# PNEUMOCOCCAL IMMUNISATION UPTAKE AND ASSOCIATED FACTORS AMONG CAREGIVERS OF INFANTS BETWEEN 4-12 MONTHS IN NYAMIRA COUNTY, KENYA

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**A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH (EPIDEMIOLOGY & DISEASE CONTROL) IN THE SCHOOL OF PUBLIC HEALTH AND APPLIED HUMAN SCIENCES OF KENYATTA UNIVERSITY.**

**NOVEMBER 2021**

## DECLARATION

This thesis is my original work and has not been presented for a degree or awards in any other University.

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## DEDICATION

I dedicate this work to Austin Bosire, Michelle Moraa and Stephanie Muthoni for their inspiration in every way.

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# TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **AOM:** | Acute Otitis Media |
| **BCG:** | Bacillus Calmette–Guérin |
| **CHeWs** | Community Health Extension Workers |
| **CHU** | Community Health Units |
| **DVI:** | Division of vaccines and immunization |
| **DPT 3:** | Diphtheria, Pertussis, Tetanus Vaccine-3 Doses |
| **GAVI:** | Global Alliance of Vaccines Immunization |
| **GAPPD** | Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea |
| **GMC** | Geometric Mean Concentrations |
| **IPD:** | Invasive Pneumococcal Disease |
| **MMWR** | Morbidity and Mortality Weekly Report |
| **NCBI** | National Centre for Biotechnology Information |
| **PCV 7:** | Pneumococcal conjugate vaccine of the seven- valent |
| **PCV 10:** | Pneumococcal conjugate vaccine of the ten- valent |
| **PCV 13:** | Pneumococcal conjugate vaccine of thirteen – valent |
| **PHiD-CV** | Pneumococcal Non-typable *Haemophilus influenzae* Protein D Conjugate |
| **UNICEF:** | United Nations Children Fund |
| **US** | United States |
| **WHO:** | World Health Organization |
| **SAGE** | Strategic Advisory Group of Experts on Immunization |

| | |
|---|---|
| **SDG** | Sustainable Development Goal |
| **SPSS** | Statistical Package for the Social Sciences |
| **USA** | United States of America |
| **CDC** | Centres for Disease Control and Prevention |
| **UoN** | University of Nairobi |

## DEFINITION OF OPERATIONAL TERMS

**Cyanosis:** Bluish or purplish discolouration of the skin or the mucous membrane caused inadequate of oxygen saturation of the tissues.

**Attenuated vaccines:** vaccines made from pathogens whose virulence is reduced by alteration.

**Care Giver:** The mother, father, family member or guardian that takes care of the infant including taking them for vaccination.

**Infant:** A young child or baby in this case the ones above four months that have already had the opportunity of full vaccination with all three doses of the PCV vaccine

**Infectious diseases:** These are disorders caused by organisms such as bacteria, viruses, fungi or parasites. They are normally harmless or even helpful, but under certain conditions, some organisms may cause disease. Some infectious diseases can be passed from person to person.

**Invasive Pneumococcal disease (IPD):** This is an infection caused by the isolation of *Streptococcus pneumoniae* from a normally sterile site such as blood or cerebrospinal fluid.

**Non-invasive Pneumococcal disease (non-IPD):** It is an infection caused by *Streptococcus pneumoniae* and occurs outside the major organs or the blood. It may be less serious than invasive pneumococcal disease

**Respiratory infections:** refers to any of a number of infectious diseases involving the respiratory tract.

**Vaccine efficacy:** Refers to the percentage reduction of disease in a vaccinated group of people compared to an unvaccinated group, using the most favourable conditions.

**Full Immunization Coverage (FIC):** Refers to when a child has received all the available and recommended vaccines in the country Expanded Immunization Programme.

## ABSTRACT

Pneumonia is the leading killer among all infectious diseases worldwide. Though treatable, it often results in high mortality and morbidity therefore putting pressure on available health resources. A child dies of pneumonia every 39 seconds bringing the total deaths to more than 2000 per day globally. In Kenya, pneumonia deaths accounted for 15% of child deaths translating to six deaths per 1000 live births in 2018, far from the GAPPD target of three per 1000. The best intervention for pneumonia is prevention through vaccination and Kenya introduced one of the vaccines, PCV 10 in January 2011.The uptake has however remained low thus leaving out a good proportion of children without prevention. The country coverage for PCV 10 has been declining between 2011 and 2017 with 85% and 71% respectively against a recommended target of ≥90%. This low coverage is reflected in the counties and one such county is Nyamira where in fact pneumonia was reported as the leading cause of death for the county in 2014. Within the County, Borabu Sub County is most affected where the PCV 10 coverage in 2017 was 61% while the County's was 64% respectively versus a national coverage of 71%. This study looked at the uptake of the Pneumococcal conjugate vaccine, ten- valent (PCV 10) immunization by Caregivers in Nyamira County, Borabu sub-county. A cross sectional approach was applied within Caregivers of children aged 4-12 months. While the County and Sub County to be studied were purposively sampled, the wards and community health units were randomly sampled. Caregivers within sampled households were then sampled to a total sample size of 349.Using questionnaires Caregivers were interviewed and a checklist was used to review the vaccination records. Data was analysed using descriptive statistics and inferential statistics including determining relationship between variables. The results obtained from this study indicated coverage of 82.7%for PCV 10. Caregivers were predominantly female, 97% and in informal employment. Among the demographic factors of the cohort, level of education and the number of children below 5 years were found to be statistically significant with p values of 0.029 and 0.019 as calculated using Fischer's Exact and Chi Square respectively. While 63% of the caregivers reported as having ever heard of PCV 10, a sizeable proportion, of 37% had never heard of the vaccine. Only 28% were aware of who is eligible for the vaccine. The likelihood of immunization increased with awareness of Caregivers on the vaccine. Indeed, results showed that knowledge of caregivers had a significant relationship with vaccine uptake with the p values of the knowledge factors resulting to <0.0001 as calculated with chi square. Furthermore, multiple logistic regression findings showed that all factors of knowledge were significant and strong influencers of PCV 10 uptake with resulting adjusted odds ratio with p values <0.005. The findings of this study therefore indicate that the uptake of PCV 10 in Borabu Sub County and in Nyamira County can be enhanced by increasing knowledge of Caregivers on PCV 10 and by enhancing compliance to the vaccination schedule.

# CHAPTER ONE: INTRODUCTION

## 1.1 Background

Pneumonia is a lower respiratory tract infection that affects one or both lungs. It can be caused by bacteria, fungi or virus. It is one of the leading causes of death in children below 5 years worldwide and a leading killer among all infectious diseases. Pneumonia contributed to 2,500 children mortality a day in 2015 across the Globe (UNICEF, 2017). Pneumonia affects children and families everywhere, but is most prevalent in South Asia and sub-Saharan Africa', (World Health Organisation, 2016). World Health Organization (WHO) estimates that *S. pneumoniae* kills close to half a million children under 5 years old worldwide every year, with most of these deaths occurring in developing countries (CDC, 2018).

Pneumonia can be prevented through immunization, proper nutrition and management of environmental factors. While the bacterial infection can be treated with antibiotics, only a third of the children who get sick are able to access the antibiotics due to various reasons including cost. Bacterial Pneumonia is caused by Streptococcus pneumonia and may result in invasive pneumococcal diseases (IPD) such as bacteraemia, meningitis and bacteremic pneumonia, or in non-IPD, such as pneumonia, sinusitis and Otitis media (McClure, Ford, & Wilson, 2006).

Children younger than 5 years are at highest risk of both IPD and non-IPD as demonstrated (UNICEF, 2017). Preventive measures must therefore be provided at the earliest age possible because the vulnerability is highest at the young age.

The importance of immunizing children against preventable diseases has long been established as demonstrated by the polio vaccination that has led to a 99% reduction of polio cases worldwide (World Health Organisation, 2017).

With pneumonia being a leading killer among infectious diseases worldwide, there is a compelling reason for the world to control it in order to achieve the Sustainable Development Goal (SDG) on health (UNICEF, 2019). One of the vaccines that are available against pneumonia is PCV-10; a ten-valent vaccine that targets 10 strains of *S. pneumonia* that cause IPD; this form of pneumonia is the most fatal. The vaccine has demonstrated 100% Vaccine Efficacy against vaccine type IPD and 70% efficacy in reducing vaccine type pneumococcal Acute Otitis Media (Tregnaghi et al., 2014).

Compared with the other vaccines available for childhood vaccination, PCV is one of the vaccines whose coverage remains low. By 2017, PCV had been introduced to 135 countries and the global coverage was estimated at 44% compared with DPT at 90% in 123 countries, (World Health Organisation, 2018). Sub-Saharan Africa is one of the regions where the coverage of PCV remains low achieving coverage less than 60% as indicated by (World Health Organisation, SAGE, 2017). The recommended routine vaccination of PCV is either three doses with DPT or 2 doses before 6 months of age, plus booster dose at 9-15 months of age, (World Health Organisation, 2018). Kenya has adopted the former routine.

According to World Health Organisation ‘a two-dose primary schedule elicits lower post-primary antibody concentrations (geometric mean concentrations, GMC) than a three-dose primary schedule for most vaccine serotypes’ (World Health Organisation, 2017). Both schedules however were reported to elicit reductions in IPD caused by serotypes within the vaccines, (World Health Organisation, 2017).

Immunization coverage is critical as a determinant of the number of children that can be saved from the infections. According to WHO, 'PCV uptake has accelerated and is now preventing almost 100,000 deaths per year', (WHO, 2017). Since introduction, 190,000 deaths have been averted; the more reason why uptake of PCV 10 in Kenya is critical, (WHO, 2017).

### 1.2 Problem Statement

In Kenya, six per 1000 deaths in under five were caused by pneumonia contributing to 15% of all child deaths in 2018, (Mugo, 2020). Pneumonia was identified as the leading killer disease in 2012 ahead of malaria with 19,011 cases, accounting for 10.9% deaths (Kenya National Bureau of Statistics, 2013). In addition, "Statistics from the Ministry of Public Health and Sanitation indicate that one in every five deaths in the country is attributed to pneumonia" (University of Nairobi, 2013).

In 2013, Nyamira County's leading cause of death was pneumonia different from the national, which was HIV/AIDs, (Department of Health Services, 2014). In addition, under five leading cause of death was reported as pneumonia (KNBS, 2015) making this an important county of study. In 2018, while the national under five mortalities due to pneumonia was six per 1000, Nyamira was among the 12 counties with more than double the rate: 12-14 deaths per 1000, (Mugo, 2020). Despite the availability of the vaccine (PCV 10) for prevention of the disease, the uptake has continued to decline in the county compared with national. The national Full Immunization Coverage (FIC) for children below one year decreased by 3% between 2016 and 2017 in Kenya while in Nyamira County it decreased by 23% between the same period, (Kenya National Bureau of Statistics, 2018).

Similarly, the coverage of PCV 10 was even lower in Borabu Sub County compared to the County. In 2017, the PCV 10 coverage in the County was 64% while Borabu Sub County was 61% for the third dose, (Department of Health Services, 2018). In Borabu Sub-County, coverage of PCV 10 decreased from 83% in 2013 to 61% in 2017 (Department of Health Services, 2018).

The high burden of pneumonia in the county coupled with low vaccine coverage means that morbidity and mortality of children due to pneumonia is still eminent. This makes this County important for this study.

### 1.3 Justification

One of Kenya's vision 2030 goals is to ensure that all forms of healthcare services are available and affordable to improve the health status of the people. Immunization during childhood has been proven the most effective strategy for the prevention of many infectious diseases, (Mutua, Murage, & Remare, 2011). PCV 10 is a vaccine 'immunogenic against Pneumococcal Disease four weeks after completion of three doses' (Nyongesa, 2015). In Kenya, an efficacy study in Kilifi established that PCV 10 results in an estimated 42.7% reduction in pneumococcal disease episodes and a 6.1% reduction in childhood deaths, (WHO, 2015). PCV 10 reduces pneumococcal bacterium in the population by two thirds therefore offering not just individual protection but also herd immunity (Laura L Hammitt, 2014). It is therefore a key pillar in reduction of pneumonia infections and deaths.

On the other hand, *S. pneumonia,* one of the causes of pneumonia has shown resistance to antibiotics used in treatment. This resistance causes reduction in efficacy of antibiotics available that not only affect pneumonia as an infection but also other infections caused by related bacteria. This has a fundamental impact on the number of antibiotics that humanity will have effective for treatment of bacterial infections something that should be avoided in all populations as it risks increasing mortality overall. Reducing the number of infections will help preserve the antibiotics.

According to (Olayinka, Ewald, & Steinglass, 2017), there is need for further study in Africa 'to identify and address factors that affect maintenance of high coverage following introduction of new vaccines in the African region'.

Few studies have been conducted in the County to determine the reasons for the low coverage and few studies exist in the country that could inform the intervention on PCV 10 vaccine uptake.

### 1.4 Research Questions

i. What is the knowledge on the Pneumococcal Immunization among Caregivers of infants between 4-12 months in Nyamira County?
ii. What are the pneumococcal immunization coverage patterns among infants between 4-12 months in Nyamira County?
iii. What are the factors that influence pneumococcal immunization uptake among Caregivers of infants between 4-12 months in Nyamira County?

## 1.5 Hypothesis

Knowledge of Caregivers of infants between 4-12 months in Borabu Sub County is not associated with Pneumococcal Immunization uptake.

There are no factors associated with Pneumococcal Immunization uptake among Caregivers of infants between 4-12 months in Borabu Sub County.

## 1.6 Objectives

### 1.6.1 General Objective:

To determine pneumococcal vaccine uptake among Caregivers of infants between 4-12 months in Nyamira County.

### 1.6.2 Specific Objectives:

i. To establish knowledge on pneumococcal immunization among Caregivers of infants between 4-12 months in Borabu Sub County, Nyamira County
ii. To determine pneumococcal immunization coverage of infants between 4-12 months in Borabu Sub County, Nyamira County
iii. To determine factors that influence pneumococcal vaccine uptake among Caregivers of infants between 4-12 months in Borabu Sub County, Nyamira County.

## 1.7 Significance

This study seeks to inform on the uptake of PCV 10 in Nyamira County, knowledge level of the Caregivers and the possible factors that influence them to seek PCV 10 vaccination. This in return will help the County Caregivers in taking relevant measures to strengthen the vaccine seeking behaviours among Caregivers and hence increasing the coverage.

Increased PCV 10 coverage could reverse the trend of pneumococcal diseases and save lives of the children as well as reduce the pressure in the health resources within the county. The study findings will also be useful for policy making, as insights for further studies or recommendations adopted by regions with similar challenges in the county, country and the globe as a whole.

## 1.8 Limitation and Delimitation

### 1.8.1 Limitation

The study involved visiting of Caregivers in their households to administer the questionnaires and review the child immunization record.

Being a vast area to cover, the issue of budget to reach the more than 300 households within the 8 wards presented financial challenges. This was addressed by use ‘bodaboda’ a more affordable transport methods that was also fast and effective.

### 1.8.2 Delimitation

This study was delimited to the Caregivers of children between 4 to 12 months and within Borabu Sub-County. Only the uptake of the PCV 10 vaccine, knowledge of caregivers on the vaccine and the factors influencing the uptake of the vaccine were analysed. The analysis was conducted from the data collected through the questionnaires and that obtained from the child vaccination record.

## 1.9 Conceptual Framework

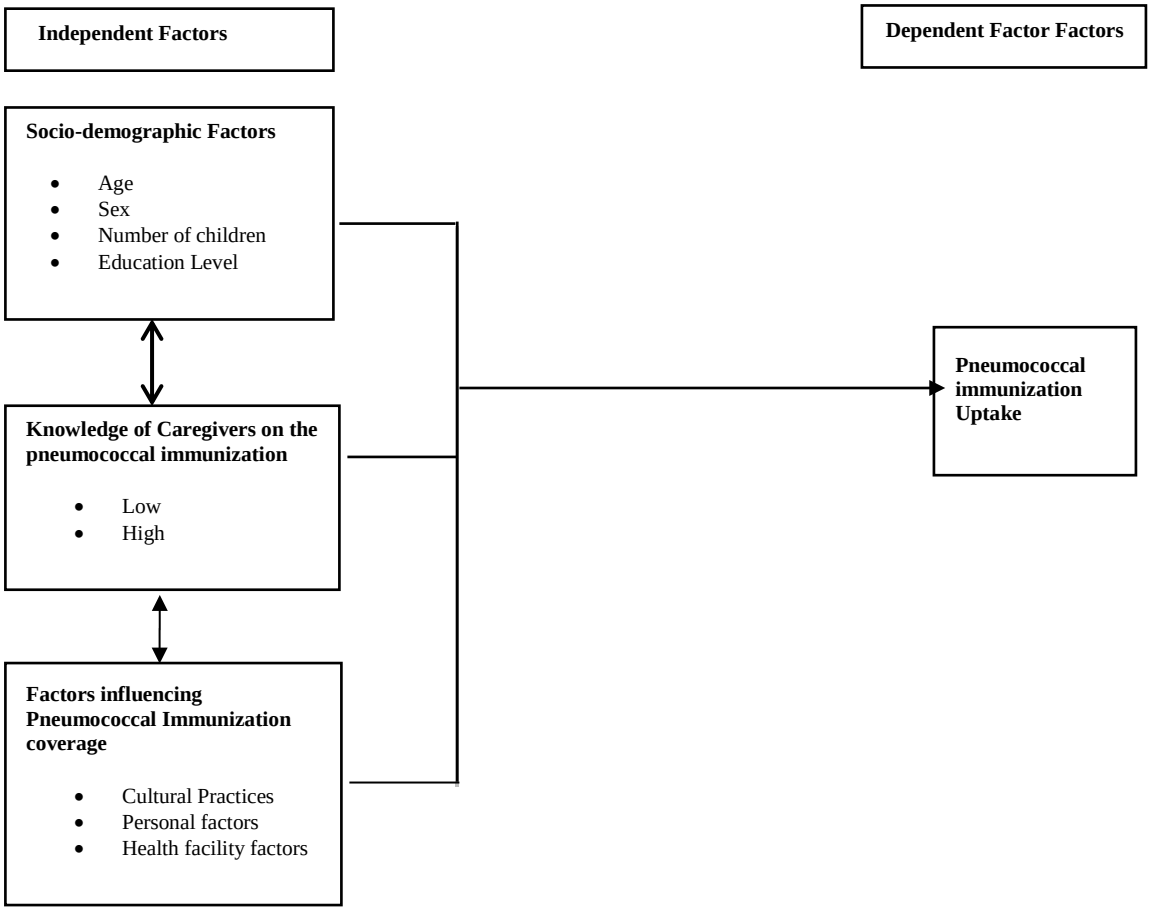


**Figure 1.1: Conceptual Framework**

# CHAPTER TWO: LITERATURE REVIEW

## 2.1 Epidemiology of Streptococcal pneumonia

Pneumonia is an inflammatory condition of the lung affecting primarily the alveoli caused by infection with viruses or bacteria and less commonly by other microorganisms. The inflammation leads to filling of alveoli with inflammatory exudates and impairing gas exchange. Morbidity and mortality from pneumonia are highest in children below five years, elderly patients and immune-compromised host. Typical symptoms of pneumonia include some combination of productive or dry cough, pleuritic chest pain, fever and trouble breathing. *Streptococcus Pneumoniae* is the major cause of bacterial pneumonia bacterial meningitis, bacteraemia, and Otitis media among other infections. It has several serotypes whose distribution and isolation in pneumonia cases is important in immunization strategies.

Treatment of pneumonia involves curing of the infection and preventing complications. It includes the use of antibiotic medicines to treat bacterial pneumonia, cough medicine to calm coughs and fever/pain relievers. Pneumonia is often treated empirically without identification of the causative pathogen, which carries the risk of the development of antibiotics resistance. Overall, pneumonia is a huge consumer of health resources more so in developing countries and therefore an important public health concern. It can however be prevented in children under two years of age through vaccination. This involves immunizing the infants with PCV vaccines.

## 2.2 Vaccines and Value of Vaccination

A vaccine is a substance used to stimulate immune responses in a host to produce antibodies that provide immunity against one or several diseases. They are prepared from the causative agent of a disease, its products, or a synthetic substitute treated to act as an antigen without inducing the disease-causing organism. Vaccination is the art of immunization with a vaccine to improve immunity of an individual against a disease organism itself. There are several types of vaccines e.g., Inactivated, Attenuated, Toxoid vaccines, Subunit, Conjugate and DNA vaccines among others. PCV is a conjugated vaccine that has been added a protein to enhance immune system response in infants below 2 years. PCV vaccines have been available since 2000 with the first PCV vaccine produced being PCV7, (World Health Organisation, SAGE, 2017). WHO has now recommended two PCV vaccines for use in pneumococcal vaccination; PCV 10 and PCV 13, (World Health Organisation, SAGE, 2017). These vaccines differ in the number of serotypes that have been included in the vaccine.

The importance of vaccines has long been established with major breakthroughs that have been made with previous vaccines. According to CDC, vaccines are one of the greatest achievements of biomedical science and public health', (Centre for Disease Control and Prevention, 1999). Every year an estimated 2-3 million deaths are averted and 750,000 children are saved from disabilities through vaccination. Vaccines have been identified as having even greater impact compared with other interventions; "With the exception of safe water, no other modality, not even antibiotics, has such a major effect on mortality reduction as compared to vaccines" (Pollard, 2007).

Due to the prevention that vaccines offer against diseases, the impact it has on health resources is quite evident. Immunization reduces the social and financial costs of treating diseases, offering opportunities for poverty reduction and greater social and economic development. Days that could have been taken up as sick offs to cater for sick children could be used to do a productive development in a society. For instance, World Health Organization estimated savings due to eradication of smallpox to more than US$ 1 billion (World Health Organisation, 2010).

Similarly, PCV vaccines have been documented as having great impact on prevention of pneumococcal disease; 'Immunization with PCV is one of the most important interventions protecting against pneumonia', (Olayinka, Ewald, & Steinglass, 2017). Vaccination with PCV not only decreases chances of children contracting pneumonia but also reduces the instances of other infections caused by the serotypes e.g., Acute Otitis Media. Review by WHO revealed evidence of impact for clinical and chest X-ray confirmed (CXR) pneumonia for three doses of PCV (World Health Organisation, 2017). PCV has been observed to reduce significantly the incidence of IPD due to *Streptococcus Pneumoniae* with 'virtual disappearance of disease due to serotypes of the organism in the vaccines used' (World Health Organisation, 2014). PCV is effective in preventing vaccine-type pneumococcal infections in HIV-uninfected children including those malnourished and exposed, (Cohen, et al., 2017). In Brazil, a study indicated that though 'improvements in nutrition, hygiene, education, and health care have an important role in reducing pneumonia mortality, PCV leads to even larger reductions in pneumonia mortality in low-income areas', (Schuck-Paim, Taylor, Alonso, Weinberger, & Simonsen, 2019). This underscores the importance of PCV vaccine in low-income countries.

The lack of vaccination whether due to absence of the vaccine or low coverage has the opposite and detrimental effect on preventable diseases. Morbidity and mortality increase with lack of vaccination. Even then, we still have a large number of infants who are still not getting the vaccines. 19.5 million Infants worldwide continue to miss basic vaccines even as the vaccine preventable diseases cause estimated 1.5m deaths due low coverage, (World Health Organization, 2018). This is a huge loss in humanity and one that can be addressed with increased uptake of vaccines and thus aversion of such deaths and loss of health resources. It is in light of these eminent challenges and the underlying importance of vaccination that studies on vaccination become critical towards making the goal of reduction of deaths of under-five.

## 2.3 Vaccination Coverage and challenges in Immunisation

### 2.3.1 Global

Despite the documented benefits of vaccines, still 58% of global infant population is not receiving them, (CDC, 2018). In 2015 while the countries using vaccines increased, the coverage remained a challenge with the global coverage for three doses of the pneumococcal vaccine reaching just 37%, (World Health Organisation, 2018). In 2016, the global coverage of PCV was 42% with the vaccine having been introduced in 134 countries (World Health Organisation, 2018). In 2018, '86% of infants worldwide (116.3 million infants) received 3 doses of diphtheria-tetanus-pertussis (DTP3) vaccine' while 129 countries reached 90% coverage of DPT3 vaccine, (World Health Organisation, 2019). PCV vaccine had been introduced to 145 countries by 2018 and the coverage was estimated at 47%, (World Health Organisation, 2018; World Health Organisation, 2019).

The coverage of vaccination varies from one country to another and from one vaccine to another. In 2018, the DPT3 coverage was 99% in China and Greece while none of the Africa Countries was among the top 10 best coverage for the vaccine, (World Health Organisation, 2019). PCV3 coverage in some developed countries was well impressive with coverage above 97% in UAE, Sweden and Japan, yet others had poor coverage e.g., Poland and Slovenia with 60% coverage, (World Health Organisation, 2019)

### 2.3.2 Africa

Developing countries host the bulk of the infants and thus a critical region where the battle of vaccination ought to be won yet there are still gaps to be filled. 62% of world under five populations are in the low and lower middle-income countries yet 90% of global pneumonia and diarrhoea deaths occur here (UNICEF, 2017). In developing countries, nearly 20% of the children still do not have access to or parents/authorities do not have willingness or ability to pay for routine childhood vaccinations before their first birthday (UNICEF; World Health Organisation; World Bank;, 2009). An approximated 15% of annual birth cohort (19.9m) are either not immunized or are under immunized; of these, 10 million are in Sub Saharan Africa and are unimmunized or under immunized due to low coverage, (Madhi, 2018).

According to World Health Organisation, while there has been an increase in the number of vaccines that have been introduced in Africa, ‘infant immunization coverage in the World Health Organisation African region has stagnated in the past few years while countries, ability to maintain high immunization coverage rates following introduction of new vaccines has been uneven’, (Olayinka, Ewald, & Steinglass, 2017).

In 2014, there were fewer than half of the African countries that had achieved 'the GVAP target to increase DTP3 coverage nationally above 90%' yet this vaccine has been in UMV for more than 10 years, (Mihigo, Badr, O'Malley, & Chaudhri, 2016).

Therefore, while availability of vaccines in Africa is a step in the right direction, coverage of the eligible population is critical in order to achieve the benefits of the vaccines.

For instance, among the countries that introduced the PCV between 2008 and 2013, 'nearly one-third of countries did not achieve 80% infant PCV3 coverage by two years post-introduction and 58% of countries experienced a decline in coverage between post introduction years two and four' (Olayinka, Ewald, & Steinglass, 2017). When compared with the developed countries, the coverage of low-income countries is still low. During 2012-2013, vaccine coverage in England with PCV13 reached 94.4% for primary immunization and 92.7% for the booster (Rodrigues, 2017). In 2004, the global immunization coverage of DPT 3 vaccine had improved with most countries achieving more than 78% coverage; however, the Africa region was only 69% (World Health Organisation, 2007). Among the top ten countries with the most unvaccinated children in 2018, four were from Africa: Nigeria, Ethiopia, DRC and Angola, (Elder, 2020; World Health Organisation, 2019). Nigeria reached 45% of its children with vaccines in 2011, (Elder, 2020).

### 2.3.3 Kenya

In Kenya, complete vaccine coverage was at 57% in 2003 while an 'estimated 35% of new-borns had not been immunized in 2006, translating into 0.5 million', (Maina, Karanja, & Kombich, 2013). National coverage does not always reflect the same level of coverage at sub national level.

In 2007, the proportion of children aged 12-23 months that were reported to have received all recommended vaccinations in Kenya was 77.4% but some regions achieved less than 50% coverage (Maina, Karanja, & Kombich, 2013). There has been a high level of missed opportunities for vaccination leading to low coverage of vaccines in Kenya and especially for vaccines with multiple does like the PCV 10 vaccine, (Mutua, et al., 2016).

Mutua et al observed that 33% of the children were not fully immunized by 12 months of age in Kenya mainly due to missed third doses of polio and pentavalent, (Mutua, et al., 2016). This pinpoints the challenge of full vaccination for vaccines with multiple doses like PCV 10. Kenya reported decline in coverage of PVC3 from 2014 to 2017 from 81% to 71% respectively (World Health Organisation/UNICEF, 2018). In 2018, Kenya had PCV3 coverage of 81%, a great improvement from 71% in 2017, (World Health Organisation/UNICEF, 2018). In the same year, the coverage of DPT3 and BCG was at 95% respectively, (World Health Organisation/UNICEF, 2018).

PCV 10 Vaccine national coverage in Kenya declined from 2011 to 2016 by 8% with 2016 coverage at 78%. This compares with BCG at 86% and DPT 3 at 78% in the same year. High vaccine uptake translates to greater immunization coverage and ultimately reduced deaths from the preventable disease.

In Kenya, a study on sustainability of the PCV vaccine post GAVI supports the continuation of the vaccine predicting that discontinuation of the PCV 10 would result to increased incidence of IPD disease from 8.5 in 2022 to 16.2 in 2032 per 100,000, (Ojal, et al., May, 2019). In 2018, UNICEF reported the deaths due to pneumonia for children below five years as six per 1000, (Mugo, 2020). Nyamira county was one of the 12 counties that had even higher than national under five mortalities due to pneumonia in 2018 rating between 12 and 14 per 1000, (Mugo, 2020).

### 2.3.4 Summary of Literature Review Isolating Study Gap

In Kenya, PCV 10 is available and free for all infants below one year. It is available in the EPI programme. However, the coverage of PCV is still below 90% and uneven with some regions achieving less than 50% (Maina, Karanja, & Kombich, 2013). Nyamira FIC dropped by 23% between 2016-2017 (Kenya National Bureau of Statistics, 2018). In Borabu Sub County, coverage of PCV 10 was 83% in 2011, 67% in 2016 and 61% in 2017 (County Government of Nyamira, 2018).

There is still high mortality rate due to pneumonia which emphasise the importance of increasing the uptake of the vaccine. One of the most affected counties include Nyamira with a mortality rate due to pneumonia at 12-14 deaths per 1000 (Mugo, 2020). A study has predicted that discontinuation of PCV would result in increased incidence of pneumonia thus the need for getting strategies to increase its uptake (Ojal, et al., May, 2019).

# CHAPTER THREE: MATERIALS AND METHODS

## 3.1 Research Design

The study adopted a cross sectional design. This design was appropriate given that the primary objective was to estimate pneumococcal vaccine uptake in a rural population in Nyamira County at a given point in time. The cross-sectional study also allowed for exploration of factors associated with pneumococcal vaccine uptake in the study population.

## 3.2 Variables

The primary dependent variable for the study was uptake of pneumococcal vaccine defined as having received all the three doses of the vaccine. This variable is dichotomized into two outcomes: Fully vaccinated with PCV versus Not Vaccinated with PCV. The independent variables include socio demographic factors and knowledge about the vaccine.

## 3.3 Location of Study

The study location was Borabu Sub- County in Nyamira County. The County and Sub-County were purposely selected from among the other Kenya Counties and Nyamira Sub-Counties respectively due to its declining PCV 10 coverage (Department of Health Services, 2018) and the high rate of mortality due to Pneumonia (Mugo, 2020).

### 3.4 Study Population

The study comprised of children between the ages of 4 to 12 months to assess their PCV vaccination status. The caregivers of the children provided information on their children's vaccination details and were interviewed on knowledge about the vaccine. The children below 1 year represent 3.3% of the total population in the county. In 2017, the Sub- County had an estimated population of 138,510 in 30,111 households. Of these, children under 1 year were 4571 (Department of Health Services, 2014).

### 3.5 Sampling Techniques

Nyamira County and Borabu Sub County were purposively selected for this study due to the low PCV 10 immunization coverage (Department of Health Services, 2018). Simple random sampling was used for the wards, the Community Health Units (CHU) and the households within the Sub County. Community Health Extension Workers (CHeWs) assigned to the respective units helped in random sampling of the households within each community unit for Caregivers of 4-12 months infants. For households with more than one Caregiver of 4-12 months infant, simple random sampling was applied.

### 3.6 Sample size determination

The Statistical Cochran equation was applied to determine sample size follows;

$n_0=Z^2pq/e^2$Where; **n0**= sample size, **Z** is the abscissa of the normal curve that cuts off an area α at the tails; at the desired confidence level of 95% $Z_=$ 1.96; **p** is the estimated proportion of an attribute that is present in the population.

**p =** 0.67 (percentage of infants between 4-12 months that are likely to be immunized based on administrative immunization coverage for 2017 at 67%); **q** is (1-p) and **e** is the degree of accuracy. At 95% level of confidence; **e**= 5% = 0.05

$n_0=Z^2pq/e^2=1.96^2*0.67*0.33/0.05^2=$**340. T**he final sample size that was taken in this study was 349.

### 3.7 Construction of Research Instruments

Questionnaires were developed as the primary data collection tools and they were administered to the study subjects through interviews. A checklist was used to review the child Vaccination record to verify the state of the immunization of the infant.

### 3.8 Pre-test.

Before actual implementation of the study, a pre-test of the questionnaires was done on a sample of households selected randomly from Bosamaro ward in Nyamira South Sub County, Nyamira County.

### 3.9 Validity

The questionnaires were subjected to reviews by experts in child health to ascertain the content validity of the questions in assessing immunization status of the eligible infants and knowledge of caregivers about the vaccine.

### 3.10 Reliability

The actual questionnaire was administered to selected study subjects to ensure that the questionnaire produced similar results on repeated interviews. Any questions that were generating varied responses on repeated administration were revised to enhance consistency.

### 3.11 Data Collection Techniques

The data was collected by use of interviewer-administered questionnaires. The research assistants were taken through basic training on interviewing techniques to enhance validity of the data collected. A checklist was used to obtain objective data on the child's immunisation status.

### 3.12 Data analysis

Descriptive analysis was performed on the data using proportions for categorical variables and means and medians for continuous variables. Inferential statistics were applied to test for association between independent variables and dependent variable. Firstly, a bivariate analysis was done using Chi square test, T test and Fisher's exact to identify variables that were significantly associated with vaccination uptake. Secondly, a multiple logistic regression was fitted using the forward selection technique to identify the influencers of vaccination uptake and their adjusted odds ratios.

### 3.13 Logistical and Ethical Considerations

In order to ensure conformity to ethical guidelines for conducting research on humans, the study sought approvals from the relevant bodies including, Kenyatta University Ethical Review Committee and the National Commission for Science and Technology (NACOSTI). Permission to collect was also sought from the county administrative offices before commencement of fieldwork. Privacy and confidentiality of the information from the respondents was ensured by having all interviews done in private. Before participation in the study, all respondents signed an informed consent form after being informed of the purpose and their expected roles in the study.

# CHAPTER FOUR: RESULTS

## 4.1 Introduction

This chapter contains a compilation of the findings obtained from the study on pneumococcal immunisation uptake among caregivers of infants between 4-12 months in Nyamira county, Kenya. In the content, various tools of data presentation including tables, charts and graphs have been compiled.

## 4.2 Socio-demographic Characteristics

The study comprised of 349 caregivers of infants aged between 4 and 12 months drawn from Borabu sub county, Nyamira County. The demographic characteristics of the study sample are summarized in table 4.1. The sample predominantly comprised of females (96.8%, n=349) and only 3.2 % were male, Table 4.1. Most caregivers had some form of education. The number of caregivers with secondary level of education was the highest at 57.9% followed by primary at 32.1% while the university level had the least population at 2%, Table 4.1. Most caregivers were in informal employment (90.49%) and only 6.05% were formally employed, Table 4.1.

**Table 4. 1: Socio-demographic characteristics of the Caregivers**

| Characteristic | Frequency | % |
|---|---|---|
| **Sex (n=348)** | | |
| Men | 11 | 3.2 |
| Female | 337 | 96.9 |
| **Education (n=349)** | | |
| None | 1 | 0.39 |
| Primary | 112 | 32.1 |
| Secondary | 202 | 57.9 |
| College | 27 | 7.7 |
| University | 7 | 2 |
| **Occupation (n=347)** | | |
| Unemployed | 12 | 3.46 |
| Informally employed | 314 | 90.49 |
| Formally employed | 21 | 6.05 |
| **Number of children below 5 years (n=351)** | | |
| 1-3 | 334 | 95.16 |
| > 3 | 17 | 4.84 |

## 4.3 Knowledge about pneumococcal vaccine

Data on each of the variables about knowledge of the vaccine is presented in Table 4.2. The data on knowledge about pneumococcal vaccine was obtained by asking questions on awareness of the vaccine, eligibility and mode and time of the vaccination.

Though a majority of the respondents reported ever having heard of the pneumococcal vaccine (62.6%), a sizeable proportion of the caregivers still indicated that they had never heard about the vaccine (37.4%), Table 4.2.

The caregivers that were aware of when the vaccine is supposed to be administered in terms of the age of the child were 64% while 36% were unaware, Table 4.2. While 27.8% knew who was eligible for the vaccine there were 72.2% who were unaware. Asked about how the vaccine is administered, 72.5% were aware while 27.5% were not, Table 4.2.

**Table 4. 2 Knowledge about pneumococcal vaccine**

| Variable | Frequency |
|---|---|
| **Aware of the vaccine (n=348)** | |
| No | 130(37.36%) |
| Yes | 218 (62.64%) |
| **Knowledgeable on eligibility for the vaccine (n=349)** | |
| No | 252(72.21%) |
| Yes | 97 (27.79%) |
| **Aware of when the vaccine is administered (n=349)** | |
| No | 125 (35.92%) |
| Yes | 224 (64.08%) |
| **Aware of how vaccine is given (n=349)** | |
| No | 96 (27.5%) |
| Yes | 253 (72.5%) |

### 4.3.1 Overall knowledge

In terms of overall knowledge on PCV vaccines more than half the Caregivers interviewed had some form of knowledge on PCV 10, Figure 4.1. This knowledge ranged from whether they knew of the vaccine, who would benefit from it, how and when it would be administered. A sizeable portion of the Caregivers lacked knowledge on the PCV vaccine, Figure 4.1.

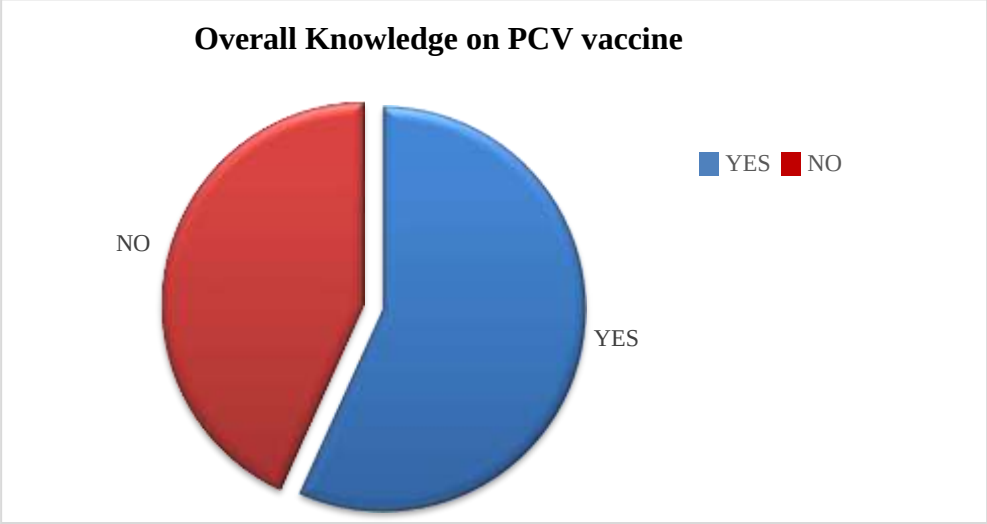


**Figure 4. 1 Overall Knowledge of Caregivers on PCV vaccine**

## 4.4 Analysis of association to vaccine uptake.

**Table 4. 3: Bivariate analysis of association of socio-demographic factors to vaccine uptake.**

| Variable | Pneumococcal vaccination uptake | | | Test | P value |
|---|---|---|---|---|---|
| | Not fully vaccinated Frequency (%) | Fully vaccinated Frequency (%) | Totals | | |
| Level of education | | | | | |
| None | 1(100) | 0 (0) | 1 (100) | Fisher's exact | 0.029* |
| Primary | 27 (24.11) | 85(75.89) | 112 (100) | | |
| Secondary | 31 (15.35) | 171(84.65) | 202 (100) | | |
| College | 2 (7.41) | 25 (92.59) | 27 (100) | | |
| University | 0 (0) | 7 (100) | 7 (100) | | |
| Age of caregivers | Mean age: 27.9 years | Mean age: 27.1 years | | t-test | 0.31 |
| Occupation | | | | | |
| Unemployed | 0 (0) | 12 (100) | 12 (100) | Fisher's exact | 0.28 |
| Informally employed | 58 (18.47) | 256 (81.53) | 314 (100) | | |
| Formally employed | 3 (14.29) | 18 (85.71) | 21 (100) | | |
| Number of children below 5 years | | | | Chi square, $X^2$= 29 df=1 | 0.019* |
| 1-3 | 55 (16.47) | 279 (83.53) | 334 (100) | | |
| >3 | 6 (40.00) | 9 (60.00) | 15 (100) | | |

### 4.4.1 Analysis of association of socio-demographic factors to vaccine uptake

The level of education of caregivers was found to be significant in terms of association with the vaccine uptake (P=0.029) (Table 4.3).

Similarly, the number of children that the Caregivers had below 5 years was significantly associated with the vaccine uptake ($\chi^2$=29; df=1; p=0.019) (Table 4.3). The age and occupation of the caregivers were not statistically significant in terms of association with the vaccine uptake with p values of 0.28 and 0.30 respectively, (Table 4.3).

### 4.4.1 Analysis of association of knowledge factors to vaccine uptake

The caregiver's awareness of the vaccine (in terms of whether they ever heard of the vaccine) was significantly associated with uptake of the vaccine ($\chi^2$=70; df=1; p=0.0001) (Table 4.4).

The caregiver's awareness of a vaccine for pneumococcal disease determined whether they took the child to the health care facility to be administered the vaccine or did not. The caregiver's awareness of who was eligible for the PCV 10 vaccine determined whether they took the child to be administered the vaccine or not (p<0.0001 $X^2$= 25.2 and df=1) Those parents that were aware of when the child was required to get the vaccine were more likely to take the child for the vaccine compared with those who were not.

**Table 4. 4: Knowledge of Caregivers on PCV 10**

| **Variable** | **Pneumococcal vaccination uptake** | | | |
|---|---|---|---|---|
| | Not fully vaccinated Frequency (%) | Fully vaccinated Frequency (%) | Test | P Value |
| **Aware of the vaccine** | | | Chi square | <0.0001* |
| No | 51 (39.23) | 79 (60.77) | $X^2$ =70.3 | |
| Yes | 9 (4.13) | 209 (95.87) | df=1 | |
| **Aware on who is eligible to receive the vaccine** | | | Chi square | <0.0001* |
| No | 60 (23.81) | 192 (76.19) | $X^2$= 25.2 | |
| Yes | 1 (1.03) | 96 (98.97) | df=1 | |
| **Aware on how the vaccine is given** | | | Chi square | <0.0001* |
| No | 47 (48.96) | 49 (51.04) | $X^2$= 91 | |
| Yes | 14 (5.53) | 239 (94.47) | df=1 | |
| **Aware on when vaccine is given** | | | Chi square | <0.0001* |
| No | 51 (40.80) | 74 (59.20) | $X^2$ = 73.1 | |
| Yes | 10 (4.48) | 213 (95.52) | df=1 | |

## 4.5 Pneumococcal vaccination Coverage

### 4.5.1 Coverage of pneumococcal vaccine among children

One of the objectives of this study was to determine pneumococcal immunization coverage of infants between 4 to 12 months. Data on the vaccination uptake was obtained by first asking the caregivers whether their children had been vaccinated, and then going further to verify the details from child's immunization card. The overall uptake of pneumococcal vaccine was dichotomized into fully vaccinated (all three doses given) and not fully vaccinated (less than three doses).

A breakdown of the number of pneumococcal vaccine doses received and the overall vaccine coverage is presented in figures 4.2, 4.3 and 4.4. Overall, a majority (82.5%,) of the children had been fully vaccinated for PCV 10 while 17.48% were not fully vaccinated, (Figure 4.2). Of the children that were not fully vaccinated (36%) had received none of the three vaccine doses that are recommended, 25% had received only one dose and 39% had received two doses (Figure 4.3). The children who received only two doses (62%) were more that those who had received only one dose 38% among the not fully immunized children (Figure 4.4).

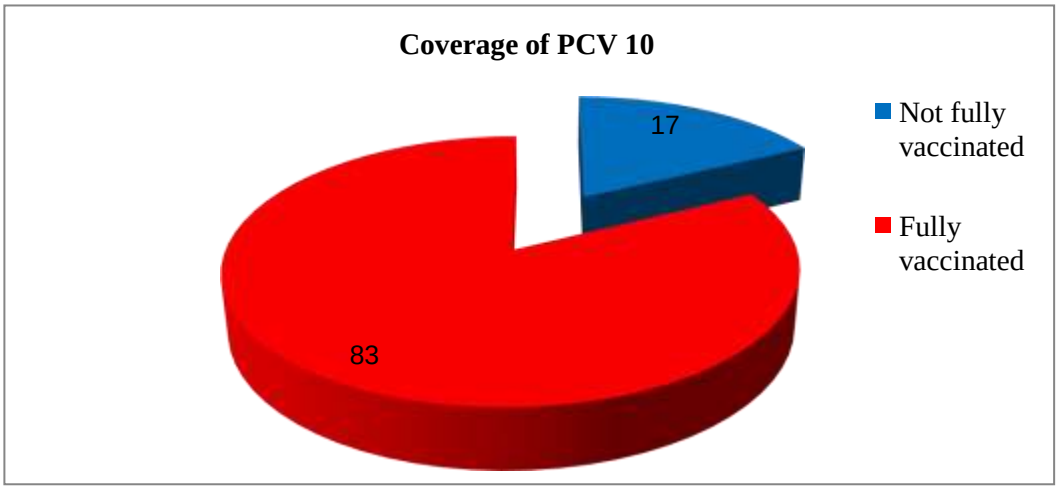


**Figure 4. 2: Proportion of doses given to children not fully vaccinated.**

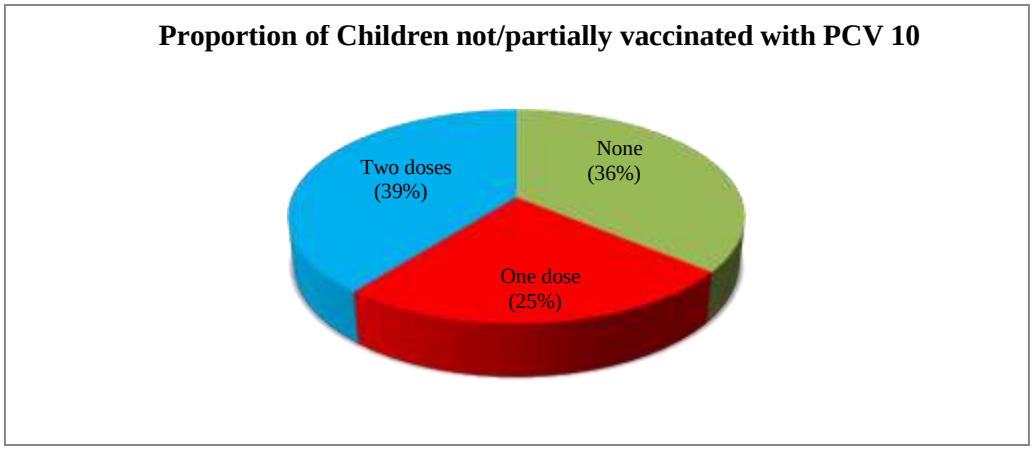


**Figure 4. 3: Unvaccinated children**

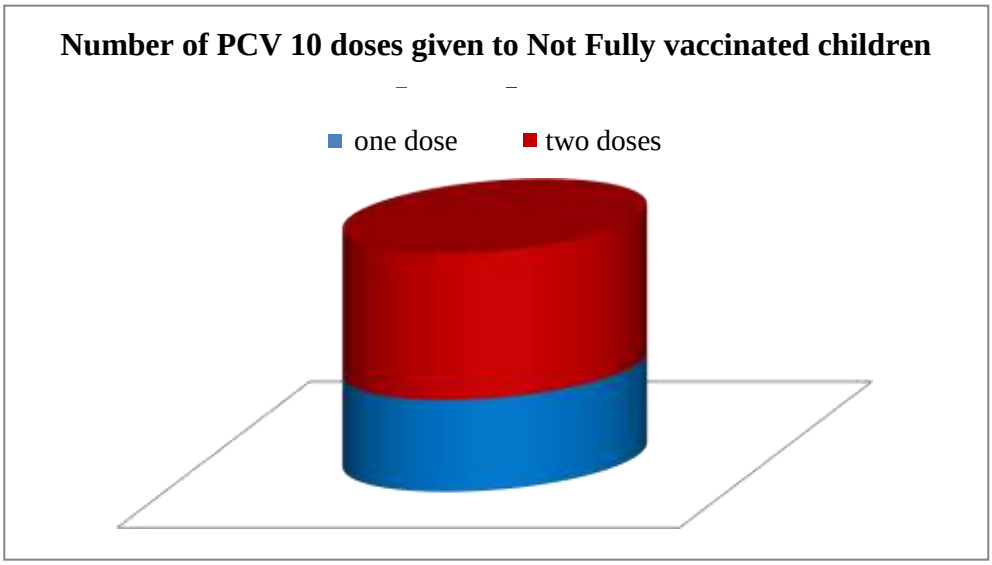


**Figure 4. 4: Partially vaccinated children**

### 4.5.2 Facilities visited by Caregivers for vaccination services and reasons for choice of facility.

The facilities where vaccination services were sought from are presented in table 4.5. The dispensary was the most utilized facility for vaccination services taking up (63%) of all health facilities visited with the least utilized being the County referral hospital at 3% (Table 4.5). The Sub- County hospital and the Mission hospital were frequented equally as in Table 4.5.

**Table 4. 5: Facilities frequented for vaccination services**

| **Facility (n=349)** | **Frequency** | **%** |
|---|---|---|
| Dispensary | 221 | 63.3 |
| Sub County Hospital | 22 | 6.3 |
| Mission Hospital | 21 | 6 |
| County Referral Hospital | 11 | 3.2 |
| Private hospital | 12 | 3.4 |

**Table 4. 6: Reasons behind Caregivers' choice of Health Facility as Dispensary**

| Reason (n= 221) | Frequency | % |
|---|---|---|
| Near | 171 | 77.4 |
| Stock available | 34 | 15.4 |
| Recommended | 27 | 12.2 |
| Vaccination schedule regular | 31 | 14 |
| Good services | 68 | 30.8 |

In terms of the reasons why certain health facilities were more preferred by the Caregivers, four factors were raised. Among them, the most cited reason was nearness of the health facility to the Caregiver. Specifically, for dispensaries, which were the highest frequented health facility, nearness to the facility took 77.4% as a reason for their choice. This was followed by the quality of services offered by the facilities at 30.8% and the least cited reason was the recommendation of the facility at 12.2%. Stock availability of the PCV 10 vaccine was a reason that was only cited by 15.4% of the respondents, Table 4.6. Figure 4.5 illustrates the most impactful reasons for choice of dispensary as a health facility.

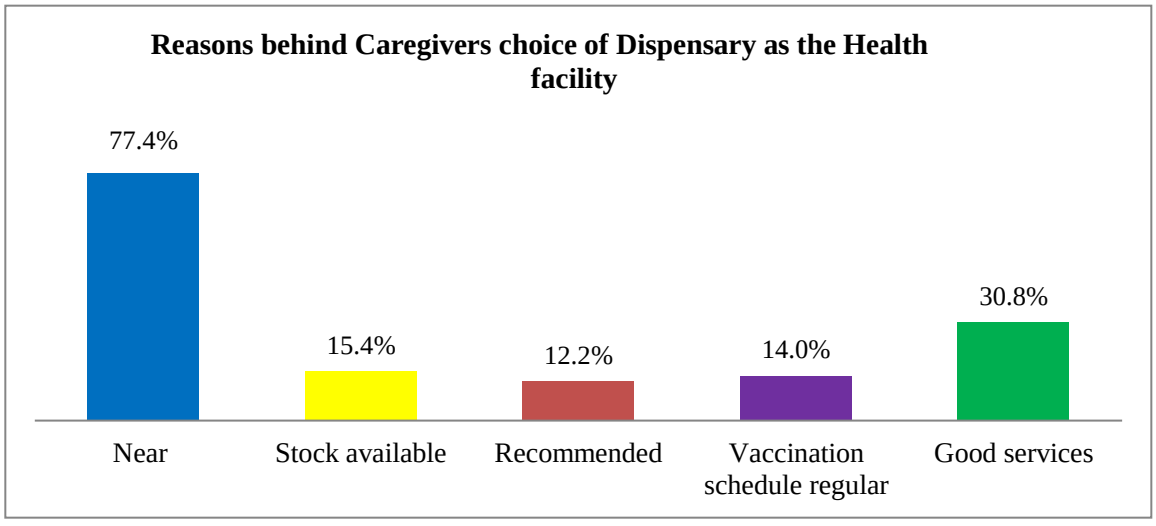


**Figure 4. 5: Reasons behind Caregivers' choice of Dispensary**

### 4.6 Reasons behind Caregivers not taking their infants for vaccination

In order to determine the hindering factors for those who had not taken their children for vaccination, the respondents were asked to identify the reason behind having their children not immunized with PCV 10. Among those whose children had not been immunized with PCV 10 (n=61), 75% of them reported that they had not heard about the vaccine, 14% said there were no nearby facilities while 11% said they used herbs to prevent children from getting pneumonia (Table 4.7).

Among those who had initiated vaccination (n=39), forgetting to take the child for the subsequent due doses of the vaccine was mentioned by 41% of them as a barrier to completion of all the three doses.

### 4.7 Reasons behind Caregivers' decision to take infants for PCV vaccination

Caregivers who had their children immunized fully or partially were asked about what motivated them to take their children for vaccination with PCV 10. The reasons given are summarized in Table 4.8.

When asked about what motivated them to seek the vaccine for their children, majority cited having been educated on the importance of the vaccine and the desire for a better quality of life for their children, 60.4% and 31.6% respectively (Table 4.7). Few cited the awareness of burden of pneumonia as a reason for vaccinating their children (Figure 4.6).

Reminders for vaccine schedule and health education on the importance of the vaccine were cited as possible measures that may be applied to help improve uptake of the vaccine at 40.1% and 48.4% respectively.

**Table 4. 7: Reasons behind caregivers' decision to take infants for PCV vaccination**

| Variable | Frequency | % |
|---|---|---|
| Reason for taking child for vaccination (n=288): | | |
| Nearness to health facility | 81 | 28.1 |
| Educated on importance of vaccination | 174 | 60.4 |
| Desire for better quality of life for the child | 91 | 31.6 |
| Awareness of the burden of pneumonia | 46 | 16.0 |
| Done the same for older children | 34 | 11.8 |

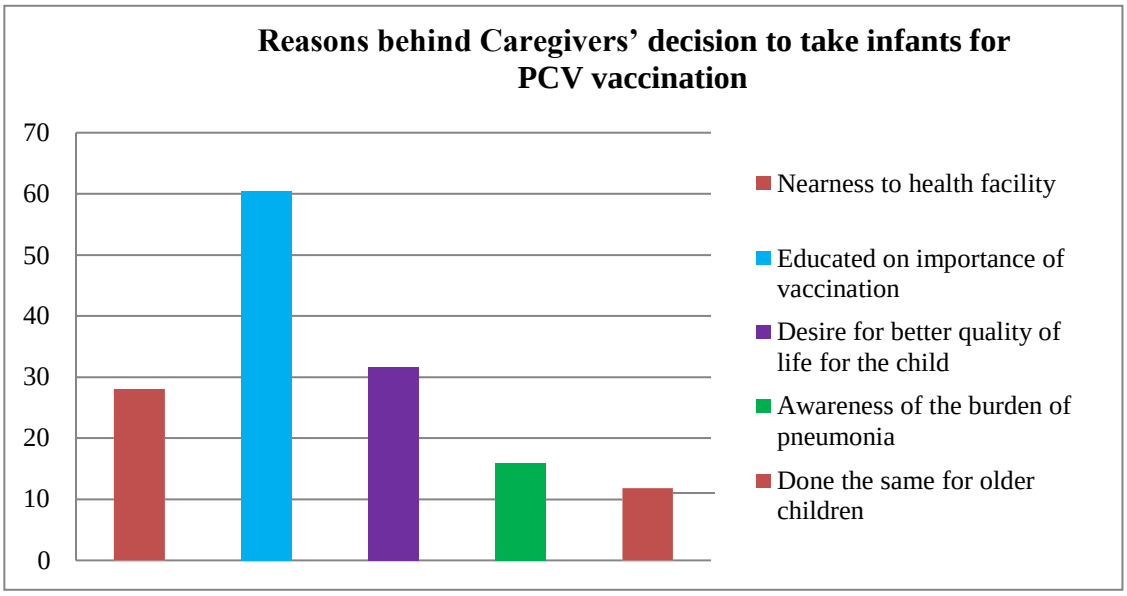


**Figure 4. 6: Reasons behind caregivers' decision to take infants for PCV vaccination**

## 4.8 Factors influencing pneumococcal vaccine uptake

Inferential statistical analysis was done to identify determinants of pneumococcal vaccine uptake. The primary outcome variable was vaccination uptake; the independent variables included were socio-demographic characteristics, knowledge about the vaccine and other variables that were found to be statistically significant at bivariate analysis, see Table 4.8.

The level of education of the caregivers was found to be statistically significant with a p value of 0.029 (Table 4.9). The age and occupation of the caregivers were statistically insignificant with p values of 0.3 and 0.28 respectively (Table 4.8). The age of children that the caregivers had below 5 years was statistically significant ($\chi^2$=29; df=1.; p=0.019) (Table 4.8). Those parents that had other children below 3 years were more likely to have vaccinated their children as compared to those without children in this age group.

Similarly, the Caregivers' awareness of the PCV 10 vaccine was statistically related to the PCV 10 uptake ($\chi^2$=70.3; df=1; p=0.0001) (Table 4.8). Caregiver's awareness on who was eligible for the PCV 10 vaccine was statistically significant ($\chi^2$=25.2; df=1; p=0.0001) (Table 4.8). The caregivers' knowledge on how the PCV 10 is administered and when it is administered were equally significantly related to the uptake of the vaccine ($\chi^2$=91; df=1; p=0.0001; $\chi^2$=73.1; df=.; p=0.0001 respectively). This makes all the knowledge factors explored in this study statistically significant. Multiple logistic regression model was fitted using the stepwise forward selection procedure (at 5% probability of entry) to identify predictors of vaccination uptake. All analysis and interpretation were done at 5% significance level.

**Table 4. 8: Bivariate analysis for factors associated with pneumococcal vaccine uptake**

| Variable | Pneumococcal vaccination uptake | | Test | P Value |
|---|---|---|---|---|
| | Not fully vaccinated Frequency (%) | Fully vaccinated Frequency (%) | | |
| Level of education | | | | |
| None | 1(100) | 0 (0) | Fisher's exact | 0.029* |
| Primary | 27 (24.11) | 85(75.89) | | |
| Secondary | 31 (15.35) | 171(84.65) | | |
| College | 2 (7.41) | 25 (92.59) | | |
| University | 0 (0) | 7 (100) | | |
| Age of caregivers | Mean age: 27.9 years | Mean age: 27.1 years | t-test | 0.31 |
| **Occupation** | | | | |
| Unemployed | 0 (0) | 12 (100) | Fisher's exact | 0.28 |
| Informally employed | 58 (18.47) | 256 (81.53) | | |
| Formally employed | 3 (14.29) | 18 (85.71) | | |
| **Number of children below 5 years** | | | Chi square $X^2$= 29 df=1 | 0.019* |
| 1-3 | 55 (16.47) | 279 (83.53) | | |
| >3 | 6 (40.00) | 9 (60.00) | | |
| **Aware of the vaccine** | | | Chi square $X^2$ =70.3 df=1 | <0.0001* |
| No | 51 (39.23) | 79 (60.77) | | |
| Yes | 9 (4.13) | 209 (95.87) | | |
| **Aware on who is eligible to receive the vaccine** | | | Chi square $X^2$= 25.2 df=1 | <0.0001* |
| No | 60 (23.81) | 192 (76.19) | | |
| Yes | 1 (1.03) | 96 (98.97) | | |
| **Aware on how the vaccine is given** | | | Chi square $X^2$= 91 df=1 | <0.0001* |
| No | 47 (48.96) | 49 (51.04) | | |
| Yes | 14 (5.53) | 239 (94.47) | | |
| **Aware on when vaccine is given** | | | Chi square $X^2$ = 73.1 df=1 | <0.0001* |
| No | 51 (40.80) | 74 (59.20) | | |
| Yes | 10 (4.48) | 213 (95.52) | | |

* Statistically significant at 5% significance level.

From bivariate analysis, the variables that were statistically significant and therefore included in multivariate logistic regression model were level of education, awareness of the vaccine, awareness on the eligibility for the vaccine, awareness on how the vaccine is administered, number of children below 5 years old and awareness on when the vaccine is administered. The multiple logistic regression findings are shown in Table 4.9. All variables on awareness and knowledge of the vaccine were identified as significant and strong predictors of pneumococcal vaccine uptake, Table 4.9.

**Table 4. 9: Logistic regression analysis of factors associated with pneumococcal vaccine uptake**

| **Variable** | **Adjusted Odds Ratio (OR) (95% Confidence Interval)** | **P Value** |
|---|---|---|
| Aware of the vaccine | | |
| No | 1 | 0.001 |
| Yes | 4.6 (1.4,8.0) | |
| Aware on how the vaccine is given | | |
| No | 1 | 0.005 |
| Yes | 3.4 (1.4, 8.0) | |
| Aware on when vaccine is given | | |
| No | 1 | 0.001 |
| Yes | 4.4 (1.8, 10.5) | |

# CHAPTER FIVE: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Discussion

This study sought to determine the level of pneumococcal vaccine uptake, establish the level of knowledge of Caregivers and the associated factors influencing the uptake of the PCV 10 in Borabu Sub County, Nyamira County.

### 5.1.1 Knowledge on pneumococcal immunization.

Awareness of different aspects of the vaccine among the Caregivers was assessed and found to be significant in determining the vaccine uptake. Most Caregivers were found to be aware of a PCV 10 vaccine, which meant they knew what vaccine they were giving their children. This awareness was found to be statistically significant with most of the caregivers that were aware of the PCV 10 vaccine fully vaccinating their children as compared to those who were unaware.

Whereas majority of the Caregivers were aware of the vaccine, they did not know who was eligible for it. This may have contributed to the missing of the vaccine as they were not clear who would be given. Almost all those who knew the eligibility of the vaccine immunised their children fully which points to its importance as a knowledge factor. This awareness was significant statistically. Awareness of caregivers on when the vaccine is administered was fair but critical with almost all those aware fully vaccinating their children. Most of the Caregivers knew that the vaccine is administered through an injection and could pinpoint the area of injection. Still a greater number of those who were aware of when the vaccine doses were being given fully vaccinated their children.

Knowledge on how the vaccine was administered was equally a significant factor associated to PCV 10 uptake. Among those that were aware of how PCV 10 is administered, majority had vaccinated their children as opposed to only about a half of those unaware.

### 5.1.2 Pneumococcal immunization coverage

From the data collected, uptake of the vaccine in the studied population was (82.5%) which is below the globally recommended coverage of ≥ 90% (WHO, 2012). In every 39 seconds, a child dies of pneumonia, making it the highest cause of death among all infectious disease for children under five years old, (UNICEF, 2019). Given that 'Immunization with PCV is one of the most important interventions protecting against pneumonia', (Olayinka, Ewald, & Steinglass, 2017), there is great importance in ensuring that as many children as are eligible for the PCV 10 vaccine are immunized. It is critical to reach the target vaccine coverage.

Kenya introduced PCV 10 in 2011 as part of the expanded childhood immunization programme and it is provided free for all children between 6weeks and 14 weeks of age and is available in health facilities. For this reason, few children if at all should be missing the immunisation of PCV 10. Other developing countries are now achieving the target for PCV vaccines for example Rwanda that had coverage of 97% in 2018, (World Health Organisation, 2019).The vaccine uptake established in the studied population compares slightly with findings from another study done in Makindu, Machakos County, where 78.1% of children surveyed had received the vaccine (Mutisya, 2013).

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### 5.1.3 Factors that influence pneumococcal vaccine uptake.

Currently, there is no data available in Kenya on the factors influencing the uptake of the PCV 10 vaccine. The Integrated Global Action Plan encourages countries to collect local data, analyze and act on it to help achieve the goal of target vaccination uptake, (UNICEF/World Health Organisation, 2013) thus the importance of this study. In order to identify the factors associated with uptake of the vaccine; both descriptive and inferential analyses were undertaken. In terms of demographics, the study group included caregivers that had children between 4 to 12 months which means that the child was ideally completely vaccinated as per the KEPI schedule of 3p+0 as recommended by WHO, (World Health Organisation, SAGE, 2017). Most of the Caregivers turned out to be female (97%) possibly because these children are young and still being breastfed among other cultural reasons.

The age of the caregiver was not statistically significant compared with the uptake of the vaccine. This means that the age of the Caregiver had no impact on whether they immunised their children or not. The age of children that the caregivers had below 5 years was statistically significant. Parents that had other children below 3 years were more likely to have vaccinated their children as compared to those without children in this age group. This could have been due to the experience they may have had with the previous vaccination practice for the other children and yet not too long before they had the child on the study.

The level of education of the Caregivers was statistically significant where the number of fully vaccinated children increased as the level of education of the caregivers increased. High level of education was associated with increase in uptake of the vaccine, which can be due to better understanding of the Caregiver on information acquired on the vaccine. Caregivers with high level of education had most of their children fully vaccinated led by the university education Caregivers who had all vaccinated their children followed by college and secondary respectively.

The knowledge of the caregivers on PCV 10 was found to be statistically significant suggesting that knowledge was an important factor in uptake of PCV 10 vaccine. This knowledge was especially critical on whether they knew of or did not know PCV 10 vaccine, how and when it was administered. Caregivers who were aware of the vaccine were over four times more likely to have had their children fully immunized compared to those who were not aware of the vaccine.

The likelihood of Caregiver having taken their children for vaccination was three times higher for caregivers who knew how the vaccine is administered compared to those who did not know. Knowing when the vaccine is administered also increased the likelihood of uptake of the vaccine by four-fold. The positive association between knowledge about a vaccine and its uptake has also been documented elsewhere in the literature.

In a recent systematic review by Smith *et al*, in developed countries, it was established that knowledge about a vaccine by the parent or guardian was associated with an increased uptake of vaccination (Smith, et al, 2017). Similar findings were also documented in another review done in developing countries where knowledge about the vaccine was identified as one of the key determinants of immunization uptake (Mazige, 2016). The positive association between knowledge about the vaccine and immunization uptake is also consistent with the Health Belief Model (HBM) theoretical framework. According to this model, possession of knowledge of a health related behaviour is a necessary prerequisite to adoption of healthy life practices (Orji, Vassileva, & Mandryk, 2012). Deliberately addressing these issues as well as longstanding weaknesses during new vaccine introduction can strengthen the immunization and broader health system.

Caregivers frequented different health facilities for vaccination services including the dispensaries, county referral hospitals and private hospitals. The reasons the caregivers gave for their choice of health facility included location of the health facility, availability of stocks of PCV 10 vaccine, recommendation by a health worker or other community members for the health facility, availability of a regular schedule in terms of immunisation and the quality of services given at the health facility.

The location of the health facility was the most considered factor in the choice of the health facility pinpointing the importance of distance as a key factor for uptake of vaccine. The further the distance of the health facility to the Caregiver, the less likely it was frequented.

Among the caregivers who had not taken their children for vaccination, the study sought information on the possible barriers behind this. Majority of the caregivers cited unawareness of the vaccine as the reason why they had not taken their children for vaccination. This finding is consistent with a previous study done in Hong Kong where lack of knowledge about a vaccine was identified as a potential barrier to seeking immunization services (Lau, Mo, Cai, Tsui, & Choi, 2013).

For those who had initially taken their children for immunization but eventually failed to complete the three doses of the vaccine, forgetting to show up in the health facilities for the scheduled doses was identified as the barrier to full immunization uptake. Forgetfulness among caregivers to present children for scheduled vaccination doses has also been cited in other studies as a hindrance to completion of immunization in children (Smith et al., 2017). Having been educated about the pneumococcal vaccine was identified as the most important reason for immunization uptake among caregivers whose children had been fully vaccinated. This finding agrees with another study done in China, where patient education was found to be an effective intervention for increasing uptake of influenza vaccine, (Leung et al., 2017).

When asked about what could be done to increase vaccination coverage in the locality, several caregivers indicated that use of reminders and health education on the importance of the vaccine could help in getting them comply with the recommended vaccination schedule. This finding provides an important opportunity for public health authorities to explore possible ways of increasing awareness and compliance to vaccination schedules through various channels such as use of mobile phone-based reminders and community sensitization campaigns. The dispensary was the most utilized facility for vaccination services, given its accessibility to majority of the rural residents. This finding further underscores the importance of the lower level facilities in provision of immunization and other primary health care services as captured in the 2013-2017 Kenya Health Sector Strategic and Investment Plan (Ministry of Health, 2013).

## 5.2 Conclusion

1 Coverage of pneumococcal vaccine in Borabu Sub-County, Nyamira County was (82.5%), still below the internationally recommended target of ≥90%. Health education, use of reminders and focus on lower-level facilities may potentially contribute to increased vaccination coverage in rural populations.

2 Knowledge on the different aspects of the PCV 10 vaccine was lacking among the Caregivers and varied between different aspects.

3 Uptake of PCV 10 vaccine was found to be influenced by Knowledge about the PCV 10 vaccine, level of education of Caregivers and the age of children that Caregivers had who were below 5 years.

### 5.2 Recommendations

Based on the findings from this study, several recommendations are suggested.

1 To increase vaccine coverage the county should explore use of reminders as suggested by Caregivers and increased capacities of lower-level health facilities as they are most frequented.

2 The health system should consider mass sensitization campaigns to increase awareness and knowledge about the PCV 10 vaccine in Nyamira County as education was cited as the greatest reason for Caregivers seeking for the vaccine.

3 Having identified Knowledge and education level as important factors influencing the uptake of the vaccine, effective interventions for increasing knowledge for all Caregivers regarding the education level should be explored.

On the other hand, given the findings of this study, there is opportunity for further research. One of the recommended researches would be to identify effective interventions for delivering health education about pneumococcal vaccine in rural populations. In addition, interventional studies may be done to test effectiveness of reminder systems on immunization uptake.

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# APPENDICES

## Appendix 1: Consent Form

My name is Jane Karicha, a Master of public Health (Epidemiology& disease control) student from Kenyatta University. I am conducting a study on "Pneumococcal Immunisation Uptake among Caregivers of Infants Between 4-12 Months in Borabu Sub County, Nyamira County, Kenya". The information will be used by the Ministry of Health to improve uptake of routine pneumococcal vaccination in Nyamira County as well as in other Counties in Kenya. This study is for academic purposes only.

**Procedures to be followed**

Participation in this study will require that I ask you questions. I will record the information from you in a questionnaire and/or tape record for key informant interviews. You will be enrolled into the study and contacted for an interview.

**Discomforts and risks**

Some of the questions you will be asked may make you uncomfortable. You are requested to answer those questions with honesty and sincerity to enable the researcher come up with appropriate recommendations targeted at improving uptake of routine pneumococcal vaccination. The interview will take at most ten (10) minutes.

**Reward/Benefits**

There is no reward/benefit that will be given for agreeing to participate in this study.

**Confidentiality and Privacy**

The interviews will be conducted in the community setting within the Sub County. The questionnaires will be kept in a locked cabinet for safekeeping.

Your identity (name/phone numbers) will not be disclosed in publications, conferences or in seminars where this work will be shared.

**Consequences of withdrawal**

Participation in the study is voluntary. You may ask questions related to the study at any time. You may refuse to respond to any questions and you may stop the interview at any time. You may also stop being in the study at any time without any consequences.

**Contact information**

If you have any questions or need clarifications, you may contact Ms. Jane Karicha on 0737868691 or Dr. Stanley Kimuhu on 0722335754 or Dr. Justus Osero on 0724869330 or the Kenyatta University Ethical Review Committee Secretariat on kuerc@ku.ac.ke.

**Participant's Statement**

The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I can leave the study at any time.

Name of Participant…….

Signature or Thumbprint_____Date_____

**Investigator's statement**

I, the undersigned, have explained to the volunteer in a language s/he understands the procedures to be followed in the study and the risks and benefits involved.

Name of Interviewer…….

Interviewer signature_____ Date_____

**Appendix 2: Questionnaire –Caregiver**

**Study Title**: Pneumococcal Immunization Uptake among Caregivers of Infants between 4-12 Months in Nyamira County, Kenya.

1. How old are you?
   .....
2. What level of education have you reached?

   .....
3. What is your occupation?

   ……..……..
4. How many children do you have?

   ……...……..
5. Are you aware of any vaccine against pneumonia?

   Yes ☐ No ☐
6. Who is eligible for PCV 10?

   ……..
7. How is the vaccine administered?

   Oral ☐ Injection ☐ Others ……
8. Do you pay for the vaccine or you get it free?

   Free ☐ Pay ☐ Others ……
9. When is the vaccine given (age)?

   6wks, 10wks and 14wks ☐ Others

   ……

**10.** Is your child vaccinated against pneumonia**?**

Yes ☐ No ☐

11. Did your child get all the doses?

Yes ☐ No ☐

**12.** What motivated you as a Caregiver, to go for the vaccine**?**

Nearness to the health facility

Availability of the vaccines

Regular vaccination at the health facility

Training campaign conducted by the county health officers

I had done the same for my older children

I want a better quality of life for my child

Current prevalence of pneumonia the children

Others (Specify)

……

**13.** Why **didn't** your child get all the doses of the vaccine**?**

The vaccine was not available

I was sick and did manage to take the child for subsequent doses

The vaccination facility is very far from where I stay and I had no money for transport

I was told to stop vaccinating the child by relatives

I forgot.

Others (Specify)

……

**14.** Why did you **NOT** vaccinate your child**?**

I was not aware the vaccine exists

I use traditional medicines/herbs

There are no health facilities nearby

I was told not to vaccine by elders/ parents

Others (Specify)……

15. What are you doing to prevent your child from getting pneumonia?

Keeping the child warm

I use traditional medicines/herbs

I do nothing at all

Others (Specify)……

16. Did you vaccinate your other children?

Yes ☐ No ☐

17. Who helps you to take the child for vaccination when you are not able to?

My parents

co-wife

Neighbour

Siblings

Others (Specify)…….

18. What would help you in future to ensure that you vaccinate your children?

Reminders

Education/training on vaccines

Avail vaccines in the nearby clinics

Build clinics near us

Do home visits for vaccination

Others (Specify)……

19. Where do you go/would you go for child vaccination

Dispensaries

County hospitals

Mission hospitals

Referral hospitals

Private hospitals

Others (Specify)

20. Why do you prefer this facility

☐ It is near

☐ It has enough stocked vaccines

Regular vaccination

Better services offered by the health workers

☐ It is a recommended facility

Others (Specify)

**Appendix 3: Check List**

1. Review vaccination record: Confirm the child is within the age group of 4-12 months.
2. Tick administered doses of PCV given and indicate age given.

| PCV Dose 1 | PCV Dose 2 | PCV Dose 3 |
|---|---|---|
| | | |

3. Review vaccination record and indicate which other vaccines the child received. Tick the doses given and indicate age

| Vaccine | BCG | OPV (birth) | Penta 1 | Penta 2 | Penta 3 |
|---|---|---|---|---|---|
| Age of vaccination | | | | | |
| Vaccine | IPV | OPV 1 | OPV 2 | OPV 3 | Measles |
| Age of vaccination | | | | | |
| Vaccine | Rota 1 | Rota 2 | | | |
| Age of vaccination | | | | | |

## Appendix 4: Population Description

**Annex2: Population description**

| | Description | Population estimates | Target population | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2013 | 2014 | 2015 | 2016 | 2017 |
| 1 | Total population | | 650,676 | 664,485 | 678,587 | 692,988 | 707,694 |
| 2 | Total Number of Households | | 141,451 | 144,453 | 147,519 | 150,650 | 153,847 |
| 3 | Children under 1 year (12 months) | 3.3% | 21,472 | 21,928 | 22,393 | 22,869 | 23,354 |
| 4 | Children under 5 years (60 months) | 16.2% | 105,410 | 107,647 | 109,931 | 112,264 | 114,646 |
| 5 | Under 15 year population | 47.3% | 307,770 | 314,301 | 320,972 | 327,783 | 334,739 |
| 6 | Women of child bearing age (15 – 49 Years) | 25% | 162,669 | 166,121 | 169,647 | 173,247 | 176,924 |
| 7 | Estimated Number of Pregnant Women | 3.4% | 22,123 | 22,593 | 23,072 | 23,562 | 24,062 |
| 8 | Estimated Number of Deliveries | 3.4% | 22,123 | 22,593 | 23,072 | 23,562 | 24,062 |
| 9 | Estimated Live Births | 3.35% | 21,798 | 22,260 | 22,733 | 23,215 | 23,708 |
| 10 | Total number of Adolescent (15-24) | 23% | 149,656 | 152,832 | 156,075 | 159,387 | 162,770 |
| 11 | Adults (25-59) | 34% | 221,230 | 225,925 | 230,720 | 235,616 | 240,616 |
| 12 | Elderly (60+) | 5.4% | 35,137 | 35,882 | 36,644 | 37,421 | 38,216 |

**Figure 3.1 Population Description**

Source ("COUNTY HEALTH STRATEGIC & INVESTMENT PLAN 2013/14-2017/18," 2014)