DECLARATION
This research paper is my original work and has not been presented for an award of a degree in any University

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DEDICATION
This research is dedicated to my son Bruce Onyango Nyadimo
ACKNOWLEDGEMENT

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ACRONYMS AND ABBREVIATIONS

ACRO: Africa Regional Office
AREPISP: African Region Expanded Programme on Immunization Strategic Plan
BCG: Bacille Calmette Guerin
DPT: Diphtheria Pertussis and Tetanus
DVI: Division of Vaccine and Immunization
ECDC: European Centre for Disease Prevention and Control
EPI: Expanded Programme on Immunization
GIVS: Global Immunization and Vaccines Strategy
HepB: Hepatitis B
HIV: Human Immunodeficiency Virus
KDHS: Kenya Demographic and Health Survey
HBM: Health Belief Model
IMCI: Integrated Management of Childhood Illnesses
KEPI: Kenya Expanded Programme on Immunization
KHPF: Kenya Health Policy Framework
KHSSP: Kenya Health Sector Strategic and Investment Plan
KRCS: Kenya Red Cross Society
MDGs: Millennium Development Goals
NA: Not Available
NHSSP: National Health Sector Strategic Plan
NICE: National Institute for Healthcare Excellence
OLS: Ordinary Least Squares
OPV: Oral Polio Vaccine
SIAs: Supplemental Immunization Activities
SEARO: South East Asia Regional Office
UN: United Nations
UNICEF: United Nations Children’s Fund
WHO: World Health Organisation
OPERATIONAL DEFINITIONS

Herd Immunity: Herd immunity occurs when individuals who are not immunized against a disease in a community get some protection against the vaccine-preventable disease because of vaccinating a large proportion (85% - 90%) of people in that community against the disease, for example measles vaccination (Republic of Kenya, 2014).

Immunization and Vaccination: Immunization and vaccination imply protecting a person or an animal from a disease, especially by giving them an injection of a vaccine (Wehmeier et al., 2005). Immunization and vaccination are synonymously used in the field of public health.

Mass Immunization Strategy: This applies to immunization against vaccine-preventable disease to eradicate, eliminate or contain diseases in cases of disease outbreak affecting the whole population aiming at achieving 100% immunization coverage to confer herd immunity to the populations irrespective of people’s age (European Centre for Disease Prevention and Control, 2013).

Primary Vaccine Failure: This occurs when an individual fails to make an initial immunological response to vaccine thus is at increased risk of infection at any point after vaccination (Salisbury et al., 2006).

Secondary Vaccine Failure: This occurs when an individual responds initially but protection wanes over time thus is at increased risk of infection over time (Salisbury et al., 2006).

Selective Immunization Strategy: This applies to immunization against vaccine-preventable disease aiming at protecting high risk populations, for example measles vaccination among the under-fives (European Centre for Disease Prevention and Control, 2013).
ABSTRACT

This paper investigated the determinants of measles vaccination in Kenya using a nationally representative Kenya Demographic and Health Survey (KDHS) 2008/09 cross-sectional data. The influence of maternal education, maternal age, marital status, household wealth index, antenatal care, too far distance to health facility, birth order of child and sex of child on measles vaccination were investigated using binomial logistic regression techniques. The study revealed that about 60% of children in Kenya were vaccinated against measles and factors found to be having significant influence on childhood vaccination against measles included antenatal care, birth order of child, too far distance to health facility, maternal age and poorest household wealth index. In conclusion, increasing the number of doctors and nurses/midwives, reducing distance to health facilities, increasing household income of the poorest, increasing age of mothers at first birth and single parity are significant determinants of measles vaccination in Kenya. The above mentioned variables increase access and utilization of quality healthcare, ultimately increasing coverage of measles vaccination.
CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Measles is an acute contagious vaccine-preventable disease affecting human beings attributable to overcrowding, non-vaccination and immunological disorders. It is a paramyxovirus disease transmitted through droplets from the nose, mouth or throat of infected persons with no known therapeutic treatment; however conservative therapy is advocated for with recovery occurring within 2 to 3 weeks after infection (WHO, 2013; Lyimo, 2012). It is one of the leading causes of death among children under-five years of age particularly those with low immunity, anaemia or severe infectious diseases (Lyimo, 2012). Mariara et al., (2012) observes that in Kenya, child mortality rates have remained high in spite of the government’s commitment to create an enabling environment for provision of quality healthcare and reduction of mortality levels.

Measles is not known to affect animals and is neither unique to children nor gender as all ages and gender are susceptible. Measles’ outbreaks experienced in Kenya have been affecting all age groups as young as three months to fifty years of age (KRCS, 2012). It is a respiratory disease affecting the throat and lungs with clinical presentation of high fever, running nose, bloodshot eyes and tiny white spots on the side of the mouth appearing within the first 8-12 days after infection, several days later a characteristic rash develops starting with the face and upper neck gradually spreading downwards with severe and fatal complications which include blindness, encephalitis, and ear infection (WHO, 2013; Republic of Kenya, 2013; Lyimo, 2012).

Preventing diseases like measles from occurring is certainly the simplest public health intervention achievable with little healthcare resources, thus releases resources to other priority areas of healthcare. Routine measles vaccination is administered at the ninth month after all other vaccines have been given according to the national routine vaccination schedule to produce protective effects by inducing active immunity and providing immunological memory enabling immune system to recognise and respond rapidly to natural infection exposure at a later date preventing or modifying the disease (Salisbury et al., 2006).

Children less than five years old are vulnerable to acute infectious vaccine-preventable diseases because of low disease-specific antibodies underpinning timely vaccinations to
stimulate cell-mediated immune response. Measles vaccine protects vaccinated people and cuts down on spread of the disease to uninfected people because vaccinating enough (85% to 90%) people in a community lowers the chance of measles infection spreading from person to person, and lowers the likelihood of unvaccinated individuals getting infected as a result of a lower risk of exposure (Republic of Kenya, 2014).

1.2 Development of Vaccinations

Vaccines are made from inactivated (killed) organisms for example oral polio vaccine or attenuated (live) organisms for example measles vaccine, while other vaccines are made from secreted products, recombinant components or constituent cell walls to stimulate immune system to respond to disease-causing micro-organisms (Salisbury et al., 2006). Salisbury et al., (2006) further observes that vaccinating healthy people allows them to build immunity without necessarily being exposed to the disease; however no vaccine offers 100% protection against vaccine-preventable diseases, thus a small proportion of individuals get infected despite vaccination referred to as primary or secondary vaccine failures. Nevertheless controlling vaccine-preventable diseases for example measles depends largely on herd immunity and vaccination remains the most cost-effective public health intervention (WHO, 2013; Republic of Kenya, 2014; 2013; Bbaale, 2013; European Centre for Disease Prevention and Control, 2013; Smith et al., 2011).

Full childhood immunization against vaccine-preventable diseases is a major health intervention for childhood survival. Apart from the single dose of measles vaccine administered at the ninth month of birth, there are other diseases under routine immunization schedule including single dose of Bacillus Calmette Guerin (BCG) administered preferably at birth or immediately after birth against tuberculosis, three doses of pentavalent administered at six, ten and fourteen weeks respectively after birth against diphtheria, pertussis, tetanus, hepatitis B, and Haemophilus influenza type B (DPT-HepB + Hib 1) and four doses of oral polio vaccine (OPV) administered at birth, six, ten and fourteen weeks respectively after birth (Bbaale, 2013).

Measles vaccination provides a safe, efficacious and cost-effective method for disease protection, and is credited with preventing over 2 million infant deaths per year accounting for a 78% decrease in measles related deaths globally between 2000 and 2008 (WHO, 2013). Effective measles vaccination programme may as well help in relieving resource constrained
healthcare systems by preventing infections from occurring, underscoring vaccination against infectious vaccine-preventable diseases which is the most-cost effective public health and medical intervention in the world (Fernandez et al., 2011).

1.3 Aetiology of Measles

Measles is a highly contagious vaccine-preventable respiratory paramyxovirus disease and is a major cause of morbidity and mortality among under-fives. The incubation period is 10-12 days from exposure to the virus to the onset of fever, a rash appears around day 14 (range of 7-18 days) and patients become contagious from about 4 days after eruption of the characteristic rash (WHO, 2005). Severity of measles varies widely depending on a number of host and environmental factors. The risks of developing severe or fatal measles include under-fives, overcrowded living conditions, malnutrition, vitamin A deficiency, and immunological disorders such as advanced HIV infections (Fernandez et al., 2011).

There is no known therapeutic management in cases of measles infection as it is with other viral infections; nevertheless the goal of management is conservative underscoring the importance of vaccination against measles. Measles is diagnosed through medical history, clinical and serological examinations, for example during measles outbreaks, cases are defined as ‘persons of all ages living in or history of having visited the affected area accompanied with fever, generalised maculo-papular rash lasting more than three days, and/or cough, coryza, conjunctivitis (KRCS, 2011).

In view of measles aetiology, the government of Kenya through the Ministry of Health formulated various health sector policies on immunization and vaccination guided by the Global Immunization Visions and Strategy (GIVS) as explained in the following section.

1.4 Health Sector Policies on Immunizations

Kenya national policy system operates within the context of international health initiatives and in this regard achievements of the Millennium Development Goals (MDGs) targets are of primary importance, especially the fourth goal for the Division of Vaccines and Immunization (WHO, 2013). Other policy documents are the Global Immunization and Vaccines Strategy (GIVS) and the African Region Expanded Programme on Immunization Strategic Plan (AREPISP) for 2006-2009. The internal policy frameworks within which Annual Operation Plan (AOP) and programmes are implemented include Kenya Health

The 1994 KHPF and the NHSSP-I 1999-2001 re-structured the implementation of the health sector reforms in Kenya into addressing clearly identified objectives, NHSSP-II 2005-2010 went a step further aiming to reverse downward trends of most health indicators that included increasing child mortality through increased access and utilization of healthcare, increased healthcare financing and working with other stakeholders. The overall health sector performance indicators and targets provide for collective monitoring framework for NHSSP-II and also for specific Ministry of Health programmes (Republic of Kenya, 2006-2010).

Kenya Expanded Programme on Immunization (KEPI) was established in 1980; however it has since been renamed ‘Division of Vaccine and Immunization’ (DVI) with key activities focussing on routine immunizations, supplemental immunizations, integrated social mobilization and training aiming at reducing morbidity, mortality and disability due to life threatening infections as a result of vaccine-preventable diseases (Republic of Kenya, 2006-2010). Immunization activities use selective and mass immunization strategies (European Centre for Disease Prevention and Control, 2013).

The Global Immunization Visions and Strategy 2006-2015 envisages achieving at least 90% national vaccination coverage in every district or equivalent administrative unit by 2015, and later in the decade, success of vaccination coverage would be measured in terms of expansion of targets in every region, country and community (WHO, 2013). Kenya has been implementing measles control activities since 2002 in line with the African Regional measles control efforts, aiming at reducing measles mortality by 50% by the end of 2005 as compared to 1999 levels that proved very successful and led to a dramatic drop in measles levels from the pre-2002 levels (Republic of Kenya, 2013).

The Government of Kenya through the Ministry of Health has put in place four disease-reduction strategies adopted for accelerated measles control, namely; strengthening measles routine immunization, strengthening measles surveillance, conducting supplemental immunization and strengthening measles case management (Republic of Kenya, 2013). Kenya committed to the goal of measles elimination by the year 2020 in line with WHO-AFRO resolution of 2012 and in order to achieve this ambitious target, the Ministry of Health
through DVI called upon all stakeholders to intensify the implementation of key control activities that include strengthening of routine immunization, providing a second opportunity for measles vaccination through supplemental immunizations activities, monitoring disease trends through measles surveillance and improving measles case management throughout the strategy of intergraded managing of childhood illnesses (IMCI) (Republic of Kenya, 2013). The Ministry of Health policy objective is to eliminate communicable diseases by increasing %age of fully immunized children from current 79% in 2013 baseline to 90% in 2017 (Republic of Kenya, 2012-2017).

WHO recommends introduction of second dose of measles vaccine into routine immunization schedule rather than supplemental immunization activities in set-ups where coverage with the first dose is above 80% (Republic of Kenya, 2013). Kenya has attained and maintained above 80% national measles coverage with the first dose since 2009, therefore qualifies and intends to introduce second dose of measles vaccine into routine immunization schedule where every child gets two doses of measles vaccine; first dose between nine and twelve months of age and the second dose between eighteen and twenty four months of age administered up to five years of age maintaining the interval of at least four weeks between the doses (Republic of Kenya, 2013).

It is further noted by Republic of Kenya (2013) that second dose of measles vaccine will help in maintaining high measles vaccination coverage ensuring pool of susceptible children do not increase rapidly over the years increasing herd immunity, reducing the cost of measles immunization, providing a second opportunity to children left out or did not develop protective antibodies after vaccination, improving vitamin A coverage and providing a platform to target children with other health interventions including different vaccines.

Kenya currently provides a second opportunity for measles vaccination through supplemental immunization activities (SIAs) with initial nationwide catch-up activities conducted in June 2002 targeting all children aged 9 months to 14 years where a total of 13,302,991 children received measles vaccine attaining 98% coverage and subsequent activities were conducted in 2006, 2009 and 2012 (Republic of Kenya, 2013).

WHO (2013; 2005), reports that by 2010 or earlier each country was expected to have increased national vaccination coverage to at least 90% and at least 80% in every district or
equivalent administrative unit that would have reduced global measles mortality by 90% compared to 2000 level, while later in the decade, success measurement for vaccination coverage would be recorded in terms of expansion of immunization services to meet vaccination coverage targets in every region, country and community. It is further noted by WHO (2013; 2005) that between 2006 and 2015 all those working on immunization should strive to prevent vaccine-preventable morbidity and mortality.

1.5 Statement of the Problem

In spite of the efforts put towards increasing measles vaccination coverage by the government of Kenya, resurgence of measles disease continues to be reported every three years in the country, while at the same time, it has not achieved GIVS goal of 95% measles vaccination coverage and child mortality is still being associated with non-vaccination of children against measles, both nationally and globally. Measles disease still remains a public health concern significantly contributing to global disease burden, morbidity and mortality among under-fives in most rural and urban populations despite availability of safe and effective vaccines (WHO, 2013; Republic of Kenya, 2013; Mariara, 2012).

Kenya has notably made tremendous progress in reducing morbidity and mortality associated with measles through routine and supplemental vaccinations; however resurgence of the disease is being reported is attributable to persistent sub-optimal measles coverage leading to accumulation of susceptible children causing measles outbreaks (Republic of Kenya, 2013). Low immunization coverage, irregular annual programme review, greater than 10% dropout rates, and irregularly conducted outreach services have been cited as the weaknesses of immunization programmes in Kenya (Republic of Kenya, 2006-2010).

More than 95% of measles deaths occur globally in low-income countries with weak health infrastructure mainly attributed to unvaccinated children that otherwise would have been avoided with universal vaccination coverage (Lyimo, 2012). Wamae et al., (2009) observes that Kenya is one of the 42 countries accounting for 90% of all under-fives deaths in the world.

Immunization has been proven to be the most effective medical and public health intervention for controlling and eliminating life threatening infectious vaccine-preventable diseases among children underscoring the importance of investigating the determinants of
measles vaccination in Kenya (Republic of Kenya, 2014; 2013; Smith et al., 2011). Universal childhood immunization against vaccine-preventable diseases is important in reducing infant and child mortality by two-thirds as envisaged in the fourth millennium development goal, however vaccines alone are not sufficient to prevent vaccine-preventable disease epidemics, (UN, 2010; Smith et al., 2011; WHO SEARO, 2008).

National immunization coverage was expected to have reached 90% by 2010, however most developed and developing countries including Kenya have so far achieved at least 80% and 70% respectively (Republic of Kenya, 2014; 2013; Lyimo, 2012; WHO, 2005). Kenya has attained and maintained national measles coverage with the first dose at over 80% since 2009; however, is still less than 85% to 90% threshold required for herd immunity implying under-fives are still highly susceptible to measles infection (Republic of Kenya, 2013). Scaling measles’ vaccination up-take reduces child morbidity and mortality increasing the proportion Kenya contributes towards reducing child mortality (WHO, 2013; 2004). There are other underlying factors influencing effectiveness of vaccination apart from availability of measles vaccines underscoring the need to empirically establish the factors that determine measles vaccination in Kenya.

1.6 General Objective

To investigate the determinants of measles vaccination in Kenya

1.7 Specific Objectives

1. To investigate factors influencing measles vaccination among under-fives

2. To suggest policies to improve childhood measles vaccination coverage in Kenya

1.8 Significance of the Study

This study may inform government policy makers and other stakeholders especially donors in understanding inherent factors determining childhood immunizations against measles. Investigating determinants of measles vaccination in Kenya may contribute to a body of knowledge; provide empirical evidence to inform decision-makers on national policies relating to measles vaccination coverage and the relationship between measles and associated factors. It may also identify some of the factors responsible for the relatively low immunization coverage in Kenya.
CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Immunization is essential for reducing under-five mortality, monitoring immunization coverage services, guiding disease eradication, disease elimination efforts and probably health resources allocation (Lyimo, 2012). Bbaale (2013) notes that immunization is one of the most effective public health investments with proven strategies making it accessible to the most hard to reach and vulnerable populations, and is a proven tool for controlling and eliminating life-threatening infectious diseases estimated to avert 2 to 3 million deaths each year worldwide and remains a key channel for attaining the fourth Millennium Development Goal that aims to reduce child mortality by two-thirds.

Lyimo (2012) also observes that immunization averts an estimated 2.5 million deaths a year however millions of children in developing countries, almost 20% of all children born every year do not get complete immunization scheduled for their first year of life (Lyimo, 2012). Measles vaccine is preferably administered at the ninth month of life and at this time all children less than five years of age are expected to have been fully immunized according to routine immunization schedule, however any time after nine months may be acceptable so long as it is not later than five years of age. Immunization against measles is a major health intervention for child’s survival throughout the world and is used as a good indicator of health system performance, to monitor progress of child health and progress of the fourth Millennium Development Goal (WHO, 2013; Bbaale, 2012; Lyimo, 2012; UN, 2010; WHO-SEARO, 2008).

In 2008, all UN member states reaffirmed their commitments to achieving 90% reduction in measles mortality by 2010 compared with 2000 from an estimated 733,000 deaths in 2000 worldwide to less than 73,300 by 2010 underscoring the need to investigate the determinants of measles vaccination in Kenya being among the developing countries still lagging behind in terms of proportionate contribution towards global measles vaccination coverage (Lyimo 2012; Wamae et al., 2009).

Access and utilization of quality health services for example maternal health services is associated with neonatal health outcomes; however the failure of health services to use every available opportunity to vaccinate susceptible children is a major obstacle in the path of
achieving measles control (Babalola et al., 2009; Spencer et al., 2003; Coetzeen et al., 1991). Low immunization coverage has been associated with maternal, child and health system related socio-economic factors that when mitigated are likely to increase measles vaccination coverage and lower susceptibility of the people reducing resurgence of measles outbreaks that are being experienced in Kenya.

**2.2 Theoretical Literature**

Economic approach emphasises the role of economic factors in shaping health-related behaviour referred to as the ‘demand for health’ viewing individuals as ‘demanding’ a commodity ‘health’ and ‘producing’ a stock of health by combing a bundle of ‘health inputs’ such as measles vaccination, high income and high level of education (Grossman, 1972; Wagstaff, 1986).

Health is assumed to be desirable because it is pleasant and permits one to engage in household and market activities; however it is not the only desirable thing in life thus the differences in utility functions (Wagstaff, 1986). Mothers directly and indirectly derive their utility from consumption of goods and services including those benefiting their children. Their utility functions are also embedded in health production of their children, therefore they must have preferences that are logically consistent and transitive in consideration of budget constraints in order to maximise their utilities (Drummond et al., 2005). It is assumed that individuals exert relatively high degree of control over their health by virtue of the fact that they can influence their health-effecting consumption patterns as argued by Wagstaff (1986), thus are rational when making decisions under uncertainties (Drummond et al., 2005).

Assuming individuals inherit an initial stock of health that depreciates with age over time however not at a constant rate, the model centrally views health as a durable stock that can be increased with investment to produce an output of healthy outcomes (Grossman, 1972). Aging, diseases and poverty among other factors lower the stock of health, while factors like higher education, higher income and healthcare seeking behaviours increase the stock of health, thus are referred to as health inputs. This argument can be expressed as:

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\text{Health stock at a time (t) = Health stock}_{t-1} \text{-depreciation + Investment in Health}
\]
Health production function depends on certain ‘environmental variables’, of which the most important one being the producer’s level of education, therefore to realise potential gains in productivity because education is assumed to influence efficiency in production process, individuals require incentives to invest in formal schooling that can be demonstrated by the benefits accrued from education in terms of individuals’ and community’s improved social welfare (Grossman, 1972; Wagstaff, 1986).

Children do not invest in their own health; however any investment in mothers’ health and education enhances health production of their children. Similarly, consumption of non-market and market activities by the mothers helps in producing health of their children. At a conceptual level, an increase in one’s stock of knowledge affects productivity because it is assumed to raise productivity in household and market sectors where one produces commodities and income earnings respectively entering one’s utility function (Grossman, 1972).

Maternal decision to invest in her health and that of her child is dependent on her level of education owing to the fact that increased education has been associated with improved comprehension of health matters, thus necessitating health promotion behaviours like seeking antenatal care and measles immunization. Increased education is also associated with high income through wages and salaries raising the returns on healthy days because individuals can access healthcare easily. Increased wages enable individuals to pay for healthcare related costs such as transport costs to the health facilities despite free maternal child health services at public health facilities.

The ‘shadow price’ of health depends on many other variables besides the price of medical care. It has been shown that the shadow price of health rises with age if the rate of depreciation on the stock of health rises over life cycle and falls with education if more educated people are more efficient producers of health (Grossman, 1972). As knowledge increases, the production function shifts upwards and vice versa, therefore one may reasonably suppose that better educated mothers are in better positions of assimilating information about health matters from mass media and health providers, than mothers who are poorly educated (Grossman, 1972; Wagstaff, 1986).
Findings from numerous studies about infant and child mortality conducted in developing countries over decades show a nearly universal positive association between maternal education and child survival; a relation which has persisted in many societies even when household’s socio-economic status has been held constant (Elo, 1992). Similarly, Culter et al., (2006) observes that there is a well-known large persistent association between education and health observed in many countries and time periods.

Investing in the mother’s education is an investment in the child’s health because education is assumed to improve efficiency in producing health; better knowledge of harmful effects of measles infection and better ability to follow health instructions are some of the positive influences of education on health of the child. Education is presumed to raise the marginal products of direct health inputs, given that investment in health capital can be generated at less cost for educated people, and yields higher rates of returns to a given health stock (Wagstaff, 1986).

Measles vaccination increases value of health investment, reduces depreciation in health and increases health stock. One may presume therefore that the position of an individual’s health production depends on his level of education because education increases efficiency of the mother’s household production of health by increasing the marginal production of health inputs thereby increasing the optimal health stock. The more educated are more likely to obtain preventive care such as measles vaccination for their children (Culter et al., 2006).

Cost of investing in health includes indirect and direct outlay of market and non-market goods for example opportunity cost of the time that must be withdrawn from competing uses and the total amount of time one spends producing income earnings and commodities is determined by the one’s stock of health (Grossman, 1972). Mothers too have limited time for use among competing needs and efficient use depends entirely on their health embedded in the health of their children; the healthier they are the more time they spend on household and market activities and vice versa. Time used to take a child for measles vaccination has an opportunity cost in terms of the earnings forgone (income or output) that the time would have produced.

Grossman (1972) further puts it clearly that mother’s stock of health determines the total amount of time she spends producing money earnings and commodities and that gross
investments in health capital are produced by household production functions whose direct inputs include own time of the consumer and market goods such as healthcare for example seeking measles vaccination for the child.

The model further assumes that neither inputs nor consumption activities are costless, and individuals have only limited resources at their disposal, that is individuals have a given income with which to finance their health production and consumption activities. This is illustrated by downward slope of the budget constraints indicating all combinations of health inputs and consumptions exhausting individual’s income (Mwabu, 2009; Wagstaff, 1986). The downward slope of the budget constraint indicates the number of units of consumption which mothers must give up in order to obtain one more unit of health input. Assuming they organise their expenditures to the best of their ability on health inputs and consumptions to give themselves the highest possible level of well-being, they seek to attain the highest indifference curve available to them and in doing this they are constrained by their limited income which is the prices they have to pay for health inputs and consumption activities and the opportunities open to them for transforming health inputs into health (Wagstaff, 1986).

In the field of public health, literature provides for the use of contemporary social science and behavioural theories in designing and evaluating public health interventions such as measles vaccination. Adopting social science and behavioural theories in understanding individual’s health behaviour may provide a theoretical foundation in developing public health interventions and policies regarding the determinants of measles vaccination in Kenya. A growing body of evidence suggests that interventions developed with an explicit theoretical foundation or foundations are more effective than those lacking theoretical base and that some combined multiple theories and concepts have larger effects (Glanz et al., 2010).

The health belief model hypothesises people’s perceptions about their risks of disease and benefits of taking actions to avoid the disease, thus influencing their readiness to take actions. Mothers assess for themselves whether the benefits for taking their children for vaccination against measles outweighs the risks of measles infection. Smith et al., (2011) notes that children have significantly lower vaccination coverage if their parents are less likely to agree that vaccines are necessary to protect health of their children, their children may get the disease if they do not vaccinate them and that vaccines do a good job of preventing the diseases they are intended to prevent.
2.3 Empirical Literature

Full childhood immunization is influenced by many factors and its coverage is used to monitor progress of child’s health indicators in cognisance of the fact that most childhood morbidities and mortalities are related to measles infections, therefore achieving universal childhood immunization is a commendable progress towards reducing child mortality rates. Kenya so far has achieved above 80% measles vaccination coverage, however un-vaccination due to missed out infants at nine months have been cited as the main contributors of failing to achieve above 95% measles immunization coverage as envisaged by GIVS (Republic of Kenya, 2013).

Historically and globally, socio-economic status is among the most important determinants of health throughout life cycle adversely affecting young children (Spencer, 2003). There is a wide range of socio-economic and environmental factors directly or indirectly determining health status of the population including the children, such as health behaviours, income, education, employment and access to healthcare (National Institute for Healthcare Excellence, 2007). Factors reported to be determining childhood immunizations are spousal level of education, household wealth status, distance to health facility, occupation of the parents, and gender of the child (Bbaale, 2013).

Among the factors influencing childhood immunization, maternal education is the most frequently cited factor, however there are other factors accompanying education differently influencing mother’s health seeking behaviour as observed by Fernandez et al., (2011). Risk factors for incomplete vaccination cited by Barata et al., (2012) include higher birth order, less maternal education level and highest socio-economic stratum. Similarly, Fernandez et al., (2011) observes education, wealth and access to skilled birth attendants as strong correlates of measles vaccination. Highly educated individuals are likely to get more rewarding occupations which are well paying, placing them in higher social classes than less educated individuals. They are therefore more likely to have their children vaccinated against measles than those from poorer households because of easy access to healthcare.

Education has been shown to modify women’s beliefs about disease causation and cure influencing domestic childcare practices and utilization of modern healthcare, thus reducing mortality (Culter et al., 2006; Elo, 1992). Mothers with higher education levels may understand implications of non-vaccination of children therefore more likely to seek
vaccination against vaccine-preventable diseases than mothers with lower levels of education, a good example is understanding the role of none vaccination against measles and its spread (Mariara et al., 2012; Wagstaff, 1986). Therefore as a result of enhanced understanding resulting from high education attainment, one would expect health to be produced more efficiently than formerly, that is more health ought to be produced per unit of health input.

Employment of women also impacts positively on childhood immunization against vaccine-preventable diseases because they can afford to pay for health services either in private or public facilities. Highly educated mothers are more likely to have higher salaries thus are more likely to have their children vaccinated against measles than mothers who are lowly educated because of improved access to healthcare including measles vaccination for their children. Social class has important consequences for the lives of individuals and the extent of an individual’s strategies and practices devoted to acquire income, as a result determining the individual’s standard of living (WHO, 2007). Poverty and low socio-economic status are associated with higher risk of death in infancy and childhood as a result of acute illnesses (Spencer, 2003).

Having a more educated spouse is associated with better health and health behaviours like taking a child for vaccination against measles, thus gender parity in all levels of education enhancement effort is crucial for equality and equity between males and females (Bbaale, 2013). Maternal age affects immunization seeking behaviour for their children, for example in Indonesia, mother’s age positively influences measles vaccination where measles immunization coverage increases up to 30-34 years group then decreases for combined rural sample, while the proportion of children immunized increased with each successive mother’s age up to 35-39 years then begins to decline for the urban sample (Fernandez et al., 2011). This implies that mothers in the rural settings are less likely to take their children for immunization as they age, than mothers in urban set ups withstanding aging process.

Reproductive age ranges between 15-49 years and it may be difficult to know when exactly mother’s age influences positively or negatively measles vaccination in Kenya; however mothers less than 20 years old may be less likely to take their children for measles vaccination because of lower education level than mothers older than them. Higher levels of education have been shown to positively affect vaccination.
Married mothers are more likely to have their children vaccinated against measles than unmarried mothers because of family social and financial support from their husbands. Couples’ concerted efforts towards health of their children increase their likelihood of taking their children for vaccination against measles because each one of them acts as cues to take their children for vaccination (Taylor et al., 2006). Marital status enhances one’s socio-economic status explained by relational mechanisms in terms of property management affecting one’s health and health seeking behaviour (WHO, 2007).

Measles vaccination is provided free of charge in public health facilities; however there are indirect costs of healthcare such as transport costs that are likely to inhibit poor mothers from taking their children for vaccination against measles even if they are willing to do so (Serpell et al., 2006). Richer parents are more likely to invest in their children’s health owing to easy healthcare access than poorer parents (Culter et al., 2006). However evidence from Brazilian capital shows success in achieving high immunization coverage among poor children rather than the wealthiest thus are requiring a strategy to reach children in the wealthiest areas who are seemingly not getting immunized against vaccine-preventable diseases (Barata et al., 2012).

Cultural definitions of gender roles may determine children’s vaccination status. Sex discrimination exists in child immunization in rural areas of Bangladesh where female children are 30% less likely to be fully immunized compared to male children (Jamil et al., 1999). Similarly, 52% of measles cases reported in Nairobi during 2010-2011 measles outbreaks were females, however it is not known whether gender influences measles vaccination uptake in Kenya (KRCS, 2011). In conclusion, characteristics of the mother, health system and child influence childhood vaccination against measles and measles outbreaks being experienced in Kenya are largely due to un-vaccination and movement of victims serving as a vehicle for measles transmission.

2.4 Overview of Literature

Many studies have been carried out on the influence of education, age and health systems on childhood vaccination and their health which have yielded valuable results, however there have been little studies on the influence of gender, culture and religion on childhood immunization coverage, yet they are also important factors contributing to health status of children. Cultural discrimination has been observed across many developing countries
including East and South Asia, therefore a study should have been carried out to determine disparities existing between girl child and boy child in getting immunized against vaccine-preventable diseases. Similarly, effects of factors like mass media on measles vaccination and apparent regional differentials in measles vaccination up-take have been left out in many studies.

It is evident that cultural, ethnic and religious diversities play a role in health of the children. Some religions advocate for non-conventional health interventions predisposing children to poor health as have been published in mass media where parents and their children vehemently refuse vaccination against vaccine-preventable disease through supplemental immunization activities. It is amazing to note that even very young children are sensitised against childhood vaccinations against known infectious, contagious and fatal vaccine-preventable diseases.

Differences in measles vaccination coverage are expected to occur between rural or urban residence and government or private health facilities, thus requires enquiries too. Further, most studies have been founded on economic theories, yet measles vaccination is both an economic and a public health concern requiring integration of theories from both fields. More so, no literature exists explaining how individuals’ psychological perceptions about health risks may influence measles vaccination and child’s health production in general. Mothers mostly interact with health systems mainly through nurses thus investigating the effects of antenatal care and distance to the health facility on measles vaccination would add value to measles vaccination and childhood immunization coverage in general.
CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter discusses methodology and data used in this study. It starts by presenting the theoretical framework forming the basis for this study followed by model specifications and lastly how the data are analysed.

3.2 Theoretical Framework

Economists define demand for any good or service, including healthcare as the quantity that consumers are both willing and able to buy, however it depends on individual preferences illustratable with an aid of indifference and downward sloping demand curves. Grossman (1972) argues that the demand for health model helps in understanding the link between resources, behaviour and health, therefore in this regard, fundamentals of Grossman’s ‘demand for health’ model are used to describe conceptual and theoretical framework used in this study.

In this context, Health Belief Model may help in understanding socio-economic and demographic factors making individuals to use or not to use public health services like measles vaccination. The core constructs of HBM that are systematically related to being immunized and may influence parents’ decision to take their children for vaccination against vaccine-preventable diseases are perceived susceptibility and severity of the disease, perceived barriers and benefits of taking action to avoid the disease, cues or reminders to action, efficacy and safety of measles vaccination (Smith et al., 2011; Taylor et al., 2006; Pielak et al., 2003; Mangal, 2003).

In utility maximization, mothers derive satisfaction from consumption of bundles of goods and services having direct and indirect influence on child’s health that can be derived from the concepts of Grossman demand for health model and the Health Belief Model. There are diverse socio-economic and demographic factors competing for the scarce resources and determining measles vaccination. Under budget constraints, mothers attempt to maximise their utility function expressed as health inputs in the demand for health model, while in the health belief model, these inputs are referred to as the socio-demographic factors influencing individual’s health behaviour and decisions in taking preventive health services (Taylor et al., 2006). These factors are associated with the mother, the child and the health system as
determinants of measles vaccination integrated in the demand for health model as health inputs to produce a conceptual framework illustrated in figure 1 whose constructs are subsequently used in the econometric model specifications for this study.

Figure 1: Variables Influencing Measles Vaccination

Measles vaccination is one of the health inputs for producing health of a child and in this regard the concepts of Grossman demand for health model is used to investigate the determinants of measles vaccination in this study. Consumer’s decisions are driven by a single objective of maximising utility obtained from consumption of goods and services. In our study utility maximization function for measles vaccination as;

\[ U = F(R, S, T) \]  

(1)

Where, \( U \) is the utility the mother gets when the child is vaccinated against measles, \( R \) is the mothers’ characteristics, \( S \), is the child’s characteristics and \( T \), and is the health system characteristics.

The utility an individual consumer obtains from each unit of the above goods, services and overall from any particular combination of goods depends entirely on individual’s preferences that must be logically consistent and transitive with the aims, thus the assumption that individual is rational when deciding under uncertainties (Drummond et al., 2005). It is further assumed that individuals behave as if they make decisions with the aim of maximizing
their well-being therefore utility function obeys such conventions like von Neumann and Morgenstern utility theory (Drummond et al., 2005).

High measles vaccination coverage is used as an indicator of access and utilization of child health services. Mothers particularly play significant roles in seeking healthcare for their children demanding for market (income, education) and non-market inputs (vaccination, diet) to produce health for their children. Behaviours determining child health demanded by the mothers and their households vary according to many factors including unobserved preferences on healthcare and unmeasured health endowment of mothers (Mwabu, 2009).

Factors associated with measles vaccination are represented in the demand for health model as health inputs, thus underscores the decision to use demand for health model to investigate the determinants of measles vaccination. These health inputs include education, age, income, healthcare (measles vaccination) and distance or no transport to health facility conceptualised in this study as mother, child and health system characteristics shown in figure 1 above.

Mwabu (2009) used a slightly modified version of a model by Rosenzweig and Schultz (1983) in which child health production is embedded in a utility-maximising behaviour of the mother. In this framework individuals are assumed to maximise the utility, $U$, obtained from the consumption of goods and services that have direct effect on health, $X$, those goods that yield utility but also affect individual health, $Y$, and the individual’s health status, $H$, (Awiti, 2013). For a typical $i$, individual, we can write this utility function as:

$$U = U(X, Y, H).$$

(2)

It is assumed that the individual exerts relatively high degree of control over their health by the virtue that they can influence their health-consumption patterns. The child health production function is thus given by:

$$H = F(Y, Z, \mu).$$

(3)

Where, $Z$, is the purchased market inputs such as medical care affecting health of the child directly, and, $\mu$, is the component of child health due to environmental factors influenced by parental behaviour and preferences for example education and income (Mwabu, 2009). It is therefore assumed that mothers maximise their utility function subject to the above health production function and a budget constraint.
3.3 Specification of the Model

The model specified here is structurally stated as a multiple regression model where measles vaccination function is hypothesised to depend on maternal education, mother’s age, marital status, household wealth index, antenatal care, too far distance to health facility, birth order of child and sex of child. The multiple regression structure is generally stated as:

\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_K X_K + \epsilon. \]  

Where, \( Y \), is the outcome/dependent variable, \( X's \), are the independent variables, \( \beta's \), are the partial slope coefficients of the parameters, and, \( \epsilon \), is the stochastic error term. From population regression function (PRF) expressed in equation, 4, a sample regression function (SRF) is expressed as:

\[ y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_K X_K + \epsilon. \]  

When, \( y \), is a binary variable taking the values zero and one, it is always true that,

\[ P(y=1|x) = E(y|x), \]  

which gives a binary logistic regression model expressed as:

\[ P(y=1|x) = \Lambda(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_K X_K). \]  

In this study, \( y \) is measles vaccination categorised as one when the child is vaccinated against measles and zero otherwise, thus the following regression model is specified as:

\[ P(mvac=1| meduc, mag, ms, hwi, ancd, ancnm, dhf, bord, sc) = \Lambda(\beta_0 + \beta_1 meduc + \beta_2 mag + \beta_3 ms + \beta_4 hwi + \beta_5 ancd + \beta_6 ancnm + \beta_7 dhf + \beta_8 bord + \beta_9 sc). \]  

Where; \( mvac \) represents measles vaccination, \( meduc \) represents maternal education, \( mag \) represents maternal age, \( ms \) represents marital status, \( hwi \) represents household wealth index, \( ancd \) represents mothers who received antenatal care from a doctor, \( ancnm \) represents mothers who received antenatal care from a nurse/midwife, \( dhf \) represents too far distance to health facility (why the mother did not deliver at a health facility), \( bord \) represents birth order of child, and \( sc \) represents sex of child. The data is analysed using binomial regression. In the section below, we define the variables used in the study and also provide their measurements. Maternal education, maternal age, marital status, household wealth index, antenatal care are
expected to positively relate to measles vaccination, while far distance to the health facility, birth order and sex of the child are expected to negatively relate to the measles vaccination depending whether the child is hind born or male.
CHAPTER FOUR: TYPES AND SOURCES OF DATA

4.1 Introduction
This chapter discusses types and sources of data used in this study including background characteristics.

4.2 Types and Sources of Data
The nationally representative cross-sectional data from Kenya Demographic and Health Survey (KDHS) 2008/09 are used in this study. The household questionnaire was completed by 6,079 households where 2,751 and 3,328 household questionnaires were completed in 2008 and 2009 respectively.

4.3 Background Characteristics of the Study Variables
In this study, measles vaccination is used as a dependent variable being affected by maternal education, maternal age, marital status and household wealth index as mother’s characteristics; antenatal care and too far distance to health facility as health system’s characteristics and lastly birth order of child and sex of child as child’s characteristics.

The dependent variable of interest is the probability of measles vaccination among children under-fives. Measles vaccination is measured in KDHS as a continuous variable indicating the total number of children who are vaccinated against measles. The question on measles vaccination was asked of every mother with a child or children under 5 years. Measles vaccination is re-coded into a dichotomous (yes/no) variable in KDHS data providing five response options: ‘yes (marked on vaccination card)’, ‘yes (date recorded on vaccination card)’, ‘yes (mother’s recall)’, ‘no’ and ‘don’t know’. Measles vaccination is defined in this study as one if a child is immunized against measles and zero otherwise with vaccinated children recorded as ‘yes’ regardless of the source of the information, i.e. vaccination date recorded on vaccination card, mother’s recall or vaccination marked on the vaccination card. Children whose mothers indicate they do not know whether measles vaccination have been given measles vaccination are deleted from the sample. A total of 5,680 mothers have information about measles vaccination status of their children with 69.79% accounting for absolute ‘yes’ answers and 30.21% accounting for ‘no’ answers (30.21%). Measles vaccination is used as a proxy for full childhood immunization, child health and health system performance. A total of 1756 children are included in the estimation sample.
Maternal education is included in the analysis because it has been a well-established determinant of vaccination coverage. It is measured in KDHS as a continuous variable categorised as 0=no education, 1=primary, 2=secondary and 3=higher levels of education. Higher education level is referred to as tertiary or university levels of education that could have been certificate, diploma or degree certificates. Higher education level is used as the reference category in the binomial regression analysis. Maternal education is used as a proxy for ability to understand health matters.

Maternal age is completed years of age measured in KDHS as a continuous variable from 15 years to 49 years which is essentially women’s age of reproduction. Mothers of first parities at primary, secondary and higher school going ages are less likely to take their children for vaccination against measles, than mothers of subsequent parities and above school going age. This is probably due to the fact that most pregnancies occurring during school going age are unplanned and the children may instead be left under the care of their aging grandmothers. Maternal age is used as a proxy for maturity and ability to take care of the child.

Marital status is the state of a woman living with a man as a husband. KDHS measures marital status as a continuous variable categorised as 0=never married, 1=married, 2=living together, 3=widowed, 4=divorced and 5=not living together indicating the number of mothers under each category. Majority (79.57%) are married followed by those never married (6.30%) and those living together (5.66%) respectively. The rest (8.47%) are either widowed, divorced or not living together. Mothers who report as married is considered married, while the rest are considered not married in this study. In the regression analysis, mother’s marital status is defined as one if a mother is married and zero otherwise. Married mothers are more likely to get their children against measles because of social and financial support from their husbands. Marital status is used as a proxy for social and financial support.

Household wealth index is the economic status of the family measured in KDHS dataset as a continuous variable categorised as in quintiles based on various factors including households, properties, as 1=poorest, 2=poorer, 3=middle, 4=richer and 5=richest. KDHS has not indicated how the quintiles are measured in terms of household income. The richest quintile is used as the reference category in the regression analysis. The richest households are more likely to take their children for vaccination against measles because of easy access to
healthcare than the poorest. Household wealth index is used as a proxy for ability to access and utilize quality healthcare.

Antenatal care is the care given to pregnant mothers by doctors, nurses/midwives. It is measured in KDHS as a continuous variable indicating the number of mothers who received antenatal care from doctor or nurse/midwife. In this study, antenatal care is defined as one if the mothers received antenatal care from doctor or nurse/midwife and zero otherwise. A mother who seeks antenatal care from doctors or nurses/midwives is more likely to take her child for measles vaccination than the mother who does not seek antenatal care from doctors or nurses/midwives, probably due to health messages she receives from doctors or nurses/midwives. Antenatal care by doctor or nurse/midwife is used as a proxy for access and utilization of quality healthcare.

Too far distance to health facility is the distance from mother’s homestead to the health facility. KDHS measures too far distance to health facility as a continuous variable. It indicates the number of mothers who do not deliver at the health facility because it is too far to health facility; however no specific measuring unit is used in KDHS dataset to determine how too far the facility is from the mother’s residence. For purposes of this study, far distance to health facility is defined as one if the mother did not deliver at the health facility because it was too far and zero otherwise. Mothers who do not deliver at a health facility because it is too far are less likely to take their children for vaccination against measles than those who deliver in the health facility. This is probably due to indirect costs of healthcare for example transport costs. Too far distance to health facility is used as a proxy for access and utilization for quality healthcare.

Birth order of child is the position each child assumes among the siblings. KDHS measures birth order as a continuous variable from 1 to 13. In this study, birth order is defined as one if the child is first born and zero otherwise. Birth order is likely to influence measles vaccination coverage with mothers of first parities being less likely to take their children for vaccination against measles than mothers of subsequent parities, probably due to inexperience in childcare. Birth order is used as a proxy for maturity of the mother and parity.

“Sex” of child designates those characteristics that are biologically determined either as female or male. KDHS measures sex of child as a categorical variable defined as one if male
and zero otherwise in this study. Society prescribes roles and behaviours expected from girls and boys, men and women based on sex, thus determines their health. Sex of child is used as a proxy for cultural gender preferences.

4.4 Definition and Measurement of Variables

This subsection presents the definition and measurement of variables used in the study. The study seeks to investigate the determinants of measles vaccination in Kenya where measles vaccination is the dependent variable of interest used as a proxy for full childhood immunization against vaccine-preventable diseases administered at the ninth month after delivery of the child when all other routine immunizations have been administered according to the national immunization schedule. Selected explanatory variables included in this study are maternal education, maternal age, and marital status of the mother, household wealth index, antenatal care, too far distance to health facility, child’s birth order and sex of child. Other factors known to influence measles vaccination in Kenya are urban/rural residence, public/private health facility, mass media, culture, and religion; however they have been intentionally excluded in the study for precision.

Table 1 below defines the variables used in this study.
Table 1: Definition of Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurement</th>
<th>Definition and Literature Source</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles vaccination</td>
<td>Proxy for full immunization, child health and health system performance</td>
<td>This is the percentage coverage of measles vaccination among under-fives. It is defined in this study as one if the child is vaccinated against measles and zero otherwise. Measles vaccination is the dependent variable of interest influenced by various factors (Elo, 1992, Fernandez et al., 2011; Jamil et al., 1999).</td>
<td></td>
</tr>
<tr>
<td>$M_{vac}$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal education</td>
<td>Proxy for ability to understand health matters</td>
<td>This is the mother’s level of education measured in KDHS dataset as an ordinal categorical variable from 0 to 3 where; 0=no education, 1=primary, 2=secondary and 3=higher level of education with each category indicating the number of mothers with various levels of education. Higher education is used as the reference category in all the regressions. It’s expected that additional level of education positively influences measles vaccination (Bbaale, 2013; Fernandez et al., 2011; Elo, 1992; Culter et al., 2006; Mariara et al., 2012; Wagstaff, 1986).</td>
<td>No education is statistically significant at 1% level of significance, while primary and secondary education levels are statistically insignificant at 10%.</td>
</tr>
<tr>
<td>$meduc$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 1: Definition of Variables (Continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Definition and Literature Source</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age</td>
<td>Proxy for maturity and ability to take care of the child</td>
<td>This is completed years by the mother measured in KDHS dataset as a continuous variable from 15-49 years. Different age groups are expected to have different magnitudes in terms of influencing measles vaccination. As mothers mature, they are expected to take their children for vaccination against measles more than younger mothers. Mother’s age positively influences measles vaccination (Fernandez et al., 2011).</td>
<td>Maternal age is statistically significant at 1% level of significance</td>
</tr>
<tr>
<td>Marital status</td>
<td>Proxy for social and financial support</td>
<td>This is the state of the mother living with a man as a husband. It is defined in this study as one if mother is married and zero otherwise. Married mothers are expected to positively influence measles immunization for their children because of socio-economic support they receive from their husbands (WHO, 2007; Taylor et al., 2006).</td>
<td>Marital status is statistically insignificant at 10%</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Variable</th>
<th>Measurement</th>
<th>Definition and Literature Source</th>
<th>Statistical significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household wealth index hwi</td>
<td>Proxy for ability to access and utilize quality healthcare</td>
<td>This is the economic status of the family measured in KDHS dataset as a categorical variable using quintiles from 1 to 5 where; 1=poorest, 2=poorer, 3=middle, 4=richer and 5=richest indicating the number of mothers in each wealth quintile. KDHS has not provided a specific amount of household income used in categorising these quintiles. Richest wealth quintile is used as the reference category in all the regressions. Wealth is strongly correlated with measles vaccination (Fernandez et al., 2011; Antai, 2009; WHO, 2007; Barata et al., 2012).</td>
<td>Poorest wealth index is significant at 1% level, while poorer, middle, and richer wealth index are statistically insignificant at 10% level.</td>
</tr>
<tr>
<td>Antenatal care by doctor acnd</td>
<td>Proxy for access and utilization of quality healthcare</td>
<td>This is the care given to pregnant mothers by a doctor. It is defined in this study as one if the mother received antenatal from a doctor and zero otherwise. Access to quality healthcare influences measles vaccination positively (Fernandez et al., 2011).</td>
<td>Antenatal care by the doctor is statistically significant at 1% level of significance</td>
</tr>
<tr>
<td>Variables</td>
<td>Measurement</td>
<td>Definition and Literature Source</td>
<td>Statistical Significance</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Antenatal care by nurse/midwife (ancnm)</strong></td>
<td>Proxy for access and utilization of quality healthcare</td>
<td>This is the care given to pregnant mothers by a nurse/midwife. It is defined in this study as one if the mother received antenatal from a nurse/midwife and zero otherwise. Access to quality healthcare influences measles vaccination positively (Fernandez et al., 2011).</td>
<td>Antenatal care by the nurse/midwife is statistically significant at 1% level of significance</td>
</tr>
<tr>
<td><strong>Too far distance (dhf)</strong></td>
<td>Proxy for access and utilization of quality healthcare</td>
<td>This is the distance to health facility from the mother’s residence. KDHS has not provided a specific measuring unit to determine how too far the health facility is. It is defined in this study as one if the mother did not deliver at a health facility because it is too far or no transport and zero otherwise. Too far distance or no transport to health facility is likely to negatively influence measles vaccination (Bbaale, 2013).</td>
<td>Too far distance to the health facility is statistically significant at 5% level of significance</td>
</tr>
<tr>
<td><strong>Birth order of child (bord)</strong></td>
<td>Proxy for maturity and parity</td>
<td>This is the position each child assumes among the siblings. First born children are likely to have positive influence on measles vaccination. It is defined in this study as one if the child is first born and zero otherwise. Higher birth order is associated with incomplete vaccination (Barata et al., 2012).</td>
<td>First birth order is statistically significant at 5%</td>
</tr>
</tbody>
</table>
Table 1: Definition of Variables (Continued)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurement</th>
<th>Definition and Literature Source</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of child $sc$</td>
<td>Proxy for cultural gender preferences</td>
<td>This is the biological description of the child. It is defined in this study as one if male child and zero otherwise. Male sex is likely to have positive influence on measles vaccination (KRCS, 2011; Jamil et al., 1999).</td>
<td>Male gender of the child is statistically insignificant at 10%</td>
</tr>
</tbody>
</table>

Source: Generated by the author
5.1 Introduction

In this chapter, we present data analysis, interpretation and discussion of the results.

5.2 Descriptive Statistics

Descriptive statistics focuses mainly on variables of the sample used in the model for estimating the determinants of measles vaccination. The results shown in Table 2 below indicate that about 60% (SD=0.5) of the children under five years old are vaccinated against measles, while about 40% are either unvaccinated against measles or their immunization status against measles are not known accounting for infants missed out at nine months which the Ministry of Health through the Division of Vaccine and Immunization intends to reach through supplemental immunization activities and the introduction of second dose of measles (Republic of Kenya, 2013).

About two-third (59%) of the mothers interviewed have primary level of education, about one-third (30%) have no education, while only about 11% and 0.01% have secondary and higher levels of education respectively. Almost none have attained higher than secondary level of education. In other words, only about 11% of the mothers have basic education (secondary) thus are literate and are able to understand health matters, for example the effects of non-vaccination on health of the children increasing the mothers likelihood of taking their children for measles vaccination. It is important to note that about 89% are either illiterate or semi-literate owing to no education and primary level of education, thus are possibly unable to understand health matters lowering their likelihood of taking children for measles vaccination.

Apparently from Table 2, illiteracy appears to be contributing to low measles vaccination coverage, because mothers with lower education are less likely to take their children for vaccination against measles than mothers with higher education levels. Infants missed out at nine months during routine and supplemental measles immunization activities have been found to lower measles vaccination coverage (Republic of Kenya, 2013; KRCS, 2011).
Table 2 below presents the summary of descriptive statistics of the sample estimated:

**Table 2: Summary Statistics of the Sample Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
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<th>Max</th>
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<td>0.5928246</td>
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Source: Author’s computation from KDHS 2008/09 Data
Individuals may get employed with secondary level of education improving their socio-economic status compared to those who do not get employed increasing their likelihood of taking their children for vaccination against measles. Similarly, high levels of education have been associated with high socio-economic status because of gainful employments. Mothers with higher levels of education are more likely have gainful employment than mothers with lower levels of education increasing the likelihood of getting their children vaccinated against measles as a result of increased ability to access and utilize quality healthcare compared to mothers with no gainful employment.

In case individuals with secondary level of education fail to get gainful employments with secondary level of education, which is likely, therefore, only 0.01% (higher education level) are likely to take their children for vaccination against measles because they can pay for direct and indirect healthcare costs even if vaccines are provided free by the Division of Vaccines and Immunization (Fernandez et al., 2011).

Maternal age ranges between 15 to 49 years with a mean of 28 years (SD=7). This observation is commendable as it shows that most of the mothers are not of school going age and are mature enough to take care of their children including taking them for vaccination against measles. It is ordinarily expected that at 28 years of age mothers are mature, married and possibly in gainful employment, thus are more likely to take their children for vaccination against measles than mothers who are unmarried, uneducated and unemployed. This is because socio-economic systems available to these mothers are different with different effects on childhood measles vaccination up take (Fernandez et al., 2011; WHO, 2007).

Table 2 above further shows that 90% of the mothers are married at an average age of 28 years which is commendable because as they mature and socialise with health systems and society at large, the mothers should be more likely to take their children for vaccination against measles. This is because of social and financial support they may receive from their husbands compared to mothers who are unmarried (WHO, 2007).

About 21% are either richer or richest thus are more likely to take their children for measles vaccination than the poorest, while about 17% who are of middle wealth quintile are either more or less likely to take their children for vaccination against measles because of obvious
budget constraints, compared to the richest. Above two-thirds (62%) of the mothers are among the poorest and poorer, thus are less likely to take their children for vaccination against measles because of inability to pay for direct and indirect healthcare costs.

Doctors are mostly allocated curative health services at public hospitals and only attend to antenatal cases referred to them by the nurses/midwives who are largely allocated maternal child health services at public health centres and dispensaries. This is corroborated by the study findings that only about 22% of the mothers receive antenatal care from the doctors, while majority (65%) receive antenatal care from nurses/midwives implying nurses/midwives provide three times more antenatal care than doctors. Nurses/midwives are thus easily accessible to pregnant mothers compared to the doctors because they are found at the dispensaries and health centres usually located nearer to them than hospitals where most doctors are found.

Comparatively, about 65% of the mothers receive antenatal care from nurses/midwives and about 60% of the children are vaccinated against measles, suggesting that most of the children vaccinated against measles are attended to by the nurses/midwives. This is attributable to easy access of nurses/midwives at public dispensaries and health centres where they are mainly allocated maternal child health services compared to the doctors mainly allocated clinical duties at public hospitals.

Barely half (45%) of the mothers do not deliver at the health facilities because they are too far, thus are less likely to take their children for measles vaccination for the same reason, similarly about half (51%) of the children are males, while about 15% children are born first among the siblings.

5.3 Analysis and Interpretation

We used maximum likelihood binomial logistic estimation technique to generate average marginal effects to determine probabilities for being vaccinated against measles given certain background characteristics that included maternal, child and health systems. Maternal education, maternal age, marital status, household wealth index, antenatal care, too far distance to health facility, birth order of child and sex of child have been regressed on measles vaccination which is a dependent binary variable. All the independent variables are simultaneously regressed on measles vaccination and are presented in table 3 below.
Table 3: Estimation of the Average Marginal Effects

| Expression                          | dy/dx | Std. Err. | z      | P>|z|      | [95% Conf. Interval]  |
|-------------------------------------|-------|-----------|--------|----------|----------------------|
| noeduc                              | -.0058569 | .1314329 | -0.04  | 0.964    | -.2634607 -.2517469 |
| primary                             | -.0174655 | .1288727 | -0.14  | 0.892    | -.2700514 .2351204  |
| secondary                           | .0275564  | .1324287 | 0.21   | 0.835    | -.2319991 .2871119  |
| higher                              | 0      | (omitted) |        |          |          |
| mag                                 | .0094568  | .0018322 | 5.16   | 0.000    | .0058653 .0130482  |
| ms                                  | -.0051251 | .0451222 | -0.11  | 0.910    | -.093563 .0833128  |
| poorest                             | -.1193686 | .0484709 | -2.46  | 0.014    | -.2143698 -.0243674 |
| poorer                              | -.07752   | .0498354 | -1.56  | 0.120    | -.1751957 .0201556 |
| middle                              | .003803   | .0522246 | 0.07   | 0.942    | -.0985553 .1061613 |
| richer                              | -.0088594 | .0536464 | -0.17  | 0.869    | -.1140044 .0962855 |
| richest                             | 0       | (omitted) |        |          |          |
| ancd                                | .1539907  | .032327  | 4.76   | 0.000    | .0906309 .2173505  |
| ancnm                               | .1259476  | .0277276 | 4.54   | 0.000    | .0716025 .1802926  |
| dhf                                 | -.0497157 | .0229392 | -2.17  | 0.030    | -.0946757 -.0047558|
| fborn                               | .0948752  | .0394191 | 2.41   | 0.016    | .0176152 .1721352  |
| male                                | .0031815  | .0229086 | 0.14   | 0.890    | -.0417186 .0480815  |

Source: Author’s computation from KDHS 2008/09
Maternal Characteristics

The results from Table 3 above show that the probability of mothers with primary education level taking their children for measles vaccination is 0.017 lesser than the mothers with higher levels of education, while the probability of mothers with secondary education taking their children for measles vaccination is 0.028 greater than mothers with higher education holding other variables included in the model constant, however the effects of, primary education and secondary education on measles vaccination are statistically insignificant at 10% significance level respectively. Similarly, the effects of mothers with no education is statistically insignificant at 10% level of significant reducing the probability of the mothers taking their children for measles vaccination by about 0.006 lesser than mothers with higher levels of education. This implies that maternal education levels do not determine childhood measles vaccination in Kenya.

One year increase in maternal age increases the probability childhood measles vaccination by about 0.01 (p<0.01), and is statistically significant at 1% significance level, implying every additional year in maternal age increases the mothers likelihood of taking their children for vaccination against measles by 1%. Marital status has been otherwise shown to reduce measles vaccination by 0.005 (p>10), however its effects on measles vaccination is statistically insignificant at 10% level of significance. Being a married mother therefore is likely to reduce her chances of taking her child for vaccination against measles compared to mothers who are unmarried, thus reducing childhood vaccination against measles coverage.

The results further show that mothers in poorest wealth quintiles reduces measles vaccination by 12% (p<0.05), with statistically significant effects at 5% significance level, holding other variables included in the model constant; however poorer and richer wealth quintiles are shown to reduce measles vaccination by 0.08 (p>10) and 0.009 (p>10) respectively, though there effects are statistically insignificant on measles vaccination at 10% level of significance holding other variables included in the model constant. Middle wealth quintile has otherwise been shown to marginally (0.004) increase measles vaccination coverage, however is equally insignificant statistically at 10% level of significance. This therefore implies that only the poorest mothers are likely to reduce measles vaccination coverage.
Child Characteristics

Table 3 above shows that male children born first in a family have positive influence on childhood vaccination against measles. Being first born in a family increases the likelihood of being vaccinated against measles by 0.1 (p<0.05), and being a male child increases the likelihood of being vaccinated against measles by 0.003 (p>10) holding other variables included in the model constant. However, the effects of being born first are significant at 5% significance level, while the effects being a male child are statistically insignificant at 10% significance level.

Health System Characteristics

It is worth noting that all health system characteristics are significant determinants of measles vaccination in Kenya. The effects of antenatal care are statistically significant at 1%, and too far distance to the health facility is significant at 5% levels of significance respectively. The probabilities of children whose mothers seek antenatal care from the doctor or nurse/midwife getting vaccinated against measles are 0.15 (p<0.01) and 0.13 (p<0.01) respectively greater than the children whose mothers do not seek antenatal care from the doctor or nurse/midwife. However, too far distance to health facility reduces the probability of childhood measles vaccination by 0.05 (p<0.05), similarly its effects are statistically significant in determining measles vaccination coverage implying that too far distance to health facility reduces the chances of children being vaccinated against measles.

In conclusion, one year increase in maternal age, receiving antenatal care from doctors, or nurses/midwives positively influence childhood vaccination against measles and are statistically significant at 1% level of significance, similarly children who are born first in a family positively influence measles vaccination, however at 5% significance level, whereas, poorest wealth quintile and too far distance to health facility negatively influence childhood vaccination against measles and are statistically significant at 5% level of significance.

To test the power of prediction of the model shown in Table 6 in the appendix, we sought to find out that \( P(y=1|x) = E(y|x) \) implying that the probability of children under-fives getting vaccinated against measles conditional to maternal education, maternal age, marital status, household wealth index, too far distance or no transport to health facility, birth order of child
and sex of child. From the estimations we obtained the correctly classification of the binomial logistic regression model= 63.10%. Therefore we conclude that the model has a good fit.

5.4 Discussion of the Results

This paper investigated the determinants of measles vaccination in Kenya. The findings showing that about 60% of children are vaccinated against measles are encouraging though not impressive in the face of measles outbreak resurgence and increasing measles’ related infant and child morbidities and mortalities. None immunization of children against measles because of high dropout rates and low coverage has been associated with measles outbreaks in Kenya (KRCS, 2011; Republic of Kenya, 2013). The government should therefore increase its efforts in increasing awareness among the population on the importance of timely childhood vaccination against measles through mass media, social mobilization and health education.

Maternal education has been highlighted in most literatures as a predictor of childhood immunization owing to changes in attitudes and traditions brought about by education, thus mothers with higher education levels are more likely to have children who are fully immunized (Bbaale, 2013; Mariara et al., 2012, Mutua et al., 2011; Fernandez et al., 2011; Culter et al., 2006; Elo, 1992, Wagstaff, 1986). However, our study fails to confirm this argument as no level of education has been found to significantly influence measles vaccination.

Increased access and utilization of quality health care is ordinarily expected to improve child health and ultimately child survival owing to adequate and timely childhood vaccination as confirmed by our study. Mothers who receive antenatal care from doctors, nurses/midwifes are associated with a higher likelihood of taking their children for vaccination against measles than mothers who do not receive antenatal care from doctors, nurses/midwifes (Bbaale, 2013; Mutua et al., 2011; Mwabu, 2009). This can be attributed to routine health education messages mothers receive from healthcare providers emphasising the importance of timely vaccination of children against measles.

Knowledge and skills attained through health education may affect a person’s cognitive functioning, making them more receptive to health education messages, or more able to communicate with health workers and access appropriate health services, for example taking
their children for measles vaccinations. Health systems may have reinforced factors that may reduce susceptibility to health effects from inequitable exposures, using various means including vaccination, empowerment and social support (WHO, 2007).

Ordinarily one would expect only children from poorest household wealth quintiles to have lower likelihood of getting vaccinated against measles than children from the richest household wealth quintiles, however this is not being corroborated in our study as both the poorest and richer mother reduce the likelihood of childhood vaccination against measles. The poorest mothers reduce the likelihood of a child being vaccinated against measles by about 0.12 greater than the richest mothers.

Mother’s household wealth is significantly associated with the likelihood of full immunization status, with higher position in the wealth index being associated with increased likelihood of full immunization according to (Antai, 2009). High socio-economic standing may be related to healthy outcomes because of certain privileges such as easier access to better healthcare (WHO, 2007). This observation has been clearly corroborated by our study that mothers in poorest wealth quintiles are less likely to take their children for measles vaccination than mothers in the richest wealth quintile (Serpell et al., 2006). Maternal autonomy regarding personal healthcare decisions are enhanced by better socio-economic status impacts on children’s vaccination coverage (WHO, 2007). Wagstaff (1986) points out that at the low levels of health and health inputs currently prevailing in the third world, even quite modest increases in the quantities of health input employed have relatively large impacts on life expectation, and vice versa.

Similarly, it is surprising to note that richer wealth quintile lowers the mother’s likelihood of taking her child for vaccination against measles, though its effects are statistically insignificant (Culter et al., 2006). This may be attributed to the ‘law of diminishing marginal product’ where at high levels of health and health inputs, even large increases in the resources devoted to health promotion appear to have relative small impacts on the quantity and quality of life in addition to the fact that individual’s lifestyles are likely to depend partially on their income, financial wealth and level of education (Wagstaff, 1986).

Our study further shows that mothers in middle wealth quintile are marginally more likely to take their children for measles vaccination than mothers in the richest wealth quintile, though
its effects are statistically insignificant. This justifies initial argument that mothers in middle wealth quintile are either more likely or less likely to take their children for vaccination against measles owing to possible budget constraints experienced by individuals in maximising on their utility functions (Mwabu, 2009; Rosenzweig et al., 1983). Similar findings are found in a study that was carried out in Indonesia revealing that the middle wealth quintiles are more likely to use subsidised health cards than the poorest quintiles, yet the health subsidy cards is intended to increase access and utilization of quality health care by the poorest (Fernandez et al., 2011; Wagstaff, 1986).

Higher birth order is associated with incomplete vaccination (Barat et al., 2012) and women with higher parity are less likely to have fully immunized children compared to those with lower parity (Mutua et al., 2011) as have been confirmed in our study. The probability of a first born child getting vaccinated against measles is about 0.1 greater than the subsequent children. Additionally, high parity is accompanied with advancing reproductive age as shown in our study where one year increase in mother’s age marginally (0.01) increases the likelihood of childhood vaccination against measles.

Too far distance to health facility is more likely to reduce the likelihood of a mother taking her child for vaccination than near distance to health facility, probably attributable to direct and indirect costs of healthcare like the transport costs (Serpell et al., 2006). Being a male child has marginal positive effects on measles vaccination, though its effects are statistically insignificant. Sex discrimination exists in the rural areas of Bangladesh where female children are 30% are less likely to be fully immunized compared to the male children (Jamil et al., 1999; KRCS, 2011).

Ordinarily one would expect that mothers who are married are more likely to take their children for vaccination than their counterparts who are unmarried because of concerted effort of the couples in attaining good health for their child. This has been disputed by our study showing that married mothers are less likely to take their children for vaccination against measles than mothers who are unmarried; however its effects are statistically insignificant. Mothers who need spousal permission to visit clinics are also less likely to have fully immunized children (WHO, 2007).
CHAPTER SIX: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Summary
The broad objective of this study was to assess the determinants of measles vaccination in Kenya where some of the variables examined were statistically significant. Antenatal care, first birth order, poorest wealth quintile and too far distance are some of the variables found to determine measles vaccination in Kenya. However, household wealth index, marital status and maternal education usually thought to relate positively with measles vaccination coverage were actually statistically insignificant. Increasing access to doctors nurses or midwifes increases the likelihood of a child being immunized against measles, being born first significantly increases the likelihood of being immunized against measles and one year increase in mother’s age marginally increases the likelihood of taking her child for vaccination against measles. Poorest and too far distance to health centre reduces the likelihood of a child getting vaccinated against measles. A key finding made in this study is that the likelihood of children born in a family is 0.1 greater than the children born after them.

6.2 Conclusions
This paper has provided insights into the factors determining childhood measles vaccination in Kenya and is expected to be of great importance to policy-makers in increasing measles vaccination and other routine vaccinations with an aim of achieving the GIVS goals on routine vaccinations.

Maternal education and marital status have been ordinarily associated with increased measles vaccination coverage; however our study reveals otherwise attributable to the fact that measles vaccination is done through routine and supplemental immunization activities. Routine vaccination is done at fixed health facilities schedules, thus immunizing the child is fully dependent on the mothers willingness to take the child for vaccination, while supplemental immunization activities are mobile health facilities, where health workers go door to door administering the vaccines, therefore is not fully dependent on the mother’s willingness to take the child for vaccination. However the results shows that too far distance or no transport to the health facility reduces measles vaccination coverage, ordinarily the effects would be more than this owing to the same scenario.
The model we used in this study have the following limitations; Secondary and higher levels of education have been interchangeably omitted in our regressions because of collinearity. Similarly, richest wealth quintile has been omitted because of collinearity (Wooldridge, 2009). This model does also not take into account contextual effects of decision-making, such as social learning influence which can lead individuals in a similar social setting to act similarly as explained by social and behavioural theories widely used in the field of public health. Rational decision-making depends on individual’s cognitive capacity which is enhanced by increase in years of education. Health belief model for example emphasises one’s perceptions of susceptibility to a disease, severity of a disease, benefits and barriers to prevent disease and cues to action, which largely depends on one’s ability to understand impacts of the disease. Therefore combining economic and public health theories may yield more significant results as far as determinants of measles vaccination are concerned.

Further research should be carried out on the determinants of Immunization in Kenya with regard to all routine vaccinations, for example ‘the determinants of apparent rural-urban differentials in measles vaccination uptake in Kenya’.

6.3 Policy Implications

There is need to increase contraceptive prevalence, enhance access and utilization of quality healthcare and awareness on timely childhood vaccination. The government spends a lot of resources in free primary education yet primary education level is statistically insignificant in improving measles vaccination coverage, therefore transition rates to secondary and higher levels of education should be enhanced. The Government’s free primary education programme is a commendable beginning that needs to be enhanced up to secondary and higher levels of education, with gender parity at the forefront.
REFERENCES


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WHO SEARO. (2008), ‘Meeting of the Advisory Committee (ACM) to review technical matters to be discussed at the Sixty-first Session of the Regional Committee WHO/SEARO, New Delhi, 30 June – 3 July 2008’, SEA/ACM/Meet.1/7.1 16 June 2008.


Table 4: Summary of the Population Descriptive Statistics

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Source: Author’s computation from KDHS 2008/09 Data
Table 5: Tabulation of Maternal Age

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<td>95.99</td>
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<td>99.92</td>
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<tr>
<td>49</td>
<td>5</td>
<td>0.08</td>
<td>100.00</td>
</tr>
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</table>

Total 6,079 100.00

Source: Authors’ computations from KDHS 2008/09 Data
**Table 6: Power of Prediction**

. *estat classification*

Logistic model for mvac

<table>
<thead>
<tr>
<th>Classified</th>
<th>D</th>
<th>-D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>889</td>
<td>496</td>
<td>1385</td>
</tr>
<tr>
<td>-</td>
<td>152</td>
<td>219</td>
<td>371</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1041</td>
<td>715</td>
<td>1756</td>
</tr>
</tbody>
</table>

Classified + if predicted Pr(D) >= .5

True D defined as mvac != 0

<table>
<thead>
<tr>
<th></th>
<th>True</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>Pr(+</td>
</tr>
<tr>
<td>Specificity</td>
<td>Pr(-</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>Pr(D</td>
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<tr>
<td>Negative predictive value</td>
<td>Pr(-D</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>False + rate for true -D</td>
<td>Pr(+</td>
</tr>
<tr>
<td>False - rate for true D</td>
<td>Pr(-</td>
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<tr>
<td>False + rate for classified +</td>
<td>Pr(-D</td>
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<tr>
<td>False - rate for classified -</td>
<td>Pr( D</td>
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<tr>
<td>Correctly classified</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors' computations from KDHS 2008/09 Data
Figure 2: Measles Cases Distribution by Month and WHO Regions, 2008-2013

Source: www.measlesrubellainitiative.org
Figure 3: Measles Positive Cases in Kenya

Source: Kenya Health Sector Bulletin August, 2012