POPULATION PROJECTIONS OF WOMEN OF REPRODUCTIVE AGE AND ITS IMPLICATION ON MATERNAL HEALTH CARE SERVICES IN KILIFI COUNTY

BY

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Q50/82739/2015

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN POPULATION STUDIES AT THE POPULATION STUDIES AND RESEARCH INSTITUTE, UNIVERSITY OF NAIROBI.

2019

DECLARATION

This research project is my original work and to the best of my knowledge has not been submitted to this or any other University for a ward of a degree.

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DEDICATION

I dedicate this work to my father, Samuel Mwaniki and my mum Lydia Njeri for supporting me and believing in me throughout my entire school life.

I also dedicate this work to my husband Samuel Maina, my brother David Ng’ethe, and my lovely sons; Keith Mwangi and Ethan Mwaniki.

I love you All!

ACKNOWLEDGEMENT

First and foremost, I am grateful to God for enabling me complete this project, Praise be to Almighty God! I would like to express the deepest appreciation to my research supervisors: Mr. Ben O. Jarabi and Dr. Samuel Wakibi, without their patient guidance, critical evaluation and professional input, this project could not have been completed. Thank you so much.

Many thanks to my friend, Dr Diana Marangu, for mentoring and guiding me during my study period. Special thanks to the entire Population Studies and Research Institute fraternity: the Director and lecturers, for their guidance provided to me during the entire period of my study. I am also grateful to the non-teaching staff. Great thanks to my classmates: Kevin Mungai, Gideon Matheka Teresa Bange, Emilly Jeptoo and Jesicca Wabwile.

My mum and dad deserve special mention for their support and always being there for me, I never would have made it here without them, I owe my success to them.
God bless you.

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LIST OF ABBREVIATIONS

ANC	Antenatal care
ASFR	Age specific fertility rate
HIV	Human immunodeficiency virus
IMR	Infant mortality rate
IPTp	Intermittent preventive treatment for malaria during pregnancy
KDHS	Kenya Demographic and Health Survey
MMR	Maternal mortality rate
RMNCAH	Reproductive maternal, newborn, child & adolescent health
SDGs	Sustainable Development Goals
STDs	Sexually transmitted diseases
TFR	Total fertility rate
WHO	World Health Organization

ABSTRACT

The main objective of the study was thus to project women of reproductive age in Kilifi County. The study used cohort component method to project the population of Kenya, coast province and Kilifi County.

The main source of data was 2009 Kenya population and housing census. However, it was first assessed for any irregularities before use. To detect the degree accuracy the UN Accuracy Index was used. Since the UN accuracy index was inaccurate light smoothing was done for the population. From the 2009 census, Kilifi's population was projected to 1,148,016 in 2010, 1,312,866 in 2015, 1,499,703 in 2020, 1,704,924 in 2025 and 1,889,895 in 2030.

The study extracted women of reproductive age from these populations since they fall in the category of 15-49 years of age. Women of reproductive age would increase from 265,924 in 2010, to 318,078 in 2015, 377,867 in 2020, 440,421 in 2025 and 503,189 in 2030.

Expectant women would also increase from 18,881 in 2010, to 22,584 in 2015, 26,829 in 2020, to 31,270 in 2025 and 35,726 in 2030. As the number of expectant women increases during the projection period so does the number of maternal beds and midwives required for maternal services. The number of midwives increases from 84 in 2010, 100 in 2015, 119 in 2020, 139 and 159 in 2025 and 2030 respectively. The study also found out that the number of beds would increase from 9 490 in 2010 to 11 782 in 2015, 14 112 in 2020, 16 448 in 2025 and 18 792 in 2030.

The study recommends training and recruitment of more midwives and putting in place the required infrastructure needed for maternal services such as beds so at to meet the number of expectant women. It also recommends further research on the same but focus on the number of maternal wards and the number of health facilities that offer maternal services in Kilifi County. Further research on the same can be done in other counties with high infant and maternal mortality.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

In most cases, demographers are called upon to generate data about future population. The output is the population projections. Population projections are an extrapolation of past data into the future. They try to explain what is likely to take place under certain clear assessment about the future as related to the immediate past. A population projection is commonly defined as the mathematical result of a precise set of assumptions about the future population (Irwin, 1977; Isserman, 1984; Keyfitz, 1972; Pittenger, 1976; Shryock & Siegel, 1973). It is a conditional arithmetic calculation indicating how the future population is likely to be if specific set of assumptions were to hold true (George et al, 2004). Population projections, thus involve a set of mathematical calculations which show the future progression of the three components of population; fertility, mortality and migration depending on the assumptions used (Smith et al, 2002).

The population of an area decreases or increases due to the interaction of the three demographic processes: fertility, mortality and migration. Projections are computed by making assumptions about how recent births, deaths and migration (emigration and immigration) rates will alter in future. Increase or decrease in population over a future period, is obtained and added to census results or a population estimation at the start of a period based on these assumptions.

Population projections differ in terms of time, geographical coverage, types of output, and use (O'neill et al, 2001). In terms of geographical coverage, population projections range from national to the smallest sub-national level. Global and national projections extend for spans of years into the future, and in some cases, more than a century. On the other hand, sub-national projections tend to use shorter time periods, normally less than a decade or can be based on national development pillars. In Kenya, population projections, for example, can be aligned to the Kenya Vision 2030. Projections for sub-national level break down the population into age and sex and also include other characteristics such as educational and labour force composition, urban residence, or household type and health (O'neill et al, 2001).

Population projections are important for social and economic development both at national and sub-national level. For example, resources can only be fairly distributed, and the needs of the population satisfied, if the size and composition of the current and future populations are known by projecting the current population. Policy makers, programme planners and implementers depend on population projections to determine demand for resources and services for the future population. Population projections also alert on population structure and composition that could have an impact on development both socially and economically and help formulate proper policies and programmes (Kaneda & Bremner, 2014).

The five main uses of population projections are:

The most obvious and frequent use of population projection is for planning purposes. Planning, whether in the private or public sector, aims at meeting present and future demands of the population in order to improve citizen's standard of living (Kenya, 2012a). National and local planners all need, for various purposes, to be aware of likely future population changes in trends of the population in their specific areas of jurisdiction. This is even more important with the current governance structure in Kenya whereby most programmes are now implemented at the county level. For example, employment of doctors and teachers so as to meet doctor-patient and teacher-student ratios, and construction of roads, hospitals, schools, etc. (Swanson et al, 1998) so as to meet the needs of the population.

Second, population projections are used in advocacy. There is need for evidence, especially where there is a negative impact of population; for example, population projections can inform us on how and when to achieve a particular population growth rate. This can be done by projecting the birth rates and other factors that affect birth rates. Such factors include level of education, family size, use and accessibility of family planning services and their effects on people and by how much the birth rate will decrease and the number of years it will take to realize any specific population growth rate and what changes will be in the age composition of the population. Birth rates can thus be projected on the basis of these factors.

Third, population projections are used in research. Researchers frequently use projections so as to answer questions of what would happen 'if'. However, population change can be regarded as being, to some extent, a dependent rather than an independent variable in the planning process. As such, population projections can also be used to approximate the possible demographic effect of planning and policy decisions, planning and policy implications of demographic change as well (Kenya, 2012a).

Fourth, population projections are used to monitor and evaluate developmental programmes at national and sub-national levels so as to attain international and national goals such as the Sustainable Development Goals and Kenya Vision 2030 goals respectively.

Fifth, population projections determine drivers of consumption; for example, construction industries, water and sanitation and manufacturing industries such as tobacco, breweries and clothing industry (Thomas, 1994). Commercial organizations typically want population categorized by socio-economic characteristics for example sex, age, income and consumption habits and by place of residence (O'neill et al, 2001). This enables them to manufacture products that will meet the needs of future generations. Population projections based on age and sex, can help approximate the future demand for their products thus plan and produce accordingly.

There are various types of population projections: national, sub-national, fertility, mortality, migration and sectoral. Sectoral population projections are those based on population-related characteristics such as households, school enrolment, poverty, employment and health. Due to their demand and their close relationship to projections on basic demographic characteristics, the sectoral projections are often done on the basis of projections of basic demographic characteristics and universally both government and non-government organizations are involved in producing these projections (CACI, 2000; Fullerton, 1999; Kintner et al., 1994; Siegel, 2002: 508-510; Tayman, 1996b).

1.1.1 Kilifi County

The Coast region has six counties, Kilifi County being one of them and it covers an area of 12,609.7 km^2 (Kilifi, 2013). According to the 2009 Kenya Population and Housing

Census, the total population enumerated in Kilifi County was 1,109,735. The unadjusted total fertility rate (TFR), was 4.8 compared to 5.2 in the 1999 census (Kilifi, 2013)

The infant mortality rate (IMR) was 55 deaths per 1,000 live births, while under five mortality rate was 72. The life expectancy of females was higher than that of males; 62 and 57 years respectively. The maternal mortality rate (MMR) was 290 deaths per 10,000 (Kenya, 2012c). According to Kilifi County HIV and AIDS strategic plan 2016-2020, Kilifi had a prevalence of 4.4 percent in 2015; hence it is categorized as a medium HIV county. In the 2009 Kenya population and housing census, Kilifi County recorded more out migrants than in migrants thus making the net migration to be at -2,697 (Kenya, 2012d)

1.2 Statement of the problem

Population projections are a critical entry point for effective allocation of resources at the county level. Although, in most instances data on projections of women of reproductive age at the national and county level can easily be obtained, its effective utilization for programmes pertaining to maternal health care services remains limited. Women of reproductive age influence fertility which is the main driver of population change, levels of infant and maternal mortality. The utilization level of maternal health care services by women of reproductive age influences level of both maternal and infant mortality which are key indicators of social development.

In Kenya, there are wide regional differentials in the level of utilization of maternal health care services, as well as in the level of maternal and infant mortality. In Kilifi County, for example, 98.2 percent of pregnant women received ANC care from a skilled provider, but only 52.6 percent delivered in a health facility and only 52.3 were delivered by a skilled provider (KNBS, 2015). Maternal health care services have not been well utilized thus contributing to Kilifi (MMR) of 290 deaths per 10,000 (Kenya, 2012c). The condition of maternal health is closely associated with the infant mortality rate. In the 2009 census, nationally, infant mortality rate was 54 while that for Kilifi County was 55, making it slightly higher than that for Kenya. This indicates that Kilifi County is one of the counties that contributes to this high infant mortality rate nationally.

Although projections of women of reproductive age do exist at the national and county level, they are not properly utilized, especially during planning for maternal health services thus leading to poor availability, accessibility and utilization of maternal health care services hence leading to high level in both maternal and infant mortality.

1.3 Research questions

The study addressed four questions:

i. What is the projected population of women of reproductive age in Kilifi County between 2010 and 2030?
ii. What is the projected population of expectant women in Kilifi County between 2010 and 2030?
iii. What is the projected number of beds in maternity wards in Kilifi County between 2010 and 2030?
iv. What is the projected population of midwives in Kilifi County between 2010 and 2030?

1.4 Objectives of the study

The general objective of this study was to project population of women of reproductive age in Kilifi County between 2010 and 2030.

The study had the following specific objectives:

i. To project the number of expectant women in Kilifi County between 2010 and 2030;
ii. To project the number of beds that will be required in maternity wards in Kilifi County between 2010 and 2030; and
iii. To project number of midwives who will be required in Kilifi County between 2010 and 2030.

1.5 Justification

Reproductive health is a worldwide concern, particularly; to women of reproductive years (15-49 years) since most of the health problems arise during this period. These women are at a greater risk of complications from pregnancy and delivery; they also experience problems while preventing unplanned pregnancy, suffer from difficulties of unsafe abortion, endure most of the burden of family planning, and are more exposed to contracting, and suffering complications of reproductive tract infections, particularly sexually transmitted diseases (STDs). This study will, therefore, generate population projections of women of reproductive age for Kilifi County for all relevant aspects of planning and advocacy.

Kilifi County is one of the counties that has been prioritized for the Reproductive Health, Maternal, Newborn, child and Adolescent Health (RMNCAH) investment framework due to the high poor maternal and child health outcomes. This study will thus aid Kilifi County to come up with its own RMNCAH, investment framework, so as to reduce maternal and infant mortality rate in line with the reproductive health strategy targets and SDGs targets.

1.6 Scope and Limitations

The study used the 2009 Population and Housing Census data. Census enumerations are not always 100 percent accurate; there is either over or under coverage of person due to errors on the reported data on age and sex. Adjustment for coverage errors will not be possible since results of the post-enumeration survey have not been published by the Kenya National Bureau of Statistics. This study will only focus on Kilifi County and the findings may not be applicable to other counties due to differentials in socio-economic and demographic parameters.

The study also utilized the KDHS data. According to Rugendo, 2016, the KDHS data has flaws since the data on date for births for women and children ever born was incomplete. However, the elements that were missing were inputted since the ages had been provided.

The study also focused on one sub-group (women of reproductive age) due to lack of enough time to deal with the other sub-groups such as the youth, elderly and school age populations. There are many reproductive health needs of women of reproductive age, however this study will focus on the maternal beds and midwives due to time.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

In this section, the concepts of population projections, methods of population projections, previous works on population projections in Kenya, and components of population projections are discussed.

2.2 Concepts in population projection

There are four terms in demography when referring to a population; estimate, forecast, projection and prediction. An estimate refers to information from sample surveys or administrative records about a contemporary or historical population (George et al, 2004). Population estimates are generally described as being of three types; inter-censal estimates, immediate post-censal estimates and future estimates or projections (Bryan, 2004). The term estimate is generally used for inter-censal or immediate post-censal periods where there is a higher degree of confidence that results obtained are likely to be very close to actual figures (Dire, 2016).

Projection and forecast are often used interchangeably, but they don't imply the same thing. The term projection refers to the mathematical output of the future population based on assumptions; whereas forecast refers to a statement, mainly in terms of probabilities, about an event whose actual outcome has not been observed. On the other hand, prediction is a statement about the way things will happen in the future, mainly in terms of certainty, but not always based on experience.

The main role of population projections is to anticipate changes in the population size and characteristics. Population projections are, therefore, a real test of demographers' understanding of the major components of population change (Dire, 2016). Most of the government and non-governmental organizations commonly use population projections as they are unavoidable in policy making and programming (Rwanda, 2014). However, it is important to note that projections should not be taken as the final population. This is because policies keep on changing yet the projections do not change. Therefore, it is critical for the review of projections every now and then to ensure that they match with the current demographic changes.

2.3 Methods of population projections

There are two methods used in the preparation of population projections: subjective or objective methods. Subjective methods cannot be duplicated approximately by other analysts because data, methodology, and assumptions are not clearly identified. However, for objective methods other analysts can copy them as they are because the data, techniques, and assumptions are clearly identified (Bryan, 2004). The two main methods used in population projections: mathematical and component methods. Mathematical method is where the evolution of a population is assumed to be described by some fairly simple mathematical method. Component method is where all the three components of a population are taken into account explicitly (USBC, 2011).

2.3.1 Mathematical methods

Mathematical methods are fast and easy methods which require little data and involve fitting one of several curves to the entire population enumerated in past censuses to project the population at some future date with the expectation that curves will precisely define how population will change or must change. They are commonly used for whole populations and for short-range projections (less than ten years) (Zimbabwe, 2012).

However, there are four basic flaws with this model:

i. The method involves inherent assumptions about continuity of population change, that is, assumptions that the same model can be used throughout the projection period;
ii. The existing levels and trends in fertility, mortality and migration are not considered;
iii. Most tend to co-estimate future population sizes mainly due to the decreasing fertility rates which are not considered by simply extrapolating past events; and
iv. They generate short term projections not exceeding 15 years.

Several mathematical functions can be used for projecting but the commonly used are; linear, geometric, exponential and logistic functions.

2.3.1.1 Linear function

This is one of the simplest function since population change over a particular period for example, a year is assumed to be of similar amount as occurred during the base period (Bryan, 2004). This means that the average annual change that occurred during a recent period of time will be repeated in the future (Eduardo et al, 1994). The simplest curve is a straight line given by the formula:

$P^t = P^o + Y*t$,

Where P^t is projected population at time t, Po refers to the population at last census, while t is the time in future and Y is the annual change in population.

However, actual observations indicate that population growth is not linear, hence the need for other functions.

2.3.1.2 Geometric function

It is also referred to as compound interest. This function assumes that changes in population will be of the same percentage rate over a given addition of time in the future as that of the base period (Bryan, 2004). Used when the population is assumed to grow at a constant rate r each year then P_t represents the population at year t while P_o is the initial population and n is the number of years of the projection period which are connected by the formula:

$P_t = P_o (1+r)^n$

This equation represents the constant ascend r each year. The addition is assumed to be made regularly every twelve months. However, in the real world, population growth is a continuous rather than an annual change, births occur every second not at the end of every year.

2.3.1.3 Exponential function

There is a close relationship between exponential function and the geometric one, the difference is that change is seen to be taking place continuously rather than at distinctive intervals (Bryan, 2004). Population grows exponentially if fertility and mortality are constant and there is no migration. Projections made using this function are computed as:

$P^{t+n} = P^t e^{nr}$

where P, t, and n represent the same concepts as above, r is the average annual growth rate, and e is the base of the natural logarithm. Thus, compared to the linear or geometric, an exponential function would better represent the growth of a population (Eduardo et al, 1994).

2.3.1.4 Logistic function

Unlike the other mathematical methods mentioned above, the logistic function can be used in projection of total populations. This clearly allows one to place a higher limit on the eventual population size for a given area. It is designed to yield an S-shaped pattern. This pattern represents a period of slow growth rates at the beginning, followed by a period of increasing growth rates, and lastly a period of decreasing growth rates that approach zero as a population approaches its higher limit (Bryan, 2004).

The logistic curve assumes that the rate of growth doesn't stay constant but gradually drops to near zero so that the population tends towards a finite size. It implies that after some time, the population growth rate slows down and the population size will never grow. The formula used for the logistic function is:

$Y_x = l_x + {}_x{}^s$

Where Y_x is the logit transformation of the life table survivors, l_x and ${}_x{}^s$ is the corresponding logit of the standard life table.

However, since most populations have not yet reached zero rate of growth, the exponential curve still gives realistic estimates although a logistic curve would be useful when one might expect a limit to the ultimate population (Eduardo et al, 1994).

2.3.2 Component method

Changes in the population size and structure can only occur if and only if any of the three vital events (births, deaths and migration) take place. Consequently, these events are called the components of population change. The components of population change are:
(Births – Deaths) + (In-migrants – Out-migrants).

The component method simulates how the population changes in relation to its components of growth. The cohort-component method, therefore, divides the launch-year population into age-sex groups (i.e., cohorts) and accounts independently for the three demographic processes: fertility, mortality, and migration of each cohort as it goes through the projection period (George et al, 2004). Thus, the component method is the most regularly used and superior to the mathematical methods.

Assumptions are made about the future trends in the three components of population change based on preceding information. The projected rates are then applied to the age and sex structure of the population also taking into account that people die as per age and sex, women give birth, and that some people change their place of residence. It is most widely used if data is available. This method usually presents a set of scenarios chosen to represent plausible, possible or relevant future paths of fertility, mortality, and migration. Among the high, medium, and low scenarios of population projections generated by the cohort-component method, the medium variant is treated as being the 'most likely' outcome, since it gives a sense of neutrality and hence an apparent plausibility in future development (Kenya, 2012a).

The component method has four advantages:

i. It enables one to appreciate the effect of each of the separate assumptions about the three components;
ii. The projected population is available by age and sex and not just total population as obtained by mathematical curves thus provide information on population dynamics;
iii. Can be used at any geographical level; and
iv. Can accommodate wide assumptions.

However, it is much more cumbersome, has heavy data requirements, and is time consuming as compared to the mathematical method (UBSC, 2011).

2.3.3 Ratio Share method

The ratio method is the most reliable method of projecting population at lower geographic levels, and, when the required data about the components of population change are not available. As the name suggests, it is based on the ratio of the sub-national population to that of the national population. Once the ratio of the sub-national population is obtained, assumptions are made on the future values of the ratios and fixed, then the projected population of the sub-national is calculated by applying the ratio to the projected national population in that year (Environment Agency, 2007).

The aggregate sub-national level population will be made to tally with the original total at national level and the aggregate county population will be made to tally with the original total at county level. Thus, the ratio (R) is defined as,

$(P_i(t))/ (P_p(t)$

where $P_i[t]$ is population of i^{th} unit at the time t; $P_p[t]$ is the population of the national at time t to which unit 'i' belongs.

The three types of ratio share method are constant share, shift share and share-of-growth.

2.3.3.1 Constant Share

The unit share of the national population in constant method, is held constant at a level observed during the base period. It is expressed as

$P_{it}= (P_{il}/P_{jl}) (P_{jt})$

where P_{it} is the population projection for the unit area (i) in the target year; $P_{il}$is the population of the unit area in the launch year; P_{jl} is the population of the parent area (j) in the launch year; and P_{jt} is the projection of the parent area in the target year.

Some of the advantages of this method are that its data requirements are from only one point in time and projections for the entire unit areas sum up exactly to the projection for the parent area. However, this method assumes that all the unit areas and the parent area will grow at an equal rate which is always not the case (George et al, 2004)

2.3.3.2 Shift share

This method is designed to deal with changes in population portions. The formula for shift share is:

$P_{it} = (P_{jt})[(P_{il} / P_{jl}) + ((Z/Y) ((P_{il} / P_{jl}) – (P_{ib} / P_{jb})))],$

where the unit area is denoted by i; the parent area by j; Z is the number of years in the projection horizon; Y is the number of years in the base period; and b, l, and t refer to the base, launch, and target years respectively.

Some of the drawbacks of this method are: it can lead to significant losses in population areas that grew very gradually during the base period, particularly when the projections cover long-time periods; and in areas that have been having fast growth rate, can lead to negative numbers and absurdly high projections (George et al, 2004).

2.3.3.3 Share-of-growth

The last method of ratio-share is share-of-growth and it focuses on shares of change in population and not population size. The method assumes that population change of the unit area and that of the parent area will remain the same over the projection horizon as it was during the base period

"$P_{it} = P_{il} + [((P_{il} - P_{ib}) / (P_{jl} - P_{jb})) (P_{jt} - P_{jl})]$"

where the components are explained the same as those in the shift-share method. In most cases, this method seems to give more rational projections than either the two previous methods discussed above. Nevertheless, it becomes problematic when a growth rate in a unit area has a conflicting sign to that for the parent area (George et al, 2004).

2.4 Components of population projections

There are three population components; fertility, mortality and migration. Nevertheless, the prevalence of HIV cannot be disregarded, especially if it is more than one percent. The three components will be projected independently (Shryock, 1976).

2.4.1 Fertility projections

Fertility, compared to the other two demographic events has a bigger impact to the growth of a population. This is because it is the primary engine of population growth in Kenya. Evaluation of the recent past of fertility trends is important in indicating the immediate and future direction of fertility (Hollman et al, 2000). In projecting fertility, two inputs are needed; total fertility rate (TFR) and age specific fertility rates (ASFR). Total fertility rate refers to the average number of children born to a woman in her life time if she were subjected to the prevailing rate of age specific fertility in the population. Hence it indicates the trend in fertility, while age specific fertility rate refers to the number of births per a thousand women of a cohort thus indicating the patterns of fertility (Kenya, 2012a).

2.4.2 Mortality projections

Projections of mortality are based on projecting future expectation of life at birth for males and females independently. Expectation of life is the estimation of the average number of additional years a person could expect to live if the age specific death rates for a given year remained the same for the rest of his/her life (Kenya, 2012a; Eduardo et al, 1994).

Adjustments due to HIV

Non AIDS mortality

This entails the population that is not affected by AIDS and is projected separately from the population that is affected by AIDS.

AIDS mortality

AIDS is an epidemic that slows down population growth, especially at birth, especially in sub-Saharan Africa, Kenya included. Botswana experienced a drop in life expectancy from about 63 years to below 50 in the late 1980s and 1990s respectively. This was also the case in Zimbabwe where it dropped from 57 to 44 years over the same period (UN, 1999c). AIDS causes an economic burden to the individual and the nation as well. Moreover, AIDS affects the age and population structure of a country (O'neill et al, 2001). The United Nations recommends that the impact of HIV/AIDS be incorporated in projecting mortality in populations where HIV prevalence is more than one percent (Shryock & Siegel et al, 1976).

2.4.3 Migration projections

The third component of population change is migration. It is a very complicated component because many countries don't have sufficient data on migration, Kenya being a good example, yet the population is always on the move both in and out. Since this study is focusing on projections at the county level, internal migration is very important and this is the main difference between national and county projections in the component method: the component of internal migration is incorporated in county projections (George et al, 2004). Previous censuses in Kenya have recorded very low volumes of international migration –

hence an insignificant factor in population change. Migration can be projected by use of either net migration or gross migration figures (George et al, 2004).

2.5 Case study on population projections

Depending on the research objective(s), there are various methods that can be utilized in order to obtain projections for a given population. Masaviru (1981), in her thesis, examined the projected school age and school going population vis-a-vis provision and distribution of education facilities. She made use of the cohort component method using the Hamilton Perry formula. Ondieki (1989), in his thesis, utilized the exponential equation to project the Nairobi population and its housing implications and observed that needs of housing were maximizing with time like the population.

Mwangi (2012) used the cohort component method in projecting the national and provincial populations and ratio method to project the county populations in his study of primary school-age population projections for counties in Central province, Kenya.

Kodiko (2014) applied sub-national projection methods like growth model share, population model share, model of growth difference and models for shortcut cohort to the counties in the former province of Nyanza, Kenya. Dire (2016) also used the cohort component and ratio share methods to project sectoral population in Isiolo county, Kenya. Projections of global mortality & burden of disease from 2002 to 2030, used socio-economic development to model future patterns of mortality and illness for a baseline scenario (Mathers et al, 2006). Ethnic population projections for the UK, 2001-2051, used cohort-component model and bi-regional model, specific for single years of age to 100, to handle large state space, (Rees et al, 2012). It is worth noting that such kind of study, where population projections are linked to maternal health services has not been done.

2.6 Needs of women of reproductive age

According to the World Health Organization (WHO), health is having complete wellness physically, psychologically and socially, and not just the lack of disease or illness. Reproductive health, hence, implies that humans are able to have a responsible, satisfying and safe sex life and that they can reproduce and the freedom to decide if, when and how often to do so. According to the United Nations, women of reproductive age fall in the age group between 15 and 49.

Reproductive health is not only a national concern but a worldwide concern. Internationally, it is within the reproductive health target under the SDG number three which states that, 'By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes'.

The nature and scope of information and services a woman receives when she is pregnant influences the levels of infant and maternal mortality. When a woman is pregnant she is supposed to receive antenatal care (ANC). Antenatal care entails identifying and managing any obstetric problems which can arise any time during the pregnancy and infectious diseases including HIV, immunization of tetanus, toxoid immunization, prevention of malaria during pregnancy, intermittent preventive treatment for malaria during pregnancy (IPTp), and identification and management of infections including HIV, syphilis and other sexually transmitted diseases (STDs).
It is during this time that women are encouraged to use skilled birth attendant and healthy activities such as breastfeeding, early postnatal care, and planning for optimal pregnancy spacing. However, this is not usually the case in Kenya because in the 2014 KDHS, only 58 percent of expectant women made the recommended four or more antenatal care visits during their pregnancy, 61 percent delivered in a health facility and 62 percent deliveries were attended to by a skilled birth attendant.

2.7 Maternal Health Services

Maternal health services refer to the services a woman gets during pregnancy, delivery and post-delivery (Ajaegbu, 2013). The quality of these services determines the level of both maternal and infant mortality. Quality in this case refers to the needs of these women being met. Quality maternal health care services reduces the levels of maternal mortality and ensures that the women remain healthy during and after pregnancy. Utilization of these services by women also plays a significant role to the wellbeing of the mother and the infant. The assessment of the mother and child begins at antenatal care (ANC).

ANC involves routine check through examinations and tests of the pregnant women and their unborn babies by medical professions such as physician, midwife or obstetrician or a combination of these professionals. One major determiner of quality maternal health care services is the human resource since they are very critical in the management of maternal health services. Midwives are key human resource in maternal health. The United Nation Population Fund, (UNFPA), defines midwife as an educated, accountable health professional who possess the skills, experience to support mother and babies through pregnancy, delivery and recovery stages of birth.

The role of a midwife in mother and child care is very unique during the birth process. It is also more comprehensive as it involves collaboration with a more skilled medical team. Midwifery care leads to lower intervention, cost-effectiveness and better outcomes. According to the 2014 World's Midwifery report, well trained midwives could help aid in prevention of ninety percent of all maternal and new born deaths. For the midwives to be effective in delivering maternal services, they need maternal beds. Maternal beds are an important infrastructure when delivering maternal health care.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter outlines data sources and methods of analysis that were used in this study.

3.2 Evaluation of the 2009 Kenya Population and Housing Census data

The main source of data for this study was the 2009 Kenya population and housing census. This was the fifth census to be undertaken in Kenya. It was conducted on the night of 24th/25th August 2009. Due to administrative and logistic problems, the 2009 census data was not 100 percent accurate but had both coverage and content errors hence the need to adjust the data before projecting the population.

3.2.1 Coverage errors

Sex ratio is an analytical tool that was used in this study to check for coverage errors. The male population was divided by the female population of the same age group and the outcome multiplied by 100. If the values of the ratios are distant from values close to 100, then the data is more likely to have errors therefore it was adjusted before use. The level of the sex ratios is dependent on the number of males and females born and on the mortality rate of the population. This is because at birth, males are more compared to females; hence sex ratio is slightly over a hundred at early ages. However, the mortality rate is higher for males than females, so the sex ratio reduces with age (Eduardo et al, 1994).

3.2.2 Content errors

Age profile of a population is very important. It is, therefore, important to evaluate the accuracy of the age distribution and correct for deficiencies wherever necessary. The principal approaches for evaluating age misreporting are digit preference and age ratios (Kenya, 2012a).

Myers' index will be used to detect digit preference. Myers blended index assesses digit preference in all the 10 terminal digits (0-9). Every one of the ten terminal digits takes 10 percent out of a 100. In an ideal situation where there is no digit preference, the terminal digit will score a total of 10 percent. A deviation from 10 percent shows either digit preference (a positive deviation value), or digit avoidance (a negative deviation value). Positive values indicate digit preference - that people prefer reporting their age ending with those digits (Kenya, 2012 pp).

Age ratios for 5-year age groups provide an alternative for detecting possible age misreporting. In a population where there is no age misreporting, age ratios should be equal throughout the age distribution, and they should all be near to a value of 100. Like in the case of sex ratios, errors in the data are indicated if the fluctuations of these ratios are large and if they largely departure from 100 (Kenya, 2012a).

The UN age-sex accuracy involves obtaining the age and sex ratios. Age ratios are 100 times the ratio of each age group divided by the number of adjacent age groups. Sex ratio scores are 100 times the male population divided by the female population in each age group. Age ratio deviation is the difference of each age ratio from 100 regardless of the sign while the difference of sex ratios is the difference between two consecutive sex ratios regardless of the sign (Eduardo et al, 1994). The final step is given by the formula:

‘Joint score= 3*sex ratio scores +age ratio scores for males+ age ratio scores for females'.

If the final joint score obtained will be less than twenty then smoothing techniques will not be required but if it is more than twenty then smoothing techniques will be used.

3.2.3 Adjustment of errors

Based on the UN accuracy index, smoothing techniques will be used to adjust detected irregularities due to age-sex misreporting in census data. If the adjusted data is inaccurate (between 20 and 40) as per the UN accuracy index then light smoothing will be done, but if it is highly inaccurate (above 40), then strong smoothing will be done. The smoothed population sets will, thus, form the base population for the projections.

3.3 Components of population projections

There are three population components; fertility, mortality and migration. Nevertheless, the HIV prevalence cannot be disregarded, especially if it is more than one percent. Each component will be projected independently (Shryock, 1976).

3.3.1 Fertility projections

In most cases, when projecting fertility, the first step was to project the level of the total fertility rates, and then the pattern of the age-specific fertility rates was estimated (Eduardo et al, 1994). Fertility projections were thus made by projecting the course of the TFR over time and then translate this total fertility rate into age-specific fertility rates. In general, the projection of TFR is divided into assumptions regarding an assumed final fertility level, and the path taken from the existing to the final level. Both assumed eventual fertility level and projected pace of fertility change are essential to driving population structure and size trends (Kenya, 2010a).

3.3.2 Mortality projections

Mortality projections were based on projecting future expectation of life at birth for males and females. The next step was to estimate mortality patterns by age for each of the projected life expectancies (Eduardo et al, 1994). Since HIV prevalence for Kilifi was more than one percent, mortality projections will include the impact of HIV/AIDS as recommended by the United Nations (Shryock & Siegel et al, 1976).

3.3.3 Migration projections

The Kenya 2009 population and housing census recorded a low rate of migrants with less than one percent of international migration and will therefore not be included into the projections of the national population. However, since the study will focus on Kilifi County, it is important to project internal migration. The study did this by establishing net migration in Kilifi County over the last three censuses. Based on this trend, appropriate projections were made.

3.4 Population projections

The study projected populations at national, sub-national and sectoral levels. Then the projected sub-national population was used in generating the projected women of reproductive age for Kilifi County.

3.4.1 National population projections

The inputs required to project the national population were; population accurately distributed by age and sex which serves as the base population for the beginning period of the projection, and reliable approximates of the three components of population change (fertility, mortality and migration). The study utilized the 2009 Kenya Population and Housing Census data.

The component method was used to project national population. Beginning with a base population by age and sex, the population at each specific age will experience death as determined by the projected mortality levels and patterns by age and sex. The deaths were calculated and subtracted from the population that is surviving, and the remaining alive ones will grow older. To estimate the number of births every year, fertility rates were projected and applied to the female population in childbearing ages. Each cohort of children born was exposed to appropriate chances of dying.

Lastly, the component method considers any in-migrants and out-migrants who are incorporated into the population and who leave the population respectively. Immigrants were thus added to and emigrants deducted from the population at each specific age. This was repetitively done for each year of the projection period so as to yield the projected population by age and sex (Eduardo et al, 1994).

3.4.2 Sub-national projections

There were two levels of sub-national projections that is, the region and the county. At the regional level, just like at the national level, the inputs were an accurate population distributed by age and sex and estimates of mortality, fertility and migration. The cohort component method was applied since data on fertility, migration and mortality was available. The only difference is on the component of migration since internal migration will be taken in consideration. Internal migration required data on net migration from the previous censuses.

At the county level, projections were carried out using the component cohort method, just like the national and sub-national level. This is because fertility, mortality, and migration data were available at the county level from the 2009 population and housing census.

3.4.3 Projections of women of reproductive age

Projections of women of reproductive age were extracted from the county population since this set of population falls within the ages 15-49. Projections of the number of expectant women were obtained by applying the percentage of women who get pregnant as per the 2014 Kenya Demographic Health Survey 2014 to that of women of reproductive age. To project the number of midwives, the study applied the recommended midwife: patient ratio to the number of projected expectant women. The number of projected beds was obtained by multiplying the number of expectant women by the percent of women who are expected to deliver in the health facilities in Kilifi County.

CHAPTER FOUR: POPULATION PROJECTIONS

4.1 Introduction

This chapter provides the findings of this study on population projections of women of reproductive age in Kilifi County. Analysis of this study begins with assessing quality of the 2009 census followed by projections of the components of population then population projections of women of reproductive age in Kilifi County. Finally, the projected numbers of expectant women, midwives and maternity beds are presented.

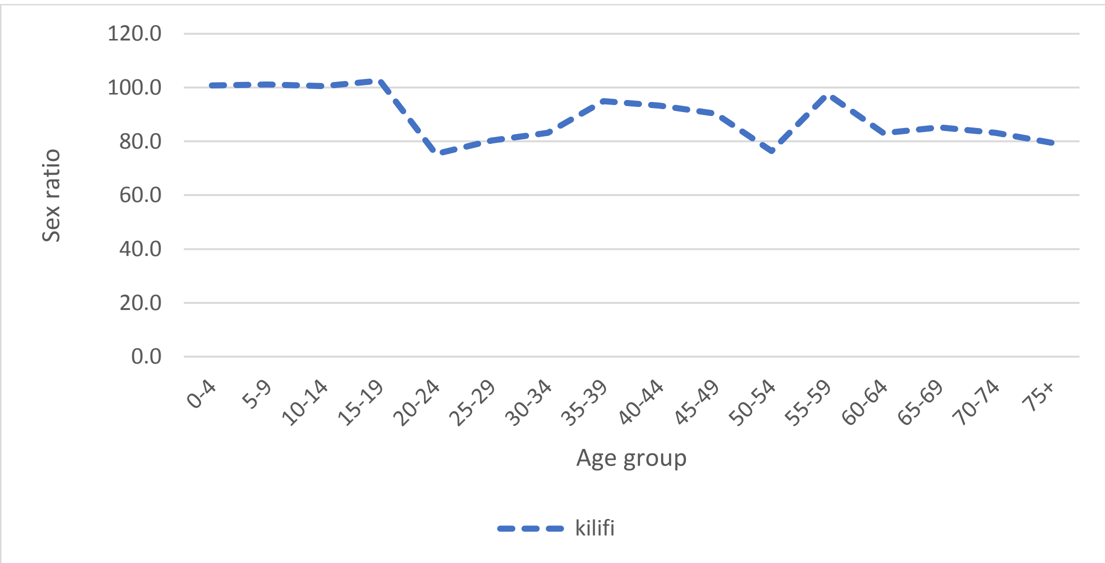
4.2 Assessment of the Quality of the 2009 Kenya Population and Housing Census Data

The quality of the 2009 population and housing census data was assessed for coverage and content errors.

4.2.1 Coverage errors

Figure 4.1 below presents sex ratios at the national and county levels. For Kilifi County, the sex ratio was as per the standard between ages 0 to 19. However, for the rest of the age groups, the sex ratios show irregularities with a minimum of 75.7 for those in the age group 20-24 and a maximum of 101.7 for those in the age group of 15-19.

Figure 4.1: Sex Ratios by Age, Kilifi County, 2009

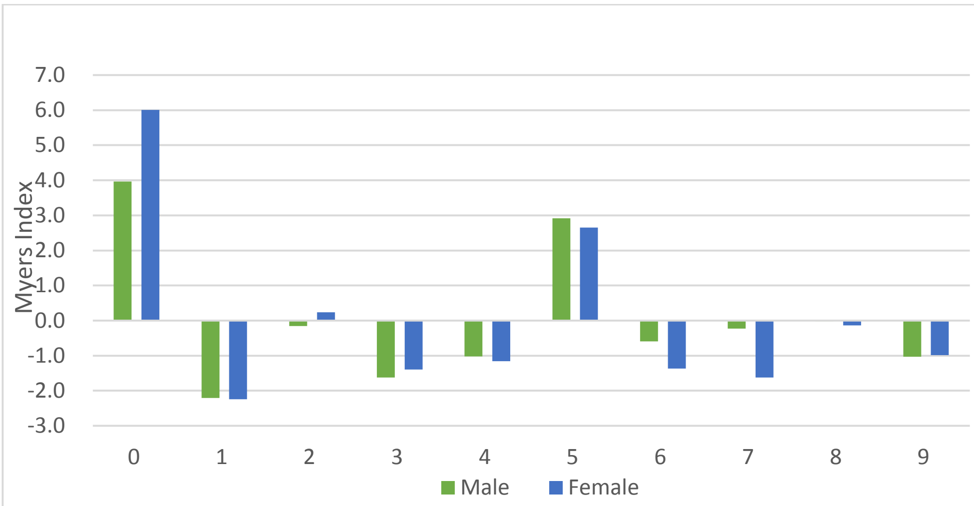


4.2.2 Content errors

The study also assessed digit preference or age heaping for Kilifi County for the 2009 census.

In Kilifi, terminal digits 0 and 5 were highly preferred with 0 having the highest preference, especially among females as shown in figure 4.3. Most people avoided reporting age ending with digit 1 for both sexes followed by 7 among female population.

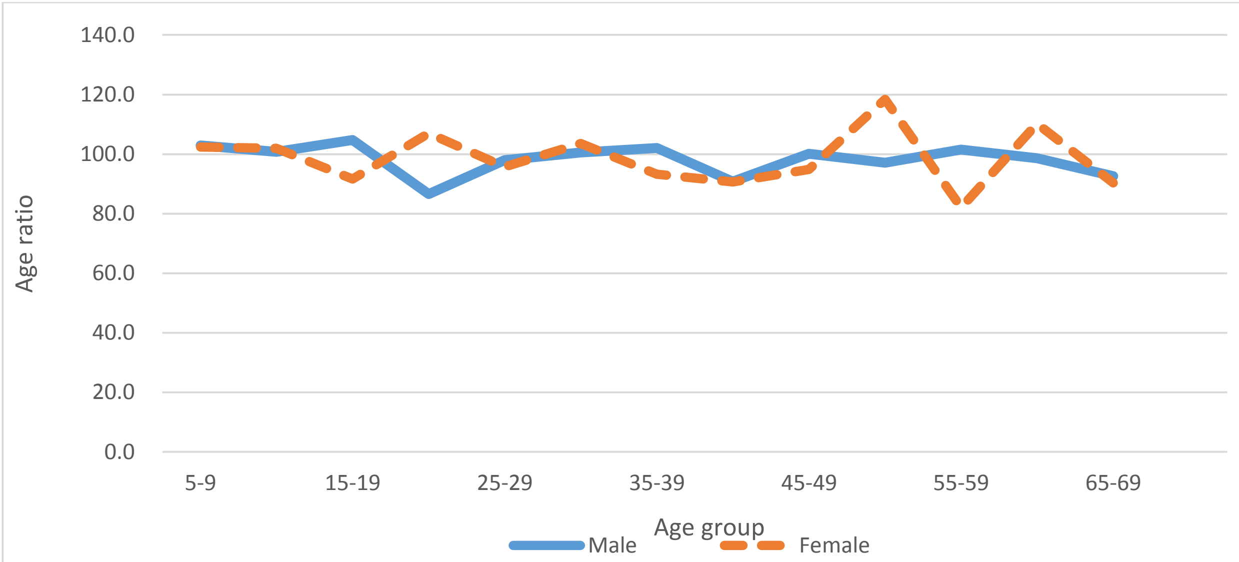
Figure 4.2: Digit preference by Sex, Myers, Kilifi County, 2009



Age ratios

As for Kilifi county, there were fluctuations for age groups 20-24, 40-44, 50-54 and 55-59 and above for both sexes as shown in figure 4.5.

Figure 4.3: Age ratios, by age and sex, Kilifi County, 2009



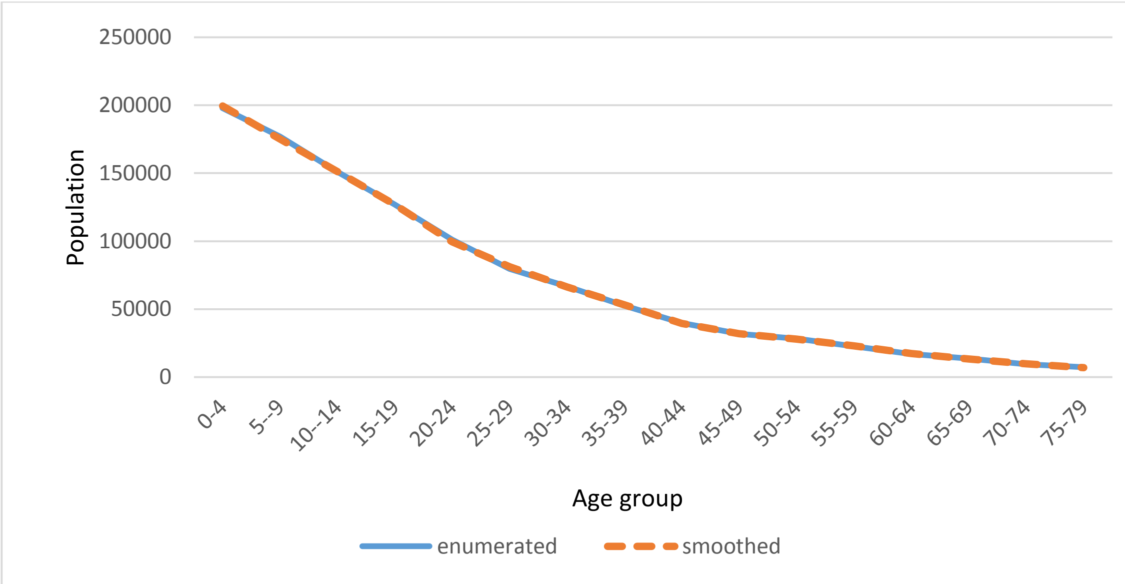
4.2.3 Age-sex accuracy index

The UN age-sex accuracy index for Kilifi County was 35.1. Therefore, the data of Kilifi County will be smoothed due to the inaccuracies before projecting as per the UN recommendations.

4.2.4 Smoothed population

After detecting errors in the 2009 data, smoothing procedures were used to adjust for coverage and content errors detected in the population data. Since irregularities were not severe in Kilifi County, light smoothing was applied. Figures 4.7 show enumerated and smoothed population by age for Kilifi County respectively.

Figure 4.4: Enumerated versus smoothed population, Kilifi County, 2009



Base population was constructed by moving the smoothed population pertaining to the 24/25th August 2009 to those referring mid-year 2010. Consequently, the base population of the projection refers to 2010 while the terminal year of the projection is 2030.

4.3 Components of projections

4.3.1 Fertility projections

The 2009 population and housing census, 2014 Kenya Demographic and Health Survey (KDHS) estimates, together with targets in the national population policy report (2012), were used as inputs to examine fertility trends. The study assumed that the total fertility rate will continue to decline over the projected years in Kilifi County. The TFR for Kilifi County was assumed to stagnate from 2010 to 2015 at 4.8, then drop to 4.4 in 2020, 3.9 in 2025 and finally reach 3.4 in 2030. This is presented in table 4.1.

Table 4.1: Projected TFR, Kilifi County, 2010-2030

Year	Kilifi
2010	4.8
2015	4.8
2020	4.4
2025	3.9
2030	3.4

Based on the TFR for respective years and the 2014 age specific fertility rates (ASFR) as base, the study projected ASFRs for Kilifi County over the projected period. As presented by table 4.2, between 2010 and 2015, ASFRs would remain the same but would start to decline from 2020 to 2030.

Table 4.2: Projected ASFRs, Kilifi County, 2010-2030

Age group	2010	2015	2020	2025	2030
15-19	0.0923	0.0923	0.0846	0.0750	0.0654
20-24	0.2270	0.2270	0.2081	0.1844	0.1608
25-29	0.2205	0.2205	0.2021	0.1792	0.1562
30-34	0.1925	0.1925	0.1764	0.1564	0.1363
35-39	0.1374	0.1374	0.1260	0.1116	0.0973
40-44	0.0670	0.0670	0.0614	0.0544	0.0475
45-49	0.0232	0.0232	0.0212	0.0188	0.0164
TFR	**4.8**	**4.8**	**4.4**	**3.9**	**3.4**

4.3.2 Mortality Projections

To project mortality, the study focused on under five and adult mortality. The study incorporated the impact of HIV/AIDs at the national and county levels. Table 4.3 presents the projected under five mortality for Kilifi County from 2010 to 2030. The estimate for 2010 was from the 2009 Kenya population and housing census and re-adjusted using the 2014 Kenya demographic survey under five mortality value. End target was from the national population policy report and the rest of the under-five mortality values were interpolated.

Table 4.3: Projected under five mortality, Kilifi County, 2010-2030

Year	Kilifi
2010	72
2015	71
2020	71
2025	69
2030	65

Using the 2009 census data on orphan hood and recent births from the 2014 KDHS, survival probabilities were computed for adult mortality.

Using projected under five values and adult survival probabilities, life tables were generated and values of nLx (mid-year of life table) were extracted. These values were used to generate the probabilities of surviving between ages x and x+n which were a key input in projecting the population.

4.3.3 Migration Projections

A low rate of net migrants was recorded in Kilifi County. Kilifi County. In the 1989 census, there were -13,262 net migrants, which was 2.2% of total population (605,165), (Kenya, 1996). The 1999 census had -2814 net migrants which was 0.52% of the total population (544,303) (Kenya, 2004); and in the 2009 census, the net was -2697, which was 0.24% of the total population. Since the net migration was less than one percent of the total population, migration will not be incorporated into the projections, as it had no impact. The study assumed that this trend will be maintained during the projection period.

Using the component cohort method, the next step was to project the required population.

4.4 Population projections

The study projected population of Kilifi County.

4.4.1 Kilifi county population projections

Kilifi County projections were done using the component cohort method which incorporated fertility and mortality projections. Population in Kilifi County will gradually increase during the projection period as shown in table 4.5. Detailed projected population by age and sex are presented in Appendix 1.

Table 4.4: Projected population by sex, Kilifi County, 2010-2030

Sex	2010	2015	2020	2025	2030
Male	567 686	648 326	740 082	844 033	935 233
Female	580 330	664 541	759 621	860 892	954 662
Total	**1 148 016**	**1 312 866**	**1 499 703**	**1 704 924**	**1 889 895**

4.5 Projections of women of reproductive age

Projections of women of reproductive age (15-49) were extracted from the county population projections. This population will increase from 266 000 in 2010, to 318 000 in 2015, followed by 378 000 in 2020, then 440 000 in 2025 then to 503 000 in 2030 as indicated in table 4.6.

Table 4.5: Projections of women of reproductive age, Kilifi County, 2010-2030

	Women of reproductive age				
Age group	**2010**	**2015**	**2020**	**2025**	**2030**
15-19	63 889	73 641	85 877	96 137	98 842
20-24	55 485	63 187	72 893	85 016	95 625
25-29	46 083	54 516	62 113	71 666	84 315
30-34	35 454	45 076	53 285	60 722	70 952
35-39	27 897	34 596	43 880	51 880	60 073
40-44	20 455	27 177	33 562	42 574	51 305
45-49	16 661	19 885	26 256	32 427	42 077
TOTAL	**265 924**	**318 078**	**377 867**	**440 421**	**503 189**

4.5.1 Projections of pregnant women

Beginning with a population of 19 000 in 2010, the population of expectant women would increase to 22 000 in 2015, to 27 000 in 2020, 31 000 in 2025 and 36 000 in 2030 as presented in table 4.7.

Table 4.6: Projected number of expectant women, Kilifi County, 2010-2030

	Expectant women				
Age group	**2010**	**2015**	**2020**	**2025**	**2030**
15-19	4 536	5 229	6 097	6 826	7 018
20-24	3 939	4 486	5 175	6 036	6 789
25-29	3 272	3 871	4 410	5 088	5 986
30-34	2 517	3 200	3 783	4 311	5 038
35-39	1 981	2 456	3 115	3 683	4 265
40-44	1 452	1 930	2 383	3 023	3 643
45-49	1 183	1 412	1 864	2 302	2 987
TOTAL	**18 881**	**22 584**	**26 829**	**31 270**	**35 726**

4.5.2 Projections of midwives

Midwives are a critical input for service delivery in maternal health care. To project the number of midwives, the study applied the midwife ratio of 44.4:10,000 expectant women (WHO, 2006) and found that the number of midwives required to attend to the expectant women who will deliver in health facilities would increase from 84 in 2010 to 100 in 2015, followed by 119 in 2020, then to 139 in 2025, and finally to 159 in 2030.

4.5.3 Projections of maternal beds

Maternal beds are required before, during and after delivery. Before and after delivery, mothers' beds are used while during delivery, those beds required are delivery beds. The mothers' beds will increase from 8 thousand to 10 thousand to 11,995 to 13,981 and 15,973 in 2010, 2015, 2020, 2025 and 2030 respectively. For delivery beds, the increase will be from 1,490 in 2010 to 1,782 in 2015, followed by 2,117 in 2020, 2,467 and 2,819 in 2025 and 2030 respectively. The projected number of midwives and maternal beds is shown in table 4.8 below.

Table 4.7: Projected number of midwives and maternal beds, Kilifi County, 2010-2030

	2010	2015	2020	2025	2030
Number of midwives	84	100	119	139	159
Number of maternal beds	9 490	11 782	14 112	16 448	18 792

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section highlights the study findings, conclusion and recommendations. The main objective of this study was to project women of reproductive age, however, projections of number of expectant women, midwives and beds were also included.

5.2 Summary of the findings

In Kilifi County, the population was projected to be 1 million in 2010, 1.3 million in 2015, 1.5 million in 2020, 1.7 million in 2025 and 1.9 million in 2030. This is slightly lower than what was published by the KNBS (Kenya, 2012a). In 2010 the population is1.3% lower, 3% in 2015, 5.8% in 2020, 7.4% in 2025 and 10% in 2030. These differences arise due to the different indices calculated when checking for data quality and use of different inputs; the age specific fertility rates used were from the 2014 KDHS while the targets were from the 2012 national population policy report.

As the population continues to increase in Kilifi County, women of reproductive age in Kilifi County would also increase from 266 thousand in 2010 to 318 thousand in 2015 to 378 thousand in 2020, 440 thousand in 2025 and 503 thousand in 2030.

The study also projected the number of expectant women who would increase from 19 thousand in 2010, 23 thousand in 2015 27 thousand in 2020, 31 thousand in 2025 and 36 thousand in 2030. Some of the maternal indicators projected include number of midwives and number of maternal beds. The study indicated that the number of midwives would increase from 84 in 2010, 100 in 2015, 119 in 2020, 139 in 2025 and 159 in 2030. The number of midwives is very important since it determines service delivery. The final indicator was the number of maternal beds. The mother's beds will increase from 8,442 in 2010 to 10,097 in 2015, 11,995 in 2020, 13,981 in 2025 and 15,973 in 2030. On the other hand, delivery beds will increase from 1,490 in 2010, 1,782 in 2015, 2,117 in 2020, 2,467 in 2025 and 2,819 in 2030.

5.3 Conclusion

The study indicated that the population of expectant women in Kilifi County would increase hence the county health department needs to ensure that these women are able to have at least the four ANC visits, deliver in health facilities and are attended to by a skilled birth attendant. As women of reproductive age increases during the projection period, so does the number of expectant women who will thus need maternal services. The study thus projected the number of expectant women, number of midwives required for service delivery and the number of maternal beds.

The number of midwives required in Kilifi county versus the number of expectant women is wanting since the current number of midwives in Kilifi county is 53 (SARAM, 2013) compared to 84 which is the projected for 2010. This is inadequate staffing which results to poor quality and ineffectiveness of patient care leading to higher rates of infant and maternal mortality due to compromised care in Kilifi County.

Due to lack of standard used for maternal beds versus the number of expectant women, the study projected the beds available at the time of the study, (2018). From the results, the number of maternal beds is also wanting as there are 95 mother's and 17 delivery beds in Kilifi's health facilities when the study was being conducted (2018). Therefore, the county health government needs to improve on its infrastructure specifically in terms of beds to cater for the increasing number of expectant women.

5.4 Recommendations

Based on these findings, the study has the following recommendations to planners and researchers. By using this data, the stakeholders can thus improve on maternal health services in Kilifi County. The end result is that maternal and infant mortality will reduce.

5.4.1 Recommendations for planners

- As indicated above, there is inadequate staffing of midwives in Kilifi County. To solve midwife shortage in Kilifi County the study recommends advocacy for recruitment of more midwives that involves county government and other partners who are involved in development of the county, and training and routinely recruitment of midwives. This will reduce the workload of the overburdened midwives who are currently, (2018) in place leading to quality maternal services.

- Source for the required number of infrastructures, that is beds as they are one of the basic equipment required during maternal services and service.

5.4.2 Recommendations for researchers

- The study also recommends a similar study in other counties, especially those with high maternal and infant mortality.

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Appendix I: Projected Population by Age and Sex, Kilifi County, 2010-2030

	2010		2015	
	MALE	**FEMALE**	**MALE**	**FEMALE**
0-4	100134	100 357	105396	101616
5-9	88864	86 942	96147	97218
10-14	77092	74 066	87778	86317
15-19	62800	63 889	76355	73641
20-24	42901	55 485	61883	63187
25-29	35796	46 083	42019	54516
30-34	35758	35 454	34741	45076
35-39	30910	27 897	34354	34596
40-44	24031	20 455	29459	27177
45-49	19563	16 661	22726	19885
50-54	15997	15 041	18305	16131
55-59	12321	12 420	14711	14445
60-64	8072	9 358	10990	11741
65-69	5 825	7 195	6815	8588
70-74	4 256	5 313	4466	6248
75-79	3 366	3 714	2181	4159
TOTAL	**567686**	**580 330**	**648326**	**664541**

	2020		2025		2030	
	MALE	**FEMALE**	**MALE**	**FEMALE**	**MALE**	**FEMALE**
0-4	118 050	116 155	130 194	124 956	112 215	107 482
5-9	101 702	99 725	115 011	114 215	127 514	123 373
10-14	94 972	96 623	100 817	99 124	114 224	113 798
15-19	86 939	85 877	94 306	96 137	100 285	98 842
20-24	72 239	72 893	88 988	85 016	93 552	95 625
25-29	60 610	62 113	74 049	71 666	85 030	84 315
30-34	40 781	53 285	59 186	60 722	72 878	70 952
35-39	33 377	43 880	39 453	51 880	59 951	60 073
40-44	32 741	33 562	32 023	42 574	38 477	51 305
45-49	27 859	26 256	31 141	32 427	31 110	42 077
50-54	21 265	19 081	26 182	25 194	30 088	32 004
55-59	16 834	15 282	19 600	18 074	25 064	24 791
60-64	13 122	13 351	14 989	14 120	18 451	17 680
65-69	9 278	10 349	10 966	11 758	13 672	13 658
70-74	5 226	6 920	6 919	8 323	9 420	11 135
75-79	2 088	4 268	3 207	4 707	5 302	7 552
TOTAL	**740 082**	**759 621**	**844 033**	**860 892**	**935 233**	**954 662**

Appendix II: Life tables for male population, Kilifi County, 2010-2030

2010

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.0424	0.9682	57.8918	57.89
1	0.9576	0.0414	3.7473	56.9236	59.44
5	0.9180	0.0173	4.5502	53.1762	57.93
10	0.9021	0.0070	4.4946	48.6260	53.90
15	0.8958	0.0121	4.4517	44.1314	49.27
20	0.8849	0.0171	4.3866	39.6797	44.84
25	0.8697	0.0240	4.2964	35.2931	40.58
30	0.8488	0.0350	4.1698	30.9967	36.52
35	0.8191	0.0437	4.0061	26.8269	32.75
40	0.7833	0.0504	3.8180	22.8208	29.13
45	0.7439	0.0584	3.6107	19.0028	25.55
50	0.7004	0.0705	3.3785	15.3921	21.98
55	0.6510	0.0910	3.1070	12.0136	18.45
60	0.5918	0.1269	2.7712	8.9067	15.05
65	0.5167	0.1887	2.3397	6.1354	11.87
70	0.4192	0.2881	1.7940	3.7957	9.05
75	0.2984	0.4335	1.1687	2.0017	6.71
80	0.1691	0.6095	0.5877	0.8330	4.93
85	0.0660	0.7792	0.2015	0.2453	3.72
90	0.0146	0.8995	0.0401	0.0438	3.00
95	0.0015	1.0000	0.0037	0.0037	2.50

2015

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.0221	0.9834	59.8979	59.90
1	0.9779	0.0285	3.8529	58.9145	60.25
5	0.9500	0.0130	4.7191	55.0616	57.96
10	0.9377	0.0054	4.6756	50.3424	53.69
15	0.9326	0.0095	4.6407	45.6669	48.97
20	0.9237	0.0139	4.5864	41.0262	44.42
25	0.9109	0.0202	4.5084	36.4398	40.01
30	0.8925	0.0307	4.3939	31.9314	35.78
35	0.8651	0.0401	4.2386	27.5375	31.83
40	0.8304	0.0485	4.0510	23.2989	28.06
45	0.7901	0.0588	3.8342	19.2479	24.36
50	0.7436	0.0739	3.5808	15.4137	20.73
55	0.6887	0.0991	3.2729	11.8329	17.18
60	0.6205	0.1434	2.8798	8.5601	13.80
65	0.5315	0.2201	2.3649	5.6802	10.69
70	0.4145	0.3416	1.7184	3.3153	8.00
75	0.2729	0.5085	1.0176	1.5969	5.85
80	0.1341	0.6888	0.4397	0.5793	4.32
85	0.0417	0.8413	0.1209	0.1396	3.34
90	0.0066	0.9371	0.0176	0.0186	2.81
95	0.0004	1.0000	0.0010	0.0010	2.50

2020

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.0223	0.9833	61.0415	61.04
1	0.9777	0.0273	3.8547	60.0582	61.43
5	0.9510	0.0123	4.7258	56.2035	59.10
10	0.9393	0.0051	4.6847	51.4776	54.80
15	0.9346	0.0089	4.6519	46.7929	50.07
20	0.9262	0.0129	4.6010	42.1410	45.50
25	0.9142	0.0187	4.5283	37.5400	41.06
30	0.8971	0.0284	4.4218	33.0117	36.80
35	0.8716	0.0369	4.2779	28.5899	32.80
40	0.8395	0.0444	4.1044	24.3120	28.96
45	0.8023	0.0536	3.9039	20.2076	25.19
50	0.7593	0.0672	3.6689	16.3037	21.47
55	0.7083	0.0902	3.3816	12.6348	17.84
60	0.6444	0.1309	3.0111	9.2532	14.36
65	0.5600	0.2026	2.5165	6.2421	11.15
70	0.4466	0.3190	1.8766	3.7256	8.34
75	0.3041	0.4848	1.1519	1.8490	6.08
80	0.1567	0.6701	0.5209	0.6971	4.45
85	0.0517	0.8297	0.1512	0.1763	3.41
90	0.0088	0.9309	0.0235	0.0250	2.85
95	0.0006	1.0000	0.0015	0.0015	2.50

2025

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.021066	0.9842	61.0980	61.10
1	0.9789	0.026492	3.8613	60.1138	61.41
5	0.9530	0.011996	4.7364	56.2525	59.03
10	0.9416	0.004991	4.6961	51.5161	54.71
15	0.9369	0.008776	4.6638	46.8200	49.98
20	0.9286	0.012755	4.6136	42.1562	45.40
25	0.9168	0.018520	4.5416	37.5426	40.95
30	0.8998	0.028152	4.4358	33.0011	36.68
35	0.8745	0.036762	4.2921	28.5653	32.67
40	0.8423	0.044437	4.1181	24.2732	28.82
45	0.8049	0.053853	3.9162	20.1551	25.04
50	0.7616	0.067852	3.6786	16.2389	21.32
55	0.7099	0.091319	3.3874	12.5603	17.69
60	0.6451	0.133040	3.0108	9.1729	14.22
65	0.5592	0.206367	2.5077	6.1621	11.02
70	0.4438	0.325125	1.8584	3.6544	8.23
75	0.2995	0.492831	1.1286	1.7960	6.00
80	0.1519	0.677890	0.5021	0.6674	4.39
85	0.0489	0.835265	0.1425	0.1653	3.38
90	0.0081	0.934061	0.0215	0.0228	2.83
95	0.0005	1.0000	0.0013	0.0013	2.50

2030

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.020606	0.9845	61.3568	61.36
1	0.9794	0.025928	3.8642	60.3723	61.64
5	0.9540	0.011744	4.7420	56.5080	59.23
10	0.9428	0.004887	4.7025	51.7660	54.91
15	0.9382	0.008594	4.6708	47.0636	50.16
20	0.9301	0.012494	4.6216	42.3928	45.58
25	0.9185	0.018148	4.5509	37.7712	41.12
30	0.9018	0.027602	4.4469	33.2203	36.84
35	0.8769	0.036069	4.3056	28.7734	32.81
40	0.8453	0.043636	4.1343	24.4677	28.95
45	0.8084	0.052933	3.9352	20.3334	25.15
50	0.7656	0.066771	3.7004	16.3982	21.42
55	0.7145	0.089995	3.4118	12.6979	17.77
60	0.6502	0.131365	3.0375	9.2861	14.28
65	0.5648	0.204299	2.5355	6.2486	11.06
70	0.4494	0.322919	1.8842	3.7131	8.26
75	0.3043	0.491129	1.1478	1.8288	6.01
80	0.1548	0.677134	0.5121	0.6810	4.40
85	0.0500	0.835112	0.1456	0.1689	3.38
90	0.0082	0.934049	0.0220	0.0233	2.83
95	0.0005	1.0000	0.0014	0.0014	2.50

Appendix III: Life tables for female population, Kilifi County, 2010-2030

2010

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.0363	0.9728	66.4537	66.45
1	0.9637	0.0620	3.8009	65.4809	67.94
5	0.9380	0.0103	4.6659	61.6800	65.76
10	0.9284	0.0041	4.6324	57.0140	61.41
15	0.9246	0.0074	4.6058	52.3816	56.65
20	0.9177	0.0146	4.5552	47.7758	52.06
25	0.9043	0.0204	4.4756	43.2206	47.79
30	0.8859	0.0233	4.3778	38.7450	43.73
35	0.8652	0.0251	4.2719	34.3671	39.72
40	0.8435	0.0266	4.1616	30.0952	35.68
45	0.8211	0.0292	4.0457	25.9336	31.58
50	0.7971	0.0345	3.9170	21.8879	27.46
55	0.7697	0.0450	3.7618	17.9709	23.35
60	0.7350	0.0649	3.5560	14.2092	19.33
65	0.6874	0.1010	3.2632	10.6531	15.50
70	0.6179	0.1656	2.8339	7.3899	11.96
75	0.5156	0.2791	2.2184	4.5560	8.84
80	0.3717	0.4549	1.4359	2.3376	6.29
85	0.2026	0.6657	0.6759	0.9018	4.45
90	0.0677	0.8333	0.1976	0.2258	3.33
95	0.0113	1.0000	0.0282	0.0282	2.50

2015

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.0182	0.9863	65.2173	65.22
1	0.9818	0.0380	3.8855	64.2309	65.42
5	0.9620	0.0087	4.7892	60.3454	62.73
10	0.9537	0.0036	4.7599	55.5562	58.26
15	0.9503	0.0067	4.7356	50.7964	53.45
20	0.9440	0.0137	4.6875	46.0608	48.80
25	0.9310	0.0204	4.6078	41.3733	44.44
30	0.9121	0.0248	4.5038	36.7655	40.31
35	0.8894	0.0283	4.3843	32.2618	36.27
40	0.8643	0.0315	4.2533	27.8775	32.26

45	0.8370	0.0363	4.1092	23.6242	28.22
50	0.8066	0.0447	3.9430	19.5150	24.19
55	0.7706	0.0609	3.7356	15.5720	20.21
60	0.7237	0.0916	3.4526	11.8365	16.36
65	0.6574	0.1482	3.0434	8.3838	12.75
70	0.5600	0.2480	2.4526	5.3405	9.54
75	0.4211	0.4087	1.6751	2.8879	6.86
80	0.2490	0.6116	0.8642	1.2128	4.87
85	0.0967	0.7966	0.2909	0.3485	3.60
90	0.0197	0.9143	0.0534	0.0576	2.93
95	0.0017	1.0000	0.0042	0.0042	2.50

2020

	l(x)	**q(x)**	**L(x)**	**T(x)**	**e(x)**
0	1.0000	0.0176	0.9868	65.2751	65.28
1	0.9824	0.0370	3.8888	64.2883	65.44
5	0.9630	0.0085	4.7945	60.3995	62.72
10	0.9548	0.0035	4.7656	55.6050	58.24
15	0.9514	0.0066	4.7416	50.8394	53.43
20	0.9452	0.0135	4.6941	46.0978	48.77
25	0.9324	0.0202	4.6151	41.4037	44.40
30	0.9136	0.0247	4.5118	36.7886	40.27
35	0.8911	0.0281	4.3927	32.2768	36.22
40	0.8660	0.0315	4.2619	27.8841	32.20
45	0.8388	0.0363	4.1177	23.6221	28.16
50	0.8083	0.0448	3.9511	19.5044	24.13
55	0.7721	0.0611	3.7427	15.5533	20.14
60	0.7250	0.0921	3.4579	11.8106	16.29
65	0.6582	0.1493	3.0453	8.3527	12.69
70	0.5599	0.2503	2.4491	5.3074	9.48
75	0.4197	0.4125	1.6658	2.8583	6.81
80	0.2466	0.6160	0.8532	1.1925	4.84
85	0.0947	0.8000	0.2840	0.3393	3.58
90	0.0189	0.9163	0.0513	0.0553	2.92
95	0.0016	1.0000	0.0040	0.0040	2.50

2025

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.0164	0.9877	65.4126	65.41
1	0.9836	0.0350	3.8953	64.4249	65.50
5	0.9650	0.0082	4.8051	60.5297	62.73
10	0.9571	0.0034	4.7772	55.7245	58.22
15	0.9538	0.0064	4.7539	50.9473	53.41
20	0.9477	0.0132	4.7075	46.1934	48.74
25	0.9353	0.0197	4.6301	41.4859	44.36
30	0.9168	0.0243	4.5284	36.8558	40.20
35	0.8946	0.0278	4.4105	32.3274	36.14
40	0.8697	0.0312	4.2804	27.9169	32.10
45	0.8425	0.0362	4.1363	23.6365	28.06
50	0.8120	0.0448	3.9690	19.5002	24.01
55	0.7756	0.0614	3.7590	15.5312	20.02
60	0.7280	0.0930	3.4708	11.7722	16.17
65	0.6603	0.1514	3.0516	8.3015	12.57
70	0.5603	0.2547	2.4449	5.2498	9.37
75	0.4176	0.4199	1.6497	2.8050	6.72
80	0.2423	0.6247	0.8330	1.1553	4.77
85	0.0909	0.8067	0.2713	0.3222	3.54
90	0.0176	0.9202	0.0474	0.0510	2.90
95	0.0014	1.0000	0.0035	0.0035	2.50

2030

	l(x)	q(x)	L(x)	T(x)	e(x)
0	1.0000	0.015954	0.9880	65.7376	65.74
1	0.9840	0.034000	3.8983	64.7495	65.80
5	0.9660	0.007996	4.8107	60.8512	62.99
10	0.9583	0.003296	4.7835	56.0406	58.48
15	0.9551	0.006185	4.7608	51.2571	53.67
20	0.9492	0.012811	4.7156	46.4963	48.98
25	0.9370	0.019197	4.6403	41.7806	44.59
30	0.9191	0.023620	4.5410	37.1403	40.41
35	0.8974	0.027106	4.4260	32.5993	36.33
40	0.8730	0.030457	4.2987	28.1733	32.27
45	0.8464	0.035311	4.1575	23.8747	28.21

50	0.8166	0.043811	3.9933	19.7172	24.15
55	0.7808	0.060042	3.7867	15.7239	20.14
60	0.7339	0.091131	3.5023	11.9372	16.27
65	0.6670	0.148871	3.0868	8.4349	12.65
70	0.5677	0.251506	2.4816	5.3481	9.42
75	0.4249	0.416774	1.6819	2.8665	6.75
80	0.2478	0.622943	0.8532	1.1845	4.78
85	0.0934	0.806304	0.2789	0.3313	3.55
90	0.0181	0.920123	0.0489	0.0525	2.90
95	0.0014	1.000000	0.0036	0.0036	2.50