnosis

Diagnosis includes identifying the organism in nasopharyngeal secretions through immunofluorescence assay or Polymerase chain reaction (PCR) or by culture (Bradley et al., 2011; El Kholy et al., 2016). Other microbiological tests include blood, sputum and pleural aspirate culture where available, serology testing for atypical bacteria (Rodrigues & Groves, 2018). Radiological tests include chest x-ray, chest ultrasound and chest computed tomography (Claessens et al., 2015; Dayie et al., 2013). In Ghana chest x ray is considered the 'gold standard' and the commonly used (Torzillo et al., 2014).

Management

There is general consensus on potent treatments and availability of universal standards for the diagnosis of pneumonia (Walker et al., 2013). WHO recommends dispersible oral amoxicillin tablet (amox DT), as first- line therapy for under -fives as standard of care ((UNICEF Supply Division, 2018). For severe pneumonia, the standard practice involves hospital stay for supportive care which includes providing oxygen, respiratory fluid aspiration and optimum nutrition, antimicrobial use, and close observation (Scott et al., 2012).

Complications

Complications of pneumonia in children include empyema, atelectasis, necrotizing pneumonia, recurrent severe pneumonia, primary lung abscess, sepsis, syndrome of inappropriate diuresis,

acute respiratory distress syndrome, hemolytic uremic syndrome and disseminated intravascular coagulation and ultimately, death (Pabary & Balfour-Lynn, 2013). One of the major outcomes of childhood pneumonia is a heightened risk of asthma.(Cillo´niz et al., 2011). Findings from a study revealed children with pneumonia have increased risk of developing protracted cough, atypical shape of the chest and more likely to have a chronic cough, abnormal chest shape, asthma diagnosis and minimized pulmonary function at 5years (Cillo´niz et al., 2011).

Prevention

Reduction of risk factors for childhood pneumonia is the primary strategy for pneumonia prevention (Gothankar et al., 2018). Immunization and good nutrition are effective measures, also tackling environmental factors can prevent pneumonia (WHO, 2020). In Ghana, the Ministry of Health adopted the Pneumococcal vaccination (PCV) in 2012 with the aim of protecting children against some serotypes of *Streptococcus pneumoniae* in children (Abbey et al., 2018). The efficacy of the 13-valent vaccines (PCV) was assessed in a cross-sectional study among children in Accra and Tamale and the results showed 48-51% protection against pneumococcal carriage isolates (Dayie et al., 2013). Despite these efforts, the elimination of childhood pneumonia-related fatalities is still a public health concern in Ghana and threatens the attainment of SDG 3(Aheto, 2019).

1.2 Problem statement

Pneumonia is responsible for 15% of all under-five deaths globally, with 808,694 children dying in 2017 alone (WHO, 2019). A child dies of pneumonia every 39 seconds (UNICEF, 2021a). Through the Integrated Global Action Plan for the Prevention and Control of Pneumonia and

Diarrheoa (GAPPD), WHO has developed a strategy to reduce deaths caused by pneumonia to less than 3 children per 1000 live births by 2025 (Qazi et al., 2015). Children from low income countries are more than 14 times predisposed to death before age 5 compared to those in high income countries (WHO-Afica, n.d.). Sub-Saharan Africa (SSA) accounts for a greater portion of the burden of pneumonia and its related mortality(WHO-Africa, n.d.) . In Ghana, pneumonia ranks third after malaria and diarrhea as the top cause of death in under 5s(Abbey et al., 2018).

In the Greater Accra Regional Hospital, pneumonia is among the top three causes of outpatient attendance (about 27%) of all outpatient visits in 2020 (GARH End of Year Report, 2020). Empirical evidence suggests that most parents are aware that pneumonia in children is a serious health threat so majority of cases are reported to the health facility (Grijalva et al., 2007). In spite of this, there is paucity of data to highlight the actual burden of pneumonia in Ghana (Abbey et al., 2016). In a mortality evaluation in a children's hospital in Accra, the evidence showed paediatric deaths from all causes had significantly declined, however, deaths due to pneumonia had surged , resulting in 18% of deaths in those below 5 years and 4%, aged 5 to 9 years (Tette et al., 2016a; Tette et al., 2016b).

Decades of progress targeted at making extinct, preventable child deaths from pneumonia such as the introduction of the pneumococcal vaccine, could be reversed by the pandemic,COVID-19 . (United Nations, 2020).This is because of the disruption in child welfare services, leading to reduced post- natal clinic attendance. Children below five years are susceptible to developing pneumonia due to their under-developed immune system. If conscious efforts are not made to reduce the prevalence of pneumonia among children under five, achieving the sustainable development goals (SDG) 3, which seeks to improve health and wellbeing may not be achieved,

hence the need to assess the trend of pneumonia among children under five at the Greater Accra Regional Hospital.

1.3 Justification

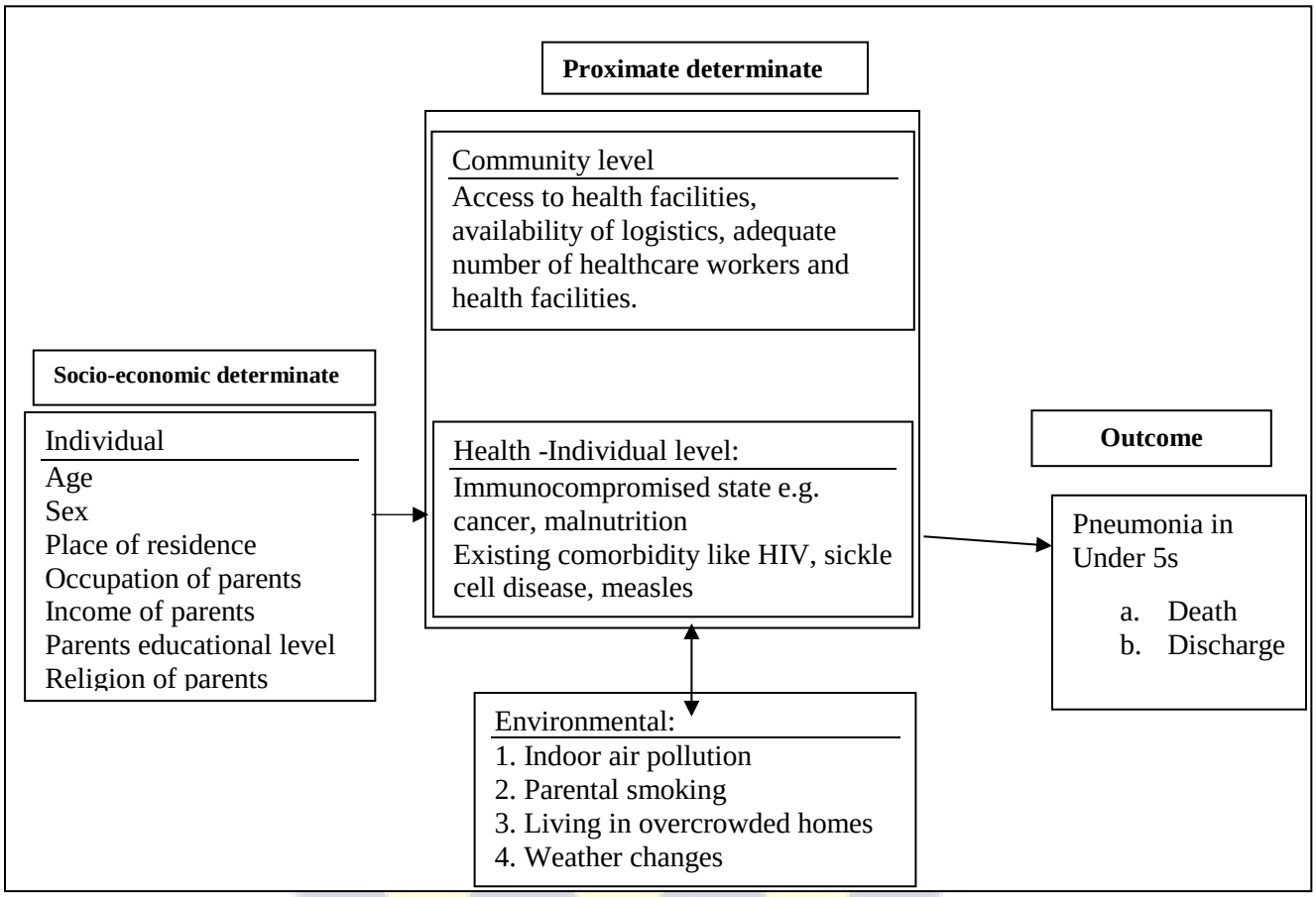
The population of Ghana is about 31 million of which 57.4% live in urban places; 42.7% reside in rural areas (O' Neill, 2021). Children aged below five constitute 14.4% of Ghana's population (Ghana Statistical Service, Ghana Health Service, 2015). Many health institutions have been established across the nation to enhance the wellbeing of children and the population at large. around 140 districts hospitals, 998 clinics, 1004 health centres and 5,421 community-based health planning and services (CHPS) in the country (GHS, 2018). The availability of these health facilities is central to the attainment of the SDG 3 by scaling up measures that can contribute to a decline in morbidity of pneumonia in children. However, in spite of these facilities the number of under 5 deaths associated with pneumonia are high (Aftab et al., 2020).

Numerous studies on factors giving rise to pneumonia prevalence among children under 5 in Ghana have been done (Abbey et al., 2016, 2018; Tette et al., 2016a; Tette et al., 2016b), not many have been conducted in the Greater Accra Region. It is important to regularly review hospital data especially for tertiary level facilities such as the Greater Accra Regional Hospital to identify disease patterns and develop hypothesis to inform interventions. Therefore, this study was planned to investigate the trends in pneumonia in children below the age of five years which has bearings on therapy and prevention with the aim of learning about the actual morbidity and mortalities from 2016 to 2020. It also looked at the trends of pneumonia by sociodemographic factors (age, sex and place of residence), the factors that influence the development of pneumonia in under 5s,

the relationship between seasonal variation and immunization status of the child with pneumonia and how immunization status affects the severity of established pneumonia in under -fives.

Findings from this study could assist clinicians and policy makers to develop strategies to curb the incidence of pneumonia and number of cases visiting the hospital due to pneumonia in under 5 children through advocacy and monitoring of risk factors identified in this study. Policymakers will also be informed by findings from this study on pragmatic steps to take to strengthen the health system with respect to detection of pneumonia and enhance interventions like childhood immunization and environmental protection to reduce under 5 pneumonia-related mortality. This study is based on pneumonia cases documented at the Greater Accra Regional Hospital, a government-owned health facility located in the Osu-Klottey sub-metro in Ghana's Greater Accra Region, from 2016 to 2020.

1.4 Conceptual framework



Source: Adapted from Mosley and Chen, (2003)

Narrative of the conceptual framework

The design of this research was modelled around the analytical child survival framework (Mosley & Chen,1984). The theory is expounded on the idea that all socio- economic determinants of child mortality imperatively work through a similar set of biological mechanisms, or proximate determinants to influence mortality (Tampah-Naah, 2019). The model assumes that the risk of a child developing pneumonia and its related mortalities are socially and economically related. The advantage of the framework is the incorporation of three components (independent, proximate and dependent variables) as key in evaluating an outcome, either morbidity or death of a child. The

independent variable; socioeconomic factors is appraised at the individual, household and community level. (Mosley &Chen, 2003; Mosley & Chen, 1984). The framework also assumes that morbidity or mortality of a child is strongly associated with their parents circumstances such as their educational attainment and income that the higher the parents' education and income, the less likely the child will be exposed to the socio-economic hardships that underpin the acquisition of pneumonia. . It also suggests that time of the care givers, particularly mothers, is a strong determinant for the development and the course of pneumonia in the child under 5 years. Looking at the biological relationship a mother and her foetus share from pregnancy through to lactation, the mother's nutritional status and health plays a role in the survival of the child. Time on the part of the mother is essential to the survival of the child as a mother needs time to visit antenatal clinic, breastfeed, wash child's cloths as often as possible, house cleaning among others, which are all cardinal in keeping the child alive. At the household level, other interrelated factors include the provision of quality and balanced meals, safe water, clean clothing and high standard hygiene.

In the community, the survival of the child is affected greatly by ecological factors such as rainfall, temperature and seasonality as they impact the quantity and quality of food produced, quality of drinking water and disease pathogen transmission (Gitz et al., 2016; Wu et al., 2016). Also, environmental factors, such as congested homes and exposure to indoor air pollution may put a child at increased risk of developing pneumonia Nga Tong, BA, 2013).

For biological factors, a healthy child has natural immunity that protect him or her from pneumonia. Malnourished children, particularly those not breastfed exclusively or who lack zinc, are susceptible to pneumonia (UNICEF, 2012). Co-existing infections like malaria, measles and

AIDS compromise the immune system and are risk factors in pneumonia-related mortality in infants. Access to appropriate and quality health care in rural settings for pneumonia is crucial due to lack of adequate number of healthcare facilities.

Furthermore, among child primary care givers, there is paucity of knowledge concerning the danger signs and symptoms of pneumonia resulting in deferred care seeking and this could be life threatening. (Källander et al., 2008; Onyango et. al, 2012). The variables termed proximate which encompass environmental conditions, feeding practices and the state of the disease together prognosticate the child survival or otherwise. The independent and proximate variables interplay to determine whether a child is sick or healthy. A child's recovery from an ailment or not is also influenced by pre-decided innate illness control variables by the independent variables.

There are varying ways by which people estimate the dependent variable. The social scientist, measures it as mortality (Mosley & Chen,1984). They are of the opinion that death is conclusive thus, simpler to collate and measure. The disadvantage of the social scientists' approach is that death is a rare event which requires large populations over a long period of time. To the medical scientist, dependent variable is measured as disease (for example pneumonia) or nutritional status of survivors. The drawback with this dimension is that deaths are not put into consideration by the medical scientists. A combination of wavering growth pattern and mortality level of specific birth cohorts is proposed by the framework.

1.5 Research questions

1. What is the trend in cases of pneumonia in children under 5 by sociodemographic factors (age, sex, place of residence)?
2. What proportion of children under 5 who were admitted to the Greater Accra Regional Hospital (GARH) with pneumonia died?
3. What factors influence pneumonia in children under 5?
4. What extent does immunization influence the severity and outcome of pneumonia in children under 5?

1.6 Objectives

1.6.1 Main objective

To assess the trends in morbidity and mortality, and extent of immunization in children under five years with pneumonia attending the Greater Accra Regional Hospital from 2016 to 2020.

1.6.2 Specific objectives

1. To determine the trend in cases of pneumonia in children under 5 by sociodemographic factors. (age, sex and place of residence).
2. To determine the proportion of children under 5 who were admitted to the Greater Accra Regional Hospital with pneumonia and died.
3. To evaluate, from patient records, factors influencing pneumonia in children under 5.
4. To assess the extent to which immunization influences the severity, course and outcomes of pneumonia in children under 5 attending the GARH

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

An extensive search was conducted using Medline, CINAHL, PubMed and Google Scholar (English only, full text) with keywords: 'Pneumonia', Pneumonia and Socio-demographic factors' and 'Pneumonia and under-five mortality'. A study was considered for literature review if it was published in a peer-reviewed journal. There was no limitation to the search by date of publication or to country. This yielded more than 90 studies distributed unevenly among the main variables under consideration. The search was specified to studies pertaining to Pneumonia and sociodemographic factor of under-5s, Pneumonia and under-5s mortality, and factors influencing pneumonia in under-fives which resulted in 50 studies. The selected studies were reviewed under the major themes and were screened for relevance for this study.

This chapter is presented in five sections as follows. Section 'A' focuses on pneumonia and socio-demographic factors of under-5s. Section 'B' presents literature on the proportion of children under-5 who reported with pneumonia and died, Section 'C' provides literature on factors influencing pneumonia in children under 5 and how immunization influences the severity, course and outcomes of pneumonia in under 5s whiles 'Section D' summarizes the chapter.

2.2 Trend in cases of pneumonia in children under 5 by sociodemographic factors

A retrospective study done in Ghana showed that the prevalence of acute respiratory disease among children under five showed an increasing trend among children residing in the middle zone of Ghana. This same study showed an increasing trend among those residing in rural areas than urban (Seidu et al., 2019). A study assessed the epidemiology of pneumonia in Bangladeshi. Using

multivariable logistic regression, the relationship between their characteristics and pneumonia severity and mortality were evaluated for children within the ages 2 to 59months admitted to three different hospitals. It was realized that greater risk of death from pneumonia was associated with ages, 2–5 months, those younger than 5, prior to the introduction of the pentavalent conjugate pneumococcal vaccine.(Saha et al., 2016).

Also, in China specifically Zhejiang Province, a descriptive population study was done to evaluate the trends and main causes of mortality in children below five years. Chi-square was used in the analysis as well as of the specific causes of mortality rates. In urban and rural places ,mortality rates in the children decreased by 59.5% (from 11.09 to 4.49 per 1000 livebirths) and 65.8% (from 19.30 to 6.61 per 1000 livebirths) accordingly.(Zhang et al., 2015).

Furthermore, a study measured the extent to which the introduction of the pneumococcal conjugate vaccine (PCV) influenced pneumonia deaths from all causes in South Africa, while variations in mortality because of other interventions were controlled for (Kleynhans, et al., 2021). A nationwide death registry from 1999 to 2016 excluding infants was used. It was found that the vaccine introduction was associated with significant decline in all pneumonia-related deaths in children from a month to 18years. In an observational case control study conducted in Alexandria, Egypt with the focus of pneumonia in children under five, the mean age of the children was found to be 23.14+/- 18.61 months .58.5% of participants which is almost two-thirds of a total sample population of 660 ,were found to be boys at about 95% confidence interval and odds ratio of 1.925 and 1.162 respectively.(Fadl et al., 2020). This shows an increase in trend among toddlers with males at increased risk of pneumonia than females.

Additionally, a study by Falagas et.al revealed sex as an indispensable factor in the epidemiology of many diseases. From the study, females were noted to be commonly affected with upper respiratory tract infections whiles males were affected with lower respiratory tract infections like pneumonia with a rather more severe disease course running in males; increasing their risk for morbidity and mortality.(Falagas et al., 2007).

2.3 Children under 5 who reported to the hospital with pneumonia and died

The lead cause of death globally is pneumonia as well as lower respiratory tract infections.(Waseem, 2020).Many children below age five worldwide are killed by pneumonia than any other infectious disease singularly, resulting in about 800,000 lives lost in 2018.(Cho et al., 2018).Globally,141 deaths occur every hour or 3,400 deaths each day from pneumonia and diarrhea deaths in children before their 5^{th} birthday. (Cho et al., 2018).A retrospective study by Ahetor J.(2019) in Ghana revealed that the odds of survival among child under five is higher in those whose parents have received formal education than those who haven't. Again, female survival rate was higher than male. The study further revealed the risk of death in under-fives is higher in those residing in the Western region of Ghana than those in other regions.(Aheto, 2019).

Denny and Clyde conducted an old but relevant community-based study in 1986 where the annual incidence rate of pneumonia was 4 in 100 preschoolers, 2 in100 children aged 5-9 years, and 1 in 100 children aged 9-15 years.(Denny F W, 1986). Also, Thompson et al., (2004) reported that in the United States, children under 5 follow elderly persons as the second highest influenza-associated hospitalizations rates after analysis by age group, hospital discharge category and

discharge type.(Thompson et al., 2014).Using the national and sub-national under-five mortality profiles ,a study discovered that in Peru, 20% of all under-five deaths was by pneumonia. (Huicho et al., 2006). In China, a study was undertaken to determine under -five pneumonia mortality from 1996 to 2013 using data from the national surveillance system. The data was evaluated to ascertain the distinctions of PMR and proportion. The study found that there was a reduction in pneumonia to total proportion deaths from 23.4% in 1996 to 12.8% in 2013, with rural areas declining from 24.4% to 13.2% as opposed to urban areas, 11.1% to 9.7%.(He et al., 2015).

A retrospective analysis involving children under five with clinical and radiologic pneumonia according to WHO categorization, who were in the intensive care unit at Dhaka Hospital between August 2013 and December 2017 was done. (Chisti et al., 2021). Prevalence of pneumonia and seizure were measured. The study reported that children with pneumonia and seizure many a time, had respiratory failure (18% vs. 3%, $P < 0.001$) and died (13% vs. 3%, $P < 0.001$) as compared to those with pneumonia alone whiles on admission. Using a stepwise binary logistic regression model, a cross-sectional study in Este town and surrounding rural Kebele in Ethiopia was done to ascertain the factors associated with pneumonia and its prevalence among under five children, (Fekadu, 2014).The overall two weeks prevalence of pneumonia was 16.1 which was high.

In Ghana, a cross-sectional study was undertaken to identify pneumonia -associated factors, prevalence and mortality rate among children under five admitted to Komfo Anokye Teaching Hospital (KATH) (Osei et al., 2018). 157 children were selected purposively from those admitted for pneumonia from June to August 2016. The study found prevalence of pneumonia of 18.4% with a 12.7% mortality rate.

2.4 Factors influencing acquisition and outcome of pneumonia in children under 5

In two randomly selected slums of Dibrugarh town, a cross-sectional study to determine and risk factors and prevalence of pneumonia in children below age of five was done. (Nirmolia et al., 2018).The incidence of pneumonia was associated significantly with mothers' education, expedient start of complementary feeding, air pollution indoors and immunization which was complete. Similarly, a community based cross sectional research was undertaken to analyse the determinants and prevalence of pneumonia in children under age five in Este town, Northwest Ethiopia (Abeje Fekadu, 2014). The study found out that pneumonia amongst under-fives was associated with stunting, cooking using charcoal, cooking with the child carried at the back, cattle keeping in the main residence and dwelling in an overcrowded house were associated with pneumonia among under-five children.

A systematic review of published literature was done to delineate the risk factors for severe acute lower respiratory infections (ALRI)in under five aged children and which include pneumonia .(Jackson et al., 2013).These included low birth weight, indoor air pollution exposure, inadequate exclusive breastfeeding, immunization not complete for age, overcrowding (above 7 persons in a household), and infection with HIV.

Another study in India undertaken identified different risk factors for acute lower respiratory tract infections (ALRI) in children from a month to 5 years which could be modified.(Savitha et al., 2007). It was a prospective case control study which found out that overcrowding, partial immunization, serving pre-lacteal feeds, anemia, malnutrition, weaning early, rickets, kerosene

lamp use, fuel pollution from biomass and inadequate ventilation were associated with pneumonia among under-five children. A case control study using children aged 2 to 59months in Western Kenya showed that for severe pneumonia, co-morbidity (odds ratio 3.8,confidence interval 1.4-10.6),contact with upper respiratory tract infection and a 3day procrastination in seeking care for were individual risk factors.(Onyango et. al, 2012).Similarly, in the Arctic, Canada, a case control design was used to investigate the factors responsible for increased likelihood of contracting lower respiratory tract infections (LRTI) during admission in the hospital.(Anna B, 2009). The study revealed that smoking during pregnancy, one's place of domicile, inadequate breast-feeding, and overpopulation were each separately associated with higher chance of hospital admission for LRTI among children below age 2.

Furthermore, in a WHO's article on household air pollution and health, it stated that particulate matter inhaled from household air pollution accounts for half of deaths of mortality in children under five. These are mainly people living in low and middle -income countries who are poor and use biomass as source of cooking fuel.(WHO, 2018).

Also, in an international journal published by Hossain et. al in 2020, weather changes and its effect on pneumonia during childhood following the introduction of pneumococcal conjugate vaccine (PCV) in Rural Bangladesh was assessed with PCV intervention adjusted for. A reduction of annual incidence from 5691/100000 to 2000/100000 was realized after the introduction of the PCV.In same study, temperature was found to have negative association with childhood pneumonia and PCV intervention appeared protective against pneumonia in childhood.(Hossain et al., 2020).

Paynter et.al reiterated this assertion when in a paper stated that, respiratory infections follow seasonal patterns. During the winter, respiratory illnesses were common as opposed to rainy seasons here in the tropics where there was a surge of lower respiratory tract infections.(Paynter et al., 2014). For example in Gambia, childhood pneumonia incidence per 1000person years during the wet season was estimated at 409(95% CI 391-427) was higher than in the cool dry season which was 160(95% CI 148-173) (Rambaud-althaus et al., n.d.)

Finally, in a situational analysis in the University of Port Harcourt Teaching hospital, Nigeria, there was a peak in the quarterly distribution during the north-east(harmattan) season. Out of a total of 592 children admitted, neonates accounted for 24.5% of cases,66.9% were infants with 97.15% for under- fives.(Eberechukwu et al., 2011).

2.5 Extent to which Immunisation influences Severity and outcomes of pneumonia

A meta-analysis from pneumococcal conjugate vaccine trials which was conducted to ascertain its efficacy in reducing severe pneumonia incidence in infants less than 2months revealed an 89% efficacy involving vaccine serotypes in both the intention-to-treat and per-protocol analyses and for all serotypes, was between 63% and 74%. Also, in the intention-to-treat and per-protocol analyses, the efficacy of the pneumococcal vaccine in staving off clinical pneumonia was 6% and 7%, respectively, and was 29% and 32% respectively for the abatement of radiograph-confirmed pneumonia.(Pavia et al., 2009).

In an ambi-directional cohort study carried out in Spain among patients aged 3months to 14years,there was a 42% decline in hospital admission each year. An increase in PCV 13

coverage reduced hospitalization from community acquired pneumonia and parapneumonic effusion. However, no statistically significant difference was observed for length of hospital stay and severity among vaccinated and unvaccinated children.(Valdivielso Martínez et al., 2020).

2.6 Chapter summary

Numerous empirical studies have reported on children under five with pneumonia across the globe. While some of the reviewed studies reported on the rate of mortality of pneumonia in children less than age five over the years, others reported on the factors associated with pneumonia but did not go further to report the outcomes after acquisition of the disease. Notwithstanding the numerous studies on pneumonia, there is inadequate documentation of studies focused on the Greater Accra Region. Therefore, using recorded data, this study seeks to report on the trend in pneumonia cases in children under the age of five from 2016 to 2020 at the Greater Accra Regional Hospital (GARH). The next chapter presents the methodology of the study.

CHAPTER THREE

3.0 METHODS

3.1 Study design

A retrospective analysis of cases of pneumonia was done using from records of children under five years who sought healthcare at the Greater Accra Regional Hospital (GARH) from 2016 to 2020. The availability of data in medical records made retrospective study review of medical records of children under 5 the best design option.

3.2 Study area

The study was undertaken in the Greater Accra Regional Hospital, formally Ridge Hospital, Ridge Regional Hospital. It is a health institution owned by the state, found in the Osu -Klottey sub-metro in the Accra metropolis of Ghana. The hospital was established in 1928. It has in recent times been licensed by the Health Facilities Regulatory Authority as a tertiary facility and thus provides tertiary care for the region.As a regional and referral hospital, its catchment area is the whole greater Accra region with a population of 4,671,363 estimated based on the projection from the 2010 census by the Ghana Statistical service.(Ghana Statistical Service, Ghana Health Service, 2015). It is an ultra-modern facility and therefore endowed with sophisticated equipment and specialists to provide among others, reproductive, child health and nutrition services. The GARH was chosen because about 80% of children with a similar condition and presentation due to proximity and standard of care of the hospital, are at increased likelihood of being taken to the hospital than other facilities for children. To add to this, the GARH has seen over a thousand (1000) pneumonia cases in attendance for those under five years from 2016 and 2020 and continues to record high cases for children.

3.3 Study population

All reported cases of under- five children that reported to the GARH from 2016 to 2020 and whose records could be accessed were eligible for inclusion in this study.

3.3.1 Exclusion criteria

Children under five diagnosed of pneumonia but whose records did not have sufficient information or data to allow for analysis.

3.4 Study variables

3.4.1 Dependent variable

Children with pneumonia who attended the GARH, were admitted, and **'Discharged** '**o**r "**Died**".

3.4.2 Independent variables

Socio-demographic characteristics (age, sex and place of residence), seasonality (effect of rainy or dry season), date of admission, immunization status, child medical history, and criteria for the diagnosis of pneumonia. The study variables and scale of measurement are summarized in Table 3.1

Table 3.1: The operational definition of variables and scale of measurement

Independent variables	Operational definition	Scale of measurement
Socio-demographic factors		
Age	Age at last birthday	Continuous
Sex	Female, Male	Nominal
Geographic location	Place of residence (peri-urban, urban)	Nominal
Seasonality		
Cases of pneumonia	Cases of pneumonia based on seasons- (dry season, rainy season)	Nominal
Factors influence pneumonia in children		
Immunization status	Immunized, not immunized	Nominal
Dependent variables		
Pneumonia	Discharged or Died from pneumonia	Nominal

3.5 Sampling

3.5.1 Sample size

Entire records of pneumonia cases in children below five years who sought health care at the Greater Accra Regional Hospital was retrieved from the hospital's electronic health information system from 2016 to 2020 and reviewed. An exploratory exercise had estimated this number at over one thousand records; all were eligible for inclusion. Therefore, no formal sample size calculation was made.

3.5.2 Sampling method

All records of pneumonia in children younger than age five years who visited the GARH were eligible for inclusion.

3.6 Data Collection

The Electronic health records system was used to extract the data using a data abstraction form**.**The data abstraction form was used to collate data for under -five -year old children with pneumonia who were on admission at the GARH from 2016 to 2020. Two data managers from the GARH were recruited and trained on the ethics of data extraction for academic purposes. They were also trained on the objectives of the study and the importance of extracting only data that corresponded with the objectives of the study. The records included socio-demographic characteristics of the child (age, sex and place of residence), month and year of admission, immunization status of child and child's medical history. Also, details of the children's diagnoses were collected and aggregated by sociodemographic factors of the children. This provided records of what necessitated the admission, out of the total number of out-patient department (OPD) cases seen over the five-year period, further helping ascertain the pneumonia and mortality pattern. These records were retrieved from the health information system of the Department of Statistics of the hospital. The data abstraction form was piloted to ensure agreement and consistency between abstractors before use.

3.6.1 Quality control

To ensure accurate information had been extracted, the principal researcher checked abstracted data independently and oversaw the whole data retrieval process**.** The data extraction form was pre-tested, and to avoid replication of entry made, unique numbers were allocated to each record.

Data entry was duplicated, and data screened for errors, any discrepancies were resolved, and a backup file created which was shared with my supervisor.

3.6.2 Data management and analysis

The data extracted were reported on year-by- year basis. Therefore, the data from the various years were merged into one Excel data. The data were cleaned by ensuring uniformity in writing and information. The data, as contained in the Excel sheet was imported into Stata (version 16). Descriptive analysis was run using Stata (version 16) for consistent data as well as to ascertain that all the data conformed to total number of entries. This was done in terms of person, place and time**.** Continuous variables were evaluated and means documented together with the standard deviations. The ages of the children were classified into four groups as; below 1 year with subdivisions as below 6months and greater than 6 months to 1year; 1.1-2 years; 2.1-3 years and 3.1-4 years**.** This was done to highlight the trend in severity of pneumonia within the subgroups of under 5. The association between under 5 pneumonia occurrence and the independent variables was assessed using independent chi-squared test. The relationship between the outcome (dependent variable) and the independent variables (the predictor variables) was assessed using logistic regression models. Variables from the Chi-squared test were included in the logistic regression**.** For the multivariate regression analysis, pairwise deletion method was used to cater for missing data. This method was important as its usage saved more data and did not distort the findings. Statistical significance was set at $p<0.05$ (95% confidence interval).

3.7 Ethical Consideration

Ethical issues involved in the study were addressed as follows:

Ethical clearance

Ethical clearance was given by the Ghana Health Service Ethics Review Committee.(Identification Number: GHS-ERC 040/09/21).

Approval from study area

An introductory letter to seek permission administratively from the Medical Director of the GARH was obtained from the School of Public health, University of Ghana.

Description of subjects involved in the study

The study collected data on children under 5 who attended the GARH between 2016 and 2020. Privacy of the data was paramount because it was obtained from personal records on vulnerable participants (children younger than 5 years). Data protection regulations in Ghana, encompassing the Data Protection Act, 2012 (Act 843) in Ghana was adhered to in the research. The national protocol provided regarding personal information; data collation, usage, disclosure and care.

Potential risk /benefits

The researcher did not anticipate any risk to the study subjects whose data were extracted. The collated data was cumulatively presented to protect the identity of the selected study subjects.

Privacy/confidentiality

The study ensured that the privacy of the children was strictly protected and respected. Names of children under five years was not included in data collection and analysis.

Data storage and usage

The data extracted was saved in Microsoft Excel and in a password protected google drive, which was shared with my supervisor. Analyzed data was saved in iCloud and kept under protected password with the student and supervisor being the only ones having access to the password**.**

Information dissemination

The authorities of the hospital were guaranteed that the children's identities would be protected while reporting the findings. The observations from this study are important in delivery of efficient healthcare services, management of resource and curtailing under-five pneumonia morbidity and mortality.

Declaration of conflict of interest

There was no conflict of interest.

Funding information

This study did not receive any financial support..

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction

This chapter shows the results from the data analysis. It is presented under five main sections/headings. Section one presents the socio-demographic characteristics of children, followed by Section two on trend in pneumonia cases by age, sex and place. Section three presents the trend in pneumonia case fatality in children under five years, section four presents the factors influencing pneumonia in children under five years and section five presents the relationship between immunization status and severity, course and outcomes of pneumonia in children under-fives.

4.2 Socio-demographic characteristics of children under five years

The results showed that the reported number of confirmed cases of pneumonia in children under the age of five years from 2016 to 2020 was 1,901. Details of the characteristics of the patients in terms of socio-demographic variables have been presented in Table 4.1. Among children under 5 with pneumonia, children aged less than 6 months reported the most cases of pneumonia; in 2017, 147 (48.4%), 186 (52.3.%) in 2018 ,135 in 2019 (47.9%) and 168 in 2020 (35.6%) compared with the other categories. However, in 2016, more cases of confirmed pneumonia were reported in children aged 1-2 years (40.4%) than in children aged less than 6 months (38.0%).

From the table, it is clearly seen that the proportion of the confirmed pneumonia cases was higher in males than females throughout the reporting years. The highest cases of pneumonia were recorded in 2016 with 279 (57.3%) for males and in 2020, 220(46.5%) for females. By year, the

least number of confirmed cases of pneumonia were recorded in 2017 with 168 (55.3%) for males and 2019 ,136 (38.7%) for females.

Majority of the confirmed pneumonia cases in 2016 from peri-urban communities (312 cases) representing 64.2%. The occurrence of confirmed pneumonia cases in urban communities followed a fluctuating trend over the years; a decrease in the number of cases from 174 (35.8%) in 2016 to 100 (32.9%) in 2017. However, in 2018, the reported cases of pneumonia increased to 144 (39.0%).

Table 4.1: Socio-demographic characteristics of children under five years reporting to the GARH with pneumonia from 2016 to 2020

	Year of Pneumonia Cases				
	2016	2017	2018	2019	2020
	n (%)	n (%)	n (%)	n (%)	n (%)
Age					
< 6 months	185 (37.99)	147 (48.36)	186 (52.25)	135 (47.87)	168 (35.59)
6months – 1 year	94 (19.30)	47 (15.46)	52 (14.61)	55 (19.50)	68 (14.41)
1 – 2 years	102 (20.94)	58 (19.08)	61 (17.13)	60 (21.28)	91 (19.28)
2.1 – 3 years	79 (16.22)	36 (11.84)	39 (10.96)	27 (9.57)	99 (20.97)
3.1 – 4 years	27 (5.54)	16 (5.26)	18 (5.06)	5 (1.77)	46 (9.75)
Total	487 (100)	304 (100)	356 (100)	282 (100)	472 (100)
Sex					
Female	208 (42.71)	136 (44.74)	174 (48.88)	109 (38.65)	220 (46.51)
Male	279 (57.29)	168 (55.26)	182 (51.12)	173 (61.35)	253 (53.49)
Total	487 (100)	304 (100)	356 (100)	282 (100)	473 (100)
Location					
Urban	174 (35.80)	100 (32.89)	115 (40.64)	86 (38.05)	144 (39.02)
Peri-Urban	312 (64.20)	204 (67.11)	168 (59.36)	140 (61.95)	225 (60.98)
Total	486 (100)	304 (100)	283 (100)	226 (100)	369 (100)

4.3 Trend in cases of pneumonia in children under five years

This section presents the trend in pneumonia cases by age, sex, and place. These findings are presented graphically as follows:

4.3.1 Trend in pneumonia cases by age in children under five years

Generally, there is increasing cases of pneumonia among children <6months compared to other ages across the five years period (Figure 4.1). The case of pneumonia in children <6months was highest in 2018,that is 186 (52.3%) which was followed by 2017,147 (48.4%). The percentage of pneumonia cases was lower in 2016 that is,185 (38.0%) compared to 135 in 2019 (47.9%). The percentage of pneumonia cases declined from 47.9% in 2019 to 35.6% in 2020.

Children aged 3.1 – 4 years recorded the least cases of pneumonia compared to the other age categories across the five years period. However, the cases of reported pneumonia among this age category varied across the years. For example, the reported cases of pneumonia had decreased from 2016 to 2019 but rose in 2020. Specifically, the reported cases of pneumonia decreased from 27 (5.5%) in 2016 to 16(5.3%) in 2017. In addition, there was a decrease of pneumonia cases from 18(5.1%) in 2018 to 5(1.8%) in 2019. However, there was a 9.0% increase in pneumonia cases in 2020. (Figure 4.1)

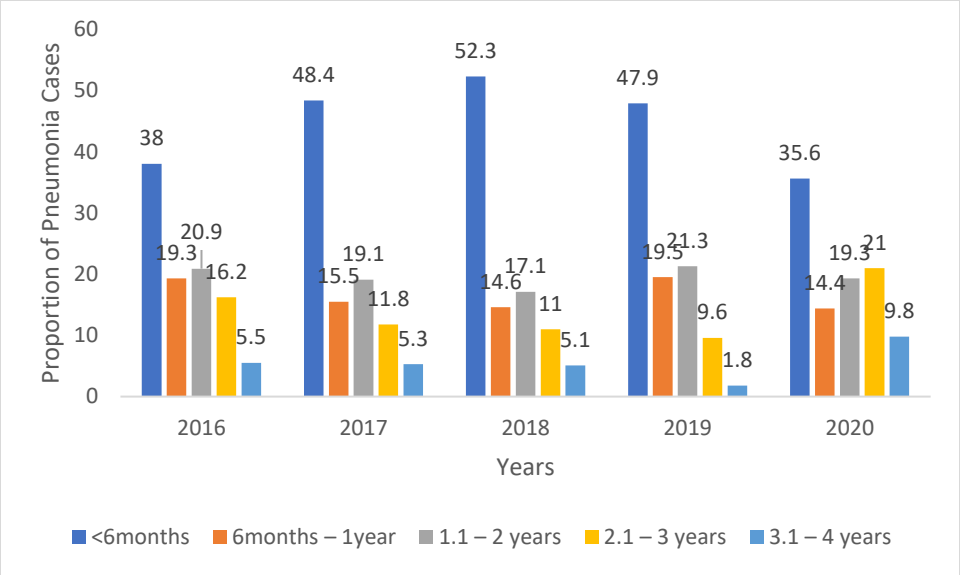


Figure 4.1:Trend in pneumonia cases by age of children under five reporting with pneumonia to the GARH from 2016 to 2020

4.3.2 Trend in pneumonia cases by sex in children under five years

Figure 4.2 shows the trend in childhood pneumonia cases by sex of those younger than five years. The number of reported pneumonia cases over the years have reduced more in male children than in female children. For example, the reported cases of pneumonia in male children decreased in 2016 from 279(57.3%) to 168(55.3%) in 2017 and 182(51.1 %) in 2018. In 2019, there was an increase from 173(61.4%)but declined sharply in 2020 to 253 (53.5)%.

The trend in pneumonia cases among female children assumed an increasing order from 2016 to 2018. Thus, the reported percentage of cases of pneumonia increased from 208(42.7%) in 2016 to 136(44.7%) in 2017 and 176(48.9%) in 2018. However, there was a sharp decline in 2019 109(38.7%), which was followed by a 7.8% increase in pneumonia cases in 2020 among female children.

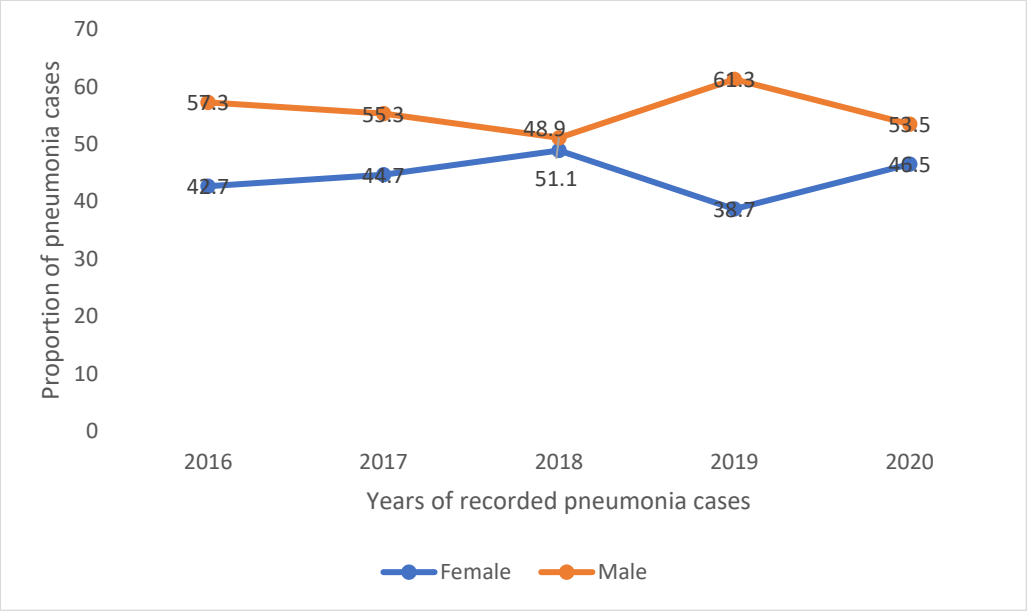


Figure 4.2:Trend in Pneumonia cases in children under five by sex reporting to the GARH from 2016 to 2020

4.3.3 Trend in pneumonia cases by Place of residence in children under five years

Comparably, children who lived in peri-urban communities were more affected with pneumonia than children who lived in urban communities. This is shown in Figure 4.3. However, the reported cases of pneumonia in children from peri-urban communities varied from year to year. There was an increase in reported cases in 2016 from 64.2%(312) to 67.1%(204) in 2017. However, there was a decline in 2018, 168 (59.4%) compared to 2017. In 2019, there was a 2.5% increase in reported cases. However, there was a minute reduction in the figure for reported cases in 2020.

A remarkable variation in the number of pneumonia cases was documented in children from urban communities. The number of reported pneumonia cases decreased from 174(35.8%) in 2016 to 100(32.9%) in 2017. However, there was an increase in the reported cases of pneumonia in

2018;115(40.6%) compared to 2017. In 2019, patients with pneumonia dwindled to 86(38.1%) compared to the increased number of reported cases in 2020;144 (39.0%). (Figure 4.3).

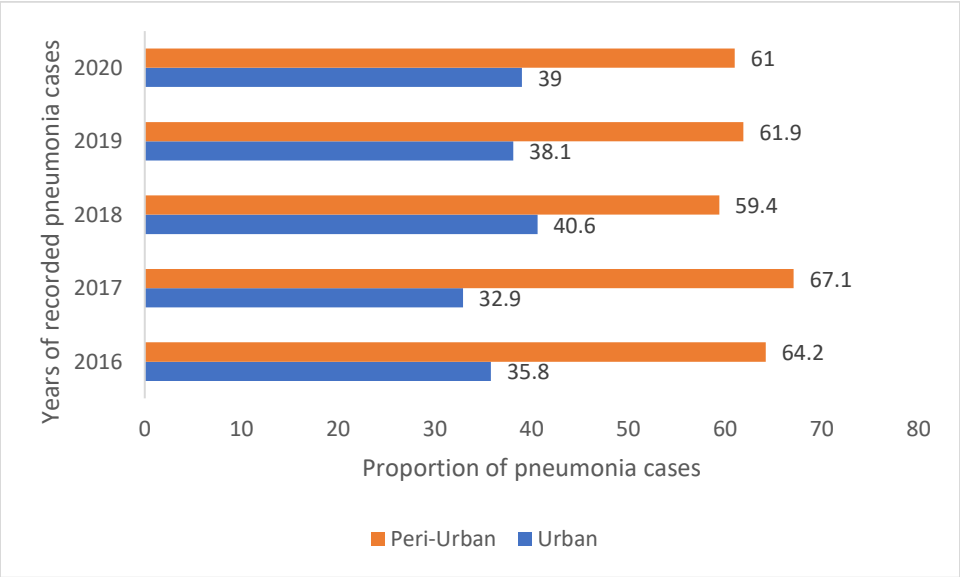


Figure 4.3: Trend in Pneumonia cases in children under five by place of residence reporting to the GARH from 2016 to 2020

4.4 Trends in case fatalities of pneumonia in children under five years

Mortality of children under-five with pneumonia saw a rise from 2016 to 2017 (that is from 13.5% to 16.8%), a rapid decline in 2018 to 9.4% (lowest among the reported years) and a rather unfortunate peak to 18.0% (highest among the years reported) and then a downslope in 2020 to 11.8%.(Figure 4.4)

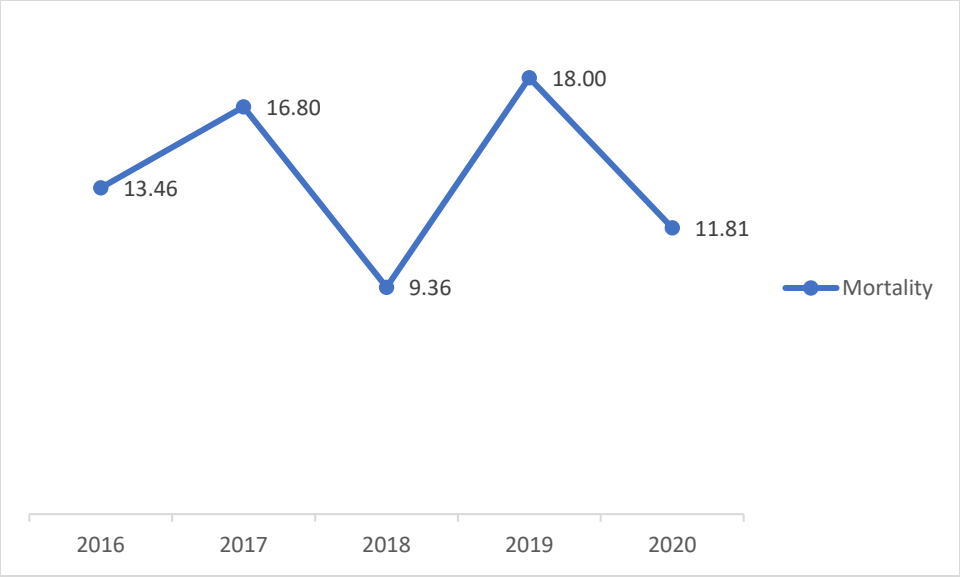


Figure 4.4:Trend in Pneumonia mortality of children under five reporting to the GARH from 2016 to 2020

4.5 Factors that influence the outcome of pneumonia in children under five years

Patients seen and admitted for pneumonia had two outcomes; discharge or death. A number of factors influence pneumonia outcome in cases aged below five. Table 4.2 shows that age of child, location of child and immunization were statistically associated with pneumonia outcome.

Results from the data collected over the 5year period showed that children under 6months of age were the most admitted age group for pneumonia with a total of 316 children. Out of this number,68 of them accounting for 21.5% died whiles 248(78.5%) were discharged. Next were the age group 1.1years to 2years who were a total of 141 with 3children(2.1%)dying and 138(97.9%) discharged. This was also followed by the 6months to 1year age group with 99 children admitted, out of which 10(10.1%) died and 89(89.9%) discharged. The 2.1year to 3year old group with a total of 83children out of which 8(9.6%) died and 75(90.4%) were discharged. The least group admitted were those aged 3.1 to 4years with 40 admitted,2 deaths(5%) and 38(95%) discharged.

Overall , more children were discharged than those who died, and these outcomes were statistically significantly associated with age ($x^2 = 37.7571, p < 0.001$) .

Also, the results showed that more males 361(53.2%)were admitted as compared to females 318(46.8%)out of a total of 679children .Out of this number,91 children died (13.4%)whiles 588children(86.6%) were discharged. More males than females were discharged and also, died .274 females accounting for 86.2% were discharged whiles 44(13.8%) died. Among males, 314(87.0%) were discharged whiles 47(13.0%) died .The factor' sex' was however not statistically associated with pneumonia outcome.

Furthermore, based on the place of residence or location ,72 out of a total of 436children (16.5%) of those who live in peri-urban areas died as compared to 19 out of 243children(7.8%) from urban areas and this association was also significant statistically($x^2 = 10.1640, p = 0.001$).

Additionally, out of a total of 679children, 569 equivalent to 86.8% were completely immunized whiles 90children (13.3%) had incomplete immunization for age. Out of those who were completely immunized,524 (89.0.%) were discharged after being managed for pneumonia .However,65of them(11.0%) unfortunately died from pneumonia. Comparatively, out of the 90 children who were incompletely immunized for age, 64 of them(71.1%) were discharged whiles close to a third of this proportion, that is 26children(28.9%)died .The results showed a statistically significant association between a child's immunization status and pneumonia outcome($x^2 = 21.4409, p = 0.001$).

In relation to seasonal variation,323 children(47.6%) were admitted in the dry season, whiles 356 children(52.4%) were admitted in the wet or rainy season.279(86.4%) of those admitted in the dry

season were discharged while 44 of them(13.6%) died. On the other hand,309(86.8%) of those admitted in the rainy season were discharged whiles47(13.2%) died. Overall, the results did not show a statistically significant association between seasonal variation and pneumonia outcomes.

Table 4.2: Pneumonia outcomes in children under five with associated influencing factors reporting to the GARH from 2016 to 2020.

	Pneumonia Outcome				
	n (%)	Died, n (%)	Discharged, n (%)	Chi-square	p-value
Age				37.7571	<0.001*
<6months	316 (46.54)	68 (21.52)	248(78.48)		
6months – 1 year	99 (14.58)	10 (10.10)	89(89.90)		
1.1 – 2 years	141 (20.77)	3 (2.13)	138(97.87)		
2.1 – 3 years	83 (12.22)	8 (9.64)	75 (90.36)		
3.1 – 4 years	40 (5.89)	2 (5.00)	38 (95.00)		
Sex				0.1973	0.255
Female	318 (46.83)	44(13.84)	274(86.16)		
Male	361 (53.17)	47(13.02)	314(86.98)		
Location				10.1640	0.001*
Urban	243 (35.79)	19(7.82)	224(92.18)		
Peri-Urban	436 (64.21)	72(16.51)	364(83.49)		
Immunization status				21.4409	<0.001*
Complete	589 (86.75)	65 (11.04)	524 (88.96)		
Incomplete	90 (13.25)	26 (28.89)	64 (71.11)		
Seasonal variation				0.9857	0.287
Dry Season	323 (47.57)	44 (13.62)	279 (86.38)		
Wet Season	356 (52.43)	47 (13.20)	309 (86.80)		

*p<0.05 [+]Row totals

4.6 Logistic Regression of Factors Associated Pneumonia in Children under five years

The multiple logistic regression of determinants of under 5 pneumonia is shown in Table 4.3.

As compared to children aged <6months,the results showed that there was 2.23 times increased odds of developing pneumonia in children aged 6months to 1year,12.17 times increased odds in those aged 1.1 to 2years,2.31 times increased odds for those aged 2.1 to 3years and 3.61 times increased odds of developing pneumonia for those aged 3.1 to 4years respectively.

The odds of suffering from pneumonia was significantly increased by nearly 13 folds among children aged 1.1 – 2 years compared to the other age groups (COR=12.61; 95%CI=3.90, 40.84). This association was statistically significant after adjusting for all other variables. Thus, children who are aged 1.1 – 2 years were 12.17 times more likely to suffer from pneumonia than other children in the respective age categories (AOR=12.17; 95%CI= 3.73, 39.70; p<0.001). Males under five years had 0.91times higher odds of developing pneumonia than females under 5.This was however realised not to be statistically significant(AOR=0.91;95%CI=0.56,1.46;p=0.691).

Children who lived in peri-urban communities had 57% reduction in their odds of suffering from pneumonia as compared to children who lived in urban communities (COR=0.43, 95%CI=0.25, 0.73; p=0.002). This association was found to be statistically significant after all other variables were adjusted for. (AOR=0.48; 95%CI=0.27, 0.84; p=0.010). Thus, the odds of contracting pneumonia among children who live in peri-urban communities was significantly reduced by 52% compared to those that live in urban communities.

Furthermore, there was a statistically significant increased odds of about 3.14 folds of developing pneumonia among children with incomplete immunization for age compared to children who are completely immunized (COR=3.28, 95%CI=1.94, 5.53; p<0.001). This association was found to be statistically significant after adjusting for all other variables (AOR=3.12; 95%CI=1.79, 5.51; p<0.010). Thus, the rate of contracting pneumonia among children with incomplete immunization was significantly increased by 3 folds compared to those that had completed immunization.

Finally, the results showed that there was 1.28 times increased odds of children under 5 developing pneumonia in the wet season than in the dry season which was not found however to be statistically significant. (AOR=1.28,95%CI=0.80,2.06; p=0.301).

Table 4.3: Multiple Linear Regression of factors associated with Pneumonia outcome in children under five reporting to the GARH from 2016 to 2020 .

	Pneumonia Outcome			
	95% AOR	p-value	95% COR	p-value
Age				
<6months	1.00		1.00	
6months – 1 year	2.23(1.08, 4.59)	0.030*	2.44 (1.20, 4.95)	0.013*
1.1 – 2 years	12.17(3.73, 39.70)	<0.001*	12.61(3.90, 40.84)	<0.001*
2.1 – 3 years	2.31(1.04, 5.14)	0.039*	2.57 (1.18, 5.59)	0.017*
3.1 – 4 years	3.61(0.82, 5.93)	0.090	5.21 (1.23, 22.14)	0.025*
Sex				
Female	1.00		1.00	
Male	0.91 (0.56, 1.46)	0.691	1.07 (0.69, 1.67)	0.755
Location				
Urban	1.00		1.00	
Peri- urban	0.48 (0.27, 0.84)	0.010*	0.43 (0.25, 0.73)	0.002*
Immunization status				
Complete	1.00		1.00	
Incomplete	3.14 (1.79, 5.51)	<0.001*	3.28 (1.94, 5.53)	<0.001*
Seasonal variation				
Dry season	1.00		1.00	
Wet season	1.28 (0.80, 2.06)	0.301	1.04 (0.67, 1.61)	0.873

*p<0.05 AOR=Adjusted Odds Ratio; COR=Crude Odds Ratio; CI=Confidence Interval

4.7 Relationship between immunization status and severity of pneumonia in children under five.

Using the International Classification of Diseases-10(ICD-10),the cases of pneumonia were classified under two categories; Type of pneumonia and Severity of pneumonia.

For type of pneumonia, it was sub-divided into Bronchopneumonia and Others whiles pneumonia severity was sub-divided into Mild to moderate disease and severe pneumonia. For those who had completed immunization for age, Bronchopneumonia formed majority of pneumonia cases seen with a total of 383children (65.0%) whiles other types were 145(24.6%) in number.19children (3.2%) had mild to moderate pneumonia whiles 42 children accounting for 7.1% had severe disease.

However, for those who had incomplete immunization for age, 59children (65.6%) had bronchopneumonia and Other pneumonia types were a total of 23(25.6%),none had mild to moderate disease with 8children(8.9%) developing severe pneumonia.

There was a statistically significant association between immunization status and severity of pneumonia outcome ($x^2 = 8.2621, p = 0.044$). More specifically, children with incomplete immunization status were more likely to suffer from severe pneumonia (8.9%) compared with children with complete immunization (7.1%).

Table 4.4: Relationship between immunization status and severity of developing pneumonia in children under five who reported to the GARH from 2016 to 2020.

	Diagnosis of Pneumonia					
Immunization status	Bronchopneumonia, n (%)	Others, n (%)	Mild to moderate n (%)	Severe, n (%)		
					Chi-square	**p-value**
Complete	383(65.03)	145(24.62)	19(3.23)	42(7.12)	8.2621	0.044*
Incomplete	59(65.56)	23(25.56)	0(0.00)	8(8.88)		

*p<0.05

CHAPTER FIVE

5.0 DISCUSSION

5.1 Introduction

This study assessed the trend in pneumonia in under -5 aged children attending the Greater Accra Regional Hospital from 2016 to 2020. This was a retrospective analysis of cases of pneumonia from records of children within the age group.

5.2 Trend in cases of pneumonia in children under five by sociodemographic factors

Findings from the study revealed that children aged 3.1 – 4years recorded the least cases of pneumonia over the five years period compared to those < 6months who had the highest number of cases. The finding is in tandem with a study by Koch et. al in 2003 that concluded that the risk of pneumonia is highest in children aged up to 12 months.(Koch et al., 2003).Similarly, the findings agree with a report by Shah et al. (1994) that the risk of acute respiratory infection, such as pneumonia, is highest in younger children.(Shah et al., 1994). Again, the finding resonates with a study by Thamer and Ban (2006) which concluded that children below 2 months old are significantly at risk of severe acute respiratory infection such as pneumonia. (Thamer & Ban, 2006).The similarities of the findings from the current study with literature could be due to the possibility of incomplete and/or under developed immune system for children under 6 months. The under developed immune system of these children makes them unable to fight infections with their natural defenses. Another reason for the increased risk of pneumonia in infants less than 6 months is the possibility of a narrow airway and relatively short bronchial tree. Considering that bronchial tree is the channel of air to the lungs, the organ in charge of breathing, there is the

possibility that the tubes swells and fills with mucus when infected with pneumonia further making breathing difficult.

The findings also revealed that the number of reported pneumonia cases over the five years period have reduced more in male than in female children with more male children reported to be at risk of pneumonia. The finding agrees with a study by Falagas et al. (2007) which revealed females were noted to be commonly affected with upper respiratory tract infections whiles males were affected with lower respiratory tract infections like pneumonia, with a rather more severe disease course running in males increasing their risk for morbidity and mortality. (Falagas et al., 2007).

Also, the findings from the present study is in agreement with findings from an observational case control study conducted in Alexandria, Egypt with the focus of pneumonia in children under five, which reported an increase in trend among toddlers with males at increased risk of pneumonia than females. (Fadl et al., 2020).and also in congruence with findings from another study which reported an excess risk of boys (males) in contracting pneumonia compared to girls (females). This may be ascribed to the bias in accessing care for males than females. Another possible reason for the findings is the genetic make-up of females. More specifically, the production of macrophages boosted by the presence of female sex hormone oestrogen which is the 'first response' to killing bacteria in the lungs.

Again, the findings revealed that children who live in peri-urban communities were at higher risk of developing pneumonia than those living in urban communities. The finding corroborates that acute lower respiratory infection, such as pneumonia, incidence rates vary markedly between

urban and rural children .In a study involving rural and urban community in India, care seeking for pneumonia among children was found to be abysmal . The Indian National Family Health Survey-3 showed that 64.2% of children only with either fever or ARI were sent to a health facility. Rural areas had substandard care-seeking behavior (59.2%) as opposed to urban areas. (Minz et al., 2017).The similarity in the findings could be due to increased transmission due to overcrowding and poor sanitation which is accompanied mostly by air pollution from dusty roads and indiscriminate burning of waste and due to better access to healthcare in urban than peri urban centers.

Additionally, the finding is consistent with a study by Cardoso et al. (2004) who found out that children with pulmonary disease were from homes with poor hygiene unlike controls.(Cardoso et al., 2004). In China, A study to assess pneumonia mortality amongst children less than 5 years found that the overall fraction of pneumonia to total deaths depreciated from 24.4% with the rural community to 13.2% and inner-city areas decreased to 9.7% from 11.1%.(He et al., 2015). The similarities in the findings can be attributed to the particulate matter that are discharged into the environment by poor sanitary practices, therefore, children with immature and/or under-developed immune system, when they inhale such air, exposes them to the risk of contracting pneumonia.

5.3 Trend of Case Fatalities of Pneumonia in Children Under Five Years

There was a substantial increase in case fatalities from 13.5% in 2016 to 16.8% in 2017. However, a steep decrease in the cases that died from pneumonia from 16.8% to 9.4% in 2018 and a further increase of 18.0% in 2019,then,reduced case fatalities in 2020 (11.8%). The fluctuating trend in the case fatalities of pneumonia can be attributed to several risk factors including incomplete

immunization, crowded households among others. This is consistent with a study which assessed predisposing factors for severe acute lower respiratory infections in children in the under-5 age group and reported that factors such as indoor air pollution exposure, insufficient exclusive breastfeeding, overcrowding with over 7 people in each household, partial immunization, influence pneumonia in children under five years (Jackson et al., 2013).

Another contributing factor to the fluctuating pattern in the mortalities seen is their place of residence. This is consistent with a descriptive study using a population in China that scrutinized the under 5 mortality trends. It disclosed that, deaths in under-five years of age dropped by 59.5% (from 11.09 to 4.49 per 1000 livebirths)in urban and 65.8% (from 19.30 to 6.61 per 1000 livebirths) in rural areas.(Zhang et al., 2015). A possible explanation for the mortality rate in 2019 (18.0%) could be from the surge in the number of cases of covid- 19 disease ,a pandemic of the SARS-COV2 (Severe Acute Respiratory Syndrome-Corona virus 2 disease which started in December 2019 in China's city, Wuhan and ongoing at the time of writing this paper .As the disease presentation is similar to non-covid- 19 pneumonia, there may have been misdiagnosis of pneumonia resulting in a false inflation of overall pneumonia cases, hence case fatalities.SARS-CoV-2 has likely been implicated for many child pneumonia cases during the COVID-19 pandemic, even those lacking etiologic confirmation as clinical confirmation requiring polymerase chain reaction (which is benchmark for diagnosis) is expensive and therefore not always readily available as an investigative tool in Ghana .(Jimenez-García et al., 2021).

Also, some guardians of the children had to journey long distances since they lived farther from the Greater Accra Regional Hospital to access healthcare. They may therefore not have reached

the facility earlier to save their ailing children. Another possible explanation for the increased mortality of pneumonia could be due to the inability of guardians to complete the immunization process for their children resulting in an increased risk of developing severe pneumonia and hence the higher mortality risk and rate.

A decline in the case fatality rate from 2019 to 2020(18.0% to 11.8%) may have been due to the adherence to sanitary and public health measures put in place as Ghana's government's policies to control the spread of the pandemic (such as regular handwashing with soap under running water, cough and sneeze etiquettes, social distancing and bans placed on public activities) as well as surge of information available through research on the pathogenesis and management of the disease. These measures put in place also favour curbing the spread of many respiratory illnesses hence reducing the incidence and case fatalities of pneumonia.(Huang, 2021).

Another factor which could have influenced the outcome of this study is the quality of care received at the hospital. The GARH has over the years been upgraded to a tertiary care facility improving its services with availability of an ultramodern edifice, state of the art logistics and equipment as well as improved patient to highly competent healthcare worker ratio. Cumulatively, these contribute to better work output, reduced hospital stay and improved outcomes of patients under their care.

5.4 Factors Associated with Pneumonia in Children Under Five Years

Among the factors associated with pneumonia in under -fives, the multiple logistic regression model revealed that children aged 1.1 – 2 years were 12.17 times more likely to suffer from

pneumonia in contrast to the older age group (AOR=12.17; 95%CI= 3.73, 39.70; p<0.001). The result from the present study is similar to a study conducted in Ethiopia which concluded that children aged 2 to 11months old were 85% more likely to contract pneumonia in reference to the older age group.(Dadi et al., 2014) .Similarly, this in congruence with a research carried out in Pakistan that revealed pneumonia occurs highest in children below age 2.(Fatmi & White, 2002). Various studies among the Suruí Indians in Rondônia and the Guarani from the South and Southeastern regions of Brazil, also made evident that children under the age 1 were more likely to be hospitalized for pneumonia especially.(Douglas et al., 2007; Fraga & Portela, 2000).Their underdeveloped immunity and restricted immunization access make them liable to pneumonia and other infections.

Furthermore, there was a statistically significant increased odds of 3 folds of contracting pneumonia among children with incomplete immunization compared to children who are completely immunized (AOR=3.12; 95%CI=1.79, 5.51; p<0.010). The result of the present study is consistent with a study which set about finding alterable lower respiratory tract infections (ALRI) risk factors in children aged 1 month to year 5 and reported them as partial immunization, early weaning, malnutrition, biomass fuel pollution and poor ventilation.(Savitha et al., 2007). The similarity in the findings corroborate that an able-bodied child's immunity guards him or her pneumonia, thus, complete immunization is essential. This is because an immunosuppressed child is more likely to develop pneumonia. Another explanation for the similarity in the findings is that children who are not completely immunized when exposed to 'harsh' environmental conditions, like congestion and air pollution indoors, are most likely at risk of contracting pneumonia.

5.5 Relationship between Immunization and Severity of Pneumonia

The study results showed a statistically significant association between immunization status and severity of pneumonia outcome ($x^2 = 8.2621, p = 0.044$). More specifically, children with incomplete immunization status were more likely to suffer from severe pneumonia (8.9%) compared with children with complete immunization (7.1%).This may be due to the immunity provided as the vaccine stimulates antibody production in the child's body, enhancing protection to fight against infectious agents when exposed to them and therefore reducing likelihood of severe outcomes of pneumonia. The vaccine protects against many but not all causes of pneumonia and therefore a child may still therefore develop pneumonia due to other interplaying factors as mentioned in the preceding text.

Findings from this study are in tandem with that done to investigate how prior influenza vaccination influences disease severity and deaths in patients with community-acquired pneumonia (CAP). From a multivariate analysis of association between vaccination status and outcome parameters in an observational, multicenter cohort study started by the German competence network for community acquired pneumonia where patients were analysed separately assessed as influenza and off-seasons cohort, it was observed that , immunised patients had substantially less severe pneumonia in the season group(2368 patients) based on the most analysed criteria (CURB index ≥ 1: OR 0.76, 95% CI 0.60-0.98; procalcitonin ≥ 2.0 ng/mL(-1): OR 0.53, 95% CI 0.35-0.81; procalcitonin ≥ 0.5 ng/mL(-1): OR 0.71, 95% CI 0.51-0.99) and these patients demonstrated improved survival within the 6-month follow-up period when followed up in 6months (HR 0.63, 95% CI 0.45-0.89). Within the off-season cohort (2,632 patients) , vaccination status did not greatly affect outcome of the disease. Previous influenza vaccination was inferred

therefore to relate with a mild clinical course and better longevity in persons with CAP during influenza seasons.((Tessmer et al., 2011).

Findings are however inconsistent with a study done by Martinez et. al in 2020 to assess the impact of pneumococcal conjugate vaccine on previously healthy children who were hospitalized for community acquired pneumonia. There was no remarkable dissimilarity in pneumonia severity of unvaccinated compared with vaccinated children.((Valdivielso Martínez et al., 2020).

5.6 Study Strengths and Limitations

The records on pneumonia cases over the five years period, as obtained from records and statistics department of the Greater Accra Regional Hospital was high, reducing bias in selection. The study population were selected carefully from the Greater Accra Regional Hospital records; hence, misclassification error was minimized. Data and results on pneumonia cases as well as trends over the five -year period among under 5 aged children was collected and disclosed objectively minimizing information bias, if it was not eliminated.

There were inherent limitations as the study was retrospective. Individual- based experience of a pneumonia could not be estimated rather the mean population exposures was used as proxy. Also, the research was done based on hospital records and therefore per data retrieved, community events transpiring before hospital admission such as duration of symptoms, community- based care, etc. could not be included for broader analysis.

Another limitation is that the records did not give the nutritional status of the children, hence excluded in the analysis. This may have caused bias because nutritional status has been reported in other studies to contribute to the risk of contracting pneumonia. The data revealed that, contrary to expectations of the GARH receiving pneumonia cases from within and around the Greater Accra region, participants were found to live mainly in the Accra Metropolitan Assembly, limiting analysis to peri-urban and urban areas only. This is one out of the over 197 metropolitan, municipal, sub-metropolitan and district assemblies. This means that the findings are localised to the Accra Metropolitan Assembly and therefore suggestive but cannot be extrapolated to the entire country.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study revealed a consistent comparatively increased number of pneumonia cases over the five years period in children aged especially less than 2years with males having an increased risk of pneumonia than females. Also, children living in peri-urban areas were more affected than those in urban areas. There was a decline in pneumonia mortality from 2016 to 2018 with a slight peak in 2019 and subsequent decline in 2020. There was a statistically significant association between one's age, place of residence and immunization status and developing pneumonia in under-fives. This therefore has implications on public health in the areas of intensifying education and coverage of immunization, environmental health strategies and clinical practice.

6.2 Recommendations

Based on the findings and conclusions, the following are recommended:

For clinical practice

- The Public and Child Health units of the Greater Accra Regional hospital should ensure their interventions for pneumonia be all year round but intensified in the wet season since most of the pneumonia cases and deaths are recorded within these months

For policy

- The Ministry of Health in conjunction with Ghana Health Service and other health organizations both local and international organizations should enforce sensitizing the public especially those living within the Accra metropolis about the risk factors, causes and prevention of under-five pneumonia.

- Also, the Ministry of health ,Works and housing and Environment should collaborate in reinforcing environmental protection laws and policies to reduce the menace of air pollution which contributes greatly to pneumonia mortality
- Community outreach programs should be intensified within the Accra Metropolis for mothers with children under five years with emphasis laid on those who fall within the 0 to 2-year age bracket and males.

For research

To expand research on existing serotypes of bacteria in current healthy population to inform a wider organism coverage of subsequent pneumococcal vaccines.

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APPENDIX A: Data Capture Sheet

Age range	**Patient folder**	**Age**	**Sex**	**Immunisation status**	**Diagnosis**	**Residence**	**Patient type**	**Outcome**
<6months	A	2 months	Male/ Female	Immunized/not immunized	Pneumonia	Gbawe	In-patient	Discharged Or died
6months-1year								
1.1-2years								
2.1-3years								
3.1-4years								