DETERMINANTS OF VACCINE UPTAKE AMONG CHILDREN UNDER 23 MONTHS IN
FUNCTIONAL COMMUNITY UNITS IN MUKURU KWA NJENGA SETTLEMENT IN
NAIROBI CITY COUNTY, KENYA

BY
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MASENO UNIVERSITY

NOVEMBER 2019
DECLARATION

I declare that this thesis comprises of my original work and to the best of my knowledge has not been presented in any institution or university for academic purpose(s).

Signed ___________________________ Date ______________

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This thesis has been submitted for examination with our approval as University supervisors

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DEDICATION

This work is dedicated to all the children under two years of age in Mukuru Kwa Njenga and to my loving family, wife Milcah and adorable daughter, Melanie and son, Jeremy.
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My honest and sincere acknowledgement first goes to my Lord, for this far He has brought me. It was not by my own making but by His grace that is sufficient for me. I thank my God for making this journey a success.

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TABLE OF CONTENTS

DECLARATION................................................................................................................................. ii
DEDICATION .................................................................................................................................. iii
ACKNOWLEDGEMENTS................................................................................................................... iv
TABLE OF CONTENTS.................................................................................................................. v
LIST OF TABLES ........................................................................................................................... viii
LIST OF FIGURES ....................................................................................................................... ix
ABBREVIATIONS AND ACRONYMS ........................................................................................... x
OPERATIONAL DEFINITION OF TERMS ...................................................................................... xi
ABSTRACT .................................................................................................................................... xii
CHAPTER ONE .............................................................................................................................. 1
1.0 INTRODUCTION .................................................................................................................... 1
1.1 Background of the study ......................................................................................................... 1
1.2 Statement of the Problem ....................................................................................................... 4
1.3 Study Objectives .................................................................................................................... 5
  1.3.1 Broad objective ................................................................................................................ 5
  1.3.2 Specific objectives: .......................................................................................................... 5
1.4 Research Questions ................................................................................................................ 5
1.5 Hypotheses............................................................................................................................. 5
1.6 Significance of the study ........................................................................................................ 6
CHAPTER TWO ............................................................................................................................... 7
2.0 LITERATURE REVIEW ........................................................................................................... 7
  2.1 Introduction .......................................................................................................................... 7
  2.2 Prevalence of Vaccine uptake among children aged 0-23 months ........................................ 7
  2.3 Socio-demographic factors related to caregivers and Vaccine uptake ................................. 9
  2.4 Religious beliefs and vaccine uptake ................................................................................... 11
  2.5 Health Care System factors associated with vaccine uptake ............................................ 13
  2.6 Summary of the literature .................................................................................................. 16
2.7 Conceptual Framework ......................................................................................................... 17
CHAPTER THREE ......................................................................................................................... 18
3.0 METHODOLOGY ..................................................................................................................... 18
  3.1 Introduction ......................................................................................................................... 18
  3.2 Study design ....................................................................................................................... 18
**LIST OF TABLES**

**TABLE 1:** SAMPLING FRAME AND SAMPLE PROPORTIONS .............................................................. 21  
**TABLE 2.** CHARACTERISTICS OF CHILDREN STUDIED ........................................................................... 27  
**TABLE 3** SOCIO-DEMOGRAPHIC AND RELIGIOUS CHARACTERISTICS OF THE PARENTS/CAREGIVERS ........ 28  
**TABLE 4** HEALTH SYSTEM CHARACTERISTICS .................................................................................... 29  
**TABLE 5** VACCINE SPECIFIC UPTAKE AT SIX WEEKS .............................................................................. 30  
**TABLE 6:** DETERMINANTS OF VACCINE UPTAKE ................................................................................. 33  
**TABLE 7:** DETERMINANTS OF VACCINE UPTAKE ................................................................................. 35
LIST OF FIGURES

Figure 1 Conceptual Framework........................................................................................................... 17
Figure 2 Overall Vaccine Up Take and Full Immunization........................................................................ 30
# ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>BCG</td>
<td>Bacillus Calmette-Guerin</td>
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<tr>
<td>CDC</td>
<td>Centers for Disease Control</td>
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<tr>
<td>DPT</td>
<td>Diphtheria, Pertussis, and Tetanus</td>
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<td>DVI</td>
<td>Division of Vaccines and Immunization</td>
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<tr>
<td>EPI</td>
<td>Expanded Programme on Immunization</td>
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<td>HepB</td>
<td>Hepatitis B</td>
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<td>KNBS</td>
<td>Kenya Demographic Health Survey</td>
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<td>KEMRI</td>
<td>Kenya Medical Research Institute</td>
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<td>KEPI</td>
<td>Kenya Expanded Programme on Immunization</td>
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<td>KNBS</td>
<td>Kenya National Bureau of Statistics</td>
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<td>MOH</td>
<td>Ministry of Health</td>
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<td>MUERC</td>
<td>Maseno University Ethics Research Committee</td>
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<tr>
<td>NACC</td>
<td>National Aids Control Council</td>
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<td>NCPD</td>
<td>National Council of Population and Development</td>
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<td>NIDs</td>
<td>National Immunization Days</td>
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<td>OPV</td>
<td>Oral Polio Vaccine</td>
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<td>SDG</td>
<td>Sustainable Development Goals</td>
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<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
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<tr>
<td>VPD</td>
<td>Vaccine Preventable Diseases</td>
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<tr>
<td>WPV1</td>
<td>Wild Poliovirus 1</td>
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OPERATIONAL DEFINITION OF TERMS

1. **Full immunization**: A fully immunized child is one who has received one dose of BCG at birth, oral polio at birth, three doses of oral polio, pentavalent vaccine, pneumococcal vaccine, and two doses of rotavirus vaccines at 6 and 10 weeks plus two measles vaccine doses at 9 months and 18 months respectively.

2. **Herd immunity**: Protection from disease in a group, due to large proportion of the population having immunity to prevent the disease from spreading from one person to another.

3. **Immunization**: The process of making a person immune or resistant to an infectious disease, typically by administration of a vaccine to stimulate the body’s own immune system to protect the individual from subsequent infection.

4. **Immunization coverage**: The proportion of people who receive one or more vaccine(s) in relation to the overall target population.

5. **Missed opportunities**: Missing the benefit of immunization by a partially or non-immunized child during a visit to a health facility for check-up or treatment when there is no absolute contraindication for that particular vaccine as per the national immunization policy.

6. **Vaccine**: A substance prepared from a disease causative agent, its products or synthetic substitute, treated to act as an antigen without inducing the disease, but with the capacity to stimulate production of antibodies and provide immunity against the disease caused by that agent.

7. **Vaccination**: Administration of a vaccine to an individual to trigger development of immunity against a disease.

8. **Vaccine drop-out rate**: The proportion of children who start out the vaccine uptake but do not finish the vaccination series.

9. **Vaccine preventable diseases**: Diseases whose occurrence is preventable by immunization. WHO tracks a list of vaccine preventable diseases including diphtheria, Haemophilus influenza serotype B, measles, meningitis, mumps, pertussis, poliomyelitis, rubella, tetanus, tuberculosis and yellow fever.

10. **Vaccine uptake**: Administration of a vaccine when it is due (Up-To-Date). In this study, vaccine uptake referred to the proportion of children who had received vaccines when it was due for them.
ABSTRACT

Immunization alone averts 2-3 million deaths annually. Immunization coverage of above 80% is need for herd immunity. Kenya’s immunization coverage for childhood vaccines is at 68%, which is below herd immunity levels and continues to experience decline trajectory. Vaccine coverage is not uniform across the regions in the country and varies by type of vaccine. Urban informal settlements experience low coverage, which leaves many children at risk of vaccine preventable diseases. The main objective of this study was establish the determinants of vaccine uptake in functional community units in Mukuru Kwa Njenga. The specific objectives were to assess the prevalence of vaccine uptake among children under 23 months, to determine socio-demographic, religious and health system factors influencing vaccine uptake among children under 23 months in the informal settlements of Mukuru Kwa Njenga. Using a cross-sectional design, 266 children aged under 23 months of consenting caregivers were studied. Quantitative data was collected using interviewer administered questionnaires. Review of vaccination information recorded in the mother and child health booklets were used to validate the vaccination data as per the KEPI schedule. Data was analyzed using descriptive statistics, bivariate and binary logistic regression at 95% confidence interval. Vaccine uptake for BCG, oral polio birth dose, and three doses for Pentavalent, Oral Polio, pneumococcal and rotavirus vaccines were each over 90%. Measles vaccine uptake was 84.9% and 40% for the second measles vaccine. Overall vaccine uptake was 84.5%, which is below the WHO recommended 90% coverage. Factors significantly associated with positive uptake of vaccines were age of the caregiver above 30 years, (OR 6.389, C.I 2.388-10.086), having knowledge on childhood vaccines (OR 1.937, C.I 1.058-3.544), history of recent treatment at a health facility (OR 2.49, C.I 1.319-2.973) and retention of mother-child health booklet (OR 5.25, C.I 1.728-15.984). Vaccine uptake in the study area had reached the threshold for herd immunity, safe for 2nd measles vaccine. Targeted efforts are necessary to boost uptake of the 2nd measles vaccine and rotavirus vaccines. The overall impact of community health on immunization coverage needs further investigations.
CHAPTER ONE

1.0 INTRODUCTION

1.1. Background of the study

Immunization remains one of the most important public health interventions and proven strategy of preventing morbidities and mortalities among children. According to World WHO, (2018), immunization averts illness, disability, and death from Vaccine-Preventable Diseases (VPDs). WHO, (2019), defines immunization as the process of making an individual immune or resistant to an infectious disease by administration of a vaccine. Expanded Program on Immunization (EPI) was launched in 1974 as a global program for controlling and reducing deaths from VPDs. According to WHO, (2019), a child is considered to be fully immunized if he or she has received a Bacillus Calmette-Guerin (BCG) vaccination against tuberculosis and Oral Polio Vaccine (OPV) at birth, three doses of diphtheria, pertussis, and tetanus (DPT), oral polio, and pneumococcal vaccine and a dose of measles vaccine a nine months of age. The vaccine preventable diseases (VPDs) include polio, diphtheria, measles, whooping cough, pneumonia, rotavirus diarrhea, rubella and tetanus. Immunization coverage is conventionally estimated by the uptake of DPT vaccines, (UNICEF/WHO, 2018)

Globally, 2-3 million deaths of under 5- year old children are averted annually by immunization only(WHO, 2018). Moreover, despite the efforts to better child health, estimated 19.9 million children under the age of one year did not receive three doses of Diphtheria-Pertussis and Tetanus (DPT) vaccine in 2017 (WHO, 2018). The Global Vaccine Action Plan (GVAP) to avert millions of deaths through equitable access to vaccines by 2020 remains off-track, (WHO, 2019), and thus millions of lives are at risk due to vaccine preventable diseases.

In a span of five years from 2009 to 2014, global immunization coverage remained between 83%-84%, (WHO, 2018). However, the coverage is not uniform in all regions, there exists pockets of lower than optimal immunization coverage. For instance, in 2013, global coverage was at 84% but in African region, the coverage rate was only at 75% compared to 96% coverage in Western pacific and European regions, (CDC, 2014). Consequently, despite the immunization coverage being above the herd immunity threshold which is 80%, some regions, 1.5 million childhood mortalities are still linked to vaccine preventable diseases, (WHO, 2018). Immunization coverage of 80% and above is the public health accepted levels that can accord a community herd immunity. The distribution of these childhood mortalities portray the disparity in immunization coverage where Africa has the highest under-five mortality rates(U5MR) of all the world’s continents, (Wiysonge, Olalekan, Uthman, & Ndumbe, 2012).
In 2011, DPT3 coverage in Africa for children under 12 months was 71%. Nearly 14 million children did not receive the first dose of DPT, whereas 8.4 million children started but did not complete the 3-dose DPT series. In 2013, estimated 21.8 million eligible children did not complete the 3-dose series, (WHO, 2014). In Sub-Saharan Africa, one child in every 13 children die before their fifth birthday, which is 14 times higher than in developed countries, (WHO, 2018).

By 1990s, Kenya had gotten vaccination coverage of 80% of the target population, (MOH, 2014). However, the vaccine coverage has not been uniform across the country, some regions have had much less vaccine coverage than others. Over the years, immunization coverage have been on decline. For instance, in 2017, Kenya was not among 123 countries that had reached DPT 3 coverage of at least 90%, (WHO 2018)

Wide vaccination coverage disparities exist between the rich and the poor and between the urban and rural children. There is also wide inter-district, intra-district, urban-rural and rich-poor differences in immunization coverage, (Sodha, 2012). In Kenya, the vaccine coverage ranges from 48.3% in North Eastern to 71.1% in Nairobi and 77.6% in Central regions (KNBS, MoH, NACC, KEMRI, & NCPD, 2014). For instance, immunization coverage in Korogocho, which is an informal settlement in Nairobi’s Kasarani sub-county, was only 44% by the year 2011, (Mutua, Murage, & Remare , 2011). Lower immunization coverage has also been documented in health facilities that serve informal settlements in Nairobi.

In Kenya, the Ministry of Health customized the Expanded Program on Immunization (EPI) into Kenya Expanded Program on Immunization (KEPI) in 1980 to coordinate the immunization services in the country,(Ministry of Health, Kenya, n.d). Through the Division of Vaccines and Immunization’s (DVI), KEPI added hepatitis B vaccine (HepB) and Haemophilus influenza type b (Hib) to DPT to form a pentavalent vaccine which prevents against diphtheria, pertussis, tetanus, hepatitis B and Haemophilus influenza type b. KEPI also introduced pneumococcal vaccine, rotavirus vaccine and a second measles vaccine (booster) at 18 months to her childhood immunization schedule, (appendix 1).

Stringent immunization strategies had kept at bay most of VPDs in Kenya. However, recent trends have shown re-emergence of VPDs like measles and poliomyelitis, (MOH, 2013). For 22 years, (1984-2006), Kenya had no single confirmed case of poliomyelitis, however, this changed with re-emergence of the disease in the face of less-than-optimal immunization coverage and poor sanitation in affected areas. Measles outbreaks have been frequent, mostly originating from pockets of less-than-optimal immunization coverage. For instance, in 2003, 1,791 suspected measles cases were reported including 59
laboratory confirmed cases, in 2005, 151 confirmed measles cases were reported in Kenya, (CDC, 2007). In 2013, a confirmed case of wild poliovirus 1(WPV1) was reported in Dadaab refugee camp on 16th May 2013 just one week after a confirmed case of WPV1 in Mogadishu Somalia, (MOH, 2013). Re-emergence of these VPDs shows the vulnerability of children in clusters with under immunization and underscores the importance of attaining and maintaining high vaccination coverage rates of over 80% that can accord a community herd immunity. It further portrays the continued need for public health interventions that directly or indirectly address the factors that contributes to the spread of vaccine preventable diseases. Additionally, in 2008, measles outbreak occurred in Kibra (AMREF, 2008), which is one of the largest informal settlements in Africa characterized by poor infrastructure and poor access to health services which often interrupt immunization activities.

With the adoption of Sustainable Development Goals (SDGs) in September 2015 by the UN, SDG 3.2 aims at reducing newborn mortalities to at least 12 per 1000 live birth in every country and reduce the under-five mortalities to less than 25 per 1000 live birth. These targets are closely linked to SDG 3.1 which aims at reducing the global maternal mortality ratio to less than 70 deaths per 100,000 live births and contributes to the new Global Strategy, named, “Global Strategy for Women’s, Children and Adolescents Health”, (WHO, 2018).

Disparities in vaccine uptake across the divide exists and have largely been attributed to social, economic demographic and health system factors. Some of these factors have negatively influenced the vaccine uptake while others have positive influence on vaccine uptake and in general the immunization coverage. Social-cultural factors influencing the vaccine uptake in urban and rural settlements have largely been religious affiliations and beliefs of the populace.

The demographic factors influencing the vaccine uptake have principally been identified as the age of the parents or the caregivers of the children, marital status of the caregivers, their occupation and their knowledge on the childhood vaccines, (Fredrickson, et al., 2014). These factors have been studied in rural and urban set-ups with varying influences on vaccine uptake and the overall immunization coverage.

Health system factors influencing the vaccine uptake and in-turn the immunization coverage have been explored at large. The place of delivery of the children, distance to the nearest health facility and availability of immunization records have been reported to positively influence vaccine uptake, (Mutua, et al., 2011).
The influence of religious beliefs on vaccine uptake have hardly been studied and there are few published reports on this aspect of immunization. The few published studies do not portray a particular direction of religious influence on vaccine uptake.

This study was carried out in Mukuru Kwa Njenga, an informal settlement within Embakasi-East Sub-county in Nairobi City County. The study area posed contextual challenges such as infrastructural inaccessibility and lack of formal sanitation facilities whose interplay with socio-demographic and religious beliefs on vaccine uptake are seldom studied in the context of strong community health strategy. Consequently, previous studies have shown low vaccine uptake in the study area at only 57% (KNBS, 2014), which below the Nairobi’s 71.1% and national average of 68%, an indication of masking of vaccine uptake in informal settlements.

1.2. Statement of the Problem

According to KNBSet al, (2014) , Kenya’s vaccination coverage has remained below the WHO recommended rates and has been on decline since late 1990s when it was above 80% to just 68%, in 2014. The vaccination coverage is not uniform in all parts of the country. Evidence shows that pockets of sub-optimal vaccine uptake exists, especially between urban affluent and urban poor. For instance, while the general vaccine uptake for Nairobi was 71.1% in 2014, that in Mukuru Kwa Njenga was 57% (KNBS et al, 2014). This implies that the low vaccine uptake in urban informal settlement such as Mukuru Kwa Njenga are pulling down national vaccine coverage rates. Moreover, prevalence of vaccine preventable diseases in Kenya is still significantly high. For instance, in 2018, 94,534 new cases of tuberculosis were reported. Out of these cases, 10% were reported among people aged 0-14 years, which are actually vaccine preventable, (WHO, 2019). On 6th April 2018, Kenya Medical Research Institute (KEMRI) laboratory positively identified poliovirus in the sewage in Kamukunji sub-county which neighbours Embakasi East sub-county, which prompted the Ministry of Health Kenya to launch a critical polio vaccine campaign,(UNICEF, 2018). These figures portray the continued vulnerability of under-immunized children, especially those in hard to reach informal urban settlements without organized sanitation facilities. Studies to inform the actual vaccination coverage in the urban informal settlements have been rare in the recent years. National vaccination data has only masked the actual vaccination rates in informal settlements. This has resulted into reporting of the wider regional vaccine uptake prevalence as the vaccine uptake prevalence in underprivileged urban informal settlements. Although the factors that determined vaccine uptake in informal settlements have been documented, the factors differ in context and location and none are documented in the context of functional community strategy in an urban
informal settlement. This realization motivated the need to carry out a study to establish the social-demographic, religious and health system determinants of vaccine uptake in the informal settlements of Mukuru Kwa Njenga, in Embakasi East, Nairobi city county.

1.3 Study Objectives

1.3.1 Broad objective
To establish the determinants of vaccine uptake among children under 23 months in functional community units in Mukuru Kwa Njenga settlements in Nairobi County, Kenya

1.3.2 Specific objectives:

1. To determine the prevalence of vaccine uptake among children aged 0-23 months in Mukuru Kwa Njenga, Nairobi County
2. To determine the socio-demographic factors associated with vaccine uptake among children aged 0-23 months in Mukuru Kwa Njenga in Nairobi County
3. To identify the religious factors associated with vaccine uptake in children aged 0-23 months in Mukuru Kwa Njenga settlement in Nairobi County
4. To determine the health system factors influencing vaccine uptake in children aged 0-23 months in Mukuru Kwa Njenga settlement in Nairobi County

1.4 Research Questions

1. What is the prevalence of vaccine uptake in Mukuru Kwa Njenga, in Nairobi County?
2. What socio-demographic factors are associated with vaccine uptake among 0-23 months in Mukuru Kwa Njenga in Nairobi County?
3. What religious factors influence vaccine uptake in children aged 0-23 months in Mukuru Kwa Njenga settlement in Nairobi County?
4. What health system factors influence vaccine uptake in children aged 0-23 months in Mukuru Kwa Njenga settlement in Nairobi County?

1.5 Hypotheses

1. Socio-demographic characteristics of caregivers of children under 23 months does not influence vaccine uptake in Mukuru Kwa Njenga
2. Health system factors do not influence vaccine uptake among children under 23 months in Mukuru Kwa Njenga
1.6 Significance of the study

Immunization is an important public health intervention in preventing morbidity and mortality of vaccine preventable diseases. Despite several studies on immunization determinants in urban informal settlements, there is seldomly any published study on determinants of vaccine uptake in urban informal settlements with a strong community health strategy as Embakasi East. The findings from this study therefore are relevant and inform local policy on vaccine uptake in informal settlement and suggest concepts for further research. The study further contributes to growing body of knowledge on immunization.
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1. Introduction

This chapter contains an exposition of literature of various studies on factors that influence the uptake of vaccines. The specific aspects of exploration are the prevalence of vaccine uptake, socio-demographic factors, religious and the health system factors determining vaccine uptake, as guided by the specific objectives.

2.2. Prevalence of Vaccine uptake among children aged 0-23 months

Childhood vaccines against the six vaccine preventable diseases are given at predetermined intervals from birth to the age of 18 months after birth. Immediately after birth, or within two weeks after birth, children are routinely given BCG and oral polio vaccines. After a span of four weeks, at 6 weeks after birth, children are given oral polio, DPT which in KEPI schedule is enhanced with hepatitis B (HepB) and Haemophilus influenza type b (Hib) vaccines thus referred to as DPT-HepB-Hib (pentavalent vaccine), pneumococcal vaccine and rotavirus vaccines. The vaccines given at 6 weeks are all repeated at 10 weeks and at 14 weeks. However, rotavirus is given only 6 and 10 weeks only (MOH, 2013). Vaccine uptake is thus vaccination of a child when she/he is due for the vaccine while immunization coverage indicates the proportions of the children who are vaccinated when they are due for their vaccine. In various studies, this has been measured as ‘Up-to-Date, (UTD). Full immunization depicts the vaccine uptake up to 14 weeks, in addition to the measles vaccines at 9 months and a booster dose at 18 months. Conventionally, immunization coverage is indicated by the coverage of DPT 3, in this case, pentavalent 3 vaccine.

Studies have shown that the prevalence of vaccine uptake differs within the vaccines, by the age of the children and by residence. In a cluster survey done in the urban slums of Ahmedabad city in India to determine vaccine coverage among children aged 12-23 months, vaccine uptake reduced with age. Vaccine uptake for the birth doses and vaccines given at 6 weeks was 83.3% compared to measles vaccine uptake at 9 months that was at 71.7%, (Kadri, Singh, Shikha, Mahajan, & Trivedi, 2010). In this study, Kadri et al, (2010), attributed non-vaccination to low levels of education among the mothers and high dropout rates at 14%.

According to KNBS et al, (2014) which used Mother and Child Health Booklet (appendix 5) records coupled with caregiver’s recall to get data on childhood vaccinations, uptake for BCG was at 95.9%. The
survey further depicts a decline of DPT-HepB-Hib uptake from 97.0% at 6 weeks to 88.3% at 14 weeks. Uptake for oral polio vaccine showed a similar decline from 97.5% to 88.1% at 6 weeks and 14 weeks respectively. Despite the decline in vaccine uptake with child’s age, the coverage was still above 80%, except for measles vaccine, which was at 78%. Further, the survey portrays lower vaccine uptake among children whose mothers had no formal education compared to children whose mothers had some formal education. Similar disparity was observed among children from the lowest wealth quintile.

While KNBS et al, (2014), gives a countrywide picture of the vaccine coverage, studies in specific regions show huge discrepancies on vaccine uptake. In a longitudinal study carried out in informal settlements of Korogocho and Viwandani in Nairobi County to determine prevalence of vaccines uptake in urban informal settlements using data from the vaccination cards and mother’s recall as the sources of data, showed a stunningly low vaccine uptake, (Mutua et al, 2011). In this study, Mutua et al, (2011) observed that the vaccine uptake at 12 months was only 41.3% and that full coverage was at 57.5%. Additionally, study findings on vaccine uptake in small urban informal settlements have been masked by findings in the wider geographical regions where the urban informal settlements are located. For instance, the KNBS et al,(2014), only reported the prevalence of vaccine uptake in Nairobi in general, the report was silent on prevalence of vaccine uptake in even large informal settlements like Kibra and Mathare slums where the contexts are different from the rest of the wider Nairobi County.

In the most recent retrospective cross-sectional study done in Kenya to determine the influence of maternal education on childhood vaccination, prevalence of vaccine uptake decreased with child’s age, (Onsomu, Okech, Abuya, Moore, & Mcneil, 2015). However, the study by Onsomu et al, (2015) was a countrywide study and did not focus on urban informal settlements, making the context different from the one in this study.

Imperatively, reviewed literature points towards variations in vaccine uptake in different location. In fact, low vaccine uptake in informal settlements is masked by uptake in affluent urban settlements within the same municipality. Disparities also exists from one vaccine to the other and by age of the children and caregivers. The determinants of vaccine uptake by these contextual differences are not documented. Thus,a study to provide specific information on prevalence of vaccine uptake in the context of informal settlements and by different vaccines and age was necessary.
2.3. Socio-demographic factors related to caregivers and Vaccine uptake

Various demographic factors are associated with vaccine uptake. Immunization of children and adherence to the immunization schedule is largely dependent on the caregivers’ awareness of the services and level of education. Maternal characteristics, such as age, education levels, marital status, place of birth and birth order have been advanced as the common determinants of vaccine uptake and child health.

In a field study carried out to determine the demographic factors that influence full childhood immunization, in Nigeria, Chidiebere (2014), found out that children born of mothers less than 18 years were less likely to be fully immunized. This finding is similar to those in the study by Mutua et al. (2011) in Korogocho and Viwandani settlements in Nairobi Kenya that showed that increase in maternal age increased the likelihood of full childhood vaccination by 1.7 times. In a similar study carried out in Ethiopia, to determine factors influencing immunization coverage for children between 12-23 months, the proportion of fully vaccinated children increased with maternal age. Precisely, mothers and caregivers aged 30 and above were 3.79 times likely to have their children fully immunized compared to the mothers/caregivers of aged below 30 years, (Mohamud, Amsalu, Walelegn, Manay, & Hardeep, 2014). These studies point out at maternal age being one of the most important and positive predictors of childhood immunization. Studies demonstrate higher vaccine coverage rates in children of mothers with higher level of education. In systematic review and meta-analysis of data to determine the global effect of maternal education on vaccination in children, showed that children of mothers with secondary or higher level of education were 2.3 times more likely to be fully immunized compared to children of mothers who had primary or lower level of education, (Forshaw, et al., 2017). According to Chidiebere (2014), higher education levels, above primary education level, enables people access multiple sources of information and have better understanding of health information, which informs decision-making. Chidiebere’s findings are similar to findings from a another study done in Malaysia in 2014, that showed that parents with up-to-date children on vaccines had significantly better knowledge on childhood vaccines than parents who did not, (Awadh, Quitaiba, Bux, Elkami, & Hazrina, 2014). Similarly, a study done in India in 2015 to determine the maternal determinants of immunization in children aged 12-23 months in urban slums portrayed a positive correlation between mother’s education level and their children vaccination status, (Ashish, Pandey, Uttam, Kumar, & Singh, 2015). This implies that knowledge informs decision-making. Higher level of education conventionally improves health seeking behavior and adoption of healthier lifestyles. In another study conducted in Kenya to determine the maternal education and immunization status among children, mothers who had primary education were 2.2 times and those with college
education level 9.1 times likely to have their children fully immunized compared to children of mothers without primary education (Onsomu, Okech, Abuya, Moore, & Mcneil, 2015). Additionally, Mutua et al, (2011) in the study to determine childhood vaccination in Nairobi’s informal settlements, found that children of mothers with education level above primary level were 1.4 times more likely to be fully vaccinated and 1.6 times more likely to be fully vaccinated if their mother had secondary level of education compared to children of mothers with no formal education at all. These findings imply that formal maternal education enables one to understand health messages and make informed choices on their health behavior and is a positive predictor of childhood vaccine uptake.

Literature review has linked marital status of the parents to childhood vaccinations. A retrospective cross-sectional study done in Ghana to determine the social demographic determinants of childhood immunization showed that children of divorced mothers were 3 times less likely to be fully immunized when compared to children of mothers who were married and living together or cohabiting,(Anokye, et al., 2018). However, a population based survey done in Mozambique, (Shemwel, et al., 2017) and a cross-sectional survey done in Nigeria, (Oyefara, 2014) to determine mother’s characteristics and under-five immunization status showed that maternal marital status had no significant influence on childhood vaccination. Similar findings were recorded in a study conducted in Zimbabwe to determine the effects of maternalliving arrangements on vaccine uptake, (Rodolfo, 2015) and a similar study in Kenya to determine childhood vaccination in informal settlements in Nairobi, (Mutua, et al , 2011). The variations in the reviewed studies portray no particular direction of the influence of marital status of the parent or caregiver towards the vaccine uptake in their children.

Evaluation of maternal occupation and income levels influence on childhood vaccine uptake has depicted varied relationship. In informal settlements in Delhi India, (Devasenapathy, et al., 2016), children born of parents in the highest wealth quintile were 1.5 times more likely to be fully vaccinated compared to children of parents in the lowest wealth quintile. Similarly, KNBS et al, (2014) also linked children from highest wealth quintile to high rates of vaccine uptake compared to children from the lowest wealth quintile. This is an interesting observation given that vaccines in Kenya are offered free of charge in all public health facilities, some faith based and some private health facilities, especially those that receive their vaccine supplies from the Kenya Medical Supplies Agencies, (KEMSA), hence wealth quintile here could be pointer to education level and occupation of the parents/caregivers rather than key factor in influencing childhood vaccine uptake.

Further review of literature has linked birth order and number of siblings to vaccine uptake practices. While the more children one has, the more the experience on better health practices, higher number of
children does not seem to be in harmony with this expectation. In a case control study conducted in Norwich in UK to determine if delay in infant immunization was associated with the number of siblings, showed that having larger number of siblings was a risk factor to delayed immunization (23.3% versus 6.2%), (Heid, Richard, & Adamson, 2004). A similar study done to investigate the relationship between the immunization status and birth order, Schaffer, (2005) found out that between the months 5 and 12 of life, the proportion of fully immunized second born children was significantly lower than the first born children (P=<0.05). This study is consistent in findings with another study done in Southeastern Ethiopia to assess the child immunization coverage and its determinants that showed that children born to the third and above birth order were 40% less likely to be fully immunized, (Legesse, 2015). This observation could be because first-born children have little resource competition and may too benefit from the anxiety of the parents and their intention to give the very best to their children.

Extensive literature review on the socio-demographic factors influencing vaccine uptake does not show consistence influence on vaccine uptake. This thus portrays a gap in unearthing the socio-demographic actual factors that influence vaccine uptake among the children under 23 months in the context of informal settlements and free access of vaccine to all. The Mukuru Kwa Njenga study was mooted to bridge this gap.

2.4 Religious beliefs and vaccine uptake

Increase in population and rural-urban migration has resulted to rapid growth of cities across the globe. Over the recent years, Africa has recorded the highest rate of urbanization at 3.5% per year compared to 2.3% in Asia and 0.36% in Europe. As result, this has put strain on the government resources and infrastructure, leading to development of informal settlements, commonly known as slums, widening income inequalities and urban poverty, (APHRC, 2014). As population grows, so does their diversity in religious realms.

Inherentlv, human beings subscribe to some form of supernatural being, some with very strong beliefs. Certain religions and belief systems do promote alternative viewpoints on vaccination, albeit promoting good health for their followers. The two major varied religious perspectives on vaccination include the dilemma of using human tissue cells to make vaccines and the belief that the body is sacred and should not receive certain drugs/chemicals or blood. While religious beliefs promote good health, some beliefs have extreme effects on health promotion with serious ethical debates especially because people have rights to worship (The college of Physicians of Philadelpia, 2016).
In 2010, Tibetan Buddhist leader and Nobel laureate Dalai Lama, helped launch polio eradication campaigns in India, (Reuters, 2010), an indication of support for immunization programme. However, there are differences in religious beliefs even within same religion.

Various studies continue to link vaccine uptake to religious affiliations. In Uganda, a study done to assess the factors influencing childhood immunization, children from Muslim families were 3% less likely to complete the scheduled vaccines compared to their catholic counterparts. Bivariate analysis showed that 56% of children from Catholic families were likely to be fully immunized compared to 51% of children from Protestant families, (Bbaale, 2013). Similar findings were recorded by Devasenapathy, et al., (2016) in New Delhi, India. However, in an Ethiopian study, multiple logistic regression analysis did not show an association on completion of child immunization to religion, marital status and ethnicity, (Legesse, 2015).

Unfounded beliefs that vaccines could be harmful or laced with unwanted chemicals, especially family planning compounds also leads to parents pulling their children from perceived harmful vaccines, (Zewdie, Mekitew, & Tinsae, 2016). However, in the face of controversies on religious determination on use of vaccines, most Pentecostal denominations leave the freedom of choice on whether to have their children vaccinated or not to the individual parents. Thus, the decision on whether to have the children vaccinated or not becomes a premeditated choice devoid of religious influence.

For instance, in 2015, controversies emerged in Kenya over safety and use of some vaccines including inactivated polio vaccine and tetanus toxoid based on religious beliefs. In a cross-sectional study to determine effects of the call by catholic Bishops for catholic believers to shun polio vaccine slated for supplemental immunization campaign in Kenya in 2015,(Njeru, et al., 2016) showed that despite the ardent campaigns by the clergy, the campaign did not significantly affect uptake of polio vaccine. These findings however point towards a possibility of adverse effect of anti-health messages shared in religious forum. This would likely be more significant if repeated anti-vaccine health messages are shared among the mainstream denominations.

In conclusion, different studies on the influence of religious beliefs have yielded different outcomes on vaccine uptake in varied contexts. The interplay of the religious beliefs in the context of a strong community health strategy remains unevaluated, which provided the motivation for the evaluation of religious beliefs in Mukuru Kwa Njenga.
Healthcare system comprises of organization of people, policies, institutions and resources organized to provide health care services. Each of the components of the healthcare system and their interplay influences utilization of healthcare services. The bulk of healthcare services is provided by nurses especially immunizations. The expertise of the health service provider, knowledge and advice offered to the clients influences the uptake of the health services by the target population. In fact, nurses are essential in easing parental concerns about vaccination of their children (CDC, 2016). Reassuring and reinforcing messages on vaccine safety and adherence to schedules go a long way to improve vaccine uptake. However, knowledge and need for good health overrides any interpersonal challenges for the benefit of the healthcare service end-user.

At times, not all children eligible for immunization end up being vaccinated at their visit to the health facility. Any contact with a health care service provider that does not result in an eligible child or woman receiving the needed and due vaccines when there are no absolute contraindications constitutes a missed opportunity (WHO (b), 2019). Children eligible for immunization will often be brought to the health facilities in search of other health care services including weight monitoring, nutritional assessments and treatment for other ailments. This presents an opportunity for the health worker to review their immunization status and administer due vaccines. However, this does not always happen, resulting to missed opportunities. Missed opportunities have been identified as an obstacle to raising immunization coverage among children and women of childbearing age in developing and industrialized countries (WHO (b), 2019).

Missed opportunities have been shown to be brought about by four major reasons including failure to administer simultaneously all eligible vaccines, false contraindications to immunization, failure to open multi-dose vials for small number of children, coupled with the fear of vaccine wastage and logistical problems like vaccine stock outs, (WHO, 2016). As such, missed opportunities contribute significantly to the under-immunization of children. WHO estimates missed opportunities among children less than 24 months at 30%. This implies that elimination of missed opportunities could raise vaccine uptake by the same percentage.

Global Advisory Group on Immunization (GAGI) has shown through systematic reviews that assessment of missed opportunities is a useful managerial tool and a method for health services research,(WHO (b), 2019). Such studies have shown that strategies to eliminate missed opportunities at national, district and health service delivery points, through specific identification of age groups, geographical areas and immunization service delivery points where missed opportunities do occur can significantly increase vaccine uptake.
In Kenya, many health facilities have designated immunization days in efforts to reduce vaccine wastage by opening a multi-dose vial for few children, an indication that under-immunization due missed opportunities could be significantly high in primary health care settings. In a small study involving 23 children in their first decade of life in Kenya Expanded Programme on Immunization (KEPI), reported 4% of children were missed for immunizations when they attended outpatient clinics for other health services, (KEPI, 1983). While this was the very first study on missed opportunities under KEPI, more recent studies show that missed opportunities for immunization, though low, remain one of the key impedances of vaccine uptake in Kenya, (Calhoun, et al., 2014). There are hardly few accessible study findings assessing missed opportunities in recent past in Kenya.

Accessibility to health services is a multidimensional process that incorporates quality healthcare services, geographical accessibility, and availability of the right type of care for those who need it, financial accessibility and acceptability of the services (Peters, Garg, Bloom, Walker, & Rahman, 2007). The impoverished people have less access to health services compared to the affluent people in the society. Geographical accessibility has been shown to directly influence uptake of healthcare services. Populations that live in close proximity to health facilities are more likely to seek healthcare services from the facility and distance acts as a disincentive to seeking healthcare service. Accessibility to health care has a positive influence on health seeking behavior and practices including vaccine uptake. However, no studies have effectively demonstrated the interplay of proximity to health facilities, and quality healthcare services as dimensions of accessibility of the healthcare services in the context of provision of free health services in an urban informal settlement.

Challenges with access in immunization are indicated by vaccine drop-out rates in a given population. Dropout refers to the proportional change in coverage for antigens over time. Conventionally, the difference between BCG and measles vaccine or between DPT1 and DPT 3 in percentage gives the measure. Immunization dropout rates thus measure the proportion of children who started immunization and those who completed the immunization as per the approved immunization schedules. Immunization dropout indicates a decreased utilization of healthcare services. Immunization dropout rates of more than 10% indicate flawed health system, (UNICEF, 2019)

In a cross-sectional study carried out in Narok North district in 2012 to establish the determinants of vaccine drop-outs in children, coverage for pentavalent 1 vaccine to pentavalent 3 vaccines dropped by 5.5% while that of pentavalent 1 vaccine to measles vaccine dropped by 9.3%, (Kiio, 2012). This signifies a high uptake of the vaccines during the first doses, usually given at six weeks of life and risk of being unimmunized increasing with age.
The immunization systems are complex and require proper administration. This is to ensure cold chain of the vaccine is maintained. Some vaccines lose their potency if exposed to light and others are sensitive to temperatures above 8°C. As such, certain vaccines are not opened daily as the vaccine vial contains many doses and may not get used up in a day. Vaccines like measles have to be opened and all the 10 doses utilized within the same day, precisely, within 8 hour working shift. Facilities that have set aside particular vaccination days contributes to missed opportunities and vaccine dropouts. However, the Ministry of Health recommends that the vaccine multi-dose vial be opened even for a single child if such a child is eligible for immunization. The result has been wastage of vaccines and stock outs in the health facilities.

Vaccine stock out is in fact a major predictor of vaccine uptake, especially in sub-Saharan Africa where 38% of the WHO member countries report national-level stock-outs (Lyndon, Schreiber, Dumolard, Urfer, & Senouci, 2017). The most commonly affected antigens are BCG and DPT which accounts for 43% of the vaccine stock outs. When vaccine stock out occur at the district level, then there is a 96% chance that it will lead to vaccination interruptions, (Lyndon et al, 2017). Kenya has experienced vaccine stock outs on several occasions in the recent past. These stock outs points towards a possible interruption of routine childhood immunization in the country. To mitigate these challenges, Ministry of Health Kenya recommends that clients be referred to the nearest health facility with the missing vaccine, (MOH, 2013).

During the antenatal period and throughout intraparum, pregnant women are given health messages at health facilities on birth plan, child vaccination and family planning. These health messages makes the would-be mothers aware of the vaccines that their children are scheduled for. In a study conducted in Uganda in 2013 to determine the factors that influence childhood immunization, showed that 48% of children whose mothers had sought professional antenatal care were likely to be fully immunized compared to 34% of children whose mothers had not sought professional antenatal care, (Bbaale, 2013). In a similar study done in Ethiopia to determine the factors associated with immunization coverage in children 12–23 months, children whose mothers knew the vaccines due for their children were 2.1 times likely to complete vaccination than those whose mothers had no antenatal care and follow up, (Etana & Wangari, 2012).

The place of delivery significantly predicts the immunization status of children. Etana, (2012), found out that children born in a health facility were 2.6 times likely to complete their immunization compared to those delivered at home. This study is in agreement with similar study done on Mozambique in which children delivered at home were less likely to be completely immunized, (Jagrati, 2008). Devasenapathy,

In the efforts to bridge immunization gaps, several strategies are employed to supplement the routine immunization programs. The most common are National Immunization Days (NIDs) and outreach services where the vaccines and other healthcare services are taken into the communities. Outreach programs are cheaper and easier to organize compared to NIDS. The outreaches have an influence on vaccine uptake. In communities where outreach services are frequently done, the probability of children being fully immunized is higher (Mohamud et al, 2014).

2.6 Summary of the literature
From the review of literature, there exist knowledge gaps in understanding the contextual influence of socio-demographic factors of the caregivers that determine vaccine uptake such as parent’s or caregivers’ age, marital status, level of education and occupation and religious determinants of vaccine uptake. Further, the caregiver’s knowledge on childhood vaccines and their influence on vaccine uptake points towards a knowledge gap that required further investigations. The contextual location of this study adds to the uniqueness as it focuses on an informal settlement within a city and an area with a strong community health strategy. None of the previous studies reviewed had the combination of the community health strategy in an urban informal settlement.
2.7 Conceptual Framework

Figure 1 below shows the schematic relationship between the independent variables and dependent variable. The independent variable depicted here are as elicited from literature reviewed.

![Conceptual framework diagram]

Figure 1 Conceptual framework
CHAPTER THREE

3.0 METHODOLOGY

3.1 Introduction
This chapter is a description of the procedures that were followed in carrying out this study. Specifically, this chapter covers the study design, study area, target population, sample size determination, sampling techniques, data collection tools, data management, inclusion and exclusion criteria and ethical considerations.

3.2 Study design
The study adopted a quantitative descriptive cross-sectional study design. A descriptive cross-sectional study design allows study of a sample at a given point in time and is broadly used to assess prevalence of conditions, or certain characteristics of a population. (LoBiondo & Heber, 2014). The design is less time consuming, less expensive and thus more manageable for the researcher.

The design was used to study the relationships between vaccine uptake and socio-demographic and religious characteristics of the study population as determinants of vaccine uptake in Mukuru Kwa Njenga informal settlements in Embakasi East sub-county, Nairobi County.

3.3 Study area
This study was carried out in Mukuru Kwa Njenga, an informal settlement located in Embakasi east sub-county, in the east of Nairobi County. Mukuru Kwa Njenga borders affluent estates of Imara Daima to the West, Tassia and Nyayo estate to the east and middle level income dwellers of pipeline and Viwandani estates in North and south respectively (Appendix 5.4). Mukuru Kwa Njenga has no official record of the number of the plots. The plots are subdivided and each accommodates one or two long buildings that are subdivided into several rooms each of which is occupied by a household. Through Community Health Strategy, Mukuru Kwa Njenga has three functional Community Units (C.Us) namely Sisal community unit with a population of 17,550, Motomoto community unit with 22,000 people and Kwapi community unit with 15,550 people. Children under 24 months are estimated at 1,692,(MoH, 2015). In functional Community Units, Community Health Volunteers (CHVs) actively links the population to the health care services, through dialogue days, home visits and referral to health facilities.

The area is served by one public health facility, Mukuru Health Centre, and other unregulated, unregistered private clinics.
3.4 Target population
The target population for this study comprised of children aged 0-23 months because this is the age bracket during which children receive vaccines against vaccine preventable diseases. The Kenya Division of Vaccines and Immunization (DVI) childhood immunization schedule focuses on these children for effective immunization program.

3.5 Study population
The study population comprised of children aged 0-23 months who were living with their caregivers/parents in Mukuru Kwa Njenga informal settlements in Embakasi East sub-count in Nairobi County. In this study, the study population comprised of 1,692 children aged 0-23 months in Mukuru Kwa Njenga. The respondents for the study were the caregivers of the children under study, who are also responsible for ensuring the needs of the health needs of the children are met. These health needs includes prevention of diseases and illnesses, like vaccinations, and positive health seeking behavior since the children are fully dependent on them. The age brackets of the children under study was extended up to 23 months to cater for the children who get late vaccinations after the 2nd scheduled measles vaccine at 18 months of age.

3.6 Sample Size determination
The study sample was determined using Cochran’s formula (1975) for a target population of 10,000 and above and adopted by Singh and Masuku, (2014). Thus:
\[ n = \frac{Z^2pq}{d^2} \]

Where
- \( n = \) sample size when the population >10,000
- \( Z = \) Standard normal deviate at 95%, confidence interval (1.96).
- \( P = \) Proportion in the target population with specific characteristic, 57%, (KNBS et al, 2014).
- \( q = 1-p \)
- \( d = \) Absolute precision (Error margin), (0.05).

Therefore \( n = 1.96^2 \times (0.57)(0.43)/0.05^2 \)
\[ n = 377 \]

Since the target population was less than 10,000, the sample size was adjusted using the following formula by (Yamane 1967):
\[ n_f = \frac{n}{1 + n - 1} \]

Where \( n_f \) = the desired sample size when population is less than 10,000
\( n \) = the desired sample size when population is more than 10,000
\( N \) = the estimate of the population size (children 0-23 months) = 1,692

Hence \( n_f = \frac{377}{1 + (377/1692)} \)

Therefore \( n_f = 308 \) children under 23 months

Adjusted with 10\%, (UNICEF, n.d), to cater for the non-responses, thus, (308+31) = 339 children were enrolled into the study. They were drawn from the three Community Units in equal proportions to ensure unbiased representation in the study as described below.

3.7 Sampling Frame
The sampling frame for this study comprised of the functional community units of Mukuru Kwa Njenga Informal settlements in Embakasi East.

3.8 Sampling Procedure
Multi-stage sampling technique was used. From the 8 CHUs, they were clustered into functional and non-functional. The three functional units were selected for this study. These three CHU included Motomoto, Kwapi and Sisal. Proportionate calculation of children aged 0 to 23 months was computed as shown in table 1. A list of children aged 0-23 months in each of the community unit was obtained from Mukuru Health Centre. Based on children list, systematic sampling technique, the \( n^{th} \) value, was used to get the proportionate sample for each of the three clusters as shown in table 1. The first child in each Community Unit was randomly selected, and then the rest were systematically selected. Community Health Workers (CHWs), who are health professional government employees, in-charge of each community unit were used to identify the homesteads of the selected children. The CHWs led the Research Assistants to the houses of the selected children
Table 1: Sampling frame and sample proportions

<table>
<thead>
<tr>
<th>Name of Community Unit (C.U)</th>
<th>Pop. Of children under 2 years</th>
<th>Proportion of respondent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sisal</td>
<td>550</td>
<td>550/1692 x 339</td>
<td>110</td>
</tr>
<tr>
<td>Motomoto</td>
<td>467</td>
<td>467/1692 x 339</td>
<td>94</td>
</tr>
<tr>
<td>Kwapi</td>
<td>675</td>
<td>675/1692 x 339</td>
<td>135</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,692</td>
<td></td>
<td>339</td>
</tr>
</tbody>
</table>

3.9 Selection criteria

3.9.1 Inclusion criteria
Children who were aged between 0-23 months and their mother/caregiver had lived in the study areas for at least two years were recruited into the study. This excluded those who had recently relocated to the area and therefore their health seeking behavior might have been influenced by other environmental factors unrelated to the context in Mukuru Kwa Njenga.

3.9.2 Exclusion criteria
The study excluded the children aged 0-23 months who were not living with their mother or a legal caregivers. All the children under the care of hired house-helps and those whose parents/caregiver did not consent to participate in the study were excluded from the study.
3.10 Research Team
The research team for this study comprised of the principal investigator and four research assistants. The research assistants were Nurses working in Mukuru Kwa Njenga Health Centre who were on off-duty. All the research assistants hold a diploma in Kenya Registered Community Health Nursing (KRCHN) with at least two years’ experience after their qualification. Their community health and clinical aspects were instrumental considerations that informed the choice for their recruitment as research assistants. In addition, the study involved review of data from the Mother and child health booklet, which also records private medical information, thus using qualified nurses who have professional ethical codes that requires them to keep clients’ information confidential, was important. An advert was placed at the Mukuru Kwa Njenga Health Centre notice board for the qualified and interested candidates to apply and five expressed their interests. One was not readily available owing to other demanding responsibilities, thus the other four were selected as research assistants. The research assistants were trained on the purpose of the study, adherence to protection of research participants, data collection method ensuring completeness of the responses, proper documentation of the responses and safeguarding the integrity of the study protocol.

3.11 Data collection
Quantitative data were collected. Below are details of the data collection procedures, data collection tools, reconnaissance study, the data collection reliability test and adjustments done on the tool before the main data collection.

3.11.1 Data Collection Tool
The researcher used a structured researcher administered questionnaire to collect primary quantitative data. The questionnaire, appendix 3, had three major sections; the introduction, section A and B. The introduction part detailed the respondent’s ascent form with clear description of the study and its purpose and the instructions to the interviewer. Section A had details for collection of demographic data, both quantitative. Section B captured the data on socio-demographic and caregivers perceptions on health systems. In total, the tool was five pages long and would take approximately 30 minutes to complete filling.

3.11.2 Data collection procedure
Structured researcher administered questionnaires were used to collect quantitative data. The research assistants used the name list in each Community Health Unit and randomly identified the first child. Then the next child was systematically identified, (nth child). The CHWs lead the research assistant to the house of each of the identified child. Where the mother/caregiver of the sampled child was not in the
house at the time of visit, a plan was made to revisit the house later. Equipped with notebooks, questionnaires, pencils and erasers, the research assistants visited the sampled children’s houses. The research objectives were explained to mother/caregivers and their level of voluntary participation. Those who consented were given consent forms to sign. Mothers/caregivers provided the Mother and Child Health Booklet to the research assistants for review and collection of child’s vaccination records. The Mother and Child Health Booklet, MOH 216, is the Kenya’s official Maternal Child Health (MCH) handbook designed by the Ministry of Health, Kenya. It is provided free of charge to all pregnant women who visit the health facilities for antenatal care services. All the clinical information about the pregnant woman and developing fetus are recorded in this booklet from the time the mother starts clinic, throughout the pregnancy period to delivery and beyond until the child is five years of age. Among critical information recorded in the booklet includes the client’s biodata, sensitive clinical tests including HIV test results among other diagnoses. After delivery, all the newborn’s information is recorded in this booklet including the biodata of the newborn and all the immunization records and any clinical diagnoses and treatment that the child may receive until he/she is five years of age. The research assistants collected the immunization data from the booklet and corroborated the data with the recall information from the mother/caregiver.

3.12 Pretesting of the Data Collection Tool
The tool was pre-tested in Mathare settlement area, which is located in Embakasi East, Nairobi County, the location has similar characteristics with the study area in that the settlement area is informal, lacks access roads and the habitants are people of the lower social-economic index. The participants in this pilot study were purposefully selected with the assistance of Community Health Workers in the area who identified households with children aged 0-23 months and their caregivers. The tool was tested on 10% of the sample size, (10% of 306), which was 31 caregivers.

3.12.1 Reliability of the Data Collection Tool
Reliability is the extent to which a research instrument is able to yield similar results on repeated trials, thus ensuring replication of the study is possible (Polit and Beck, 2013). To test for reliability, Cronbach's alpha (α) was computed by relating the score for each of the scale item with the total score for each item using the data collected during pretesting. Cronbach’s alpha is a measure used to assess the reliability and internal consistency of a set of test items. According to Polit and Beck, (2013), a reliable data collection tool should have Cronbach’s alpha (α) of at least 0.6 to 0.9. In this study, the tool had an overall Cronbach’s (α) score of 0.73, and thus it was reliably acceptable tool.
3.12.2 Study variables
Variables are characteristics or attributes of an individual or study sample that are of interest to the research. They can be dependent or independent. In this study, both independent and dependent variables were measured at different levels. Sub-sections 3.12.3 and 3.12.4 below describe the details of the study variables.

3.12.3 Independent variables
Independent variables in a study are those that are altered or controlled (in an experimental study) in order to test the resultant effects on the dependent variable. It affects the dependent variable/ the outcome of the test. In this study, independent variables were:

a) Socio-demographic attributes related to caregivers: age, sex, marital status, education level, income levels and number of children a caregiver had
b) Religious beliefs and practices
c) Health system variables: facility ownership, distance from caregivers home, retention of mother child booklet, child’s birth place

3.12.4 Dependent variable
This is the variable that show the effect of manipulation of the independent variable. In this study, the dependent variable was vaccine uptake among children aged 0-23 months. The uptake of vaccines among the children aged 0-23 months was measured at different levels. First, each child was assessed whether they got specific vaccines when they were due, (vaccine uptake) for each vaccine. This was recorded as on track on the immunization schedule or non-on track in the immunization schedule. The other measurement was record of overall vaccine uptake at the end of the vaccination schedule and this was recorded as fully vaccinated or not fully vaccinated.

3.12.5 Validity of the data collected
For any study, the researcher must establish the variables used to provide the required results as per the study objectives. Therefore, content validity deals with the degree to which the test indicators attempt to measure various aspects of the concepts in question. In this study, the researcher worked with the supervisors to ensure that the data collection tool was suitable for the study. The input of the knowledgeable supervisors were incorporated in to the data collection tools accordingly.
3.13 Data Management

3.13.1 Data Storage
The filled questionnaires forms were stored safely in locked cupboards away from public access by members other than the researcher and team. This was also done in order to protect them from physical damage, tampering or loss and to maintain the integrity of the collected data. The quantitative data obtained during the study was entered on the Statistical Package for Social Sciences (SPSS) version 25 spreadsheets of numerical data and stored in a computer. The computer files were backed up in password-protected formats and the backup data stored securely in hard drives, flash disks and on CD-ROM.

3.13.2 Data analysis
Data was edited and inspected for completeness and consistency. Coding and data entry involving quantification was done. Univariate analysis was done and distribution frequencies obtained for all the variables. Bivariate analysis was done to determine relationships between the vaccine uptake, the dependent variables and independent variables; religious beliefs, demographic characteristics of the caregivers and the health system factors. Explanations were drawn from the variable relationships. Statistical significance was tested at \( \alpha=0.05 \) with 95% confidence interval. Tables with simple frequencies and percentages were also developed. At bivariate level of data analysis, independent variables that portrayed significant relationship to vaccine uptake were analyzed at multivariate level, binary logistic regression, to assess the extent of the relationship. This helped assess the odds ratios at 95% confidence interval.

3.13.3 Data Presentation
The data findings of this study were presented using figures (graphs, charts) and tables.

3.14 Ethical consideration
Approval for the study was obtained from Maseno University Ethics and Research Committee (MUERC) and from Nairobi City County where the study was conducted (Appendix 7). Moreover, the researcher ensured the basic ethical principles and guidelines on protection of human subjects in research as outlined in the Belmont Report, 1979 (Ryan, et al., 1979).

a) Respect for persons
The study involved getting data on children under the age of 23 months. These subjects have not yet developed the speech and comprehension skills. As such, the key gatekeepers to accessing data
concerning the children are government and the parents. A clearance with the government of Kenya was obtained through the Directorate of Criminal Investigation, Appendix 8. Since the children were not of the age where they could give consent to participate in the study, their parents/caregivers were given the information about the research and upon satisfaction that they understood the purpose of the study, they signed a consent form (ascent form) to allow their children to participate in the research, appendix 2. This ensured respect for their autonomy to participate in the study without undue pressure or coercion and to withdraw at any stage of the study without any repercussions whatsoever, whether implied or overtly.

b) Beneficence

The study involved minimal risks, as there were no invasive procedures. However, it involved access to private clinical information like medical diagnoses such as HIV test results among others. Use of Registered Nurses as Research Assistants helped safeguard and keep knowledge of such information confidential since they are required by the law to maintain professional codes of ethical practice among them confidentiality. The duly filled questionnaires were kept under lock and key and data so collected used for academic purposes only. This ensured that the study subjects were free from any form of discomfort, whether physical or emotional, thus conforming to the Hippocratic maxim of “do no harm”.

c) Justice

All the study participants were fairly selected to participate in the study. No study participant was selected based on their weakness or inability to negotiate their opting out of the study. Necessary information was offered to all participants as per their requests and as necessary.

3.15 Study limitations and scope

Quantitative data only was used in this study. This limited the study in that there was no qualitative data from health service providers to corroborate the findings from the caregivers. The findings were thus limited to caregiver’s responses and not the heath service provider perspective. The findings from this study are therefore generalizable to informal settlement with a functional community health strategy as was in the study area. The research recommends use of mixed methods approach to help explain the determinants of vaccine uptake in further research work.
CHAPTER FOUR

4.0 RESULTS

4.1 Introduction
This chapter contains the findings of the study presented in reference to the objectives of the.

4.2 Response rate
The study had a sample size of 339, but 266 participants completed the study. This was a response rate of 78.5% and has adequate statistical power (84%) to prove existence of a relationship between the dependent and independent variable. According to Polit & Beck, (2009), interviews normally achieve a response rate of between 80% and 90% and a response rate of 65% and above is regarded as adequate for most research purposes. The first sub-aim of this chapter describes the social-demographic characteristics and the religious affiliations of the care givers. The second sub-aim presents the findings on the age-specific and overall vaccine uptake. The third sub-aim presents the findings on determinants of vaccine uptake as analyzed at univariate, bivariate and multivariate levels.

4.2 Characteristics of children studied
Majority of the children studied were female and most were aged between one to four months.

Table 2. Characteristics of children studied

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of the children under 23 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>102</td>
<td>38.3</td>
</tr>
<tr>
<td>Female</td>
<td>164</td>
<td>61.7</td>
</tr>
<tr>
<td>Age group of the children ( months)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 4</td>
<td>131</td>
<td>49.2</td>
</tr>
<tr>
<td>5-9</td>
<td>89</td>
<td>33.5</td>
</tr>
<tr>
<td>10-14</td>
<td>28</td>
<td>10.5</td>
</tr>
<tr>
<td>15-19</td>
<td>10</td>
<td>3.8</td>
</tr>
<tr>
<td>20-24</td>
<td>8</td>
<td>3.0</td>
</tr>
</tbody>
</table>

4.3 Socio-demographic characteristics of the caregivers
Table 3 indicates the socio-demographic characteristics of the parents/care givers who participated in the study. Majority of the respondents were female (88%) and most of the parents/care givers, 33.5% (n=, 89), were aged between 25-29 years. The youngest caregiver was aged 17 years and the oldest 41 years with a mean age of 27 years. Majority of the caregivers, 88% (n=233) were married and 66% (n=176) of the respondents were in employment. Almost all (99%) of the respondents had at least primary level of education. Most of the respondents earned between Ksh 10,000 ($100) and Ksh 20,000 ($200) monthly.
Majority of the respondents were Christians, 87.2% (n=232) while 5 respondents preferred not to answer the question on religion.

Table 3 Socio-demographic and religious characteristics of the parents/caregivers

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex of caregivers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>32</td>
<td>12</td>
</tr>
<tr>
<td>Female</td>
<td>243</td>
<td>88</td>
</tr>
<tr>
<td><strong>Age of parents/caregivers (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 19</td>
<td>13</td>
<td>4.9</td>
</tr>
<tr>
<td>20-24</td>
<td>72</td>
<td>27.1</td>
</tr>
<tr>
<td>25-29</td>
<td>89</td>
<td>33.5</td>
</tr>
<tr>
<td>30-34</td>
<td>66</td>
<td>24.8</td>
</tr>
<tr>
<td>35-39</td>
<td>19</td>
<td>7.1</td>
</tr>
<tr>
<td>40 and above</td>
<td>7</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Mean age 27 years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education Level of parents/caregivers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>90</td>
<td>34</td>
</tr>
<tr>
<td>Secondary</td>
<td>138</td>
<td>52</td>
</tr>
<tr>
<td>Tertiary</td>
<td>34</td>
<td>13</td>
</tr>
<tr>
<td>No Formal Education</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td><strong>Marital status of the caregivers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>233</td>
<td>87.6</td>
</tr>
<tr>
<td>Single</td>
<td>29</td>
<td>10.9</td>
</tr>
<tr>
<td>Separated</td>
<td>4</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Employment status of the parent/caregivers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>176</td>
<td>66.2</td>
</tr>
<tr>
<td>Not employed</td>
<td>90</td>
<td>33.8</td>
</tr>
<tr>
<td><strong>Income level of the parents/caregivers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;Ksh10,000</td>
<td>104</td>
<td>39.1</td>
</tr>
<tr>
<td>Ksh 10,001-20,000</td>
<td>123</td>
<td>46.2</td>
</tr>
<tr>
<td>Ksh 20,001-30,000</td>
<td>19</td>
<td>7.1</td>
</tr>
<tr>
<td>Ksh 30,001-40,000</td>
<td>3</td>
<td>1.1</td>
</tr>
<tr>
<td>&gt;Ksh 40,000</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>No response</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td><strong>Religion of the parents/caregivers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christians</td>
<td>232</td>
<td>87.2</td>
</tr>
<tr>
<td>Muslims</td>
<td>28</td>
<td>10.5</td>
</tr>
<tr>
<td>Hindu</td>
<td>1</td>
<td>0.4</td>
</tr>
<tr>
<td>Prefer not to answer</td>
<td>5</td>
<td>1.9</td>
</tr>
</tbody>
</table>
4.4 Health System characteristics

Majority of respondents lived near the health facility, taking less than 30 minutes’ walk to the facility. Consequently, majority of children were born in a health facility, table 4

Table 4 Health system characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time taken to the nearest health facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 30 minutes</td>
<td>214</td>
<td>80.5</td>
</tr>
<tr>
<td>&gt;30 minutes</td>
<td>52</td>
<td>19.5</td>
</tr>
<tr>
<td>Ownership of Preferred Health facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>215</td>
<td>80.8</td>
</tr>
<tr>
<td>Private</td>
<td>51</td>
<td>19.2</td>
</tr>
<tr>
<td>Place of child delivery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital</td>
<td>258</td>
<td>97</td>
</tr>
<tr>
<td>Home</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Mother child Health booklet available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>251</td>
<td>94.4</td>
</tr>
<tr>
<td>No</td>
<td>15</td>
<td>5.6</td>
</tr>
<tr>
<td>Child Treated in a health facility in the last one month prior to the study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>45</td>
<td>16.9</td>
</tr>
<tr>
<td>No</td>
<td>192</td>
<td>72.2</td>
</tr>
<tr>
<td>No response</td>
<td>29</td>
<td>10.9</td>
</tr>
</tbody>
</table>

4.5 Vaccine –uptake as per Kenya Expanded Program for Immunization (KEPI) schedule

Uptake of vaccine was measured based on whether the child had received all the vaccine due for his/her age as per the KEPI schedule. Maternal and child health booklet record on the child vaccination was reviewed and the data obtained corroborated with report form the mother/caregiver. Age-specific vaccine uptake was evaluated at 6 weeks, 10 weeks and at 14 weeks of age. Majority, 94.2% (n=251) of the caregivers had the mother-child booklet and 5.8% (n=15) did not have the mother-child booklet. Those who did not have the booklet, recall alone was used to provide vaccination information.

4.5.1 Vaccine uptake

The proportion of vaccine uptake was computed at birth, 6, 10 and 14 weeks, and then at 9 and 18 months, which are intervals at which the vaccines are administered. This computation helped to determine the children who were up-to-date on their vaccine schedules from birth to 23 months. Children who had not reached the age due for a particular vaccine were not included in the computation of the up-to-date (on schedule). The uptake reduced with age of the children from 99.2% for the birth doses to 40.0% for the 2nd measles vaccine given at 18 months, table 5.
Table 5 Vaccine specific uptake at six weeks

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>At birth</th>
<th>At 6 weeks</th>
<th>At 10 weeks</th>
<th>At 14 weeks</th>
<th>At 9 months</th>
<th>At 18 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>99.2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPV0</td>
<td>99.2%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentavalent</td>
<td>96.2%</td>
<td>94.8%</td>
<td>95.3%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPV</td>
<td>96.2%</td>
<td>94.8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>95.0%</td>
<td>94.3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rotavirus</td>
<td>95.0%</td>
<td>92.3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measles</td>
<td>84.5%</td>
<td>40.0%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.5.2 Overall vaccine up take

The vaccine up take remained relatively high, above 90%, in the first 14 weeks (3 ½ months). However, with increase in age, the vaccine uptake reduced significantly to 84.5% at 9 months further to 40% at 18 months.

Figure 2 overall vaccine up take and full immunization
4.6 Vaccine drop-out rates

The vaccine dropout rate, the proportion of children who start vaccination to those who finish vaccination series, was assessed. The dropout rates give the information about access and utilization of the immunization services. Pentavalent 1 to pentavalent 3 drop-out rates was obtained by comparing the proportion of the children who got the first dose of pentavalent vaccine at 6 weeks to those who got the 3rd pentavalent dose at 14 weeks. Pentavalent 1 to pentavalent 3 dropout rate was (96.2-95.3)/96.2 *100%= 0.93%. When pentavalent 1 vaccine was compared to measles 1 vaccine, the dropout rate was (96.2-84.5)/96.2*100)=8.4%. This analysis did not include injectable polio vaccine which was introduced a year prior (2016) to this study.

4.7 Determinants of vaccine uptake

To explain the determinants (independent variables) of the vaccine uptake (dependent variable), binary logistic regression model was used. The model was selected because the dependent variable was categorical dichotomous in nature while the independent variables were a mixture of continuous and categorical data. A chi-square test of independence was performed to assess the relationship between vaccine uptake and each of the demographic factors of the caregivers.

Table 6 show the relationship between vaccines uptake as assessed against marital status of the caregivers. Assessment of relationship between marital status of the caregivers of children aged under 23 months and vaccine up take was not significant, Pearson’s chi-square, $\chi^2(2, N=266)=1.872$, $p=0.392$. The gender of the caregiver had no significant influence on vaccine uptake among the children under study, $\chi^2(1, N=266)=0.019$, $p=0.889$ either.

However, the age of the caregivers was a significant predictor of childhood vaccine uptake, $\chi^2(2, N=266)=25.409$, $p<0.001$. This was analyzed at multivariate level to establish the age predictors of vaccine uptake. Binary logistic regression model using conditional method was used, which was valid, $p=0.004$. Children of caregivers in the older age brackets, 34-39 years were 6.4 times more likely to be on track in the immunization schedule compared to children whose caregivers were young, (OR 6.389, CI 2.195-18.591). Children of caregivers in the younger age brackets, (up to 19 years) were 22.2% less likely to have their children track in the immunization schedule (OR 0.222 C.I 0.084-0.590).

The education level of the caregivers was assessed against vaccine uptake among the children under 23 months. Comparison of vaccine uptake among the children under 23 months and caregivers education level did not show statistically significant relationship, $\chi^2(2, N=266)=3.406$, $p=0.333$. 

When the caregiver’s knowledge influence on vaccine uptake was assessed, 77.2% of the children whose caregivers knew about the vaccines given to children to prevent vaccine preventable disease were on track compared to 64.1% of children whose caregivers did not have knowledge on childhood vaccines. This relationship was significant, $\chi^2 (1, N=266) =4.581$, $p=0.031$. This was further analyzed via binary logistic regression to determine the predictors of vaccine uptake. By enter method, knowledge on childhood vaccines was a significant predictor of vaccine uptake. Caregivers who had knowledge on vaccines were 1.9 times likely to have their children on track in the immunization schedule compared to the children of caregivers who did not have knowledge on vaccines, (OR 1.937 C.I 1.058-3.544).

The occupation of the caregivers was not a statistically significant predictor of vaccine uptake among the children under study, $\chi^2 (1, N=266) =1.169$, $p=0.280$.

The religious affiliation of the caregivers was assessed to see if there is a relationship between religion and vaccine uptake. Among the Christians, 66.4% of children were on track in the immunization schedule compared to 71.4% of children whose caregivers were Muslim. Bivariate analysis did not show statistically significant relationship between religious affiliation and vaccine uptake, $\chi^2 (2, N=266) =3.224$, $p=0.199$.

The child’s age and sex were each assessed to find out its influence on vaccine uptake. There was no significant difference between the child age groups in Pearson’s chi-square test of independence, $X^2 (1, N=266) =2.047$, $p=0.152$. Vaccine uptake was almost equal across the sexes of the children under study, 68.6% for males and 67.1% for females. This was also not statistically significant, $\chi^2 (2, N=266) =0.351$, $p=0.839$. 
Table 6: Bivariate and multivariate analysis of socio-demographic determinants of vaccine uptake

<table>
<thead>
<tr>
<th>Variable</th>
<th>Child on schedule</th>
<th>Child not schedule</th>
<th>Chi Square</th>
<th>df</th>
<th>P value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>161</td>
<td>69.1</td>
<td>72</td>
<td>30.9</td>
<td>1.87</td>
<td>2</td>
</tr>
<tr>
<td>Single</td>
<td>17</td>
<td>58.6</td>
<td>12</td>
<td>41.6</td>
<td>0.392</td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>2</td>
<td>50</td>
<td>2</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender of the caregivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>68.8</td>
<td>10</td>
<td>31.2</td>
<td>0.019</td>
<td>1</td>
</tr>
<tr>
<td>Female</td>
<td>158</td>
<td>67.5</td>
<td>76</td>
<td>32.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age of the caregivers (year)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;19</td>
<td>5</td>
<td>38.5</td>
<td>8</td>
<td>61.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-24</td>
<td>50</td>
<td>69.4</td>
<td>22</td>
<td>30.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-29</td>
<td>70</td>
<td>78.7</td>
<td>19</td>
<td>21.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-34</td>
<td>46</td>
<td>69.7</td>
<td>20</td>
<td>30.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-39</td>
<td>5</td>
<td>26.3</td>
<td>14</td>
<td>73.7</td>
<td></td>
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</tr>
<tr>
<td>40+</td>
<td>4</td>
<td>57.1</td>
<td>3</td>
<td>42.9</td>
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<td></td>
</tr>
<tr>
<td>Education Level of caregivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>61</td>
<td>67.8</td>
<td>29</td>
<td>32.2</td>
<td>3.406</td>
<td>3</td>
</tr>
<tr>
<td>Secondary</td>
<td>98</td>
<td>71.0</td>
<td>40</td>
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<td></td>
</tr>
<tr>
<td>Tertiary</td>
<td>20</td>
<td>55.6</td>
<td>16</td>
<td>44.4</td>
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<td></td>
</tr>
<tr>
<td>No formal education</td>
<td>1</td>
<td>50</td>
<td>1</td>
<td>50</td>
<td></td>
<td></td>
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<tr>
<td>Knowledge on vaccines</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knows some or all vaccines</td>
<td>61</td>
<td>77.2</td>
<td>18</td>
<td>22.8</td>
<td>5.207</td>
<td>1</td>
</tr>
<tr>
<td>No knowledge on vaccines</td>
<td>116</td>
<td>64.1</td>
<td>65</td>
<td>35.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>123</td>
<td>69.9</td>
<td>57</td>
<td>30.1</td>
<td>1.169</td>
<td>1</td>
</tr>
<tr>
<td>Not employed</td>
<td>53</td>
<td>63.3</td>
<td>33</td>
<td>36.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Religion of the caregivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Christian</td>
<td>154</td>
<td>66.4</td>
<td>78</td>
<td>33.6</td>
<td>3.224</td>
<td>3</td>
</tr>
<tr>
<td>Muslim</td>
<td>20</td>
<td>71.4</td>
<td>8</td>
<td>28.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hindu</td>
<td>1</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
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<td>100</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Health services related factors were assessed to determine their influence on vaccine uptake among the target population. These included the preference of health facilities, place where the children were delivered, history of recent treatment at a health facility, time taken to get to the nearest health facility and availability of mother-child health booklet.

Majority of the children, 96.7% (258) were born in a health facility. However, there was no significant relationship between the place of birth and vaccine uptake, $\chi^2(1, N=266) =0.203$, p=0.653. The preference of health facility was categorized as private and public. The influence of the preference of the
health facilities by the caregivers was assessed to establish if it determined vaccine uptake among the children under 23 months. Majority of the caregivers, 80.8% (215) preferred public health facilities though there was no significant relationship between preference of the health facility and vaccine uptake, $\chi^2(1, N=266) = 0.346$, $p=0.620$.

The history of the child being treated at a health facility at least a month prior to the study was assessed against vaccine uptake. The importance of history of recent visit to a health facility is that during such visit, any missed opportunities may be identified and due vaccine services offered. Bivariate analysis showed that there was a significant relationship between being recently treated at a health facility and vaccine uptake, $\chi^2(1, N=266) = 8.128$, $p=0.017$. This was analyzed further to establish the nature of the relationship between being treated at a health facility and vaccine uptake. Children who had recently received treatment at a health facility, were 2.5 times likely to be on track in the immunization schedule, (OR 2.491, C.I 1.319-2.973), $p=0.040$. Retention of the mother-child health booklet showed a significant relationship with vaccine uptake, $\chi^2(1, N=266) = 8.566$, $p=0.003$. Further analysis at multivariate level showed that caregivers who had the mother-child health booklet available were 5.3 times likely to have their children on track in the immunization schedule, (OR 5.25, C.I 1.728-15.954), $p=0.003$.

The time taken to reach the nearest health facility was estimated and categorized as less than 30 minutes to signify a close distance and more than 30 minutes to indicate long walk. The average walking speed of a healthy person and on a straight unobstructed path is about 5km per hour, (Manoj, 2013). Given dynamics in the study area, no designated footpaths, congested buildings making walkways meandering and unnecessarily long, and the fact the caregivers would be carrying a baby, the average speed was assumed to be much less. Via cross-tabulation, the time taken to get to the health facility did not show a significant relationship to vaccine uptake, $\chi^2 (1, N=266) = 0.154$, $p=0.695$. 


Table 7: Determinants of vaccine uptake

<table>
<thead>
<tr>
<th>Variable</th>
<th>Child on schedule</th>
<th>Child not schedule</th>
<th>Chi Square</th>
<th>Df</th>
<th>P value</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother-Child Health booklet available</td>
<td>Available</td>
<td>175</td>
<td>97.2</td>
<td>5</td>
<td>2.8</td>
<td>8.566</td>
</tr>
<tr>
<td></td>
<td>Not available</td>
<td>76</td>
<td>88.4</td>
<td>10</td>
<td>11.6</td>
<td>0.203</td>
</tr>
<tr>
<td>Place of delivery</td>
<td>Health Facility</td>
<td>174</td>
<td>96.7</td>
<td>6</td>
<td>3.3</td>
<td>0.154</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>84</td>
<td>97.7</td>
<td>2</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Preferred Health facility</td>
<td>Public</td>
<td>144</td>
<td>67.3</td>
<td>70</td>
<td>32.7</td>
<td>2.306</td>
</tr>
<tr>
<td></td>
<td>Private</td>
<td>36</td>
<td>69.2</td>
<td>16</td>
<td>30.8</td>
<td></td>
</tr>
<tr>
<td>Time to the nearest Health facility</td>
<td>Up to 30 minutes</td>
<td>146</td>
<td>68.2</td>
<td>68</td>
<td>31.8</td>
<td>0.154</td>
</tr>
<tr>
<td></td>
<td>&gt;30 minutes</td>
<td>34</td>
<td>65.4</td>
<td>18</td>
<td>34.6</td>
<td></td>
</tr>
<tr>
<td>Child recently treated at a health facility (within 1 month prior to the study)</td>
<td>Yes</td>
<td>30</td>
<td>66.7</td>
<td>15</td>
<td>33.3</td>
<td>8.128</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>137</td>
<td>76.1*</td>
<td>55</td>
<td>28.6*</td>
<td></td>
</tr>
<tr>
<td>Child’s age in months</td>
<td>Up to 4</td>
<td>94</td>
<td>71.8</td>
<td>37</td>
<td>28.2</td>
<td>7.906</td>
</tr>
<tr>
<td></td>
<td>4-9</td>
<td>59</td>
<td>66.3</td>
<td>30</td>
<td>33.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10-14</td>
<td>18</td>
<td>10</td>
<td>10</td>
<td>35.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15-19</td>
<td>7</td>
<td>70</td>
<td>3</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20-24</td>
<td>2</td>
<td>25</td>
<td>6</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>Sex of the child</td>
<td>Male</td>
<td>70</td>
<td>68.6</td>
<td>32</td>
<td>31.4</td>
<td>0.351</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>108</td>
<td>67.1</td>
<td>53</td>
<td>32.9</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER FIVE

5.0 DISCUSSION

5.1 Introduction
This section contains the discussion of the results obtained in this study. The section delves into comparison of the findings in this study and other similar studies as discussed in the literature review.

5.2 Prevalence of vaccine uptake among children aged 0-23 months
The prevalence of vaccine uptake was evaluated in phases at birth, 6 weeks, 10 weeks and 14 weeks to determine age specific prevalence of vaccine uptake. Full childhood vaccine uptake was evaluated at 9 months. The prevalence of vaccine uptake was above the WHO recommended rate of over 90% for the birth doses because most of the children were born in a health facility and they were vaccine before discharge.

The prevalence of uptake of the oral polio birth dose and BCG in the study area was higher than the overall prevalence for Nairobi County and national average, thus the prevalence of vaccine uptake in the study area could be higher than in other urban informal settlements. The uptake of 1st, 2nd and 3rd doses of pentavalent, oral polio and pneumococcal vaccine uptake signified an improvement at 6, 10 ad at 14 weeks. In fact, the prevalence was higher even than the national average. This indicates that the community has high likely of having herd immunity against tuberculosis, whooping cough, tetanus, hepatitis B, haemophilus influenza and pneumococcal diseases. The observation of high vaccine uptake further points to a fact that vaccine uptake in informal settlements could be higher than previously thought, indicating a change on conventional trends.

Although vaccine uptake was above WHO recommendations up to 14 weeks, a huge decrease in uptake was noted at 9 months, hence reducing the full vaccination significantly. In fact, 13% of the children who got BCG at birth did not complete the vaccination series at 9 months. Consequently, the Measles vaccine uptake at the study area was 7.6% lower than the Nairobi County vaccine uptake, and 2.2% lower than the Kenya national vaccine uptake (KNBS, et al, 2014). This shows reveals there are missed opportunities for vaccinations in the informal settlements. Although the prevalence of measles vaccine uptake was high enough to accord the community herd immunity, these pockets of under-vaccination with measles vaccine are risky foci for outbreak of measles. Several explanations have been advanced to this observation including vaccine stock outs and forgetting by the caregivers since the time span between the 3rd pentavalent vaccines and the measles vaccines is long, five and half months. Further, unwillingness of health workers to open multiple dose vials for few children have been cited to
contribute to under-vaccination with measles vaccines. This puts the children in the study area at an increased risk of contracting measles. This declining trend in prevalence of vaccine uptake in the Mukuru Kwa Njenga study has been documented in similar previous studies by Mutua, et al, (2011) study in Kiandutu and Korogocho in Thika Sub County and Nairobi County and Chidiebere, (2014) in Nigeria.

Contrary, uptake for 2nd rotavirus vaccine at 10 weeks and the booster measles vaccine at 18 months remained lower than the rest of vaccines and way below the WHO recommendation of 90%. In fact, one in two children who got BCG and polio birth doses missed the second (booster) measles vaccine. These two vaccines, booster measles and 2nd rotavirus vaccines, were the major draw-backs of the overall prevalence of vaccine uptake in the study area and put the children in the study area at increased risk of fatal rotaviral diarrhoea and measles disease.

Thus, the prevalence of vaccine uptake in the study area was higher than expected. This could perhaps be attributed to presence of free vaccination services offered at the public health facility within the informal settlement, which cuts the transport costs and time taken to reach the health facility. Further, the strong community health strategy embraced in the study area contributes to increased demand and utilization of health services via linking the residents of Mukuru Kwa Njenga to specific health services as per their need. Overall, there is change in common trends of lower than optimum vaccine uptake in urban informal settlements.

5.3 Socio-demographic factors associated with vaccine uptake among children aged 0-23 months

Socio-demographic characteristics of the caregivers including their marital status, gender, education level and employment status were not significant predictors of vaccine uptake among children under 23 months in the study area. Interestingly, previous similar studies have documented these caregiver factors as key predictors in determining childhood vaccine uptake, (Mutua, Murage, & Remare, 2011). In the Mukuru Kwa Njenga study, practice of community health strategy could have contributed to the observed variations. Increasing maternal age, having knowledge on childhood vaccines and retention of mother and child health booklet are strong predictors of childhood vaccine uptake even in the context of effective community health strategy.

In this study, maternal age over 30 years was positive predictor of vaccine uptake in children under 23 months. Children of younger mothers, below age 30, are least likely to complete scheduled vaccines and are at increased risk of contracting vaccine preventable diseases. Perhaps experience with previous children and exposure to health services over the years in the older caregivers provides a significant knowledge the importance of childhood vaccinations and commitment for better health for their children.

In this study, marital status of the caregivers did not portray significant relationship with vaccine uptake among the children under 23 month, p=0.185. These findings rhyme with another study done South East Ethiopia to assess immunization coverage and its determinant where marital status of the parents was a significant predictor of vaccine up take, (Legesse, 2015). Similarly, Oyefara, (2014), Rodolfo, (2015), Shemwel, et al., (2017) and Mutua, et al., (2011) found no significant influence of marital status and vaccine uptake. Thus, marital status does not significantly influence vaccine up take.

In this study, formal education level of the caregivers was not a significant predictor of vaccine uptake, p=0.333. These findings contradicts observations by Forshaw, et al., (2017) and Chidiebere, (2014) that formal education was a positive predictor of vaccine uptake. However, the Kenya Demographic Health Survey (KNBS, et al, 2014) showed that children of parents who had secondary education were 25% more likely to complete vaccinations as scheduled compared to children whose parents did not have any formal education at all. However, having knoweldge of the childhood vaccine, not the formal education, was a strong predictor of vaccine uptake in this study. This observation points to the fact that formal education does not necessarily translate to having knowledge on specific health information. It further indicates that the educated population may benefit from targeted health eduation. This could be attributed to routine practice of offering health education to clients at health facilities by the services providers and further health education by the Community Health Workers in the Community Strategy in the study area. Moreover, knowledge generally informs decision making, in this case, knoweldge seems to influence positive health seeking behaviour among the caregivers of children under 23 months of age. This observation is similar to findings by Ashish, et al., (2015), Awadh, et al., (2014), and Mutua, et al., (2011) whose studies all showed that having knowledge on childhood vaccines increasd the odds of full childhood vaccination in children under 23 month of age.

Children of caregivers who were employed had slightly higher chances of being on track in the immunization schedule. This finding compares well with Kriti, (2013), in a study in India to determine the relationship between maternal occupation and vaccine uptake, which showed that tight working schedule among the employed parents had negative influence on vaccine uptake.

While higher income levels have previously been linked to increased likelihood of full childhood immunization, this study had different findings. The level of income in this study did not portray a significant relationship with vaccine uptake. These findings however, differ with observations by KNBS
et al, (2014) and Devasenapathy, et al., (2016). This is perhaps because, even though there exists a difference in income levels among the caregivers, the overall level is still low and highest income bracket cannot feature among those considered urban affluent. Moreover, the vaccines are offered free-of-charge in all public health facilities in the country and some private health facilities that get the vaccine supplies from the government of Kenya owned Kenya Medical Supplies Agency (KEMSA). Moreover, presence of public health facility within short distance in the study area means transport costs are negligible and are not an impedance to access to health services in the study area.

The religious affiliation of the caregivers in this study did not show significant relationship with vaccine uptake. Thus, even though reports have shown religious based teachings on vaccines, some challenging the quality of vaccines and discouraging the acceptance of some vaccines by their followers, (Njeru, et al., 2016), their effects on vaccine uptake is not significant in the general population. Similarly, in a study done in Malaysia, by Awadh, et al., (2014), religious affiliation of the parents was not a significant predictor of vaccine uptake. Comparable findings were documented by Odusanya, (2008) in Nigeria and by Legesse, (2015) in Ethiopia.

Both the child’s age and gender did not show a significant influence on vaccine uptake. The same finding were reported by the KNBS et al, (2014). However, other studies have shown significant differences in vaccine uptake per gender. Antai, (2012), in his study in Nigeria, found out that female children were 1.2 times more likely to be fully immunized. However, in a similar study in India, it is male children who were likely to be fully immunized, Ashish, et al.,(2015). While these findings may point out at child gender preferences among the parents, the findings in this study portray a balanced regard to either child’s gender and at equal importance to their health.

5.4 **Health system factors influencing vaccine uptake in children aged 0-23 months**

In this study, there was no significant association between birth place and vaccine uptake. This finding contradicts similar studies in Nigeria, (Chidiebere, 2014)that showed children born at health facilities were more likely to be fully immunized. The difference in findings in this study could be because through community health strategy, home deliveries are referred to the nearest public health facility soon after delivery, thus, providing an opportunity for the home-delivered children to get skilled healthcare services, including vaccinations, soon after delivery. Moreover, the findings could be due to the difference in study settings in the studies. The findings in the literature reviewed are in rural settings and covering extensive study areas whereas the Mukuru Kwa Njengastudy focused on small urban area with vast population in an informal setting where also majority of the deliveries occurred in a health facility.
However, children who had recently been treated at a health facility were on track in the immunization schedule. In the current Kenya healthcare system, the children under two years are treated using the mother-child booklet as the reference file. This means they come into contact with skilled birth attendants who are able to review the immunization status of the child as part of the routine clerkship, and therefore missed vaccines are identified and given. However, via cross-tabulation, 33.3% of the children who were not on track in the KEPI schedule, had actually visited a health facility in preceding four weeks period to this study. This indicates that these children interacted with a service provider and though due or overdue for some vaccines, this was not noted or was noted but not acted upon. This represents a missed opportunity for immunization for these children. Also 28.6% who were not on schedule had not been treated in a health facility in the period preceding the study. This signifies the proportion of children lost on follow-up for the immunization as per the KEPI schedule.

Proximity to health facility has been shown to favor complete immunization coverage. In this study however, distance to the nearest health facility was not a significant predictor of vaccine uptake. This finding contradicts a study done in Ethiopia, where those who walked for less than 30 minutes to the health facility were 3 times likely to be fully vaccinated, (Legesse, 2015). Similarly, in Khartoum Sudan, Ibnouf, et al., (2015) found that both time and distance taken to get to the nearest health facility had significant relationship with vaccine uptake. Correspondingly, Slim et al., (2009), found out that long distances and lengthy time spend traveling to the health facility reduced utilization of the health services, in Burkina Faso. The same association was observed by Mutua et al., (2011) in Kenyan. This indicates that caregivers may not be willing to walk long distances or for long hours in search of health services or perhaps, distance discourages the caregivers’ effort to search for health services. It further portrays that visibility of the health facility to the caregivers during normal life activities could serve as a constant reminder of scheduled vaccines. The findings in this study could be different because on average, the study area is geographically a small area and beside the one public health facility, Mukuru Kwa Njenga Health Centre, there are many other privately owned health facilities that offer immunization services.
CONCLUSION AND RECOMMENDATIONS

Conclusion

1. The study established that the age specific vaccine uptake was above WHO recommended 90% and overall vaccine uptake in Mukuru Kwa Njenga was 84.5%, which was above the threshold for herd immunity. Overall, the vaccine uptake in Mukuru Kwa Njenga settlement was higher than previously thought. Vaccine dropout rates at the study area were not significantly high for pentavalent, oral polio and pneumococcal vaccines. However, specific uptake for rotavirus vaccine and for the second measles vaccine given at 18 months were quite low and thus are the major draw-backs in the vaccine uptake trends in the study area and for Nairobi city county. The vaccine dropout rates for the second measles vaccine surpassed the WHO alert level of 10.0%. The study area therefore has areas of potential focal point of outbreak of measles and rotavirus diseases.

2. Among the socio-demographic factors studied, only caregiver’s age above 30 years and caregivers having knowledge on childhood vaccines were positive predictors of vaccine uptake in the study area.

3. Religious beliefs had no significant influence on vaccine uptake among children under 23 months in the study area.

4. Positive history of the child having been treated at a health facility in the recent past one month and retention of the mother-child health booklet were positive predictors of vaccine uptake in the study area.

Recommendations

1. The Ministry of Health (MOH) needs to plan and carry out national immunization day for booster measles vaccines and beef-up the campaigns for uptake of rotavirus vaccine as well to ensure all record an uptake of 80% and above among the target population.

2. There is an immediate need to establish vaccine defaulter tracing system to get the children who get lost on immunization program. Service providers at health facilities should review the mother child health booklet for every child under 23 months and ensure that are eligible vaccines have been given. Where vaccines have been missed, measures should be instituted to ensure they are given according to the KEPI guidelines.
3. Community health strategy should continue being strengthened so as to help surpass herd immunity levels and attain vaccine coverage over 90% as recommended by WHO

4. The Ministry of Health (MOH) should do an evaluation on the overall impact of Community Health Strategy in the country, strengthen the existing interventions under strategy and initiate the implementation of the policy where uptake of the services have been low
REFERENCES


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doi:10.1007/s10995-015-1686-1


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## APPENDICES

Appendix 1: KEPI immunization schedule

<table>
<thead>
<tr>
<th>CHILD’S AGE</th>
<th>ANTIGEN (VACCINE)</th>
<th>DISEASE PREVENTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>At Birth</td>
<td>BCG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OPV</td>
</tr>
<tr>
<td>2</td>
<td>6 weeks</td>
<td>Pentavalent (DPT + HepB + Hib)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OPV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumococcal vaccine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rotavirus</td>
</tr>
<tr>
<td>3</td>
<td>10 weeks</td>
<td>Pentavalent (DPT + HepB + Hib)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OPV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumococcal vaccine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rotavirus</td>
</tr>
<tr>
<td>4</td>
<td>14 weeks</td>
<td>Pentavalent (DPT + HepB + Hib)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OPV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumococcal vaccine</td>
</tr>
<tr>
<td>5</td>
<td>9 months</td>
<td>measles</td>
</tr>
<tr>
<td>6</td>
<td>18 months</td>
<td>Measles booster</td>
</tr>
</tbody>
</table>

Source: Division of Vaccines and Immunization (DVI), 2010
Appendix 2: CONSENT FORM

This Informed Consent form will be administered to the mothers/guardian of children aged between 12-23 months who will be selected to participate in this research.

Name of researcher: BONNIE M. MUNYALO.

Name of Organization: MASENO UNIVERSITY

Title of Proposal: DETERMINANTS OF VACCINE UPTAKE IN MUKURU KWA NJENGA.

This Informed Consent Form has two parts:
1. Information Sheet (to share information about the research with you),

2. Assent form (for signatures if you agree to take part).

You will be given a copy of the full Informed Consent Form

PART I: Information Sheet

Introduction

My name is Bonnie M. Munyalo. I am a post graduate student undertaking a Master in Public Health-Epidemiology and Population Health studies option, Maseno University. As a requirement by the university, for the completion and award of my degree, I am conducting a study on the determination of vaccine uptake in Mukuru Kwa Njenga, Nairobi County.

I am going to extensively explain about this research and invite you to voluntarily participate. I am going to give you time to decide on whether you will participate in the research. You are free to consult before making any decision.

I am going to use the language that you understand either spoken or written. You are free to ask any question or clarification about the research during, and after data collection using the contact address provided at the end of this document.

Purpose of the research

This study seeks to establish the determinants of vaccine uptake in Mukuru Kwa Njenga, specifically, the study seeks to determine the demographic characteristics, socio-cultural and health care system factors associated with vaccine uptake, and their significant associations in influencing vaccine uptake in informal settlements. The data so collected will inform targeted public health interventions to improve vaccine uptake in informal settlements.
Benefits
There are no direct benefits for you as an individual but your involvement will help in finding the response to the research question stated in the research proposal. There are no benefits to the community at this stage of the research, but future generations can benefit from the published document that will inform public interventions to vaccination practices.

Risks
There are no risks involved in taking part in this research.

Voluntary Participation
Your involvement in this research is completely voluntary. It is your choice whether to take part or not. Whether you choose to take part or not will not affect you in any way. You may change your mind later and discontinue taking part even if you had agreed earlier without any consequences whatsoever.

Confidentiality
The identity of those taking part in the research will not be disclosed or shared with anyone. Informed consent will be obtained from you in order to participate in the study. To ensure confidentiality, the data collection forms will not bear your name or any form of identity. You will only be identified by the study code number. Only the researchers will recognize what your number is and the collected data will be kept under lock and key. All the data and the information obtained during the study will be used for academic purposes only.

Duration
The data collection will only take a period of about 30 minutes. During this time, you will be expected to answer questions as read out to you. Kindly try as much as possible to answer all the questions.

Contacts
Questions are welcome at the moment or later, even when the study is in progress. Should you have any concerns, contact the researcher as per the contacts below.

Bonnie Munyalo

P.O Box 1434-90200 Kitui, Mobile 0720 666 924

Email: bonniemunyalo@gmail.com
PART 2: caregiver’s assent form

The information about the study has been explained to me. I fully understand the nature of the study and how I will participate in it. I fully understand that if I agree to participate in the study, I will fill questionnaires. I understand that participation is voluntary and I am free to withdraw from the study at any time. I am also aware that if I decide not to participate in the study, it will not affect the services I receive in any health facility. By signing this form, I will be accepting to participate in the study.

I agree to take part in this study

Signature___________________ Date_________ /_______/_________

Researcher

Name____________________________

Signature__________________________ Date______/ ________ /_________
Appendix 3: Questionnaire

Instructions for the interviewer

1. Do not write the name of the participant anywhere in the questionnaire
2. Tick the boxes provided where applicable, as the interviewee answers
3. Please try to ask all the questions. Offer clarification as may be deemed necessary
4. Record in the questionnaire the answers as provided by the participant
5. All information obtained herein will be treated with utmost confidentiality

Section A: Caregiver socio-demographic information

1. Gender  Male ☐  Female ☐

2. Age (indicate age in years) _____ _________

3. Marital status
   i. Married ☐
   ii. Single ☐
   iii. Separated ☐
   iv. Divorced ☐

4. Religion
   i. Christian ☐
   ii. Muslim ☐
   iii. Hindu ☐
   iv. Others, specify ______________

5. Level of education
   i. Primary ☐
   ii. Secondary ☐
   iii. Tertiary (college) ☐
   iv. University degree ☐
   v. Never attended school ☐

6. Occupation
   i. Employed ☐
ii. Self-employed  

iii. Unemployed  

7. Number of children (indicate the number)____________________

8. The child aged less than 24 months is born number? Indicate the birth order________

9. What are the sources of income of the parents/care givers? Mark all that apply
   i. Employed  
   ii. Self-employed  
   iii. None  
   iv. Others, please specify ___________________________________________________

10. Level of monthly income (in KSH)
    i. Below 10,000  
    ii. 10,001-20,000  
    iii. 20,001-30,000  
    iv. 30,001-40,000  
    v. Above 40,000  

11. Do you know how many vaccines your child should get? Yes  ■  No  ■

12. If yes to No. 11 above, kindly mention the one you know and the time due

<table>
<thead>
<tr>
<th>Vaccine</th>
<th>Time(s) due and purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Section B: child immunization status

1. Date of birth ______/____/______

2. Child gender  Male  ■  Female  ■

3. Where was the child delivered at? ______________________if health facility, state whether public or private__________________________________________________________

4. Mother child Book available/immunization card  Yes  ■  No  ■

5. Tick if the child has gotten the following vaccines
6. For the table below, fill in the columns D, E, F and G as appropriate. Use the mother–child booklet to confirm the dates where applicable.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>C. ANTIGEN</th>
<th>D. Given? Indicate date</th>
<th>E. Not Given</th>
<th>F. Not yet due</th>
<th>G. Vaccination status on schedule?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Birth</td>
<td>BCG, OPV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6 weeks</td>
<td>Pentavalent (DPT, HepB, Hib), OPV, Hepatitis B, Pneumococcal, Rota virus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10 weeks</td>
<td>Pentavalent (DPT, HepB, Hib), OPV, Hepatitis B, Pneumococcal, Rota virus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>14 weeks</td>
<td>Pentavalent (DPT, HepB, Hib), OPV, Hepatitis B, Pneumococcal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>6 months</td>
<td>Vitamin A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>9 months</td>
<td>Measles vaccine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>18 months</td>
<td>Measles vaccine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. How far is the nearest government health facility? Give approximate time one may take to get there________________________________________________________

8. Where do you prefer to get health care services from?
   a. Private [ ]  Government [ ]

**Interviewer**

Name _________________ Sign _______________ Date __/__/________________

55
Appendix 4: Map of Mukuru Kwa Njenga

Source: Google maps

Map of Mukuru Kwa Njenga
Appendix 6: Bioethical certificate

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Bonnie Munyalo successfully completed the NIH Web-based training course "Protecting Human Research Participants."

Date of Completion: 05/30/2018

Certification Number: 2827891
Appendix 7: MUERC Ethical Approval

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

FROM: Secretary - MUERC
TO: Bonnie Mwanza Munyelo
EL/ESM/0368/2013
Department of Public Health
School of Public Health and Community Development,
Maseno University
P. O. Box, Private Bag, Maseno, Kenya

DATE: 22nd February, 2018
REF: MSU/DRPI/MUERC/00480/17

RE: Determinants of Vaccine Uptake in Mukuru Kwa Njenga Settlement in Nairobi County, Kenya. Proposal Reference Number MSU/DRPI/MUERC/00480/17

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 22nd day of February, 2018 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 21st February, 2019. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 15th January, 2018.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 15th January, 2018.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee.

CC: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED
TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR BONNIE MWANZA MUNYALO — EL/ESM/00368/2013

The above named is registered in the Master of Public Health in the School of Public Health & Community Development, Maseno University. This is to confirm that his research proposal titled “Determinants of vaccine uptake in Mukuru kwa Njenga settlement in Nairobi County, Kenya” has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

Prof. J.O. Agure
DEAN, SCHOOL OF GRADUATE STUDIES