VACCINATION COVERAGE AND ITS ASSOCIATED FACTORS AMONG INFANTS IN KAMUKUNJI SUB-COUNTY, NAIROBI, KENYA

BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF EPIDEMIOLOGY AND MEDICAL STATISTICS, SCHOOL OF PUBLIC HEALTH, MOI UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENT OF THE MASTER OF SCIENCE IN FIELD EPIDEMIOLOGY IN THE MOI UNIVERSITY

Declaration

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Declaration by the Supervisors

This research report is being submitted to Moi University with our approval as University supervisors.

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Dedication

I wish to dedicate this study to all parents with infants who are to undergo vaccination

Abstract

Background: Childhood vaccination is an important cost-effective public health intervention. It prevents illnesses, disabilities, and deaths/from vaccine preventable diseases. The World Health Organization (WHO) recommends 90% vaccination coverage for herd immunity to develop. The global vaccination coverage has stalled at 86% between 2015 and 2016.The poor vaccination coverage led to close to 19.5 million infants across the world missed out on basic vaccines in 2016, majority of them in sub-Sahara Africa. In Africa, vaccination coverage was 80%, the lowest ever in the world. Kenya's vaccination coverage of 69% in 2016 and 63% in 2017 were suboptimal to prevent vaccine preventable diseases. In Kamukunji sub-County, there were reported cases of polio and measles outbreaks in 2018.

Objectives: To determine coverage of fully vaccinated, vaccination coverage of each antigen and describe socio-demographic and health facility factors associated with vaccination uptake among infants in Kamukunji sub-County, Nairobi County, Kenya

Methods: A cross-sectional study was carried out targeting infants aged 3 to 11 months old. Multistage sampling that included simple random sampling and modified WHO 30x7 cluster method was used to enroll 510 infants. Interviewer-administered questionnaires and data abstraction tool were used to collect data from caretakers and abstract data from vaccinating facilities and patient cards. Descriptive analysis was done using measures of central tendency and dispersion for continuous data and frequency and proportions were used for discrete data. Chi square test was used to assess the association between vaccination status and independent variables. Factors with P value <0.2 were entered into unconditional logistic regression analysis and factors with P value <0.05 were considered significantly associated with vaccination coverage.

Results: Five hundred and ten (510) infants, aged 3 to 11 months with a mean age of 9 months were interviewed, 174 (34.1%) infants were not fully vaccinated according to their ages. Infants aged 3 to 5 months had 25.9%, 6 to 8 months had 53.2% while 9 to 11 months had 78.4% full vaccination coverage. All antigens had vaccination coverage of 80% and above except second dose of Rota virus vaccine (Rota2) with 78.4%. Half of vaccinating facilities attained 80% targeted vaccination coverage. Factors associated with infants' vaccination in Kamukunji included age [aORs 0.09 (P value 0.000) for 3 to 5 months old and 0.45 (P value 0.001) for 6 to 8 months old] and distant to vaccinating facilities [aORs 0.35 (P value 0.002) for 0.5 Km to 1 Km and 0.20 (P value 0.000) for >1 Km to 5 Km]. The main (97.1%) reason of non-vaccination was not being aware of subsequent doses.

Conclusion: Full vaccination coverage according to age was suboptimal. Older infants were more likely to be fully vaccinated. Longer distance to facilities had negative effect on vaccination.

Recommendation: The county government should increase the number of vaccinating facilities to reduce the distance. Health facilities to put in place measures to remind the caretakers of subsequent vaccination visits

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List of Abbreviations and Acronyms

AFP	-	Acute Flaccid Paralysis
ANC	-	Antenatal Care
aOR	-	Adjusted Odds Ratio
BCG	-	Bacillus Calmette-Guérin
CDC	-	Centre for Disease Control and Prevention
COR	-	Crude Odds Ratio
cVDPV2	-	Circulating Vaccine Derived Polio Vaccine type 2
DHIS	-	District Health Information System
DTP	-	Diphtheria Tetanus Pertussis
DVI	-	Division of Vaccines and Immunization
DVU	-	Division of Vaccine Unit
EPI	-	Expanded Program on Immunization
FELTP	-	Field Epidemiology and Laboratory Training Program
FIC	-	Fully Immunized Child
GAVI	-	Global Vaccine Alliance
GoK	-	Government of Kenya
GVAP	-	Global Vaccine Action Plan
HB	-	Hepatitis B
HiB	-	Haemophilus influenza type B
Km	-	Kilometer
Kshs	-	Kenya shillings
IPV	-	Inactivated Polio Vaccine
IREC	-	Institutional Research & Ethics Committee
KDHS	-	Kenya Demographic & Health Survey
KEPI	-	Kenya Expanded Program on Immunization
MCH	-	Maternal Child Health
MCV 1	-	Measles Containing Vaccine – First Dose
MCV	-	Measles Containing Vaccine
MDG	-	Millennium Development Goals
MOH	-	Ministry of Health

NACOSTI	-	National Commission for Science, Technology & Innovations
NMS	-	Nairobi Metropolitan Services
OPV 0	-	Oral Polio Vaccine – Birth Dose
OPV 1	-	Oral Polio Vaccine – First Dose
OPV 2	-	Oral Polio Vaccine – Second Dose
OPV 3	-	Oral Polio Vaccine – Third Dose
OPV	-	Oral Polio Vaccine
OR	-	Odds Ratio
PCV 10	-	Pneumococcal Conjugate Vaccine against 10 subtypes
PCV 10 1	-	Pneumococcal Conjugate Vaccine against 10 subtypes – First Dose
PCV 10 2	-	Pneumococcal Conjugate Vaccine against 10 subtypes – Second Dose
PCV 10 3	-	Pneumococcal Conjugate Vaccine against 10 subtypes – Third Dose
Penta 1	-	Pentavalent Vaccine – First Dose
Penta 2	-	Pentavalent Vaccine – Second Dose
Penta 3	-	Pentavalent Vaccine – Third Dose
Rota 1	-	Rota Virus Vaccine – First Dose
Rota 2	-	Rota Virus Vaccine – Second Dose
SCHMT	-	Sub – County Health Management Team
SCMOH	-	Sub – County Medical Officer of Health
UNICEF	-	United Nations International Children’s Education Fund
USA	-	United States of America
WHA	-	World Health Assembly
WHO	-	World Health Organization

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CHAPTER ONE

1.0 Introduction

1.1 Background

Childhood vaccination is one of the most important and cost-effective public health intervention (Konstantyner et al., 2011) (Xeuatvongsa et al., 2017). Vaccination prevents illness and disabilities from Vaccine Preventable Diseases (VPDs) like pneumococcal pneumonia, poliomyelitis (polio), diarrhea due to rotavirus, rubella, hepatitis B, measles, tetanus, and cervical cancer, among other Vaccine Preventable Diseases (VPDs). Getting vaccinated against vaccine preventable diseases is the first a vital step towards protecting the child from potential infections. There is always very little risk that the vaccine carries on the child. In fact, a child who has been vaccinated against a disease passes some major protections to the population; leading to development of a condition called, herd immunity. Vaccination is the most important ways through which parents can offer protection to their children against serious childhood infections and avert childhood deaths. In the event that children are not vaccinated, then the world's target of eliminating all the preventable diseases might be a reality only on paper but not in actual practice. The majority of the children if not all, must be fully immunized to guarantee a future disease-free society. Every year, it is approximated that more than 2 million deaths can easily be prevented through vaccination.

Vaccine coverage rates are different based on a number of factors such as accessibility within the health facility and other socio-economic determinants. Despite strengthening of vaccination services worldwide, there is still a much concern regarding the failure to achieve high vaccination coverage. Global vaccination coverage has stalled for years at

86% since 2010, this means no herd immunity for the infants to prevent outbreaks due to VPDs and avert preventable deaths if the global vaccination could have improved between 2015 and 2016 more than 1.5 deaths could have been prevented. In 2016, close to 19.5 million infants across the world missed out on basic vaccines majority of them in sub-Sahara Africa. It was observed in 2017, at World Health Assembly (WHA) that nations' progress towards Global Vaccine Action Plan (GVAP) targets of Polio Eradication, Elimination of Neonatal Tetanus, Measles and Rubella, introduction of New Vaccines and Reduction of Mortality are off track and emphasized on its implementation for it was the roadmap to prevent millions of deaths through equitable access to vaccines by 2020.

In Africa, vaccination coverage was 80%, the lowest ever in the world hence infants have poor protection against VPDs making them prone to out breaks.

Kenya's vaccination coverage has been declining over 3 years, from 75% in 2015 to 63% in 2017. These figures were much below the WHO recommended coverage of 90%. Infants were at a greater danger of acquiring the VPDs and having surrounded by neighbours with vaccination coverage of below 50%, this posed greater risk of transmission of the diseases into the country. The vaccination coverage trend in Kenya is worrying. In the last two decades, there has been a continuous decline in vaccination coverage levels across regions in Kenya with worse trends documented in marginalized areas according to 2008 Kenya Demographic and Health Survey (KDHS) report. According to the 2014 KDHS, basic vaccination coverage reduced from 77 percent in 2008 to 71 percent in 2014. There is evidence of existence of weakness in the Kenyan health systems that impede the absorption capacity of the vaccination programs, thereby preventing realization of the targeted 90% countrywide coverage. Low vaccination coverage will lead to an increase in preventable

deaths and increased disease burden resulting in negative impact on health outcomes and socio-economic development in the country.

Despite the vaccination program being offered at no cost in Kenya, its uptake has remained below the WHO recommended threshold of 95% by 2020 (WHO, 2018). According to the records at District Health Information System (DHIS) and Division of Vaccine Unit, Ministry of Health (DVU-MOH), the Fully Immunized Child (FIC) coverage at national level is on the downward trend. In 2015, the Fully Immunized Child coverage was 73%, in 2016, the coverage dropped to 69% and the coverage dropped further and reached 63% in 2017. The Nairobi County Fully Immunized Child coverage in 2015 was at 77 % and in 2016 the coverage dropped slightly and reached 75% and the coverage increased to 84% in 2017. The Fully Immunized Child coverage for Kamukunji sub-County stalled at 77% through 2016 and 2017. Due to this low vaccination coverage, the country was not able to prevent occurrence of outbreaks of vaccine preventable diseases. In 2011, there was a measles outbreak in the country, it started in the former North-Eastern Province, brought to Eastleigh in Kamukunji sub-County, Nairobi, and later spread to several counties with many deaths. In May 2017, there was one confirmed case of measles in Eastleigh which is in Kamukunji sub-County following measles outbreak in Garissa and Mandera counties earlier. Unfortunately, measles outbreak has occurred in Kamukunji sub-County and several other parts of the country with reported deaths in 2018.

Over a period of 20 years, Kenya had no single case of poliomyelitis (1984 - 2006). However, the re-emergence of the disease was recently witnessed, a factor that was closely associated with low vaccination coverage resulting into “less- than- optimal vaccination coverage” and the poor sanitation in the environment. For instance, in April 2018,

circulating Vaccine Derived Polio Virus type 2 (cVDPV2) was isolated in an environmental site in Kamukunji sub-County and WHO declared an outbreak of polio in the country. The isolated cVDPV2, was said to be similar genetically to the cVDPV2 isolated in Mogadishu, Somalia in October 2017, suggesting spread and presence of transmission. The re-emergence of polio shows the importance of attaining and maintaining high vaccination coverages to achieve herd immunity. It also emphasizes the continuing need for addressing other public health measures that directly or indirectly contribute to the spread of vaccine preventable diseases.

Kenya had 63% Fully Immunized Child (FIC) coverage in 2017 (DHIS) which was below the WHO recommended coverage of 90% for national levels and 80% for counties. Despite these recommendations, the Polio Eradication End Stage Strategies emphasizes on reaching every child with live saving vaccines. The schedule of the Kenya Expanded Program on Immunization (KEPI) which manages vaccination activities is such that by the end of first year of life, the infant should be fully immunized (GoK, 2013). WHO recommends monitoring of data at the national and subnational levels so that proper prioritization can be done with respect to vaccination strategies and reach every child with live saving vaccines.

Several factors have been attributed in influencing vaccination coverage including; mothers' vaccination knowledge, accessibility to a health facility providing routine vaccination services, attitude of parents to vaccination and vaccination services, mother having attended antenatal care, and proximity to urban area (Ismail et al., 2014). Social factors such as parents' education, religion and marital status have also been found to influence vaccination coverage (Sanou et al., 2009). Other factors mentioned to influence

vaccination include; child's place of birth, family size, sex of the child and the economic status of parents (Awino, 2016). Advice on date of next visit, distance to vaccinating facility and mother's age may also affect the vaccination coverage (Awino, 2016). There may be regional and local disparities due in terms of resources; competing health priorities; poor management of health systems and inadequate monitoring and supervision (Awino, 2016). Factors attributed to low vaccination coverage included knowledge problems of mothers, access problems and attitude problems among others (Ismail et al., 2014). Other reasons given for failure to vaccinate an infant included other competing priorities and religion (Kariuki, 2012). Sickness of an elder sibling following vaccination and lack of knowledge regarding subsequent vaccination have also been cited in failure to vaccinate a child (Nath et al., 2007). The age of mother, level of education of mother, family income status and number of children (under-fives) in the family also affects the vaccination status. Gender, child's birthplace and childbirth order have been shown to affect vaccination too (Kamau & Esamai, 2001). Other factors associated with vaccination include; level of education of the mother, wealth, perceived quality of the vaccine, mother's awareness about the importance of vaccine, and place of residence (Makokha, 2016). Long waiting time at the facility, missed opportunities, inadequate vaccination services, limited access to services, availability of vaccines at the facility, poor staff attitude and unreliability of services are also mentioned affecting vaccination (Makokha, 2016).

The isolation of circulating Vaccine Derived Polio Vaccine type 2 (cVDPV2) in an environmental surveillance site in Kamukunji sub-County, Nairobi, Kenya in April 2018 has attracted global attention to this sub-County whose immunization coverage in 2017 was 77%. Following the cVDPV2 isolation, a household Polio Routine Immunization

Coverage Survey was carried out in Kamukunji sub-County in April 2018. The results were as follows: birth oral polio vaccination (OPV0) 88%, at 6 weeks of age (OPV1) 81.6%, at 10 weeks of age (OPV2) 75.9%, at 14 weeks of age (OPV3) 74.1% and the coverage for Inactivated/Injectable Polio Vaccine (IPV) was 24%. The OPV2, OPV3 and IPV are all suboptimal. There have been outbreaks of measles reported in Kamukunji sub-County in recent past and spreading to other parts of the country, latest was in 2018.

To gain insight into the level of vaccination coverage and prioritize vaccination strategies, this study was carried out in Kamukunji sub-County, Nairobi County, Kenya to determine the immunization coverage and associated factors.

1.2 Problem statement

The coverage of FIC for Kamukunji sub-County was 77% in 2017 according to the records at District Health Information System (DHIS, 2017) and Division of Vaccine Unit, Ministry of Health (DVU-MOH). This was not ideal to prevent the occurrence of VPDs in the sub-county. Kamukunji sub-County is also the migration route of people especially from Somalia whose vaccination coverage was as low as <50% (WHO/UNICEF, 2018). These posed greater danger of transmission of vaccine preventable diseases in the sub-County. There was already an evidence of transmission, the isolated circulating Vaccine Derived Polio Virus type 2 (cVDPV2) in Kamukunji sub-County in April 2018, was similar to the one isolated in Mogadishu in October 2017 (Advisory et al., 2018). The isolation of cVDPV2 in April 2018 in an Acute Flaccid Paralysis (AFP) environmental surveillance site elicited global attention to Kenya and particularly Kamukunji sub-County, as this posed a great draw back to efforts of eradication of polio globally.

Following the polio outbreak in Kamukunji sub-County in April 2018 (World Vision, 2018) and subsequent household surveys on polio vaccination coverage carried out in the area produced 74.1% vaccination coverage for OPV3 and 24% vaccination coverage for IPV. The population-based vaccination coverage performance of other vaccines/antigens were unknown. There were also several infants coming into Kamukunji sub-County especially from Somalia whose vaccination coverage status were unknown.

There was one confirmed measles case in Eastleigh, Kamukunji sub-County in 2017 followed by several cases in the sub-county in 2018 indicating presence of susceptible population with poor vaccination coverage status. Factors contributing to the low vaccination coverage in this sub-county were unknown.

1.3 Justification

The study findings would provide information that would help Kamukunji sub-County Health Management Team (SCHMT) and the Nairobi County Health Management Team (CHMT) to put interventions in place to improve their vaccination coverage status thereby preventing vaccine preventable diseases and avert preventable deaths among infants in the sub-county. The gaps and factors identified would form basis for recommendations and help decision makers at all levels including the sub-county, the county, the Ministry of Health at the national level and partners not forgetting the vaccinating health facilities to come up with strategies and policies to address vaccination among infants.

1.4 Research question

What was the vaccination coverage and its associated factors among infants in Kamukunji sub-County, Nairobi County?

1.5 Objectives

Broad objective: To determine the vaccination coverage and associated factors among infants in Kamukunji sub-County, Nairobi County.

Specific objectives

1. To estimate the coverage of fully vaccinated infants in Kamukunji sub-County, Nairobi County.
2. To determine the antigen specific coverages in infants in Kamukunji sub-County, Nairobi County
3. To describe the socio-demographic factors associated with vaccination uptake among infants in Kamukunji sub-County, Nairobi County
4. To describe the health facility related factors associated with vaccination coverage among infants in Kamukunji sub-County, Nairobi County

CHAPTER TWO

2.0 Literature Review

2.1 Introduction

Vaccination during childhood is one of the most important and cost-effective public health interventions (Konstantyner et al., 2011)(Xeuatvongsa et al., 2017). It has been proven to be the most effective strategy to prevent infectious diseases more so vaccine preventable infectious diseases among children and reduce childhood morbidity and mortality (Mutua et al., 2011). Vaccination prevents illness and disability, and averts deaths caused by vaccine preventable diseases like diphtheria, hepatitis B, measles, mumps, pertussis (whooping cough), pneumonia, poliomyelitis (polio), rotavirus diarrhea, rubella, tetanus and cervical cancer. It is estimated that over 2.5 million deaths among children are prevented through vaccination per year (Mutua et al., 2011), (Konstantyner et al., 2011) The number of deaths caused by vaccine-preventable diseases; measles, neonatal tetanus and pertussis among children has decreased from an estimated 705,487 in 2000 to 165,770 in 2015 (Restrepo-méndez et al., 2016). Not only do vaccination prevent diseases and deaths caused by vaccine preventable diseases, they also help countries to make savings for other priorities like education and economic development (Chan et al., 2015).

Vaccination coverage is an important indicator of child health outcomes and World Health Organization (WHO) advices that children receive the complete schedule of vaccination (Fully Immunized Child – FIC) during infancy before they celebrate their first birth day (Awino, 2016). In 2012, World Health Organization (WHO) formed the Global Vaccine Action Plan (GVAP), a roadmap which included accelerating control of all vaccine preventable diseases, polio eradication, measles elimination, and promoting research and

development for the next generation of vaccines to prevent millions of deaths through more equitable access to vaccines by 2020, and countries to achieve vaccination coverage of at least 90% nationally and at least 80% in each district (Awino, 2016). The progress towards achieving the GVAP targets is off track (WHO/CDC, 2018).

Vaccines include oral polio vaccine (OPV) and inactivated polio vaccine (IPV) for poliomyelitis. Any one of three serotypes of poliovirus causes poliomyelitis, though the wild serotype type 2 has been eradicated in most parts of the world, often transmitted fecal-orally among persons living in unsanitary environments. The virus initially replicates in gastrointestinal track. Before the advent of polio vaccines, 90% of children in the developing world were infected with the polio viruses in the first two or three years of life (Kariuki, 2012). Pentavalent vaccine, which is a five-in-one vaccine that combines 5 antigens, namely: Diphtheria; Pertussis; Tetanus; Hepatitis B (HB) and Haemophilus influenza type b (Hib) vaccines, against diphtheria, pertussis, tetanus, hepatitis B and Haemophilus influenza type B infections, Bacillus Calmette – Guerin (BCG) vaccine for tuberculosis, Rota vaccine for diarrhoea caused by rotavirus, Measles Containing Vaccine (MCV) for measles and Pneumococcal Conjugate Vaccine 10 (PCV10) against 10 common serotypes of pneumococcal pneumonia.

World Health Organisation (WHO) recommends vaccination coverage of 90% for herd immunity to develop against vaccine preventable diseases in the population. Herd immunity provides protection, especially for those who cannot be vaccinated. These include vulnerable groups such as babies too young to be vaccinated or immune-compromised children who are potential victims of low vaccination rates. Low vaccination coverages are associated with outbreaks of vaccine preventable diseases (Haji et al., 2016).

WHO recommends monitoring of data at the national and subnational levels such as at counties and sub-counties so that proper prioritization can be done with respect to vaccination strategies and reach every child with live saving vaccines (WHO/CDC, 2018).

2.2 Global Perspective

In 2017, over 19 million infants worldwide were not reached with routine vaccination services such as three doses of Diphtheria-Tetanus- Pertussis (DTP) vaccine. Most of the children in this case (60%) were from Afghanistan, Angola, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Iraq, Nigeria, Pakistan and South Africa (WHO/CDC, 2018). The global coverage for vaccine has remained stagnant at 85% since 2010 with no significant changes during the past few years and an additional 1.5 million deaths could have been avoided if global vaccination coverage could have improved (WHO/CDC, 2018).

Globally in 2016, close to 13 million infants, almost 10 in every 100, did not receive any vaccinations. This critically means that the infants in this case did not get the first DPT vaccine dosage, making them become at risk of these potentially fatal diseases (WHO/UNICEF, 2018). The coverage of first dose of Measles Containing Vaccine (MCV1), third dose of Oral Polio Vaccine (OPV3) and third dose of Diphtheria-Tetanus-Pertussis (DTP3) has stagnated at (74%–75%) in the African region, at (82%–83%) in the Eastern Mediterranean Region (EMR) and at (88%–89%) in the Southeast Asia Region (SEAR) since 2016 (Dabbagh et al., 2017; Patel et al., 2019). Similarly, the coverages for the European Region (EUR) and the Western Pacific Region (WPR) remained constant at (93%–95%) and (95%–95%) respectively since 2008 (Patel et al., 2019). In the American Region, the MCV1 coverage decreased by 2% from 92% in 2016 to 90% in 2018

(WHO/UNICEF, 2018). Accordingly, 130 of the 194 WHO Member States have achieved and sustained at least 90% coverage for DTP3 at the national level, however an estimated 10 million additional infants need to be vaccinated in 64 countries if all countries are to achieve at least 90% coverage. Out of these10 million children, 7.3 million children live in fragile or unstable humanitarian settings, including countries affected by conflict. The situation in some countries were pathetic with eight nations reporting less than 50% coverage of DTP3 in 2016, which included 2 countries (Somalia and South Sudan) neighboring Kenya (WHO/UNICEF, 2018). In 2017, DPT global coverage was 85% but in 2016, DTP3 coverage was between 74% in African Region to 97% in the Western Pacific Region. Close to 20 million children who failed to complete the third dose DTP series in 2016, 12.9 million (66%) failed to be given any DTP doses with the greatest proportion of infants who were left out (17%) and highest dropout (11%) were in the WHO African Region (WHO/CDC, 2018), (Feldstein et al., 1974). In 2017, globally 85% of infants received OPV3 and in 2016 the coverage ranged from 73% in WHO African to 95% in WHO Western Pacific Region while 85% of children globally had received one dose of measles vaccine (MCV1) by the age of 1 year in 2017 and in 2016, the coverage ranged from 72% in the African Region to 96% in the Western Pacific Region and only 123 (63%) countries achieved the Global Vaccine Action Plan (GVAP) 2020 target of ≥90% national MCV1 coverage. The global BCG coverage was 88% in 2016 and ranged from 81% in WHO African Region to 95% in WHO Western Pacific Region (WHO/CDC, 2018)(Feldstein et al., 1974).

Among new and underused vaccines, Pneumococcal Conjugate Vaccine vaccination coverage increased during 2010- 2016 from a vaccination coverage of 11% to a vaccination

coverage of 42% and by the end of 2017 had been introduced in 135 countries and global vaccination coverage was estimated at 44% and *Haemophilus influenza* type b (Hib) vaccine vaccination coverage increased from a vaccination coverage of 42% in 2010 to a vaccination coverage of 70% in 2016 and by the end of 2017 had been introduced in 191 countries and global vaccination coverage with 3 doses of Hib vaccine was estimated at 72%. Meanwhile Rubella vaccine, which is part of measles containing vaccine, its vaccination coverage increased from a vaccination coverage of 35% in 2010 to a vaccination coverage of 47% in 2016 and by the end of 2017, Rubella vaccine was introduced nationwide in 162 countries, and global vaccination coverage was estimated at 52%. While global vaccination coverage increased during 2010- 2016 for two doses of rotavirus vaccine from a vaccination coverage of 8% to a vaccination coverage of 25% and ranged from a vaccination coverage of 2% in WHO Western Pacific Region to a vaccination coverage of 43% in WHO African Region and by the end of 2017, it had been introduced in 91 countries with global vaccination coverage of 28%. Hepatitis B vaccine global vaccination coverage increased from a vaccination coverage of 74% in 2010 to a vaccination coverage of 84% in 2016 and by the end of 2017 hepatitis B vaccine for infants had been introduced nationwide in 187 countries and global vaccination coverage with 3 doses of hepatitis B vaccine was estimated at 84% and was as high as 93% in the Western Pacific and in addition, 105 countries introduced one dose of hepatitis B vaccine to newborns within the first 24 hours of life, and the global vaccination coverage for birth dose of hepatitis B vaccination was 43%. Human Papilloma Virus (HPV) vaccine had been introduced in 80 countries globally by the end of 2017 (WHO/CDC, 2018).

"Most of the children that remain un-immunized are the same ones missed by health

systems," says Dr. Jean-Marie Okwo-Bele, Director of Immunization, Vaccines and Biologicals at WHO. "These children most likely have also not received any of the other basic health services. If we are to raise the bar on global immunization coverage, health services must reach the unreached. Every contact with the health system must be seen as an opportunity to immunize" (WHO/UNICEF, 2018).

2.3 National (Kenya) Perspective

Kenya Expanded Programme on Immunization (KEPI) was established back in 1980 within the Ministry of Health, Division of Vaccines and Immunization (DVU) with the sole aim being offering vaccination against the six main killer diseases in childhood thereby prevent and control vaccine preventable diseases. The diseases in question were measles, tetanus, whooping cough, diphtheria, polio and tuberculosis (Kariuki, 2012); (GOK, 2013). Though KEPI had initially been focused in establishing and strengthening the delivery of healthcare services, this was changed in 1990s when the vaccination coverage had hit 80% to disease eradication and elimination. However, a number of challenges were faced, for instance, achieving and maintaining high vaccination coverage in some districts or provinces in the country, eradicating poliomyelitis and eliminating measles and neonatal tetanus before the year 2000 and strengthening surveillance of EPI diseases (Ministry of Helth, 2013). World Health Organization through the Expanded Program on Immunization (EPI) recommends specific schedules of the recommended vaccines and Kenya Expanded Program on Immunization (KEPI) follows the schedule and the ministry recommends all districts and counties should achieve and maintain a ***minimum coverage*** of 80% of fully immunized children, based on the principle of *"the full protection of any child is based on the collective protection of all children"*(GOK, 2013). The KEPI schedule is: at birth;

Bacillus Calmette Guérin (BCG) and birth Oral Polio Vaccine (OPV0), at 6 weeks of age; first dose of Pentavalent vaccine (Pentavalent1) (Diphtheria-Tetanus- Pertussis (DTP), Haemophilus influenza type B and Hepatitis B virus antigens vaccine), first dose of Oral Polio Vaccine (OPV1), first dose of Pneumococcal Conjugate Vaccine 10 (PCV10 1) and first dose of Rota virus vaccine (Rota1), at 10 weeks of age; second dose of Pentavalent vaccine (Pentavalent2), second dose of Oral Polio Vaccine (OPV2), second dose of Pneumococcal Conjugate Vaccine 10 PCV10 2 and second dose of Rota virus vaccine (Rota2) and at 14 weeks of age; third dose of Pentavalent vaccine (Pentavalent3), third dose of Oral Polio Vaccine (OPV3), a dose of Inactivated Polio Vaccine (IPV) and third dose of Pneumococcal Conjugate Vaccine 10 (PCV10 3) and first dose of Measles Containing Vaccine (MCV1) at 9 months of age and a second dose of Measles Containing Vaccine (MCV2) at 18 months of age. For vaccine effectiveness, high coverage is required for both individual and herd immunities.

The vaccination coverage trend in Kenya has been worrying and continuously declining for the last 2 decades with worse trends in marginalized areas according to 2008 KDHS report (Awino, 2016). According to the 2014 KDHS, basic vaccination coverage reduced from 77 percent in 2008 to 71 percent in 2014. There is evidence of existence of weakness in the Kenyan health systems acting as barrier to absorption capacity of the immunization programs, thereby preventing realization of the targeted 90% countrywide coverage by 2015. Low vaccination coverage will lead to an increase in preventable deaths and an increased disease burden due to vaccine preventable diseases resulting in negative impact on health outcomes and socio – economic development in the country (Awino, 2016).

According to the records at District Health Information System (DHIS) and Division of Vaccine Unit, Ministry of Health (DVU-MOH) the FIC coverage at national level is on the downward trend; in 2015, the FIC vaccination coverage was 73%, 2016 the coverage was at 69% and 2017 the FIC vaccination coverage was 63%. The Nairobi County FIC coverage was at 77% in 2015, in 2016 the FIC vaccination coverage reduced to 75% and in 2017 the FIC coverage increased to 84%. In Kamukunji sub-County the vaccination coverage of Fully Immunized Child (FIC) stalled at a coverage of 77% through 2016 and 2017. Due to this low vaccination coverage. the country was not able to prevent occurrence of outbreaks of vaccine preventable diseases. In 2011 there was a measles outbreak in the Country, which started in former North- Eastern Province and was brought to Eastleigh in Kamukunji sub-County, Nairobi, and later spread to several districts resulting in huge number of measles cases with many deaths (Federation et al., 2011). In 2017, also there was one confirmed case of measles in Eastleigh, Kamukunji sub-County in May following measles outbreak in Garissa and Mandera counties earlier. Unfortunately, measles outbreak has occurred in Kamukunji sub-County and several other counties in 2018 with an unacceptable number of preventable deaths among children reported.

Over a period of 20 years, Kenya had not reported a single case of poliomyelitis, between 1984 and 2006. However, the re-emergence of the disease was recently witnessed, a factor that was closely associated with less – than – optimal vaccination coverage or low vaccination coverage and the poor sanitary conditions in the environment. For instance, in April 2018, circulating Vaccine Derived Polio Virus type2 (cVDPV2) was isolated in an environmental polio surveillance site in Kamukunji sub-County and WHO declared an outbreak of polio in the country. The isolated cVDPV2, was said to be similar genetically

to the cVDPV2 isolated in Mogadishu, Somalia in October 2017, suggesting spread. The re-emergence of the virus in this case showed that there is need for the government to continuously strengthen the public health measures that are aimed at ensuring that close to all children in Kenya are vaccinated against polio virus to achieve significant herd immunity. It also outlines the continuing need for addressing other public health measures that directly or indirectly contribute to the spread of certain vaccine preventable diseases. In the case of polio this refers to improvement in environmental sanitation and health education activities (Ministry of Health, 2013).

2.4 Factors Influencing Vaccination

Several factors have been attributed to influencing vaccination coverage including; mothers' vaccination knowledge, accessibility, mothers' attitude, mother having attended antenatal care, and proximity to urban area (Ismail et al., 2014). Social factors such as parents' education, religion and marital status have also been found to influence vaccination coverage (Sanou et al., 2009). Other factors mentioned to influence vaccination include; child's place of birth, family size, sex of the child and the economic status of parents (Awino, 2016). Advice on date of next visit for both vaccination and growth monitoring, distance to vaccinating facility, rainfall season and mother's age may also affect the vaccination coverage (Awino, 2016). There may be regional and local disparities due in terms of availability of resources; competing health priorities; poor management of health systems and inadequate monitoring and supervision (Awino, 2016). Factors attributed to low vaccination coverage included knowledge problems of mothers, access problems and attitude problems while children whose mother attended antenatal care and those from urban areas were more likely to complete their vaccination schedule (Ismail et

al., 2014). Several factors have been linked to the utilization of vaccination services. The age of the mother, child's birth order, awareness of vaccination, and knowledge of the benefits of vaccination has been associated with the uptake of vaccination services. The rate of defaulting vaccination was found to be higher among younger mothers than the older ones. This decreased with an increase in the age of the mother where older mothers were more likely to have their children fully immunized than the younger ones (Etana & Deressa, 2012). This is so because the younger women may be having insufficient knowledge of health care services and the importance of completing vaccination compared to the older ones.

The child's birth order has also been found to affect the completion of vaccination. Studies have shown a strong association between being born second or later in the family with incompletion of vaccination (Nath et al., 2007). This may be because the firstborn child may have special attention from the mother adhering to the ANC profile and making good use of the available health care services.

The mother's or /caregiver's education level has also been associated with the uptake of vaccination services. Educated mothers have been found to be more likely to ensure that their children are vaccinated as compared to the uneducated (Nath et al., 2007). This may be due to literate mothers being informed about VPDs and the importance of vaccination. The mothers who do not recognize the benefits of vaccination are likely to default as compared to those who are not aware of it.

Other factors that have shown an association with the uptake of vaccination services include the education level of the father, occupation of the mother, family earnings, and place of delivery. The fathers' level of education may influence the decision of whether to

vaccinate a child or not. If the father is knowledgeable of the VPDs and the importance of vaccinating children, he would be able to advocate for vaccination and ensure that the child is vaccinated (Kariuki, 2012). A mother's occupation and family income have been found to affect the uptake of vaccination services. The rate of vaccination of children is higher among mothers with some form of employment as compared to those who were just housewives. Vaccination in children delivered at the health facility and whose mothers attended the Antenatal Clinic (ANC) has also been found to be higher compared to those born at home. The reason might be that at the health facilities' the mothers may be educated on the importance and benefits of vaccination after delivery.

Despite all the efforts to ensure all infants are vaccinated before they celebrate their first birth day a good number of them still miss out on life saving vaccines. Reasons given for failure to vaccinate an infant included forgetting due to other responsibilities and religion (Kariuki, 2012). Sickness of an elder sibling following vaccination and lack of knowledge regarding subsequent vaccination have also been cited in failure to vaccinate a child (Nath et al., 2007). The age of mother, level of education of mother, family income status and number of children (under - fives) in the family also impacts on the vaccination status. Gender, child's birth place and child birth order have been shown to affect vaccination too (Etana & Deressa, 2012). As reported by Makokha (2016), long waiting at the facility, missed opportunities, inadequate vaccination services, limited access to services, availability of vaccines at the facility, also affect vaccination.

2.5 Gaps

It is evident that the vaccination coverage in the sub-county was suboptimal to avert the occurrence of vaccine preventable diseases. Actually, outbreaks of the vaccine preventable

diseases have been reported in Kamukunji sub-County severally. Factors which resulted in low vaccination coverage in Kamukunji sub-County and led to outbreaks of vaccine preventable diseases, were not clearly known.

2.6 Conceptual framework

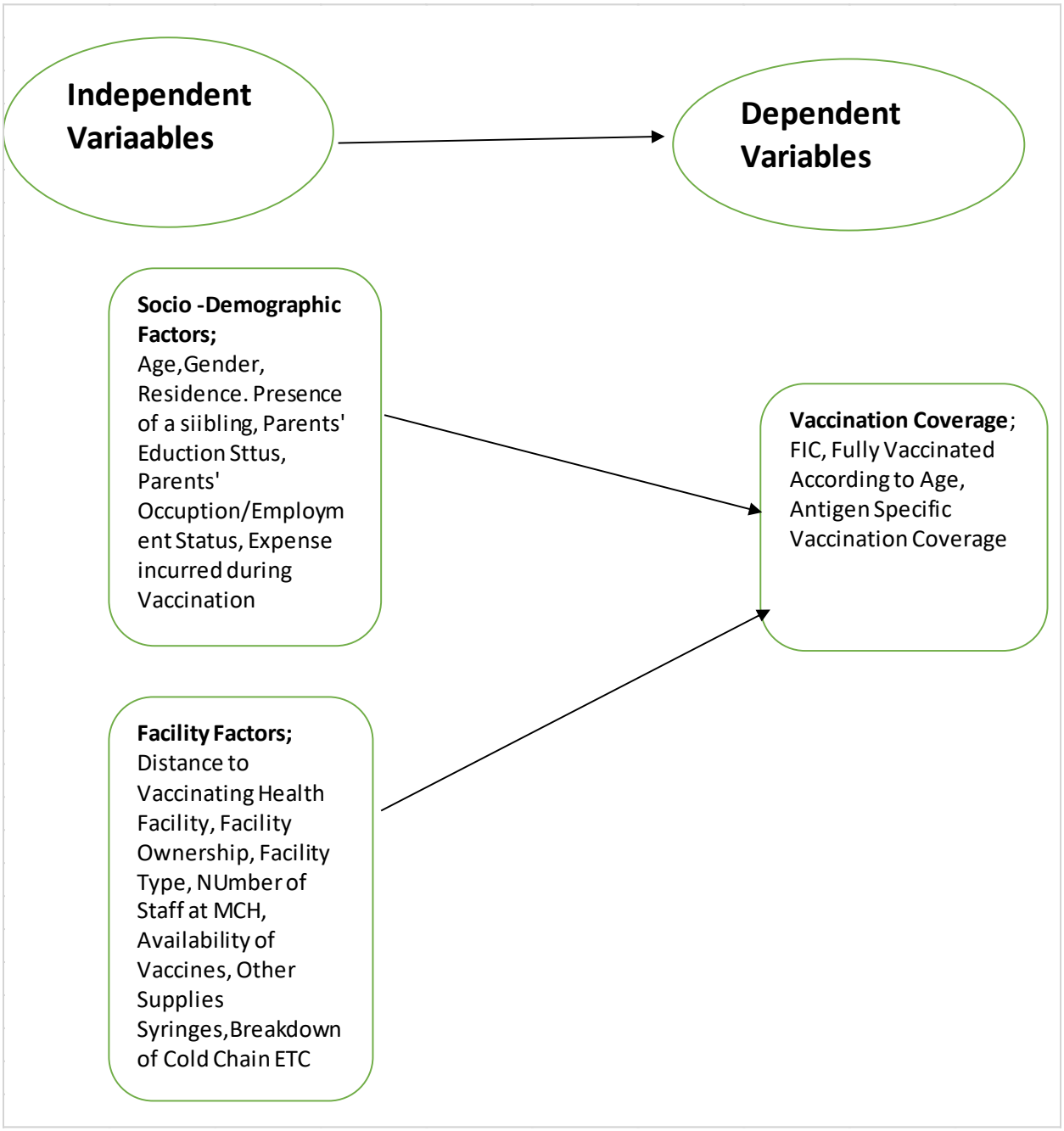

FIGURE 1: CONCEPTUAL FRAMEWORK

CHAPTER THREE

3.0 Methodology

3.1 Study Site

The study was conducted in Kamukunji sub-County within Nairobi County, which has five wards: Airbase, California, Eastleigh North, Eastleigh South and Pumwani. In 2019, the sub-County had 81 villages defined by landmarks such as roads and streets, and a total projected population of 333,805 people out of whom 10,352 were children below 1 year of age. In the year 2017, Fully Immunized Child (FIC) vaccination coverage was 77%, while the vaccination coverage of first dose of Oral Polio Vaccine (OPV1) and the third Oral Polio Vaccine (OPV3) were 81.6% and 74.1% respectively. The sub-county has approximately 200 health facilities out of which only 26 offer vaccination services.

The sub-county is the center of transit for people moving from Northern Kenya where the vaccination coverage was suboptimal and people from Somalia where there was a breakdown of health services.

In recent years, Vaccine Preventable Diseases (VPDs) outbreaks have been rampant in Kamukunji sub-County. In 2011, there was measles outbreak in Kamukunji sub-County which was traced to the former North Eastern Province and later spread to other parts of the country. In 2017, there was one confirmed case of measles in the sub-county followed by a wave of measles outbreaks in the sub-County and several other counties in 2018. There was also a polio outbreak in the sub-county reported in April 2018.

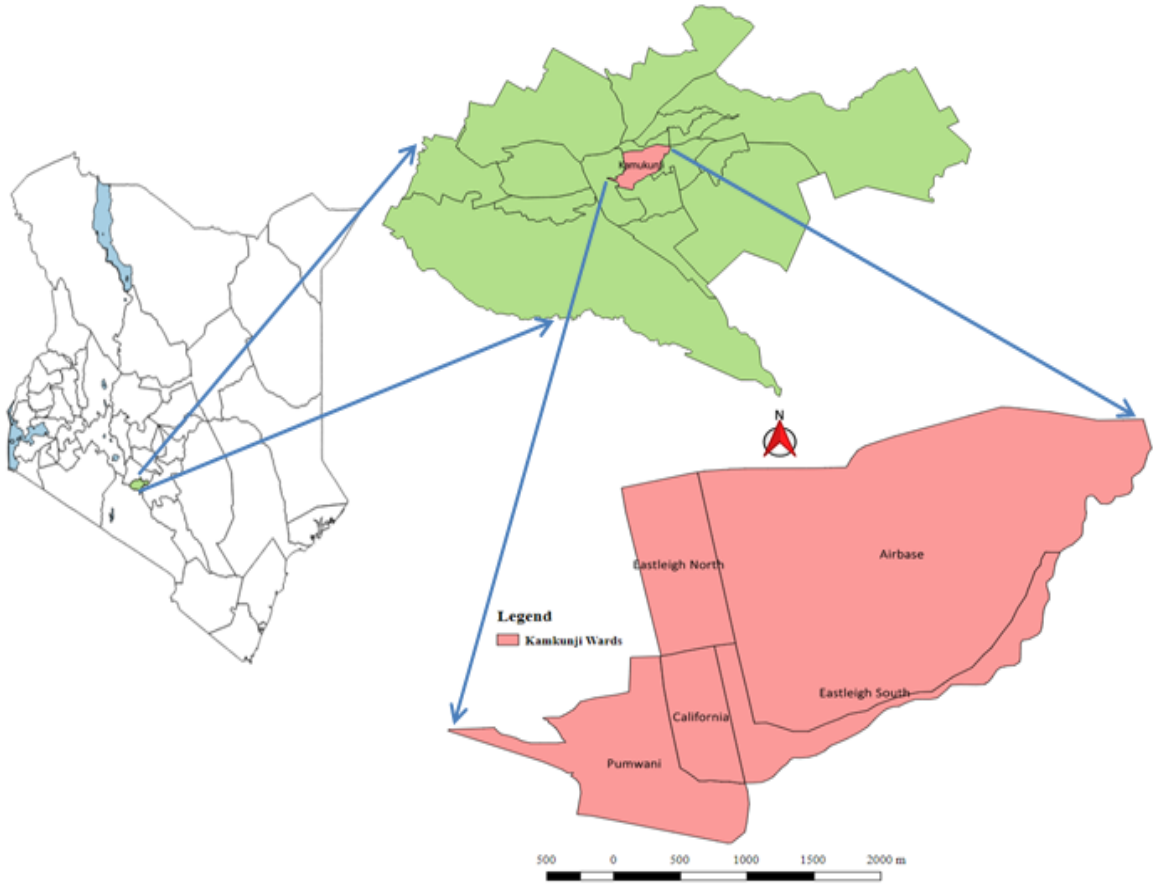

FIGURE 2: MAP OF KAMUKUNJI SUB - COUNTY, NAIROBI

3.2 Study population

The study population were infants (under 1 year of age) living in Kamukunji sub-County who were estimated to be 10,352 in 2019. The parents/guardians of the infants in the sub-county were interviewed. The health workers at vaccinating health facilities participated in the study by responding to the questionnaire during interviews held at vaccinating health facilities.

3.3 Study design

This was a cross-sectional study among infants focusing on their vaccination status and factors associated factors with vaccination in 2019.

3.4 Sample size calculation

The sample size was calculated by use of **Cochran sample size formula; $n= z^2 p (1-p)/ e^2$**

TABLE 1: COCHRAN SAMPLE SIZE FORMULA CALCULATION AND ADJUSTMENTS PARAMETERS

Sampling parameter	Value	Description of parameter
A measure of the confidence level (z)	1.96	Describe the level of uncertainty in the prevalence (level of confidence 95%)
Error margin (me)	0.05	The expected half-width of the confidence interval. The smaller the margin of error, the bigger the size of the sample needed
The basal level of indicator (p)	0.77	The immunization/vaccination coverage within the target population was 77% in 2017.
Effect of the design (ef)	1.5	Describes the loss of efficacy of the sampling due to the use of complex sampling design
Expected response rate (r)	0.80	Expected response rate. Recommended value: enter response rate from previous national/subnational household surveys, else use 0.8 as an estimate

- **Initial calculation using Cochran's formula.**

$N_0 = z^2 * (p * (1- p) /e^2 = (1.96^2 (0.77(1-0.77))/0.05^2 = (3.8416 \text{ x } (0.77 * 0.23))/0.0025$

$= (3.8416*0.1771)/0.0025=0.68035/0.0025 = 272$

- **Adjustment for the effect of the complex sampling design**: The initial sample size calculated using Cochran's formula was adjusted upwards by 50% to correct for the possible error that could occur due to the complex sampling design employed (West et al., 2014). Therefore, the initially calculated sample size was multiplied by 1.5 as shown below.

  $N_1 = N_0 * ef * = 272 * 1.5 = 408$

- **Adjustment for the expected rate of response:** The expected response rate from previous studies was 80% (0.8). Therefore, the adjusted sample size calculated above was again adjusted to the expected response rate by dividing the N_1 above by 0.8 as shown below:

  $N = N_1 / r = 408.0 / 0.8 = 510$ (final size of the sample)

  The total sample of infants studied by interviewing their caretakers was 510.

3.5 Sampling procedure

The multistage sampling technique was employed. Multiple sampling techniques were used at different stages, including stratified sampling, stratifying the study sample into wards and villages. The villages in the sub-county were demarcated by special landmarks including streets, roads and buildings and have been used by different partners in the sub-county to implement activities and programs including vaccination campaigns and relief assistance among others in the. The villages in the sub-county were selected by simple random sampling after allocating the number of villages to the wards by use of probability proportionate to size of children. Using the modified WHO 30x7 Epi cluster method, 30 villages were selected, and by dividing the sample size of 510 by 30, 17 households were selected in each village and the questionnaire administered to the infants' caregivers. The

method therefore became 30 by 17. By probability proportionate to size, 30 villages were distributed to the wards based on the number of villages each ward had and dividing by the total number of villages in the sub-county (81 villages) and then multiplied by the required number of villages (30 villages), Airbase Ward (16/81)*30=6 villages, California Ward (5/81)*30=2 villages, Eastleigh North Ward (17/81)*30=7 villages, Eastleigh South Ward (13/81)*30=5 villages and Pumwani Ward (30/81)*30=10 villages.

At the village level the identification of central point was done with the assistance of the village Community Health Volunteer (CHV) and then randomly selected direction from the central point (Milligan et al., 2004). Eight directions; East (E), North-East (NE), North (N), North-West (NW), West (W), South-West (SW), South (S) and South-East (SE) were written on 8 same size and same-colored papers and rolled to hide the writings. The rolled papers were thoroughly mixed in a container and the Community Health Volunteer picked one rolled paper, unrolled the picked paper and identified the selected direction.

All households along the line from the center to the edge of the village along the direction selected were interviewed until reaching the required number of households per village. In case of non-response, call backs were not implemented.

The healthcare worker in-charge of vaccination services at all the 26 health facilities providing vaccination services in the sub-county were interviewed about vaccination service information at the facility using pretested questionnaire.

3.6 Inclusion Criteria

All infants born and lived in Kamukunji sub-County plus those who had moved in and have lived in the sub-county for 3 months or more.

3.7 Data Collection and Management

A structured questionnaire was used to obtain the following data from parents/guardians (caretakers) of infant's: socio-demographic data, natal history and vaccination history as shown in the attached questionnaire (Appendix V). Healthcare workers were interviewed on health facility administrative data and vaccination data as in the attached healthcare workers' interviewer guide (Appendix VI).

Two research assistants who were fluent in Kiswahili, English and Somali, the common languages of the residents of the sub-county were recruited and trained on the use of interviewer-administered questionnaire (Appendix V), for data collection. The interviewer administered questionnaire was pre-tested through a pilot that was done in the villages not selected to participate in the main study to validate and ensure the tool was reliable. Fifty-one participants were interviewed during the pilot and necessary corrections were made to the questionnaire after the pilot. This was to ensure the data collection tool was giving valid and reliable data. The Principal Investigator (PI) collected data from healthcare workers in health facilities providing vaccination services. This was after testing the healthcare workers' interviewer guide in 3 vaccinating health facilities in the neighbouring Starehe sub-County and the necessary corrections made to the questionnaire.

3.8 Data storage and analysis

The data from the questionnaires were entered into the computer. They were then cleaned and coded ready for analysis. The analysis was done using Microsoft® Excel 2013 (Seattle, Washington, USA) and Stata 12. Data were always stored under safe and secure custody.

Accordingly, the soft copies were stored in laptop with password and hard copies were kept in a cabinet under lock and key.

Participants were described by person, place, and time characteristics using means, and medians for continuous variables and proportions for categorical variables.

The following formulae were used to calculate vaccination coverages:

a) Full Vaccination Coverage according to age: by dividing number of infants who got all age-specific antigens by the number of all infants under the study (510) and multiplying by 100.
b) Antigen specific coverage: by dividing the number of infants vaccinated against an antigen by the number of infants who were due for vaccination with the antigen and multiplying by 100.

Vaccinating health facilities were described by type and ownership, achievement of the minimum target of vaccination coverage (80%) for all antigens, whether the vaccinating health facility provide vaccination services on all days of the week or not, the number of staff providing vaccination and stock outs of routine supplies of vaccination and breakdown of cold chain.

Bivariate analysis was done by assessing the association between vaccination status and various variables such as age of the infant, ward of residence, parents' education level and occupation status, distance covered to reach vaccinating health facility providing vaccination, the expense incurred by caretakers while seeking vaccination services at the vaccinating health facilities, number of siblings an infant had among others. Prevalence Odds Ratio with 95% Confidence intervals was used as the measure of association while chi square test was used to test for significance. Any factor with P-Value of less than 0.2

was entered into multivariate analysis using unconditional logistic regression (backward elimination) and factors with P value < 0.05 were considered significant and independently associated with vaccination.

3.9 Ethical consideration

Before embarking on the study, an ethical clearance for the study was obtained from Moi University/Moi Teaching & Referral Hospital Institutional Research and Ethics Committee (MU/MTRH IREC). The Kenya Field Epidemiology and Laboratory Training Program (KFELTP) of the Ministry of Health (MOH) gave the study clearance and the approval to carry out the study in the sub-county. Permission to carry out the study was also obtained from National Commission for Science, Technology & Innovations (NACOSTI) as required by law. The authority and permission to carry out the study in Kamukunji sub-County was given by the Department of Health, Nairobi Metropolitan Services (NMS). Permission to collect vaccination data from vaccinating health facilities was obtained from the Sub-County Health Management Team (SCHMT) through the office of sub-County Medical Officer of Health (SCMOH).

The participants were fully informed about the study and informed written consent obtained from the parents/guardians (caretakers) of infants and from the healthcare workers working at the vaccination table (MCH in-charges) at the vaccinating health facilities in the sub-county. Confidentiality of the collected information was maintained throughout the study period. This was done by storing the hard copy data under key and lock and the soft copy data and information were stored in a computer under password in the custody of Principle Investigator. Names of participants were never collected during the interview of caretakers and the identity of participants were not disclosed.

Participation was voluntary and a participant was free to leave the study at any time. No disclosures of any personal information made to unauthorized individuals.

.3.10 Expected use of the findings

The findings will be shared among stakeholders, decision-makers and healthcare managers especially at all levels including the sub-county, county, and national levels. The findings will be disseminated to all partners participating in the provision of basic vaccination and providing logistical support for vaccination services at the national, county and the sub-county levels. Results of the study will be used as basis to make recommendations to the managers of vaccination at both the national, county and sub-county levels. The results will then be used as the basis to come up with strategies to address vaccination gaps identified and develop policies to better manage vaccination services and have desirable vaccination outcomes. The findings will also add to the body of knowledge by publishing them in a scientific journal.

CHAPTER FOUR

4.0 Results

4.1 Household Interview Results

4.1.1: Participants (infants) characteristics

In total, data from five hundred and ten (510) infants were collected from the caretakers in the sub-county. The ages of the infants ranged from 3 months to 11 months with a mean age of 9 months (SD ± 2 months). Majority (315 or 61.8%) of the study participants (infants) were aged between 9 and 11 months and the least (54 or 10.6%) were aged 3 to 5 months (Figure 4.1). Out of 510 infants, 336 (65.9%) were fully vaccinated according to their age. Out of the 315 infants aged 9 to 11 months 247 (78.4%) were fully vaccinated according to age while of the 54 infants aged 3 to 5 months 14 (25.9%) were fully vaccinated according to age (Figure 3). More than a third, 174 (34.1%) of the infants were not fully vaccinated according to their age; age group 3 to 5 months had 40 infants not fully vaccinated according to age, 6 to 8 months had 66 infants not fully vaccinated according to age and 9 to 11 months had 68 infants not fully vaccinated according to age (Figure 3).

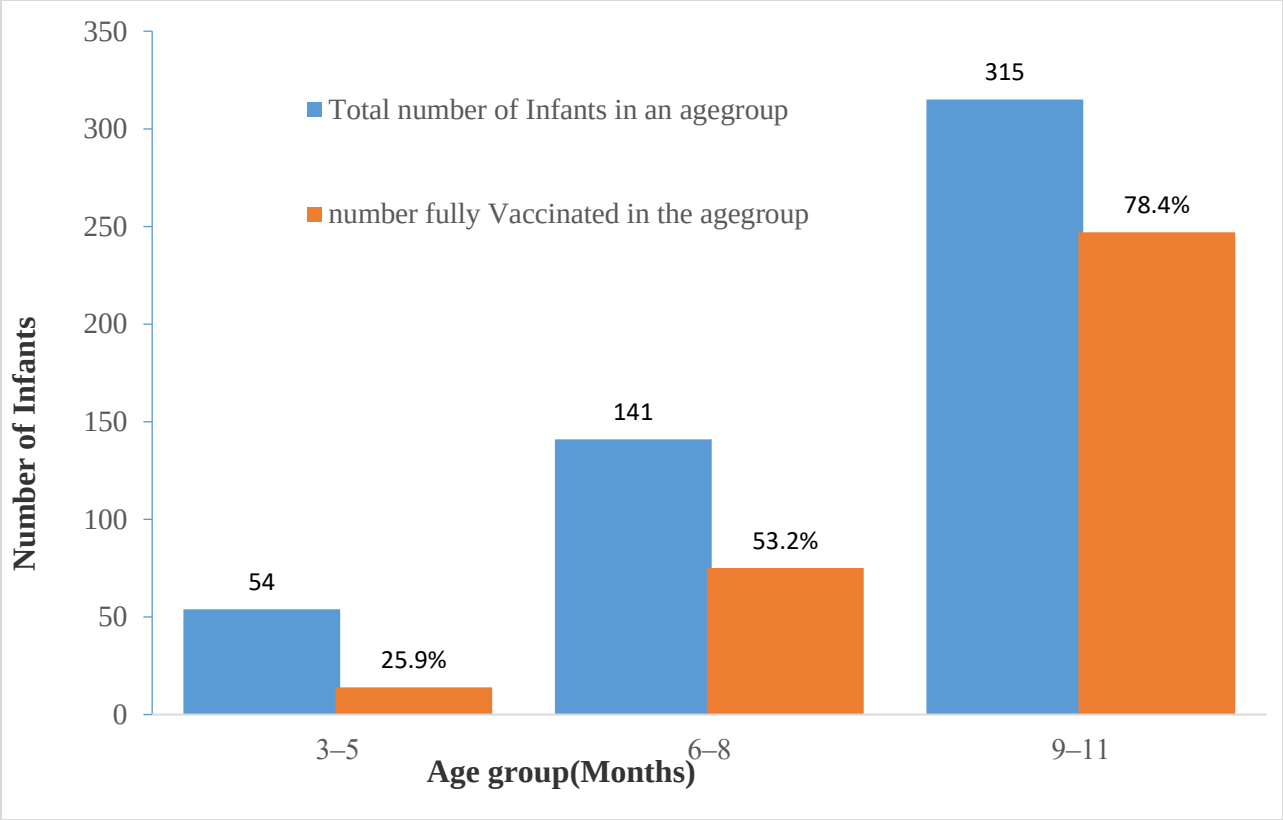

FIGURE 3: AGE GROUP DISTRIBUTION AND NUMBER FULLY VACCINATED AMONG INFANTS IN KAMUKUNJI SUB-COUNTY (N=510)

Out of 510 participants, females were 276 (54.1%). Four hundred and ninety (490), 96.1% of the infants studied were born in the hospital. One hundred and eighteen (118) 23.1% of the infants studied were from Eastleigh North Ward and 94 (79.7%) of them were fully vaccinated according to their age while 52 (10.2%) of the infants, whose data were collected from California Ward had29 (55.8%) of them fully vaccinated according to their age. One hundred and seventy-seven (177) 34.7% of the participants were the only child of their families and 101 (57.1%) of them were fully vaccinated according to their age while 140 (27.5%) of infants studied had one (1) sibling in the family and 101 (72.9%) of them were fully vaccinated according to their age. Five hundred (500), 98% of the participants reported having Mother and Child Card but only 7 (1.4%) of them were able to produce the cards during the interview (Table 2).

TABLE 2: SOCIO-DEMOGRAPHIC CHARACTERISTIC S OF INFANTS AND FULL VACCINATION COVERAGE, KAMUKUNJI SUB-COUNTY (N=510)

	Female n (%) 276 (54.1%)	Male n (%) 234(45.9%)	Total N (%)	Fully Vaccinated N (%)
Ward				
Airbase	40 (14.5)	29 (12.4)	69 (13.5)	39 (56.5)
California	26 (9.4)	26 (11.1)	52 (10.2)	29 (55.8)
Eastleigh North	64 (23.2)	54 (23.1)	118 (23.1)	94 (79.7)
Eastleigh South	52 (18.8)	50 (21.4)	102 (20.0)	62 (60.8)
Pumwani	94 (34.1)	75 (32.1)	169 (33.1)	112 (66.3)
Number of Siblings				
0	97 (35.1)	80 (34.2)	177 (34.7)	101 (57.1)
1	66 (23.9)	74 (31.6)	140 (27.5)	102 (72.9)
2	74 (26.8)	49 (20.9)	123 (24.1)	84 (68.3)
3 and Above	39 (14.1)	31 (13.2)	70 (13.7)	49 (69.0)
Mother and Child Card Possession				
Yes, and Available	1 (0.4)	6 (2.6)	7 (1.4)	6 (85.7)
Yes, and Not Available	270 (97.8)	223 (95.3)	493 (96.6)	320 (64.9)
No	5 (1.8)	5 (2.1)	10 (2.0)	10 (100)

4.1.2 Characteristics of parents and caregivers

Majority of the mothers 246 (48.2%) under the study and the fathers 280 (54.9%) under the study had secondary level of education while majority of the mothers 330 (64.7%) under the study and fathers 463 (90.8%) under the study were self-employed (Table 2). Infants of secondary educated mothers had the highest 190 (77.2%) full vaccination coverage according to their age while infants of primary educated mothers had the least 119 (54.1%) full vaccination coverage according to their age. Infants of secondary educated fathers had the highest 216 (77.1%) full vaccination coverage according to their age while those of fathers without formal education had the least 3 (30%) full vaccination coverage according to their age. Fathers who were in formal employment (31) under the study had 30 (96.8%) of their infants fully vaccinated according to their age while mothers in formal employment (5) under the study had all their infants fully vaccinated according to their age. Self – employed mothers (330) under the study had 214 (64.8%) of their infants

fully vaccinated according to their age while self – employed fathers (463) under the study had 295 (63.7%) of their infants fully vaccinated according to their age (Table 2).

TABLE 3: PARENTS' EDUCATION & EMPLOYMENT STATUS AND INFANTS' VACCINATION COVERAGE, KAMUKUNJI SUB-COUNTY (N=510)

	Mother N (%)	Fully Vaccinated N (%)	Father N (%)	Fully Vaccinated N (%)
Education Level of Parent				
No Education	25 (4.9)	16 (64.0)	10 (2.0)	3 (30.0)
Primary	220 (43.1)	119 (54.1)	86 (16.8)	46 (53.5)
Secondary	246 (48.2)	190 (77.2)	280 (54.9)	216 (77.1)
Tertiary	19 (3.7)	11(57.9)	128 (25.1)	67 (52.3)
Quranic/Islamic	0 (0)	0 (0)	6 (1.2)	4 (66.7)
Occupation Status of Parent				
Formal Employment	5 (1.0)	5 (100)	31 (6.1)	30 (96.8)
Self –Employment	330 (64.7)	214 (64.8)	463 (90.8)	295 (63.7)
Unemployed	174 (34.1)	116 (66.7)	15 (2.9)	10 (66.7)
Casual	0 (0)	0 (0)	1 (0.2)	1 (100)
Pastoralist	1 (0.2)	1(100)	0 (0)	0 (0)

4.1.3: Distribution of the participants by vaccinating health facilities characteristics and vaccination status

Majority 480 (94.1%) of the participants (infants), under the study in the sub-county, were attending government owned vaccinating health facilities in the sub-county for vaccination services while a minority 7 (1.4%) of infants under study, were attending faith based vaccinating health facilities in the sub-county for vaccination services.

Infants under the study attending government owned vaccinating health facilities, in the sub-county, for vaccination services had 321 (66.9%) of them fully vaccinated according to their age while out of the 23 (4.5%) infants under the study attending privately owned vaccinating health facilities in the sub-county for vaccination services had 12 (52.2%) of

them fully vaccinated according to age. Meanwhile out of 7 (1.4%) infants attending faith based vaccinating health facilities in the sub-county for vaccination services,3 (42.9%) of them were fully vaccinated according to their age. As the infants were seeking vaccination services at the vaccinating health facilities in the sub-county, majority 217 (42.5%) of the infants under the study covered a distance of less than half a kilometer (Km) to vaccinating health facilities while 25 (4.9%) of them travelled a distance of more than 5 Km to 10 Km to the vaccinating health facilities (Table 3). Out of 217 (42.5%) infants under study whose caretakers covered a distance of less than half a kilometer to the vaccinating health facilities within the sub-county, 178 (82.0%) of them were fully vaccinated according to their age which was the highest coverage compared to others and out of 159 (31.2%) of infants under study whose caretakers covered a distance of more than a kilometer to 5 kilometers to the vaccinating health facilities in the sub-county, at least 77 (48.4%) of them were fully vaccinated according to their age (Table 3).

The caretakers incurred expenses, while seeking vaccination services for their infants in the sub-county, ranging from <100 Kenya shillings (Ksh.) 247 (48.4%) of the caretakers under the study to 1000 Ksh. and above 10 (2.0%) of the caretakers under the study. Out of 247 (48.4%) of the caretakers under the study spending less than Kenya shillings 100 in seeking vaccination services for their infants in the sub-county, their infants had the highest with 196 (79.4%) of them being fully vaccinated according to their age. While out of 157 (30.8%) caretakers under the study who have spent Kenya shillings between 500 and 999 in seeking vaccination services for their infants in the sub-county, their infants had the least 77 (49.0%) of them fully vaccinated according to their age (Table 3).

TABLE 4: FACILITY CHARACTERISTICS AND VACCINATION STATUS AMONG INFANTS, KAMUKUNJI SUB-COUNTY (N=510)

	Number of Infants N (%)	Infants Fully Vaccinated N (%)
Vaccinating Facility Ownership		
Government (Public)	480 (94.1)	321 (66.9)
Private	23 (4.5)	12 (52.2)
Mission (Faith-based)	7 (1.4)	3 (42.9)
Distance to Vaccinating Facility in Km		
<0.5 Km	217 (42.5)	178 (82.0)
0.5 Km –1 Km	109 (21.4)	67 (61.5)
>1 Km –5 Km	159 (31.2)	77 (48.4)
>5 Km –10 Km	25 (4.9)	14 (56)
Expenses Incurred During Vaccination Visit in Kshs		
<100	247 (48.4)	196 (79.4)
100–499	96 (18.8)	56 (58,3)
500–999	157 (30.8)	77 (49.0)
1000 and above	10 (2.0)	7 (70.0)

4.1.4: Specific antigen vaccination coverages

The vaccination coverage according to age of infants in the sub-county, in 2019, for most of the antigens were above the WHO recommended minimum coverage of 80% except for the second dose of Rota virus vaccine (Rota2). All infants got the first dose of Oral Polio Vaccine (OPV1) while 508 (99.6%) infants got Bacillus Calmette-Guérin (BCG) Vaccine. Five hundred and four (504), almost 99% of infants got first dose of Pentavalent Vaccine (Penta1) and 486 (95.3%) of infants got third dose of Pentavalent Vaccine. Cumulatively only 336 (65.9%) were fully vaccinated according to their age and more than a third 174 (34.1%) of them missed 1 or more antigens (vaccine) (Figure 2).

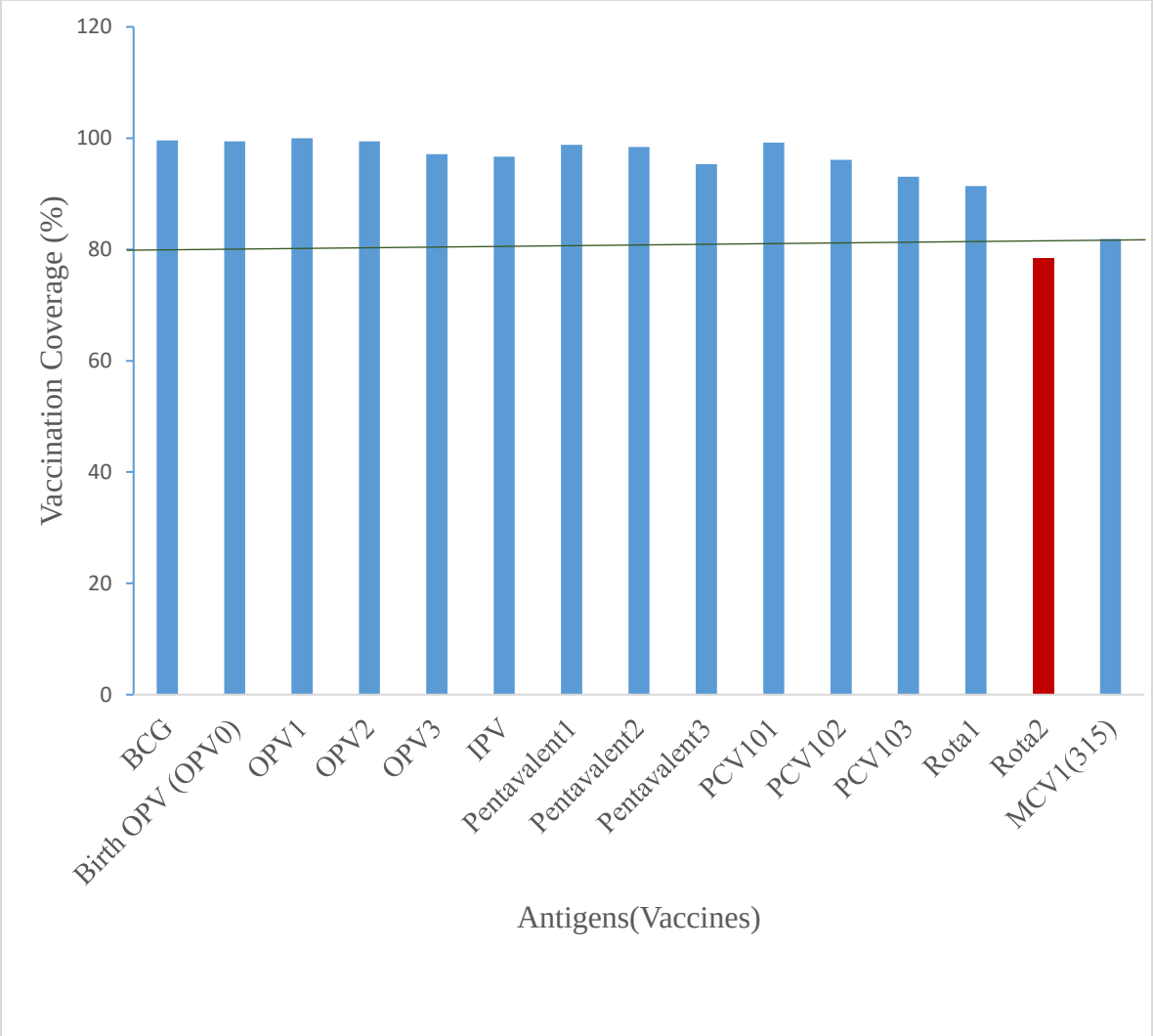

FIGURE 4: ANTIGENS' VACCINATION COVERAGE AMONG INFANTS, KAMUKUNJI SUB-COUNTY (N=510)

4.1.5: Reasons for not fully vaccinating according to age

Majority, 169 (97.1%) out 174 caretakers whose infants were not fully vaccinated according to age in the sub-county, in 2019, did not know the subsequent doses were supposed to be given while the others gave child being sick, forgetfulness and being busy among reasons for not fully vaccinating their infants (Figure 4).

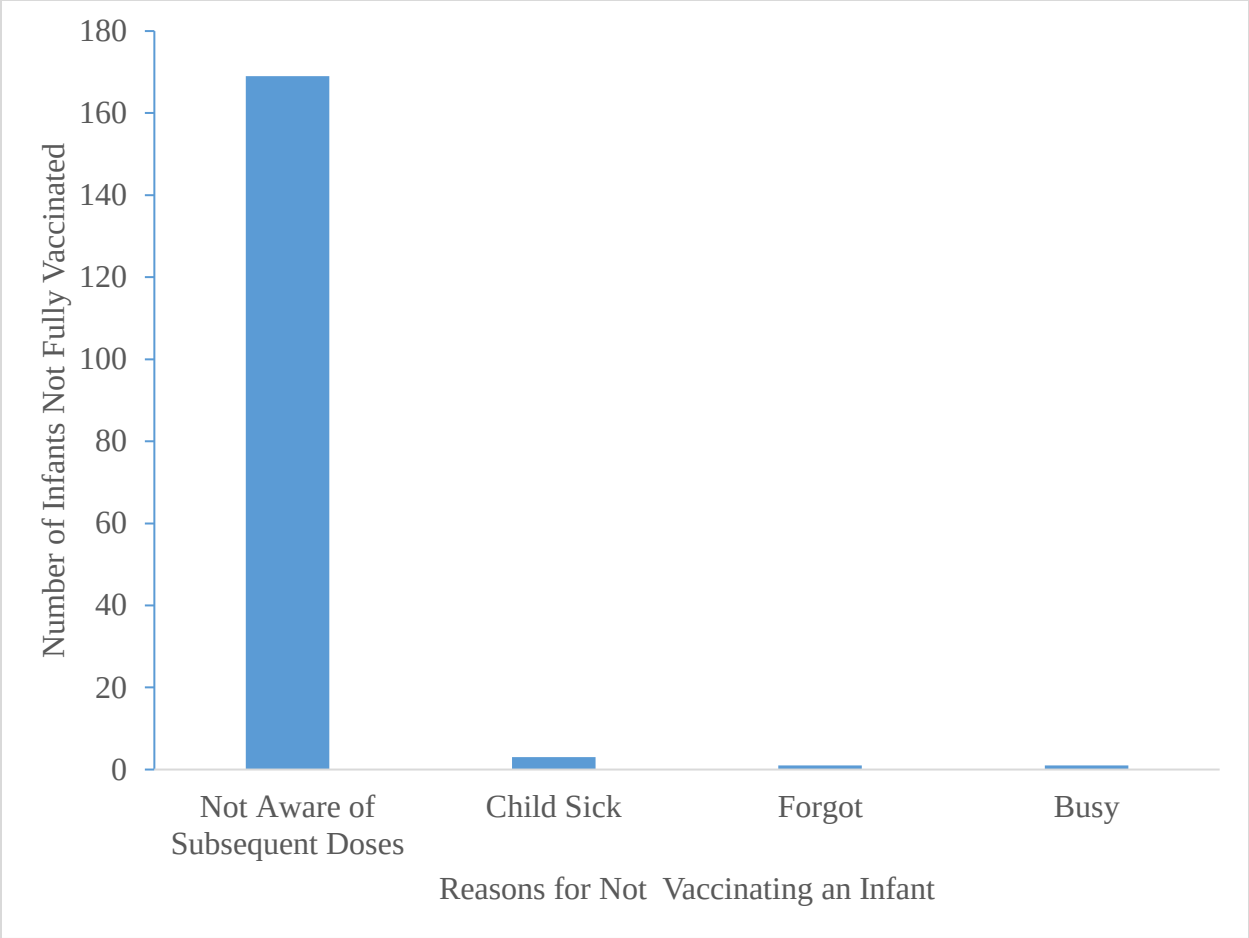

FIGURE 5: REASONS GIVEN FOR NOT FULLY VACCINATING AN INFANT IN KAMUKUNJI SUB - COUNTY (N=174)

4.1.6: Risk factor analysis

4.1.6.1: Bivariate analysis

In bivariate analysis of the factors under the study, there were statistical association between full vaccination coverage according to the age and most of the factors analyzed in the study except the ownership of vaccinating health facility attended for vaccination services with p-values of 0.05 and below (Table 5). Infants aged 9 to 11 months in Kamukunji sub-County, in 2019 had the highest vaccination coverage (78.4%) according to age than other age group of infants in the sub-county (Figure 4.1). Infants aged 3 to 5 months were 10% likely to be fully vaccinated according to their age compared to infants

aged 9 to 11 months in the sub-county, in 2019 while those aged 6 to 8 months were 30% likely to be fully vaccinated according to their age compared to infants aged 9 to 11 months in the sub-county, and the results of the analysis were both statistically significant with p-values of <0.001 (Table 4.4).

Infants in Eastleigh North Ward had the highest proportion (79.7%) of fully vaccinated according to age compared to infants from other wards in Kamukunji sub-County in 2019 (Table 2). Infants staying in California Ward were 32% likely to be fully vaccinated according to their age as compared to infants staying in Eastleigh North Ward in 2019 and the analysis gave a p-value of 0.002. Infants staying in Airbase Ward were 33% likely to be fully vaccinated according to their age compared to their counterparts staying in Eastleigh North Ward with a resultant p-value of 0.001. The infants staying in Eastleigh South Ward were 40% likely to be fully vaccinated according to their age compared to infants staying in Eastleigh North Ward and the analysis yielded a p-value of 0.002 while those staying in Pumwani Ward were 50% likely to be fully vaccinated according to their age compared to infants staying in Eastleigh North Ward and the analysis brought forward a P value of 0.014 (Table 4). The p-values generated out of the analysis of Ward residence and attainment of fully vaccinated infants according to the age were all statistically significant.

Infants whose caretakers travelled less than half a kilometer to vaccinating health facilities while seeking vaccination services for them had the highest proportion (82.0%) of them fully vaccinated according to age in Kamukunji sub-County in 2019 than infants whose caretakers travelled more than half a kilometer to vaccinating health facilities while seeking vaccination services in the sub-County (Table 3). Infants whose caretakers travelled a

distance of between 1 kilometer to 5 kilometers to vaccinating health facilities while seeking vaccination services for them were 21% likely to be fully vaccinated according to their age as compared to infants whose caretakers travelled a distance of less than a half kilometer to vaccinating health facilities while seeking vaccination services for them in the sub-county and the analysis yielded a P-value of <0.00. Infants whose caretakers travelled a distance of between 5 kilometers to 10 kilometers to vaccinating health facilities while seeking vaccination services for them were 28% likely to be fully vaccinated according to their age as compared to infants whose caretakers travelled a distance of less than a half kilometer to vaccinating health facilities while seeking vaccination services for them in the sub-county and the resultant p-value out of the analysis was 0.004. Infants whose caretakers travelled a distance of between 0.5 kilometers to 1 kilometer to vaccinating health facilities were 35% likely to be fully vaccinated according to their age as compared to infants whose caretakers travelled a distance of less than a half kilometer to vaccinating health facilities while seeking vaccination services for them in the sub-county and the analysis produced a p-value of <0.001 (Table 4). The p-values produced out of the analysis of the distance travelled by the infants' caregivers while seeking vaccination services in the sub-county, in 2019 and the attainment of fully vaccinated infant according to age were statistically significant.

Infants whose fathers had secondary level of education had the highest proportion (77.1%) of them fully vaccinated according to their age in Kamukunji sub-County, in 2019 compared to infants whose fathers had other level of education other than secondary level of education in the sub-county (Table 2). Infants whose fathers had no formal education (illiterate) were 13% likely to be fully vaccinated according to their age as compared to

infants whose fathers had secondary level of education in the sub-county and the analysis gave a p-value of 0.003. While infants whose fathers had primary level of education were 34% likely to be fully vaccinated according to their age as compared to infants whose fathers had secondary level of education in the sub-county and the resultant P-value out of the analysis was <0.00. Meanwhile infants whose fathers were in formal employment had the highest proportion (96.8%) of them fully vaccinated according to their age compared to infants whose fathers were not in formal employment in Kamukunji sub-County, in 2019 (Table .2). Infants whose fathers were self – employed were 6% likely to be fully vaccinated according to their age compared to infants whose fathers were in formal employment in the sub-county and this analysis produced p-value of 0.005. Infants whose fathers were unemployed were 7% likely to be fully vaccinated according to their age compared to infants whose fathers were in formal employment in the sub-county and the resultant p-value of the analysis was 0.019 (Table 4). The analyses of both fathers' education status and employment status compared to their infants' attainment of fully vaccinated infant according to the age were statistically significant.

Infants whose mothers had secondary level of education had the highest proportion (77.2%) of them fully vaccinated according to their age in Kamukunji sub-County, in 2019 compared to infants whose mothers had other level of education other than secondary level of education in the sub-county (Table 2). Infants whose mothers had primary level of education were 35% likely to be fully vaccinated according to their age compared to infants whose mothers had secondary level of education in the sub-county and the analysis resulted in a statistically significant p-value of <0.001. While infants who had no sibling in their family were 50% likely to be fully vaccinated according to their compared to infants who

had a sibling in the family in the sub-county, in 2019 and the analysis produced a statistically significant p-value of 0.004 (Table 5).

TABLE 5: BIVARIATE ANALYSIS OF FACTORS ASSOCIATED WITH VACCINATION COVERAGE AMONG INFANTS, KAMUKUNJI SUB-COUNTY (N =510)

Factors	Fully Vaccinated according to age: N(%)	Crude Odds Ratio (COR)	95% Confidence Interval (CI)	P-Value
Age Group in months				
3 – 5	14 (25.9)	0.10	0.05 – 0.18	0.000
6 – 8	75 (53.2)	0.31	0.20 – 0.48	0.000
9-11	247 (78.4)	Ref	Ref	Ref
Mother Education				
No formal education (Illiterate)	16 (64.0)	0.52	0.22 – 1.25	0.145
Primary education	119 (54.1)	0.35	0.23 – 0.52	0.000
Tertiary education	11 (57.9)	0.41	0.16 – 1.06	0.065
Secondary education	190 (77.2)	Ref	Ref	Ref
Father Education				
No formal education (Illiterate)	3 (30.0)	0.13	0.03 – 0.51	0.003
Primary education	46 (53.5)	0.34	0.21 – 0.57	0.000
Quranic (Islamic) education	4 (66.7)	0.59	0.11 – 3.31	0.551
Tertiary education	67 (52.3)	0.33	0.21 – 0.51	0.000
Secondary education	216 (77.1)	Ref	Ref	Ref
Father Occupation				
Self employed	295 (63.7)	0.06	0.01 – 0.43	0.005
Unemployed	10 (66.7)	0.07	0.01 – 0.64	0.019
Formal employment	30 (96.8)	Ref	Ref	Ref
Ward				
Airbase	39 (56.5)	0.33	0.17 – 0.64	0.001
California	29 (55.8)	0.32	0.16 – 0.65	0.002
Eastleigh South	62 (60.8)	0.40	0.22 – 0.72	0.002
Pumwani	112 (66.3)	0.50	0.29 – 0.87	0.014
Eastleigh North	94 (79.4)	Ref	Ref	Ref
Number of Siblings				
0	101 (57.1)	0.50	0.31 – 0.80	0.004
2	84 (68.3)	0.80	0.47 – 1.37	0.417
3 and Above	49 (69.0)	0.87	0.46 – 1.64	0.664
1	102 (72.9)	Ref	Ref	Ref
Vaccination Facility Ownership				
Faith based	3 (42.9)	0.37	0.08 – 1.68	0.198
Private	12 (52.2)	0.57	0.23 – 1.25	0.151
Government	321 (66.9)	Ref	Ref	Ref
Vaccination Facility Distance in Km				
0.5 Km –1 Km	67 (61.5)	0.35	0.21 – 0.58	0.000
>1 Km –5 Km	77 (48.4)	0.21	0.13 – 0.33	0.000
>5 Km –10 Km	14 (56,0)	0.28	0.12 – 0.66	0.004
< 0.5 Km	178 (82.0)	Ref	Ref	Ref
Vaccination Expenses in Ksh				
100 – 499	56 (58.3)	0.36	0.22 – 0.61	0.000

500 – 999	77 (49.0)	0.61	0.15 – 2.43	0.481
1000 and Above	7 (70.0)	0.25	0.16 – 0.39	0.000
<100	196 (79.4)	Ref	Ref	Ref

The Highlighted P Values are Statistically Significant

4.1.6.2 Multivariate analysis

A multivariate logistic regression (backward elimination) model with all factors under the study that had p-value of 0.2 or less at bivariate analysis was applied. The analysis resulted in a final model that had the following factors: the age of the infant, fathers' education level, fathers' occupational status, the ward of residence of the infant and distance covered by caretakers to vaccinating health facilities while seeking vaccination services for their infants with p-values of less than 0.05 (Table 6). The infants aged 3 to 5 months had an adjusted odd of 0.09 to be fully vaccinated according to their age compared to infants aged 9 to 11 months in Kamukunji sub-County, in 2019 and their p-value was <0.001 and infants aged 6 to 8 months had an adjusted odd of 0.45 to be fully vaccinated according to their age compared to infants aged 9 to 11 months in the sub-county and a resultant p-value of 0.001 (Table 5).

The infants staying in California Ward had an adjusted odd of 0.23 to be fully vaccinated according to their age compared to infants staying in Eastleigh North Ward in 2019 and the analysis yielded a P-value of 0.001 while infants staying in Airbase Ward had an adjusted odd of 0.40 to be fully vaccinated according to their age compared to infants staying in Eastleigh North Ward and the analysis resulted in a p-value of 0.018 (Table 6).

The infants whose caretakers travelled a distance of between > 1 kilometer and 5 kilometers to vaccinating health facilities in seeking vaccination services for them had an adjusted odd of 0.20 to be fully vaccinated according to their age compared to infants whose caretakers travelled less than half a kilometer to vaccinating health facilities while seeking vaccination

services for their infants in Kamukunji sub-County, in 2019 and the analysis had a p-value of <0.001. Infants whose caretakers travelled a distance of between half a kilometer and a kilometer to vaccinating health facilities when seeking vaccination services for their infants had an adjusted odd of 0.35 to be fully vaccinated according to their age compared to infants whose caretakers travelled less than a half kilometer to vaccinating health facilities while seeking vaccination services for their infants in the sub-county and the analysis produced a p-value of 0.002 (Table 6)

The infants whose fathers were self – employed had an adjusted odds of 0.06 to be fully vaccinated according to their age compared to infants whose fathers were in formal employment in Kamukunji sub-County, in 2019 and the analysis resulted in a p-value of 0.014 and infants whose fathers were unemployed had an adjusted odds of 0.08 to be fully vaccinated according to their age compared to infants whose fathers were in formal employment in the sub-county and the analysis produced a p-value of 0.049 (Table 6).

Based on the analysis all these factors were statistically significant and independently associated with infant's attainment of full vaccination according to their ages (Table 6)

TABLE 6: MULTIVARIATE ANALYSIS FINAL MODEL OF FACTORS ASSOCIATED WITH VACCINATION

Factors	Adjusted Odds Ratio (aOR)	95% Confidence Interval (CI)	P-Value
Age Group in months			
3 – 5	0.09	0.04 – 0.18	0.000
6 – 8	0.45	0.28 – 0.72	0.001
9-11	Ref	Ref	Ref
Father Education			
No formal education (Illiterate)	0.12	0.02 – 0.60	0.010
Primary education	0.57	0.31 – 1.02	0.056
Quranic (Islamic) education	0.96	0.11 – 8.06	0.971
Tertiary education	0.47	0.28 – 0.78	0.004
Secondary education	Ref	Ref	Ref
Father Occupation			

Self employed	0.06	0.01 – 0.57	0.014
Unemployed	0.08	0.01 – 0.99	0.049
Formal employment	Ref	Ref	Ref
Ward			
Airbase	0.40	0.18 – 0.85	0.018
California	0.23	0.10 – 0.55	0.001
Eastleigh South	0.51	0.25 – 1.04	0.064
Pumwani	0.69	0.36 – 1.35	0.279
Eastleigh North	Ref	Ref	Ref
Vaccination Facility Distance in Km			
0.5 Km –1 Km	0.35	0.18 – 0.68	0.002
>1 Km –5 Km	0.20	0.11 – 0.36	0.000
>5 Km –10 Km	0.44	0.16 – 1.19	0.107
< 0.5 Km	Ref	Ref	Ref

4.2 Vaccinating Facilities Key Information

4.2.1: Type and ownership of vaccinating health facilities and their distribution per ward

We collected key vaccination information from all the 26 vaccinating health facilities in the sub-county. Three (3) were community – based vaccinating health facilities and 12 were privately owned vaccinating health facilities and 5 were public – owned vaccinating health facilities. There were 6 clinics providing vaccination services in the sub-county and were distributed as follows: 2 clinics in Airbase Ward, 1 clinic in Eastleigh North Ward, 2 clinics in Eastleigh South Ward and 1 clinic in Pumwani Ward. There were 5 dispensaries providing vaccination services in the sub-county and they were as follows: 1 vaccinating dispensary in Airbase Ward, 1 vaccinating dispensary in Eastleigh North Ward, 1 vaccinating dispensary in Eastleigh South Ward and 2 vaccinating dispensaries in Pumwani Ward. There was a health centre providing vaccination services in Airbase Ward. There were 14 hospitals providing vaccination services in the sub-county distributed in the wards as follows: 1 vaccinating hospital in Airbase Ward, another 1 vaccinating hospital in California Ward, 7 vaccinating hospitals in Eastleigh North Ward, 1 vaccinating hospital in Eastleigh South Ward and 4 vaccinating hospitals in Pumwani Ward (Table 6).

TABLE 7: VACCINATING HEALTH FACILITIES BY OWNERSHIP, TYPE AND WARDS, KAMUKUNJI SUB - COUNTY (N=26)

	AIRBASE WARD (N)	CALIFORNIA WARD (N)	EASTLEIGH NORTH WARD (N)	EASTLEIGH SOUTH WARD (N)	PUMWANI WARD (N)	TOTAL (N)
FACILTTY OWNERSHIP						
COMMUNITY BASED HEALTH FACILITIES	2	0	1	0	0	**3**
FAITH BASED HEALTH FACILITIES	1	0	2	2	1	**6**
PRIVATE HEALTH FACILITIES	1	1	6	1	3	**12**
PUBLIC HEALTH FACILITIES	1	0	0	1	3	**5**
FACILITY TYPE						
CLINIC	2	0	1	2	1	**6**
DISPENSARY	1	0	1	1	2	**5**
HEALTH CENTRE	1	0	0	0	0	**1**
HOSPITAL	1	1	7	1	4	**14**
TOTAL (N)	**5**	**1**	**9**	**4**	**7**	**26**

4.2.2 Vaccinating health facilities vaccination status

One facility in the sub-county, Al Amin Hospital, attained the WHO recommended vaccination coverage of 80% and above for all antigens. Nine (9) vaccinating health facilities had achieved the target of 80% and above vaccination coverage for BCG while 8 vaccinating health facilities attained the 80% and above recommended vaccination coverage for Birth OPV (OPV0). Fifty percent (13) of the vaccinating health facilities managed to reach the 80% and above vaccination coverage for first dose of Oral Polio Vaccine (OPV1) and 14 vaccinating health facilities had the recommended 80% and

above vaccination coverage for both first dose of Pentavalent vaccine (Pentavalent1) and third dose of Pentavalent vaccine (Pentavalent3). Eight (8) of the vaccinating health facilities attained the 80% and above vaccination coverage recommended by WHO for first dose of Measles Containing Vaccine (MCV1). Eight (8) of the vaccinating health facilities did not achieve the targeted vaccination coverage of 80% and above for all the antigens (Table 8).

TABLE 8: FACILITY ATTAINMENT OF THE RECOMMENDED 80% AND ABOVE VACCINATION COVERAGE IN KAMUKUNJI SUB-COUNTY (N = 26)

Antigens	**Number of Facilities with 80% and above Vaccination Coverage**	**Number of Facilities with less than 80% Vaccination Coverage**
BCG	9	17
Birth OPV (OPV 0)	8	18
OPV 1	13	13
OPV 2	11	15
OPV 3	12	14
IPV	13	13
Pentavalent 1	14	12
Pentavalent 2	12	14
Pentavalent 3	14	12
PCV10 1	14	12
PCV10 2	13	13
PCV10 3	15	11
Rota 1	14	12
Rota 2	11	15
MCV 1	8	18
All Antigens	1 (3.8%)	25 (96.2%)

4.2.3: Essential supplies for vaccination

There were out of stocks of Oral Polio Vaccine (OPV) in 6 of the Vaccinating health facilities in the sub-county; 4 vaccinating health facilities had the out of stock for 2 months and 2 vaccinating health facilities had the out of stock for 1 month. Ten (10) vaccinating health facilities in the sub-county had reported stock out of Measles Containing Vaccine (MCV). The MCV out of stock ranged from a month to 3 months. One (1) vaccinating health facility had no functional vaccine fridge, 4 vaccinating health facilities reported cold chain breakdown; one (1) vaccinating health facility had cold chain breakdown for 1 month, another vaccinating health facility had the breakdown for 3 months, the next vaccinating health facility had the cold chain breakdown for 7 months and one vaccinating health facility stayed for 9 months without repairing the cold chain breakdown issue. Twenty (20) vaccinating health facilities reported out of stock of Auto-Disposable syringes (AD syringes) for a period of time ranging from 1 month to 4 months. Out of 26 vaccinating health facilities, 16 vaccinating health facilities do not conduct vaccination services on all weekdays, most giving facility arrangement and shortage of staff as the reasons for not vaccinating on all days of the week.

The assessment of 3 key indicators of vaccination; Pentavalent1 for accessibility, Pentavalent3 for utilization and MCV1 for Fully Immunized Child (FIC), out of 5 vaccinating health facilities located in Airbase Ward; 3 vaccinating health facilities attained the recommended 80% and above vaccination coverage for both Pentavalent1 and Pentavalent3 and 1 vaccinating health facility attained the recommended 80% and above vaccination coverage for MCV1. In Eastleigh North Ward, out of the 9 vaccinating health facilities 6 vaccinating health facilities attained the recommended 80% and above vaccination coverage for both Pentavalent1 and Pentavalent3 and 2 vaccinating health facilities attained the recommended 80% and above vaccination coverage for MCV1 and the performance of these indicators for the other wards is as shown in Table 9 below. The performance of these indicators by vaccinating health facilities based on facility type were as follows; out of the 6 vaccinating clinics in the sub-county; 4 vaccinating clinics attained the recommended 80% and above vaccination coverage for both Pentavalent1 and Pentavalent3 and 3 vaccinating clinics attained the recommended 80% and above vaccination coverage for MCV1. Out of the 5 vaccinating dispensaries in the sub-county;

3 vaccinating dispensaries attained the recommended 80% and above vaccination coverage for Pentavalent1 and 1 vaccinating dispensary attained the recommended 80% and above vaccination coverage for Pentavalent3 and 3 vaccinating dispensaries attained the recommended 80% and above vaccination coverage for MCV1. The only vaccinating health centre in the sub-county attained the recommended 80% and above vaccination coverage for Pentavalent1 and Pentavalent3 but did not attain the recommended 80% and above vaccination coverage for MCV1. Out of 14 vaccinating hospitals in the sub-county; 8 vaccinating hospitals attained the recommended 80% and above vaccination coverage for both Pentavalent1 and Pentavalent3 and 2 vaccinating hospitals attained the recommended 80% and above vaccination coverage for MCV1.The Performance of these indicators according to facility ownership and number of staff at vaccination table is as detailed in Table 9 below.

TABLE 9: FACILITY ATTAINMENT OF 80% AND ABOVE VACCINATION COVERAGE OF KEY INDICATORS, KAMUKUNJI SUB-COUNTY (N=26)

	Pentavalent 1 N	**Pentavalent 3 N**	**MCV1 N**
Ward (No. of Facilities)			
Airbase (5)	3	3	1
California (1)	1	1	1
Eastleigh North (9)	6	6	2
Eastleigh South (4)	1	1	1
Pumwani (7)	6	6	3
Facility Type (No. of Facilities)			
Clinic (6)	4	4	3
Dispensary (5)	3	1	3
Health Centre (1)	1	1	0
Hospital (14)	8	8	2
Facility Ownership (No. of Facilities)			
Community based (3)	1	1	1
Faith based (6)	5	4	3
Private (12)	6	4	2
Public (Government) (5)	4	3	2
Number of Staff at Vaccination table (No. of Facilities)			
1 (11)	8	4	2
2 (12)	9	8	6
3 (2)	2	2	0
>3 (1)	0	0	0

CHAPTER FIVE

5.0 Discussion

The study found that more than a third (34.1%) of infants were not fully vaccinated according to their ages in the sub-county in 2019. It was also found out that despite cumulatively not attaining full vaccination coverage according to their ages, the infants had attained good vaccination coverage of specific antigens of vaccination expect for second dose of Rota virus vaccine (Rota2), The socio-demographic factors independently associated with attainment of full vaccination coverage according to their age among infants in Kamukunji sub-County, in 2019, included age of infant, the infants' ward of residence, the distance travelled by caretakers to vaccinating health facilities while seeking vaccination services for the infant in the sub-county. include fathers' level of education and fathers' occupational status in Kamukunji sub-County, in 2019. The main reason given by the caretakers in the sub-county, in 2019 for failing to fully vaccinate their infants accordingly was unawareness of subsequent doses of vaccination to be given and other reasons mentioned included sick child, forgetfulness and being too busy. Other factors which contribute to poor vaccination outcome in the sub-county at health facility level, in 2019, include uneven distribution of vaccinating health facilities among the wards, of the sub-county, stocks out of essential supplies of routine vaccination such as vaccines and auto-disposable syringes, breakdown of cold chain at the vaccinating facilities and failure by majority of vaccinating health facilities to provide vaccination services on all weekdays.

This study identified that 65.9% of infants in Kamukunji sub-County were fully vaccinated according to their age in 2019, which was below the 80% and above vaccination coverage recommended by World Health Organization (WHO). The vaccination coverage attained among infants in the sub-county was suboptimal to prevent occurrence of Vaccine Preventable Diseases (VPDs) and avert preventable deaths among infants. This finding was similar to the MOH vaccination coverage report of 2019 in Kenya District Health Information System (KDHIS) with Fully Immunized Child (FIC) coverage of 73% which is below the WHO recommended figure of 80% vaccination (KDHIS, 2020). The vaccination coverage of Rota2 vaccine was below the WHO recommended minimum vaccination coverage of 80%. This was contrary to the vaccination coverage report of 2019

in KDHIS which showed Rota2 vaccination coverage was at 87% (KDHIS, 2020). The other antigens; Bacillus Calmette Guérin (BCG), Birth Oral Polio Vaccine (Birth OPV), first dose of Oral Polio Vaccine (OPV1), second of dose Oral Polio Vaccine (OPV2), third dose of Oral Polio Vaccine (OPV3), Inactivated Polio Vaccine (IPV), first dose of Pentavalent vaccine (Pentavalent1), second dose of Pentavalent vaccine (Pentavalent2), third dose of Pentavalent vaccine Pentavalent3, first dose of Pneumococcal Conjugate Vaccine against 10 sub-types (PCV101), second dose of Pneumococcal Conjugate Vaccine against 10 sub-types (PCV102), third dose of Pneumococcal Conjugate Vaccine against 10 sub-types (PCV103), first dose of Rota virus vaccine (Rota1) and first dose of Measles Containing Vaccine (MCV1) had vaccination coverage well above the WHO recommended vaccination coverage of 80% and above, in agreement with the 2019 KDHIS vaccination coverage report. The reasons given for not fully vaccinating the infant according to their age included not knowing the subsequent doses were supposed to be given, an unawareness of subsequent doses of vaccination to be given by caretakers definitely denied the infants in Kamukunji sub-County the opportunity to be a fully vaccinated infant according to their age. The reason, of not knowing the subsequent doses of vaccines were to be given, for failure not to fully vaccinate a child was reported in previous studies as evidenced by Nath et al study (Nath et al., 2007) and they were in agreement with the findings of the study. Child being sick and forgetting to take the infant for vaccination was also reported in Kamukunji sub-County for not fully vaccinating infants according to their age. Parents and caretakers need to be educated that sickness is not a contra indication to vaccination, Child being sick and forgetting to take the child for vaccination due to other responsibilities has been cited by Kariuki (Kariuki, 2012). Sickness of an elder sibling following vaccination and lack of knowledge regarding subsequent vaccination have also been cited in failure to vaccinate a child (Nath et al., 2007). The proportion of infants who had Rota2 vaccination was the lowest and highest for BCG. The coverage for Rota2 was below the WHO lowest recommended vaccination coverage of 80% this was reported in another study (Awino, 2016) but there is an upward trend consistent with what is happening globally (WHO/CDC, 2018). The vaccination coverage for other antigens were way above the minimum coverage recommended by WHO, as also evidenced by the 2019 KDHIS vaccination coverage report.

Older infants were more likely to be fully vaccinated according to their ages than younger infants in Kamukunji sub-County, in 2019. The likelihood of infants aged 3 to 5 months in the sub-county to be fully vaccinated according to their ages was 10% compared to infants aged 9 to 11 months in the sub-county, while that of those aged 6 to 8 months in the sub-county was 31% compared to infants aged 9 to 11 months in the sub-county. Age of an infant significantly and independently affected the vaccination outcome among infants in the sub-county, in 2019. Parents and caretakers need to be educated that routine vaccination schedule need to be adhered to starting from early life of an infant immediately after delivery. Age of child affecting the vaccination coverage was also documented by Makokha (Makokha, 2016).

The ward of residence in Kamukunji sub-County being place of residence significantly and independently influenced the full vaccination coverage according to their age among infants. This could probably be due to uneven distribution of vaccinating health facilities, or the distance travelled by caretakers to reach these facilities for vaccination. California Ward with the lowest proportion of fully vaccinated infants according to their age, had the least number of vaccinating health facilities while Eastleigh North Ward with highest proportion of fully vaccinated infants according to their age, in 2019, had the highest number of vaccinating health facilities in the sub-county. The place of residence influencing vaccination outcome among children was also reported by Makokha (Makokha, 2016) and was in agreement with the findings of the study.

Both infants of secondary educated mothers and secondary educated fathers in the sub-county had the highest proportion of fully vaccinated infants according to their age, in 2019, while the least proportion of fully vaccinated infants according to their age were found in infants of primary level educated mothers and those whose fathers had no formal education (illiterate). Infants of illiterate mothers were 52% likely to be fully vaccinated according to their age compared to infants of secondary educated mothers while those of infants of primary educated mothers was 35% likely to be fully vaccinated according to their age compared to infants of secondary educated mothers. Those of infants of tertiary educated mothers were 41% likely to be fully vaccinated according to their ages compared to infants of secondary educated mothers.

The odds of infants of primary educated mothers in Kamukunji sub-County, in 2019 to be fully vaccinated according to their age compared to infants of secondary educated mothers in the sub-county was statistically significant, hence mothers' level of education significantly affected full vaccination coverage according to age among infants in the sub-county. The mothers' education level influencing vaccination coverage among children has been cited by many studies including Kariuki and Ismail (Kariuki, 2012); (Ismail et al., 2014). Educated mothers have been found to be more likely to ensure that their children are vaccinated as compared to the uneducated mother (Nath et al., 2007). This may be due to literate mothers being informed about Vaccine Preventable Diseases (VPDs) and the importance of vaccination.

Infants whose fathers had secondary school level of education in Kamukunji sub-County, in 2019, had the highest percentage of full vaccination coverage according to age followed by infants of primary educated fathers and infants of fathers without formal education in the sub-county had the lowest full vaccination coverage according to age in 2019. All odds of infants of primary educated fathers, infants of fathers without any formal education and infants of tertiary educated fathers in the sub-county to be fully vaccinated according to their ages compared to infants of secondary educated fathers in the sub-county, in 2019 were statistically significant. Fathers' level of education not only significantly but also independently influenced full vaccination coverage according to age among infants in Kamukunji sub-County, in 2019. The paternal education influencing infants' vaccination outcome has been mentioned in a previous study by Rammohan (Rammohan et al., 2012) and was in agreement with the study findings. Factors that have shown an association with the uptake of vaccination services include; the education level of the father, 'If the father is knowledgeable of the VPDs and the importance of vaccinating children, he may be able to ensure that the child is vaccinated' (Kariuki, 2012).

The proportion of fully vaccinated according to their ages of infants of self-employed mothers in Kamukunji sub-County and proportion of fully vaccinated according to their ages of infants of unemployed mothers in the sub-county in 2019 were almost similar while it was highest in infants of fathers with formal employment in the sub-county and least in infants of self-employed fathers. The likelihood of infants of self-employed fathers in

Kamukunji sub-County to be fully vaccinated according to their ages was 6% in 2019 compared to the infants of fathers who were in formal employment in the sub-county and that of infants of unemployed fathers in the sub-county to be fully vaccinated according to their ages was 8% compared to the infants of fathers who were in formal employment in the sub-county, in 2019 and both odds of infants of self-employed fathers and infants of unemployed fathers in the sub-county of being fully vaccinated according to their age compared to the infants of fathers who were in formal employment in the sub-county, in 2019 were statistically significant. The adjusted odds of being fully vaccinated according to their age among infants in Kamukunji sub-County based on fathers' occupation status were still significant therefore father's occupation status significantly and independently influenced full vaccination according to age among infants in the sub-county, in 2019. The significance of paternal occupation status in vaccination outcome of their off springs has also been mentioned in previous studies (Awino, 2016) (Kamau & Esamai, 2001) (Makokha, 2016) agreeing with the findings of the study.

The infants who had one sibling in Kamukunji sub-County had the highest proportion of fully vaccinated infants according to their age in 2019 while those without a sibling had the lowest proportion of infants fully vaccinated according to their age in the sub-county. The likely of an infant without a sibling in the sub-county to be fully vaccinated according to their age compared to those who had one sibling was 50% in 2019, while those who had 2 siblings had 80% likelihood of being fully vaccinated infant according to their age and those with 3 or more siblings had 87% likelihood of fully vaccinated infant according to their compared to infants with one sibling in the sub-county, in 2019. These odds of being fully vaccinated according to age based on the presence of sibling in the family were statistically significant hence impacting on the vaccination outcome in Kamukunji sub-County in 2019. Presence of a sibling influencing vaccination outcome was also reported in other studies (Kamau & Esamai, 2001) which was in agreement with the findings of this study.

Infants whose caretakers travelled a distance of less than 0.5 Km to vaccinating health facilities in Kamukunji sub-County, had the highest proportion of fully vaccinated according to their age in 2019, while infants whose caretakers travelled a distance of more

than 1 kilometer to 5 kilometers to vaccinating health facilities in the sub-county, had the least proportion of fully vaccinated according to their age. The likelihood of infants whose caretakers travelled a distance of 0.5 Km to 1 Km to vaccinating health facilities in the sub-county to be fully vaccinated according to their age was 36% compared to infants whose caretakers travelled a distance of <0.5 Km to vaccinating health facilities in 2019. While the likelihood of infants whose caretakers travelled a distance of >1 Km to 5 Km to vaccinating health facilities in the sub-county was 20% in the same year and that of those whose caretakers travelled a distance of >5 Km to 10 Km to vaccinating health facilities in the sub-county was 45% in 2019. The odds of being fully vaccinated according to age among infants in Kamukunji sub-County based on distance travelled by the caretakers to vaccinating health facilities during vaccination of the infants were statistically significant in 2019. Similarly, the adjusted odds of being fully vaccinated according to age among infants in the sub-county, in 2019 based on distance travelled by the caretakers to vaccinating health facilities during the seeking of vaccination services for their infants were also significant. The distance to vaccinating health facility significantly and independently affected full vaccination coverage according to age among infants in the sub-county, in 2019. Similarly it has been documented that distance travelled by caretakers to vaccinating health facilities while seeking vaccination services negatively affect favorable vaccination outcome (Awino, 2016)(Odutola et al., 2015) in conforming to the findings of this study.

Meanwhile infants whose caretakers incurred an expense of less than 100 Kenya shilling during the seeking of vaccination services for their infants in Kamukunji sub-County had highest proportion of infants fully vaccinated according to their age in 2019 and those whose caretakers incurred an expense of 500 – 999 Kenya shillings during the seeking vaccination services in the sub-county had the least proportion of infants fully vaccinated according to their age, in 2019. The infants whose caretakers incurred an expense of 100 to 499 Kenya shillings during the seeking vaccination services in the sub-county were 36% likely to be fully vaccinated according to their age compared to those whose caretakers spent <100 Kenya shillings in seeking the vaccination services in the sub-county, while that of those whose caretakers spent 500 to 999 Kenya shillings in seeking the vaccination services in the sub-county was 61% in 2019 compared to those whose caretakers spent <100 Kenya shillings while seeking the vaccination services in the sub-county and that of

those whose caretakers spent 1000 Kenya shillings or more in seeking for vaccination services for their infants in the sub-county was 25% compared to those whose caretakers spent <100 Kenya shillings in seeking the vaccination services in the sub-county, in 2019. The odds of infants whose caretakers spent 100 to 499 Kenya shilling while seeking vaccination services in the sub-county, in 2019 to be fully vaccinated according to age compared to those whose caretakers spent <100 Kenya shillings while seeking vaccination services in the sub-county and those whose caretakers spent 1000 Kenya shillings or more while seeking vaccination services to be fully vaccinated according to their age compared to those whose caretakers spent <100 Kenya shillings in seeking vaccination services in the sub-county were statistically significant. The cost incurred by caretakers in terms of travel expenses incurred during vaccination service was found to significantly contributing negatively in the attainment of full vaccination according to age among infants in Kamukunji sub-County, in 2019 but had no independent influence. Travel cost to parents impeding good vaccination outcome has been documented in a previous study (Zhou et al., 2014) in keeping with the findings of the study.

Only one vaccinating health facility in Kamukunji sub-County had attained the 80% and above vaccination coverage recommended by WHO (Awino, 2016) among their under 1 year target, for all the antigens given for routine vaccination in 2019. Slightly above 50% of vaccinating health facilities in the sub-county attained the WHO recommended vaccination coverage of 80% and above for Pentavalent1 and Pentavalent3 among their under 1 year target in 2019 while some 31% of vaccinating health facilities in the sub-county had attained the recommended vaccination coverage of 80% and above for MCV1 among their under 1 year target in 2019, the three antigens used to assess; Pentavalent1 for accessibility of vaccination services, Pentavalent3 for utilization of vaccination services and MCV1 for fully vaccinated child. The vaccination coverage were suboptimal within the vaccinating health facilities in the sub-county, in 2019 indicating poor health outcomes, the vaccination coverage, especially of the performance indicators, is a vital indicator of an infant health outcome at health facility level (Awino, 2016), which need to be continuously monitored (WHO/UNICEF, 2018) . The vaccination performance in the sub-county at the vaccinating health facility level, for the other antigens were dismal among their under 1 year target in 2019; 35% of the vaccinating health facilities in the sub-county

had achieved the recommend vaccination coverage of 80% and above for BCG among their under 1 year target of 2019 and only 27% of vaccinating health facilities in the sub-county had attained the 80% and above recommended vaccination coverage for Birth OPV (OPV0) among their under 1 year target in the year 2019. The Birth OPV is given within 2 weeks of birth, indicating majority of the infants in the sub-county were either not born in the health facilities or were seen for the first time at the facilities after 2 weeks of delivery hence missing out on getting the Birth Oral Polio Vaccine. The proportion of health facilities in the sub-county which had the minimum 80% recommended vaccination coverage for OPV1 was 50% among the under 1-year target in the year 2019. The proportion of health facilities in the sub-county which had the minimum 80% recommended vaccination coverage for OPV2 was 42.3% among the under 1- year target in 2019, while the proportion of vaccinating health facility in the sub-county that had achieved the minimum 80% recommended vaccination coverage for OPV3 was 46.2% among the under 1-year target in 2019. Half of vaccinating health facilities in the sub-county had achieved the minimum 80% recommended vaccination coverage for IPV among the under 1-year target of 2019 and almost half of vaccinating health facilities in the sub-county had achieved the minimum 80% recommended vaccination coverage for Pentavalent2 among the under 1-year target in 2019. Vaccinating health facilities in the sub-county which attained the 80% and above recommended vaccination coverage for PCV10 antigens were 50% and above among the under 1-year target of 2019 and about half of the vaccinating health facilities in the sub-county, in 2019 had achieved the 80% and above recommended vaccination coverage for the two Rota antigens among the under 1-year target.

The vaccinating health facilities in Kamukunji sub-County were not evenly distributed among the wards in 2019; the highest proportion of vaccinating health facilities in the sub-county, more than a third, were located in Eastleigh North Ward and California Ward with the least proportion of vaccinating health facilities in the sub-county had only one vaccinating health facility and this may explain why the infants in the two wards had the highest proportion of fully vaccinated infants according to age and lowest proportion of fully vaccinated infants according to age respectively in the sub-county, in 2019. The government owned vaccinating health facilities in the sub-county were about a fifth while

almost a half of vaccinating health facilities in the sub-county were privately owned. The unequal distribution of vaccinating health facilities among the wards in the sub-county affected the achievement of fully vaccinated infants according to their age in wards of Kamukunji sub-County, in 2019. The inequality in distribution of vaccinating health facilities impeding the achievement of the targeted vaccination coverage was also a finding in Awino's study (Awino, 2016) in keeping with the findings of this study. The Government owned vaccinating health facilities had better vaccination outcomes in the sub-county compared to non-government owned vaccinating health facilities in the sub-county, probably due to closer supervision by the Sub-County Health Management Team (SCHMT). Sixty (60%) percent of government vaccinating facilities in the sub-county were in Pumwani ward explaining the better vaccination outcome indicators in the ward. More than half of these vaccinating health facilities in the sub-county were hospitals of which half were located in Eastleigh North ward which had the best proportion of infants with fully vaccinated according to age in the sub-county. The other vaccinating health facilities were clinics, dispensaries, and a health centre. In providing vaccination services, the vaccinating health facilities deploy staff to vaccination table to provide vaccination to clients who seek the vaccination services, 42% of the vaccinating health facilities in the sub-county deployed 1 health worker to vaccinating table, 46% of vaccinating health facilities in the sub-county deployed 2 staff for vaccination services, 8% of vaccinating health facilities deployed 3 health workers and 4% of vaccinating health facilities in the sub-county deployed more than 3 health workers to the vaccination table. The number of staff operating vaccination table at vaccinating health facilities greatly affected the vaccination service outcomes as evidenced by attainment of the minimum recommended vaccination coverage of 80% by only 18% of vaccinating health facilities and by 50% of vaccinating health facilities whose vaccination table was operated by 1 and 2 healthcare workers respectively. The number of health workers providing vaccination services at a vaccinating health facility affecting vaccination service outcome at the vaccinating health facilities has also been reported by Makokha (Makokha, 2016) which was in agreement with the findings of the study, probably due to long waiting time. Only 38% of vaccinating health facilities in the sub-county provided vaccination services on all days of the week, disrupting services provision, which may explain the poor attainment of the minimum

recommended vaccination coverage of 80% by the vaccinating health facilities in the s sub-county. The number of days per week vaccinating health facilities provide vaccination services influencing vaccination services outcome at the vaccinating health facility was also reported in previous studies (Makokha, 2016) in keeping with the findings of this study. Stock outs of essential commodities such OPV, MCV, Auto Disposable (AD) syringes and Safety boxes, lack of functional vaccine fridge and reported cold chain breakdown by vaccinating health facilities disrupted the vaccination service provision at the vaccinating health facilities in the sub-county, in 2019. These factors disrupting vaccination services at vaccinating health facilities was also reported by Makokha (Makokha, 2016) in agreement with the findings of the study.

Study limitation

This study could not link the actual vaccination outcomes at household level and that of individual vaccinating health facility in the sub-county.

CHAPTER SIX –

6.0 Conclusion and Recommendation

6.1 Conclusions

Despite good vaccination coverages of individual antigens, the cumulative number of infants having received all antigens according to their ages were suboptimal among infants in Kamukunji sub-County, in 2019. Younger infants had lowest full vaccination coverage according to age compared to older infants in the sub-county. Presence of a sibling positively influenced vaccination outcome according to age among infants. California Ward was the worst performing ward in the sub-county, in terms of fully vaccinated infants according to their age and it had only one vaccinating health facility. The indicators of vaccination coverage among vaccinating health facilities were below the World Health Organization recommended target of 80% and above in the sub-county, in 2019. There were also few government-owned health facilities in the sub-county offering vaccination services. Infants attending government health facilities for vaccination have better vaccination outcomes according to age compared to those attending non-government owned facilities. Stock outs of some key supplies like vaccines and auto-disposable syringes and breakdown of cold chain for provision of undisruptive vaccination services were reported in a number of vaccinating health facilities.

Infants whose caretakers travelled longer distance in the sub-county to vaccinating health facilities had poor vaccination outcomes compared to those whose caretakers travelled shorter distance to vaccinating health facilities in the sub-county in 2019.

Illiterate fathers in Kamukunji sub-County had negative impact on the attainment of fully vaccinated according to age by their infants while infants of secondary educated fathers in the sub -county had better full vaccination coverage according to age, in 2019. Fathers who were either unemployed or self-employed negatively influenced the vaccination outcome of their infants in Kamukunji sub–County in 2019.

The major reason given by caretakers in the sub-county, as to why their infants were not fully vaccinated according to age was lack of awareness of subsequent vaccination visit.

6.2 Recommendations

We recommend that the sub-County Health Management Team should ensure that all eligible infants within the sub county are reached and provided lifesaving vaccines by coming up with priorities and tailor strategies and operational plans to address vaccination gaps like utilizing all encounters with infants into opportunities to vaccinate. Vaccinating health facilities should ensure the infants' caretakers are well informed about the importance of vaccination by continuously educating them about vaccination, in an effort to improve the vaccination outcome. They should ensure the caretakers understand well vaccination schedule and when to return for the subsequent vaccination, even if a child is sick, during vaccination sessions. This should clearly be explained and documented in their baby booklet. The essential supplies of vaccination such as vaccines and auto-disposable syringes should be provided by the sub-County Health Management Team to ensure there is no disruption of vaccination services at the facilities. There should be prompt and timely repair of cold chain breakdowns in the sub-county. Vaccination services should be provided on all days of the week by all vaccinating health facilities in the sub-County. The sub-County Health Management Team (SCHMT) with other stakeholders of vaccination should increase the number of vaccinating health facilities especially in California Ward.

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Appendix I: IREC Approval Letter

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2019/212
Approval Number: 0003445

26th September, 2019

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
26 SEP 2019
APPROVED
P. O. Box 4606-30100 ELDORET

Abbas G. Godana,
Moi University,
School of Public Health,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Mr. Godana,

VACCINATION COVERAGE AND ITS ASSOCIATED FACTORS AMONG INFANTS, KAMUKUNJI SUB-COUNTY, KENYA

This is to inform you that ***MU/MTRH-IREC*** has reviewed and approved your above research proposal. Your application approval number is ***FAN:0003445.*** The approval period is **26th September, *2019 – 25th September, 2020.***

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by ***MU/MTRH-IREC***.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to ***MU/MTRH-IREC*** within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to ***MU/MTRH-IREC*** within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to ***MU/MTRH-IREC.***

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc	CEO	-	MTRH	Dean	-	SOP	Dean	-	SOM
	Principal	-	CHS	Dean	-	SON	Dean	-	SOD

Appendix II: NACOSTI Research License

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **432883**

Date of Issue: **03/February/2020**

RESEARCH LICENSE

This is to Certify that Dr.. Abbas Godana of Moi University, has been licensed to conduct research in Nairobi on the topic: *Vaccination Coverage and Its Associated Factors among Infants, Kamukunji Sub County, Kenya* for the period ending : *03/February/2021.*

License No: **NACOSTI/P/20/3237**

432883

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

Appendix III: Nairobi County Research Authorization Letter

NAIROBI CITY COUNTY

'egrams: "PRO-MINHEALTH", Nairobi
'ephone: Nairobi 217131/313481
«: 217148
nail: pmonairobi@yahoo.com

COUNTY HEALTH OFFICE
NAIROBI
NYAYO HOUSE
P.O. Box 34349-00100
NAIROBI

ıen replying please quote

f. No. CMO/NRB/OPR/VOL1-2/2020/3

COUNTY HEALTH SERVICE

Dr. Abbas Godana
Principle Investigator
FELTP Resident
P.O BOX
Nairobi

8/1/2019

RE: RESEARCH AUTHORIZATION

This is to inform you that the Nairobi City County Operational Technical Working group reviewed the documents on the study titled, **"Vaccination Coverage and its Associated Factors among Infants, at Kamukunji Sub County in Nairobi County".**

I am pleased to inform you that you have been authorized to undertake the study in Nairobi County.

The researcher will be required to adhere to the ethical code of conduct for health research in accordance to the Science Technology and Innovation Act, 2013 and the approval procedure and protocol for research for Nairobi County

On completion of the study, you will submit one hard copy and one copy in PDF of the research findings to our operational research technical working group.

FOR COUNTY DIRECTOR HEALTH SERVICES NAIROBI COUNTY

Raphael Muli

FOR COUNTY DIRECTOR OF MEDICAL SERVICES

CC: **MOH – Kamukunji**

Appendix IV: Informed Consent (Sample)

Makkah Hospital

Appendix 1: Informed consent Form

Dear Participant/ Key Informant,

My Names are: Dr. Abbas Gobu Godana from Moi University, and Field Epidemiology and Laboratory Training Program of Ministry of health, carrying out a study on Estimation of Vaccination Coverage and Associated Factors Among Infants in Kamukunji Sub- County. I have prepared set questionnaire as data collecting tool to carry out the study. There has been outbreak of vaccine preventable diseases (VPD) in the sub county like polio outbreak was declared in April 2018 after isolation of polio virus from an environmental site in the sub – county and measles outbreak was reported in the sub – county in September 2018. VPDs causes illnesses, disabilities and even deaths in children under one year especially among non-vaccinated ones. The diseases can be prevented by vaccination which are provided for free at both public and mission health facilities. The study intends to establish the true vaccination coverage among infants in the population and factors associated with vaccination.

You are hereby being asked to participate in this study. Once you understand the study, and if you agree to be enrolled, you will be asked to sign this consent. Please note that your participation in this research is entirely voluntary and no coercion. There is no monetary benefit from this study and there is no cost to you for enrolling in the study. You are free to leave the study anytime you like. However, the findings and knowledge gained from this study may help in the prevention and management of VPD. Any information you will give regarding this study and records will be treated with utmost confidentiality. You will not be personally identified in any publication about this study.

Please sign below if you agree to participate in the study.

Sign ----------.

Date 11/3/2020

Appendix V: Household Questionnaire

Estimation of Vaccination Coverage and Factors Associated Among Infants, Kamukunji, Kenya

Interview date __ __ / __ __ / __ __ __ __ Time __ __: __ __ AM / PM
[DD/MM/YYYY]

Basic information

Ward _____ Village _____ Household Number _____

GPS Coordinates ___ ___.___ ___ ___ ___ ___ N/S ___ ___.___ ___ ___ ___ ___ E/W

Interviewer's Name _____ Telephone No. _____

Informant's background information

1. What is the child's date of birth? (dd/mm/yyyy) ____/____/_____ Age (months) _____

2. What is the sex of the child?

- ☐ Male
- ☐ Female

3. Relationship of the respondent to child

- ☐ Mother
- ☐ Father
- ☐ Sibling
- ☐ Grandparent
- ☐ Aunt
- ☐ House help/maid
- ☐ Other (specify) _____

4. Level of education of the mother

- ☐ No education
- ☐ Primary education- not completed.
- ☐ Primary education- completed.
- ☐ Secondary
- ☐ Post-secondary
- ☐ Quranic
- ☐ Other (specify) _____

5. Level of education of the father

- No education
- Primary education- not completed.
- Primary education- completed.
- Secondary
- Post-secondary
- Quranic
- Other (specify) _____

6. Occupation of the mother

- Subsistence farming
- Pastoralist
- Self-employed
- Formal employment
- Unemployed
- Retired
- Other (specify) _____

7. Occupation of the father

- Subsistence farming
- Pastoralist
- Self-employed
- Formal employment
- Unemployed
- Retired
- Other (specify) _____

8. Any history of travel to/from other countries in the last 4 years?

- Yes
- No

9. If yes to which country?

- Somalia
- Ethiopia

 Sudan

 South Sudan

 Eritrea

 Djibouti

 Other(specify)_____

Child's Background information

10. How many siblings does the child have? _____

11. What is the child's birth order? _____

12. Was the child born in a hospital?

 Yes

 No

 Do not know.

13. How long has the child stayed within Kamukunji Sub County?

 Duration (in months)

14. Where was the child staying before? (ask if the duration of stay is not since birth)

[Country, County, Sub County, Ward, Village, Household]

_____

Knowledge/perception on vaccination

15. Have you ever heard of vaccination?

 Yes

 No

16. What is the benefit of vaccination?

 Protects the child against infections.

 Others (Specify) _____

 Do not know.

 Does not have benefit.

17. When does vaccination of child begin?

 At birth

 At 4 weeks

 At 6 weeks

 At 10 weeks

 At 14 weeks

 At 6 months

 At 9 months

 At 1 year

 Over 1 year

18. Do you vaccinate/ have you vaccinated your child?

 Yes

 No

19. If yes, when did you last visit the health facility?

_____

20. How were you handled by staff during the vaccination session at the health facility?
_____

21. If no, why? _____

22. Have you heard of vaccination campaigns?

 Yes

 No

23. If yes have any of your children been vaccinated during the campaigns?

 Yes

 No

24. If no, why haven't they been vaccinated?

 Had no eligible child.

 Child had been vaccinated.

 Did not trust the safety.

 Other (specify) _____

Child's immunization information and health seeking behavior:

25. Do you have the child's vaccination booklet?

 Yes, and available

 Yes, but not available

 No

26. Has the child ever been vaccinated?

 Yes

 No

 Don't know.

27. If NO, what are the reason(s)?

 Did not know about vaccination.

 Child was sick.

 Family refused.

 Did not trust the safety of the vaccine.

 Other (specify) _____

28. If YES, please indicate type, dose and date given below (verify with immunization card if available)

Dose	Type	Date [DD/MM/YYYY]	Source of information
	BCG		❒Card ❒Verbal
Birth	❒OPV		❒Card ❒Verbal
1	❒OPV		❒Card ❒Verbal
2	❒OPV		❒Card ❒Verbal
3	❒OPV ❒IPV ❒Both		❒Card ❒Verbal
1	PENTAVALENT		❒Card ❒Verbal
2	PENTAVALENT		❒Card ❒Verbal
3	PENTAVALENT		❒Card ❒Verbal
1	PCV 10		❒Card ❒Verbal
2	PCV 10		❒Card ❒Verbal
3	PCV 10		❒Card ❒Verbal
1	ROTA		❒Card ❒Verbal
2	ROTA		❒Card ❒Verbal
	MEASLES		❒Card ❒Verbal

29.(If not all the doses) Why did the child not receive all the vaccination doses?

- Didn't know the doses supposed to be given.
- The doses were too many.
- Child reacted to initial doses.
- Was busy.

- I forgot.
- Other (specify) _____

30.Where did the child receive vaccination?

- Government health hospital
- Mission health facility
- Private health facility
- Health outreach
- Polio SIA
- Other (specify) _____

31. Is this the closest health facility to you?

- Yes
- No

32. If no, why do you go to it instead of the one closest to you?

- _____
  _____

33. How far is the health facility where the child gets vaccinated?

- Less than 500 meters
- 500 meters to 1 Km
- > 1 Km to 5 Km
- > 5 km to 10 Km
- > 10 Km

34. How much expense do you incur to take the child to the facility for vaccination?

- Less than Ksh. 100
- Ksh. 100 to 499
- Ksh. 500 to 999
- Ksh. 1000 and above

Appendix VI: Healthcare Workers' Interview Guide

Estimation of Vaccination Coverage and Factors Associated Among Infants, Kamukunji, Kenya

Interview date __ __ / __ __ / __ __ __ __ Time __ __: __ __ AM / PM

[DD/MM/YYYY]

Basic information

Ward _____ Facility Name _____

GPS Coordinates ___ ___.___ ___ ___ ___ ___ N/S ___ ___.___ ___ ___ ___ ___ E/W

Interviewer's name _____ Telephone No. _____

Facility questions

1. Facility type
   - Hospital
   - Health Centre
   - Dispensary
   - Clinic
2. Facility ownership
   - Public
   - Faith based/ Mission.
   - private
   - Community based.
3. What is your annual target for vaccination (under 1 year)?

   . _____
4. What was the facility coverage in the previous year for the following?
   - BCG _____
   - Birth OPV _____
   - OPV 1 _____

- OPV 2 _____
- OPV 3 _____
- Pentavalent 1 _____
- Pentavalent 2 _____
- Pentavalent 3 _____
- PCV 10 1 _____
- PCV 10 2 _____
- PCV 10 3 _____
- Rota 1 _____
- Rota 2 _____
- MCV 1 _____

5. How many staff members are stationed at MCH/ vaccination table per day?
    - 1
    - 2
    - 3
    - >3
6. Is routine vaccine done on all days of the week at the facility?
    - Yes
    - No
7. If no, why? _____
8. Have you had any vaccine stock-out in the last 1 year?
    - Yes
    - No
9. If yes, which vaccine and how many months?
    - BCG _____
    - OPV_____
    - IPV_____
    - Pentavalent_____
    - PCV 10_____
    - Rota _____

- MCV_____

10. Have you had any stock-out of the following RI supplies in the last 1 year?
    - AD syringes
    - Diluting syringes
    - Diluents
    - Safety boxes
11. If yes, for how many months?
    - AD syringes _____
    - Diluting syringes _____
    - Diluents _____
    - Safety boxes _____
12. When did your facility last receive funding for RI?
    - Less than a month
    - 1 month to 3 months
    - 4 to 6 months
    - > 6 months to 1 year
    - Never received in the last 1 year

13. How many vaccination outreaches activities were planned in the previous month?

_____

14. How many of the planned vaccination outreaches activities were done in the previous month?

_____

15. Do you have partners supporting your facility in vaccination activities?
    - Yes
    - No

Appendix VII: Example of Extract from Statistical Data analysis (Stata)

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   15.1   Copyright 1985-2017 StataCorp LLC
  Statistics/Data Analysis            StataCorp
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 RECODE of |        Fully
 AgeMonths | VaccinatedAccordingto
(AgeMonths |         Age
        ) |        No        Yes |     Total
-----------+----------------------+----------
      3-5 |        40         14 |        54
      6-8 |        66         75 |       141
     9-11 |        68        247 |       315
-----------+----------------------+----------
    Total |       174        336 |       510
```