Family factors associated with immunization uptake in children aged between 12-59 months: A household survey in Kakamega Central district, Western Kenya

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Abstract

Immunization is regarded as one of the most important achievements of public health. Immunization coverage in children in Kenya is about 88%. Regional disparities however exist and these are mediated by provider, system and client related factors. The aim of this study was to assess complete immunization coverage and to identify family factors associated with immunization in children aged between 12 and 59 months in Kakamega Central, Western Kenya.

A cross sectional study was conducted in 13 sub-locations between June and July, 2013. Stratified sampling was conducted followed by simple random sampling to identify households to be visited within each stratum. Data on 577 children were collected from their respective care givers by trained research assistants. Information collected included immunization status of the child, sociodemographic characteristics of the caregivers and their partners and the household's socioeconomic status. Factors affecting immunization uptake were assessed through bivariable and multivariable logistic regression methods.

The proportion of completely immunized children was 81.1% (95% CI 76.9%-85.3%). The immunization coverage rates for BCG, OPV3, DPT3 and measles were 99.4%, 85.3%, 96.0% and 92.4% respectively. At bivariable levels, the factors associated with immunization included caregiver's age, education level of the caregiver and partner, the child's birth order, maternal attendance of antenatal clinics, place of delivery of the child and socioeconomic status of the household. At multivariable levels, greater immunization uptake was predicted by high school level of the caregiver and partner, attendance of ANC clinics and delivery within a health facility.

Immunization uptake in Kakamega central is still low compared to neighbouring regions. Various family sociodemographic characteristics are associated with immunization uptake. Further inquiry is required into this area to fully comprehend the inextricable linkage between factors affecting immunization.

Chapter 1: Introduction

1.1 Background to the problem

Immunization has been one of the most successful and cost effective public health interventions in history. It has led to the total eradication of small pox and achieved a marked reduction in morbidity and mortality of many vaccine-preventable illnesses (WHO, 2011). Prior to its inception, many people lost their lives due to diseases such as small pox, polio, diphtheria, whooping cough and tetanus. In the United States, over 10,000 people died due to diphtheria from 1936-1945 while 7,518 people died due to pertussis in 1934 (Centres for Disease Control and Prevention, 1980). By 2006, there was a greater than 99% reduction in the number of cases of vaccine preventable diseases in the United States as compared to the pre-vaccination era (Roush & Murphy, 2007). Vaccination is likely to have made a significant contribution to this reduction.

Immunization plays an important role in reducing morbidity and mortality due to infectious diseases both at individual and community level. Once a child has been vaccinated, the immune system is stimulated to produce antibodies against the disease for which the child was vaccinated. First exposure to a vaccine or antigen leads to the primary immune response wherein B cells differentiate into plasma cells which then proliferate rapidly and produce antigen-specific antibodies. These plasma cells however have a short life span and within a few weeks, antibody titres begin to decline. Subsequent activation of the immune system through additional vaccine doses results in secondary immune response. During this phase, long-lived plasma cells produce antibodies over a sustained period of time, conferring long term protection (Manz, Hauser, Hiepe, & Radbruch, 2005). This is the rationale for administration of vaccines in more than two doses. To ensure long term vaccine efficacy, priming or 'boosting' of the immune system is required, often achieved through administration of several vaccine doses (Siegrist, 2008).

Immunization is however not a perfect system due to various challenges. Firstly, not all healthy children respond optimally to immunization owing to individual biological variation in the immune response and population heterogeneity. Secondly, some children may fail to qualify for immunization due to age (either too young or too old for specific vaccines) or presence of a debilitating medical condition such as stage IV HIV/AIDS or chemotherapy. Such children constitute a special group that has to rely on

healthy vaccinated children within the community for protection against vaccine-preventable diseases. This form of indirect immunity is termed herd immunity or community immunity and can be defined as the reduction of disease or infection within the unimmunized segment as a result of immunizing a proportion of the population (John & Samuel, 2000). Each vaccine-preventable disease has its own herd immunity threshold, expressed by the equation below (Fine, Eames, & Heymann, 2011).

$V_c = 1 - 1/R_o$ Where

V_c = Critical vaccination level: Proportion of the population that must be vaccinated to achieve the herd immunity threshold, assuming that vaccination takes place randomly within the community and that the vaccine is 100% effective.

R_o = Basic reproduction number: The number of secondary cases generated by an infectious individual when the rest of the population is susceptible. Each disease has its own unique R_o and the assumption is that the population in question is homogeneous and individuals mix and interact randomly.

Owing to the complexity of population dynamics and the inextricable interaction among many factors affecting immunity, this equation is a simple model that only serves as a guide for determination of herd immunity thresholds. As further research is conducted into this area, more complex models are expected to be developed. The World Health Organization (WHO) recommends immunization coverage of greater than 90% to achieve herd immunity against diphtheria, pertussis and tetanus (Brown et al., 2011). Despite its success, immunization has not achieved its full potential, with two million people across all age groups dying from vaccine-preventable diseases annually (WHO, 2006).

Building on the success of the smallpox eradication campaign, the World Health Organization launched the Expanded Program on Immunization (EPI) initiative. Its aim was to ensure that children in all countries had benefited from vaccination against the six diseases diphtheria, whooping cough, tetanus, poliomyelitis, measles and tuberculosis. Since then, more than 85% of children aged below one year have received immunization against these diseases. More vaccines are being added to the schedule including hepatitis B, haemophilus influenza type B and yellow fever (WHO, 2011). Infants in many countries have accessed immunization with trends in immunization coverage increasing. Despite this, an estimated 22.4 million infants (mostly from developing countries) failed to access the three basic vaccines (Diphtheria, Pertussis and Tetanus) during first year of life in 2011 (WHO, 2013a).

Currently, WHO recommends that all children under one year receive one dose of Bacille Calmette-Guérin vaccine (BCG), three doses of Diphtheria-Pertussis-Tetanus vaccine (DPT), three doses of oral polio vaccine (OPV), three doses of hepatitis B vaccine (HebB), three doses of pneumococcal conjugate vaccine (PCV), three doses of Hemophilus influenza type B vaccine and one dose of the measles vaccine (WHO, 2012a). The third dose of DPT (DPT3) is considered the proxy indicator for assessment of immunization coverage (Sullivan et al., 2010). Global DPT3 immunization coverage rose from 74% in 2000 to 85% in 2010 (Brown, Burton, Gacic-Dobo, & Karimov, 2011). This increase in immunization was attributed to aggressive global campaigns aimed at increasing immunization access and utilization. Central to this was the development of the Global Immunization Vision and Strategy (GIVS) for the period 2006-2015, a joint initiative by WHO and UNICEF.

The main objectives of GIVS are: to immunize more children against more diseases; to introduce a range of newly available vaccines and technologies; to integrate immunization with other critical health interventions; and to manage vaccination programs within the context of global interdependence (WHO & UNICEF, 2005). Since the inception of GIVS, more children have accessed immunization. However, a mid-term assessment of global immunization coverage has identified gross disparities in vaccination coverage between developed and developing countries (Brown et al., 2011). To mitigate this divide, policy makers need to implement strategies that will ensure equal access and utilization of immunization services in all regions of the world.

In Kenya, the Ministry of Health is charged with the delivery of efficient immunization services, through the Division of Immunization (DVI) department. Within one year of birth, each child is supposed to receive one dose of BCG, three doses of DPT, four doses of OPV, three doses of Hepatitis B vaccine, three doses of Hemophilus influenza type B vaccine, three doses of pneumococcal conjugate vaccine and one dose of Measles vaccine (Table 1).

Table 1: Infant immunization schedule in Kenya

Vaccine	Schedule
BCG (Bacille Calmette-Guérin for TB)	Birth
OPV (Oral Polio Vaccine)	Birth, 6, 10, 14 weeks
DPT (Diphtheria, Pertussis, Tetanus)	6, 10, 14 weeks
Hepatitis B vaccine	6, 10, 14 weeks
Hemophilus influenza type B vaccine	6, 10, 14 weeks
PCV (Pneumococcal Conjugate Vaccine)	6, 10, 14 weeks
Measles vaccine	9 months

Adapted from WHO (2013b). Available from http://apps.who.int/immunization_monitoring/globalsummary/countries?countrycriteria[country][]=KEN

Immunization coverage refers to the proportion of individuals, within a given target population, that have received DPT3 (the proxy indicator especially in children) or have received all vaccines as stipulated in the immunization schedule (Burton, 2009). Immunization coverage is important in monitoring of utilization of immunization services, guiding stakeholders in disease eradication and a good indicator of healthcare system performance. In Kenya, immunization coverage is obtained from routine health facility reports. In addition, coverage data is obtained from the Kenya Demographic and Health Indicator Surveys (KDHS), conducted every six years. Survey findings complement routine data as they explain reasons for failing to immunize, as reported by care givers.

1.2 Statement of the problem

Immunization coverage in Kenya, as measured by the third dose of DPT is 88% (WHO, 2013b). This national coverage tends to hide regional inequalities in access to immunization. In 2009, Central province recorded the highest immunization coverage of 85.8% while the lowest was North Eastern province with 48.3% (KNBS & ICF Macro, 2010). These disparate proportions are an indication that some regions in Kenya enjoy the benefits of immunization services more than others. Nonetheless, other factors such as better and timely reporting could account for variation in immunization uptake within the country.

Despite a global reduction in polio prevalence, Kenya still experiences pockets of outbreaks especially along its border with Uganda, (Gauri & Khaleghian, 2002). In addition, vaccine-preventable disease burden in Kenya is still significantly high. For instance, TB prevalence rate in 2011 was 291/100,000 while the incidence rate was 288/100,000 with a mortality rate of 0.022% (WHO 2013c). In 2012, 3486 cases of

measles were suspected with 2380 cases being confirmed. The incidence rate for measles in the same year was 5.57/100,000 (WHO 2013d). These figures call for more study to understand why outbreaks of vaccine-preventable diseases still occur and how this problem can be addressed.

Immunization dropout rate refers to the number of children who enrol for vaccination but never complete. It is often calculated by taking DPT1 coverage minus Measles coverage divided by DPT1 coverage, expressed as a percentage (WHO & UNICEF, 2002). Dropout rate is an important indicator of utilization of immunization services as it shows whether mothers who had brought their children for initial vaccination return for subsequent vaccine doses (Bos & Batson, 2000). In Kenya, the DPT1-Measles dropout rate for 2011 was 8.4% (WHO, 2012a). The WHO recommends that dropout rates remain below 10% for every country. Although Kenya meets the guidelines for the country, there is a lot of variability at the district level, with some areas having dropout rates that often exceeded the guidelines for the country. For instance, the 2012 dropout rates for Kakamega East, Kakamega Central and Mumias districts were 5%, 9% and 19% respectively (Kenya Health Information System, 2013)

Failure to completely immunize children within the required time can lead to disease outbreaks, resulting in death and disability. Repeated outbreaks of vaccine-preventable diseases have occurred in different parts of Kenya. Some of the diseases reported in the country in 2012 included polio, measles, neonatal tetanus and influenza types A (H3) and B (Ministry of Public Health and Sanitation, 2012). These outbreaks are an indication that despite improved immunization coverage in the country, not all children are protected through routine immunization programmes. Wider determinants of health are important in understanding variations in immunization coverage. They include social, cultural, economic, political and biological factors.

1.3 Purpose of the study

The purpose of this study is to describe sociodemographic factors associated with immunization uptake in children aged between 12 and 59 months in Kakamega central district, Western Kenya.

Primary aim

To assess the prevalence of complete immunization among children aged between 12 and 59 months in Kakamega central district, Western Kenya.

Secondary aims

1) To assess coverage rates for various childhood vaccines in Kakamega central district.

2) To explore the nature of associations between maternal, paternal, child and household sociodemographic characteristics and immunization uptake. Sociodemographic factors included in this study are age and education level of the parents, the child's sex and birth order, maternal attendance of antenatal clinics and family's socioeconomic status.

1.4 Significance of the study

Immunization in children is important in preventing morbidity and mortality due to vaccine-preventable illnesses. Despite several studies being published on determinants of immunization uptake in children, fewer studies have been conducted in Kenya and none in Kakamega central district. Should this study identify significant sociodemographic factors associated with immunization uptake, policy makers will be in a position to identify families at risk of failing to immunize. Policy makers will thus be able to design programs both at national and local levels that can improve immunization uptake. This will help in ensuring that interventions are targeted to vulnerable groups. Such interventions might include outreach activities and community health education. If policy efforts were to focus on ensuring that all children receive full vaccination, the country stands a chance at attaining more than 90% immunization coverage. Control of infectious diseases through vaccination will lead to reduced morbidity and mortality in children aged below five years. Subsequently, government expenditure on management of disease outbreaks will reduce with funds being redirected to scaling up of other healthcare service delivery programmes.

1.5 Theoretical foundation

An understanding of the interplay between various social determinants of health guided this research. The world Health Organization defines social determinants of health as conditions in which people are born, grow, live, work and age and how these affect access and utilization of health services (WHO, 2012b). There is a shift therefore, from the biomedical model of disease causation to a social perspective which emphasizes on the role of the social environment (attitude, beliefs and social behaviors) in disease causation.

Social determinants can be explained further through the upstream-downstream concept (Braveman, Egerter, & Williams, 2011). In this model, downstream determinants are those factors which are spatiotemporally close to health effects and are easily identified as the immediate causes of poor health. These are in turn shaped by upstream determinants which are spatiotemporally distant. Upstream factors set in motion the causal pathways and are the target for reducing health inequalities. Between the upstream and downstream determinants is a web of intervening and interactive factors which play a big role in health.

A lot of literature has been written on the upstream-downstream model of disease causation (Gehlert et al., 2008; Krieger, 2008; Braveman, Egerter, & Williams, 2011). Dahlgren and Whitehead (1991) describe a hierarchical model which includes various levels of determinants (Figure 1). This can be applied to immunization uptake as described below:

Biological factors: The effect of personal characteristics on immunization uptake. Such characteristics include age of the caregiver, age of the partner and sex of the child.

Individual lifestyle factors: Refers to the lifestyle choices that people make and how these choices affect immunization uptake. Some caregivers might choose to adopt healthy lifestyle options such as family planning, attending antenatal clinics while pregnant and delivering their children with help from skilled personnel (such as trained midwives). Other caregivers might lead a lifestyle characterized by alcoholism and drug abuse. Their children often suffer from neglect and may not be able to access immunization services.

Social and community networks: People live in social networks comprising relatives, friends and other community members. Health characteristics within the community have a direct bearing on individual behavior. For instance, if a caregiver is surrounded with colleagues whose children are fully immunized, such a caregiver is likely to have his/her children immunized as well in an effort to keep up with the norms within the community. Conversely, a caregiver living in a community characterized by crime and social neglect is less likely to take his/her children for immunization.

Living and working conditions: People live and work within communities surrounded by conditions such as employment, welfare, health, social amenities, housing and sanitation. Immunization determinants considered at this level include education level

of the caregiver and the partner, distance to the nearest immunizing facility and ease of travel (public transport).

Socioeconomic, cultural and environmental conditions: These are the most distal determinants of health. They include political good will, government policy, social equity, cultural beliefs, economic and environmental factors. Within this category, this study explored the effect of socioeconomic status on immunization uptake.

Figure 1: The determinants of health

Dahlgren and Whitehead (1991)

Despite the above hierarchy, it is important to acknowledge that human health-seeking behaviour and risk perception is complicated. Health determinants are multiple and do not operate in isolation. Arguably, no single model can conclusively explain why some children get fully immunized while others do not.

1.6 Definition of terms

Vaccine-Preventable Diseases (VPDs): Refers to diseases that can be prevented by routine vaccination. They include Diphtheria, Hemophilus influenza type B, Hepatitis B, Measles, Meningococcal meningitis, Mumps, Pertussis, Poliomyelitis, Rotavirus, Rubella, Tetanus, Tuberculosis, Pneumococcal pneumonia and Yellow Fever. For the current study, the operational definition limits the diseases to Diphtheria, Pertussis, Tetanus, Hemophilus influenza type B, Hepatitis B, Tuberculosis, Poliomyelitis and Pneumococcal pneumonia.

Sociodemographic factor: A characteristic of individuals or households potentially affecting immunization status, such as age, education level, sex and socioeconomic status.

Immunization coverage: The proportion of children who have received vaccinations against specific vaccine-preventable diseases by a certain age.

Dropout rate: The proportion of children who begin but never complete immunization according to the schedule.

Immunization status: Refers to the extent to which the required vaccines had been received, as at the time of the interview. Classified as fully immunized (having received all the doses of vaccines as required by KEPI), partially immunized (having received less than the required doses of vaccines) or unimmunized (never received any vaccine dose).

Parental age: Age of the parent at the time of the interview, as reported by the mother.

Parental education level: Highest level of education acquired by the parent at the time of the interview.

ANC visits: Number of times the mother attended antenatal clinics while pregnant with the child in question.

Child's sex: Whether male or female

Birth order: Ranking of the child at time of birth, whether 1st, 2nd, 3rd born, etc

Health facility: Any facility offering immunization services. Can be a clinic, dispensary, health centre, nursing home or hospital

Family's socioeconomic status: Socioeconomic status estimated using the family's assets and utilities.

Chapter 2: Literature Review

2.1 Introduction

Sociodemographic factors are thought to be relevant in immunization uptake. This chapter will focus on understanding the effect of sociodemographic factors on immunization uptake as evidenced by previous studies. This will be achieved through critical analysis of the methodology and findings of various studies. The literature review will also identify strengths and weaknesses of each study and how these were addressed by researchers. The review is organized and presented in related sections in terms of relevance to each variable of interest.

2.2 Search strategy

Research relating to factors affecting immunization uptake was obtained from articles published between 2000 and 2012 in relevant peer reviewed journals. The databases used were PUBMED, Summon and ScienceDirect as they contain the most relevant articles in public health and medicine. Additional information was obtained from reference lists from articles in which one or several factors had been reported to affect immunization uptake in children. Key words used in the search are indicated below, with their corresponding success rates after narrowing the search criteria:

Immunization	208,550
Determinants/factors	33,878
Children aged 12-59 months	2,757
2000-2012	382

After screening the titles and abstracts of the final articles for relevance to the study problem, 40 articles qualified and were included in the literature review.

2.3 Immunization determinants

The reasons for inadequate immunization rates and disparities within and between countries are multiple and include both provider-related and client-related factors (Sullivan, Tegegn, Tessema, Galea, & Hadley, 2010). Provider-related factors include inadequate funding, staff shortage, poor health infrastructure, inadequate vaccine supply and insufficient number of immunizing facilities (Babalola, 2011). Most local and international activities aimed at scaling up of immunization services tend to focus on

addressing provider-related and service delivery factors (Cassell, Leach, Fairhead, Small, & Mercer, 2006). In Kenya, some of the activities aimed at increasing immunization include ensuring sustained vaccine supply and maintenance of the cold chain. These have proved inadequate as is evidenced by variations in immunization uptake within the country. Client-related factors are equally as important because populations live in social networks which are in turn affected by social, political, cultural and economic determinants of health. As indicated in the first chapter, distal and proximal factors are important determinants of health. Within the context of immunization in Kenya, distal factors are provider-related while proximal factors are client-related. There is a need therefore to focus more on proximal (client-related) factors in order to gain more understanding regarding immunization uptake. In one study in Uganda by Babirye et al (2011), decisions by mothers to immunize their children were based on accessibility to health facilities, knowledge and attitudes regarding immunization, beliefs and myths (Babirye et al., 2011).

Research on factors affecting immunization uptake has been undertaken in both developed and developing countries. In developed countries, low socioeconomic status (Babatsikou, Vorou, Galani, Ktenas, & Koutis, 2010), low maternal education (Samad et al., 2006) and higher birth order (Haynes & Stone, 2004) have been associated with low immunization uptake. In developing countries, education level of both parents (Sullivan et al., 2010), maternal age (Kamau & Esamai, 2001) and maternal knowledge affect immunization (Phimmasane, Douangmala, Koffi, Reinharz, & Buisson, 2010). Each of these will be discussed in turn.

2.4 Maternal factors

Studies have shown that maternal education or literacy is a strong and consistent predictor of child immunization outcome (Kamau & Esamai, 2001; Kumar, Aggarwal, & Gomber, 2010). In both the US and Kenya, it has been shown that higher maternal education is associated with higher immunization uptake (Luman, McCauley, Shefer and Chu, 2003; Abuya et al., 2011). Despite most studies associating maternal education with immunization uptake, this relationship is not so clear. Some researchers have demonstrated a U-shaped association with children born to mothers with no formal education or higher education levels being likely to be immunized compared to those with moderate education (Streatfield, Singarimbun, & Diamond, 1990). Others studies have shown that the association between maternal education level and immunization

uptake disappears when other variables are considered, including the father's education level and socioeconomic status (Steele, Diamond, & Amin, 1996).

Maternal age has been associated with immunization uptake in some studies. In Kenya, Mutua, Kimani-Murage, and Ettarh (2011) found that children belonging to older mothers were more likely to be vaccinated than those whose mothers were less than 20 years. Similarly, Fatiregun and Okoro (2012) were able to establish an association between maternal age and immunization completion. In this study however, young mothers were more likely to immunize their children than older mothers. A similar study carried out in the Philippines failed to identify maternal age as a significant predictor of full immunization status in children though there was a trend approaching significance (p=.053), (Bondy, Thind, Koval, & Speechley, 2009).

Focused antenatal care is one of the pillars of maternal health during pregnancy (The World Bank, 2012). Mothers attending antenatal clinics have an opportunity to gain knowledge about pregnancy, child birth and post natal care. During such visits, mothers are taught about the need to develop an individual birth plan and the importance of bringing their children for vaccination. In their study in Ambo Woreda, Ethiopia, Etana and Deressa (2012) were able to show that children belonging to mothers who had fully attended antenatal care were likely to be fully immunized. In the Philippines, children whose mothers attended at least four antenatal visits were one and a half times more likely to be vaccinated than those whose mothers attended less visits or none (Bondy, Thind, Koval, & Speechley, 2009).

Closely linked to antenatal care is the choice of the place of delivery. Studies have been able to demonstrate a strong correlation between place of delivery and the ability of the child to complete immunization. An example is the study by Nath et al. (2007) in which children born at home were less likely to be vaccinated than those born in a health facility. At the community level, mothers residing in a community with a high prevalence of hospital deliveries were more likely to have their children vaccinated. In Nigeria, Antai (2009) extended his analysis of immunization determinants to involve community factors. In this study, he found that living in a community with a low number of hospital deliveries was associated with lower likelihood of full immunization. This illustrates the potential importance of communities in which mothers live and how they influence individual decision making, including health-seeking behaviour.

2.5 Paternal factors

Most studies on determinants of immunization tend to focus more on maternal than paternal variables. This is perhaps due to the fact that it is mostly mothers who take children to immunization clinics. A study in rural Ethiopia by Sullivan et al (2010) was able to identify the effect of paternal age on immunization. Children belonging to older fathers were more likely to be immunized than those whose fathers were young. Fathers with a higher education level are also likely to have their children immunized (Phimmasane et al., 2010). Higher literacy level of the father (and mother) was also found to be associated with full immunization of the child in studies by Chhabra et al. (2007) and Bondy et al. (2009). There is a need for further studies to be carried out to ascertain the true nature of association between paternal sociodemographic variables and childhood immunization. This is because fathers are important in decision-making regarding the health of their children and in some cases they have to give permission to the mothers to take children to clinics, especially within the African community (Dodoo, 1998; Mufune, 2009). The role of the father with regard to immunization in Kenya is not very clear since no literature is available on the same.

2.6 Characteristics of the child to be immunized

The child's sex and birth order are important characteristics that have been included in a number of studies. In the 2009 Kenya Demographic and Health Indicator Survey (KDHS), there was no significant difference by sex in immunization status of the child (KNBS & ICF Macro, 2010). Studies conducted elsewhere in Kenya also failed to show any significant differences in immunization uptake based on the sex of the children being immunized (Mutua et al., 2011; Owino, Irimu, Olenja, & Meme, 2009). It is possible that male and female children have an equal chance of accessing health services due to gender mainstreaming campaigns by both the Kenyan government and non-governmental organizations. On the other hand, in rural Bangladesh, Rahman and Obaida-Nasrin (2010) discovered that male children were more likely to be immunized. This could be explained by cultural differences between the two countries.

A child's birth order has been shown to be associated with various health outcomes including growth and development, exposure to accidents and morbidity and mortality due to some diseases (Elliott, 1992). Two studies in Kenya and one in the Philippines have been able to associate birth order with immunization uptake (Bondy et al., 2009; Owino et al., 2009; KNBS & ICF Macro, 2010). In the researcher's opinion, first born children are more likely to be immunized due to the excitement associated with the first

child. As mothers get more children, resources might get constrained with parental excitement waning (Brenner, Simons-Morton, Bhaskar, Das, & Clemens, 2001). A study in northern India however showed no association between birth order and immunization uptake (Kumar et al., 2010). The limitation with this study was that participants were selected from children admitted into one tertiary level hospital. The hospital attends to children predominantly from surrounding slum areas and so use of admitted children as participants may limit generalisation of research findings.

2.7 Household factors

Some of the household factors that determine childhood immunization are thought to include socioeconomic status and distance between the household and the nearby health facility. Family socioeconomic status is associated with child immunization uptake with children from higher socioeconomic status households being likely to be immunized than those from low socioeconomic status (Hu, Chen, Li, Chen, & Qi, 2011; Kusuma, Kumari, Pandav, & Gupta, 2010; Topuzoglu et al., 2005). This was indeed noted by the 2009 Kenya Demographic and Health Survey (KDHS) in which low immunization rates were noted in children from households within the lowest wealth quintile. However, a study conducted prior to the KDHS in Mathare Valley, Kenya by Kamau and Esamai (2001) had failed to show any association between socioeconomic status and childhood immunization. This study, however, had a small sample size (n=360) compared to the KDHS (n=1096) and researchers did not clarify how they analyzed association between socioeconomic status and immunization uptake.

Distance from the household to the nearby health facility is an important indicator because it affects access to health services. In coastal Kenya, Ndiritu et al. (2006) were able to accurately measure the distance between each household and the nearby vaccination clinic, using Geographical Information System (GIS) software ArcGIS v9.0. They reported that distance to the nearest clinic affects immunization, with those closer to clinics more likely to take children for immunization. In Lasbella district, Pakistan, living closer to a health facility (less than 5 kilometres) was associated with more immunization (Mitchell et al., 2009). These findings highlight the importance of ensuring that health facilities are adequate and accessible to all households.

2.8 Methodological issues arising from these studies

A number of studies have been conducted in various parts of the world to understand the effect of sociodemographic factors on immunization uptake. These have resulted in

varied findings, perhaps due to methodological issues including research design, sampling methods, number of participants, measurement tools and data analysis. Each of these is discussed below.

The majority of the studies reviewed made use of cross sectional study design. One study used a longitudinal design with baseline immunization data being collected at four months after birth, there after every four months until the child's age reached 24 months (Mutua et al., 2011). Another study used mixed methods design where cross sectional study was combined with qualitative research methods (Owino et al., 2009).

Participants in most of the studies were children aged below five years. It is expected that most children complete immunization between 12 and 60 months. This wide range is due to variations in immunization schedules in different countries. While looking at the prevalence and determinants of full immunization in Turkey, Babatsikou et al. (2010) recruited children aged between 0 to 12 years old. This is likely to affect the quality of research findings because children below one year are still receiving immunization and might be misclassified as unvaccinated. While most studies described how they made use of the WHO (2005) cluster sampling technique for immunization and explained the rationale behind its use, one study only mentioned it without providing details of the sampling procedure (Kamau & Esamai, 2001).

The two measures used to identify immunization history were records on vaccination cards and maternal recall. Despite the possibility of recall bias, asking mothers questions on routes of administration and dosage schedule helps to improve accuracy of maternal recall. Studies have shown that maternal recall can be relied upon to assess immunization with a 98% parental accuracy (AbdelSalam & Sokal, 2004) and high correlation between maternal recall and vaccine card information, Spearman's *rho*=.71 (Valadez & Weld, 1992). However, it is necessary to involve mothers without immunization cards in immunization studies to avoid missing out on vital information.

Studies varied in their approach to measurement of socioeconomic status within households. Two studies used family income as a proxy indicator of socioeconomic status (Kamau & Esamai, 2001; Kusuma et al., 2010). This can introduce measurement bias especially in developing countries where majority of families do not have a stable income. It is not possible to get accurate records of monthly income from such families. Sullivan et al. (2009) used a picture of a ladder with ten rungs to represent varying levels of socioeconomic status. Participants were asked to use this to rank their

socioeconomic status relative to others in the community. This is a subjective measurement tool prone to bias and has not been tested for validity and reliability.

The process of determining socioeconomic status needs to be considered before analysis of the relationship between socioeconomic status and immunization uptake. A good measure of economic status would be one in which several indicators are combined before establishing of the final score. This is because the use of one indicator, such as income, may not be appropriate in countries where majority of the population are unemployed or have erratic sources of income. Topuzoglu et al. (2005) used the Socioeconomic Status Index for Turkey, a test that utilizes variables such as occupation, household assets and education level. Kusuma et al. (2010) used similar measures to rank socioeconomic status in India. This is more applicable in developing countries where use of fixed assets and household utilities would be useful in estimating socioeconomic status. This is illustrated in the KDHS (2009) and a study in Kenya by Mutua et al. (2011) who used Principal Component Analysis (PCA) to construct wealth indices for socioeconomic status, based on ownership of fixed assets. In this approach, ownership of an asset is assigned a score. After standardization, all the scores are added up to give the final value which is taken as a measure of socioeconomic status for the household.

Some studies looked at the association between immunization and distance to the nearest health facility. Most of these did not explain how they measured distance between each household and the nearest health facility except for Ndiritu et al (2006) who used Geographical Information System (GIS) software to document the distance accurately.

Despite most of the studies reporting association between sociodemographic variables and immunization uptake, some reported negative association or none at all. This variation could be due to study design and nature of data analysis. Some studies focused on the effect of one variable for example maternal age (Salmon et al., 2009) or education (Abuya et al., 2011) on immunization uptake. These two studies reported significant association between the stated variables. Consideration of other variables including paternal education and socioeconomic status led to contradicting results (Steele, 1996). This highlights the importance of considering all potential factors and confounders in such studies.

Choice of a longitudinal study design or larger sample size (more than 3000 participants) led to consistency in research findings among various studies (Mutua et al., 2011; Topuzoglu et al., 2005; Mitchel et al., 2009). Studies with contradictory findings had relatively small sample sizes with less than 500 participants (Fatiregun & Okoro, 2012; Kumar et al., 2010; Kamau & Esamai, 2001). Studies need to have larger sample sizes to minimize selection and information bias to achieve consistency in research findings. Use of multivariable data analysis methods led to disappearance of association between variables in studies by Chhabra et al. (2007), Bondy et al. (2009) and Rahman and Obadia (2010). In these studies, multivariable methods probably adjusted for the confounding effect of explanatory variables on each other. This informs researchers on the importance of analyzing association between variables in both bivariable and multivariable models.

2.9 Summary

A number of studies have been conducted on the effects of sociodemographic factors on immunization uptake. The majority of the studies reviewed seem to be in agreement that sociodemographic factors affect immunization uptake. Varied findings could be attributed to use of different sample sizes, measurement tools and data analysis methods. Use of larger sample sizes and validated measurement tools would help in ensuring consistency in findings of future research.

Sociodemographic factors are likely to have an interaction with each other for example maternal age, education level, paternal age and socioeconomic status. This could be due to effect modification and/or collinearity. Use of multivariable methods, for instance, logistic regression, is important in ruling out or identifying interaction between variables thereby revealing significant predictors of immunization uptake. Informed by these findings, the study design aims to improve quality of findings by recruiting an adequate sample size, using validated measurement tools and analysing factors on both bivariable and multivariable levels.

Immunization uptake is still a problem in Kenya as shown by regional inequalities in access to immunization. In addition, the country is still faced with a high burden of vaccine-preventable diseases such as tuberculosis and measles. This is an indication that immunization has not optimally protected the Kenyan population against these diseases, either directly or through herd immunity. Regarding factors affecting immunization, few studies have investigated the role of sociodemographic factors in Kenya. The

literature review revealed that no studies have been conducted in Western Kenya and so this study aimed to fill this gap. A clear understanding of the role of sociodemographic factors would direct decision makers in understanding the entry levels at which to initiate community based interventions that can increase immunization access and utilization.

Chapter 3: Methodology

3.1 Introduction

A survey with a cross sectional study design was used to determine the completeness of immunization in a sample of households within Kakamega central district. Also investigated was the association between the family's sociodemographic factors with childhood immunization uptake. This was a pilot study in which data were obtained from a household survey. In this chapter, research design, study population, sampling, instrumentation, data collection procedures and plan for analysis of the data are discussed.

3.2 Study design

A cross sectional study was utilized to collect information on completeness of immunization and family sociodemographic variables. This was a pilot study designed to generate quantitative data which would provide a baseline for further research into this area through qualitative and mixed methods. The study made use of a quantitative methodology with most family socio-demographic factors being categorical. Immunization status (outcome variable) was divided into two categories: fully immunized and not fully immunized. The explanatory variables included age of the caregivers and their partners, education level, place of delivery, sex of the child and socioeconomic status. Given the nature of these variables, a quantitative approach was convenient in correlating explanatory variables with the outcome variable. Research findings would then set the stage for further inquiry into factors affecting immunization.

3.3 Research questions and hypotheses

The research questions and hypotheses were as follows:

1. **Is there association between the age of the caregiver with immunization uptake?**

   H_{o1}: The age of the caregiver is not associated with immunization uptake.

   H_{a1}: The age of the caregiver is associated with immunization uptake.

2. **Is there association between the age of the caregiver's partner with immunization uptake?**

   H_{o2}: The age of the caregiver's partner is not associated with immunization uptake.

   H_{a2}: The age of the caregiver's partner is associated with immunization uptake.

3. **Is there association between the caregiver's education level with immunization uptake?**

   H_{o3}: The education level of the caregiver is not associated with immunization uptake.

   H_{a3}: The education level of the caregiver is associated with immunization uptake.

4. **Is there association between the education level of the caregiver's partner with immunization uptake?**

   H_{o4}: The education level of the caregiver's partner is not associated with immunization uptake.

   H_{a4}: The education level of the caregiver's partner is associated with immunization uptake.

5. **Is there association between maternal ANC attendance with immunization uptake?**

   H_{o5}: There is no association between maternal ANC attendance and immunization uptake.

   H_{a5}: Maternal ANC attendance is associated with immunization uptake.

6. **Is the child's sex associated with immunization uptake?**

   H_{o6}: There is no association between immunization uptake and the child's sex.

   H_{a6}: Immunization uptake is associated with the child's sex.

7. **Is the child's birth order associated with immunization uptake?**

   H_{o7}: There is no association between immunization uptake and the child's birth order.

   H_{a7}: Immunization uptake is associated with the child's birth order.

8. **Is the place of delivery of the child associated with immunization uptake?**

   H_{o8}: There is no association between immunization uptake and the child's place of delivery.

   H_{a8}: Immunization uptake is associated with the child's place of delivery.

9. **Is immunization uptake associated with the family's socioeconomic status?**

   H_{o9}: Immunization uptake is not associated with the family's socioeconomic status.

   H_{a9}: Immunization uptake is associated with the family's socioeconomic status.

3.4 Study population

The study population included a sample of parents or guardians to children aged between 12-59 months at the time of the study who lived in Kakamega central district, Western Kenya. Children aged below 12 months were still undergoing immunization hence were considered unsuitable to be assessed for immunization uptake, while those aged above 60 months (five years) were older and did not require routine childhood immunization. Besides, including children aged above 60 months would increase chances of recall bias from respondents and also extend the study period further back to children born before 2008, reducing the ability to capture more current immunization behaviour. To be considered for the study, children must have been resident in the household at the time of the study and must have lived there for more than six months. Children from neighbouring households and those visiting at the time of data collection were not considered. In households with two or more children qualifying for inclusion, the youngest was selected as it was thought more likely that their families would have most recent data on immunization and be able to recall this. In situations where twins lived within the household and fitted the inclusion criteria, only one child was selected for inclusion in the study after the tossing of a coin. Households with no children aged between 12 months and 59 months were excluded from the study.

3.5 Sampling procedure

The selection of participants was done through stratified sampling followed by simple random sampling of households within strata. Kakamega central district consists of 13 administrative units, called sub-locations. Each sub-location constituted a stratum from which households were drawn for the survey. The Ministry of Provincial Administration maintains an updated list of all households per sub-location with names of household heads. This list was obtained by request through the District Medical Officer of Health (DMOH). Permission to use the list was sought and obtained from the two ministries with confidentiality being maintained during the entire sampling process. This was achieved through the use of numbers to refer to each household rather than the use of names of household heads which would reveal identity. Households to be surveyed per stratum were selected using a computer assisted generation of random numbers. The first household within each stratum was selected randomly with the next one being the nearest household that met the inclusion criteria. Data were collected door to door with recruitment of participants being done at this point. If, for some reason, any participant was unwilling to be recruited, interviewers moved on to the next household.

3.6 Sample size

The purpose of sample size calculation was to enable the researcher to estimate the immunization coverage in Kakamega central district, taking account of the chosen stratified sampling mechanism. Based on this, the researcher aimed to calculate the smallest sample size that would allow for estimation of immunization uptake in the district.

Step 1: Base sample-size calculation

The appropriate sample size for the survey was determined largely by three factors: (i) The estimated prevalence of the variable of interest – percentage of fully immunized children in the district, (ii) The desired level of confidence and (iii) The desired width of confidence interval. Hence:

$$n = \frac{Z^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

Description:

n = required sample size

$Z_{1-\alpha/2}$ = Standard normal quantile at the desired confidence level at 95% (standard value of 1.96)

p = estimated prevalence of fully immunized children in Kakamega central district.

d = desired width of confidence interval (±5%)

According to the KDHS (2010), 80% of children in Kakamega central district are fully immunized. Use of the standard values listed above provides the following calculation.

$$n = \frac{1.96^2 \times .8(1-.8)}{.05^2}$$

$$= \frac{0.6147}{0.0025}$$

= 245.88, rounded up to 246

Step 2: Design Effect

In quantitative studies, the sampling method determines computing of statistical tests. Most tests assume that data are obtained by simple random sampling and such tests are likely to be incorrect if data were obtained using different sampling methods. To adjust for the extent to which sampling variance in a survey departs from sampling variance expected under simple random sampling, the design effect is used. This immunization

survey was designed as a stratified sample, rather than a simple random sample. To correct for the difference in design, the sample size was multiplied by the design effect (D). The design effect was assumed to be 2, as recommended for immunization surveys by WHO (2005).

n x D = 246 x 2 = 492

Step 3: Contingency

The sample size was increased further by 5% to account for contingencies such as non-response or recording error.

n + 5% = 492 x 1.05 = 516.6 ˜ 517

Step 4: Distribution of Observations

Finally, the necessary sample size was rounded up to the closest number that matched well with the number of strata (13 sub locations) to be surveyed.

517/13 = 39.77 ˜ 40 children per sub location.

The final number of children, n = 40 x 13

n = 520

A final necessary sample size of 520 households was therefore determined, based on the WHO (2005) recommended single proportion formula for immunization. This method has been used in a number of immunization surveys (Etana & Deressa, 2012; Fatiregun & Okoro, 2012; KNBS & ICF Macro, 2010).

3.7 Instrumentation

A structured questionnaire was used to collect information on sociodemographic characteristics of interest. Some of the questions were adopted from those used in the Kenya Demographic and Health Survey (KNBS & ICF Macro, 2010). The questionnaire included sections on sociodemographic characteristics of the child and parents, the number of antenatal visits, place of the child's delivery, details of household assets and child's immunization history (Appendix B).

Socioeconomic status was determined by use of asset indicators to develop a wealth index. The procedure for estimation of socioeconomic status was as shown below (Rutstein & Johnson, 2004).

1. All household assets/utilities were dichotomized into 1 (asset present) or 0 (asset absent) then entered into principal component analysis (PCA), a factor reduction in technique in SPSS. The factor score on the first component was then recorded.

2. Each asset was then assigned a weight (factor score) as generated through PCA.

3. Resulting asset item scores were then standardized so that they had a mean of zero and standard deviation of one.

4. Weighted standardized asset item scores were summed up per household to yield the household wealth index Y_i, as shown below.

$$Y_i = \frac{\alpha_1(x_1 - \bar{x}_1)}{S_1} + \frac{\alpha_2(x_2 - \bar{x}_2)}{S_2} + \cdots \frac{\alpha_k(x_k - \bar{x}_k)}{S_k}$$

x_k= Asset score. Either 1 (asset present) or 0 (asset absent)

$\bar{x}_k$ = Mean of the asset score for asset k

S_k = Standard deviation of the asset score for asset k

α_k = Weight for each asset from the first principal component

Y_i = Wealth index

5. Household wealth indices were then ranked from the lowest to the highest then divided into five wealth quintiles.

Initially validated for education research by Filmer and Pritchett (2001) and later used by other health researchers (Gunnsteinsson et al., 2010; Rutstein & Johnson, 2004; Vyas & Kumaranayake, 2006), principal component analysis can be utilized to generate wealth indices based on assets owned by households. Household wealth indices can then be ranked by ascending order then divided into quintiles representing socioeconomic status. In Kenya, this method has been used in determining socioeconomic status during household surveys (KNBS & ICF Macro, 2010; Mutua et al., 2011).

The immunization history for the child of interest was obtained from the vaccination card. This information included types of vaccines administered against vaccine-preventable diseases, doses and timeliness of these vaccines. In the absence of vaccination cards, caregivers were asked to give verbal reports based on recall. Routes of vaccine administration and the dosage schedule helped in identifying vaccines based on maternal history. For instance, two vaccine drops into the mouth referred to the polio vaccine while an injection to the left upper shoulder (deltoid muscle) referred to measles vaccine. Research has shown that maternal recall is just as reliable as use of

vaccination cards in collecting immunization data (Bondy et al., 2009). To confirm BCG vaccine uptake in the absence of the vaccination card, a BCG scar was checked for on the lateral aspect of the left forearm. Information on sociodemographic profiles was obtained verbally then corroborated with available documents including national identification cards, birth certificates and academic certificates.

3.8 Variables

The explanatory variables of interest included maternal characteristics (age at delivery of the child, education level, antenatal visits and place of delivery), paternal characteristics (age and education level), characteristics of the child to be immunized (birth order and sex) and household characteristics (socioeconomic status). The outcome variable was immunization uptake as indicated by completeness of vaccination as per the schedule (Table 1). A child's vaccination status was considered *complete* if he/she had received complete doses with appropriate spacing between the doses. If a child began vaccination, received a number of doses but never completed the schedule, such a child's status was classified as *partially complete*. Finally, a child was considered *unvaccinated* if he/she never received any vaccine dose. For convenience in data analysis, the vaccination status was assigned numerical values 2, 1 and 0 respectively.

3.9 Data collection

To provide more time for potential participants to consider their involvement, village chiefs were informed about the study two weeks before it commenced, and were asked to disseminate this information to village elders who then disseminated the information further within the villages. Village elders are in a good position to meet household members almost daily during market days, public meetings and home visits. Prior to the research exercise, announcements were made in local schools, churches and market where potential participants were told of the number of times when researchers would be visiting.

Before beginning the study, six research assistants were recruited from the district public health office, based on their availability and willingness to assist in the research process. Five were public health officers serving in various regions within the district while one was a health records and information officer. Four of the research assistants were female while two were male. The research assistants participated in a one day training session, run by the principal investigator, to familiarize themselves with the

research process and data collection tools. At the end of the training, administrative issues and logistics were addressed. Each research assistant was allocated two sub-locations which included selected households (90-100 households per officer). Funding for the recruitment and training exercise was obtained from the New Zealand AID Foundation.

On arriving at each household, researchers checked to ensure that the household met the inclusion criteria. Caregivers from qualifying households then gave both verbal and signed consent before proceeding with the study (Consent form is presented in Appendix A). Researchers then read out the questionnaire items to participants and recorded their responses appropriately. At the end of the exercise, the researcher thanked the respondent then moved on to the next household. Due to time limitations and the nature of the study, interviewers were only able to visit each household once. Village elders assisted researchers in accessing households since they have local knowledge on location of various households within the study area. Each village elder introduced the researcher to the potential participant. He then waited outside the house until the researcher returned to him. The researcher divulged no information to the village elder about the choice of the individual to participate or not, nor any details of the discussions held.

Various approaches were used to ensure quality control of the data collection exercise. Firstly, field editing of questionnaires was conducted by the researcher to ensure that all errors were checked and corrected. Missing data were retrieved from the respondents through the use of contact details on the questionnaire. Secondly, the primary investigator observed data collection by research assistants in a few households at random to ensure adherence to the research procedure and protocol. To improve on the quality and validity of the collected data, the primary investigator made a few random calls to selected respondents to ensure that data collection actually took place and that research findings were genuine. On average, 10 respondents were called from each stratum.

3.10 Data analysis

Respondents' information was coded by the primary researcher into numerical responses to facilitate data entry and processing using the software SPSS v20 for Windows. Some closed ended questions had options for respondents to fill in the category classified as 'others' and specify what such options meant. This was an open

ended response which required open ended coding. Such responses were reviewed periodically to assess whether certain answers appeared with a high frequency to allow for generation of additional unique codes so as to distinguish them from the 'other' responses. A code sheet was prepared to explain how each variable was coded before being entered into SPSS (Appendix C).

A double entry method conducted in Microsoft Excel was used to ensure validity of the data. The double entry procedure was as follows:

-Two Excel datasheets were prepared, adjacent to each other. The sheets were blank with only data labels at the top of the columns.

-The principal investigator then entered data from the questionnaires in the first datasheet (sheet 1) followed by entry of the same data in the second datasheet (sheet 2) by a research assistant. Data in the two sheets was entered in the same order, based on household identification numbers.

-A third data sheet (sheet 3) was then opened. Value labels were copied from sheet 1 to sheet 3. A cursor was placed in the second row of sheet 3 (A2) followed by insertion of the following formula:
=IF(EXACT(SHEET1!A2,SHEET2!A2),0,SHEET1!A2&"/"&SHEET2!A2)

-The formula was then copied to all cells. Sheet3 therefore compared values entered in sheet1 to those in sheet2 and recorded the similarities and differences.

-Differences/errors were corrected by referring to the original questionnaire. After the double entry process was complete, data were imported from the Microsoft Excel data sheet into SPSS for analysis.

In SPSS, cleaning of the data was carried out to detect and correct errors that might have occurred during computerization of survey data. Range checking was conducted to ensure that only valid ranges of numbers were used in the coding of the survey data. This was achieved through computing and reviewing of frequency distributions of responses to survey questions. Any value outside the range was deemed an error and subsequently labelled as missing (9). Contingency checking was also conducted through checks of related questions to ensure consistency. For instance, if a number of questions were to be skipped due to a prior filter question, filling in of these questions was considered an error.

For cases involving missing data, group estimates such as mean for the whole sample or subgroup were used to assign numbers for the missing values. Deductive imputation was also carried out where other information in the questionnaire was used to guide in the recording of a missing response. An example of such imputation is filling in of missing information about sex, by looking at the name. For variables with over 25% missing data, the whole variable was ignored from analysis rather than imputation. For the questionnaires with incomplete information, the researcher made a follow-up by contacting the respondents physically or by telephone.

Initial assessment of data was done using descriptive statistics to profile the characteristics of the whole sample and subgroups. Adequacy of subgroups to conduct valid analysis, presence of outliers and normality of distribution were checked. Choice of the various descriptive statistics was based on the nature of the variables. Mean, median, range and standard deviation were used to describe continuous variables while frequencies and percentages were used for categorical variables. Extreme outliers and normality in distribution were identified through the use of histograms and box plots.

Aim 1: Assess the prevalence of complete immunization among children aged between 12 and 59 months in Kakamega central district, western Kenya.

The total number of fully immunized children aged between 12 and 59 years was divided by the total number of children interviewed. This was then adjusted based strata weights to estimate the district prevalence of complete immunization.

Aim 2: Determine the nature of association between maternal, paternal, child and household sociodemographic characteristics and immunization uptake.

Research question 1: Is there association between the age of the caregiver with immunization uptake?

An independent sample t-test and Chi square test of independence were used to determine whether the distribution in age of the caregiver was different between the two categories of immunization uptake.

Research question 2: Is there association between the age of the caregiver's partner with immunization uptake?

An independent sample t-test and Chi square test of independence were used to determine whether the distribution in age of the caregiver's partner was different between the two categories of immunization uptake.

Research question 3: Is there association between the caregiver's education level with immunization uptake?

A Chi square test of independence was used to determine the association between education level of the caregiver with immunization uptake

Research question 4: Is there association between the education level of the caregiver's partner with immunization uptake?

A Chi square test of independence was used to determine the association between education level of the caregiver's partner with immunization uptake.

Research question 5: Is there an association between maternal attendance of the ANC clinic and immunization of the child?

A Chi square test of independence was used to determine the association between maternal attendance of ANC clinics with immunization uptake. To understand this association further, a Mann-Whitney U Test was used to test the difference in the number of ANC visits attended by mothers of completely vaccinated children and partially vaccinated children

Research question 6: Is the child's sex associated with immunization uptake?

A Chi square test of independence was used to determine the difference in the number of children immunized with regard to sex.

Research question 7: Is the child's birth order associated with immunization uptake?

To test for association between the child's birth order and immunization uptake, an independent samples *t* test was used.

Research question 8: Is the place of delivery of the child associated with immunization uptake?

A Chi square test of independence was used to test for association between immunization uptake and place of delivery of the baby.

Research question 9: Is immunization uptake associated with the family's socioeconomic status?

A Mann-Whitney U test was used to determine the association between the family's socioeconomic status (as measured by the wealth index) and immunization uptake.

Multivariable analysis

Logistic regression was used to determine significant predictors of immunization uptake. It is an appropriate multivariable method because it attempts to adjust for the confounding effect of explanatory variables on each other thus establishing the independent association of each explanatory variable on the outcome variable. Logistic regression was important in estimating the probability that a child would be fully immunized (or not) given a set of explanatory variables for instance maternal age, education level and family socioeconomic status.

The logistic transformation (logit) was modelled as a linear function of independent variables as shown below

$$\text{Logit}(p) = 1n(p/(1-p)) = \alpha + \beta_1 X_1 + \ldots\ldots + \beta_k X_k$$

Where $\alpha, \beta_1 \ldots\ldots \beta_k$ = model coefficients

$X_1 \ldots\ldots \ldots X_k$ = explanatory variables

P = Probability of being fully immunized

3.11 Ethical and cultural considerations

Ethical approval for the study was sought and obtained from Auckland University of Technology Ethics Committee (AUTEC). Permission to proceed with the study was also obtained from the District Medical Officer of Health and the District Public Health Officer. The following ethical principles applied:

Informed consent: Participants were informed about the nature of the study and given a chance to withdraw from the study any time up to the start of data analysis. Both verbal and written consent were obtained voluntarily from the participants.

Confidentiality: Information from participants, including raw data, was locked up at AUT University in a locker for a maximum of 10 years. The principal investigator was

the sole custodian of participants' information and kept it confidential. Data files were stored under a password protected folder.

Risk minimization: Before the study, participants were informed about the nature of questions to be asked; some which may have been sensitive for instance pregnancy related information. Participants who felt they would become distressed by the study were allowed to choose not to participate, thereby preventing emotional discomfort.

Cultural considerations: The people of western Kenya value their cultural beliefs and practices. Participants were encouraged to point out any questions or behaviour that appeared to be culturally inappropriate and suggest ways of addressing these. Partnership, participation and protection guided the research process. This is explained below:

Partnership: Chiefs and village elders were consulted about the study since they represent the people.

Participation: Social mobilization was done before the study in churches, schools and markets with everyone being encouraged to participate in the study.

Protection: The local administration (chiefs), together with researchers ensured that participants were protected from physical or psychological harm.

3.12 Assumptions

The following assumptions were made in this study:

1. Childhood vaccination is an accepted Primary Health Care strategy by the Kenyan Ministry of Health.
2. Families desire to have healthy children.
3. Participants responded honestly to all research questions.
4. Immunization data, as recorded in the immunization cards and maternal child booklet was accurate.
5. Factors affecting immunization uptake remained relatively constant during the previous five years.

3.13 Delimitations and scope

Study delimitations were as follows:

1. The study was delimited to a quantitative, cross-sectional design.

2. Study participants were delimited to Kakamega Central district, Western Province in Kenya.
3. Study participants were delimited to those with a child aged between 12 and 59 months.
4. The study was delimited to the following variables: immunization status of the child, age and education level of the parents, the child's sex and birth order, maternal attendance of antenatal clinics and family's socioeconomic status.

3.14 Summary

A cross sectional study design was used to investigate the relationship between family sociodemographic factors and immunization uptake in children belonging to those families. A questionnaire was used to collect data on sociodemographic variables and immunization status. A sample of 520 children was identified using the inclusion criteria as specified in the study. Approval for the study was obtained from AUT university ethics committee and the District Medical Officer of Health, Kakamega Central district.

Descriptive statistics including frequency distributions and measures of central tendency were used to describe the sample. Association between maternal, paternal, child and household sociodemographic characteristics and immunization uptake were assessed by use of independent sample t-test, Mann-Whitney U test and the Chi square test of independence. The level of significance for this study was set at <0.05.

It is worth clarifying at this point that this study had initially targeted to interview 100 households as a pilot study with eight households being surveyed per stratum. This was due to uncertainty about the availability of enough respondents to participate in the interview. During data collection, it was noted that more households had caregivers who were willing to participate in the survey and that resources were available including time and funds. Consequently, caregivers from 577 households participated in the study. This probably adds more value to study findings due to increased sample size.

Chapter 4: Results

4.1 Introduction

This study aimed to assess the immunization status among children in Kakamega central and to explore the nature of associations between sociodemographic characteristics and immunization uptake. This chapter presents the study findings beginning with sample characteristics followed by a descriptive analysis of sociodemographic background variables. Immunization coverage for each vaccine-preventable disease within the study group is presented. Associations between explanatory and outcome variables were assessed by use of bivariable and multivariable methods. These are presented under each research question.

4.2 Data collection

Out of the 649 households visited, 28 were locked with no one at home. Researchers were able to talk to respondents from 621 households. After verifying the age of the children, 38 households were excluded from the study due to ineligibility (no children in the household, children too young or too old for the study). The researchers then administered a total of 583 questionnaires. None of the respondents declined to take the survey. Prior to entry into SPSS, six questionnaires were rejected due to recording errors (Figure 2). A total of 577 questionnaires were therefore included in data analysis, translating to a response rate of 90.6%. Table 2 shows the total number of respondents in each stratum under survey.

Figure 2: Survey response

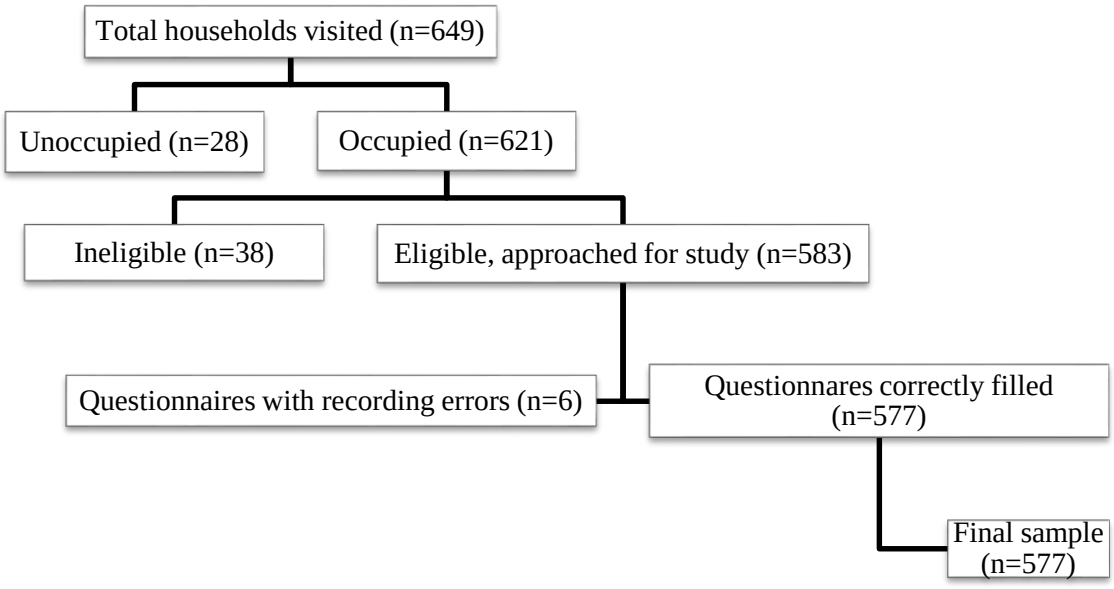


Table 2: Total number of respondents per stratum

No	Stratum	Location	Households interviewed	Percentage
1	Shirere	Urban	46	8.0
2	Mahiakalo	Urban	48	8.3
3	Township	Urban	39	6.8
4	Sichirayi	Urban	48	8.3
5	Eshisiru	Rural	48	8.3
6	Shibuli	Rural	38	6.6
7	Lurambi	Rural	45	7.8
8	Emukaya	Rural	33	5.7
9	Matioli	Rural	49	8.5
10	Murumba	Rural	48	8.3
11	Shirakalu	Rural	46	8.0
12	Indangalasia	Rural	44	7.6
13	Shiyunzu	Rural	45	7.8
	Total		577	100

4.3 Demographic characteristics of the study sample

4.3.1 Caregiver's relationship to the child

Of the caregivers interviewed, majority were mothers (94.8%) while the rest were fathers (2.3%) and other relatives (2.9%), (Table 3).

Table 3: Relationship of the respondent to the child (n=577)

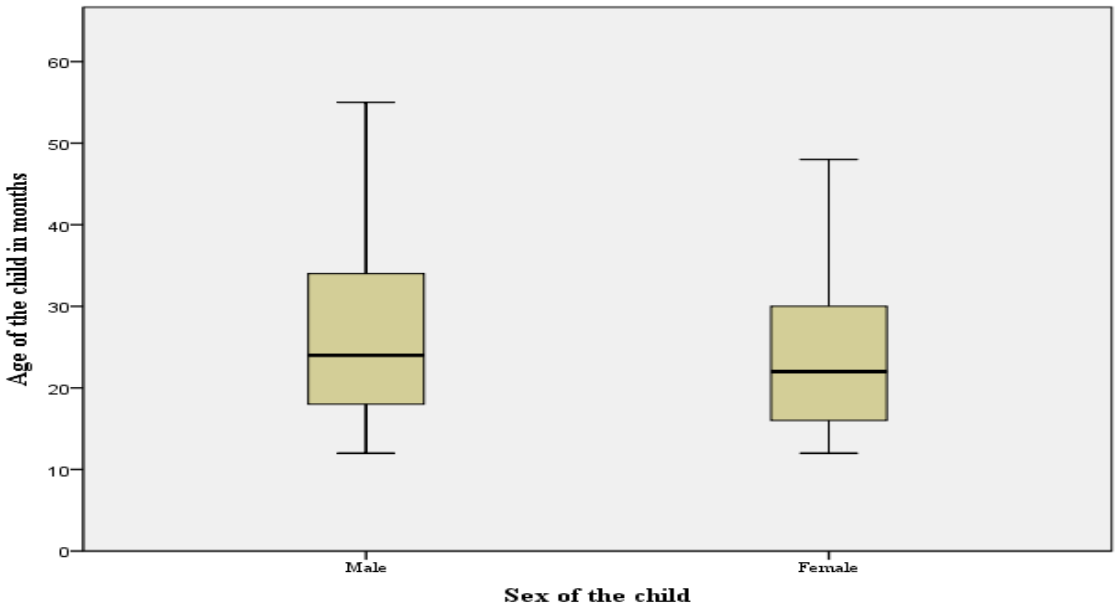
Caregiver	Frequency	Percent
Mother	547	94.8
Father	13	2.3
Other	17	2.9
Total	577	100

Note: Other includes grandmothers and aunts

4.3.2 Profile of the child

The age of the children whose caregivers were interviewed (N=577) ranged from 12 to 55 months (M=24.8, SD=9.6). Of these, 53.2% were male while 46.8% were female. Most of the children whose information was collected were aged below three years. Figure 3 is an illustration of age distribution by sex of the child.

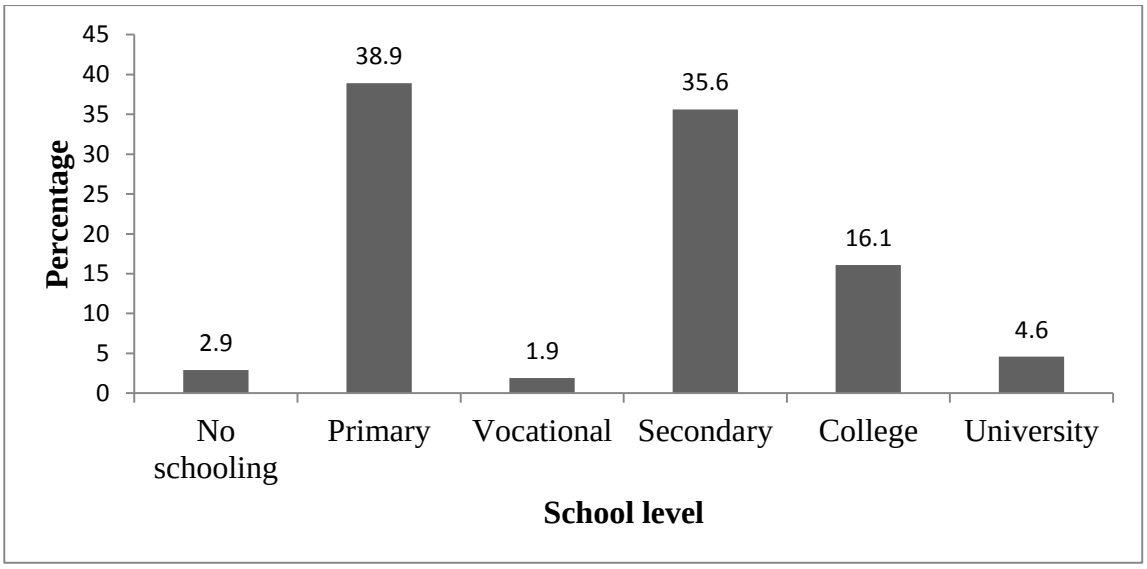
Figure 3: Age distribution of the children interviewed



4.3.3 Profile of the caregiver

Majority of the caregivers were married (83.7%) while the rest were either single (12.1%), divorced (2.1%) or widowed (2.1%). Regarding the age of the caregiver, most of them were fairly young (M=27.6 years, SD=6.9). The youngest age was 17 years while the oldest was 60 years. The elderly cohort of caregivers mainly consisted of grandmothers who were taking care of the children. Most of the caregivers (97.1%) had attended school up to some level while a few (2.9%) had never attended school (Figure 4). For those who had attended school, primary school was a common category.

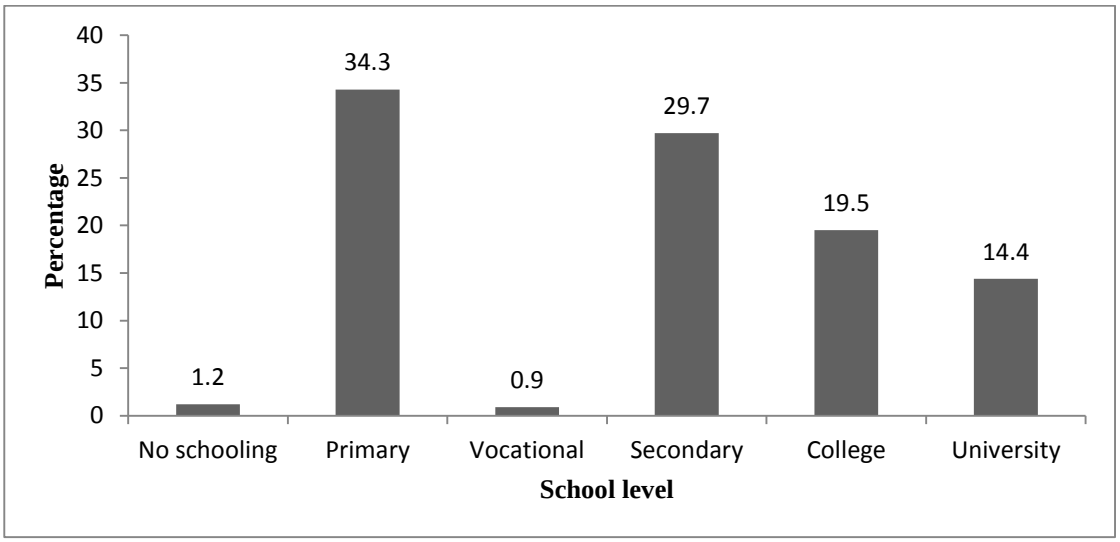
Figure 4: Caregiver's highest school level (n=577)



4.3.4 Profile of the caregiver's partner

99 (17.2%) respondents did not have a partner (single, divorced or widowed) while 478 (82.8%) did have a partner. For those caregivers with partners (n=478), the age of the partner ranged from 20 to 70 years (M=32.4, SD 7.6). Information on the education level of the partner was available from 569 respondents (478 of these had partners in the household while 91 respondents did not have partners but knew the partner's education level). Eight respondents did not know the education level of the partner. Majority of the partners attended school (98.8%), with the most common attendance being primary school (34.3%) and the least common vocational (0.9%), Figure 5.

Figure 5: Partner's highest school level (n=569)*



4.3.5 Distance to the nearest health facility

The distance from each household to the nearest health facility varied from one household to the other. More than half of the care givers (62.7%) resided less than five kilometres from the nearest health facility while the rest (37.3%) resided more than five kilometres away.

4.3.6 Antenatal clinic attendance

Most mothers attended antenatal care clinics (95.8%) while a few did not (4.2%). The number of antenatal care visits ranged from 0 to 10 (M=3.7, SD=1.4). Antenatal care providers included nurses (57.9%), doctors (33.6%), traditional birth attendants (4.2%) and community health workers (0.3%). Mothers residing less than 5km from the immunizing health facility attended more antenatal clinics than those residing more than

5km. Table 4 summarizes antenatal clinic attendance in relation to the distance to the nearest health facility.

Table 4: Number of ANC visits in relation to distance to the nearest health facility

Number of ANC visits	Distance to the nearest health facility		Total
	<5km	>5km	
0	12	1	24
1	17	5	22
2	40	3	43
3	77	24	101
4*	134	170	304
5	35	1	36
6	31	0	31
7	5	0	5
8	9	0	9
9	1	0	1
10	1	0	1
Total	362	215	577

*The Kenyan Ministry of Health recommends that each pregnant woman attends at least 4 antenatal visits.

4.3.7 Place of delivery

Health facilities were the most common places where mothers chose to deliver their children (65.3%). These included dispensaries, health centres, private clinics, nursing homes and hospitals. Home-based deliveries were also fairly common (31.5%) followed by delivery at the homes of traditional birth attendants (3.1%).

4.3.8 Number of children and birth order

Within the households that qualified for the study, the total number of living children ranged from a minimum of 1 to a maximum of 11 (M=2.73, SD=1.6). The birth order of each child interviewed followed a similar pattern from the first born to the 11th born. Table 5 summarizes the birth order by categories.

Table 5: Birth order of the child by categories

Birth order category	Frequency	Percentage
1-2	332	57.5
3-5	219	38.0
6-8	25	4.3
9+	1	0.2
Total	577	100

4.3.9 Socioeconomic status

Wealth indices were calculated for each household through the use of asset ownership and utilities within each household. Within the study area, wealth distribution, as measured by the wealth index, was positively skewed (Figure 6).

Figure 6: Wealth index distribution within the study population

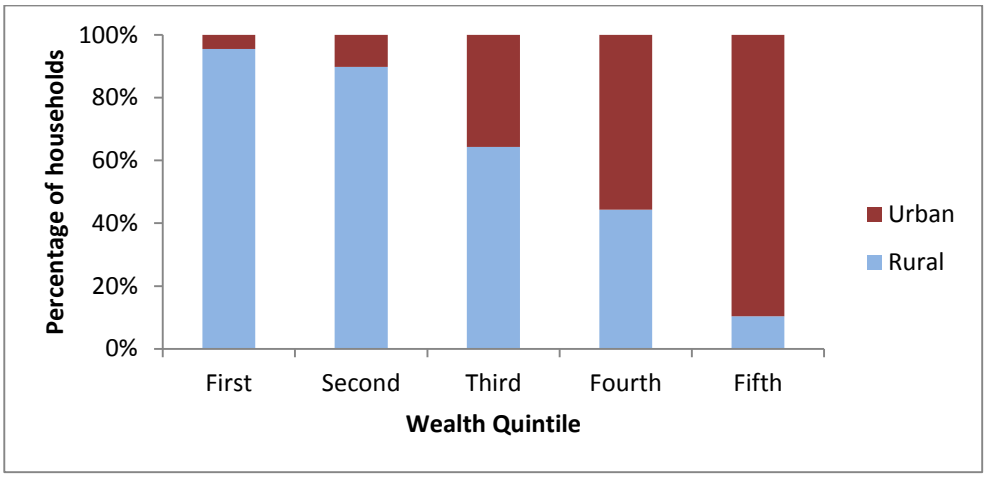
Utilities or assets which were fairly common (owned by almost all households) had low weights after principal component analysis (PCA). For instance, almost all households in the rural areas own houses in which they stay, land for agriculture and pit latrines. Rare assets such as ownership of a car and use of electricity had higher PCA weights. Table 6 highlights the mean and standard deviation of each asset indicator with the respective first component loading from principal component analysis. Assets and utilities are arranged according to how much weight they contributed to the wealth index, starting with the highest. The percentage of variance explained by the first component was 25.7%.

Socioeconomic status based on wealth indices was divided into quintiles. Wealth indices varied greatly from one household to the next and also varied according to the location of the household. Figure 7 compares the distribution of the wealth indices in urban and rural areas.

Table 6: Asset indicators

Asset/Utility	Mean	Std deviation	PCA Weight
Finished wall	0.35	0.476	0.864
Finished floor	0.41	0.492	0.852
Use electricity in the house	0.28	0.450	0.823
Piped water	0.26	0.437	0.780
Flush toilet	0.12	0.321	0.699
Own tv	0.42	0.494	0.612
Own fridge	0.07	0.254	0.489
Own clock	0.47	0.500	0.434
Finished roof	0.09	0.287	0.429
Domestic servant available	0.09	0.289	0.412
Own cell phone	0.78	0.415	0.253
Own car	0.03	0.164	0.252
No of sleeping rooms	1.85	0.891	0.175
Own radio	0.86	0.344	0.165
rain	0.02	0.149	0.116
Own motor cycle	0.12	0.325	-0.028
borehole	0.13	0.340	-0.052
well	0.05	0.215	-0.067
Rudimentary floor	0.04	0.192	-0.085
Natural wall	0.07	0.263	-0.147
Natural roof	0.06	0.236	-0.160
Rudimentary roof	0.85	0.356	-0.239
Own bicycle	0.32	0.465	-0.248
surface	0.18	0.388	-0.298
spring	0.41	0.491	-0.389
Own land for agriculture	0.60	0.489	-0.596
Pit latrine	0.91	0.292	-0.644
Own the house you stay in	0.61	0.488	-0.654
Rudimentary wall	0.57	0.495	-0.764
Natural floor	0.55	0.498	-0.810

Figure 7: Wealth quintile distribution



4.4 Immunization coverage in Kakamega Central

4.4.1 Immunization cards

Of the care givers interviewed, 75.7% had cards which were seen and verified by researchers, 23.6% had cards but were not able to show them to researchers (due to misplacement) while 0.7% did not have immunization cards.

4.4.2 Immunization status

To ensure accurate estimation of immunization coverage in Kakamega Central district, each sample proportion (with the respective 95% confidence intervals) was weighted (Table 7).

Table 7: Summary of the survey data per stratum*

Strata	Population distribution		Sample distribution		Survey results		Weights
	N	%	n	%	$\hat{p}_i$	*Var* ($\hat{p}_i$)	
Emukaya	1235	3.3	33	5.7	0.818	0.00465	0.57
Lurambi	1130	2.9	45	7.8	0.844	0.00299	0.38
Eshisiru	989	2.6	48	8.3	0.896	0.00198	0.32
Indangalasia	1566	4.2	44	7.6	0.432	0.00571	0.54
Shibuli	2417	6.4	38	6.6	0.868	0.00310	0.97
Shirakalu	1173	3.1	46	8.0	0.935	0.00135	0.39
Shiyunzu	1919	5.1	45	7.8	0.956	0.00096	0.65
Sichilayi	10475	27.8	48	8.3	0.771	0.00376	3.34
Shirere	7738	20.5	46	8.0	0.870	0.00251	2.58
Township	2691	7.2	39	6.8	0.846	0.00343	1.06
Matioli	1387	3.7	49	8.5	0.673	0.00458	0.43
Murumba	2104	5.6	48	8.3	0.646	0.00487	0.67
Mahiakalo	2865	7.6	48	8.3	0.896	0.00198	0.91
Total	37689	100	577	100			

*N and n refers to number of households from which respondents were picked

The sample weights, w_i were derived from the formula

$$w_i = \frac{\%\ \text{of population in stratum } i}{\%\ \text{of sample in stratum } i}$$

The estimated prevalence of fully immunized children in the district was 81.1% (95% CI 76.9%-85.3%). Each child had received at least one form of vaccine against the diseases in the Kenyan immunization schedule.

4.4.3 Coverage rates per vaccine

BCG vaccine: The total number of children who had received BCG vaccine at birth was 574. The weighted proportion for BCG coverage in the study area was 99.4%.

Polio vaccine: 573 children were able to receive the polio vaccine while one was not. Three mothers were not sure whether their children had received the polio vaccine. For children to be considered fully immunized against polio, they must receive four doses of the polio vaccine. Table 8 shows the number of polio doses administered.

Table 8: Number of times the polio vaccine was given*

Polio doses given	Number of children	Percentage
1	3	0.5
2	16	2.8
3	58	10.1
4	491	85.6
Total	568	100

*Missing values=9

Pentavalent vaccine: This vaccine is a combination of DPT, Hepatitis B and Haemophilus influenza vaccines. 570 (98.8%) children received the vaccine while five (0.8%) did not. Two mothers were not sure whether their children had received the pentavalent vaccine. Uptake of the vaccine doses is shown in table 9. Each child is expected to receive three doses.

Table 9: Number of times the pentavalent vaccine was given*

Pentavalent doses given	Number of children	Percentage
1	4	0.7
2	16	2.8
3	545	96.5
Total	565	100

*Missing values=12

Measles vaccine: An equivalent of the MMR vaccine, measles vaccine is usually the last to be administered, at the age of nine months. A total of 524 (90.8%) children received the vaccine while 49 (8.5%) did not. Four mothers were not sure of the child's measles vaccination status.

4.5 Addressing of the research questions

The total number of respondents considered for data analysis was 577. Sample weights (rounded off to two decimal places) were considered during data analysis. In some tables, the total number of valid cases might be different from 577 due to weighting and rounding off of the cell counts during Chi-square test calculation.

4.5.1 Research question 1: Is there association between the age of the caregiver with immunization uptake?

Immunization status for each age category is shown in table 10.

Table 10: Age of the caregiver and immunization status of the child

Age of the caregiver (yrs)	Immunization status		Total
	Fully Immunized	Not fully immunized	
<20	51	15	69
21-25	128	39	167
26-30	181	22	203
31-35	67	10	77
36+	37	25	62
Total	467	111	578

A Chi-square test for independence indicated that there is significant association between the caregiver's age and immunization uptake, X^2 (4, n = 578) = 31.04, p < .001. Caregivers aged between 21 and 30 years had more fully immunized children than the other age cohorts. An independent samples t-test was also conducted to compare the age of the caregivers for fully immunized and not fully immunized children. There was significant difference in age of the caregiver for fully immunized (M = 27.16, SD = 5.92) and not fully immunized (M = 28.57, SD = 8.67); t (575) =2.05, p = .04. Further analysis revealed that the relationship between the age of the caregiver and the probability of a child being fully immunized is curvilinear. Figure 8 shows the predicted probability of a child being fully immunized for any given age of the caregiver.

4.5.2 Research question 2: Is there association between the age of the caregiver's partner with immunization uptake?

A Chi-square test for independence indicated that there is significant association between the age of the caregiver's partner and immunization uptake, X^2 (4, n = 559) = 13.78, p = .008. Caregivers with partners aged between 26 and 35 years had more children fully immunized compared to the rest of the age categories. This relationship is shown in table 11. An independent samples t-test was also conducted to compare the age of the partner for fully immunized and not fully immunized children. There was significant difference in age of the partner for fully immunized (M = 31.93, SD = 6.69) and not fully immunized (M = 33.66, SD = 9.56); t (558) =2.2, p = .03.

Figure 8: Probability of a child being immunized for a given age of the caregiver

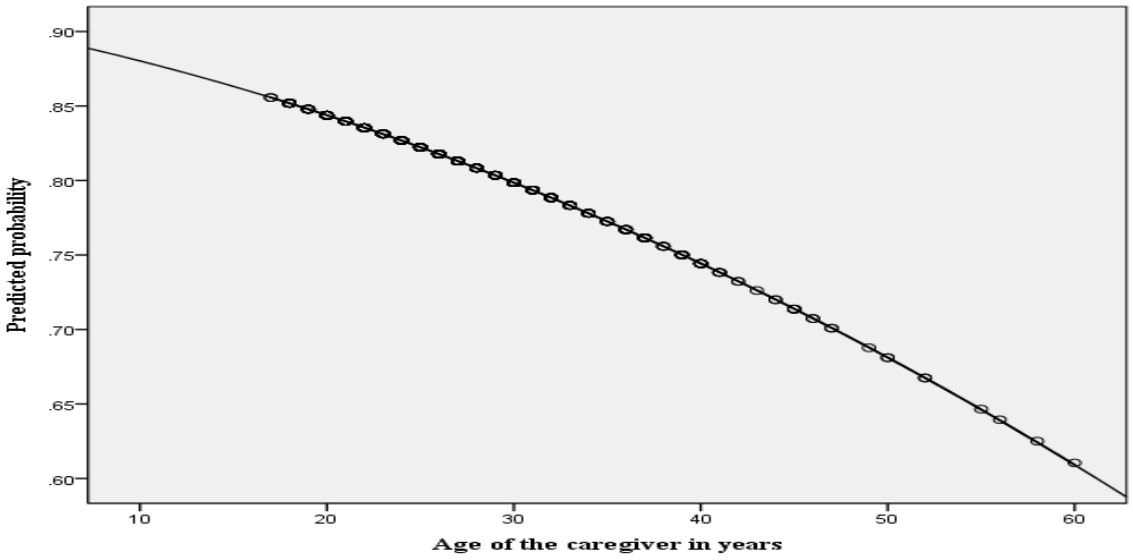


Table 11: Age of the caregiver's partner and immunization status of the child*

Age of the partner (yrs)	Immunization status		Total
	Fully Immunized	Not fully immunized	
<25	70	14	84
26-30	159	43	202
31-35	119	18	137
36-40	60	10	70
41+	44	22	66
Total	452	107	559

*Missing values = 18

4.5.3 Research question 3: Is there association between the caregiver's education level with immunization uptake?

Immunization uptake for each category of the caregiver's education level is shown in table 12. Three school levels had low values for both fully and not fully immunized children. These included No formal education, Vocational and University sub-groups. To avoid violation of statistical test assumption, the caregiver's highest school level was re-categorised into a 2X2 table as shown in table 13.

Table 12: Immunization uptake by caregivers' highest school level

Caregiver's highest school level	Immunization status		Total
	Fully Immunized	Not fully immunized	
No formal education	13	8	21
Primary	221	70	291
Vocational	5	5	10
Secondary	152	25	177
College	56	5	61
University	16	1	17
Total	463	114	577

Table 13: Association between caregivers' school attendance and immunization uptake

Caregiver's highest school level	Immunization status		Total
	Fully Immunized	Not fully immunized	
<Secondary	176	76	252
>=Secondary	290	34	324
Total	466	110	576

A Chi-square test for independence, after correcting for continuity, indicated that there is significant association between the caregiver's highest education level and immunization uptake, X^2 (1, n = 556) = 35.48, p < .001.

4.5.4 Research question 4: Is there association between the education level of the caregiver's partner with immunization uptake?

Table 14 illustrates immunization uptake for each education level of the caregiver's partner. This is further re-categorised for ease of data analysis as shown in table 15.

Table 14: Immunization uptake by highest school level of the caregiver's partner*

Partner's highest school level	Immunization status		Total
	Fully Immunized	Not fully immunized	
No formal education	13	8	21
Primary	221	70	291
Vocational	5	5	10
Secondary	152	25	177
College	56	5	61
University	16	1	17
Total	454	112	566

*Missing values = 11

Table 15: Association between partners' school attendance and immunization uptake

Partner's highest school level	Immunization status		Total
	Fully Immunized	Not fully immunized	
<Secondary	160	47	207
>=Secondary	300	62	362
Total	460	109	569

Partners educated beyond secondary school (65.2%) had more fully immunized children compared to those with an education level below secondary school. Despite this, a Chi-square test for independence indicated that there is no significant association between the education level of the care giver's partner and immunization uptake, X^2 (1, n = 569) = 2.65, p = .104.

4.5.5 Research question 5: Is there an association between maternal attendance of the ANC clinic and immunization of the child?

Mothers who ever attended ANC clinics had more children immunized than those who did not. This is shown in table 16.

Table 16: Ever attended ANC clinic and immunization uptake

Ever attended an ANC clinic	Immunization status		Total
	Fully Immunized	Not fully immunized	
Yes	459	98	557
No	8	12	20
Total	467	110	577

A Chi-square test for independence indicated significant association between ever attending an ANC clinic and immunization uptake, X^2 (1, n = 577) = 22.5, p < .001.

Regarding the number of ANC clinics attended, mothers of fully immunized children had more ANC clinic attendance than mothers of those children who were not fully immunized (table 17). A Mann-Whitney U Test revealed significant difference in the median number of ANC visits attended by mothers of fully immunized children (*Md* = 4, *n* =463) and not fully immunized children (*Md* = 3, *n* = 114), *U* = 19516, *z* = –4.684, *p* < .001, *r*=.20.

4.5.6 Research question 6: Is the child's sex associated with immunization uptake?

The relationship between the sex of the baby and immunization uptake is shown in table 18. Despite more boys being fully immunized than girls, a Chi-square test for independence indicated that there is no significant association between the sex of the child and immunization uptake, X^2 (1, *n* = 557) = .11, *p* = .739

Table 17: Number of ANC visits for each immunization category

Number of ANC visits	Immunization status		Total
	Fully Immunized	Not fully immunized	
0	13	11	24
1	13	9	22
2	28	15	43
3	74	27	101
4	267	37	304
5	30	6	36
6	25	6	31
7	4	1	5
8	7	2	9
9	1	0	1
10	1	0	1
Total	463	114	577

Table 18: Immunization status by sex of the baby

Sex of the baby	Immunization status		Total
	Fully Immunized	Not fully immunized	
Male	238	58	296
Female	229	52	281
Total	467	110	577

4.5.7 Research question 7: Is the child's birth order associated with immunization uptake?

Figure 9 is a scatter plot showing immunization status for each birth order category. It can be seen that less children are fully immunized as birth order increases. A Chi square test was conducted to test for association between birth order and immunization status of the children (Table 19). The test revealed significant association, X^2 (2, n = 578) = 17.98, p < .001.

4.5.8 Research question 8: Is the place of delivery of the child associated with immunization uptake?

Within the category of mothers of fully immunized children, 69.3% of the mothers delivered from a health facility compared to 49% for mothers of children not fully immunized (Table 20). A Chi-square test for independence indicated that there is significant association between the place of delivery of the child and immunization uptake, X^2 (1, n = 557) = 41.5, p < .001.

Figure 9: Probability of being fully immunized by birth order

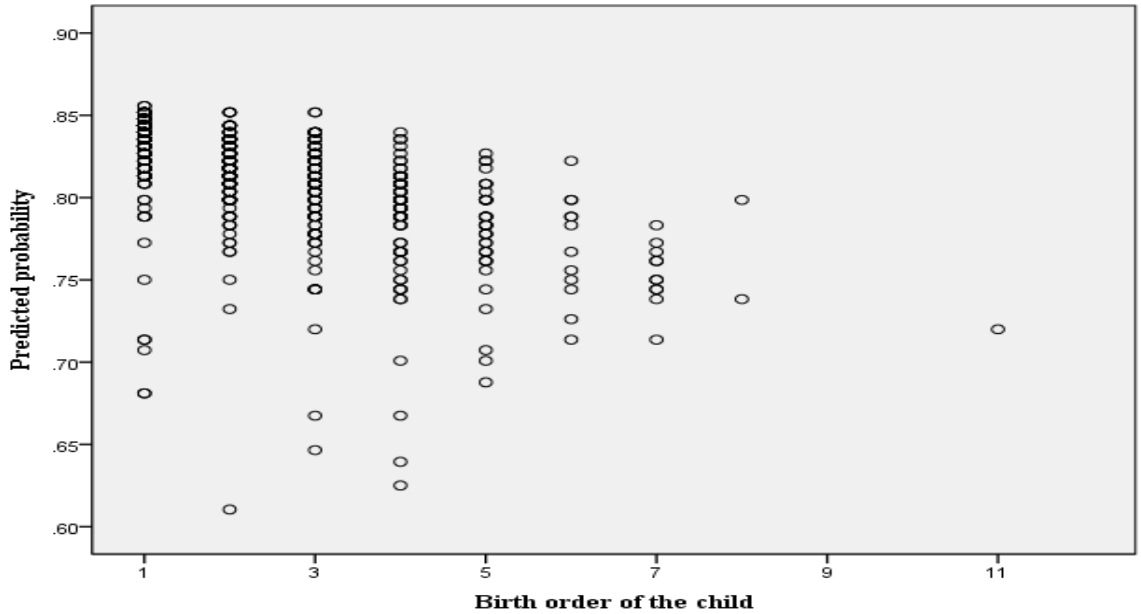


Table 19: Birth order and immunization uptake

Birth order	Immunization status		Total
	Fully Immunized	Not fully immunized	
<3	293	62	355
3-5	158	34	192
6+	16	15	31
Total	467	111	578

Table 20: Place of delivery and immunization status

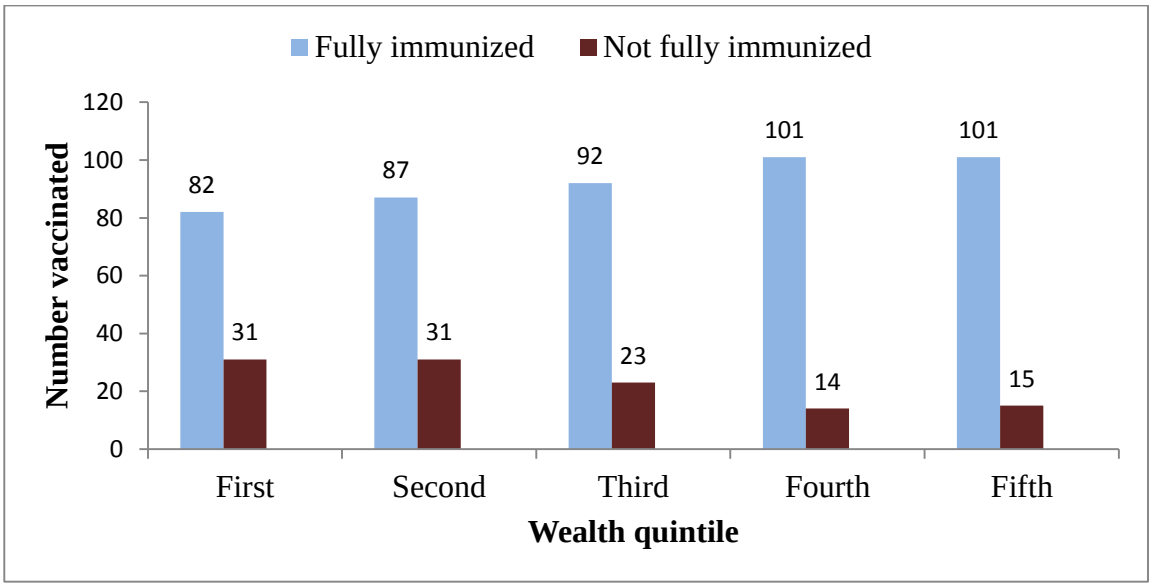
Place of delivery	Immunization status		Total
	Fully Immunized	Not fully immunized	
Home*	142	58	200
Health facility	321	56	377
Total	463	104	577

* Includes mothers who delivered from the homes of traditional birth attendants (TBAs).

4.5.9 Research question 9: Is immunization uptake associated with the family's socioeconomic status?

A Mann-Whitney U Test revealed significant difference in the wealth index scores for care givers of fully immunized children (*Md* = -3.112, *n* =463) and not fully immunized children (*Md* = -4.956, *n* = 114), *U* = 20273, *z* = –3.837, *p* < .001. Care givers with a high socioeconomic status were more likely to have their children immunized than those with a lower socioeconomic status. The association between socioeconomic status (based on the wealth index) and immunization uptake is shown in figure 7.

Figure 10: Immunization uptake by wealth quintiles.



4.6 Logistic regression

Complex samples logistic regression was performed to assess the impact of sociodemographic factors on the likelihood that children would be fully immunized. The choice to use complex samples analysis was informed by the sampling process

(stratified sampling followed by simple random sampling). Prior to interpretation of regression coefficients, the model was tested to determine its fitness. The Hosmer-Lemeshow Goodness of Fit Test indicated that the logistic regression model was fit to test the association between sociodemographic variables and immunization uptake.

After backward stepwise elimination, the final model contained four explanatory variables, all of which were statistically significant. These included education level of the caregiver, education level of the partner, antenatal visit attendance and place of delivery of the baby. The model as a whole explained between 13.4% (Cox and Snell R squared) and 21.5% (Nagelkerke R squared) of the variance in vaccination status, and correctly classified 83.5% of cases. As shown in Table 23, the strongest predictor of immunisation of the child was the education level of the caregiver with an adjusted odds ratio of 0.25. This indicated that less educated caregivers were less likely to have their children completely immunized compared to those with a higher education level (secondary school and above), controlling for other factors in the model.

Table 23: Multivariable analysis of determinants of complete immunization

Variable	AOR	95% CI
Caregiver's highest school level		
<Secondary	0.25**	(0.12, 0.52)
>=Secondary	1	
Partner's highest school level		
<Secondary	1	
>=Secondary	2.18*	(1.12, 4.25)
Ever attended ANC visit		
Yes	3.36*	(1.25, 9.06)
No	1	
Place of delivery		
Home	0.4**	(0.21, 0.73)
Health facility	1	

** $p < 0.005$, * $p < 0.05$

4.7 Summary

This chapter outlined the analysis of data collected from 577 respondents. The first section of the chapter described the data. This was followed by estimation of the proportion of immunization coverage for individual vaccines and completeness of immunization. Immunization coverage rates for each vaccine varied widely.

At bivariable levels, a number of sociodemographic factors were associated with immunization uptake. A higher wealth quintile, caregiver's education level and partner's education level were associated with increased immunization. Similarly,

delivery at the hospital, a higher birth order and increased attendance of antenatal clinics were associated with increased likelihood of immunization.

At multivariable levels, immunization uptake was predicted by the place of delivery of the child, number of antenatal care visits, caregiver's education level and partner's education level.

Chapter 5: Discussion

5.1 Introduction

Routine screening of immunization coverage rates is important in public health as it informs stakeholders on whether trends in uptake are improving, declining or stable. Based on the evaluation findings, stakeholders and policy makers can develop strategies designed to accelerate or maintain immunization uptake and ensure that enough children are protected against vaccine-preventable diseases to maintain herd immunity. This study assessed immunization coverage rates within a sample of children aged below five years in Kakamega Central district, Western Kenya. Sociodemographic factors affecting immunization uptake were also evaluated. The aim of this chapter is to interpret findings from the previous chapter (chapter 4). Immunization coverage rates will be discussed followed by the effect of sociodemographic factors on immunization uptake and how these make sense in the context of public health theory. Implication for policy and practice and recommendation for further research will also be discussed. The chapter closes with conclusions from the study.

5.2 Methodology

This study made use of a cross sectional stratified survey to assess factors associated with immunization of children against vaccine preventable diseases. Kakamega Central district is one of the regions with low immunisation coverage in Kenya. The district consists of households located in both rural and urban centres with a population characterised by variations in sociodemographic characteristics such as age, education levels, socioeconomic status and access to healthcare services. The district was thus an ideal sampling frame from which participants were selected to address the research questions.

The aim of this study was to describe sociodemographic factors associated with immunization uptake in children aged between 12 and 59 months in Kakamega central district, Western Kenya. Eleven factors thought to impact on immunization uptake were considered. These were maternal/care giver's characteristics (age at delivery of the child of interest, education level, antenatal visits and place of delivery), characteristics of the partner (age and education level), characteristics of the child to be immunized (birth order and gender) and household characteristics (socioeconomic status, total number of living children within the household and distance between the household and the nearest

health facility). The study sample included respondents from 577 households drawn from 13 strata within the district.

Cross sectional studies, like any other observational studies, are prone to bias and confounding. Potential sources of bias to this study included selection bias and measurement bias (maternal/care giver recall of immunization history). While some degree of bias is always present in any study (Webb & Bain, 2010), efforts were made to minimize bias within this study. For instance, the study area was divided into 13 strata from which households were randomly drawn for the study. This ensured that each household had an equal probability of being included in the study, minimizing on selection bias. To minimize measurement bias, an adequate sample size of 577 was considered for the study with a similar questionnaire being used in all households. Prior to data collection, interviewers were trained on how to use the questionnaire to collect relevant information. Weighting of study findings and use of complex samples analysis plan in SPSS also increased accuracy and generalisability of results. Potential sources of confounding in the study were minimized through the use of logistic regression in data analysis. By eliminating the confounding effect of explanatory variables on each other, logistic regression establishes the independent association of each explanatory variable on the outcome variable.

5.3 Interpretation of the outcome variable

5.3.1 Immunization coverage rates for Kakamega Central district.

Coverage rates for fully immunized children within the study population varied from previous estimates in Kenya. The latest World Health Organization estimate for immunization coverage in Kenya for the year 2012 is 83% (WHO, 2013). This figure is quite similar to what was found in the study sample (81.1%, CI 76.9%-85.3%). However, immunization coverage for Kakamega Central was slightly higher than what had been reported in a previous survey for the same region (73.1%) (KNBS & ICF Macro, 2010).

Regarding individual vaccines, coverage for BCG (99.4%), DPT 3 (96.0%) and OPV 3 (85.3%) vaccines was higher in the study sample than the national coverage rates (84%, 83% and 82% respectively). The percentage of children immunized against measles was similar between the study area (92.4%) and the national level (93%) (WHO, 2013). In as much as coverage rates within the study population are promising, these figures are still lower than the estimates for neighbouring developing countries (Save The Children,

2012). Approximately, of the 30,458 children in the district aged below five years, the number of those not fully immunized ranges from 4,478 to 7,036 children.

Immunization uptake revealed missed opportunities especially for vaccines administered concurrently. For instance, there was a discrepancy between the third polio dose (OPV 3) and the third dose of diphtheria, pertussis and tetanus vaccine (DPT 3). These vaccines are administered together and could be expected to have similar coverage rates. The difference in uptake between the two vaccines could be due to stock outs of either vaccine leading to less availability. In addition, some health care workers may be unwilling to open new vaccine vials for fear of wastage, especially if the children to be vaccinated are few (Torun & Bakırcı, 2006).

5.3.2 Possible explanations for differences in immunization between this study and other coverage estimates

Differences in immunization between the study group and the national coverage rates could have been due to several factors. Firstly, this could be due to missing or incomplete information on babies' immunization dates. Delayed or incomplete reporting in particular regions or districts within the country will impact on national coverage estimates. Secondly, movement of population into and out of various regions in the country (internal migration) is likely to result in changes in coverage rates. Thirdly, the distance between vaccine storage units and immunizing centres varies all over the country. This can lead to delayed delivery of vaccines to centres located far away. Finally, variation in immunisation coverage from other studies could be due to differences in study design, sample sizes and the timing of the studies. For instance, one strength of the research presented here is that it describes results from an active surveillance study. Estimates by the World Health Organization is based on passive surveillance conducted through routine reporting by districts. Nonetheless, determining the reasons why immunization rates within the study sample were different from the rest of the country is a complicated task that would require more than one study to explain the differences.

5.4 Interpretation of explanatory variables

Nine explanatory variables were assessed for association with immunization uptake. These included age of the care giver, age of the partner, care giver's highest school level, partner's highest school level, maternal attendance of antenatal care clinics, sex of the baby, birth order of the baby, place of delivery and socioeconomic status of the

family. All these were significantly associated with immunization uptake at bivariable levels except sex of the baby and partner's highest school level. The possible reasons for association between each explanatory variable with immunization uptake are discussed in detail below.

5.4.1 Age of the caregiver

Caregivers aged between 21 and 30 years were more likely to have their children fully immunized than other age groups. The association between the age of the caregiver and probability of completing immunization appears to be curvilinear, with teenage and older care givers being less likely to have fully immunized children. Previous studies in Kenya have also shown that the care givers' age has a significant impact on the immunization of their children. In a study by Kamau and Esamai (2001), mothers, aged between 25-29 years, were more likely to have their children completely immunized. A similar study conducted elsewhere within an urban area in Kenya found that mothers aged between 25-29 years have higher odds of having their children immunized compared to the rest of the age cohorts (Mutua, Kimani-Murage, & Ettarh, 2011). This is consistent with studies conducted elsewhere globally (Babalola, 2011; Fatiregun & Okoro, 2012; Salmon et al., 2009).

A possible explanation for caregivers aged between 21-30 years having completely immunized children could be due to the fact that such caregivers have fewer children and can focus on ensuring that their children stay healthy. Older caregivers may give less priority to immunization due to a large family size and competing needs within the family. Teenage caregivers (aged below 20 years) may not have gained adequate knowledge and experience on motherhood and may not understand the importance of immunization hence less likely to have their children completely immunized.

5.4.2 Age of the partner

The age of the partner was significantly associated with immunization uptake. Partners aged between 26 and 35 years had more fully immunized children. This is similar to previous research where age of the father has been reported to have significant impact on immunization of the child (Sullivan, Tegegn, Tessema, Galea, & Hadley, 2010). On average, as parents grow older, their households are likely to have fewer young children. This could explain why fewer fully immunized children were found within households belonging to elderly care givers and partners.

5.4.3 Education level of the caregiver

Education level of the caregiver was found to be associated with immunization uptake. Caregivers educated beyond secondary school were more likely to have their children fully immunized compared to those with pre-secondary education level. These findings are similar to prior studies conducted in Kenya (Abuya, Onsomu, Kimani, & Moore, 2011; Kamau & Esamai, 2001; Mutua et al., 2011) and elsewhere (Desai & Alva, 1998; Streatfield, Singarimbun, & Diamond, 1990). Higher education level of the caregivers, especially mothers may be important in increasing awareness of the importance of immunizations. Such mothers are therefore likely to become autonomous and develop demand for immunization services (Bbaale, 2013). Educated caregivers have an opportunity to access information on the importance of immunization from the media, education workshops and other forums.

Despite maternal education being associated with immunization of the child, causal pathways for this relationship are not clear. Vikram, Vanneman and Desai (2012) propose four pathways through which maternal education can influence immunization of the child. In the first pathway, termed the human capital advantage, educated mothers have more knowledge on good medical practices (perhaps through courses undertaken within learning institutions) and are thus aware of the benefits of medical care. They are therefore likely to take children for immunization. The second pathways is social capital, wherein education exposes mothers to many contacts (friends and professionals), who are aware of the benefits of immunization. By interacting with these contacts, mothers become influenced to take their children for immunization. Thirdly, educating mothers raises their social status, confidence and self-esteem. This eases their interaction with other persons of higher social status such as healthcare workers. This is termed the cultural capital pathway. In the empowerment pathway, educating women empowers them to be more active and assertive within their households and the public arena. Such women are more likely to advocate for better healthcare for their children. Regardless, these pathways are not exhaustive in explaining why maternal education is associated with immunization of the child. It is possible that more reasons exist and these are context specific, for instance differences in access to healthcare and the influence of factors such as religion, traditional beliefs and politics.

5.4.4 Education level of the partner

In this study, the education level of the partner was not found to be associated with immunization. This is contrary to other studies which have reported that educated

partners are likely to have their children fully immunized, even if the mothers are not educated (Phimmasane, Douangmala, Koffi, Reinharz, & Buisson, 2010; Phukan, Barman, & Mahanta, 2009). In Uganda, a qualitative study on barriers to immunization found that fathers have a bigger role in decision making regarding immunization as they influence their partners' decision making (Babirye et al., 2011). The role of the father in immunization of their children cannot be overlooked. An educated father is as important in decision making regarding choice of health care as the mother. The finding that education level of the partner was not associated with immunization of the child could be an isolated finding. This calls for further research into this area to fully understand this association.

5.4.5 Antenatal care clinic attendance

Mothers who attended antenatal care clinics were more likely to have their children completely vaccinated than those who did not. The more times they attended the clinic, the higher the likelihood that their children could be immunized. Previous studies have shown than maternal attendance of antenatal care clinics is a significant predictor of immunization (Bbaale, 2013; Bondy, Thind, Koval, & Speechley, 2009; Etana & Deressa, 2012). In 1987, the World Bank, WHO and UNFPA spearheaded the launch of the Safe Motherhood Initiative (The World Bank, 2012). One of the pillars of this initiative is focused antenatal care, an initiative that envisages 100% attendance of antenatal clinics by all pregnant mothers.

The Kenyan government recommends that pregnant mothers attend at least four ANC visits. During such visits, mothers undergo a number of teaching sessions where they are taught about peri-partum care and the importance of immunization to their children. ANC clinics create a platform where mothers and healthcare providers interact at a personal level. During these interactions, mothers are likely to gain confidence and trust in health workers due to the established rapport, leading to a strengthened provider-women relationship (Rowe & Calnan, 2006). Such mothers are more likely to take their children for vaccination than those who never attended ANC classes.

5.4.6 Sex of the baby

There was no difference in immunization uptake between male and female children. This is similar to prior studies in Kenya where sex of the child was not associated with immunization uptake (KNBS & ICF Macro, 2010; Mutua et al., 2011; Owino, Irimu, Olenja, & Meme, 2009). Studies investigating inequality in access to immunization by

sex of children have yielded inconsistent findings in different countries. In rural India and rural Bangladesh, male children have been reported to be immunized more than female children (Pande, 2003; Rahman & Obaida-Nasrin, 2010). Conversely, studies in Nigeria and Ireland found that female children have a higher likelihood of being immunized (Antai, 2012; Jessop et al., 2010).

The reason for equal access to immunization between boys and girls in Kenya could be due to gender mainstreaming programs by the Kenyan government. Due to such programs, both boys and girls may have equal chances of accessing healthcare services, including immunization. However, of note is that most of the reasons forwarded by researchers for difference in immunization uptake based on the sex of the child are quite speculative. To date, no clear literature exists to explain the relationship between immunization uptake and sex of the child. There is a need for qualitative studies to be conducted to gain an in-depth understanding of this relationship.

5.4.7 Birth order of the baby

The child's birth order was associated with immunization uptake. Children from the highest birth order (first, second and third born) were more likely to be fully immunized than those from the lower birth order (6^{th} born and above). The average number of children per household in Kenya is 4.8 (KNBS, 2009). Some families may have as many as 10 children, as was evident from the study. When a mother gives birth to the first born there is excitement in the family and both parents usually want the child to survive. They will therefore strive to ensure that the child is healthy and accesses health services, including immunization. As the mother gets more children, the excitement wanes and these are less likely to be vaccinated.

The research finding that higher birth order is associated with full immunization is consistent with previous studies (Antai, 2009; Bondy et al., 2009; Owino et al., 2009). It is also possible that the experience during the immunization of the first child affects the decision to take the rest of the children for immunization. For instance experiences such as condescending comments from health workers and adverse reactions from administered vaccines are likely to discourage the mother from taking the other children for immunization.

5.4.8 Place of delivery of the child

There was significant association between the place of delivery of the child and immunization uptake. Children born in a health facility (private clinic, dispensary,

health centre and hospital) were more likely to be fully immunized than those born at home. This has also been reported in other studies (Chhabra, Nair, Gupta, Sandhir, & Kannan, 2007; Maina, Karanja, & Kombich, 2013; Phukan et al., 2009). When mothers deliver from health facilities, they undergo health education about the care of their children. Before such mothers are discharged from the hospital, their children are given two vaccines; polio birth dose and BCG. The mothers are then advised on when to come back for the next set of vaccines. Those who deliver from home often do not have these services availed to them and they may not be adequately informed about the same. Children born from home therefore only access the first set of vaccines on first contact with the health care provider, usually when they are being brought to hospital for other reasons such as sickness. In Kenya, home-based vaccination programs are not in place for routine immunization. Children are only vaccinated from home during campaigns to control outbreaks such as measles and polio.

5.4.9 Socioeconomic status of the family

The finding that socioeconomic status was associated with immunization uptake has been reported in several studies (Hu, Chen, Li, Chen, & Qi, 2011; KNBS & ICF Macro, 2010; van Lier, van de Kassteele, de Hoogh, Drijfhout, & de Melker, 2013). Households with a higher socioeconomic status (third, fourth and fifth quintile) were more likely to have their children fully immunized than those within the first and second quintile. Despite this finding, the exact mechanism by which socioeconomic status of a family affects health is unclear.

Socioeconomic status is a widely researched construct within social sciences such as anthropology and psychology. What socioeconomic status represents in the field of public health is a hotly contested discourse. This is evidenced by the wide array of literature that exists linking socioeconomic status to various health outcomes. It is not clear why families with low socioeconomic status were less likely to have their children fully immunized. Invoking theoretical frameworks in social epidemiology (psychosocial and social production theories) might help in elucidating pathways between socioeconomic status and immunization uptake.

According to the psychosocial theory (Krieger 2001), psychosocial variables play a big role in health disparities linked to socioeconomic status. Both low and high socioeconomic status families are likely to experience some form of stress. Potential sources of stress include social hierarchies, family disharmony, and rapid change in

social status, among others. The way each family copes with stress in turn impact on the health outcomes of the children. Low socioeconomic status families are more likely to experience stress due to uncontrollable events such as environmental hazards, violence, family dissolution and household moves (Bradley & Corwyn, 2002). Coping with these events reduces the likelihood of a family engaging in health promotion activities such as immunization of their children. Failure to cope with stressors might predispose care givers to unhealthy behaviour. Families with low socioeconomic status are more likely to engage in unhealthy lifestyle such as tobacco use, alcoholism and consumption of unhealthy food (Baum, Garofalo, & Yali, 1999). This affects both the physical and mental well-being of care takers and their partners leading to a negative effect on the health of their children. A mother, who is addicted to drugs, for instance will not see the need for taking her child for immunization but will rather focus all her energy on acquiring the drug.

The social production theory focuses on proximal determinants of health. Existing political and economic institutions create and maintain inequalities within the society. Consequently, existing conditions favour highly placed individuals within the social ladder (Krieger 2001). Families with low socioeconomic status have less access to resources which could enable them to live well and access medical care. For instance, care givers from such families may lack fare to take their children to health centres for immunization. This is not made any easier by competing needs within the household such as access to food, shelter, clothing and education. Care givers would rather spend the little cash they have to buy food instead of travelling over long distances to have their children immunized.

The two theories are not exhaustive and conclusive. It is almost impossible to determine the precise process through which socioeconomic status affect immunization in children due to a number of challenges. Firstly, low socioeconomic status occurs concurrently with other conditions which may act as mediators or confounders. Such mediators include belonging to a minority group (race, profession), single parenthood, disability and medical conditions (Bradley & Corwyn, 2002). Secondly, there is wide intra-class variability in what children experience within each socioeconomic status group. It is difficult therefore, to generalize lived experiences in individuals within each group without committing an ecological fallacy. Thirdly, measures of socioeconomic status vary by country and culture globally. What appears to be low socioeconomic status in one country or context might be high socioeconomic status in another.

Interaction between socioeconomic status and immunization in children is a complex phenomenon. This is because socioeconomic status acts on health indirectly (Angell, 1993). In this study, a web of interaction exists between socioeconomic status and other explanatory variables such as education level of the caregiver and partner, antenatal clinic attendance and the place of delivery of the child. It is therefore not clear whether improving socioeconomic status in isolation leads to increased immunization in children. Further research might help explicate the causal pathways affecting this relationship, leading to a better understanding.

5.5 Interpretation of the logistic regression model

Despite several predictor variables being significant at bivariable levels, only four predicted the likelihood of immunization in the logistic regression model. These included education level of the caregiver, education level of the partner, antenatal clinic attendance and place of delivery of the baby. Logistic regression eliminated the confounding effect of explanatory variables on each other resulting in less variables being significant at the multivariable level.

5.6 Strengths and limitations of the study

This survey was an active surveillance study as opposed to routine data collection on immunization. Errors such as delayed reporting and inflated values on immunization coverage were not present. The sample size was adequate indicating that study findings were close to population estimates. Efforts to minimize bias were put in place during sampling, data collection and data analysis. The study also controlled for confounding through the use of logistic regression in data analysis. The other strength of the study is that results are line with other studies conducted in Kenya and other countries. Sociodemographic factors under study made a significant contribution to immunization uptake.

This study had a number of limitations. Firstly, the design was cross sectional and thus could only show association and not causation. Secondly, there was a possibility of recall bias especially for those respondents without immunization cards, who had to rely on memory. Thirdly, broader determinants of immunization uptake such as politics, health policy and socio-cultural values were not assessed. Due to delimitation of the survey to Kakamega Central district, it may not be possible to generalize study findings to the rest of the country. One interesting observation from the study is that in as much as nine factors were significantly associated with immunization at bivariable levels,

only four factors contributed significantly to the final logistic model. The finding that most predictor factors were significant at bivariable levels could be due to multiplicity, leading to type 1 error. Multiplicity occurs when multiple pair wise tests are performed on a single set of data (in this case Chi square tests) increasing the chance of obtaining false positive results. A possible solution for future studies is to consider Bonferroni correction while analysing such data.

5.7 Implications for practice and policy

In this study, immunization uptake was generally good. However uptake of some vaccines was better than others. Factors associated with immunization uptake among children within the study area were identified. The main consumers of study findings include caregivers and their partners, healthcare workers, non-governmental organizations and the government of Kenya. Study findings highlight the importance of demand creation for immunization services through health education during immunization, outreach sessions and through the media. This would in turn improve the knowledge, attitude and practice of all the stakeholders hence increase immunization uptake (Campbell, 2006). Such education could be conducted in churches, markets, village public meetings and other places of social gathering. Community health workers are better placed to conduct health education in such places as they interact with parents daily and so parents will feel comfortable to discuss any challenges with them. Apart from educating mothers on the importance of immunization, community health workers need to talk to teenagers on the need to avoid early pregnancy and child birth. The teenagers would be encouraged to concentrate on education and career progression until such a time when they have enough resources to start families. Non-governmental organizations have a big role in assisting community health workers to conduct health communication by providing resources to carry out advocacy and social mobilization.

The results of this study may be important in helping health workers to understand factors affecting immunization at the household level. For instance, health workers will encourage mothers to start antenatal clinics early and ensure that mothers attend more than four antenatal visits during their pregnancy. During such visits, mothers will be advised on the importance of immunization to their children and be encouraged to deliver under skilled care, probably within a health facility. Delivery in a health facility will ensure that the child receives the first vaccine doses and the mother is encouraged to bring the child back for follow-up vaccines. Health workers will also educate mothers on the need to have smaller, manageable families. Mothers will have a wide range of

contraceptive methods to choose from and will make an informed choice after being advised on the advantages and disadvantages of each contraceptive method. The end result of a well planned family is better access to health services by all family members.

The government of Kenya will also be a major consumer of the study findings. Study findings indicated that education of the caregiver is associated with immunization of the child. The role of the government is to create opportunities for care givers and their partners to increase their literacy levels. For those who missed formal education, adult education programs will ensure that care givers and their partners can read and understand health messages from the ministry of health, the media and other advocacy groups. To ensure timely access to health services, the government will need to increase the number of health facilities within the rural areas and improve transport networks in such areas.

To understand policy implications of this study, there is need to perceive immunization determinants from a wider context. An efficient immunization policy has to address several needs and emerging issues in order to mitigate the growing divide in access to immunization, as shown by the 2009 KDHS. The policy should seek to achieve a sustained supply of immunization commodities. This can be done through adequate government funding for purchase of vaccines, syringes, ice packs and other equipment and vaccine forecasting to ensure timely acquisition, subsequently reducing vaccine stock outs or wastage. Inability to complete infant immunization has been linked to vaccines and other equipment running out of stock (USAID, 2003).

The role of the national immunization program in Kenya is to ensure efficient delivery of immunization services. A lot of data is generated during routine immunization exercises and household surveys. Once collected, such data is forwarded through the districts to the national level where it is archived. In this era of evidence based service delivery, information on immunization impact must be supported by timely, robust and relevant data (Brown, 2011). Through evidence based monitoring, such data will be useful in forecasting immunization trends, policy making and bargaining for more funding (Levine et al., 2011). Local stakeholders are likely to support immunization services if they get access to data on the impact of immunization. Donors will similarly support a program once assured by data that such a program is a high impact intervention.

Community strategy for partnership is essential in ensuring that most immunization activities are community centred. This will ensure ownership of the immunization process by community members. In addition, the government of Kenya needs to show the will to undertake organizational strengthening in order to improve immunization coverage. This will involve deploying skilled health personnel and strengthening the supply system by reducing bureaucracy in procurement and supply of vaccines.

The impact of a well-structured immunization strategy is improved service delivery and health outcomes, including immunization (Brown, 2011). Vaccine public confidence and stakeholder power and interest can all change with good policy interventions. Owing to the complexity of vaccine manufacture, transport, storage and administration, it is difficult to confidently predict the future of immunization. Kenya has just ushered in a new constitution with change of governance from a centralized to a devolved system. It is expected that this will translate into improved access and utilization of immunization services within the country.

5.8 Conclusion

Immunization coverage in children is an important public health indicator. The interaction between household characteristics and uptake of healthcare services is a widely researched area. This study sought to examine family factors associated with immunization of children within households. Research findings provided insight into the nature of this association. There were seven sociodemographic variables that were found to be significantly associated with immunization at bivariable levels (classified as either fully or not fully immunized). These included age of the caregiver, age of the partner, caregiver's highest school level, maternal attendance of antenatal care clinics, birth order of the baby, place of delivery and socioeconomic status of the family.

Complex samples logistic regression was performed to assess the impact of socio-demographic factors on the likelihood that children would be fully immunised. After backward stepwise elimination, the final model contained four explanatory variables, all of which were statistically significant at $p < 0.05$. These included education level of the caregiver, education level of the partner, number of antenatal care visits and place of delivery of the baby. Of these variables, education level of the care giver was found to be the strongest predictor of immunization uptake.

This study identified family factors associated with immunization of children in Kakamega Central, Western Kenya. Further research is suggested to identify factors

specific to the other regions of the country. It is important that research on factors affecting immunization uptake goes beyond screening of individual and household factors. Studies on immunization policy, funding, the cold chain system and healthcare personnel would lead to a broader understanding of the magnitude of the problem.

The importance of immunization in children cannot be overemphasized. Due to cross-border infections of vaccine-preventable diseases (notably polio and measles), increased immunization coverage should be a concern for both developing and developed countries. Finding ways to increase immunization coverage in Kenya should be top on the agenda if the government is to realize a healthy future populace.

5.9 Study recommendations for future research.

This study looked at family factors associated with immunization uptake in Kakamega Central, Western Kenya. The study made use of a quantitative questionnaire to generate data from households. Findings from this study were incongruent with previous studies on the role of sex of the baby and the education level of the partner on immunization uptake. Immunization coverage for the various vaccines also varied from country rates and those of neighbouring countries. This calls for further research into this area, using varying samples and other design methods such as cohort studies to further understand this problem.

Factors affecting immunization are complex. A further inquiry into this problem, through qualitative methods would help shed more light. Qualitative research would focus on mothers to partially immunized children. Through interviews and focus group discussions, researchers would understand why such mothers missed to complete vaccinations and what the mothers feel should be done to improve the immunization program.

Another potential opportunity for further research is the vaccine supply system. This includes vaccine funding, the cold chain, health care personnel and government policy. A comprehensive evaluation of these major areas will inform stakeholders on how to carry out vaccine system strengthening to ensure sustained supply of vaccines in the country.

This study had initially been designed as a pilot survey with an aim of collecting data from 100 households. Due to availability of respondents, 577 caregivers had their data

analyzed. There is potential for future studies in Kenya to involve even bigger sample sizes to improve on the quality of study findings.

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Appendices

Appendix A: Consent form

Project title: ***Family factors associated with immunization uptake in children aged between 12-59 months: A pilot study in Kakamega central district, Western Kenya.***

Project Supervisors: ***Penny Neave and Steve Taylor***

Researcher: ***Joram Sunguti Luke***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 09 January 2013.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.
- ○ If I withdraw, I understand that all relevant information including questionnaires, or parts thereof, will be destroyed.
- ○ I agree to take part in this research.
- ○ I wish to receive a copy of the report from the research (please tick one): Yes○ No○

Participant's signature:

.....

Participant's name:

.....

Participant's Contact Details (if appropriate):

……..

……..

……..

……..

Date:

Approved by the Auckland University of Technology Ethics Committee on 04 April 2013 AUTEC Reference number 13/15

Note: The Participant should retain a copy of this form.

Appendix B: Questionnaire

FAMILY FACTORS AFFECTING IMMUNIZATION UPTAKE IN KAKAMEGA CENTRAL DISTRICT, WESTERN KENYA

HOUSEHOLD QUESTIONNAIRE

IDENTIFICATION

DIVISION _____
SUBLOCATION _____
HOUSEHOLD NUMBER _____
LOCATION OF HOUSEHOLD RURAL ☐ URBAN ☐
NAME OF HOUSEHOLD HEAD _____
NAME OF RESPONDENT _____
PHONE NUMBER _____
RELATIONSHIP TO THE CHILD _____
NAME OF THE CHILD _____ AGE IN MONTHS ☐
INTERVIEWER'S NAME _____
DATE OF INTERVIEW _____
TIME OF INTERVIEW _____

SECTION 1: MATERNAL AND PATERNAL VARIABLES

NO.	QUESTION	CODING CATEGORY	SKIP
101	How old are you? CONFIRM WITH IDENTIFICATION DOCUMENT IF AVAILABLE	YEARS..... ☐	
102	What is your marital status?	MARRIED..... 1 SINGLE..... 2 DIVORCED..... 3 OTHER..... 4 (Specify)	
103	Have you ever attended school?	YES..... 1 NO..... 2	→ 105
104	What is the highest level of school you attended: primary, vocational, secondary or higher?	PRIMARY..... 1 VOCATIONAL..... 2 SECONDARY/A LEVEL..... 3 COLLEGE (MIDDLE LEVEL)..... 4 UNIVERSITY..... 5	
105	How many living children do you have?	NUMBER OF CHILDREN..... ☐	
106	What is your partner's age? CONFIRM WITH IDENTIFICATION DOCUMENT IF AVAILABLE	YEARS ..... ☐	
107	Has your partner ever attended school?	YES..... 1 NO..... 2	→ 201
108	What is the highest level of school he/she attended: primary, vocational, secondary or higher?	PRIMARY..... 1 VOCATIONAL..... 2 SECONDARY/A LEVEL..... 3 COLLEGE (MIDDLE LEVEL)..... 4 UNIVERSITY..... 5	

SECTION 2: PREGNANCY AND POSTNATAL CARE			
NO.	**QUESTION**	**CODING CATEGORY**	**SKIP**
201	While pregnant with (NAME), did you see anyone for antenatal care? TBA: TRADITIONAL BIRTH ATTENDANT, CHW: COMMUNITY HEALTH WORKER.	DOCTOR..... 1 NURSE/MIDWIFE..... 2 TBA..... 3 CHW..... 4 OTHER (specify)..... 5 NO ONE..... 6	→ 203
202	How many times did you receive antenatal care during this pregnancy?	NUMBER OF ANC VISITS.... ☐	
203	Where did you give birth to (NAME)?	HOME..... 1 HEALTH FACILITY..... 2 OTHER (specify)..... 3	
204	What is the birth order of (NAME)?	BIRTH ORDER..... ☐	
205	What is the sex of (NAME)?	MALE..... 1 FEMALE..... 2	
SECTION 3: IMMUNIZATION PROFILE			
301	Do you have a mother-child booklet and /or vaccination card for (NAME)? If yes, may I see it please?	YES, SEEN..... 1 YES, NOT SEEN..... 2 NO CARD..... 3	→ 303
302	CHECK VACCINE RECORDS AND CONFIRM WHETHER THE CHILD IS FULLY IMMUNIZED (DPT 3), PARTIALLY IMMUNIZED (RECEIVED SOME VACCINES BUT NOT DPT3), UNIMMUNIZED (HAS NEVER RECIEVED ANY VACCINES)	FULLY IMMUNIZED..... 1 PARTIALLY IMMUNIZED..... 2 UNIMMUNIZED..... 3	→ 401
303 303A	Please tell me if (NAME) received any of the following vaccines: BCG vaccine against TB (injection on the arm leaving a scar)	YES..... 1 NO..... 2 DON'T KNOW..... 3	
303B	Polio vaccine (2 drops in the mouth)	YES..... 1 NO..... 2 DON'T KNOW..... 3	→ 304D
303C	How many times was the polio vaccine received?	NUMBER OF TIMES..... ☐	
303D	Pentavalent vaccine (an injection given to the thigh, sometimes at the same time as polio drops	YES..... 1 NO..... 2 DON'T KNOW..... 3	→ 304F
303E	How many times was the Pentavalent vaccine received?	NUMBER OF TIMES..... ☐	
303F	Measles vaccine (a shot in the right upper arm at the age of 9 months or older	YES..... 1 NO..... 2 DON'T KNOW..... 3	
SECTION 4: SOCIO-ECONOMIC STATUS INDICATORS			
NO.	**QUESTION**	**CODING CATEGORY**	**SKIP**
401	How many people live in your household?	NUMBER OF PEOPLE ☐	
402	How many rooms in the house are used for sleeping?	NUMBER OF ROOMS ☐	

403	Do you have a domestic servant?	YES..... 1 NO..... 0	
404	Do you own the house you stay in?	YES..... 1 NO..... 0	
405	Do you own any land for agriculture?	YES..... 1 NO..... 0	
406	Does your household have: A clock or watch A radio A television A mobile phone A refrigerator Car/truck Bicycle Motor cycle/scooter Electricity	YES NO CLOCK/WATCH..... 1 0 RADIO..... 1 0 TELEVISION..... 1 0 MOBILE PHONE..... 1 0 REFRIGERATOE..... 1 0 CAR/TRUCK..... 1 0 BICYCLE..... 1 0 MOTORCYCLE..... 1 0 ELECTRICITY..... 1 0	
407	What is the approximate distance between your house and the nearest health facility i.e. clinic, dispensary, health centre or hospital?	<5km..... 1 5-10km..... 2 >10km..... 3	
408	What is the main source of drinking water for the household? SURFACE WATER INCLUDES RIVER, DAM, POND, LAKE, STREAM,CANAL, IRRIGATION CHANNEL	PIPED WATER..... 1 TUBE WELL/BOREHOLE..... 2 DUG WELL..... 3 SPRING..... 4 RAIN WATER..... 5 TANKER TRUCK..... 6 SURFACE WATER..... 7 BOTTLED WATER..... 8 OTHER (specify)..... 9	
409	What kind of toilet facility do household members use?	FLUSH TOILET..... 1 PIT LATRINE..... 2 NO FACILITY/BUSH/FIELD..... 3 OTHER (specify)..... 4	
410	MAIN FLOOR MATERIAL, RECORD OBSERVATION. Natural (earth, sand, dung), Rudimentary (wood planks, palm, bamboo), Finished (parquet, polished wood, vinyl, ceramic tiles, cement, carpet	NATURAL FLOOR..... 1 RUDIMENTARY FLOOR..... 2 FINISHED FLOOR..... 3 OTHER (specify)..... 4	
411	WALL MATERIAL, RECORD OBSREVATION. Natural (no wall, cane, palm, trunks), Rudimentary (bamboo, mud, plywood, cardboard, refused wood), Finished (cement, stone, bricks, cement blocks, covered adobe, wood planks and shingles)	NATURAL WALL..... 1 RUDIMENTARY WALL..... 2 FINISHED WALL..... 3 OTHER (specify)..... 4	
412	MAIN ROOFING MATERIAL, RECORD OBSERVATION. Natural (grass thatch, palm leaves, dung, mud), Rudimentary (corrugated iron, tin cans), finished (asbestos sheet, concrete, tiles)	NATURAL ROOFING..... 1 RUDIMENTARY ROOFING..... 2 FINISHED ROOFING..... 3 OTHER (specify)..... 4	

Appendix C: Code book dictionary

Full variable name	SPSS variable name	Coding instructions
Identification number	ID	Household identification number
Division	division	1=municipality, 2=Lurambi
Sub location (stratum)	subloc	Each assigned a number (1-18)
Location of the household	houseloc	1=rural, 2=urban
Relationship of the respondent to the child	relchild	1=mother, 2=father, 3=other
Age of the child	childage	In months
Age of the caregiver	carerage	In years
Ever attended school	school	1=yes, 2= no
Highest schooling level	schlevel	1=primary, 2=vocational, 3=secondary, 4=college, 5=university
Total number of living children	children	Numerical
Partner's age	partage	In years
Partner ever attended school	partsch	1=yes, 2=no
Partner's highest school level	ptschlev	1=primary, 2=vocational, 3=secondary, 4=college, 5=university
Ever attended antenatal clinic	ANC	1=Yes, 2=no
Antenatal care provider	antcarer	1=doctor, 2=nurse/midwife, 3=TBA, 4=CHW, 5=other, 6=no one
Number of ANC visits	ancvisit	Numerical
Place of delivery	delsite	1=home, 2=health facility, 3=other
Baby's birth order	order	Numerical
Sex of the child	sex	1=male, 2=female
Vaccination card or booklet available	card	1=yes, seen, 2=yes, not seen, 3=no card
Vaccination status	status	1=fully immunized, 2=partially immunized, 3=unimmunized
Child received BCG vaccine	BCG	1=yes, 2=no, 3=don't know
Child received polio vaccine	polio	1=yes, 2=no, 3=don't know
Number of times polio vaccine given	poldoses	Numerical
Child received Pentavalent vaccine	penta	1=yes, 2=no, 3=don't know
Number of times Pentavalent vaccine given	pentdose	Numerical
Child received measles vaccine	measles	1=yes, 2=no, 3=don't know
Number of household members	members	Numerical
Sleeping rooms in the household	rooms	Numerical
Domestic servant available	servant	1=yes, 0=no
Own the house you stay in	ownhouse	1=yes, 0=no
Own land for agriculture	ownland	1=yes, 0=no
Household owned assets	clock, radio, TV, cell, fridge, car, bicycle, motcycle, elec	For each of the assets, indicate 1=yes, 0=no
Distance to nearest health facility	distance	1=<5km, 2=5-10km, 3=>10km
Source of household drinking water	Piped, borehole, well, spring, rain, tanker, surface, bottled, other	1=yes, 0=no
Toilet facility	Flush, pit, bush, other	1=yes, 0=no
Main floor material	Natural, rudim, finished, other	1=yes, 0=no
Wall material	Natural, rudim, finished, other	1=yes, 0=no
Roofing material	Natural, rudim, finished, other	1=yes, 0=no