**UNIVERSITY OF NAIROBI**

**POPULATION STUDIES AND RESEARCH INSTITUTE**

# MANDERA COUNTY'S 2010- 2030 POPULATION PROJECTIONS AND THEIR IMPLICATIONS ON HUMAN RESOURCES FOR HEALTH

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**NOVEMBER, 2019**

## DECLARATION

I hereby declare that this research project is my original work, and that to the best of my knowledge, it has not been presented in this or any other university for an academic degree award.

Signature Date

……..... ……..

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This project has been submitted for examination with our approval as university supervisors.

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## DEDICATION

I dedicate this work to my entire family without whom, I would not have come this far. Special mention to my mother (Nyakio), father (Mungai) and siblings Paul, Njeri, Ciku, Shiru, and Ngugi who have always supported me in my quest for education.

You all made this journey worthwhile and made sure I never lacked. Thank you all for the moral support and understanding during my time in school. May God bless you all abundantly!

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| ABS | Australian Bureau of Statistics |
| ASAL | Arid and Semi-Arid Lands |
| ASFR | Age Specific Fertility Rate |
| CCM | Cohort Component Method |
| HIV and AIDS | Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome |
| HRH | Human Resources for Health |
| iHRIS | Integrated Human Resources Information System |
| KDHS | Kenya Demographic and Health Survey |
| KIPPRA | Kenya Institute of Public Policy Research and Analysis |
| KNBS | Kenya National Bureau of Statistics |
| KPHC | Kenya Population and Housing Census |
| KPMG | Klynveld Peat Marwick Goerdeler |
| MoH | Ministry of Health |
| NACC | National AIDS Control Council |
| OECD | Organization for Economic Co-operation and Development |
| TFR | Total Fertility Rate |
| WHO | World Health Organization |

## ABSTRACT

The core objective of this study was to project the population of Mandera County from 2010 and 2030 incorporating the county population dynamics and determine their implications on human resources for health. The study employed the cohort component method to project the population of Mandera County and the workforce-to-population ration method to project the required number of heath personnel from the year 2010 to 2030. The study used secondary data from the 2010 Kenya National Bureau of Statistics Analytical Reports on Population projections, fertility and nuptuality, mortality and migration. The study also used secondary data from the 2014 KDHS report. The base year for this study was 2010 and thus it the data derived from the 2010 analytical reports had been subjected to quality assessments to check on its accuracy and address any coverage or content errors.

The study began by projecting Mandera County's population dynamics whereby the total fertility rates and age-specific fertility rates of the county are projected to decline for the period of the projection. The TFR of Mandera County declined from 7.3 in 2010 to 3.1 in 2030. The projected under-five mortality rates also declined from a high of 155 in 2010 to a low of 26 in 2030. After projecting the population dynamics of the county, the study projected the entire population of the county using these dynamics as is required using the Cohort Component Method. This study found out that Mandera County's population will increase from 642,733 in 2010 to 747,206 in 2015, to 830,714 in 2020 to 917,324 in 2025 and finally to 1,018,127 by 2030.

Finally, after projecting the population of the county this study projected the required minimum and maximum number of health care personnel per a population of 10,000 people. The county will require a minimum of 1,719 health personnel in 2015, and a maximum 4,531 by 2030. The county also required a minimum of 7,113 nurses and 2,541 doctors in 2015 and a maximum of 9,693 nurses and 3,462 doctors by 2030.

Based on these findings, there is need for more funding that will go towards hiring of health personnel as well as further research on population projections at the county level incorporating the population dynamics, which has not been done previously.

# CHAPTER ONE: INTRODUCTION

## 1.0 Background of Study

Population projection implies the predictions of the future populations in a particular geographical area if at all the assumptions of the future fertility, mortality, as well as migration trends prevail as postulated (ABS, 2013). Typically, population projections are arrived at by subjecting a particular consistent decennial data to evaluation using various standardized methods that encompass cohort-component method, participation ratio method, cohort progression method, and mathematical methods.

Population projections show the changes in the future population if at all a set of assumptions about the prospect trends were to hold true or occur (O'Neill, et al., 2001; David and Jacob, 2004; George, et al. 2004; ABS, 2013). Population projections are built on the assumptions about current population and how it will grow or decrease in the future. Projections play a very diverse and influential role in any demographic analysis, which enables us to understand the dynamics of population change. Projection provides crucial statistics regarding the characteristics and other aspects of the population that can assist planners in allocating sufficient resources to match the population needs (George, et al. 2004).

The three terms population projection, estimate, and forecast offer an analysis of the data. Nonetheless, population projection and forecast differ in nature regarding the assumptions that have to hold true in projection but not in forecast(ABS, 2013). Similarly, projection differs with estimate regarding the procedures utilized to arrive at the population whereby estimates uses statistics drawn from a sample for a previous reference period to generate conclusion for the entire population while projection gives a value of a future population if the assumptions of the future trends hold true (ABS, 2013). Population projections offer insights of the anticipated changes in the particular population. In other words, it provides an elaboration of the primary elements of population change (Arthur and Thomas, 2000).

The Kenya National Bureau of Statistics conducts population projections after every census carried out in the country. The last major comprehensive projections were carried out in 2010, and KNBS used the cohort component and ratio method. Since the 2010 projections, there is availability of

data on population components at the county level and this thus necessitates a more in-depth projection of the population at the county level. This projection will help in depicting the true picture on the ground in Mandera County and assist the county government to know the existing gaps.

Mandera County is one of the hard to reach counties located in North Eastern Kenya, and this has disadvantaged it in that very few demographic health surveys and health indicator surveys have been conducted in the region. Being a remote county, data capture has over the years been a problem and thus the entire North Eastern region was not extensively covered in previous surveys until 2014 when the region and Mandera County were included. This meant that projecting the population of Mandera County could only rely on the ratio method for lack of data on the different population dynamics. However, with the availability of data on fertility and mortality from the Kenya Demographic and Health Survey (KDHS) 2014, it is now possible to carry out more accurate population projections for Mandera County.

The methods used for the 2010 population projections by KDHS only took into account population dynamics at the national and regional levels, and used the ratio method at the district/county level. This thus means that the projections were less accurate for the counties since they did not take into account the various county population dynamics. Therefore, there is need to conduct county population projections taking into account the specific county population dynamics derived from recent studies such as the 2014 KDHS. There are several methods that can be used to conduct projections in within counties taking into account the population dynamics and for the case of this study, the researcher made use of the cohort component method.

The ushering of devolution on August 2010 saw decentralization of some functions of national government such that some of its roles were devolved and shared with the county governments (KPMG , 2013; World Bank, 2012). One function that was devolved was health, which was entirely left to be managed by county governments. The implementation of devolution has affected human resources for health (HRH) across the counties; with HRH management being transferred to the counties, the policy makers did not assume a pragmatist approach by first establishing whether the counties had appropriate structures and adequate capacity to undertake HRH-related

functions (Miseda et al., 2017). This translated to problems in hiring, distribution, and retention of human resources for health.

Ideally, any growth in the population should lead to a corresponding growth and hiring of health care staff that will be able to manage this population. In Kenya, the distribution of health workers does not take into account the population of a region. There is an unequal distribution of health workers, more so in the frontier/hard-to-reach counties of the country. The distribution of these essential HRH is usually slanted towards urban areas and more developed counties at the expense of rural areas/counties. These rural counties in general are deprived of the necessary health human resources, whereas they face many health challenges (KIPPRA, 2012). Across the world, developing countries face a myriad of challenges with regards to health human resources, and Kenya is no exception. Lack of human resources in the health sector correlates to poor quality health services as well as health outcomes.

For instance, as of 2012, Mandera County had 0.9 nurses (serving in public sector) per 10,000 people. Likewise, Kwale County had 3.7 nurses per 10,000 individuals (KNBS, Kenya Demographic and Health Survey 2015). This is against the WHO recommended ratio of 8 nurses per 10,000 people. On the contrary, Kisumu County which somewhat urban as opposed to Mandera and Kwale had 7.3 nurses per 10,000 people (Barker et al. 2014). As of 2013, statistics from the Ministry of Health (MOH) showed that Mandera County had the lowest health human resources per 100,000 population standing at 9, 3, and 6 for nurses, doctors, and clinical officers respectively.

Wakaba et al. (2014) study on public sector nursing workforce in Kenya, states that the health care workforce imbalances in arid and semi-arid (ASAL) region in Kenya are a major concern.[1] The health care personnel inequities across the ASAL region have serious adverse implication on the worth of amenity provision. Inspite of the ASAL region having 35 percent of Kenya's population, the area is still marginalized with regards to the health care personnel deployment. Studies depict the sum of the total health workforce in the counties that fall in the ASAL region is lowest as compared to the other parts of the nation.

[1] ASAL- Arid and Semi-arid Lands region cover the counties in the Northern Kenya that include Garissa, Wajir, Mandera, West Pokot, Marsabit, Lamu, Samburu, Turkana, Isiolo, and Tana River. The area has a unique characteristics that incorporate rural geography, low population density, insecurity, nomadism, as well as weak telecommunication infrastructure.

The current projections provided by Ministry of Health offer an outlook of the national situation from 2013-2030. These projections depict the gaps by cadre especially during the planning period (Ministry of Health 2014). As at the current, few studies have projected health human resources to reflect the new constitutional dispensation. Developing Mandera County health workers projections will make it a lead county on the same, and thus can inspire the other counties to take the course.

At the onset of devolution, there was availability and change of some of the needed components of population change acquired from the 2014 Kenya Demographic and Health Survey. It is imperative to conduct population projections not only for Mandera County up to the sub-county level but all the other 46 counties in Kenya taking into account the county population dynamics based on this new information. The primary needs of the Kenyan people, which development programmes target to fulfil, cannot be judged rationally regardless of the anticipated size, structure and distribution of the population at different geographic elements and themes in time. Transfer of the management of the health function i.e. recruitment and retention of HRH from national to county governments necessitates for better planning in the counties, and as such, population projections of HRH are indispensable for an effective plan going forward.

### 1.1 Problem Statement

In spite of the Kenya National Bureau of Statistics being tasked with the responsibility of carrying out censuses as well as projections, the body has yet to generate population projections that reflect the decentralized system of government in Kenya. While undertaking the 2009 population projections, the Kenya National Bureau of Statistics (KNBS) used the Cohort Component Method to project national and regional populations; while the ratio method was used at the county and sub-county (then constituency) level because the required input information was not readily available. The projections done in 2010 did not also take into account the population dynamics of counties and their sub-counties, and consequently this call for further projections to take care of the aforementioned. The information lacking related to components of population change that were not readily available at the time of performing the projections.

Ideally, population projections should be done by taking into account population dynamics of various targeted areas. However, this is not always the case because in some cases, crucial data on the population dynamics and especially in lower administrative areas is lacking. In the case of Kenya, previous projections only applied population dynamics at the national and provincial level only. Since KNBS lacked the necessary data on population dynamics in these counties, they projected the population using the ratio method. Since then, new data on population dynamics within the counties is now available. This thus makes it possible to conduct more accurate population projections in all the counties, taking into account the availability of data on population dynamics within the counties.

The development process of health care workforce in Kenya is faced with numerous challenges that encompass severe shortages of crucial cadres, uneven supply of workers, low and unequal rewards, as well as poor work settings. Previous studies have explored these concerns. However, few studies have dealt with the issue of population projections of health care workforce as being an integral element in the future development of the health sector both in the national and the county levels. Most of the studies conducted on health usually look at the supply side and rarely on the demand side.

Population projections have various implications on different fields such as health, education, security, agriculture etc. In health specifically, population projections may have implications on the number of hospitals needed, funding of health services, policies in health and the all-important human resources for health. Studies have done little to utilize population projections in predicting the future demand for human resources for health. Existing projections for human resources for health have seldom if at all taken into account future population projections. However, with production of more accurate population projection figures especially at the county level, it's now easier to get more correct HRH figures based on population ratios. Consequently, there is the need for health workforce projections at the county level using the projected population per county.

## 1.2 Research Questions

The key research questions that the study sought to answer was:

- What will be the 2030 population projections in Mandera County incorporating the county population dynamics?
- What will be the implication of the projections on human resources for health during the same period?

## 1.3 General Objective

The overall research objective of the study was to project the population of Mandera County and its sub-counties between 2010 and 2030 incorporating the county population dynamics and determine their implications on human resources for health.

### 1.3.1 Specific Research Objectives:

The study aimed to accomplish the ensuing explicit objectives:

i. To project the population of Mandera county and its sub-counties up to the year 2030 from the base year 2010, taking into account recent change in population dynamics;
ii. To determine the implications of population projections on human resources for health for Mandera County from 2010 to 2030;

## 1.4 Justification

The current population projections that exist in Kenya used the ratio method to get the county and sub-county populations, without taking into account the population dynamics of the various counties. As a result, there is need to apply other population projection techniques not used in the 2010 projections within the counties, taking into account population dynamics that are specific to target counties. This way, the findings will be more accurate and go a long way in helping for better planning within the county. Typically, the data generated through population projection is dependable because it offers reasonable information regarding characteristics and structure of the future population that is utilized in the monitoring process of the development goals as well as

policies initiated either in the county or the national level during the intercensal years (Kintner and D A, 1994).

Since the last projections were done by KNBS in 2010, new data on population dynamics within the counties across the country is now available. Hence it is now possible to carry out population projections within counties using the cohort component method which relies on using the various population dynamics for input. Using the cohort component method will give more accurate population projection figures at the county level compared to using the ratio method which has been used previously due to lack of data.

Human resources for health are one of the factors that that are critical in managing health. Therefore, there is serious need to project the required number of health workforce using accurate population estimates to enable countries and counties to plan better. Mandera County is considered one of the least developed in Kenya in terms of health indicators. Year in, year out, the county is faced with various health challenges. Key among them is the high maternal mortality rates witnessed in the county, which are one of the highest anywhere in the world. The county's proximity to the Somalia border also makes it susceptible to disease outbreaks such as cholera. The culture in the county has also contributed to poor health outcomes. One of the ways to improve on the health outcomes is to have an adequate human resource that will assist in providing the essential care and expertise that is needed.

There exist projections for human resources for health at the national level but not at the county level based on the demand for the health personnel. In Kenya, with health being a fully devolved function and the county government being in charge of budgeting and hiring of staff, it thus behooves on researchers to carry out HRH projections at the county level using accurate population estimates to be able to know the required demand. Hence, the findings of this study will enable the county government of Mandera plan well in advance concerning the hiring of new health staff as well as health financing. The findings of this study will provide insights into the population change in Mandera County over time based on various population characteristics and help in also approximating the numbers of medicalworkforce required in Mandera County between 2010 and 2030.

### 1.5 Scope and Limitations of the Study

The base year for this study was 2010. Of the three population dynamics, i.e. fertility, mortality and migration, data on migration is the most difficult to collect due to variances in collection and recording systems. KNBS in its Analytical Report on Population Projections of 2010 points out that it was difficult to capture data on migration at the local level. KNBS thus used the average figures of migration generated in the last three censuses (1989, 1999 and 2009) to represent internal migration at the provincial level. KNBS does not also collect routine data on migration, whether internal or international. Consequently, this study used data from the projections done by KNBS in the 2010 Analytical Report on Population Projections, hence the same assumptions applied to the projections on migration were used in this study; and it was assumed that the averages used would remain constant during the projection period. This means that any limitations experienced during the projections and especially with data on migration, were also inherent to this study. Further, the KDHS 2014 did not have data on migration hence limiting this study to the migration assumptions made in the 2010 Analytical Report on Population Projections.

Since this study focused on Mandera County, the county population dynamics were assumed to be those that were generated from the 2014 KDHS. The dataset is more recent and gave findings that are more accurate. Equally, the projections for the sub-counties in Mandera County assumed the Mandera County population dynamics estimates. This study assumed that the 2015-2030 national decline pattern in fertility will also hold in Mandera and in the entire North Eastern region. Another limitation was that the national projected patterns contained in the 2012 population policy document will hold for the case of Mandera in the 2015 to 2030 period and the Mandera 2015 rates are same as 2014 KDHS rates.

This study solely focused on human resources for health as the county level and not on the sub-county level. This is because all healthcare personnel are hired at the county level before they are seconded to the sub-counties. Further, the study focused on projecting the ratio of doctor: population, doctor: nurse and health personnel: population only and not other cadres' of the health workforce. This is because there are clearly established mechanisms for projecting these cadres and there lacks adequate data on other cadres of health workers.

# CHAPTER TWO: LITERATURE REVIEW

## 2.0 Introduction

This chapter contains a review of the literature on methods of population projections, and determinants of future population trends then an empirical review of projections for human resource health.

## 2.1 General Methods of population projections

One can either use subjective or objective methods in population projections. In using subjective methods, data, techniques, and assumptions are not identified (David and Jacob 2004), meaning that it is challenging for such projections to be replicated in their exact format by other analysts. On the other hand, in objective methods, data, techniques, and assumptions are identifiable and can thus be precisely replicated by other analysts. Some of the methods used for projections include four parameter logit system, trend extrapolation methods, ARIMA model, and cohort component model.

The four-parameter logit system also known as the Brass model has been widely used to describe age patterns of mortality in populaces (Zaba, 1979). This is categorised under the mortality model referred to as relational models. Trend extrapolation method is another model used for population projection. This is made up of mathematical functions that spread the detected trend over a precise base period in future. Linear model, polynomials like cubic curves, Gompertz curve, the hyperbolic curve, and the modified exponential curves (Kodiko, 2014). The trend extrapolation models that do not have bounds adopt a continuous base period into the future whose results are highly unlikely forecasts. Even more, polynomials having order three or more are likely to forecast quick rise and decline in population (Tom, 2011). This shows that trend extrapolation methods are reliant on the future period in which they are tailored for. The major advantage of this model is the minimal need for data entry, fast calculations on spreadsheets hence minimal labour is needed (Kodiko, 2014).

Another method used is the regression approach which is effective when used for horizons that are below ten years (Tom, 2011). This method incorporates social, economic, demographic and environmental variables that affect changes in the population. However, the major drawback of this model is the assumption that relationships observed in previous variables are applicable in the

forecast horizon. Even more, there is no direct model for mortality, fertility and migration processes.

Objective methods are widely used and can be divided into three categories i.e. structural models, which are centred on observed connections between demographic variables, other variables such as employment in relation to the population changes at the current time and the projected population changes concerning the variables (David and Jacob, 2004). Another approach is the cohort component technique. In this technique, the population is divided into sex-age cohorts while accounting for each cohort's fertility, mortality, as well as migration (Swanson et al., 2004). Finally, the third category is the trend extrapolation whereby a demographer observes historical trends in a population. Swanson, et al. (1998) argues that the three models are not always mutually exclusive but that they can be used together.

George, et al. (2004), opine that projections of households, health, as well as other population-associated features are required for purposes of analysis, planning, and budgeting. These are known as socio-economic projections. Both private and public organizations are involved in conducting socio-economic projections, which produce basic demographic features for both national and sub-national entities (Lee and Tuljapurkar, 1994; Wolfgang and Harold, 1996; Arthur and Thomas, 2000; Howard, 1999; Kintner and D. A., 1994)

There are two key methods used to calculate socio-economic projections; the participation ratio approach and the cohort progression method. The participation ratio approach is also referred to as the incidence rate method. In this methodology, ratios are used to relate socio-economic features to demographic characteristics (David and Jacob 2004;Kintner and D A 1994;UN 2015). After establishing the ratios, they are then projected in various ways such as extrapolating them in relation to recent trends, creating structural models, which estimate the changes to occur in them, and finally holding them to current trends (Swanson et al., 2004). In the cohort progression approach, projections are established by 'surviving' persons with certain socio-economic features (George, et al. 2004).

The cohort-component approach was introduced and used by Cannan in 1895 and was successively applied by Bowley in 1924. Later, Whelpton independently re-discovered it in 1928. The cohort-component method is considered most widely utilized approach to the production of the national-

level population. In spite the sophistication in the present methods, this method has changed a little, and still, it bears most of the elements of the pioneering works of the three men (George, et al. 2004).

The most suitable method for this study is the cohort method. The gain of dividing the population by cohort hence resulting to age-specific estimates is the rationale used to select this model.

### 2.2 Population Projection Using Population Components

The cohort component method is the utmost typically used means in population predictions and is superior to mathematical and ratio methods because it involves a separate analysis of the changes affecting each component of the population (fertility, mortality and migration) (KNBS, 2012).

The constituents of population transformation are:

(Births – Deaths) + (In-migrants – Out-migrants)

The cohort component method is utilized to project the population forward into future years where by the population change components are estimated independently for each birth group. The cohort component method normally presents a set of circumstances picked to symbolize probable, possible or relevant future paths of fertility, mortality, and migration. This method leads to the high, medium, and low scenarios of population projections. The middle alternate among the three scenarios is treated as the 'most likely' outcome, as it offers a logic of neutrality and consequently an ostensible probability in imminent development (KNBS, 2012).

The cohort component method takes path of each cohort of people throughout its lifetime according to its exposure to the constituents of population change. The population at single age is disclosed to the likelihoods of dying as driven by projected mortality levels and patterns by age and sex beginning with a base population by age and sex, leading to deaths estimation in the cohort. The deaths are then deducted from the surviving population and those staying alive become older. On the other hand, fertility rates are projected and related to the women of reproductive ages to estimate the number of births each year and single children born cohort is as well followed through time by disclosing it to the appropriate rates mortality rates (KNBS, 2012).

When the cohort component approach is utilised as a prediction means, it adopts the constituents of demographic change, mortality, fertility, and migration, will not change during the course of the projection period and thus the preference for this method in this study. As a predicting tool, developers can revise the vital indicators and migration estimations to imitate their understanding of the future.

Choi, Choi and Valley (2010) suggest that the cohort component method system offers explanation for the previous population aspects like rate of growth, shifting composition of age-sex and size through the historical assumptions of fertility, mortality and migration. A combination of previous inputs and algorithms precede the real historical dynamics, while taking account of the inaccuracies in basic data. The closure provided by the cohort component method separates it since most models in social science cannot quantify the historic inputs. With provision of suppositions on future inputs, the dynamics of future population essentially and inevitably follow. Confidence in assumptions is important in cases of short forecast horizons in order for the outputs to be foreseeable. Moreover, this solidity in forecasting is not common in most social sciences (Choi, Choi & Valley, 2010).

Apart from offering reliable predictions, the cohort component method tool presents direction for controlling population dynamics in future. It substantially deals with fundamental mechanisms of prospective population dynamics and singles out migration, fertility, and mortality as policy levers that can be used to manipulate the dynamics to the preferred course and extent. As a tool for population prediction, this model provides sensible facts on the structure of age-sex in comparison with logistic forecasts of the population as a whole. This fact has enhanced the model's forecasts reliable for sectional arrangement. Even more, the feature on age-sex offers a firm basis for overlaid age-sex distributions like household or marital status like the headship rate technique in household prediction.

Without other assumptions in place, a hypothesis of continuity in mortality, migration, and fertility trends is the enduring natural assumption; which was the case until World War II. Choi, Choi and Valley (2010) suggest that, because of widespread demographic gaps like the increase in divorce rates, cohabitation and mortality after 1960's, the adoption of unlikeliness of discontinuities, even with high chances of continuity, was confirmed.

The Cohort component method also permits developers to study the impending necessities of different fragments of the population containing the prerequisites of children, women in their reproductive years, and persons in the labour force, the health sector and the elderly. It correspondingly permits planners to plan the complete extent of the population. The fallouts can be used in all phases of local and county progress plans. Finally, the cohort component method of population projections considers net-migrants who are included at every specific age. Subsequently, the full procedure is done again for every year of the projection period, which results in the projected population by age and sex for each year, for each particular cohort of people (CBS, 2002).

Notably, cohort component method has been used in the past to project population. It was remarkably applied in the projection of the size and composition of the US population 2014-2060 based on the 2010 Census data (Sandra and Ortoman, 2015). According to Sandra and Ortoman projections the US population will increase from 319 million to 417 million. Nonetheless, they projected the population to grow at a measured frequency in future years as opposed to the recent past following a continuous decline in fertility rate and a modest plummet of net international migration. The usage of 2010 Census data is expected to encompass non-sampling error as a result of potential enumeration errors such as differential under coverage or over coverage by demographic characteristics. In addition, the non-sampling error can occur because the assumptions for the components of change were primarily based on time series analysis that exempts the incorporation of future predictions of policy changes that can influence levels of population components and their directions as well.

Choi (2010) applied cohort component method to develop local population projections of Southern California 2010-2040. In the application of the Model, Choi utilized gross migration, county/regional demographic assumptions, and the local populace resulting from the housing unit method. In the study, various data sources were used for consistent results which include US Internal Revenue Service's data, Census Bureau data, and California Department of Public Health data. The study employed gross migration with the assumption that gross migration offers a true reflection of migration process. Besides, it is based on the population at risk (Choi, 2010). Nonetheless, such assumptions may not hold particularly if the region adopts policies favouring or

discouraging either in-immigration or out-migration. As such, the utility of a constant gross migration throughout the projection period is likely to offer unreliable population projections.

Another notable utility of cohort component method was in the projection of the US population by age, sex, and race 1983-2080 (Spencer, 1984). The base population for the study was the 1982 population estimates that were carried forward year by year using the projected survival rates as well as the net immigration by single year of age, sex, and race. Withal, the study applied different assumptions for future fecundity, mortality, and net immigration levels in the fashion of middle, high, and low assumptions such that the cohorts were subjected to the three variants (Spencer 1984). The usage of population estimates likely provides a leeway for errors, and thus rendering the projections unreliable. Further, the utility of the three variants bring in confusion to which resultant to consider as definite. As established, the usage of cohort component method in this case had numerous inefficiencies.

In Kenya cohort component method was successfully employed in sectoral population projections for Isiolo County (Bilala, 2016). The study used the 2009 Kenya Population and Housing Census Data that was subjected to a quality check to deduce both content and coverage errors. As inferred in the research, the 2009 KPHC data was accurate and its use gave out accurate and reliable projections. Bilala (2016) recommends for population projections in other counties and eventual comparison of the resultant data. This will be accomplished in the process of projecting population in Mandera County for this study.

### 2.3 Projections for human resources for health

Planning and forecasting is a critical element in health workforce as it ensures that a proficient workforce is available to meet health demand when required. Dreesch et al., (2005) argue that the projections are aligned with the goal of realization of sustainable development goals and Vision 2030. Generally, the major goal of human resource health planning is to determine the distribution and quantity of health workers.

The needs-based approach is used for the approximation of the future health workforce using the forecasted needs of health services in future for the present population. With this approach, the major goal is to address all the needs in the health care. As such, it assumes that the utilization of

resources will be allocated depending on the need (Hall, 1978). One of the advantages drawn from this is efficiency as it forms the basis of this approach. This is as a result of combining HRH resources to provide health care services. Additionally, using this approach is best for advocacy as it is easy to explain and understand. However, McQuide et al., (2009) argue that the major limitation of the model is the necessity to reorganise the model in tandem with technological or medical changes affecting service delivery. Even more, the use of the model does not necessarily expound on the basic definition of a need in relation to the quality and extent. Lastly, forecasts made using the model may demand for an impractical number of healthcare providers without altering the inequalities in distribution of health services (McQuide et al., 2009).

Another approach used in projecting HRH is the utilization based approach also known as demand based approaches. Scheffler et al., (2008) assert that this model uses present health service utilization to predict the future health service needs. This may be used along with forecasted trends in the present human resources. With this method, the major assumption is that the present combination of health facilities is effective. Therefore, McQuide et al., (2009) offer that the future healthcare is projected basing on the patterns of fertility, migration, and mortality. One advantage of the approach is the cost efficiency of the predicted HRH objectives because predictions of future rates are closely linked with the current utilization. However, because the predictions are heavily dependent on the existing status of health utilization, the imminent problems in the service delivery may not be addressed (McQuide et al., 2009).

Apart from that, the adjusted service target-based approach is another approach used in projections of human resource health and precise intervention programs. Dreesch et al., (2005) offers that in this approach, goals are set depending on the urgent health service requirements showcased by the population demographics and expert opinion. Specific alterations meant to meet pressing needs are selected. Dreesch et al., (2005) adds that this is followed by the job evaluation and selection of a competent workforce that has the capacity to undertake every intervention. One benefit of this approach is the recognition of the serious health human resource skills and further giving guidelines on future trainings. Even more, planning in this scenario is reliant on the skills and capabilities needed to deliver the health care services. Nonetheless, one drawback in this model is the dependency on present infrastructure and resources (Dreesch et al., 2005).

World Health Organization (2010) suggests that facility-based models are used to make projections regarding the nursing workforce. One is the professional judgement model that is dependent on a formula and expert that are used to establish amount of nurses needed depending on the amount of hours in each shift. Despite being very simple to use, the approach is said to be rather subjective and rigid as it does not consider the quality of the nursing.

Another method used is the acuity quality method that considers the need of the patients and frequency of occupancy (World Health Organization, 2010). These can be modified to show individual shifts in line with the performance indicators. Implementation of this model is quite tasking as it requires acquisition of detailed data about the nurse labour force and the populace of the patients. Another method is the staffing structure referred to as nurses per occupied bed method. This method facilitates benchmarking but has been disapproved because of its incapacity to change both the different levels of care and the requirements of the patients (World Health Organization, 2010).

Finally, WHO also recommends the workforce-to-population ratio method: This is a simple projection of future quantities of essential health workers in relation to recommended thresholds for labour force concentration (e.g. physicians per 10,000 population). This methodology is least challenging in terms of numbers, and is grounded on the conjecture that there is uniformity at the levels of the numerator (all physicians are equally productive and will remain so) and of the denominator (all populations have comparable necessities, which will stay persistent). Such assumption is undoubtedly precarious. The benefit of using a workforce-to-population ratio method for HRH calculation is that the style is speedy and simple to apply, may be used for practical evaluation through countries and over time, and is easy to understand among a wide range of audiences containing those who might not be familiar with more advanced statistical modelling techniques.

Health workforce-to-population ratios have been tallied and used, for example, for advocacy purposes among governments and development partners, in order to focus attention on HRH challenges which aim at improving coverage rates for essential health care interventions, such as those prioritized by the Sustainable Development Goals. The researcher will utilize this method in coming up with projections for HRH in Mandera County.

Liu et al. (2017) conducted a research which focused on projections of global health workforce labour market for 2030 in low- and middle-income countries. He combined the labour market approach as well as the workforce-to-population ration method in the study. This was able to project economic growth, health coverage and demographics. Data relating to the workforce was retrieved from WHO Global Health Observatory (1990-2013) which comprised of 165 countries. The projection proposed by the research was an increase of 80 million workers by 2030 which translates to a shortage of 15 million health workers. Subsequently, the results also showed that while the growth will be imminent in upper middle-income countries, it will be slow in middle-income countries and slowest in low income countries hence the shortage.

A study by Scheffler et al. (2008) further provides evidence of use of the projection models. This research focused on forecasting the global shortage of physicians, a case study of WHO. Data on physicians was obtained from 158 countries between years 1980 and 2001. The study adopted two approaches to aid in the projection. On the one hand, the needs-based approach was used to establish the amount of physicians per capita needed to execute 80% coverage of births by a competent health-care attendant. On the other hand, the workforce-to-population ratio model was used to establish the number of physicians per capita who are expected to be needed depending on the economic development of different countries. The findings revealed that the international supply of physicians is likely to be equal with the estimated economic demand.

These models and others have been applied in different fields for various purposes all pointing towards postulation in human resource health. Hurst (2003) offers that these models have been widely used in projection of human resource health including acuity quality method. The researcher argues that this model has mostly been used for nursing workforce planning.

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3.0 Introduction

This chapter outlines the research methodology employed to perform population projections for Mandera County and conduct HRH projections for the county up to 2030 based on the projected population. More critically, this chapter provides the approaches that were utilized for data analysis, assumptions, interpretation and reporting.

## 3.1 Data sources

This research utilized secondary data as the primary source of data. The study used secondary data from the published reports of KNBS Analytical Report on Population Projections Volume XIV of 2010, Analytical Volumes on Fertility and Nuptuality, Mortality, Migration and the published 2014 Kenya Demographic and Health Survey. The base year for the population projections was adopted from the 2010 population projections conducted by KNBS. Therefore, this study assumed that the population as of 2010 had already been corrected and all irregularities rectified.

The Mandera County population dynamics for this study were derived from the published 2014 Kenya Demographic and Health Survey report. The report, together with various analytical volumes from KNBS provided both mortality and fertility indicators for the study. However, for migration, the study adopted the same assumptions used by KNBS for the 2010 population projections. The preference for the 2014 KDHS was due to the fact that it is the latest available report with accurate population dynamics for Mandera County. Previous DHS surveys did not comprehensively cover Mandera and the North Easter region as a whole, thus limiting their use in this study.

Other data sources that were used for this study and especially on Human Resources for Health will come from records at the Ministry of Health. Specifically, the study utilized data from the Integrated Human Resources Information System (iHRIS) which is a human resources management tool used by The Ministry of Health for managing health care workers. Existing journals published five years and below about HRH were also used to enrich the literature as well as portraying the need for the study. Information from the WHO reports on Kenya's HRH offered premises for various sentiments in the paper. Further sources of data on Human Resources for

Health came from already published reports by international and local organizations that have been involved in human resources for health in Kenya.

### 3.2 Method for Population Projection

In conducting population projections, the selected base population for this study was derived from the 2010 Population Projections Analytical Report. The main focus was the projected population for Mandera County and it's sub-counties as provided in the report. The Cohort Component Method was used in projecting the population of Mandera. This is the most applied tool while projecting population across the world. It is considered more accurate and superior to other methods as it incorporates an analysis of variations in population components.

The need to offer comprehensive demographic information on population in population projection is one of the key benefits accrued from using the cohort-component model. This tool has, over time, been stretched for project population of smaller areas like counties and regions provided the major demographic information is available. Therefore, this model facilitates presentation of rational projections in smaller regions through assumptions made from key components-deaths, births and migration by age cohort.

This study aimed to project the future population by separately taking into account the changes reported in each birth cohort while integrating the components of population change i.e. migration, fertility and mortality. In the case of mortality, and following recommendations from the United Nations, the impact of HIV and AIDS were included for these projections since the prevalence rate for Mandera County (1.7% as per KNBS Kenya HIV Estimates, 2016) exceeds one per cent.

In using the Cohort Component Method, this study tracked each cohort throughout its existence based on its exposure to migration, mortality and fertility. Below are the steps that were used to project the future population for Mandera County;

i. The base population used was the 2010 projected populations by KNBS, where age and sex cohorts were derived. The projected mortality levels were used to expose these cohorts to chances of dying over their lifetime;
ii. After an estimation of the death rates, they were removed from the population that is left alive, while these population becomes older;

iii. For the female population of reproductive age, fertility rates were projected and then applied to them so as to get the estimated number of child births per year;

iv. These cohorts of children born yearly were also exposed to mortality rates throughout their lifetime as with the other cohorts;

This procedure was repeated for all years under consideration for this study. The Cohort Component Method was used to project the population for Mandera County since there was available input information on the components of population adjustment such as fertility rates, mortality rates, HIV prevalence etc.

The cohort component formula used in this study was:

$$P_{(t+n)} = P_{(t)} + B_t^{t+n} - D_t^{t+n} + IM_t^{t+n} - OM_t^{t+n}$$

$$= P_{(t)} + b_n P_{(t} - d_n P_{(t} + M_n$$

where:

$P_{(t+n)}$ = Population at the end of the period (at time t+n)

$P_{(t)}$ = population at the beginning of the period (at time t)

$B_t^{t+n}$ = births during the period (time t to t+n)

$D_t^{t+n}$ = deaths during the period (time t to t+n)

$IM_t^{t+n}$= in-migration during the period (time t to t+n)

$OM_t^{t+n}$= out-migration during the period (time t to t+n)

$b_n$ = birth rate for n years

$d_n$ = death rate for n years

After applying the Cohort Component Method, this study utilized the ratio method to carry out projections at the sub-county level. The study specifically used the constant share ratio method to project the sub-county population in Mandera County. The reason for selecting this method was because it is considered to be the most accurate and reliable method for population projections of lower level geographical areas where the requisite information on population dynamics is not available. The procedure to be followed is outlined below;

i. The entire ratio of the sub-counties population was based on the population of the county that has already been projected using the Cohort Component Method;
ii. After acquiring the ratios of the sub-counties to the county population, assumptions were made on the forthcoming rate of these ratios;
iii. After fixing the future rates of the ratios, the population of the sub-counties was then determined by subjecting the ratios to the projected county population for various years under consideration.

This *constant-share* method formula used was:

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

Where $P_{it}$was the population projection for the sub-county (i) in the target year; $P_{il}$ was the population of the sub-county in the launch year; $P_{jl}$was the population of the county (j) in the launch year; and $P_{jt}$was the projection of the county in the target year. The main assumption used while utilizing this method was that the growth rate of the sub-county would be similar to that of the county over the years.

### 3.3 Quality of Data Used

The Kenya National Bureau of Statistics (Kenya, Republic of. 2012d.) notes that during the 2009 census, there were irregularities noted especially on reporting of sex ratios at all age-levels in North Eastern region. Mandera County was part of this region and hence was affected by the same. The region exhibited preference for terminal digits (i.e. 0 and 5) as was the case in previous censuses with most females favouring the digit zero.

Whereas the national accuracy index was 23.7 in Kenya, the North Eastern region demonstrated a very highly inaccurate accuracy index of 108. Therefore, KNBS applied strong smoothing to the initially reported figures in North Eastern region and Mandera County. On the age-sex ratio, anomalies and discrepancies were noted in the data especially for persons aged above 65 years. This was attributed to variance in age shifting by sex. KNBS was able to correct the data from North Eastern region and Mandera County and used it to make the 2010 population projections.

One of the weaknesses of using the cohort component method model is the problem of formulating practical death, birth and local migration ranges. This can be subdued by integrating the local population forecasts and assumptions to the county projections and assumption. Both the past and present connection between the local and regional demographic can facilitate formulation of preliminary sub-county population forecast in the regional planning framework. Preston, Heuveline and Guillot (2000) offer that the modification of the county birth and death rates to reflect the sub-county trends have simplified the extraction of migration flows through residual method. The improvised association of local-regional demographic can be used in the application of local cohort-component model. However, there is a challenge in creation of migration suppositions (Choi, Choi and Valley, 2010).

**Fertility Projections**

Fertility is referred to as the number of children who are born to a woman throughout her lifetime. Births are the single highest contributor to population growth compared to any other demographic event. Fertility in the future is considered critical in knowing fertility trends in the future. Assumptions in fertility are usually articulated as the total number of children a woman has throughout her reproductive life i.e. total fertility rate. In this study, fertility projections were done by projecting the path of the TFR over a period of time and converting this TFR to age-specific fertility rates. While conducting the fertility projections, this study assumed that the TFR of Kenya and that of Mandera County would continue to reduce as has been witnessed recently. This was used to determine trends in population age and size make up.

This study utilized two previous estimates of fertility i.e. estimates from the 2009 census and the 2014 KDHS estimates. The reason for selecting these estimates was because they are the most accurate and comprehensively captured data from Mandera County. At the county level, it was assumed that the TFR would continue to decline until the final year of projection as evidenced from various studies. As of 2014, Mandera County's TFR was at 5.2 (KDHS, 2014) and was expected to continue declining. Similar fertility assumptions were made at the sub-county level. The estimates from the previous census were used to create a trend that was then be applied in this study to project the age-specific fertility rates.

**Mortality Projections**

Projecting mortality is based on forecasting future probability of life at birth for males and females, demarcated as the average lifespan of a child born today if current age-specific mortality levels were held fixed in the future. The expectation of life at birth was assumed to have increased from 2010 to 2030. This is due to the fact that both the 2009 census and 2014 KDHS reveal that there's improvement in infant and child mortality. Thus, expectation of life at birth was assumed to improve over the period of the projection.

Below is the formula that was used in calculating mortality rates;

$$\text{Mortality Rate} = \frac{\text{number of deaths in a given time period}}{\text{population from which the deaths occurred in the same time period}} \times 10^{n}$$

**Adjustment due to HIV and AIDS**

In this study, the 2014 KDHS infant and child mortality estimates were used to deduct the estimated HIV and AIDS mortality from the DHS mortality estimates. The resulting figures of non-AIDS survival rates were projected to 2030 for the county. The 2014 KDHS estimates were also used to project the sub-county population. The KDHS 2014 did not provide mortality estimates at the county level, and therefore the infant and child mortality estimates were split by sex. This study first carried out an estimate of the sex ratio at birth by applying the county estimates and then dividing the sub-county estimates using the implicit sex ratio.

These estimates for the sub-county were used to estimate the non-AIDs age-specific mortality rates. This was attained by deducting the estimated AIDS-only mortality from the mortality estimates contained in the 2014 KDHS, to obtain a non-AIDS life table. Thereafter, the values for non-AIDS expectation of life at birth were projected to 2030.

**AIDS-only Mortality**

This study utilized the AIDS-only age-specific mortality rates from the 2010 to 2014 Spectrum file of National Aids Control Council (NACC). An adjusted exponential growth rate reliant on the changes in mortality as derived from the 2009 KPHS and 2014 KDHS was used for each precise 5-year age group. The synced growth rate took into account the two contiguous age groups, permitting for the modification of changes in rates that might be present in only a single age group is used. It was assumed that the results would depict a continuation in the slowing down of AIDS-only mortality in the future years under consideration.

The AIDS-only age-specific mortality figures were combined with the non-AIDS mortality rates to produce fixed mortality amounts that comprise AIDS. This study further used the ratio of the sub-counties HIV prevalence to the County HIV prevalence as outlined in the KDHS 2014 report to come up with the AIDS-only specific mortality rates for each sub-county.

**Migration Projections**

Various factors influence migration in and out of a place and this may affect migration flows making them fluctuate over time. Migration is considered a technical population component to estimate. From previous studies and censuses, Kenya has recorded very low international migration in general. This makes international migration in the country as well as counties an inconsequential feature is population change. Based on the 2009 census, which recorded a less than 1 per cent, rate of international migration, this study did not integrate the same into its projections. The key assumption here was that the same trend of international immigration will hold constant up to the final year of projection.

For internal migration, the average rates of net migration in the North Eastern region were used. These figures were applied to the county and sub-county with the assumption that they would remain constant over the period of the projections. Consequently, it was assumed that migration will remain constant during the consideration period.

### 3.4 Method for Human Resources for Health Projection

There are various methods that have been established to project human resources and all have different results. All the methods have their benefits and shortcomings. Choosing a method that best suits a particular study depends on the availability of data, the technical capability to perform the projections as well as the policy requirements. Various methods have been advanced as possible ways of projecting HRH. These include the needs-based approach, the demand based approaches, the adjusted service target-based approach, facility-based models, the acuity quality method and the workforce-to-population ratio method

The workforce-to-population projection model was used to compute the future health labour force need in this study due to various reasons. The study chose this approach because it was less demanding in terms of data for health personnel. The method can also utilize data from household censuses as a primary source of data. Because there is already census data on Mandera County, this method thus suited this study. One key limitation of this approach is that it does not consider other health variables such as diseases, number of hospitals, technological improvements in health, existing health policies, etc. Thus, the methodology only takes into consideration population size, which might not be a representative of the entire health needs of a country or county.

By utilizing health workforce-to-population ratio, this study made the assumption that the comparative quantity of health workers in Mandera County at a assumed moment was the most significant determining factor of its health structure's capability to provide health services. The study further assumed that analysis of the perceived ratio in Mandera County was practically designated as a comparator.

The workforce-to-population ratio technique was utilized to project impending figures of essential health labourers on the foundation of anticipated thresholds for employees' density (e.g. physicians per 10, 000 population). This study applied the required World Health Organization standards of health workers to population to come up with the projected figure. This are the same standards adopted by Kenya's Ministry of Health. Below is a systematic explanation of how the projection was carried out;

i. The first step was to subject the entire projected population to the WHO doctor to patient ratio in order to attain the required doctor: patient ratio for the years under consideration;
ii. The next phase was use the acquired doctor rates to calculate the needed number of other health workers such as nurses and midwives for the years under review;
iii. This was done in 5-year cohorts just as with the population projections;
iv. Finally, the study made conclusions on the need for HRH based on the projected figures.

The researcher then made conclusions established on the conclusion of this examination and elucidation of data. This methodology is centred on the hypothesis that there is homogeneousness at the levels of the numerator (all physicians are correspondingly productive and will continue so) and of the denominator (all populations have related necessities, which will stay constant).

# CHAPTER FOUR: POPULATION PROJECTIONS AND THEIR IMPLICATION ON HUMAN RESOURCES FOR HEALTH

## 4.0 Introduction

This chapter will discuss the results of Mandera County's 2030 Population projections using the Cohort Component Method and what implications the projections have on human resources for health in the county. The chapter will begin by discussing the changes that occur in all the 3 components of population from 2010 to 2030; then discuss how the component were applied in projecting the population of Mandera County and finally discuss the implications that the projections have on human resources for health.

## 4.1 Component projections

There are three key components of population projections i.e. fertility, mortality and migration. Over time, each component experiences separate changes that necessitate that they be projected singularly.

### 4.1.1 Fertility Projection Assumptions

This study used data estimates from the 2009 Kenya Population and Housing Census as well as the 2014 Kenya Demographic and Health Survey as the main inputs in calculating the fertility trends of Kenya, North Eastern region and Mandera County from 2010 to 2030. The fertility data derived from previous reports was used to extrapolate the Total Fertility Rate for the years ahead. This study used the 2009 census fertility data and the 2014 KDHS data to calculate the projected Total Fertility Rate for the five-year cohorts of 2015, 2020, 2025 and 2030. The 2015 to 2030 national decline pattern (percentages) stipulated in the population policy document apply for this study. Further, the 2015 figures for North Eastern and Mandera (obtained from KDHS results) are the base figures used in this survey. Finally, this study assumed that the 2015 to 2030 national decline pattern in fertility would also hold in Mandera and in North Eastern.

Generally, Total Fertility Rate is projected to fall at all levels. Kenya's Total Fertility Rate will decline from 4.8 in 2010 to 3.8 in 2015 to 3.2 in 2020 to 2.7 in 2025 and finally to 2.3 in 2030. Similarly, North Eastern Region's Total Fertility Rate will decline from a high of 6.8 in 2010; 6.2 in 2015; 5.3 in 2020; 4.4 in 2025; 3.8 in 2030. Finally, Mandera County's Total Fertility Rate will follow the same trend and decline from 7.3 in 2010; 5.1 in 2015; 4.3 in 2020; 3.6 in 2025 and finally 3.1 in 2030. Table 4.1 below depicts the above-mentioned trend in decline of Total Fertility

Rate. The decline in total fertility rates implies that the number of children a woman can give birth to over her entire reproductive life will also decline in Kenya, North Eastern region and Mandera County.

**Table 4.1: Projected Total Fertility Rates Assumptions from 2010 to 2030**

| YEAR | Kenya | North Eastern | Mandera |
|---|---|---|---|
| **2010** | 4.8 | 6.8 | 7.3 |
| **2015** | 3.8 | 6.2 | 5.1 |
| **2020** | 3.2 | 5.3 | 4.3 |
| **2025** | 2.7 | 4.4 | 3.6 |
| **2030** | 2.3 | 3.8 | 3.1 |

**Source: Study Data**

After projecting the total fertility rates of Mandera County, the study used the same method of extrapolation to project the future Age Specific Fertility rates of the county. Using data from the 2009 census and the projected 2030 Age Specific Fertility rates, the study extrapolated the rates in the years in between using MS-Excel as the statistical software.

The study found out that Age Specific Fertility rates for each age cohort for Mandera County will decline from 2010 to 2030. For example, in the age cohort of 25-29, the Age Specific Fertility rates will decline from 0.3304 in 2010 to 0.2293 in 2015 to 0.1931 in 2020 to 0.1630 in 2025 and finally to 0.1388 in 2020. Table 2 below shows the decline in the projected Age Specific Fertility rates for the various age cohorts for women of reproductive age in Mandera County over the years under consideration. The decline in Age Specific Fertility rates per age-cohort over the period under consideration implies that the number of children given birth per 1,000 women will decline over the years as shown in Table 4.2 below. Thus few children will continue to be born per 1,000 women of any age-cohort in the period under consideration in this study.

**Table 4.2: Mandera County's Projected Age Specific Fertility Rates Assumptions from 2010-2030**

| | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **15-19** | 0.1442 | 0.1001 | 0.0843 | 0.0711 | 0.0606 |
| **20-24** | 0.3225 | 0.2238 | 0.1885 | 0.1590 | 0.1355 |
| **25-29** | 0.3304 | 0.2293 | 0.1931 | 0.1630 | 0.1388 |
| **30-34** | 0.2840 | 0.1971 | 0.1660 | 0.1401 | 0.1193 |
| **35-39** | 0.2217 | 0.1539 | 0.1296 | 0.1093 | 0.0931 |
| **40-44** | 0.1194 | 0.0829 | 0.0698 | 0.0589 | 0.0501 |
| **45-49** | 0.0377 | 0.0262 | 0.0220 | 0.0186 | 0.0158 |
| **Total TRF** | **7.3** | **5.1** | **4.3** | **3.6** | **3.1** |

**Source: Study Data**

Table 4.2 also shows the trend that Mandera County's age specific fertility rates will take from 2010 to 2030 according to this study's projection. From the table above, the age specific fertility rates peaks at the age cohorts of 20-24 and 25-29, before it starts declining from the age cohorts of 30-49 for all years under consideration. This implies that the number of children born per 1,000 women will be less in the age-cohort of 15-19 years, and then increase in the age cohorts of 20-24 years and 25-29 years. Further, the number of children born per 1,000 women will start declining considerably from the age-cohorts of 30-49 years. From Table 2 above, it is evident that more children will be born per 1,000 women in the age-cohorts of 20-29 years as compared to the other age-cohorts.

### 4.1.2 Mortality Projection Assumptions

This study also projected under-five mortality rates for Mandera County. This study assumed that the 2015 to 2030 national decline pattern in mortality would also hold in Mandera and in North Eastern. Further, the national projected patterns contained in the 2012 population policy document will hold for the case of Mandera in the 2015 to 2030 period and the Mandera 2015 rates are same as 2014 KDHS rates. The first step was to calculate the trend in under-five mortality rates from previous census results. The national average decline in under-five mortality rates was 30 percent from 1999-2009. This percentage decline was applied in calculating subsequent under-five mortality rates from 2010-2030. The second step was to project the county's total under-five mortality rates. This was done by extrapolating the already available data on under-five mortality rates from the 2010 analytical report on mortality and 2014 KDHS. The available data was extrapolated to give figures for subsequent years under consideration. After calculating the county's under-five mortality rates, this study used the totals per each five-year period to extrapolate the gender specific rates. This study used the gender specific data provided in the 2010 analytical report on mortality and the 2014 KDHS to infer the under-five mortality rates for the proceeding years.

The study findings show that expectation of life at birth is projected to rise for Kenya, North Eastern region and Mandera County from 2010 to 2030. In Mandera County, the expectation of life is expected to increase from 2010 to 2030 for both sexes. The expectation of life will increase from 66 for males and 64 for females in 2010 to 69 for males and 66 for females respectively by 2030.

Under-five mortality rates for Mandera County are projected to decrease from 53 in 2010 to 45 in 2015 to 37 in 2020 and to 31 in 2025 and 26 in 2030 respectively. In Mandera County, the under-five mortality rates for female are projected to be lower compared to those of males. The under-five mortality rates for males will decrease from 55 in 2010 to 45 in 2015 to 38 in 2020 and to 32 in 2025 and 27 in 2030 respectively. Conversely, under-five mortality rates for females will continue to decrease from 52 in 2010; 44 in 2015; 37 in 2020; 31 in 2025 and 26 in 2030 respectively. Table 4.3 below shows the decline in under-five mortality rates in Mandera County. Decline in under-five mortality rates in Mandera County indicates that there will be less deaths occurring per 1,000 children under-five years from the year 2010-2030.

**Table 4.3: Mandera County's Projected Under-Five Mortality Rates Assumptions from 2010-2030**

| Year | Mandera (Overall) | Male | Female |
|---|---|---|---|
| 2010 | 53 | 55 | 52 |
| 2015 | 45 | 45 | 44 |
| 2020 | 37 | 38 | 37 |
| 2025 | 31 | 32 | 31 |
| 2030 | 26 | 27 | 26 |

**Source: Study Data**

### 4.1.3 Migration Projection Assumptions

According to the Analytical report on Migration, Kenya recorded very low numbers of international migration i.e. less than one per cent and hence this was not included in subsequent population projections as the migration was not significant. At the regional level, internal migration was taken in to account. Mandera County's net migrants were -2,650 (0.41% of total population) with reference to the 2009 census. This will have an insignificant impact on the county population and therefore was not integrated into the County Population Projections. This study presumed that the rate of net migration in the county would hold steady from 2010 to 2030, which was the time under consideration for the projections.

After projecting the three components of population, the study went ahead to project the county population projection using the Cohort Component Method as all components were now available.

## 4.2 Population Projections

This study projected Mandera County's population using the Cohort Component Method. The projected population of Mandera County was then used to project the required human resources for health in the county and thus deduce the implications of the projections on HRH in the county. The study used the 2010 projected population by KNBS as the base population for subsequent population projections in Mandera County. The study thus assumed that the base population had already been assessed for its quality, coverage and content errors and thus there was no need to repeat the process. Consequently, any limitations experienced in the 2010 population projections by KNBS are inherent to this study.

### 4.2.1 Mandera County Population Projections

The cohort component method was used to project the population of Mandera County in various age cohorts. The first step was to project all components of population as they are the required to carry out projections using the cohort component method. This study thus projected fertility and mortality from the national level to the county level using recently available data from the 2010 Analytical Report on Population Projections and the KDHS 2014. The study did not project migration at any level as the rate of both international and internal migration was less than one percent, and thus would not have any noteworthy effect on the population. Hence, for migration, the study anticipated that the trend of migration would be left steady for the entire period of the projections.

After projecting the components of population, the study applied them in calculating the expected number of births for every five-year period and adding them to the population as well as the anticipated sum of deaths for the same period and deducting them from the population. By using the cohort component period, the study was able to track an age cluster from a particular year they survive, while considering their births, deaths and migration (KNBS, 2012d).

Projecting a population requires one to project the population of every age-cohort first at the base year, to enable the estimation of the number of people still alive at beginning of the next interval. The first step of projecting the population of Mandera County was to calculate the number of births for every age-cohort for every 5-year interval. The births across all age-cohorts were then added to yield the overall number of births which were then used to calculate the number of those who

lived up to the beginning of the next interval. This was done for all 5-year age groups in 2010, 2015, 2020, 2025 and 2030.

The next step was to use the under-five mortality rates to calculate the survival ratio of each age-cohort per every 5 year period from 2010-2030. This assisted in calculating the survivors at the next interval (apart from those of the open age group i.e. 80+ years). The study multiplied the survival ratio by the number of persons at the commencement of every interval while at the same time moving the results one row down. For the open age group, which usually combines survivors from two age-cohorts, survivors from the preceding age-cohort were added to the survivors from the open age-cohort. This was done for all 5-year age groups in 2010, 2015, 2020, 2025 and 2030.

For the population of those who are under-five years old, this study began by calculating the number of births for each sex occurring in each interval, and then exposing them to their correct survival ratios. The number of births was obtained by multiplying the age specific fertility with the number of women in their child-bearing ages for each interval. This was done for all 5 year age groups in 2010, 2015, 2020, 2025 and 2030. Table 4.4 below depicts the methodology used i.e. the Cohort Component Method in calculating the projected population from 2010 to 2015 using the above explanations. The same was repeated for all 5 year cohorts up to 2030.

**Table 4.4: Formula for projecting population using the Cohort Component Method in Mandera County**

| Females | | | | | | | Males | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Age Groups** | **2010*** | **Lx*** | **ASFR** | **Births** | **Female Births** | **Projected Pop 2015** | **Age Groups** | **2010** | **Lx** | **Male Births** | **Projected Pop 2015** |
| 0-4 | 104762 | 4.8199 | | | 64312 | 61996 | 0-4 | 112244 | 4.7934 | 67528 | 64738 |
| 5-9 | 44370 | 4.7145 | | | | 102472 | 5-9 | 51515 | 4.7062 | | 110201 |
| 10-14 | 31437 | 4.6788 | | | | 44034 | 10-14 | 40273 | 4.6800 | | 51229 |
| 15-19 | 20674 | 4.6498 | 0.1442 | 2982 | | 31242 | 15-19 | 29711 | 4.6604 | | 40104 |
| 20-24 | 21519 | 4.5931 | 0.3225 | 6939 | | 20422 | 20-24 | 18249 | 4.6312 | | 29525 |
| 25-29 | 23419 | 4.5013 | 0.3304 | 7738 | | 21089 | 25-29 | 16810 | 4.5917 | | 18093 |
| 30-34 | 16439 | 4.3845 | 0.2840 | 4669 | | 22812 | 30-34 | 12364 | 4.5374 | | 16611 |
| 35-39 | 13598 | 4.2540 | 0.2217 | 3015 | | 15950 | 35-39 | 14030 | 4.4684 | | 12176 |
| 40-44 | 6462 | 4.1145 | 0.1194 | 771 | | 13152 | 40-44 | 7655 | 4.3901 | | 13784 |
| 45-49 | 6700 | 3.9646 | 0.0377 | 253 | | 6227 | 45-49 | 7463 | 4.3036 | | 7504 |
| 50-54 | 2641 | 3.7957 | | **26368** | | 6415 | 50-54 | 4380 | 4.2054 | | 7293 |
| 55-59 | 3180 | 3.5897 | | **131840** | | 2498 | 55-59 | 5354 | 4.0869 | | 4257 |
| 60-64 | 979 | 3.3156 | | | | 2937 | 60-64 | 2008 | 3.9318 | | 5151 |
| 65-69 | 1522 | 2.9290 | | | | 865 | 65-69 | 2121 | 3.7112 | | 1895 |
| 70-74 | 1403 | 2.3832 | | | | 1238 | 70-74 | 1728 | 3.3780 | | 1931 |
| 75-79 | 2382 | 1.6703 | | | | 983 | 75-79 | 3153 | 2.8620 | | 1464 |
| 80+ | 5846 | 0.9085 | | | | 2899 | 80+ | 6342 | 2.1027 | | 4021 |
| | **307333** | | | | | **357229** | | **335400** | | | **389977** |

**Source: Study Data**

***2010 base year population data and Lx Values obtained from the 2009 population census analytical report on population projections.**

Table 4.5 below depicts a summary of the total projected population of Mandera County from the base year 2010 to 2030 for both males and females.

**Table 4.5: Summary of Mandera County's Projected Population from 2010 to 2030 for both sexes**

| | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Male** | 335400 | 389977 | 433707 | 479117 | 529269 |
| **Female** | 307333 | 357229 | 397007 | 438206 | 488858 |
| **Grand Total** | **642733** | **747206** | **830714** | **917324** | **1018127** |

**Source: Study Data**

Mandera County's population is anticipated to rise from 642,733 in 2010 to 747,206 in 2015, to 830,714 in 2020 to 917,324 in 2025 and finally to 1,018,127 by 2030. The final projected figure for Mandera County by this study differs slightly by that produced by KNBS in the 2010 Analytical Report on Population Projections, which projected Mandera County's population to be at 917,930 by 2030. Further, Mandera County's population contains more males than females throughout the projection period. This is in line with previous projections in the North Eastern Region as well as Mandera County. A more detailed table of the projected population for Mandera County by sex and age group is in tables 4.6 and 4.7 below.

**Table 4.6: Mandera County's Projected Population from 2010 to 2020 for both sexes**

| Age Groups | 2010 | | | 2015 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Males** | **Females** | **Total** | **Males** | **Females** | **Total** | **Males** | **Females** | **Total** |
| **0-4** | 112244 | 104762 | 217006 | 64738 | 61996 | 126734 | 51350 | 49068 | 100418 |
| **5-9** | 51515 | 44370 | 95885 | 110201 | 102472 | 212673 | 63720 | 60803 | 124523 |
| **10-14** | 40273 | 31437 | 71710 | 51229 | 44034 | 95263 | 109656 | 101771 | 211427 |
| **15-19** | 29711 | 20674 | 50385 | 40104 | 31242 | 71346 | 51036 | 43785 | 94820 |
| **20-24** | 18249 | 21519 | 39768 | 29525 | 20422 | 49947 | 39877 | 30891 | 70768 |
| **25-29** | 16810 | 23419 | 40229 | 18093 | 21089 | 39182 | 29295 | 20042 | 49336 |
| **30-34** | 12364 | 16439 | 28803 | 16611 | 22812 | 39423 | 17896 | 20572 | 38467 |
| **35-39** | 14030 | 13598 | 27628 | 12176 | 15950 | 28126 | 16375 | 22160 | 38536 |
| **40-44** | 7655 | 6462 | 14117 | 13784 | 13152 | 26936 | 11974 | 15441 | 27415 |
| **45-49** | 7463 | 6700 | 14163 | 7504 | 6227 | 13731 | 13523 | 12681 | 26204 |
| **50-54** | 4380 | 2641 | 7021 | 7293 | 6415 | 13707 | 7338 | 5963 | 13300 |
| **55-59** | 5354 | 3180 | 8534 | 4257 | 2498 | 6754 | 7090 | 6064 | 13154 |
| **60-64** | 2008 | 979 | 2987 | 5151 | 2937 | 8088 | 4095 | 2303 | 6398 |
| **65-69** | 2121 | 1522 | 3643 | 1895 | 865 | 2760 | 4857 | 2584 | 7440 |
| **70-74** | 1728 | 1403 | 3131 | 1931 | 1238 | 3169 | 1719 | 697 | 2415 |
| **75-79** | 3153 | 2382 | 5535 | 1464 | 983 | 2447 | 1619 | 849 | 2468 |
| **80+** | 6342 | 5846 | 12188 | 4021 | 2899 | 6920 | 2289 | 1333 | 3622 |
| **Total** | **335400** | **307333** | **642733** | **389977** | **357229** | **747206** | **433707** | **397007** | **830714** |

**Source: Study Data**

The projected population of Mandera County will increase by a margin of 16% from 2010 to 2015, after which it will start increasing by a margin of 11% from 2015 to 2030 as shown in table 4.6 above and 4.7 below.

**Table 4.7: Mandera County's Projected Population from 2020 to 2030 for both sexes**

| Age Groups | 2020 | | | 2025 | | | 2030 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Total | Males | Females | Total | Males | Females | Total |
| 0-4 | 51350 | 49068 | 100418 | 52365 | 50018 | 102383 | 57598 | 60962 | 118560 |
| 5-9 | 63720 | 60803 | 124523 | 50641 | 48241 | 98882 | 51726 | 49273 | 100999 |
| 10-14 | 109656 | 101771 | 211427 | 63436 | 60429 | 123866 | 50436 | 47968 | 98404 |
| 15-19 | 51036 | 43785 | 94820 | 109281 | 101247 | 210528 | 63238 | 60139 | 123377 |
| 20-24 | 39877 | 30891 | 70768 | 50772 | 43334 | 94106 | 108762 | 100262 | 209024 |
| 25-29 | 29295 | 20042 | 49336 | 39591 | 30356 | 69947 | 50435 | 42612 | 93046 |
| 30-34 | 17896 | 20572 | 38467 | 28999 | 19578 | 48576 | 39216 | 29666 | 68882 |
| 35-39 | 16375 | 22160 | 38536 | 17658 | 20009 | 37667 | 28633 | 19041 | 47674 |
| 40-44 | 11974 | 15441 | 27415 | 16118 | 21474 | 37592 | 17392 | 19376 | 36767 |
| 45-49 | 13523 | 12681 | 26204 | 11758 | 14896 | 26654 | 15835 | 20687 | 36522 |
| 50-54 | 7338 | 5963 | 13300 | 13234 | 12144 | 25379 | 11510 | 14232 | 25742 |
| 55-59 | 7090 | 6064 | 13154 | 7139 | 5633 | 12772 | 12876 | 11427 | 24303 |
| 60-64 | 4095 | 2303 | 6398 | 6824 | 5581 | 12405 | 6868 | 5146 | 12014 |
| 65-69 | 4857 | 2584 | 7440 | 3861 | 2016 | 5876 | 6422 | 4815 | 11238 |
| 70-74 | 1719 | 697 | 2415 | 4396 | 2056 | 6452 | 3477 | 1561 | 5038 |
| 75-79 | 1619 | 849 | 2468 | 1431 | 466 | 1897 | 3613 | 1311 | 4924 |
| 80+ | 2289 | 1333 | 3622 | 1613 | 728 | 2341 | 1234 | 379 | 1613 |
| **Total** | **433707** | **397007** | **830714** | **479117** | **438206** | **917324** | **529269** | **488858** | **1018127** |

**Source: Study Data**

From the two tables above, Mandera County's young population (0-14 years) will reduce from a high of 60 percent in 2010 to 31 per cent in 2030. The adult population (65+ years) will also reduce from 4 percent in 2010 to 2 per cent in 2030. The population of women of reproductive age (15-49 years) will increase from 17 percent of the total population in 2010 to 29 per cent of the entire population in 2030.

After getting the county projected population, the study used the constant share ratio to project the sub-county population in Mandera County. The entire ratio of the sub-counties population was based on the population of the county that has already been projected using the Cohort Component Method. The first step was to acquire the ratios of the sub-counties from that of the county. This study used the 2010 projected data to get the ratios for the sub-counties. After acquiring the ratios of the sub-counties to the county population, assumptions were made on the forthcoming rate of these ratios. After fixing the future rates of the ratios, the population of the sub-counties was then

determined by subjecting the ratios to the projected county population for various years under consideration.

Table 4.8 beneath illustrates the projected sub-county population for all six sub-counties in Mandera County. The table depicts that Mandera South Sub-county will have the highest population in Mandera County from 2010-2030, it will be followed by Mandera North and East sub-counties respectively, then Mandera West, Banissa and Lafey sub-counties in that order.

**Table 4.8: Projected Sub-county Population in Mandera County from 2010-2030**

| | **Sex** | **2010** | **2015** | **2020** | **2025** | **2030** |
|---|---|---|---|---|---|---|
| | Male | 80496 | 93595 | 104090 | 114988 | 127025 |
| **Mandera South** | Female | 73760 | 85735 | 95282 | 105169 | 117326 |
| | Male | 57018 | 66296 | 73730 | 81450 | 89976 |
| **Mandera North** | Female | 52247 | 60729 | 67491 | 74495 | 83106 |
| | Male | 57018 | 66296 | 73730 | 81450 | 89976 |
| **Mandera East** | Female | 52247 | 60729 | 67491 | 74495 | 83106 |
| | Male | 36894 | 42898 | 47708 | 52703 | 58220 |
| **Lafey** | Female | 33807 | 39295 | 43671 | 48203 | 53774 |
| | Male | 53664 | 62396 | 69393 | 76659 | 84683 |
| **Mandera West** | Female | 49173 | 57157 | 63521 | 70113 | 78217 |
| | Male | 50310 | 58497 | 65056 | 71868 | 79390 |
| **Banissa** | Female | 46100 | 53584 | 59551 | 65731 | 73329 |
| **Total** | | 642733 | 747206 | 830714 | 917324 | 1018127 |

**Source: Study Data**

Having projected the population of Mandera County, the next phase was to project the required human resources for health for the period 2010-2030.

### 4.2.2 Mandera County Human Resources for Health Projections

This study used the projected county population to determine the required number of healthcare workforce in Mandera County from 2010 to 2030 by using WHO estimates of health care workforce to population ratio. The study did not project the sub-county level number of health workers since they are all hired at the county level before being deployed to the sub-county level. In doing so, the study utilized the workforce-to-population ratio method. The reason for using this method was that it requires less input as compared to other methods, which require input that is not readily available. The World Health Organization puts a threshold of a minimum of 23 healthcare personnel (including doctors, nurses and midwives) per a population of 10,000 people

for a country to be able to attain acceptable coverage rates of 80 per cent. On the other hand, WHO recommends a maximum of 44.5 healthcare personnel (including doctors, nurses and midwives) per a population of 10,000 people for a country. Without this, it is difficult to provide critical health interventions, which will contribute to achieving the Sustainable Development Goal 3 on Health and Well-being.

Kenya is beheld as one of the countries that has an acute deficiency of health personnel. Mandera County is even worst hit by the issue of shortage of health workers due to many challenges such as being as ASAL area, insecurity among others which make is difficult to attract human resources for health. The World Health Report (WHO, 2006) notes that countries with less than 23 health personnel (doctors, nurses and midwives) per a population of 10,000 will normally be unsuccessful in attaining the goal of 80 percent reporting rate for trained birth attendance and child vaccination. As of 2013, Mandera County had a total of 1.2 health personnel (doctors, midwives and nurses) per 10,000 population according to MOH's Integrated Payroll and Personnel Database. This shows that Mandera County was doing poorly compared to WHO's recommended ratio.

This study applied the minimum and maximum recommended workforce to population ratios to calculate the required human resources in the health sector in Mandera County. Table 4.9 below shows the projected minimum required health personnel (doctors, midwives and nurses) per 10,000 population for Mandera County from 2010 to 2030 as recommended by WHO. The study used a ratio of 23 health care personnel (doctors, midwives and nurses) to 10,000 population to calculate the minimum required number of health personnel.

**Table 4.9: Projected Minimum Required Health Personnel in Mandera County from 2015 to 2030**

| | **2010** | **2015** | **2020** | **2025** | **2030** |
|---|---|---|---|---|---|
| **Total Population** | 642733 | 747206 | 830714 | 917324 | 1018127 |
| **Required Minimum Health Personnel** | 1478 | 1719 | 1911 | 2110 | 2342 |

**Source: Study Data**

The projections show that Mandera County required a minimum of 1,719 health personnel in 2015, and will require 1,911 health personnel in 2020, which will continue increasing to 2,110 in 2025 and 2,342 by 2030. This represents an 11 percent increase in the required minimum number of health personnel every 5 years from 2015. The implication that this has on the current numbers of

health personnel is that they are overburdened by work since they have to serve beyond the recommended number of patients.

Table 4.10 below shows the projected maximum required health personnel per 10,000 population in Mandera County from 2010 to 2030 as recommended by WHO. This study used a ratio of 44.5 health care personnel to a population of 10,000 to calculate the maximum required number of health personnel.

**Table 4.10: Projected Maximum Required Health Personnel in Mandera County from 2015 to 2030**

| | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|
| **Total Population** | 642733 | 747206 | 830714 | 917324 | 1018127 |
| **Required Health Personnel** | 2860 | 3325 | 3697 | 4082 | 4531 |

**Source: Study Data**

The projections show that Mandera County required a maximum of 3,325 health personnel in 2015, and will require 3, 697 health personnel in 2020, 4,082 in 2025 and 4,531 by 2030. Just as with the minimum required ratio, this represents a 11 per cent increase in the required maximum number of health personnel every 5 years from 2015. As per the latest statistics on human resources for health, Mandera County has a dire necessity for healthcare employees. They are presently functioning at a capacity of 5 percent of the essential minimum health personnel. The increase in population in Mandera County will require an equal increase in human resources for health to be able to meet health needs.

The Organization for Economic Co-operation and Development, which is a multi-country economic organization, recommended an average ratio of 3.4 doctors to a population of 1,000 in 2017 (OECD, 2017). This study applied this ratio to calculate the ratio of doctors to population needed in Mandera County from 2015 to 2030. This study found out that Mandera County required 2,541 doctors to be able to attend to the needs of its population in 2015, which would increase to 2,824 in 2020, 3,119 in 2025 and 3,462 in 2030 as represented in table 4.11 below. As of 2013, Mandera County had only 1.2 doctors serving a population of 10,000. This is below the recommended 34 doctors per a population of 10,000 by the OECD. Thus, the county has improvements to make in terms of achieving the minimum OECD recommended number of doctors.

**Table 4.11: Projected Ratio of Doctors in Mandera County based on OECD Recommendation**

| Year | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Total Population** | 747206 | 830714 | 917324 | 1018127 |
| **Required Doctors** | 2541 | 2824 | 3119 | 3462 |

**Source: Study Data**

The OECD also recommends an average ratio of 2.8 nurses to one doctor (OECD, 2017) to enable a country meet its health requirement needs. This study used the projected number of doctors in Mandera County to also project the number of required nurses from 2015-2030. Table 4.12 below shows the required number of nurses in Mandera County per OECDs recommended average ratio of nurses to doctors. The study projected that Mandera County needed 7,113 nurses in 2015, and will need 7,908 nurses in 2020, 8,733 nurses in 2025 and 9,693 nurses in 2030. Compared to available data from reports in Mandera County, the projected number of required nurses to attend to the population is higher than the available number of nurses in the county. This means that the county needs to invest in hiring of more nurses as well as having more trained within the county.

**Table 4.12: Projected Ratio of Nurses to Doctors in Mandera County based on OECD Recommendation**

| Year | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| **Total Population** | 747206 | 830714 | 917324 | 1018127 |
| **Required Doctors** | 2541 | 2824 | 3119 | 3462 |
| **Required Nurses** | 7113 | 7908 | 8733 | 9693 |

**Source: Study Data**

# CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.0 Introduction

This chapter reflects on the study findings, draws conclusions from the findings and makes recommendations based on the findings and conclusions. The general research objective for this study was to project the population of Mandera County and its sub-counties between 2010 and 2030 incorporating the county population dynamics and determine their implications on human resources for health.

## 5.1 Summary of Findings

This study observed that the population dynamics of Mandera County, which are utilized in conducting projections, would change significantly during the period under consideration. The TFR and ASFR of Mandera County will fall at all age-cohorts for women of reproductive age. The decline in TFR in Mandera County was more than half-decreasing from a high of 7.3 in 2010; 5.1 in 2015; 4.3 in 2020; 3.6 in 2025 and finally 3.1 in 2030. Concerning mortality, this study established that under-five mortality rates for Mandera County was projected to decrease from a high of 155 in 2010 to 45 in 2015 to 37 in 2020 and to 31 in 2025 and 26 in 2030 respectively. The same decline in under-five mortality rates was witnessed in both sexes. Further, due to decline in mortality rates, the expectation of life in Kenya and Mandera County specifically rose during the period under consideration. The expectation of life increased from 66 for males and 64 for females in 2010 to 69 for males and 66 for females respectively by 2030.

According to the population projections for Mandera County, its population will increase from 642,733 in 2010 to 747,206 in 2015. This represents a 14 percent increase in the population in the period of 5 years after the national census. The population of Mandera County will then increase from 747,206 in 2015; 830,714 in 2020; 917,324 in 2025 and 1,018,127 in 2030. This represents an increase in the population of 10 percent 2020, 9 per cent 2025, and 10 percent in 2030 respectively. The projected population for this study differs slightly with that projected by KNBS for 2030.

This study also projected that Mandera County's young population (0-14 years) will decline during the period under consideration to about a third of the entire population by the year 2030. The total population will reduce from 60 percent in 2010 to 31 percent in 2030. The decline was experienced

in the adult population, which is aged 65+ years, which will be reduced to around 2 per cent of the entire population by the year 2030. On the other hand, the total population for women of reproductive age is projected to increase from the year 2010 to the final year of projection i.e. 2030. The total population increased from 17 percent in 2010 to 29 percent of the entire population respectively in 2030.

The Human Resources for Health in Mandera County were also projected in this study. The study projected both the minimum required number of health personnel per a population of 10,000 and the maximum recommended number for the same population. The findings of this study show that Mandera County required a minimum of 1,719 health personnel in 2015, 1,911 in 2020, 2,110 in 2025 and 2,342 by 2030. This represents an 11 percent increase in the required number of health personnel every five years after 2015. On the higher side, this study projected that the county would require a maximum of 3,325 health personnel in 2015, 3,697 health personnel in 2020, 4,082 in 2025 and 4,532 by 2030. Currently, the county is only able to provide only 5 percent of the recommended minimum ratio of health personnel to population by WHO going by the projected figures in this study. The implication of this is that the health workforce is Mandera County is overworked and overburdened in their efforts to provide health care services.

The study also projected the required number of doctors and nurses per OECDs indicators. The findings show that Mandera County required a total of 2,541 doctors to be able to attend to the needs of its population in 2015, which would increase to 2,824 in 2020, 3,119 in 2025 and 3,462 in 2030. The study findings also indicate that Mandera County needed 7,113 nurses in 2015, and will need 7,908 nurses in 2020, 8,733 nurses in 2025 and 9,693 nurses in 2030.

### 5.2 Conclusion

From the findings in this study, it is evident that the population of Mandera County will increase significantly from 2010 to 2030. The increase in population means that the county will have to invest in various requirements to satisfy the needs of this population. The projected population of women of reproductive age will increase considerably from 2010 to 2030. This shows that the county will have to invest more in facilities and services that are needed to cater for the age group.

Concerning human resources for health, the study identified that Mandera County is in dire need to health personnel. As is currently stands, the county has a deficit of 95 percent of the minimum

required number of health personnel per a population of 10,000. The health personnel in Mandera County are overloaded with work in their pursuit of offering better services. The current numbers of health personnel are therefore not adequate to facilitate the county in attaining noteworthy strides in health indicators and service provision.

## 5.3 Recommendations

This study makes recommendations to healthcare policy makers as well as for further research in the field of projections for human resources for health. In making the recommendations, the research hopes that the quality and quantity of healthcare personnel will be improved not only in Mandera but also in Kenya as a whole. The desire for the recommendations is to improve health services while at the same time, ensuring that there are adequate human resources for health.

### 5.3.1 Recommendation for Policy Makers

One of the Seventeen Sustainable Development Goals launched as a follow up to the Millennium Development Goals in 2015 is on Good Health and well-being. The goal has several targets and one of them is to significantly rise health funding and the employment, improvement, teaching and retention of the health labour force in emerging countries, specifically in least advanced countries and Small Island developing States. This goal relates directly to this study. This study thus recommends that the policy makers in the country and specifically in Mandera County should design policies and legislature that enables the county to hire more health personnel. The county should aim at reaching the minimum recommend ratio of health personnel by WHO that will assist the overburdened healthcare workers as discovered by the study.

Another recommendation from this study is goes to the health department in Mandera County. The department should develop a HRH database that will inform their advocacy and planning process. With a well-developed database, it will be easy for the county to keep track of the entire health workforce and enable continuous development and upgrading of the healthcare workforce.

Finally, the county government should put in place measures that will attract and retain more health personnel into the county. They can do this by either paying for training of more health personnel or having a competitive pay package for the health personnel.

### 5.3.2 Recommendation for Further Research

Based on the outcomes of this study, there is a necessity for further research to be carried out on population projections at the county level incorporating the population dynamics. This was not previously done, and with the ushering in of devolution it is now paramount as the findings will assist counties to make key decisions on various sectors such as health.

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