TRENDS AND FACTORS ASSOCIATED WITH ACUTE RESPIRATORY INFECTION AMONG UNDERFIVE CHILDREN IN ZAMBIA 1996-2014

By

NELIA LANGA

A thesis/dissertation submitted to the University of Zambia in partial fulfilment of the requirements of the award of the degree of Master of Science in Epidemiology

THE UNIVERSITY OF ZAMBIA

LUSAKA

2019

DECLARATION

I **Nelia Langa** declare that the work presented in this dissertation is my own work and that it has been produced in accordance with the guidelines for the Master of Science in Epidemiology dissertation for the University of Zambia. It has never been presented or submitted elsewhere in part or whole for the award of a degree or any qualification from any institution

Signature:
………………………………………………………………………………………..

Date:
……………………………………………………………………………………………

Copyright: All rights reserved; no part of this dissertation may be produced, stored in a retrieval system or transmitted in any form or by other means, electronic, mechanical, photocopy or recording without prior consent from the author

CERTIFICATE OF COMPLETION OF DISSERTATION

I, **Nelia Langa,** hereby certify that this dissertation is the product of my own work and in submitting it for the Degree of Master of Science in Epidemiology programme, further attest that it has not been submitted to any other university either in part or whole for the award of any degree

Signature: ………………………………………………………………………………..

Date: ……………………………………………………………………………….

I **Dr. Mpundu Makasa** having supervised this dissertation and is satisfied that this is the original work of the author under whose name is being presented. I confirm that the work has been completed satisfactorily and is ready for presentation to the examiners

Supervisor/signature: ………………………………………………………………

Date: ……………………………………………………………………………….

Department of Epidemiology and Biostatistics

APPROVAL

This thesis/dissertation by Nelia Langa has been approved as fulfilling the requirements for the award of Master of Science in Epidemiology degree by the University of Zambia

Examiner 1

Signature……………………………………………………………….

Date…………………………………………………………………....

Examiner 2

Signature………………………………………………………………

Date…………………………………………………………………....

Examiner 3

Signature……………………………………………………………….

Date…………………………………………………………………….

Chairperson Board of Examiners……………………………………….

Signature……………………………………………………………….....

Supervisor………………………………………………………………

ABSTRACT

Acute Respiratory Infection (ARI) is one of the leading causes of morbidity and mortality among children under the age of five years globally accounting for 16% of deaths. In Zambia, ARI accounts for 30-40% of children's outpatient attendance and 20-30% of hospital admissions. The study therefore sought to assess trends and factors associated with ARI using demographic health survey data from 1996 to 2014.

We conducted a cross-sectional secondary analysis of Zambia Demographic and health survey data from 1996, 2002, 2007 and 2014 involving under five children and their mothers. We extracted data using a data extraction tool from the women's file and prepared for analysis. We assessed trends using chi-square for trends. We conducted a complex survey logistic regression analysis using STATA version 14.0 and reported adjusted odds ratios (AOR) 95% confidence intervals (CI) and p-values.

The highest prevalence of ARI was in 2002 and a drop in 2007 and 2014 (Non-Parametric-trend p-0.001). Occurrence of ARI was associated with nutritional status, underweight children were more likely to develop ARI (Adjusted odds ratio [AOR] 1.50 95% [confidence interval] CI 1.25 – 1.68) compared with children who were not. Use of cooking fuels such as charcoal and firewood were associated with high odds for ARI compared to electricity use (AOR 2.67 95%CI 2.09 – 3.42 p-<0.001 and 2.79 95%CI 2.45 -3.19 p<0.001) respectively. Children with co-morbidities such as malaria and diarrhea (AOR 5.85 95%CI 5.01 – 6.64 p-<0.001 and AOR 1.45 95%CI 1.25 – 1.68 p-<0.001 respectively) compared to those who did not have. ARI was less likely among children with mothers who had secondary or higher education (AOR 0.30 95% 0.15-0.58 p-<0.001). Receiving micronutrients such as vitamin A was protective from ARI (AOR 0.46 95%CI 0.40 – 0.52).

Interventions to reduce the burden of ARI should be targeted at health promotion and sensitization of mothers to avoid crowded places, use of cooking fuels such as firewood and charcoal as well as seeking healthcare early should signs of ARI occur. Furthermore, vaccination monitoring and ARI surveillance should continue in the community and health facilities in order to identify high burden areas.

Key terms: ARI Under-five children Underweight Factors Trends Co-morbidities Zambia

ACKNOWLEDGEMENT

My supervisors Dr. Mpundu Makasa, Dr. Ntazana Sinyangwe and Danielle Barradas for the encouragement and guidance during the research work.

Ms. Chola N. Daka from the Central Statistical Office, Dr. Mushota Kabaso from ZPCT, Dr. Vesper Chisumpa from the University of Zambia and Dr. Tom Pullum from measure DHS program for providing statistical guidance

The faculty staff from the University of Zambia, School of Public Health Department of Epidemiology and Biostatistics for the continued encouragement I would like to acknowledge the contributions of my classmate Francis Nanzaluka for peer reviewing the work

The Resident Advisor Dr. Ellen Yard and program manager of the Zambia Field Epidemiology Training Program Dr. Sinyange and staff from Zambia National Public Health Institute for their support and contributions during the preparation of the dissertation

DEDICATION

This dissertation is dedicated to my husband Dr. Jairos Mulambya and our children Salipa and Subilanji for their unwavering support during the period of the program. To my mother Mrs. Albertina Maureen Langa for the spiritual support and believing in me. Above all am grateful to God for giving the strength and keeping me alive. To the mothers and children of under five children, past present and future.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABREVIATIONS AND ACRONYMS

CSO	Central Statistical Office
CI	Confidence Interval
EA	Enumeration Areas
GAPD	Global Action for ARI and Diarrhoea
HMIS	Health Management Information System
ICCM	Integrated community case management
IMCI	Integrated Management of Childhood Illnesses
MCDMCH	Ministry of Child Development Mother and Child health
MDG	Millennium Development Goal
MoH	Ministry of Health
OR	Odds Ratios
PCV	Pneumococcal conjugate vaccine
DPTHibHepB	Diphtheria Pertussis Tetanus Haemophilus influenza type B Hepatitis B Vaccine
SDG	Sustainable Development Goal
UNICEF	United Nations Children's Emergency Fund
WHO	World Health Organization
ZDHS	Zambia Demographic Health Survey

CHAPTER 1

INTRODUCTION

1.1 Background

Pneumonia is one of the leading causes of morbidity and mortality among children under the age of five years globally. Pneumonia is defined as the infection of the lungs by a microbe is one of the serious manifestations of acute respiratory infections (ARI). The infection causes fluid and inflammatory waste to accumulate into the lungs, covering alveoli and inhibiting gaseous exchange in the lungs causing breathing problems (Hockenberry et al., 2013). It is characterized by cough, accompanied by short rapid and painful breathing leading to limited oxygen intake (Gereige and Laufer, 2013). ARI affects all age groups but is particularly life threatening in young children below the age of five years (Banda W, 2016, Banda., 2016) .

ARI can be caused by numerous pathogens such as bacteria, viruses, fungi, parasites and can be transmitted through various vehicles. ARI can result in various complications including ear, brain infections as well as septicemia and death if not recognized and treated early. (Pabary and Balfour-Lynn, 2013). Studies conducted in United Kingdom and Australia have also shown that children with repeated episodes of ARI may be more susceptible to chronic lung disease in adulthood (Grimwood and Chang, 2015).

Globally, ARI is the leading cause of death for children under the age of five and its control continues to top child health agenda. The World Health Organization estimates that more than 160 million children around the world develop ARI each year, 20 million of whom are hospitalized and 2 million of whom die (Walker et al., 2013). In 2015, there were 920,136 deaths among under five children globally due to ARI, accounting for 16% of all deaths in this age group. It is further estimated that seven out of ten deaths among under five children are due to ARI (WHO, 2016).

ARI remains a major killer of children under five years of age, and the highest under-five mortality rates are in low- and middle-income countries in sub-Saharan Africa and in Southern Asia accounting for almost half a million (490,000) of the deaths (Chopra et al, 2013; (WHO, 2016); UNICEF, 2016). Sub-Saharan Africa and South Asia accounts for the highest number of cases with each child having about 0.28 ARI episodes per child year while children in developed countries have as low as 0.05 episodes per year (Walker et al., 2013) (Grimwood, 2015).

More than half of the world's annual new ARI cases are concentrated in just five countries where 44% of the world's children aged less than 5years live: India (43million), China (21.1million), Pakistan (9.8million), Bangladesh (6.4million), and Nigeria (6.1million) (Yaguo Ide, 2011, Tong, 2013).

In Zambia, ARI remains among the leading causes of morbidity and mortality among children aged under five years (CSO et al., 2015). ARI, malaria and diarrhea remain among the major causes of under-five mortality in Zambia (MCDMCH, 2013). The Health Management Information System (HMIS) report of 2016, also shows ARI as the highest cause of morbidity among under five children in Zambia and the most frequent reason for health facility attendance (MoH, 2016).

ARI can be caused by numerous pathogens such as bacteria, viruses, fungi, parasites and can be transmitted through various vehicles. ARI can result in various complications including ear, brain infections as well as septicemia and death if not recognized and treated early. (Pabary and Balfour-Lynn, 2013). Studies conducted in United Kingdom and Australia have also shown that children with repeated episodes of ARI may be more susceptible to chronic lung disease in adulthood (Grimwood and Chang, 2015).

There are several other factors associated with ARI among under five children and these include socio-demographic, environmental health system related factors which may include exposure to infectious diseases, malnutrition, poor hygiene and sanitation, and unhealthy environments (Abuka, 2017d). Children living in developing countries in remote regions where poverty, hunger and poor access to healthcare have increased risk of developing respiratory infections such as ARI (Fonseca Lima, 2016). Little is known about the trends and factors associated with ARI among under five children at country level in Zambia.

1.2 Statement of the problem

Zambia's under-five mortality rate is at 75/1,000 live births. It is further estimated that 1 in every 22 children dies before reaching the age of 1 year while one in thirteen children does not survive the fifth birthday (CSO et al., 2015). Among the causes of death in this age group is ARI, which accounts for 15% of total deaths among under five children. It is responsible for more deaths than Malaria, Diarrhea and HIV combined (CSO, 2012).

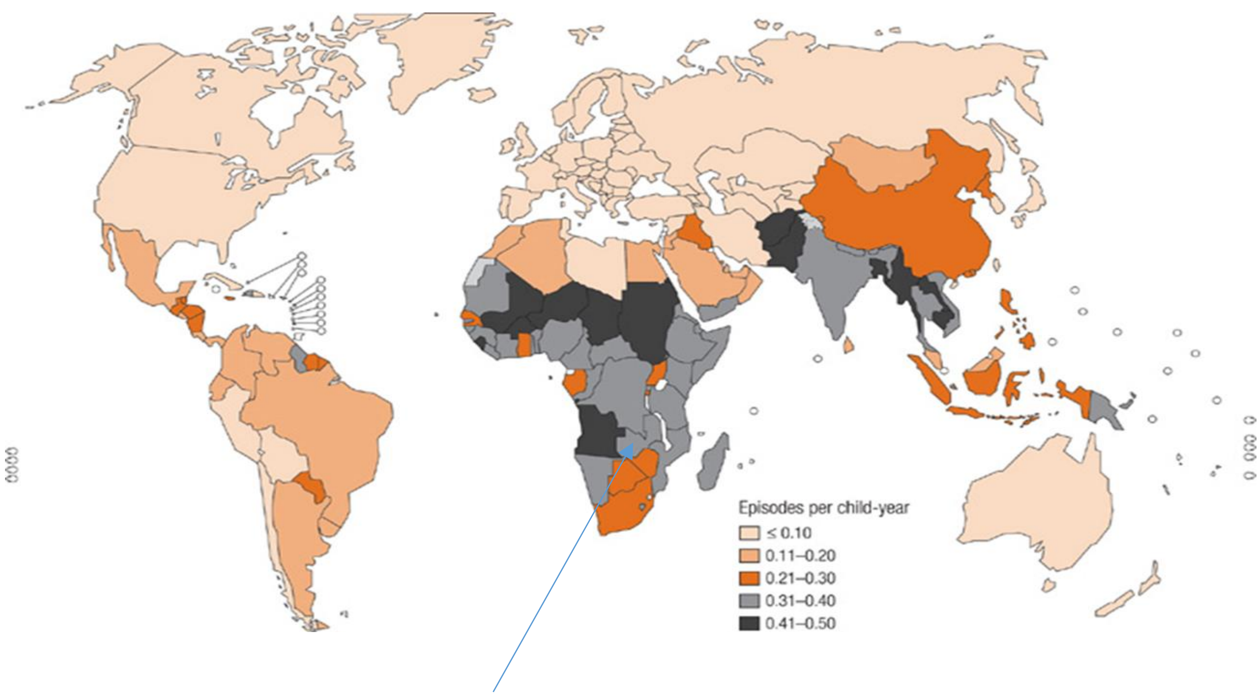
ARI remains among the three major causes of morbidity and mortality among under five children in Zambia and a major threat to child survival. ARI was still among major causes of childhood illnesses in two districts of southern province (Katepa-Bwalya, 2014). Twenty to forty percent of children's out-patient attendance and 20-30% hospital admissions in Zambia are due to acute lower respiratory infections (ARI) (Banda., 2016) (Mara, 2016). The Health Management Information system (HMIS) report of 2016 also cites ARI as one of the major causes of morbidity and mortality among under five children from all provinces (MoH, 2016). Although identified as such, ARI is among oldest, commonest childhood illness that is preventable and treatable world-wide (WHO, 2015).

Zambia adopted the integrated management of childhood illness (IMCI) and integrated community case management (ICCM) which are WHO strategies to try and address this major child killer in 1989 and 2010 respectively. The IMCI protocol helps teach health workers, caretakers and community health workers to identify and treat ARI. Some of the IMCI strategies include, case identification, case management with appropriate antibiotics as well as referral for further care. The ZDHS of 2014, shows that only 51% of children with ARI were treated with antibiotics although the percentage was higher in urban areas as compared to rural areas (70% urban versus 43% rural) (CSO et al., 2015).

ARI continues to be a major concern for UNICEF, WHO and other global partners as it continues to threaten child survival and achievement of sustainable development goal (SDG) number 3.2 which is focused on ending preventable child deaths. The WHO and UNICEF have launched the global action plan for ARI and diarrhea (GAPPD) which is aimed at providing strategies to end preventable child deaths (UNICEF, 2016).

Zambia is one of the countries which has signed to the WHO plan to end deaths due to ARI and diarrhea with a combination of interventions to protect, prevent and treat ARI along with countries such as Bangladesh, Kenya and Uganda. Identifying and targeting specific factors remains key in the successful control of ARI and diarrhea.

Several studies have been conducted in Zambia most of which have focused on risk factors for ARI among hospitalized children as well as etiology of ARI. Other studies have been conducted outside Zambia focusing on factors associated with ARI. Despite these interventions and strategies, ARI has continued to claim the lives of under five children. Therefore, there was need to study and assess the trends and factors associated with childhood ARI in Zambia using nationally representative data such as demographic health survey to effectively control ARI.



Map showing number of pneumonia episodes per child per year at country level: Zambia 0.31 – 0.40 episodes

Figure 1: Incidence of childhood clinical ARI at the country level in 2013 (WHO, 2013)

1.3 Justification

ARI has continued to be a major contributor to under-five mortality world-wide and in Zambia.

Although evidence overflows on the influence of socio-demographic and environmental factors on child health, very few studies have investigated these factors using the nationally representative data. The study therefore sought to investigate factors associated with childhood Acute Respiratory infection (a proxy for pneumonia). The study also aims to collate information on existing data and chart out the trends of factors associated with ARI from 1996-2014. Knowing the factors associated with ARI will help the country develop interventions which will be more specific to reduce the burden. Findings from this study may inform policy and the Ministry of Health in mapping up strategies which will help to reduce the country burden of ARI. The study findings will provide evidence which can be useful in identifying strategies to reduce child morbidity and mortality related to ARI and help the country achieve the targets set in the "every breath counts" campaign launched by UNICEF in 2016. The campaign is a renewed global call to reduce mortality due to ARI globally. The study will benefit the ministry of health child health unit and parents and caregivers countrywide by providing evidence on sociodemographic and service related factors associated with ARI among under five children in Zambia.

The findings of the study may also help service providers to renew health promotion strategies which equip mothers, caretakers and communities with information necessary for the successful prevention of ARI. By knowing factors associated with ARI in this setting, we will be able to develop interventions targeted at specific factors in order to reduce the burden of ARI among under five children.

1.4 Research Questions

What is the ARI prevalence trends among under five children in Zambia from 1996 to 2014?

What factors are associated with ARI among children under the age of five children in Zambia?

1.5 Objectives

1.5.1 General Objective

To assess trends and factors associated with ARI among under five children in Zambia from 1996 to 2014.

1.5.2 Specific objectives:

1. To determine the prevalence and trends of ARI among under-five children in Zambia
2. To identify socio-demographic, socio-economic and environmental factors associated with ARI among under five children in Zambia

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of ARI

ARI refers to inflammation of the lung tissue. The lungs are made up of small sacs called alveoli, which fill with air when a healthy person breathes. When an individual has ARI, the alveoli are filled with pus and fluid, which makes breathing painful and limits oxygen intake (Tong., 2013). ARI can be classified according to causative agent as bacterial, fungal, viral, protozoal and parasitic. It can also be classified anatomically according to the part of the lung affected, as Broncho ARI, Lobar ARI and Interstitial ARI (WHO, 2016). The most common organisms responsible for childhood ARIs are: *Streptococcus Aureus* – the most common cause of bacterial ARI in children; *Haemophilus influenzae* type B (Hib) – the second most common cause of bacterial ARI; respiratory syncytial virus is the most common viral cause of ARI; in infants infected with HIV, *Pneumocystis jiroveci* is one of the most common causes of ARI, responsible for at least one quarter of all ARI deaths in HIV-infected infants (WHO, 2016). ARI can be spread in a number of ways; the viruses and bacteria that are commonly found in a child's nose or throat can infect the lungs, if they are inhaled. They may also spread via air-borne droplets from a cough or sneeze (Hockenberry et al., 2013).

Clinical features of acute ARI include sudden onset of systemic disturbance, shortness of breath as a result of pleuritic chest pains, fever with temperatures ranging from 39-40°C, cough may be present although not a common feature in children. The respiratory rate may range between 50-60 breaths per minute and other respiratory features, such as flaring of nostrils, chest in drawing, and use of intercostal muscles (WHO, 2014).

The World Health Organization recommended treatment for ARI is antibiotic therapy with oral Amoxicillin. Children with fast breathing ARI with no chest in-drawing or general danger sign should be treated with oral amoxicillin: at least 40 mg/kg/dose twice daily (80mg/kg/day) for five days (WHO, 2014). The WHO guideline further recommends the use of amoxicillin for at least three days in areas with low HIV prevalence (WHO, 2014).

The WHO also encourage community level treatment of ARI by trained community health worker using dispensable Amoxicillin and hospitalization of severe cases (WHO, 2016).

2.2 Factors associated with ARI in under-five children

Socio-demographic factors

Maternal age

Maternal age is associated with an increased risk of children under the age of five years developing acute respiratory infection (ARI). A study conducted in Brazil showed a 2.5 times increase in children whose mothers or caretakers were less than 19years old (Fonseca Lima, 2016). Similar findings were shown in a study conducted in Thailand, were young maternal age that is a mother with age <18years was highly associated with ARI (IRR 1.59, 95%CI 1.12-2.27 p=0.001) as compared to older mothers (Turner et al., 2013). In Ghana a study on factors contributing to morbidity among under five children showed an association between mothers' age and acute respiratory infection. Children of mothers aged 25years and above were less likely to have ARI as compared to children of mothers aged 15-24years (OR=0.73, 95% CI=0.58, 0.92) (Amugsi et al., 2015).

The study by Pradhan et al (2016) in their study on knowledge and perceptions on ARI also showed significant relationship between maternal age, education level and perception of mothers on ARI (Pradhan et al., 2016).. On the contrary, in a study conducted in Ethiopia found no significant association between ARI and age of mother or caretaker despites most of the caretakers being below 35years (Gebretsadik et al., 2015).

Age of the child

A study conducted by Gedefaw et al (2014) on the prevalence of ARI in under five children in Este town Ethiopia showed that socio-demographic factors such as age, place of residence, education level, occupation of the mother and the father were significantly associated with ARI. The study further illustrated that ARI was more common in children aged 0-11 months as compared to those between 24-59 months. Children at age range of 2-12 months were 4 times more likely to develop ARI as compared to children at age range of 12-59 months (AOR=4.04 (95%CI)=(1.85, 8.80) (Gedefaw et al., 2014). The study conducted in Rwanda by Harerimana et al found similar results that children less than 12 months were more likely to develop ARI OR 0.53 (95% CI 0.40-0.69) (Harerimana et al., 2016a). A study conducted in Tanzania also showed that the Incidence and hospitalization rate of ARI decreased with age, with the highest rates found among children younger than one year and the lowest among children aged 4 (incidence: 4.25% vs 0.83%; hospitalization: 2.75% vs 0.36%). The incidence was slightly higher among boys than girls (2.92% vs 2.08%) (PrayGod et al., 2016). A study conducted by Abuka (2017) in Sidama zone Ethiopia also showed children aged 2-12 months were 2.5 times more likely to develop ARI compared to children aged 12-59 months (AOR 2.49 95% CI 1.37, 4.54) (Abuka, 2017a).

A study conducted by Jroundi and others cited more cases from the 12-24months age group although more severe cases occurred among the age group 0-11 months both from rural and urban areas (Jroundi et al., 2015). Children from households with no separate kitchens were 3.68 times more likely to develop ARI as compared to children from households with kitchen separate from the main home. On the contrary, the study by Harerimana (2016) did not show any association between carrying children on the back during cooking, instead children were looked after by other family members when mothers were preparing meals (Gedefaw et al., 2014).

Study findings from Banda et al (2016) in Ndola Zambia and Onyango et al, (2012) also showed that low socio-economic status and history of contact with respiratory infection in the family were strongly associated with ARI in children.

Environmental factors

Findings from a refugee camp in South East Asia showed an association between distance from the stove and the bed and ARI among under five children, the shorter the distance, the higher the risk (Turner et al., 2013)

Environmental factors such as air pollution, use of public transport, type of kitchen and cooking fuel used were also associated with ARI in under five children. A study conducted in Morocco also showed an increased risk for ARI among children who lived in homes with smokers (OR 1.79 95%CI 1.18-2.72 (Jroundi et al., 2015). A study conducted in Ethiopia by Fekadu et al (2014) showed a strong association between the use of charcoal or firewood with ARI in under-five children. Children whose mother/caretakers utilized charcoal or firewood for cooking were 7 times more likely to develop ARI (Adj. OR=7.41, 95% CI: 2.75-19.95). A study conducted in Gondar Ethiopia also showed that children living in households using high pollution biomass had higher odds of developing Acute respiratory infection compared to children living in households using low pollution fuels LPG/ natural gas or electricity for cooking (OR = 5.86, 95% CI: 1.46, 23.53) (Alemayehu et al., 2014) . It was further noted that carrying children on the back while cooking increased the episodes of ARI in the children. Harerimana et al in a study conducted in Rwanda showed that children being with other family members during cooking was protective against ARI. The study by Harerimana also drew an association between rainy season and ARI among under five children. They attributed the finding to the overcrowding associated with wanting protection from the rain.

Other environmental factors associated with ARI among under-five children included housing and roofing material. The findings from the study by Fekadu et al (2014) also found a statistically significant association between type of roof and ARI among under-five children as children from houses with thatched roof 2.5 times likely higher compared to children who lived in corrugated iron roofed.

While the studies by Fekadu et al, (2014) and Onyango et al, (2012) found associations between carrying children on the back while cooking and ARI (Fekadu et al., 2015) the study carried out in Rwanda by Harerimana et al (2016) did not show findings. The study further showed an association between ARI in under-five children and crowding. Children from crowded homes had increased risk of transmission of illness. Kadek-Nira et al (2013) also noted insignificant associations between cooking fuel and ARI in under-five children. They also noted that families were big and children were cared for by other family members while their mothers cooked which reduced exposure to pollutants (Harerimana et al 2014).

Other environmental factors associated with ARI included weather patterns. A study conducted by Kim et al, (2016) on the effects of meteorological factors on the risk of ARI among under five children in Papua New Guinea, showed an risk of ARI in children by 0.24% (95% C I: ´0.01%–0.50%), per every 10 mm increase of rainfall and 4.88% (95% CI: 1.57–8.30) risk per every 1 °C increase of the monthly mean of the maximum daily temperatures (Kim et al., 2016).

There were more cases of ARI during the rainy season as was noted in the study in Rwanda and Ethiopia. The studies conducted in Ethiopia by Gedefaw et al (2014) and Abuka (2017) also attributed the findings to the use of firewood and charcoal indoors while trying to keep the homes dry and warm while Harerimana attributed the finding to overcrowding which occurs in most homes as they shielded from rain.

Another environmental factor noted in the study by Manya (2006) in Kenya was the type of floor. The study demonstrated an increased risk of 3 times for those children whose floor was not cemented as compared with those who resided in houses with cemented floors (matched odds ratio= 3.33, 95% C.I=1.48-7.33, p-value=0.004). Other environmental factors included use of public transport, a study by Banda et al 2016 in Ndola Zambia showed an increased risk of ARI and other ARIs in children who used public transport. An increased risk for ARI and ARI was also seen in children who lived in large families (Banda., 2016).

Care seeking behavior

A study conducted in Sierra Leone to assess care seeking among caretakers of under five children with ARI malaria and diarrhea showed an increase in care seeking due to a free health care initiative in the country. However despite the increase the study showed that almost 37 percent of children with ARI were taken to traditional healers (Diaz et al., 2013). A study conducted in Guatemala focused on determinants of care seeking for children with ARI and diarrhea showed perceptions of caregivers towards the illness as major barriers to care seeking. Twenty seven percent of the children with ARI were taken to health facilities 2 days after onset (Bruce et al., 2014).

Onyango et al (2012) revealed a delay on the part of mothers and care takers. The study demonstrated that a delay of 3 or more days of treatment was associated with 2.3 times risk for severe ARI. A study conducted in Uganda also demonstrated that a delay resulting from poor care seeking behavior was associated with severe ARI. The study further revealed that lack of caretaker's knowledge on danger signs were strongly associated with late presentation and severe ARI (Tuhebwe et al., 2014). Care seeking was also associated with ARI in the two studies as it showed that most mothers and caretakers did not know the danger signs of ARI. A study conducted by Noordam et al (2015), on care seeking patterns of six countries with highest ARI burden in sub-Saharan Africa. The study examined whether children with suspected ARI were taken for care, and type of care providers, using national survey data of 76,530 children. The study also assessed factors independently associated with care seeking from health providers, also known as 'appropriate' providers. The study showed important differences in care seeking patterns across these countries, with Tanzania showing 85% of children with suspected ARI were taken for care, whereas this was only 30% in Ethiopia. Most of the children living in these six countries were taken to a primary health care facility. In Uganda, hospital care was sought for 60% of children. 16–18% of children were taken to a private pharmacy in Democratic Republic of Congo (DRC), It was further noted that in Tanzania, children from the richest households were 9.5 times (CI 2.3–39.3) more likely to be taken for care than children from the poorest households, after controlling for the child's age, sex, caregiver's education and urban-rural residence (Noordam et al., 2015).

Duration of breast feeding

A study by Abuka, (2016) showed a significant association between occurrence of ARI and the duration of breast feeding. Children who fed breast milk less than one year had a 4.2 times higher chance of acquiring ARI as compared those who fed more than a year (AOR=4.2 (95%CI) (1.07, 16.6) (Moyo et al., 2018). Evidence showed that breastfeeding protects infants against infection and has protective factor for reducing risk of respiratory illness among infants.

Nutritional status

A study by Shahunja et al (2015) also demonstrated that obesity was associated with severe ARI in a study conducted in Bangladesh. The study showed that obese or overweight children were 4.9 times more associated with hypoxemia and severe ARI as compared to their normal weight counterparts (Shahunja et al., 2016). A study conducted in Nigeria on risk factors associated with ARI among under five children also cited malnutrition. ARI was noted in about 75.7% (56/74) of inadequately nourished children compared to 22.6% (82/362) in adequately nourished children (Ujunwa and Ezeonu, 2014a).

Another study conducted in Rwanda also showed that the nutritional status of the child was also associated with ARI in children compared to children with normal weight for height. Similar findings were seen in Ethiopia. Children who were severely malnourished were 1.7 times (95% CI; 1.1-2.7) more likely to develop ARI compared with children with normal weight for height (Gebretsadik et al., 2015).

Knowledge of mother/caretaker

There was an association between caregiver's knowledge and ARI as shown in by Pradhan et al (2016), studies conducted in India. It was further shown that lack of knowledge on the signs and symptoms also contributed to childhood ARI. A study conducted in Nigeria on the knowledge of care takers showed an association between mothers/caretakers level of education and knowledge on danger signs. The study further showed poor health seeking behavior among caretakers with low education (Ndu et al., 2015). These findings were similar to those by Tuhebwe (2014) and Onyango (2016) conducted in Uganda and Kenya respectively, who found that caretakers and mothers had inadequate knowledge on the danger signs of ARI according to the integrated management of childhood illnesses (IMCI). Additionally, the caretakers were not utilizing the community agents in their communities (Onyango et al., 2012).

Immunization status

Studies have shown that children who did not receive full immunizations were at higher risk of ARI as compared to fully immunized children. A study conducted in Brazil showed children who either did not complete immunization and those that did not receive influenza virus vaccine were 3.5 times likely to develop ARI as compared to those with complete vaccinations (Fonseca Lima, 2016) . The study showed that children who did not complete immunization were 2.6 times more likely to have ARI as compared to children who were fully immunized. Harerimana et al (2014) also found an association between children who did not receive vitamin A and episodes of ARI. Similarly, a study conducted in Mwanza Tanzania found an increased risk of ARI among children with delayed measles immunization had an increased risk of having severe ARI as compared to those who received immunizations timely (OR 3.9, 95% CI: 1.1, 14.8), however, the study found no association with lack of vitamin A supplementation (PrayGod et al., 2016).

A study conducted in Kafue and Mazabuka districts of southern and Lusaka province showed high prevalence of fever, cough and diarrhea, the study also showed a major gap in number of vaccines received by the children (Katepa-Bwalya, 2014).

2.3 Conceptual framework

The above framework is based on a hierarchical analysis of factors associated with respiratory infection among under five children. From literature, maternal characteristics such as age, education level and socioeconomic status. Environmental factors such as cooking fuel, household characteristics and place of residence also play a role in ARI among under five children

The second level focuses on the perinatal factors such as child's nutritional status. Vaccination status that is types of vaccines received and whether complete or incomplete. The level also focuses on nutritional status, including breast feeding. The level also includes personal history of ARI and family history of Asthma and or rhinitis which may be associated with the occurrence of acute respiratory infection among under five children or maybe protective against development of ARI. (Figure 3)

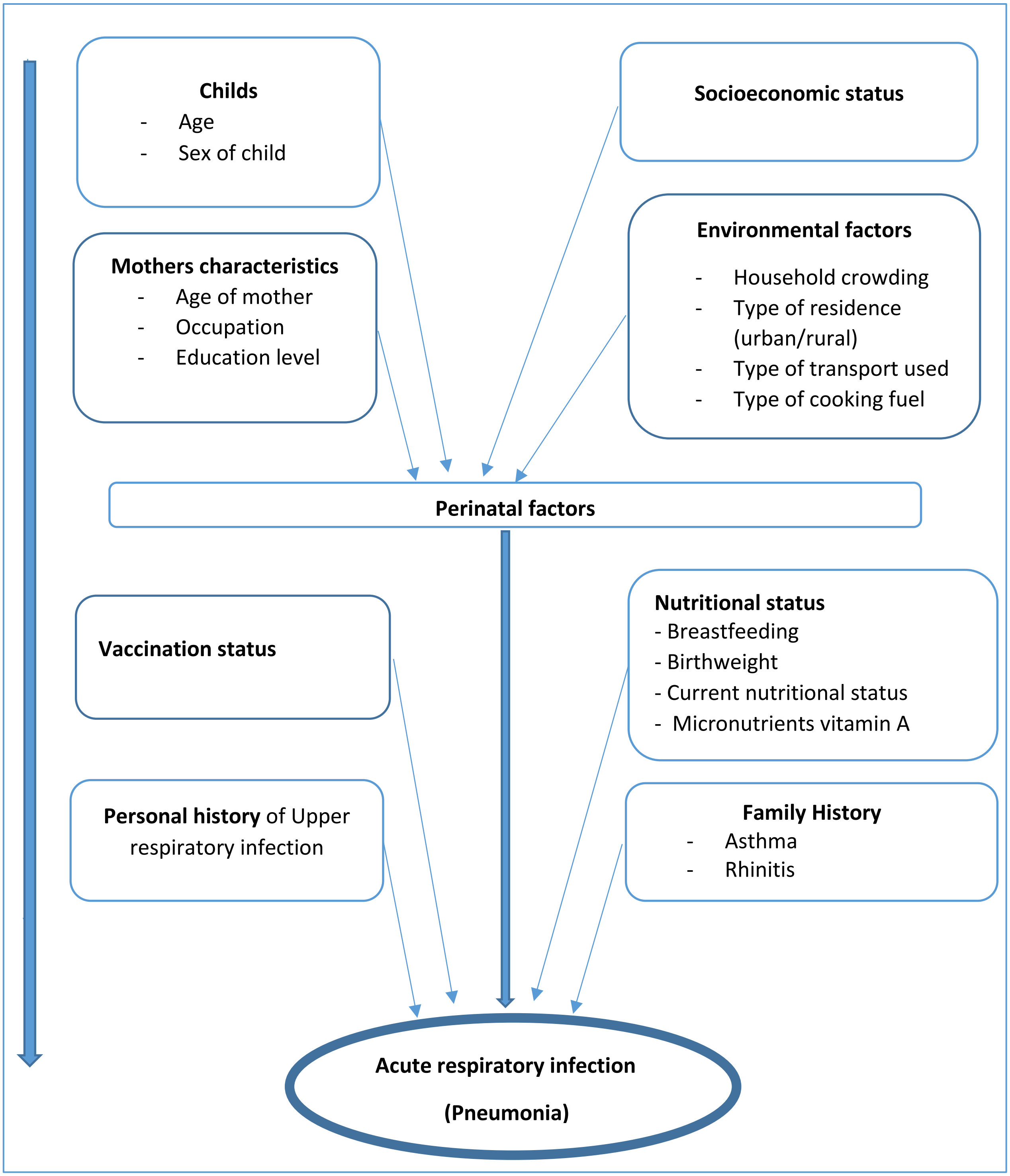


Figure 2: Conceptual framework based on logistic analysis model for respiratory illness: (Cardoso et al., 2013)

CHAPTER 3

METHODOLOGY

3.1 The ZDHS Sample design

The Zambia Demographic and Health Survey (ZDHS) report was implemented by the Central Statistical Office (CSO) in partnership with the Ministry of Health, University Teaching Hospital (UTH) virology lab, the Tropical Diseases Research Centre (TDRC), and the Department of Population Studies at the University of Zambia (UNZA). It is conducted every five years to provide policy makers with detailed information on demographic and health characteristics of the citizens.

The ZDHS obtained information on some of the child health indicators which included malaria, diarrhea, and respiratory infections. Acute Respiratory infection was one of the major health concerns in the survey which called for the need to assess the factors.

The ZDHS utilized a two stage stratified cluster sample with enumeration areas (clusters) selected during the first stage and households selected during the second stage. In the first stage 312, 320, 319 and 722 enumeration areas (EAs) were selected with probability proportional to size from 1996 to 2014 ZDHS. Prior to selected, the EAs were stratified by province and then by urban rural. In the second stage, a complete list of households served as a sampling frame for the selection of household. An average of 25 houses were selected in each EA. The surveys utilized the 2010, 2000 and 1990 population and household census sampling frames.

All women aged 15-49years who were either permanent residents or visitors in the households on the night before the survey were eligible to be interviewed using questionnaires. Three questionnaires used in this survey include; the household questionnaire, women's questionnaire, and men's questionnaire. The three instruments are based on the questionnaires developed by the Measure Demographic and Health Surveys programme and adapted to Zambia's specific data needs. The questionnaires were translated into seven major languages: Bemba, Kaonde, Lozi, Lunda, Luvale, Nyanja and Tonga (CSO, 2014, CSO, 2007, CSO, 2002, CSO, 1996).

The main objectives were to provide information on levels and trends on fertility, childhood mortality, use of family planning methods, maternal and child health indicators including HIV/AIDS (CSO et al., 2015). The primary objectives of the ZDHS were to:

- Collect up-to date information on fertility, infant and child mortality, and family planning.
- Collect information on health- related matters such as breastfeeding, ante natal care, children's, and childhood diseases.
- Assess knowledge on contraceptive practices among women.
- Assess the nutritional status of mothers and children.
- Improve understanding of variations in HIV Sero -prevalence levels according to social and economic characteristics and behavioral risk factors.
- Estimate levels of HIV prevalence in the general population of adults.
- Estimate unmet need for antiretroviral treatment (CSO et al., 2015).

Since the study was focused on analyzing data on ARI a proxy for ARI among under five children, data on women who had responded to the question did the child have cough with difficult breathing that was chest related two weeks before the survey.

3.2 ZDHS Data Collection

Trained interviewers conducted oral interviews at respondents' home using the women's questionnaire. Questionnaires and field procedures were pretested prior to implementation of the main survey. The pretest fieldwork was conducted in two urban and three rural clusters. (CSO, 2014). To assess the prevalence of ARI, mothers were asked if their children under five years had been ill with a cough in the past two weeks before the survey accompanied by short rapid breaths that was chest related.

3.3 Study Design

This study was a cross-sectional study using data from Zambia Demographic and Health Survey 2014, 2007, 2002 and 1996 datasets. The study was aimed at providing an assessment of the trends and factors associated with Acute Respiratory Infection (a proxy for ARI) in Zambia. The survey's had estimates for a wide range of socio-economic indicators at national, urban and rural levels. Data were extracted from the ZDHS data sets, from the Central Statistics Office, Zambia. According to the 2010 census report, the population of the country was at 13,092,666 (CSO, 2012).

3.4. Study site

The study site was Zambia because the study utilized secondary data from the ZDHS which was nationally representative.

3.5 Study Population

The population comprised children aged between 0 and 59 months from both rural and urban areas from all the ten provinces of Zambia who were surveyed during the 2014, 2007, 2002 and 1996 demographic health surveys. These were children who were permanent residents or visitors of the household the night before the survey. The population included children 0-59 months who had episode of acute respiratory infection (ARI) a proxy for pneumonia. A total of 30, 391 under five children were analyzed for acute respiratory infection 12, 634 (CSO, 2014), 5,852(CSO, 2007), 5,787(CSO, 2002) and 6,109 (CSO, 1996)

3.6 Inclusion Criteria

All children aged 0-59 months dwelling in urban and rural districts of Zambia with symptoms of acute respiratory infection or ARI that is cough with difficulty breathing two weeks prior to the survey were included in the study. The responses were extracted from the woman's questionnaire of the ZDHS on mothers aged between 15 – 49years.

3.7 Exclusion Criteria

Children from 0-59 months whose mothers did not respond to the question of interest and those with incomplete responses were excluded from the analysis.

3.8 Data extraction and cleaning

All the data that was needed for this study was obtained from the ZDHS 1996, 2002, 2007 and 2014 data sets from the woman's questionnaire. Files from the same ZDHS were merged then the four (4) different ZDHS datasets were appended before analysis. Only variables which were collected in all the datasets were considered for analysis. The variables that were not part of the analysis were deleted. The outcome variable ARI was defined as a cough accompanied by short rapid breaths and difficulty in breathing that was chest-related. These symptoms are consistent with conditions leading to pneumonia (CSO, 2014). The predictor variables were checked for completeness and only those that were complete were considered for analysis. The variables included child's age, sex, breastfeeding, vaccination, vitamin A, mother's age, education, employment status, environmental such as household size, cooking fuel (Table 1)

Table 1: Summary of study variables

Type of Variable	**Variable**	**Indicator**	**Measurement scale**
Dependent	ARI (cough with short rapid breaths that was chest related)	Yes/No	Binary
Independent	Childs age	Age in months	Continuous
	Sex	Male/Female	Binary
	Vaccination status	Complete/Incomplete	Binary
	Breastfeeding	Yes/No	Binary
	Nutrition status (Underweight)	Yes/No	Binary
	Received Vitamin A in last 6months	Yes/No	Binary
	Residence	Urban /Rural	Binary
	Household size	Continuous	Continuous
	Age of mother	Age in Years	Continuous
	Education of mother	No education, primary, secondary and higher	Categorical
	Employment	Yes/no	Binary
	Cooking fuel	Electricity or gas, charcoal and wood or straw	Categorical
	Income wealth index	Poorest, Poorer, middle, rich, richest	Ordinal

3.8.1 Categorical variables

The dependent variable ARI was constructed using three variables namely cough, cough with short rapid breaths that was chest related and modeled it as binary variable coded as 1 if child had ARI and 0 otherwise. Sociodemographic variables such as mother's age were categorized as 15-19, 20-24, 25-29, 30-34, 35-39 and 40-49, education level as No education, Primary, Secondary, and Higher, residence, Childs age was categorized as 0-11, 12-23, 24-35,36-47 and 48-59, anthropometric measurements such as underweight was defined as <-2SD based on WHO definition and constructed using weight/age variable in the dataset. Cooking fuel was recoded as electricity, charcoal and wood. Socioeconomic variables such as employment status and wealth index were also extracted. We extracted environmental variables such as household size was categorized as overcrowding and no overcrowding (based on Zambia Public Health Act).

3.9 Data Analysis

Data were analyzed using statistical software, STATA version 14.0 SE (Stata corporation college status, Texas). A weighted survey analysis was done as this was survey data and a design effect of average 1.490 was considered due to multi-stage clustering of the sample (CSO et al., 2015).

Cross tabulations were done and variables with expected cell frequencies above five were subjected to chi-square tests to examine associations of study variables. P-values of <0.05 were considered significant at 95% confidence level. Trend analysis done using chi-square tests for trend as well as non-parametric trends test (NP-trend) based on the prevalence of ARI across the surveys and reported graphically. Univariate analysis was done to determine the strength of associations, variables which were significant were then subjected to multivariable logistic regression analysis to control for confounding at p-value <0.05 and 95% confidence level. We reported unadjusted and adjusted odds ratios to measure the strength of association.

We used a planned backward block stepwise regression by arranging covariates into logical groups then running analysis to determine the best multiple regression model since stepwise backward logistic regression does not work with survey data. Model fit was tested using the F test.

3.10 Ethical Approval

Ethical approval for this study was sought and obtained from Excellence in Research Ethics and Science Ethics committee (ERES CONVERGE) reference **2017-July-029**. Further permission to use the Zambia Demographic and Health Survey Data sets were obtained from the Central Statistical Office and Measure DHS website. Data were not be used for other purposes or handed to any other person or organization apart from the study. No harm was paused to the participants since the study utilized secondary data which was already de-anonymized. The data sets were kept in a password protected folder to in order to maintain confidentiality.

3.11 Plan for dissemination

The findings of the study will be communicated to the ministry of health in writing, so that the evidence can be used to improve child health. The findings will also be disseminated to the provinces during provincial integrated meetings in order to help renew health workers' commitment to preventing and controlling ARI among under five children. The study findings will also be disseminated at scientific fora, such as the National Health Research Conference.

3.12 Limitations

The study utilized secondary data which was collected for purposes other than the objectives of the study hence certain variables of the study were not be assessed. Since the study utilized data from various surveys, a per province comparison of trends was not be done due to differences in the number of provinces from the 1996-2007 survey reports which only considered nine provinces. The 2013-2014 survey report includes 10 provinces. The effect of variables such as cooking fuel type, roofing material were not assessed as they were not collected in the 2002 and 1996 datasets.

CHAPTER 4

RESULTS

4.1 Descriptive statistics of study participants

A total of 30,391 children under age 5 were analyzed from 1996, 2002, 2007 and 2014 Zambia Demographic Health Surveys. Of these 50.2% were females and majority (70%) lived in rural areas. The mean age of the children was 28 months. A total of 6,854 children were reported to have had cough two weeks preceding the survey. Out of these, only 2,389 (8%) had symptoms consistent with ARI. About 15% of the respondents belonged to the poorest wealth quintile while 9% belonged to the richest quintile. The commonest type of cooking fuel was wood (46%) and only 19% of the households had electricity. (Table 2A)

TABLE 2A: Frequency distribution of background characteristics of the participants

	n(%) 6,109		p-value	n(%) 5,787		p-value	n(%) 5,861		p-value	n(%) 12,634		p-value
	1996			2002			2007			2014		
Mothers characteristics												
	ARI											
Mothers age	**No**	**Yes**		**No**	**Yes**		**No**	**Yes**		**No**	**Yes**	
15-19	396	73	0.3584$^{\chi2}$	480(8)	89(2)	0.8237$^{\chi2}$	337(6)	20(0.3)	0.8784$^{\chi2}$	833(14)	49(0.8)	0.2228$^{\chi2}$
20-24	1609	254		1721(30)	262(5)		1410(24)	72(53)		2910(50)	107(2)	
25-29	1329	175		1519(26)	202(3)		1579(27)	97(2)		3159(54)	121(2)	
30-34	1022	142		982(17)	139(2)		1155(20)	62(1)		2568(44)	87(1.5)	
35-39	622	79		660(11)	89(2)		659(11)	35(0.6)		1672(29)	68(1.2)	
40+	358	50		425(7)	62(1)		418(7)	19(0.3)		1023(17)	35(0.6)	
Mother currently working												
No	3187	361	0.0475$^{\chi2}$	2084(36)	290(5)	0.0471$^{\chi2}$	2817(48)	111(2)	0.0014$^{\chi2}$	5448(43)	170(1)	0.0169$^{\chi2}$
Yes	3195	410		2856(49)	553(10)		2740	193(3)		6673(53)	299(2)	
Residence												
Urban	2084(34)	309(5)	0.0552$^{\chi2}$	1548(27)	248(4)	0.8237$^{\chi2}$	1602(28)	95(2)	0.5840$^{\chi2}$	4182(33)	136(1)	0.2228$^{\chi2}$
Rural	3200(52)	464(8)		3396(59)	595(10)		3955(68)	209(4)		7983(63)	322(3)	
Education												
No education	719(12)	110(2)	0.0475$^{\chi2}$	689(12)	153(3)	0.0002$^{\chi2}$	755(13)	41(1)	0.5260$^{\chi2}$	1331(11)	56(0.4)	0.4562$^{\chi2}$
Primary	3429(56)	468(8)		3121(54)	535(9)		3507(60)	205(3)		6831(54)	260(2)	
Secondary	1091(18)	172(3)		1049(18)	149(3)		1164((20)	53(1)		3548(28)	144(1)	
Higher	110(2)	8(0.13)		87(2)	5(0.1)		131(2)	5(0.1)		444(4)	8(0.1)	

TABLE 2B: **Frequency distribution of background characteristics of under five children with ARI in Zambia**

Variable	1996 n (%)		p-value	2002 n (%)		p-value	2007 n (%)		p-value	2014 n (%)		p-value
ARI	**No**	**Yes**		**No**	**Yes**		**No**	**Yes**		**No**	**Yes**	
Sex												
Male	2625	364	0.7688$^{\chi2}$	2448(42.3)	428(7.4)	0.5487$\chi2$	2714(46)	173(3)	0.0080$^{\chi2}$	6163(49)	231(2)	0.5945$^{\chi2}$
Female	2711	409		2496(43.1)	415(7.2)		2843(48.5)	131(2.2)		6002(48)	238(2)	
Childsage												
0-11	1107(18)	213(3.5)	0.0811$^{\chi2}$	1004 (17)	234(4)	0.0001$\chi2$	1203(21)	85(1.5)	0.0148$^{\chi2}$	2385(19)	93(0.7)	0.0153$^{\chi2}$
,12-23	1144(19)	203(3.3)		1065 (18)	234(4)		1206(21)	66(1.1)		2450	126(1)	
24-35	1087(18)	152(2.5)		966 (17)	177(3)		1084(18)	67(1.1)		2450(19)	97(1)	
36-47	995(16)	117(2)		904 (16)	99(2)		1033(17.6)	44(0.8)		2368(19)	78(0.6)	
48-59	1003(16.4)	88(1.4)		1004 (17)	99(2)		1031(17.5)	42(0.7)		2552(20)	75(0.6)	
Vaccination status												
Incomplete	243(13)	27(2)	0.7116$^{\chi2}$	336(18)	41(2)	0.72$\chi2$	471	28	0.3278$^{\chi2}$	536(14)	16(0.4)	0.4031$^{\chi2}$
Complete	1411(77)	149(8)		1304(69)	206(11)		1262	56		3050(82)	103(3)	
Breast feeding												
No	2030(33)	251(4)	0.0115$^{\chi2}$	1798(31)	274(5)	0.1011$\chi2$	2042	105	0.5016$^{\chi2}$	5423(43)	206(1)	0.8443$^{\chi2}$
Yes	3306(54)	522(9)		3146(54)	569(10)		3515	199		6747(53)	262(2)	
Under weight												
No	4234(69)	598(10)	0.6221$^{\chi2}$	3736(65)	581(10)	0.006$\chi2$	4864(83)	261(1)	0.3968$^{\chi2}$	10583(84)	391(3)	0.0742$^{\chi2}$
Yes	1102(18)	175(3)		1208(20)	262(5)		693(12)	43(0.7)		1582(13)	77(1)	
Vitamin A last 6months												
No	na	na		1833(32)	338(6)	0.0185$\chi2$	739(22)	38(1)	0.5160$^{\chi2}$	3887(31)	115(1)	0.0052$^{\chi2}$
Yes	na	na		3007(52)	503(9)		2420(73)	133(4)		8278(66)	354(3)	
Malaria												
No	3396(56)	265(4.3)	**<0.001$^{\chi2}$**	2934(51)	211(4)	<0.0001$^{\chi2}$	4681(80)	136(2)	<0.001$^{\chi2}$	9550(76)	212(2)	<0.001$^{\chi2}$
Yes	1940(32)	508(8.3)		1863(32)	632(11)		876(15)	168(3)		2403(19)	252(2)	
Diarrhoea												
No	4185(69)	489	**0.0004$^{\chi2}$**	3882(67)	538(9.3)	<0.0001$^{\chi2}$	4750(81)	200(3)	<0.001$^{\chi2}$	10075(81)	309(2)	<0.001$^{\chi2}$
Yes	1171(19)	264		1063(18)	304(5.3)		807(14)	104(2)		1873(15)	157(1)	

Table 2C: Frequency distribution of Housing characteristics of under-five children with ARI in Zambia

Housing characteristics	ARI No	Yes		No	Yes		No	Yes		No	Yes	p-value
Electricity												
No	4256(70)	629(10)	0.0275$^{\chi2}$	3985(69)	728(13)	**0.0013$^{\chi2}$**	4782(82)	254(4)	0.9919χ2	9442(75)	364(3)	0.7651$^{\chi2}$
Yes	1080(18)	144(2)		836(14)	115(2)		775(13)	50(1)		2723(22)	105(0.8)	
Main floor material												
Earth	3,471 (56)		0.0744$^{\chi2}$	3189(55)	589(10)	**<0.0003$^{\chi2}$**	3749(64)	201(3.4)	0.8246χ2	7494(60)	306(2.4)	0.4107$^{\chi2}$
Ceramic/Polished wood	84 (1)			18 (0.3)	0		163(3)	0		97 (1)	0	
Cement	2,515(41)			1491(26)	216(4)		1634(28)	103(1.8)		4114(34)	163(1.3)	
Carpet	8 (0.1)			110(2)	34(1)		11(0.2)	0		53(0.4)	0	
Cooking fuel												
Electricity	na		na	635(11)	74(1)	**0.045$^{\chi2}$**	585(10)	37(0.6)	0.7729χ2	972(8)	23(0.2)	0.0777$^{\chi2}$
Charcoal	na			1301(23)	216(4)		1289(22)	85(1.5)		4100(32)	145(1.2)	
Wood	na			3021(52)	537(9)		3683(63)	182(3)		7091(56)	301(2.4)	
Household size												
Not crowded	2563(42)	369(6)	0.3994$^{\chi2}$	2706(47)	486(8)	0.2515$^{\chi2}$	3353(57)	184(3)	0.9402	4550(36)	295(2.3)	0.6598$^{\chi2}$
crowded	2773(45)	404(7)		2238(4)	357(6)		2203(38)	120(2)		7615(60)	174(1.4)	

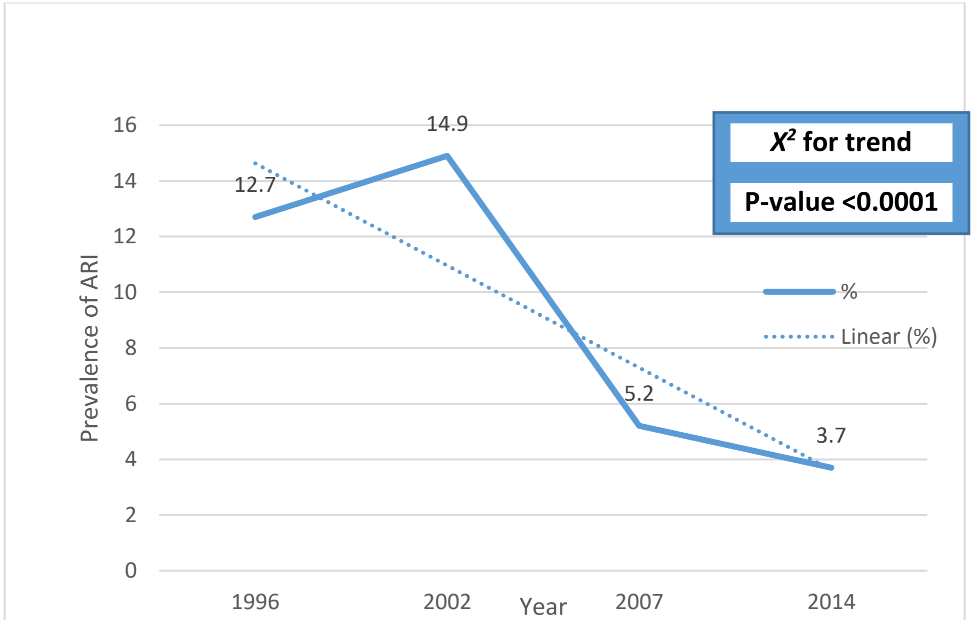


Figure 3**:** ARI Trends among under five children in Zambia 1996-2014 by year of ZDHS

Significant changes have been noted in the prevalence of ARI from 1996 to 2014. A 3% increase in prevalence was noted from 1996 to 2002 when the highest prevalence of ARI was recorded at 15%. The prevalence of ARI decreased drastically from 15% in 2002 to 5% in 2007. However, from 2007 to 2014 the decrease by 1.5%.

Chi square for trend was significant at p-value <0.001 (figure 3)

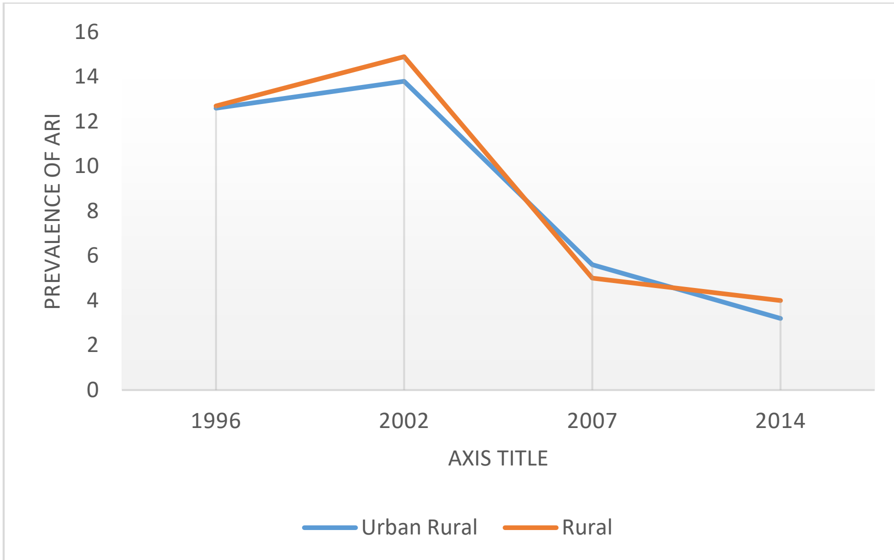


Figure 4: ARI Trends among under five children in Zambia 1996-2014 by urban - rural residence

Figure 5 shows ARI trends by residence. The prevalence of ARI was higher in rural areas across the surveys except 2007 which showed high prevalence in the urban areas.

In the Table 3, the odds of ARI were higher in 2002 as compared to 1996 (AOR 1.61 95%CI 1.37 -1.89). A downward significant trends of ARI prevalence were noted in 2007 and 2014 were the odds of ARI decreased by 88% and 99% in 2007 and 2014 comparing to 1996 (AOR 0.12 95% CI 0.09-0.15 and 0.09 95%CI 0.08-0.11).

Table 3: NP-trends of ARI by year of ZDHS

ARI Trends by Year

Year of DHS	Odds Ratio (95%CI)	P-value	Adjusted Odds Ratio(95%CI	P-value
1996	1			1
2002	1.49 (1.26 -1.76)	**<0.001**	1.61 (1.37 -1.89)	<0.001
2007	0.21 (0.17- 0.26)	**<0.001**	0.12 (0.09 -0.15)	<0.001
2014	0.14 (0.12 -0.17)	**<0.001**	0.09 (0.08 -0.11)	<0.001

The year of ZDHS variable was adjusted for educational status, residence, underweight, child’s age, malaria, diarrhoea and overcrowding and cooking fuel

4.2 Mother's socio-demographic factors associated with ARI among under-five Children in Zambia

Compared to mothers aged between 15-19 years, children of mothers aged 20 years and more were associated with a decreased chance of ARI (Odds Ratio [OR] 0.63 95% Confidence Interval [CI] 0.50 - 0.80 P-value [p-] < 0.001). Higher education was associated with decreased chance of ARI compared with no education (OR 0.27 95%CI 0.17 - 0.40 p-<0.001) (Table 4)

Table 4: Predictor's variables of ARI among under-five children in Zambia

Variable	**Unadjusted** **Odds Ratio (95%CI*)**	**P-value**
Mother's Age		
15-19	1	
20-24	0.83 (0.69 - 0.97)	**0.018**
25-29	0.67 (0.57 - 0.81)	**<0.001**
30-34	0.63 (0.53 - 0.75)	**<0.001**
35-39	0.64 (0.53 - 0.77)	**<0.001**
40+	0.63 (0.50 - 0.80)	**<0.001**
Residence		
Urban	1	
Rural	1.04 (0.95, 1.14)	0.372
Level of education		
No education	1	
Primary	0.82 (0.73 - 0.93)	**0.002**
Secondary	0.66 (0.57 - 0.76)	**<0.001**
Higher	0.27 (0.17 - 0.40)	**<0.001**
Wealth index		
Poorest	1	
poorer	1.21 (0.94, 1.57)	0.141
middle	0.97 (0.74,1.26)	0.799
richer	0.98 (0.73, 1.31)	0.896
richest	1.00 (0.71, 1.40)	0.995

***Confidence interval**

4.3: Child's Socio-demographic variables associated with ARI

Children who suffered from malaria had higher chance (OR 5.85 95%CI 5.34-6.40 p-<0.001) of getting ARI compared to those who did not. Co-morbidity with diarrhea increased the odds of ARI by 2.61 times (OR 2.61 95%CI 2.34-2.92 p-<0.001). Children who had not received vitamin A in the last six months were 2.48 times more likely to develop ARI compared to those that had received (OR 2.48 95%CI 2.22-2.77). Children who were not breastfeeding had a decreased likelihood of having ARI as compared to those who were breastfeeding at the time of the survey (OR 0.72 95%CI 0.65-0.80). (Table 5)

Table 5: Sociodemographic characteristics associated with ARI among under-five children in Zambia

Variable	Unadjusted Odds Ratio (95%Confidence Interval)	P-value
Childs age in months		
0-11	1	
12-23	0.98 (0.87 - 1.11)	0.783
24-35	0.83 (0.73 - 0.94)	**0.004**
36-47	0.60 (0.52 - 0.69)	**<0.001**
48-59	0.52 (0.45 - 0.60)	**<0.001**
Sex		
Male	1	
Female	1.00 (0.92 - 1.10)	0.887
Vaccination status		
No	1	
Yes	1.03 (0.80 - 1.24)	0.772
Diarrhoea		
No	1	
Yes	2.61 (2.34 - 2.92)	**<0.001**
Malaria		
No	1	
Yes	5.85 (5.34 - 6.40)	**<0.001**
Under weight		
No	1	
Yes	1.94 (1.75 - 2.15)	**<0.001**
Breast feeding		
Yes	1	
No	0.72 (0.65 - 0.80)	**<0.001**
Vitamin A last 6months		
No	1	
Yes	0.44 (0.39 – 0.49)	**<0.001**

4.4 Household factors associated with ARI

Being in a crowded home was associated with increased odds for ARI (OR 1.06 95%CI 1.04-1.08 p-<0.001). The number of children five years and under in the household showed an increased chance of ARI (OR 1.10 95%CI 1.03-1.16 p-0.002). Using charcoal (OR 3.24 95%CI 2.89 – 3.42 p-<0.001) for cooking had an increased odds for ARI compared to electricity (Table 6).

Table 6: Household factors associated with ARI among under-five children in Zambia

Variable	**Unadjusted Odds Ratio (95%CI*)**	**P-value**
Household size		
Normal (<6)	1	
Crowded (>7)	1.24 (1.13 -1.36)	<0.001
Number of children 5 and under	1.10 (1.03,1.16)	0.002
<2	1	
>3	1.57 (1.16 -2.12)	0.004
Type of cooking fuel		
Electricity	1	
Charcoal	**3.24** (2.89 - 3.42)	<0.001
Wood	1.69 (2.45 - 2.07)	<0.001
Electricity		
No	1	
Yes	0.77 (0.64, 0.90)	0.001
Floor type		
Earthen	1	
Tiles	0.61 (0.34, 1.09)	0.096
Cement	0.94 (0.82, 1.08)	0.404
Carpet	1.16 (0.64, 2.11)	0.62

4.5: Factors associated with ARI among under five children in Zambia

Multivariable analysis of factors associated with ARI

At multiple variable logistic regression, children whose mothers' were between 25-29years had reduced odds of ARI (AOR 0.68 95%CI 0.52-0.89 p-<0.005) as compared to mothers younger than 20years after controlling for education level, diarrhea, malaria, underweight, child's age in months, vitamin A and number of household members. Mother's education was another significant factor in this study. Higher education was associated with 70% decreased (AOR 0.30 95%CI 0.15-0.58 p- <0.0001) odds of ARI after controlling for all variables in the model

A 36% reduction in the likelihood of developing ARI was observed among children whose mothers had secondary education compared to those whose mothers had no education. (AOR 0.64 95%CI 0.52-0.80 p-value <0.0001). Children who had malaria were 5.77 times more likely to have ARI compared with those that had no malaria (AOR 5.77 95% 5.01-6.64 p-<0.0001). Having diarrhea was 1.45 times increased odds of ARI compared with children who had no diarrhea (AOR 1.45 95%CI 1.25-1.68 p-<0.0001)

Being underweight was significantly associated with an increased chance of ARI. Children who were underweight were 1.50 times more likely to have ARI compared to those who were not underweight (AOR 1.50 95%CI 1.28 -1.68 p-<0.0001). Using charcoal for cooking was associated with 2.67 times more likely associated with ARI (AOR 2.67 95%CI 2.09-3.4 p-<0.0001) as compared to using electricity for cooking. Children from crowded homes were 1.15 times more likely to have ARI (AOR 1.15 CI 0.99 -1.33 p-0.061) compared to those from non-crowded homes although this was not statistically significant (Table 7).

Table 7: Multivariable analysis of factors associated with ARI among under-five children in Zambia

Variable	Unadjusted odds ratios	p-Value	Adjusted Odds Ratio [95% conf. interval]	p-Value
Mother's Age				
15-19	1		1	
20-24	0.83 (0.70 -0.97)	0.018	0.77 (0.59 -1.00)	0.053
25-29	0.67 (0.57 -0.79)	**<0.001**	0.68 (0.52 - 0.89)	**0.005**
30-34	0.63 (0.53 -0.75)	**<0.001**	0.59 (0.44 -0.78)	**<0.001**
35-39	0.64 (0.53 -0.77)	**<0.001**	0.62 (0.46 -0.85)	**0.003**
40-49	0.64 (0.51 -0.78)	**<0.001**	0.61 (0.43 -0.86)	**0.004**
Education				
No education	1		1	
Primary	0.82 (0.73 -0.93)	**0.002**	0.80 (0.67 -0.96)	**0.018**
Secondary	0.66 (0.57 -0.76)	**<0.001**	0.64 (0.52 -0.80)	**<0.001**
Higher	0.26 (0.17 -0.40)	**<0.001**	0.30 (0.15 -0.58)	**<0.001**
Childs age in months				
0-11	1		1	
12-23	0.98 (0.87 -1.11)	0.783	0.91 (0.67 -0.96)	0.365
24-35	0.83 (0.73 -0.94)	**0.004**	0.97 (0.79 -1.19)	0.799
36-47	0.60 (0.52 0.69)	**<0.001**	0.74 (0.59 -0.92)	**0.007**
48-59	0.52 (0.45 -0.60)	**<0.001**	0.82 (0.66 -1.03)	0.095
Vitamin A last 6months				
No vitamin	1		1	
Yes last 6months	0.44 (0.39 -0.49)	**<0.001**	0.46 (0.40 -0.52)	**<0.001**
Malaria				
No	1		1	
Yes	5.85 (5.34 -6.40)	**<0.001**	5.77 (5.01 -6.64)	**<0.001**
Underweight				
No	1		1	
Yes	1.94 (1.75 -2.15)	**<0.001**	1.50 (1.28 -1.68)	**<0.001**
Diarrhoea				
No				
Yes	2.61 (2.39 -2.86)	**<0.001**	1.45 (1.25 -1.68)	**<0.001**
Household characteristics				
Number of household members				
Not crowded	1		1	
Crowded	1.24 (1.13 -1.36)	**<0.001**	1.15 (0.99 -1.33)	0.061
Type of Cooking fuel				
Electricity	1			
Charcoal	3.24 (2.89 -3.42)	**<0.001**	2.67 (2.09 - 3.42)	**<0.001**
Wood	1.69 (1.39 -2.07)	**<0.001**	2,79 (2.45 - 3.19)	**<0.001**

CHAPTER 5

DISCUSSION

5.1 DISCUSSION

In the current analysis, age of child, underweight (weight for age), maternal age and education level, number of people in the household and comorbidities such as malaria and diarrhea were among factors found to be significantly associated with ARI.

Our study showed a downward trend of ARI from 1996 to 2014. These findings are in agreement with global trends (Greenwood et al 2013, WHO 2017). Between 1996 and 2002 a 2% rise in prevalence was noted before the 10% drop noted in 2007. The drop in prevalence could be attributed to the introduction of haemophilus influenza vaccine, and a further drop was noted in 2007-2014 notably due to introduction of pneumococcal conjugate vaccine (PCV) that was introduced in 2013 (Health, 2013) (MoH, 2013, MoH, 2016)

Analysis of trends by residence showed a higher prevalence in the rural area as compared to urban areas. This finding tallies with findings from a study conducted in Ghana were a higher prevalence of ARI was observed in the rural area. This finding can be related to the poor social economic status associated with rural areas including overcrowded homes and mostly poor ventilation which promotes disease transmission (Amugsi et al, 2014). However, contrary to other survey findings, the 2007 ZDHS showed a higher prevalence in the urban area as compared to rural areas (CSO et al., 2009).

Although vaccination plays a major role in disease prevention, it is worth noting that our study findings did not show statistically significant association between ARI morbidity and vaccination at multivariable analysis. This finding may be related to the fact that at the time the three earlier surveys were implemented, the PCV vaccine had not yet been introduced in the immunization schedule. However this was not a finding unique to this study as studies conducted by Mackenzie et al have shown a reduction in the incidence of ARI with the introduction of the PCV vaccine (Mackenzie et al., 2017).

Among sociodemographic variables associated with ARI, mother's age, education level and child's age were significantly associated with ARI. The multivariable analysis showed that increase in maternal age was associated with reduced odds for developing ARI. This result is in line with findings from studies conducted in Brazil and Ghana (Fonseca Lima et al., 2016, Amugsi et al., 2015) which showed that children born to mothers younger than 20years had higher odds for developing ARI compared to mothers older than 20 years. This finding can be related to the inexperience, immaturity and unpreparedness among these adolescent mothers (Fonseca-Lima et al). On the contrary, studies conducted in different parts of Ethiopia found no significant associations between mother's age and occurrence of ARI among under five children (Fekadu et al., 2014, Abuka, 2017b). Amugsi and others found similar findings in a study conducted to determine factors associated with under five morbidity in Ghana. They found that maternal age was significantly associated with morbidity (Amugsi et al., 2015, Abuka, 2017a).

The study findings also showed that child's age was significant. Children who were under one year old were more likely to have ARI compared to older children. The finding is consistent with studies done in Rwanda, Ethiopia, Ndola Zambia (Geberetsadik et al., 2015, Amugsi et al., 2015, Abuka, 2017c, Harerimana et al., 2016b) which showed increased odds of children younger than one year developing ARI. This finding can be attributed to the element that as children grow older, there is an improvement in the immune system secondary to exposures to vaccinations and generally developing resistance to infections. Children younger than 11months may be at increased risk due to incomplete vaccinations such as PCV, DPT Hib HepB and Measles (Ujunwa and Ezeonu, 2014a). Contrary to our study findings as well as findings from most studies which show the most affected age group to be among the 0-11 months, a study conducted in Nigeria in 2014 found higher prevalence among children aged 10-19 months, an age which was consistent with high complementary feeding which also increases the risk of exposure to other risk factors associated with ARI (Ujunwa and Ezeonu, 2014b).

In our study a high prevalence of 16% ARI was noted among underweight children. This finding is consistent with studies done in Nigeria and Tanzania which equally showed a higher prevalence of ARI among children who were malnourished and of low weight for age. A study conducted at the university Hospital Zambia also showed high prevalence of ARI and diarrhea among malnourished children. (Munthali et al., 2015) This finding further underscores the effect of underweight and undernutrition on the occurrence of ARI. Underweight indicates long term malnutrition which weakens the body and increases risk for infections. This finding is so related to the low immunity of underweight children which increases their vulnerability to developing infections, including respiratory infections such as ARI (Ujunwa and Ezeonu, 2014b).

On the other hand having a mother with secondary or higher education was found to be protective against ARI among under five children compared to children of mothers who had no formal education. The finding is in line with studies conducted in Kenya, Ghana and Rwanda citation. This finding may be related to the fact that these mothers may have access to literature which helps them to protect their children citation. A study conducted in India found no statistical significant between ARI and maternal education level (Shahunja et al., 2016) Kamnik's findings were not in agreement with our findings and other studies, apart from young age of the mother, the study also found an increased odds for ARI among older mothers. In the study, older women were less likely to be educated compared to their younger counterparts. (Kanmiki et al., 2014)

Among variables related to housing and environmental, cooking fuel and crowding (Crowding was defined as a more than six family members) were associated with ARI. The odds of ARI were higher among children from crowded homes as compared to houses were there was no crowding. These findings relate to the increased risk for spread of infectious agents associated with overcrowding. Overcrowding is associated with poor ventilation which facilitates risk for spread of infectious diseases such as respiratory tract infections This finding is similar to what was observed by Banda et al in Ndola were children exposed to crowded conditions such as in public transport had higher odds for ARI (Banda et al., 2016). Similar findings were also observed in Ethiopia where children from crowded homes were four (4) times more likely to suffer from ARI compared to others. On the contrary, a study conducted by Harerimana did not find any association between crowding and occurrence of ARI. Cooking fuel was associated with increased odds for ARI, children from homes where charcoal and wood were used for cooking had increased odds for ARI as compared to those were electricity was used. These findings are similar to the findings from a multi-country study which was conducted in Africa. The showed that the use of charcoal coal and wood were associated with increased risk for acute respiratory infections and ARI (Buchner and Rehfuess, 2015). A number of studies conducted in various parts of Ethiopia have also shown significant associations among type of cooking fuel and ARI among under five children. The odds of developing ARI were higher among children from households which used charcoal and firewood for cooking (Abuka, 2017b, Fekadu et al., 2014). A study conducted in Rwanda also showed that cooking fuel was associated with increased risk for ARI. Similar findings were also reported in Nigeria, Brazil and Ghana which reported significant associations among cooking fuels such as wood, charcoal and coal as compared to the use of electricity (Ujunwa and Ezeonu, 2014a, Fonseca Lima et al., 2016, Amugsi, 2015). These findings can be attributed to the environmental pollutants such as wood smoke and charcoal smoke which results in the production of respirable particulate matter which increases the risk for respiratory infections such as ARI in children below the age of five years. Wood smoke and charcoal smoke also reduces respiratory clearance functions and increases risk for infections.

This study showed that children with comorbidities such malaria and diarrhea had higher odds of having ARI. Similar findings have been observed in a study conducted by Tazinya et al in Cameroon where they found that 8.9% of children with ARI also had malaria (Tazinya et al., 2018). Malaria affects the body at cellular level which increases susceptibility to other infections. In this study it was also observed that history of diarrhea was also associated with ARI. Children who had history of diarrhea had increased odds for developing ARI. This finding was also observed in a study conducted in Ethiopia by Dadi and others who found that children with history of diarrhea were 3 times more likely to have ARI (Dadi et al., 2014).

Our study also showed that receiving vitamin A in the last 6 months before the survey was a protective factor against ARI. Children who had received vitamin A had reduced odds for developing ARI. The findings are consistent with those of a study conducted in India which showed increased odds for ARI among children who did not receive Vitamin A supplementation (Kazi and Abdul, 2009). On the contrary, another study conducted in India found no statistical significant association between developing ARI and vitamin A supplementation (Srivastava et al., 2015).

5.2 Conclusion:

This study has shown a significant decline in ARI trends in over two and a half decades. The lowest prevalence seen was in 2014, the most recent survey. Vaccination programs have had a great impact on the reduction of ARI prevalence among under five children in Zambia as was seen between 2002 and introduction of PCV in 2007. Programs aimed at promoting vaccinations should be supported in order to reduce the prevalence of ARI in this age group. Associated factors of having ARI include young maternal age, no education, and young age of the child, underweight, and lack of vitamin A supplementation and history of malaria or diarrhea. Environmental factors associated with ARI were type of cooking fuel and overcrowding.

5.3. Strengths

The study was among the first documented studies to assess the trends of ARI in Zambia from 1996 to 2014. The study utilized nationally representative data that was collected in a standardized manner hence will inform policy more effectively at identifying factors associated with this preventable yet leading cause of morbidity and mortality among under five children

5.4 Recommendations

- Sensitization of mothers during antenatal, under five clinics about signs of ARI as well as encouraging them to avoid crowded places, avoid smoke and also on the need for seeking care early should signs of ARI occur
- Vaccination monitoring and ARI surveillance in all health facilities so that high burden areas can be identified and target specific interventions.
- There is need to scale up nutrition education programs to equip the mothers and caretakers on food storage and preparation to reduce on the number of underweight children which increases susceptibility to infection

- Community sensitization programs should to done to address overcrowding and use of unclean cooking fuels such as charcoal and firewood. Information should be given on how children can be protected from ARI associated with these activities

REFERENCES

ABUKA, T. 2017. Prevalence of pneumonia and factors associated among children 2-59 months old in Wondo Genet district, Sidama zone, SNNPR, Ethiopia. *Curr Pediatr Res 2017; 21 (1):* , 21

Alemayehu, M., Alemu, K., Sharma, H. R., Gizaw, Z. & Shibru, A. 2014. Household fuel use and acute respiratory infections in children under five years of age in Gondar city of Ethiopia. *J Environ Earth Sci.,* 4.

Amugsi, D. A. 2015. socio-demographic and environmental determinants of infectious disease morbidity in children under five years in Ghana. 8.

Amugsi, D. A., Aborigo, R. A., Oduro, A. R., Asoala, V., Awine, T. & Amenga-Etego, L. 2015. Socio-demographic and environmental determinants of infectious disease morbidity in children under 5 years in Ghana. *Glob Health Action,* 8**,** 29349.

Banda, W., Mazaba, M. L., Mulenga, D. & Siziya, S. 2016. Risk factors associated with acute respiratory infections among under-five children admitted to Arthur Davisons Children's Hospital, Ndola Zambia. *Asian Pacific Journal of Health Science,* 3**,** 153-159.

Bruce, N., Pope, D., Arana, B., Shiels, C., Romero, C., Klein, R. & Stanistreet, D. 2014. Determinants of care seeking for children with pneumonia and diarrhea in Guatemala: implications for intervention strategies. *Am J Public Health,* 104**,** 647-57.

Buchner, H. & Rehfuess, E. A. 2015. Cooking and Season as risk factors for Acute Lower Respiratory Infections in African Children: A cross _sectional Multi-Country analysis. *PLOS ONE*.

Cardoso, A. M., Coimbra, C. E., Jr. & Werneck, G. L. 2013. Risk factors for hospital admission due to acute lower respiratory tract infection in Guarani indigenous children in southern Brazil: a population-based case-control study. *Trop Med Int Health,* 18**,** 596-607.

CSO 2014. *Zambia Demographic Health Survey,* lusaka, Central Statistics.

CSO, Ministry Of Health/Zambia, Tropical Disease Research Centre/Zambia & University Of Zambia 2009. Zambia Demographic and Health Survey 2007. Calverton, Maryland, USA: Central Statistical Office/Zambia and Macro International.

CSO, Ministry Of Health/Zambia, University Of Zambia Teaching Hospital Virology Laboratory, University Of Zambia Department Of Population Studies, Tropical Diseases Research Centre/Zambia & Icf International 2015. Zambia Demographic and Health Survey 2013-14. Rockville, Maryland, USA: Central Statistical Office/Zambia, Ministry of Health/Zambia, and ICF International.

Dadi, A. F., Kebede Y & Birhanu Z 2014. Determinants of Pneumonia in Children Aged two Months to five years in urban areas of Oromia Zone, Amhara Region, Ethiopia1**,** 1-10.

Diaz, T., George, A. S., Rao, S. R., Bangura, P. S., Baimba, J. B., Mcmahon, S. A. & Kabano, A. 2013. Healthcare seeking for diarrhoea, malaria and pneumonia among children in four poor rural districts in Sierra Leone in the context of free health care: results of a cross-sectional survey. *BMC Public Health,* 13**,** 157.

Fekadu, G. A., Terefe, W. M. & Alemie, G. A. 2014. Prevalence of pneumonia among under five children in Este town and the surrrounding rural kebeles, Northwest Ethiopia; A community based cross sectional study. *Science journal of public health,* 2**,** 150 -155.

Fekadu, Y., Mesfin, A., Haile, D. & Stoecker, B. J. 2015. Factors associated with nutritional status of infants and young children in Somali Region, Ethiopia: a cross- sectional study. *BMC Public Health,* 15**,** 846.

Fonseca Lima, E. J., Mello, M. J., Albuquerque, M. F., Lopes, M. I., Serra, G. H., Lima, D. E. & Correia, J. B. 2016. Risk factors for community-acquired pneumonia in children under five years of age in the post-pneumococcal conjugate vaccine era in Brazil: a case control study. *BMC Pediatr,* 16**,** 157.

Fonseca Lima, E. J. M., M. J. Albuquerque, M. F. Lopes, M. I. Serra, G. H. Lima, D. E. Correia, J. B. 2016. Risk factors for community-acquired pneumonia in children under five years of age in the post-pneumococcal conjugate vaccine era in Brazil: a case control study. *BMC Pediatr,* 16**,** 157.

Geberetsadik, A., Worku, A. & Berhane, Y. 2015. Factors associated with acute respiratory infection in children under the age of 5 years: evidence from the 2011 Ethiopia Demographic and Health Survey. *Pediatric Health Med Ther,* 6**,** 9-13.

Gebretsadik, A., Worku, A. & Berhane, Y. 2015. Less Than One-Third of Caretakers Sought Formal Health Care Facilities for Common Childhood Illnesses in Ethiopia: Evidence from the 2011 Ethiopian Demographic Health Survey. *Int J Family Med,* 2015**,** 516532.

Gedefaw, A. F., Mamo, W. T. & Getahun, A. A. 2014. Prevalence of pneumonia among under- five children in Este town and the surrounding rural kebeles, Northwest Ethiopia; A community based cross sectional study. *Science Journal of Public Health.* , Vol. 2**,,** pp. 150-155. doi: 10.11648/j.sjph.20140203.12.

Gereige, R. S. & Laufer, P. M. 2013. Pneumonia. *Pediatrics in Review,* 34**,** 438-456.

Grimwood, K. A. C., A. B., 2015. Long-term effects of pneumonia in young children. *Pneumonia,* 6**,** 101-114.

Harerimana, J.-M., Nyirazinyoye, L., Thomson, D. R. & Ntaganira, J. 2016a. Social, economic and environmental risk factors for acute lower respiratory infections among children under five years of age in Rwanda. *Archives of Public Health,* 74**,** 19.

Harerimana, J. M., Nyirazinyoye, L., Thomson, D. R. & Ntaganira, J. 2016b. Social, economic and environmental risk factors for acute lower respiratory infections among children under five years of age in Rwanda. *Arch Public Health,* 74**,** 19.

HEALTH, M. O. 2013. *Roadmap for Accelerating Reduction of Maternal, Newborn and Child Mortality, 2013-2016*.

Hockenberry, M. J., Wilson, D. & Wong, D. L. 2013. *Wong's essentials of pediatric nursing,* St. Louis, Mo., Elsevier/Mosby.

Jroundi, I., Mahraoui, C., Benmessaoud, R., Moraleda, C., Benjelloun, B. & Bassat, Q. 2015. Knowledge gaps on paediatric respiratory infections in Morocco, Northern Africa. *Arch Public Health,* 73**,** 28.

Kanmiki, E. W., Bawah, A. A., Agorinya, I., Achana, F. S., Awoonor-Williams, J. K., Oduro, A. R., Phillips, J. F. & Akazili, J. 2014. Socio-economic and demographic determinants of under-five mortality in rural northern Ghana. *BMC Int Health Hum Rights,* 14**,** 24.

Katepa-Bwalya, M., Masaninga, F., Kalesha-Masumbu, P., Malumo, S., Kankasa, C., Babaniyi, O., Mukonka, V., & Siziya, S. 2014. Prevalence of childhood illnesses and immunization status in infants and young children in two districts of Zambia. Vol.6(8), **,** pp. 246-251.

Kazi, M. D. & Abdul, K. A. 2009. Risk Factors for Acute Respiratory infections (ARI) among under-five children in Bangladesh. 1.

Kim, J., Kim, J. H., Cheong, H. K., Kim, H., Honda, Y., Ha, M., Hashizume, M., Kolam, J. & Inape, K. 2016. Effect of Climate Factors on the Childhood Pneumonia in

Papua New Guinea: A Time-Series Analysis. *Int J Environ Res Public Health,* 13**,** 213.

Mackenzie, G. A., Hill, P. C., Sahito, S. M., Jeffries, D. J., Hossain, I., Bottomley, C., … & Corrah, T. 2017. Impact of the introduction of pneumococcal conjugate vaccination on pneumonia in The Gambia: population-based surveillance and case-control studies. *he Lancet Infectious Diseases***,** 965-973.

Mara, D. 2016. Disease Priorities in Zambia. *The American Journal of Tropical Medicine and Hygiene,* 95**,** 248-249.

MCDMCH 2013. *Roadmap for Accelerating Reduction of Maternal, Newborn and Child Mortality, 2013-2016 No Woman Should Die Giving Life Committing to Child Survival: A Promise Renewed,* Lusaka.

MOH 2013. Roadmap for Accelerating Reduction of Maternal, Newborn and Child Mortality, 2013-2016.

MOH 2016. Zambia National Health Strategic Plan 2017 - 2021. 22.

Moyo, N., Makasa, M., Chola, M. & Musonda, P. 2018. Access factors linked to maternal deaths in Lundazi district, Eastern Province of Zambia: a case control study analysing maternal death reviews. *BMC Pregnancy and Childbirth,* 18**,** 101.

Munthali, T., Jacobs, C., Sitali, L., Dambe, R. & Michelo, C. 2015. Mortality and morbidity patterns in under-five children with severe acute malnutrition (SAM) in Zambia: a five-year retrospective review of hospital-based records (2009-2013). *Arch Public Health,* 73**,** 23.

Ndu, I. K., Ekwochi, U., Osuorah, C. D., Onah, K. S., Obuoha, E., Odetunde, O. I., Nwokoye, I., Obumneme-Anyim, N. I., Okeke, I. B. & Amadi, O. F. 2015. Danger Signs of Childhood Pneumonia: Caregiver Awareness and Care Seeking Behavior in a Developing Country. *Int J Pediatr,* 2015**,** 167261.

Noordam, A. C., Carvajal-Velez, L., Sharkey, A. B., Young, M. & Cals, J. W. 2015. Care seeking behaviour for children with suspected pneumonia in countries in sub-Saharan Africa with high pneumonia mortality. *PLoS One,* 10**,** e0117919.

Onyango, D., Kikuvi, G., Amukoye, E. & Omolo, J. 2012. Risk factors of severe pneumonia among children aged 2-59 months in western Kenya: a case control study. *Pan Afr Med J,* 13**,** 45.

Pabary, R. & Balfour-Lynn, I. M. 2013. Complicated pneumonia in children. *Breathe,* 9**,** 210-222.

Pradhan, S., Rao, A., Pattanshetty, S. & Nilima, A. 2016. Knowledge and perception regarding childhood pneumonia among mothers of under-five children in rural areas of Udupi Taluk, Karnataka: A cross-sectional study. *Indian Journal of Health Sciences and Biomedical Research (KLEU),* 9**,** 35-39.

Praygod, G., Mukerebe, C., Magawa, R., Jeremiah, K. & Torok, M. E. 2016. Indoor Air Pollution and Delayed Measles Vaccination Increase the Risk of Severe Pneumonia in Children: Results from a Case-Control Study in Mwanza, Tanzania. *PLoS One,* 11**,** e0160804.

Shahunja, K. M., Ahmed, T., Hossain, M. I., Das, S. K., Faruque, A. S., Islam, M. M., Shahid, A. S., Das, J., Sarker, M. H. & Chisti, M. J. 2016. Factors Associated With Pneumonia Among Overweight and Obese Under-Five Children in an Urban Hospital of a Developing Country. *Glob Pediatr Health,* 3**,** 2333794x16672528.

Srivastava, P., Mishra, A. K. & Roy, A. K. 2015. Predisposing factors of community acquired pneumonia in under five children. *Journal of Lung Diseases & Treatment,* 1.

Tazinya, A. A., Halle-Ekane, G. E., Mbuagbaw, L. T., Abanda, M., Atashili, J. & Obama, M. T. 2018. Risk factors for acute respiratory infections in children under five years attending the Bamenda Regional Hospital in Cameroon. *BMC Pulmonary Medicine,* 18**,** 7.

Tong., N. 2013. *Priority Medicines for Europe and the World "A Public Health Approach to Innovation,* 2013.

Tuhebwe, D., Tumushabe, E., Leontsini, E. & Wanyenze, R. K. 2014. Pneumonia among children under five in Uganda: symptom recognition and actions taken by caretakers. *Afr Health Sci,* 14**,** 993-1000.

Turner, C., Turner, P., Carrara, V., Burgoine, K., Tha Ler Htoo, S., Watthanaworawit, W., Day, N. P., White, N. J., Goldblatt, D. & Nosten, F. 2013. High rates of pneumonia in children under two years of age in a South East Asian refugee population. *PLoS One,* 8**,** e54026.

Ujunwa, F. & Ezeonu, C. 2014a. Risk Factors for Acute Respiratory Tract Infections in Under-five Children in Enugu Southeast Nigeria. *Ann Med Health Sci Res,* 4**,** 95-9.

Ujunwa, F. & Ezeonu, C. 2014b. Risk Factors for Acute Respiratory Tract Infections in Under-five Children in Enugu Southeast Nigeria. *Ann Med Health Sci Res,* 4.

UNICEF 2016. *One is too many ending child deaths from pneumonia and diarrhoea*.

Walker, C. L., Rudan, I., Liu, L., Nair, H., Theodoratou, E., Bhutta, Z. A., O'brien, K. L., Campbell, H. & Black, R. E. 2013. Global burden of childhood pneumonia and diarrhoea. *Lancet*, 381**,** 1405-16.

WHO 2014. Revised WHO classification and treatment of childhood pneumonia at health facilities: EVIDENCE SUMMARIES. Geneva, Switzerland: World Health Organization.

WHO. 2016. *Pneumonia Factsheet* [Online]. WHO. Available: http://www.who.int/mediacentre/factsheets/fs331/en/ [Accessed 2017].

APPENDICES

Appendix 1 Data Extraction Tool

The child file will be extracted from the ZDHS using Stata and the following data extraction form

	Data extraction	
	Variable	**Source**
1	Sex of Child	Children's Recode
2	Age of the mother	Individual Recode
3	Have you ever attended school?	Children's Recode
4	What is the highest level of school you attended?	Children's Recode
5	Total number of children under five in household	Children's Recode
6	Total number of people in the household	Individual recode
7	Residence	Children's Recode
8	Province	Children's Recode
9	Source of drinking water	Children's Recode
10	What do you usually do to make the water safer to drink?	Children's Recode
11	Type of cooking fuel	Household recode
12	Number of rooms in the house	Household recode
13	Place of delivery	Children's Recode
14	Mode of delivery Who assisted with the delivery of (NAME)?	Children's Recode
15	Duration of Breastfeeding	Children's Recode
16	Is the child currently breast feeding	Children's Recode
17	Residence	Children's Recode
18	Wealth index	Wealth index factor score
19	Does the child have a vaccination card	Children's Recode
20	How many times did the child receive the vaccinations	Children's Recode
21	Did the child receive vitamin A in the past 6 months	Children's Recode
22	Did the child receive measles injection	Children's Recode
23	When (NAME) had an illness with a cough, did he/she breathe faster than usual with short, rapid breaths or have difficulty breathing?	Children's Recode
24	Where did you seek treatment	Children's Recode
25	Nutritional status	Height and weight score

Appendix 2: Ethical approval

ERES CONVERGE

33 Joseph Mwilwa Ro
Rhodes Park, Lusa
Tel: +260 955 155 6
+260 955 155 6
Cell: +260 966 765 5
Email: eresconverge@yahoo.co.

I.R.B. No. 000059
F.W.A. No. 000116

30th August, 2017

Ref. No. 2017-June-014

Principal Investigator
Ms. Nelia Langa
The University of Zambia
School of Medicine
Dept. of Public Health
P.O Box 50110,
LUSAKA.

Dear Ms. Langa,

RE: TREND AND FACTORS ASSOCIATED WITH PNEUMONIA AMONG UNDER-FIVE CHILDREN IN ZAMBIA.

Reference is made to your resubmission dated 28th August, 2017. The IRB resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	**Ordinary**	Approval No. **2017-Jul-029**
Approval and Expiry Date	Approval Date: 30th August, 2017	Expiry Date: 29th August, 2018
Protocol Version and Date	Version-Nil	29th August, 2018
Information Sheet, Consent Forms and Dates	• N/A	29th August, 2018
Consent form ID and Date	Version-Nil	29th August, 2018
Recruitment Materials	Nil	29th August, 2018
Other Study Documents	Checklist.	29th August, 2018
Number of participants approved for study	-	29th August, 2018

Where Research Ethics and Science Converge

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

Conditions of Approval

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to the IRB within 5 days.
- All protocol modifications must be IRB approved prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to the IRB within 5 working days.
- All recruitment materials must be approved by the IRB prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. Documents must be received by the IRB at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Any documents received less than 30 days before expiry will be labelled "late submissions" and will incur a penalty.
- Every 6 (six) months a progress report form supplied by ERES IRB must be filled in and submitted to us.
- ERES Converge IRB does not "stamp" approval letters, consent forms or study documents unless requested for in writing. This is because the approval letter clearly indicates the documents approved by the IRB as well as other elements and conditions of approval.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of ERES Converge IRB, we would like to wish you all the success as you carry out your study.

Yours faithfully,
ERES CONVERGE IRB

Prof. E. Munalula-Nkandu
BSc (Hons), MSc, MA Bioethics, PgD R/Ethics, PhD
CHAIRPERSON

Appendix 3: Letter of authority

THE NATIONAL HEALTH RESEARCH AUTHORITY
C/O Ministry of Health
Haile Selaisse Avenue,
Ndeke House
P.O. Box 30205
LUSAKA

MH/101/23/10/1

11 September 2017
University of Zambia
School of Public Health
P.O Box 50110
LUSAKA

Re: Request for Authority to Conduct Research

The National Health Research Authority is in receipt of your request for authority to conduct research titled **"Trends and Factors Associated with Pneumonia among under five children in Zambia from 1996-2014"**

I wish to inform you that following submission of your request to the Authority, our review of the same and in view of the ethical clearance, this study has been **approved** on condition that:

1. The relevant Provincial and District Medical Officers where the study is being conducted are fully appraised;
2. Progress updates are provided to NHRA quarterly from the date of commencement of the study;
3. The final study report is cleared by the NHRA before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by the NHRA, the final study report is shared with all relevant Provincial and District Directors of Health where the study was being conducted, University leadership, and all key respondents.

Yours sincerely,

Sandra Chilengi-Sakala
For/Director
National Health Research Authority

Appendix 4: Data extraction tool

Data Extraction Tool

The child file will be extracted from the ZDHS using Stata and the following data extraction form

	Data extraction	
	Variable	**Source**
1	Sex of Child	Children's Recode
2	Age of the mother	Individual Recode
3	Have you ever attended school?	Children's Recode
4	What is the highest level of school you attended?	Children's Recode
5	Total number of children under five in household	Children's Recode
6	Total number of people in the household	Individual recode
7	Residence	Children's Recode
8	Province	Children's Recode
9	Source of drinking water	Children's Recode
10	What do you usually do to make the water safer to drink?	Children's Recode
11	Type of cooking fuel	Household recode
12	Number of rooms in the house	Household recode
13	Place of delivery	Children's Recode
14	Mode of delivery Who assisted with the delivery of (NAME)?	Children's Recode
15	Duration of Breastfeeding	Children's Recode
16	Is the child currently breast feeding	Children's Recode
17	Residence	Children's Recode
18	Wealth index	Wealth index factor score
19	Does the child have a vaccination card	Children's Recode
20	How many times did the child receive the vaccinations	Children's Recode
21	Did the child receive vitamin A in the past 6 months	Children's Recode
22	Did the child receive measles injection	Children's Recode
23	When (NAME) had an illness with a cough, did he/she breathe faster than usual with short, rapid breaths or have difficulty breathing?	Children's Recode
24	Where did you seek treatment	Children's Recode
25	Nutritional status	Height and weight score

APPROVED
30 AUG 2017
ERES CONVERGE
P/BAG 125, LUSAKA.

Appendix 5: Letter from Central Statistical Office

The Director,
Attn: The Data manager,
Central Statistical Office,
P.O. Box 31908,
Lusaka, Zambia.

BOX 31908, LUSAKA
DISSEMINATION OFFICE
24 AUG 2017
CSO
REPUBLIC OF ZAMBIA

5th May, 2017.

The University of Zambia,
School of Public Health,
P.O Box 50110,
Lusaka, Zambia.

Dear Sir/Madam

RE: PERMISSION TO HAVE ACCESS TO THE 2001-2002, 2007 AND 2013-2014 ZAMBIA DEMOGRAPHIC HEALTH SURVEY (ZDHS) DATA SET.

I am a postgraduate student currently pursuing a Master's of Science in Epidemiology and Biostatistics at the University of Zambia under the School of Public health. I am carrying out an academic research on the **"**Trends and factors associated with acute respiratory infection (Proxy for Pneumonia) among under-five children in Zambia using evidence from the 2001/02, 2007 and 2013/14 ZDHS**".**

Purpose of the study

The study will therefore investigate the factors associated with acute respiratory infection **(ARI)** among under five children in Zambia for the past twelve years (2002-2014). The findings will help with the reviewing and designing of new and targeted/appropriate prevention and control policies and programs/projects aimed at reducing acute respiratory infection among under five children in Zambia.

Benefits and Risks

The study will be able to add to the existing body of knowledge on respiratory infections which will help policy makers come up with the evidence based interventions. The study poses no harm

Data provided on 24/08/2017