HELPMAN
DEVELOPMENT
INSTITUTE

A Review of National Population Projections By age, sex and level of educational attainment (Nigeria) 2006-2031

Population Studies Program Discussion Paper
December 2021

Version Number: 2
Date of this version: December 2021

Helpman Development Institute
Plot 044 Ubiaja Crescent, Off Ladoke Akintola Boulevard,
Garki II, Abuja FCT
https://www.helpmaninstitute.org/New

Contents

INTRODUCTION 4

METHODS OF POPULATION PROJECTION 6
Mathematical method 6
Economic method 6
Cohort component method 6

CRITERIA FOR CHOOSING A PROJECTION METHOD 8

POPULATION METHOD ADOPTED BY NIGERIAN STATISTICAL AGENCIES 9

MIGRATION 10
Immigration in Nigeria 10
Emigration in Nigeria 11
Impact of migration on fertility 11

FIGURES FROM PROJECTIONS 12

ASSUMPTIONS 13

METHODOLOGY 1 15

DIFFERENCES IN POPULATION AND AGE DISTRIBUTION 16

DATA PRESENTATION IN CHARTS 18

DISCUSSION 21

CONCLUSION AND POLICY RECOMMENDATIONS 22

PROJECTION BY EDUCATIONAL ATTAINMENT 25
Basic Idea *26*

METHODOLOGY 2 28
Educational Fertility Differentials 28
Educational mortality differentials: 31

REFERENCES 32

INTRODUCTION

The main purpose of population projections is to provide estimates of future population size and structure for decision-making. The projections are vital for planning and budgeting by state and non-state stakeholders in the development community, and a well-aimed estimation is essential to making adequate preparation for future demands on resources[1]. Besides, concerns about the localized consequences of human population growth and demographic changes have motivated forecast about the demographic future [2]. Such concerns have necessitated projections to determine both size and structure, especially by sex and age, of future population trends in a geographical region at a particular time [2][3].

Demographers mainly view population projections as indicative rather than predictive. The methodology of a projection can either be objective or subjective [4] and there are several methods to make population projection [5]. Projections are, in general, based on certain assumptions; hence population projections are the implications of assumptions at future dates. They show a picture of the future population if specific assumptions hold. Nevertheless, they do not predict whether the assumptions will hold [2][3]. Future events prove the accuracy of a population forecast, as forecast represents an analyst's most realistic prediction of the future population. Projections are conditional as they are the combination of methodological assumptions, available records, and techniques [2].

Agencies such as United Nations Population Division (UNDP), U.S. Census Bureau, International Institute for Applied Systems Analysis (IIASA) and the World Bank make projections for global, regional and national populations, with United Nations projections most widely used [6]. Also, various national statistical bodies make projections for their countries [7]. The United Nations takes the lead in the production of projections and dissemination of their results [8]. However, individual demographers tend not to undertake global long-run population projections and have created projections at the national-level (or subnational level). Most national statistical governments make population projections for their own countries [7] [5].

Nigeria's first modern and carefully planned nationwide census was the 1952/1953 enumeration [8],[9] while the most recent population census was conducted in 2006 [10]. Later population figures have been estimated or projected by statistical and population agencies at national and subnational levels. Since its establishment in 1989, the National Population Commission (NPopC) of Nigeria has been tasked with collecting, analyzing and disseminating demographic data in the country. In 2000, the commission received the mandate to "review population policy, coordinate and monitor all population management activities" [11], and has been responsible for making the national population projections and supporting agencies at subnational levels.

Nigeria is undeniably geographically very large, populous, heterogeneous and rich in human and material resources [1]. Currently, Nigeria is projected as the most populous country in Africa and the 7th largest population in the world [11]. It is projected that Nigeria will be the 3rd largest nation in the world by 2050 [7]. Population estimates at subnational and national level are based on the 2006 census and annualized population

growth rates experienced between the 1991 and 2006 censuses at the respective level. Nigerian population was enumerated at 140,431,790 in the 2006 national population census and projections are based on 3.2% annual growth [12]. On this basis, the population was estimated to be 164,728,579 in 2011 and 186,939,754 in 2015 a report by the national bureau of statistics [13].

Individual demographers have also projected the population of Nigeria for various years using different methodologies. For instance, using the Exponentially Collocation Approximation (EFCAM), Differential Transformation (DTM) and Analytical Solution Method [14], projected Nigeria's population for the period of 2006-2031. At the end of the time interval, he projected that Nigeria's population would increase from about 140 million in 2006 to over 273 million by 2031[15]. Additionally, [16] used the Exponential, Logistic and Average projection methods for projection between 1991 and 2050. Using the Average projection method, his projection results indicated that by 2050, the Nigerian population would be approximately four times (404 million) its size in 1990 (92 million) [16]. Thus, indicating a continuous increase similar to our findings in this study. When compared with official projections by NPopC, the Average projection showed a closer approximation and better stability in the long run than the other methods [16].

Kuranga et al, [17] modelled an equation for the Nigerian population and made a projection. They employed the multiple linear regression using SPSS and obtained the equation $Y=37184.262+0.825x1+1.051x2+1.654x3$. This was used to estimate the symptomatic value. They compared their results with NPopC projections and discovered that the projections using the Symptomatic Estimated method for is approximately the same with NPopC [32]. That is, their Symptomatic Estimated population was 163,736,835 while that of NPC was 163,609,494. Hence, they recommended that the model obtained can be used to project the Nigerian population. Furthermore, in 2015, Ashinze[18], gave projections from the 2006 census and estimated that by 2011, the Nigerian population would be about 162 million, which is similar to our estimate of approximately 167 million in 2011. He also compared the exponential model and linear population growth model to determine the best model for the Nigerian population. From his findings, he concluded that the exponential model is the best growth model for the Nigerian population. This model was closely followed by the linear model [18].

However, there are challenges with the appropriateness of these methods of projection. The projections are based on the fixed age structure obtained from the 2006 census in which 42.0% were under 15 years of age, 55.0% were aged 15-64 and 3.0% were 65 and above [19]. The fixed age structure undermines planning for age-specific groups in the population. Fertility rates have changed substantially from the interdental experience, and so have mortality and migration trends. Thus, there is need for population projections that incorporate these changes.

METHODS OF POPULATION PROJECTION

Generally, there are three methods for population projection. Each of the three types of methods involves some basic assumption without which its use would not be justifiable. The implicit conditions might be stated as follows:

Mathematical method

use of a "mathematical" method presupposes that the trend of total population growth is fairly regular and that relevant features of the economic and social setting of the future will be the same as those of the past, or will represent the result of a gradual evolution. Consistent trends of change can reasonably be expected in populations with fairly regular age composition where the social and economic environment exerts a steady or only gradually changing influence. "Mathematical" methods are not appropriate for use where the present age structure of the population exhibits marked peculiarities. Moreover, where important and rapid changes in social and economic conditions relevant to population growth can be expected on grounds of current indications or the previous experience of other populations similarly situated, it is not appropriate to use a "mathematical" method that implies the continuation, without modification, of the growth tendencies observed in the past [1].

Economic method

The use of an "economic" method is justified where some major economic variable, such as the rise or decline of an industry, can exert an overriding influence on population change, particularly through migration. Birth rates and death rates are only moderately responsive to economic change, since they depend also on a variety of other factors in the cultural and social environment, some of which are statistically imponderable. The "economic" method is most pertinent where migration is sufficiently free of legal barriers or other impediments to become a major element in the trend of population.

Cohort component method

The cohort component method is superior to "mathematical" methods in that it involves a separate analysis of the changes affecting each component of the population. It is most convenient to project the population by time-intervals equal to the age-intervals into which it has been divided. Thus, if the population is subdivided by five-year groups of ages, the projection can most easily be made for five-year intervals of time: at the end of a five-year period, all surviving members of one age group will have moved into the next subsequent age group. Component projections of a population with respect to characteristics other than sex and age do not require any departure in basic method. It follows that a component method is generally preferable to others except where there are important obstacles to its application (inaccuracy or lack of detailed statistics, smallness of the population), or where

an economic or other factor in the environment assumes an overriding importance, with its influence exerted primarily through migration. If one or more of these reasons prejudice the use of a "component" projection, then a "mathematical" or "'economic" method is to be preferred, depending on the conditions of the particular case. The methods developed by the United Nations staff have as their main objective to facilitate the making of "component" projections for as many countries as possible, including those where the available statistics are defective in several respects. In the latter instances, the procedures include the use of certain general schemes by which the missing figures can be approximated. Since the projections themselves are in the nature of estimates, they are still justified where a part of their statistical basis is likewise estimated. The latter estimates should, of course, be realistic. The method also satisfies all the criteria's for choosing suitable projection method [20].

The Cohort Component Method (CCM) presents a more practical method of population projection. CCM makes projection with the summary of components affecting population change. It requires more effort and data and makes more sufficient projections than the mathematical method as it utilizes the fertility rate, mortality rate and migration across various age groups.

This modeling was carried out following the pattern of the United Nations (UN) population models and projections [20]. The projection was conducted in 5 stages that focused on the following factors:

a) Data Availability

b) General Analytical Strategy and steps for producing population estimate

c) Addressing challenges arising from data quality issues

d) Fertility Assumptions: Convergence towards a lower fertility rate

e) Mortality Assumptions: Increased life expectancy for the state

We used this method to project Nigerian age and sex structure, population share of women of childbearing age, population structure and the rate of population change due to fertility, mortality and migration for an open population. The age and sex structure of the population is derived for every five-year interval till 2031. In addition, the new series takes in to account level of educational attainment which is directly applied to the fertility, mortality and migration base of the differential of each determinant of population.

CRITERIA FOR CHOOSING A PROJECTION METHOD

Demographers face a number of considerations in choosing appropriate demographic inputs for their analyses. The considerations involved in such choices are varied and depend on the nature of each application. An all-encompassing theme of the general discussion of scenarios and probabilistic projections is that uncertainty in demographic projections is substantial [15]

It is therefore advisable to avoid using a single population projection for any analysis. Either a range of alternative scenarios, or a probabilistic projection, should be employed to reflect the inherent demographic uncertainty. However, in many cases it would be beneficial to include demographers on an interdisciplinary research team who can produce projections that are custom-designed for the research question at hand. While this is not always feasible, it would have the potential to greatly improve the consistency and rigor of the analysis.

1. Desired outputs: Length of time horizon (short, medium or long term) and amount of subject detail (total population, broad age groups, five-year age groups, single years of age and subgroups.
2. Input data: Data availability, Data quality, missing data (Plausible assumptions).
3. Projection tools [21].

A suitable population projection method is chosen based on the above mentioned criteria.

Table 1: Comparison of Projection methods

No	Method	Meaning	Strength	Weakness
1	Trend extrapolation methods[12].	It is based on the continuation of observable historical trends	It is used for making quick estimates for illustration and comparison purposes	It is usually not useful for policy-related purposes. It is not recommended for making official population projections
2	Cohort-Component Method (CCM)[8]	It is based on grouping the initial population into cohorts defined by age and sex.	It provides information on potential growth, decline of a locale by age and sex.	It is based on the assumption of fixed survival, birth rates and estimates of net migration throughout the projection period.
3	Structural modeling[22]	Structural models base population projections on the underlying socio-economic development and other determinants	They are well suited for analyses of policy changes on demographic variables.	The lack of data on one or more parameters in the model
4	Microsimulation	This technique simulates life events for each individual.	It performs well even with large numbers	Data requirements can be prohibitive.

POPULATION METHOD ADOPTED BY NIGERIAN STATISTICAL AGENCIES

Effective planning has been a major challenge for the Nigerian Government at national and subnational levels [23] and [24] and population data is fundamental to these challenges. The population projection method adopted by NPopC determines only the total population without segregating the population into demographic and epidemiological groups. At national level and subnational levels, each State Bureau of Statistics (SBS) develops state population projections using a mathematical formula that grows the 2006 total population at a fixed or varying rate. Common projection methods include exponential growth formula $P_t = P_o e^{rt}$, geometric progression $P_t = P_0(1+r)^t$ and log-linearized formula $P_t = P_0(1+rt)$ where P_t is the total population at time t, P_o is the initial population, r is the growth rate, t is duration from time o and e is Euler's number. The use of only mathematical growth formulas for projection do not provide opportunities for comprehensive data for planning purposes. It only estimates the population size (the total number of people in the state or country) at the end of the time interval based on assumed growth rate of the aggregate population.

However, Nigerian Statistical Bureaus uses approximately 3% annual growth rate to project population by means of the above mathematical formulas, this growth rate (3%) is quite questionable. Conferring to Nigeria Demography and Health Surveys (NDHS) fertility rate has decrease. In NDHS, Nigeria total fertility rate (TFR) decreased from 5.7 in 2008 to 5.5 in 2013. Similarly, in the most recent NDHS 2018 fertility decrease to 5.3 [25]. At the same time, mortality rate has improved with the rates of infant and under-five mortality decreasing in 2018 as against the 2013 report [26]. Changes in mortality and fertility drive changes in population age structure and these changes are part of the determinants of overall population growth. In addition to insensitivity to fertility and mortality changes over the projection period, current projection methods exclude consideration of socio-economic advances including level of educational attainment whilst it is proven that the population is strongly related to these events.

In addition, a new attempt has been made by NPopC to improved Nigerian population projection this is according to the recent publication by NPopC about the Nigerian population projection. The note highlighted that; Population projections were carried out using the cohort-component method. In its simplest form, given by the equation:

$$P_{t+n} = P_t + B_{t,t+n} + M_{t,t+n}$$

Inputs on each component from the 36 states and FCT were aggregated into National Level Spectrum 5 (A computer program for making population projections integrated into DemProj) was used in creating the state projections validated on MORTPAK, other packages used includes PAS (Population Analysis Spreadsheets) and Microsoft Excel 2019. DemProj calculations were based on the standard cohort component projection modified to produce a single year projection. This is achieved by separating the population by five-year age groups through the use of Beers formulas (Beers,1945).

DemProj (Demographic Projection) contains baseline population data and estimated baseline (initial) rates for the duration of projection and provides aggregate data (results) computed from the demographic data. Accuracy of population projection using DemProj and Mortpak depends on the accuracy of the inputs, where there are no sufficient and accurate inputs obtaining accurate result can be cumbersome. Similarly, other important factors or determinant of population such level of educational attainment were not captured in this software's. These shortcomings impose limitations on suitability of the projections for effective planning. They limit the effectiveness of healthcare interventions, as planning depends largely on demographic data, and economic development and poverty reduction initiatives.

MIGRATION

Nigerian population is quite open to international migration; migration is considered one of the determinant of population structure. Migration occurs over a series of different push and pull factors that revolve around social, political, economical, and environmental factors according to Migration Trends. Social migration is when an individual migrates to have a higher standard of living, to be closer to family or to live in a nation with which they identify more. Political migration then is when a person is going in as a refugee to escape war or political persecution. This form of migration can also be called forced migration, where residents migrate due to persecution, conflict, generalized violence or human rights violation Environmental migration is when natural disasters force you to move into a new area. Once we analyze all of the migrating factors we can get to the idea that the net migration rate can tell us so much about a country.

Immigration in Nigeria

The 2006 census of Nigeria recorded close to one million (999,273) foreigner nationals in Nigeria. This indicates that Nigeria has continued to attract immigrants, much more than recorded in previous censuses. The total stock of immigrants increased over the census years from 101,450 in 1963, to 477,135 in 1991. The estimated immigrant stock in the country in 2010 was 1.1 million people. Nationals of ECOWAS countries constitute the majority (51.4%) of recent (2006) immigrants in Nigeria. This, together with the nearly 16% who were nationals of other African countries, indicate that more than two thirds of the immigrant population in Nigeria were of African origin. Only 32.7% of immigrant's in Nigeria were non-Africans in 2006. There has been an increasing proportion of female immigrants in Nigeria relative to males (narrowing down from 43.8%:56.2% in 1990 to 46.5%:53.5% in 2005). The immigrant annual growth rate remains high and stable, above 5% since the 1990s[27].

Emigration in Nigeria

The number of Nigerians living outside Nigeria more than doubled between 1990 and 2013, from 465,932 to 1,030,322. In 2013, nearly two-thirds of emigrants (61.4%) were resident in more developed regions. This is a relatively new pattern. For instance, in 1990 only 33.8% of Nigerian migrants lived in more developed regions (MDRs). By 2000, the percentage had increased to 52%, and further 56.7% in 2010. That increasingly more Nigerians find their way to MDRs is a function of employment-driven nature of Nigerian emigration. Also, Nigerian emigration to the West is highly selective of the educated, skilled and professionals who are more likely to be attracted by the economic opportunities of MDRs[27]. Nigeria recorded a negative net international migration rate which indicated that the number of people leaving the country is higher than those coming in to the country.

Impact of migration on fertility

International migration and fertility are two phenomena generally seen as independent variables. But it is obvious that they are strongly related, with migration usually increasing the resident population of young (and potentially procreating) adults in receiving countries and reducing this age group in sending countries. Studies have also demonstrated an indirect link caused by the change of social norms influencing fertility behavior [34]. In general, the impact of migrants' exposure to new socioeconomic and institutional circumstances, values, behavioral norms, and practices, including those affecting fertility decisions, takes time to become apparent. One observable trend is that migrants from high to low fertility countries who stay long enough progressively assimilate and along with their integration in the new environment adopt the host country's prevailing childbearing practices and desired number of children.

Direct communication of emigrants and returnees with their families and friends. With modern telecommunication technologies, and especially with the rapid growth and vast spread of the Internet, emigrants are able to maintain increasingly close contact with those they left behind. Not only do they remit financial resources but also knowledge, ideas, values, and behavioral norms that prevail in host countries [28]. This point indicate that emigrant can stay long in the host country without their spouses due to social contact.

FIGURES FROM PROJECTIONS

Conferring from the figures presented by the Nigerian bureau of statistics, population projection is derived from the above-mentioned formulas with constant growth rates per annum for states and national growth. The growth rate was derived between the difference in the census 1991 and 2006 and it is shown in the table below.

TABLE 2:PROJECTED POPULATION OF NIGERIA STATE BY NBS

	2006	2015	2016	2017	2018	2019
	3.2%					
Linearized	140431790	176926008	181526084	186245762	191088152	196056444
Compounding	140431790	177455858	182130214	186927696	191851549	196905101
exponential	140431790	178348367	182561320	186774273	190987226	195200179

Source: Author's computations; Growth rate and 2006 numbers are from National Bureau of Statistics

Furthermore, according to Nigeria Living Standard Survey (NLSS 2018), a survey report by the Nigerian national bureau of statistics in collaboration with world bank 2018/2019, there are variations in the percentage distribution across different age groups as population indicators vary concerning fertility and mortality for a closed population including migration for an open population. Hence, an appropriate scientific method should be applied to calculate an apt estimate for projections that will form the basis of planning and intervention in several areas of economy and development. The tables below (**TABLE 2**) show the variation in percentage distribution across different age group for Nigeria.

TABLE 3: VARIATION IN PERCENTAGE DISTRIBUTION ACROSS DIFFERENT AGE GROUPS

AGE GROUP	MALE	FEMALE	TOTAL
0-5	8.7	8.5	17.2
6-9	6.3	6.2	12.5
10-14	6.6	6.3	12.9
15-64	25.2	27.3	52.5
65+	2.4	2.5	5.0
TOTAL	49.2	50.8	100

Source: Nigeria living standards survey 2018/2019

ASSUMPTIONS

In preparation of inputs for this projection we included the preparation of the age and sex structure of the population for the initial year of the plan. Also, we involved formulating assumptions on the components of population change such as fertility, mortality and migration for an open population during the plan horizon, we assumed Nigerian population to be closed hence migration is zero in the first instances and in second instances we assumed Nigeria population to be opened hence, we formulate assumption for migration. These assumptions are formulated by considering expected socio-economic trends as well as social, economic and population policies to be implemented over the plan horizon. In addition, in this projection we used Nigerian Demography and Health Surveys (NDHS) and world development indicators data and studying some trends as basis for our assumption.

TABLE 4 : FERTILITY ASSUMPTION FOR A CLOSED POPULATION

Time Interval(years)	Total Fertility Rate(TFR)
2006-2011	5.7
2011-2016	5.5
2016-2021	5.3
2021-2026	5.0
2026-2031	4.7

Source: NDHS 2008, 2013 and 2018

TABLE 5 : FERTILITY ASSUMPTION FOR AN OPEN POPULATION

Time Interval(years)	Total Fertility Rate(TFR)
2006-2011	5.7
2011-2016	5.5
2016-2021	5.3
2021-2026	5.2
2026-2031	5.0

Source: NDHS 2008, 2013 and 2018

Table 4: mortality assumption

Time Interval(years)	Expectation of life at birth	
	male	Female
2006-2011	59.79	61.66
2011-2016	61.39	62.81
2016-2021	63.76	64.30
2021-2026	64.94	65.52
2026-2031	66.04	67.85

Data source: Model Life Table

These assumptions give rise to variation in population proportion across age group (%) at the end of each interval.

METHODOLOGY 1

Assumptions were made on fertility, mortality and migration rates for an open population, based on socio-economic trends and reports from statistical offices. We assumed Nigerian population to be closed in which case migration has negligible effect in population change. Also we assumed Nigerian population to be open in which case migration effect the population change.

The 2006 population census is our initial population, and the initial age and sex structure was obtained from the enumeration. All assumptions were made for a period of 5 years. To calculate population structure at the end of the 2006-2011 interval, we segmented the population into 2 groups:

a) Age 5 and above: To derive the segment of population age 5 and above, we calculated the survival ratios from mortality assumptions using the model life table for each of the age groups, we also modify these survival ratio using migration assumption for an open population. These survival ratios were applied to the corresponding size of the age group at the beginning of the projection interval (2006) to determine the number of survivors at the end of the interval (2011), by which time they are 5 years older.
b) Below Age 5: From the total number of births in the interval, we estimated the total and age specific fertility rates and survival rate of births. The number of births were calculated from the fertility rates and the mid-interval numbers of women in different childbearing age groups (15years to 49years). Using the United Nations birth-gender ratio, we calculated proportion of males to females (aged 0-4 years) for the 2006–2011 interval. To complete the derivation of the segment of the population structure below age 5, the net international migration rates are initially used to compute net changes due to migration among survivors below age 5 for an open population. Then, population below age 5 is obtained by modifying the numbers of survivors by those net changes.

This procedure was repeated over subsequent time intervals and projected population structures were obtained for the end of intervals 2011-2016, 2016-2021…...2026-2031.

From the projected population structures, the population indicators and aggregates were calculated for various intervals. The indicators included dependency ratio, proportions by broad age groups, median age, sex ratio and proportion of women in child bearing ages. Population aggregates such as population size, young age population, working age, growth rate etc. were also calculated. Similarly, we calculated some migration indicators. Population size is the sum of all persons across various age group both males and females for the interval, young age population is sum of persons' age group 0-14 both males and females for the interval, working age population is the sum of persons in age group 15-64 both males and female for the interval and the number of women of the childbearing ages is the sum of women in age groups 15-49. Other indicators are calculated in same way based on the demographic groups.

DIFFERENCES IN POPULATION AND AGE DISTRIBUTION

Using the CCM, we have been able to forecast changes in population structure over time. We decided to show varying changes in population overtime.

TABLE 5: POPULATION PROPORTION ACROSS AGE-GROUPS (%) AT THE END OF INTERVAL (CCM) FOR AN OPENED POPULATION

Agegroup	2006	2011	2016	2021	2026	2031
0-4	16	19	17	16	15	15
5-14	26	25	26	28	26	25
15-49	49	47	45	44	46	46
50-64	6	6	8	8	8	9
65+	3	3	3	4	5	6
Total	100	100	100	100	100	100

Source: Author's Projection

TABLE 6: POPULATION PROPORTION ACROSS AGE-GROUPS (%) AT THE END OF THE INTERVAL(CMM) FOR A CLOSED POPULATION

Agegroup	2006	2011	2016	2021	2026	2031
0-4	16	19	18	16	15	14
5-14	26	25	26	28	26	24
15-49	49	47	46	45	46	47
50-64	6	6	7	8	8	9
65+	3	3	3	4	4	5
Total	100	100	100	100	100	100

Source: Author's Projection

TABLE 7: POPULATION PROPORTION ACROSS AGE-GROUPS (%) AT THE END OF THE INTERVAL (NBS)

Age Group	2006	2011	2016	2021	2026	2031
0-4	16	16	16	16	16	16
5-14	26	26	26	26	26	26
15-49	49	49	49	49	49	49
50-64	6	6	6	6	6	6
65+	3	3	3	3	3	3
Total	100	100	100	100	100	100

Source: NBS Projections

TABLE 8: TOTAL PROJECTED POPULATION FROM 2006-2031 OPEN POPULATION

Year	NBS	CCM	GR for the end of the interval(%)
2006	140431790	140431790	3%
2011	159662246	164,608,098	3%
2016	181526084	193,062,272	3%
2021	206,383,913	223,151,809	3%
2026	234,645,725	256,045,266	3%
2031	266,777,655	296,112,046	

Source: NBS and Author's projection

TABLE 9: TOTAL PROJECTED POPULATION FROM 2006-2031 FOR A CLOSED POPULATION

Year	NBS	CCM	GR for the end of the interval (%)
2006	140431790	140431790	4%
2011	159662246	167,544,306	4%
2016	181526084	199,954,319	3%
2021	206,383,913	234,841,765	3%
2026	234,645,725	273,330,604	3%
2031	266,777,655	320,277,412	

Source: NBS and Author's projection

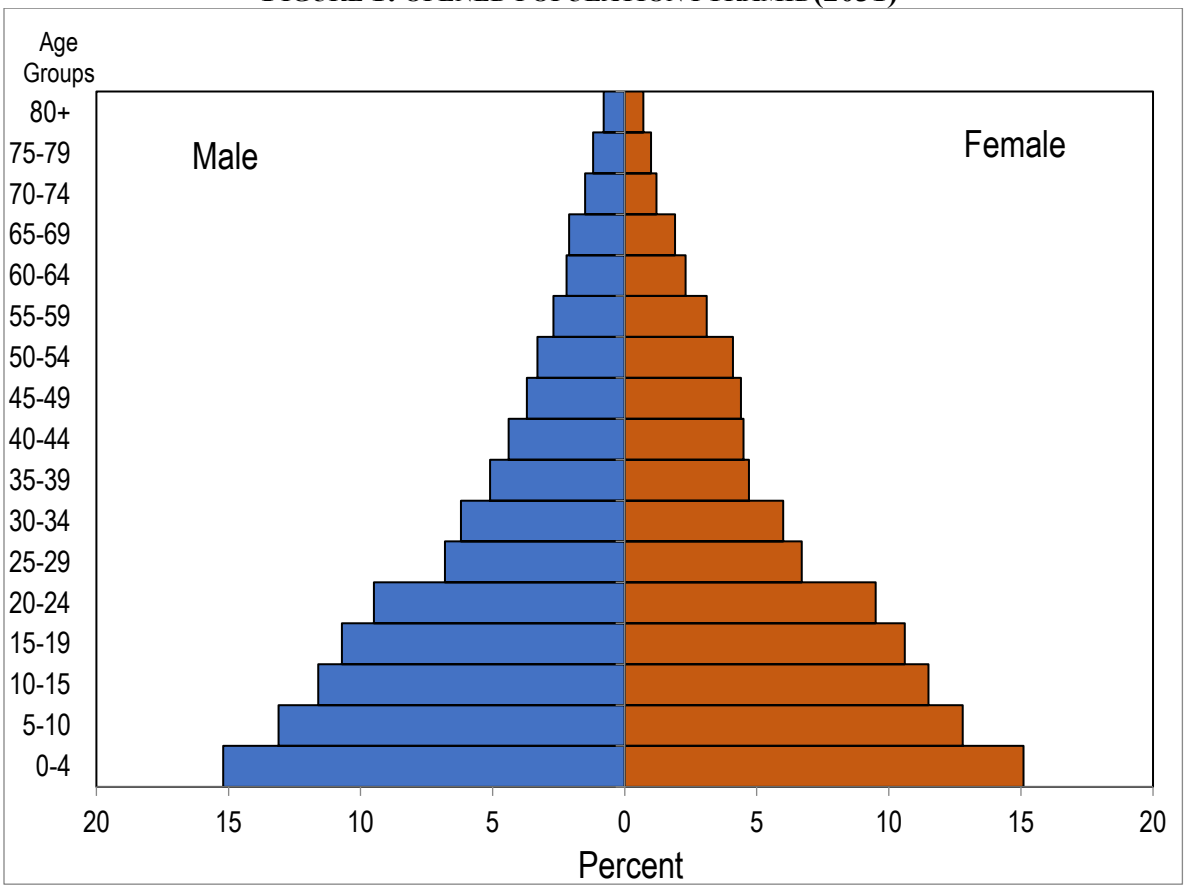
TABLE 10: COMPARING PROJECTED OPENED AND CLOSED POPULATION

YEAR	2006	2011	2016	2021	2026	2031
OPENED	140,431,790	164,608,098	193,062,272	223,151,809	256,045,266	296,112,046
CLOSED	140,431,790	167,544,306	199,954,319	234,841,765	271,707,716	315,770,400

DATA PRESENTATION IN CHARTS

Presenting data in charts help to easily understand the data, attract and sustain the interest of readers and efficiently present large amounts of complex information. Hence, we used population pyramid to show the structure of initial (2006) and final population (2031) for both opened and closed population. As shown in Figure 1: opened population pyramid(2031) and Figure 2: closed population pyramid(2031).

FIGURE 1: OPENED POPULATION PYRAMID(2031)



Source: Author's Computation

FIGURE 2: CLOSED POPULATION PYRAMID(2031)

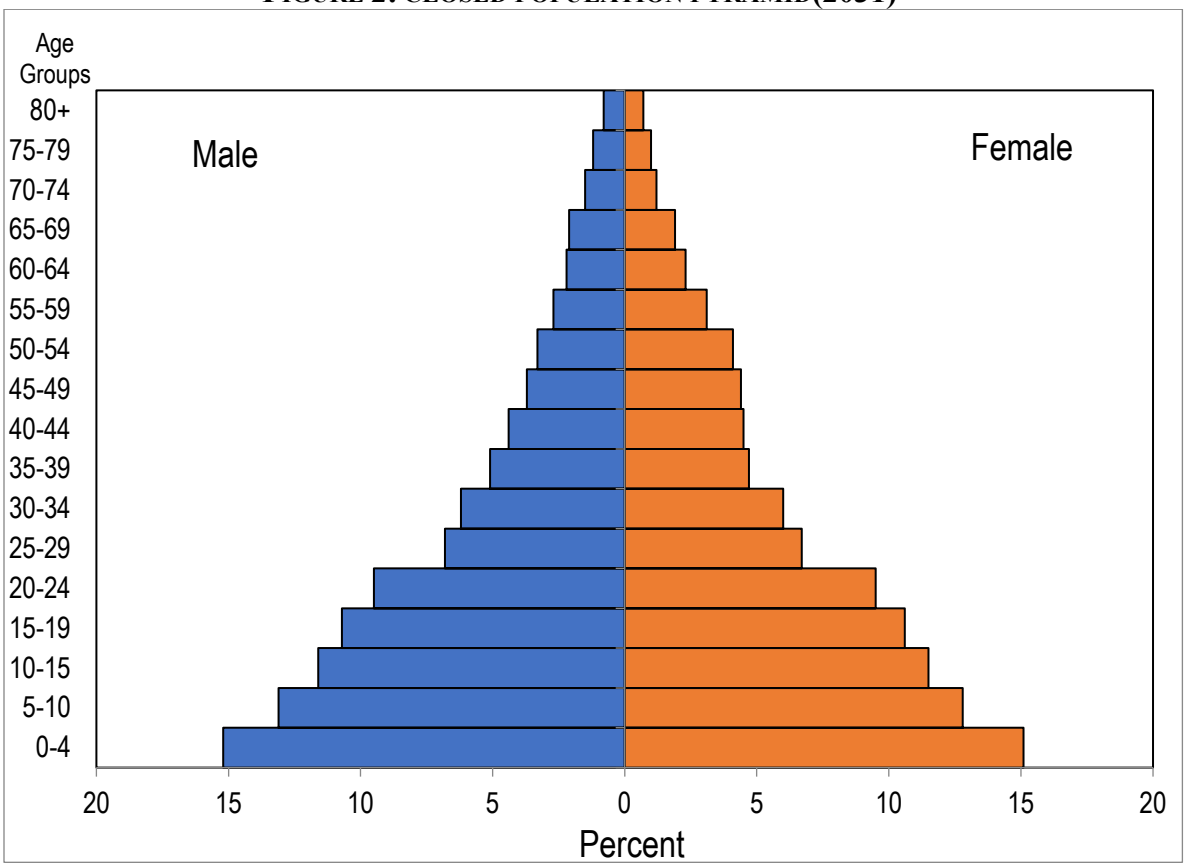
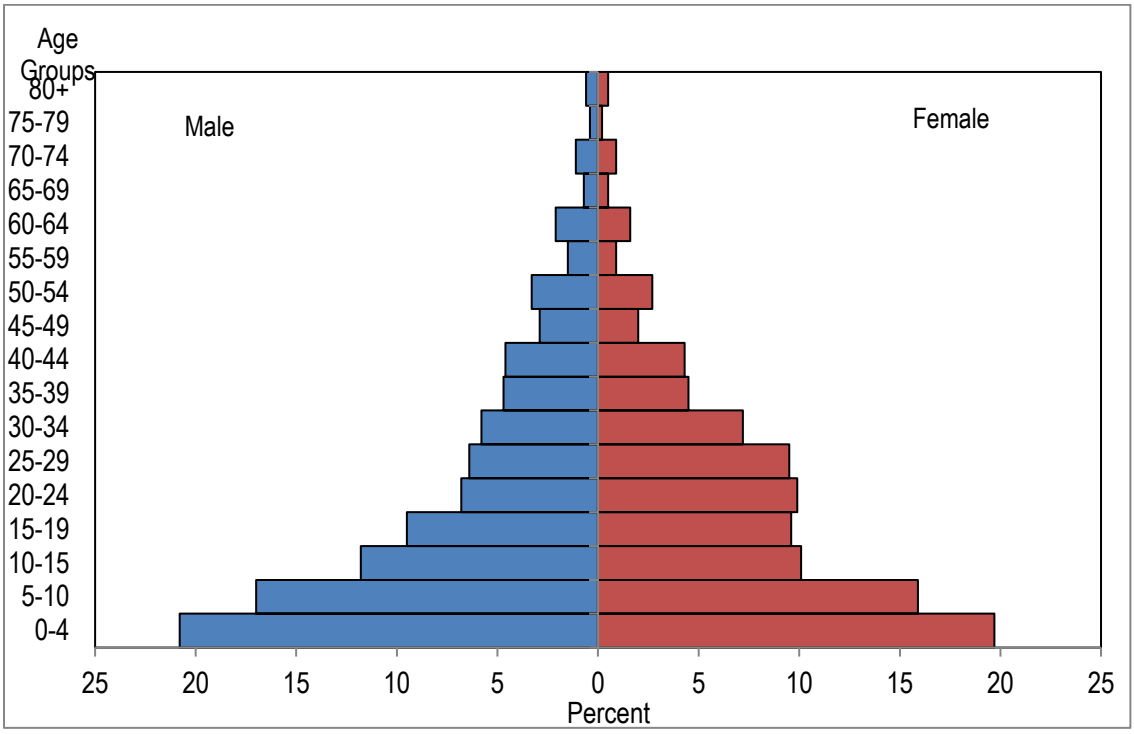


FIGURE 3: POPULATION PYRAMID 2006



DISCUSSION

Public policymakers and planners around the globe use population projections to gauge future demand for food, water, energy, services, and to predict future demographic characteristics. Population projections can allow policymakers craft policies that can be adapted for various projection scenarios. The accuracy of population projections has been attracting more attention, driven by concerns about the possible long-term effects of aging, HIV/AIDS, and other demographic trends.

The National Research Council of the U.S National Academy of Science (NAS) convened a panel of experts in 1998 to examine the assumptions, accuracy, and uncertainty related to the most widely used population projections and to recommend ways to improve these projections. After extensive review, the panel concluded in July 2000 that current world population projections to the year 2050 are based on scientific evidence and provide plausible forecasts of demographic trends for the world. The panel warned, however that projections for specific countries, for certain population groups, or for longer periods in the future are less than global and shorter-range projections.

Users of population projections need to understand the reliability and the limitations of projection series. Awareness of how projections are prepared and the possible sources of uncertainty in the numbers can help policymakers more effectively incorporate projections in their planning process[6].

Policymakers and program planners can undertake several steps to ensure projections are useful for policy and planning purpose, the steps include:

a. Proper understanding of the causes of uncertainty in population projections and the implications of this uncertainty for plans and policies that span different time horizons and target specific population groups.
b. Contributing to national and international efforts to collect more accurate demographic data which would lead to more accurate assumptions about fertility, mortality, and migration and better projections
c. Cooperate with national and international research efforts to develop more accurate projections by supporting organizations that investigate better projection methodologies, the demographic effect of HIV/AIDS, the effect of policies and programs on fertility trends[6]

Population projections come with some uncertainty and it was discussed extensively in International Statistical review [29], The review concluded that

a. Uncertainty should be ignored and one projection should be published
b. Alternative probability-free scenarios should be defined
c. High, medium and low variants that are supposed to cover a plausible range should be publish
d. Probabilistic projections that give quantitative information about the range of uncertainty should be publish.

Another area where conventional population projections are in need of renewal and expansion of focus is the explicit incorporation of other major covariates in addition to age and sex. Level of education and rural/urban place of residence are two prime candidates for such explicit inclusion in population projections, because both fertility and mortality tend to vary greatly with level of education and place of residence.

Making this important hidden source of heterogeneity explicit and including it in the form of multistate population projections significantly affects the projected population dynamics. In addition to this purely demographic effect, variables such as place of residence and education are very important in their own right. In the June 2001 issue of Population and Development Review, the first global population projections by level of education was produced. The changing educational composition of the population is very significant at different levels: It matters greatly for individual development and individual life changes. It makes a big difference for a nation's institutional and economic performance. It also matters for the relative weights, productivity, and competitiveness of major world markets[30].

CONCLUSION AND POLICY RECOMMENDATIONS

Projections can only illustrate potential trajectories of population change. The projections in this report will hold true only if all assumptions about future fertility and mortality hold true.

This report discussed the projected population changes since the last Nigerian census. Such statements are always conditional on the underlying assumptions about the components of population change. Overall, we projected an increased population size, a shift in the population structure which may yield a demographic dividend associated with higher economic growth, reduced fertility and death rates throughout the projection period. The implications of a demographic transition in age structure on economic growth can be immense [31]; the most obvious benefit comes from having a bigger labor force that are productive and able to contribute positively to the economy.

Nevertheless, there are some challenges related to these seemingly favorable outcomes, such that if appropriate policies are not formulated, these projected positive changes including the resultant demographic dividend might instead result in a demographic burden or disaster. The critical questions facing policymakers are: where will productive jobs necessary for economic growth in sufficient numbers to provide employment for the projected youth bulge come from? What have been the sources of growth in Nigeria, and how do they compare with other fast-growing African economies? Also, will Nigeria be able to make adequate investments in education and health to ensure a healthy, skilled and productive workforce? Most importantly, will the Nigerian government finally rise up to

the task ahead of them to adopt and implement policies that will avert the projected negative demographics from this study and similar studies?

On the basis of the findings of the present study, a number of policy recommendations are actionable. Firstly, the Nigeria government should ensure that the projected increased population have available jobs. If Nigeria's large population of young adults can find productive employment, then the country can enjoy a first demographic dividend, raising the current standard of living and spurring economic growth [32] The World Bank estimates that 13.6 % of youth were unemployed in Nigeria in 2014 and to stabilize the rate to keep pace with population growth, the country needed to create 40 - 50 million additional jobs by 2030 [12]. To reduce poverty and promote economic growth, these jobs need to be more productive and provide higher incomes than are available. The public sector remains the largest employer of formal labor and with reductions in government expenditure due to falling oil prices, the number of new jobs in the public sector will decline. The private sector will have to lead the way for employment creation in Nigeria to accommodate the ensuing youth bulge.

Secondly, we estimate that Nigeria will have large numbers of children and women of childbearing age by 2030. Hence, maternal and child healthcare services in particular will be put under pressure. Currently, the situation is already worrying. Only 36% of births in Nigeria are delivered in a health facility and 38% percent of deliveries are attended by a skilled birth assistant; two interventions which have been shown to improve maternal and child-health outcomes [32]. As a result, the Nigeria government should increase access to affordable health care services and overall coverage. These efforts should be targeted towards providing sufficient number of skilled medical human resources, health materials, equipment and infrastructure to meet the pressure of population expansion.

Thirdly, efforts at providing reproductive health services should be intensified to meet the increasing needs of the increasing population. These reproductive health services are often the most effective avenues where women can access information regarding care practices and family planning services such as the use of contraceptives, which influences fertility rates.

Fourthly, access to education ought to become a priority for Nigeria. The education sector like other basic services will be confronted by the projected increased population size. This brings the challenge of educating more than 140 million school age population by 2030. In a country where 10.5 million Nigerian children of primary age were out of school [22], better access to quality education will boost productivity, inclusiveness and economic growth. Additionally, women's education is considered a highly effective means of lowering fertility; education delays women's entrance to marriage which indirectly delays the first birth. Furthermore, school attendance takes adolescents out of their traditional environment, increases literacy and exposure to new ideas which ultimately leads to economic prosperity.

The growing Nigeria population presents with unique opportunities if harnessed effectively. The Nigerian government should invest in meeting the demands of ensuing

effects of this population growth which will set Nigeria on its course to sustainable economic growth.

PROJECTION BY EDUCATIONAL ATTAINMENT

Education in general, has an important role in national economic growth since it boosts human capital by improving people's abilities and knowledge. At the individual level more education tends to imply better health, wider economic opportunities, and greater autonomy, especially for women [33]. Within the context of population Lutz mentioned that "education leads to lower birth rates and slows population growth and this makes it easier for countries to develop. A more-educated workforce also makes poverty eradication and economic growth easier to achieve." The increasing awareness over the past decades of the importance of human capital in development has stimulated attempts to estimate and project the educational composition of the population[33]. What is required is a complete matrix of the population's composition by age group, sex, and level of educational attainment at various points in time. Many attempts to measure human capital stock have failed to meet this goal because of problems with country-level data and the lack of appropriate demographic methodologies. For the case of Nigeria as mentioned earlier, apart from lack data there is also lack appropriate population projection methodologies that takes in to account different determinants of population such as fertility, mortality, migration and changes in socio-economic development including level of educational attainment.

Education-specific population projections are important, both because the information they produce is of intrinsic and practical interest, and because taking education into account improves the accuracy of the population projection itself. The latter is true because all three fundamental demographic components of fertility, mortality, and migration are strongly affected by education[34]. In many ways education has a direct effect on population growth, within fertility context women who are educated are most likely to have few children during their childbearing span. In most societies, fertility levels vary significantly between women with different education levels [35]. Education levels have a strong influence not only on the number of children, but also on the timing of births and marriages. Regarding mortality, education levels have a strong influence on life-expectancy. If educational attainment improves in a population, it usually follows that the proportion of individuals with lower education levels decreases, while the proportion of those with higher education increases. Consequently, the health of the overall population should increase accordingly hence, life-expectancy increases as well[36]. Finally, the highly educated are more likely to migrate and to move greater distances, and they are less likely to return to their country of origin[34].

As a result, population projections in the presence of education variables may produce significantly different results than in the absence of education variables. Without education, they may also be less useful than they could be otherwise[34]. United Nations recognized education as one of the essential underpinnings of human development and societal progress. The right to education is proclaimed in the Universal Declaration of Human Rights (1948), and education's importance with respect to population and individual development has been strongly endorsed in major United Nations conferences and

summits[37]. The spread of education across a population has been shown to be critical for the long-term demographic transition from high to low fertility levels[37].

Therefore, understanding the population's educational level is critical when speculating about future development trajectories. Recently, we prepared a database for national and subnational population projection for Nigeria subdivided by age group, sex, based on different fertility, mortality and migration assumption for an open population following united nation population projection models, see details explanation in methodology section. This new series of national population projection will focus strictly on the level of educational attainment, which are measures of the quantity and formal level of schooling obtained. Since the effects of educational attainment can also be expected to differ by age (e.g., one might expect that the education of 25-34-year-olds should be more important for economic growth than that of persons beyond retirement age) as well as by sex, having full age details for men and women can be considered a great asset for a comprehensive projection of future economic growth prospects[34]. Therefore, a comprehensive data is required strictly for this new series.

BASIC IDEA

The most crucial issue is the available data set, starting from the dataset available in 2006 (base year) distributions by level of education would be projected along cohort lines. The projections are based on the demographic method of multi-state population projection developed at International Institute for Applied System Analysis (IIASA) during the 1970s, and is now widely accepted by technical demographers.

The basic idea is direct and precise. Assuming that a person's educational attainment remains constant after a certain age, the proportion of women without any formal education aged 50-54 in 2011 can be calculated directly from the proportion of women without any formal education aged 45-49 in 2006. Again, assuming that this proportion remains constant across cohorts, the proportion of women without education aged 85+ in 2031 for the same cohort can be calculated directly. Similarly, the proportions for each educational category and each age group of men and women can simply be moved to the next older five-year age group as we progress forward in time in five-year steps.

These proportions would be precisely correct if no individual were to move up to the category with primary education after the age of 15, and if mortality and migration did not differ by level of education. This follows directly from the fact that the size of a birth cohort as it ages over time can only change through mortality and migration. However, strong links do in fact exist between the educational level on the one hand, and mortality, fertility, and migration behavior on the other[34]. In this case, the size of birth cohorts is dependent on the levels of education of women of childbearing age, where a negative relationship is traditionally observed. In projecting these cohorts forward, differential survival rates are applied to the education groups. The differentials are based on a comprehensive literature review, as well on modeling exercises based on available data and possibilities of inter/extrapolation of the available data. This analysis is simplified by the assumption that changes in educational attainment is that individuals can only move from the ‘no education’

status to primary, and on to secondary and possibly to tertiary; but can never revert to a lower status[34].

Table 6: Education Categories

Category	Definition
No formal education (edu1)	No formal education or less than one year primary
Primary education (edu2)	Uncompleted primary, completed primary, (ISCED 1) and uncompleted lower secondary
Secondary education (edu3)	Completed lower secondary (ISCED 2), uncompleted and completed higher secondary (ISCED 3/4), and uncompleted tertiary education
Tertiary education (edu4)	Completed tertiary education (ISCED 5/6)

Source: International Standard Classification of Education (ISCED 1997)

However, Nigeria's education system encompasses three different sectors: basic education (nine years), post-basic/senior secondary education (three years), and tertiary education (four to six years, depending on the program of study). According to Nigeria's most recent National Policy on Education (2004), basic education consists of nine years of formal (compulsory) schooling, divided into six years of elementary education and three years of junior secondary education. Three years of senior secondary education are included in post-basic education. These categories of education are closed in the international standard classification of education (ISCED 1997).

METHODOLOGY 2

We will first focus on data availability as a baseline for the projections, we need population distributions by age, sex, and level of educational attainment for the country. Base on the available data, no single source of data provides this comprehensively, so an integration of a diverse range of datasets is required. The baseline year 2006 was chosen because 2006 census provide distributions by age group and sex. Although, level educational attainment wasn't included. Therefore, we need to consider other sources of data such as NDHS, MICs, WDIs and so on. Our steps can be summarized as follows:

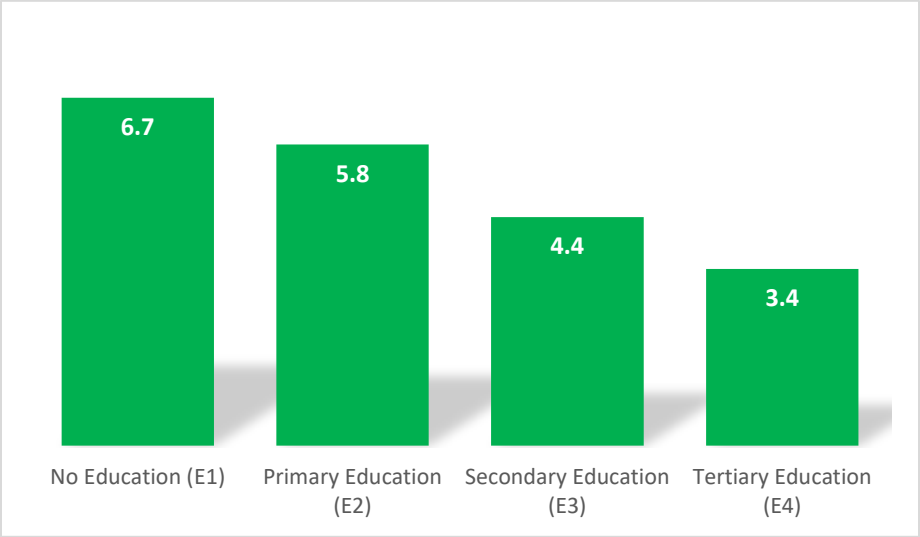
1. A baseline population distribution by five-year age group, sex, and level of educational attainment is derived for the year 2006.
2. For each five-year time step, cohorts move to the next highest five-year age group.
3. Mortality rates are applied, specific to each age, sex, and education group, and to each period.
4. Age, and sex-specific educational transition rates are applied.
5. Age, sex, and education-specific net migrants are added to or removed from the population.
6. Fertility rates are applied, specific to each age, sex, and education group, and to each period, to determine the size of the new 0-5 age group.
7. The new population distribution by age, sex, and level of educational attainment is noted, and the above steps are repeated for the next five-year time step.

The target of the projection is to obtain a dataset with the population distributed by five-year age groups (starting at age 15 and ending with the age group 85+), by sex, and by four levels of educational attainment over a period of 25 years in five-year intervals, from 2006 (base year) to 2031.

Educational Fertility Differentials

There exists strong relationship between level of education and fertility rate, change in level of educational attainment influence fertility pattern. According to recent Nigeria Demographic and Health Survey (NDHS 2018) Fertility decreases with increasing education and wealth. The number of children per woman declines with increasing education. Women with no education have 3.3 more children than women with more than a secondary education (6.7 children versus 3.4 children) Figure 1. The TFR is highest in the North West (6.6 children per woman) and lowest in the South West (3.9 children per woman). By state, it ranges from 3.4 children per woman in Lagos to 7.3 children per woman in Katsina. This indicates fertility rates varies by level of education as illustrated in Figure 1.

Figure 4: TFR of mothers by level of education(2018)



Source: NDHS2018

Figure 5: TFR of mothers by level; of education (2013)

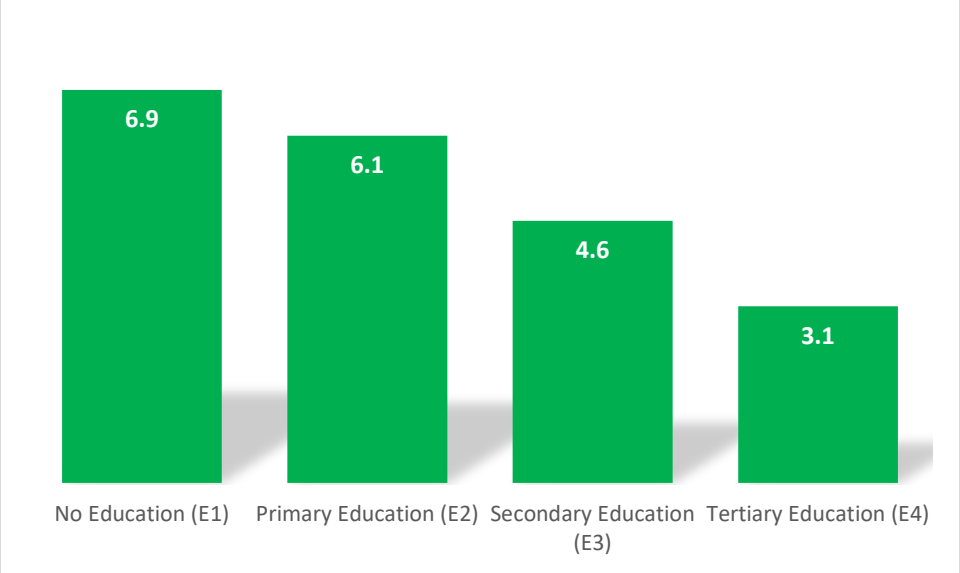


Figure 6: TFR of mothers by level of education (2008)

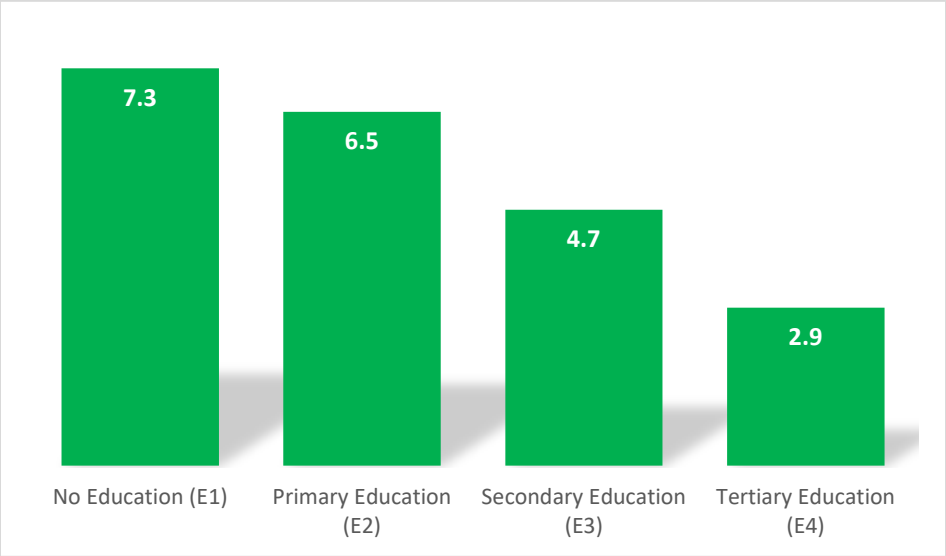
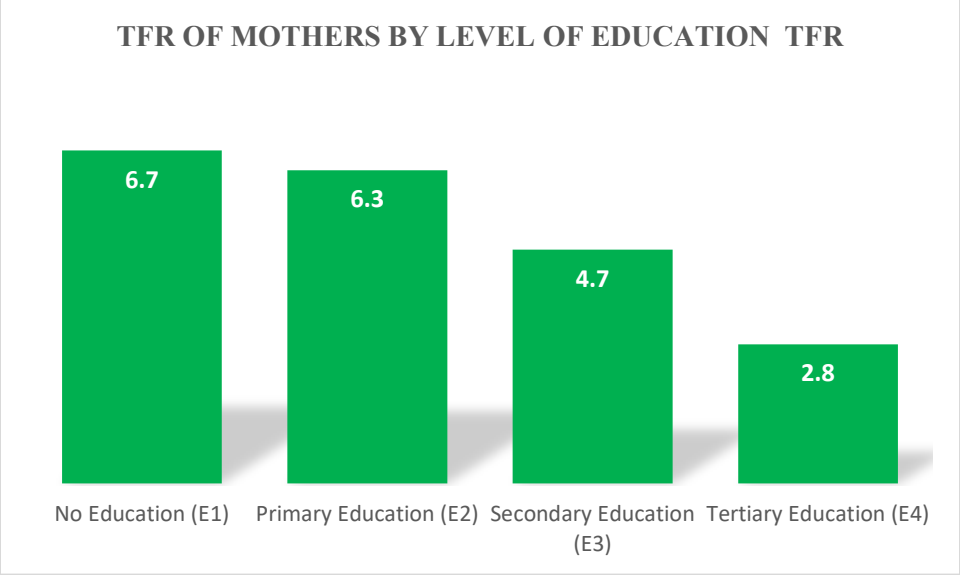


Figure 7: TFR of mothers by level of education (2003)



In developing countries, education has a stronger fertility-reducing effect than in developed countries. For those with little or no education, children will more likely represent net benefits and social security even in a relatively short term, especially when the children work from an early age and receive low health and education investments [34]. According to United Nation 1995, the level of education is generally lower in developing countries, and increasing schooling from low levels rather than from medium levels can have stronger fertility-reducing implications.

Like fertility, child mortality also declines systematically as a function of mothers' education. This implies that, under a scenario of improving female education, fewer children will be born but more of them will survive. Combining these two effects, under a high education scenario the lower fertility far outweighs the lower mortality influencing the total population growth. This point can be illustrated by means three alternative education scenarios each combined with identical assumptions on the future trajectories on education specific fertility, mortality and migration and the four education categories discussed earlier [38].

Educational mortality differentials:

Demographers are aware that mortality rates differ substantially among different socioeconomic groups in the population, educational attainment contribute to changes in mortality in population. For the purposes of projection, in particular of the projection of the working age population 15-60 or 15-65, mortality plays a much smaller role. Accordingly, this issue is discussed only briefly here, and more attention is paid to the question of fertility differentials, which are more important for forward projection [30].

Mortality by level of education requires a reliable and comprehensive death registration system, together with information on the education of the deceased and the corresponding risk populations, such empirical data are limited to a few industrialized countries and are virtually absent in the developing world. This leaves only a sequence of censuses as a source of insight [34].

REFERENCES

[1] R. Dias, M. F. Mendes, M. da G. Magalhães, and P. Infante, "The Role of the Population Projections for a Redefinition of the Portuguese Higher Education Institutional Network," 2013.

[2] S. K. Smith, J. Tayman, and D. A. Swanson, *State and local population projections: Methodology and analysis*. Springer Science & Business Media, 2006.

[3] Divisha S, "Population Projections: Meaning, Types and Importance," 2017. http://www.sociologydiscussion.com/demography/population-projections/population-projections-meaning-types-and-importance/3058.

[4] M. V. t George, S. K. Smith, D. A. Swanson, and J. Tayman, *Population projections*. na, 2004.

[5] T. Wilson, *A Review of Sub-Regional Population Projection Methods*. Brisbane, Queensland: Queensland Centre for Population Research, 2011.

[6] Population Reference Bureau, "Understanding and Using Population Projections," 2001. https://www.prb.org/understandingandusingpopulationprojections/.

[7] United Nations and D. of E. and S. Affairs, "World Population Prospects, the 2015 Revision.," New York: United Nations Population Division, 2015.

[8] A. Adepoju, "Military rule and population issues in Nigeria," *Afr. Aff. (Lond).*, vol. 80, no. 318, pp. 29–47, 1981.

[9] I. Tijani, "Census in Nigeria Lessons for the 1991 head count in Johnson S (ed) Readings In selected Nigerian Problems," *Niger. Lagos Okanlawon*, 1990.

[10] J. A. Bamgbose, "Falsification of population census data in a heterogeneous Nigerian state: The fourth republic example," *African J. Polit. Sci. Int. relations*, vol. 3, no. 8, p. 311, 2009.

[11] H. P. Project, "National Population Commission and Health Policy Project., "Nigeria's 2004 National Policy on Population for Sustainable Development: Implementation Assessment Report," *Washingt. DC*, p. 42, 2015.

[12] W. Bank, "More, and More Productive, Jobs for Nigeria," *0nline*, 2016, [Online]. Available: https://www.worldbank.org/en/country/nigeria/brief/more-and-more-productive-jobs-for-nigeria.

[13] F. R. of Nigeria, "National Bureau of Statistics, Annual Abstract Statistics," *NBS*, vol. 1, 2016.

[14] K. I. Falade, "On Mathematical Projection of Nigeria Population using Numerical Techniques," *FULafia J. Sci. Technol.*, vol. 5, no. 176–182, 2019.

[15] N. P. Commission, "The 2006 population and housing census of the Federal Republic of Nigeria," *Fed. Repub. Niger.*, pp. 22–39, 2009.

[16] J. N. Igabari, "The Population Question in Nigeria: Models and Reliable Projections," *Asian Res. J. Math*, pp. 1–10, 2017.

[17] K. Fasagba, I., Adeoye, A., Babalola, J., and Kuranga, "Modeling of Population Projection and Symptomatic Estimated Population in Nigeria," *IPASJ Int. J. Manag*, vol. 2, pp. 5–10, 2014.

[18] A. Ashinze, "A Robust Model for The growth of the Nigerian Population," *IOSR J. Math. IOSR-JM*, vol. 11, pp. 65–69, 2015.

[19] N. B. of Stastistics., "Social Statistics in Nigeria," *Fed. Repub. Niger.*, p. 418, 2009.

[20] United Nations, "Projections Methods for Integrating Population Variables in to Development Planning," *Dep. Econ. Soc. Aff. United Nations. New York, United States Am.*, 1989.

[21] L. Cheryl, S., and Bassarsky, "Regional Workshop on the Production of Population Projections." Overview of projection methods," 2016, [Online]. Available: www.unpopulation.org.

[22] UNICEF, "Global Initiative on out-of-school children: UNICEF and the UNESCO institute for statistics," 2012.

[23] M. O. Filani, "Transport and Rural Development in Nigeria," *J. Transp. Geogr.*, pp. 248–254, 1993.

[24] I. . Marcellus, "Development Planning in Nigeria: Reflections on the National Economic Empowerment and Development Strategy (NEEDS) 2003-2007," *J. Soc. Sci.*, pp. 197–210, 2009.

[25] N. P. C. and ICF, "Nigeria Demographic and Health Survey 2018," *Abuja, Niger. Rockville, Maryl.*, 2019.

[26] N. P. C. and ICF., "Nigeria Demographic and Health Survey 2013," *Abuja, Niger. Rockville, Maryl.*, 2014.

[27] C. I. Uche, "Migration in Nigeria," *Int. Organ. Migr. Geneva, Switz.*, 2014.

[28] M. . Desiderio, "Policies to Support Immigrant Entrepreneurship. Migration Policy Institute," 2014, [Online]. Available: www.migrationpolicy.org/research/policies-support-immigrant-entrepreneurship.

[29] W. G. J. Lutz, "Special issue on "How to deal with uncertainity in population forcasting.," *Int. Sta*, pp. 157–208, 2004.

[30] W. . Lutz, "World Population In 2050: Assessing the Projections," *Conf. Ser. ; [Proceedings], Fed. Reserv. Bank Bost.*, vol. 46, 2001.

[31] J. Bloom, D., Canning, D., and Sevilla, "The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change," *Rand Corp.*, 2003.

[32] I.-A. R. A. Network, "Nigeria Trend Analysis: Challenges and Opportunities of the

Demographic Shift and its Link to Stunting," *An Outlook to 2030*, 2016.

[33] W. Lutz, "No TitleThe World's Changing Human Capital Stock: Multi- State Population Projections by Educational Attainment," *IIASA*, p. 17, 2001, [Online]. Available: http://pure.iiasa.ac.at/id/eprint/6525/1/RP-01-11.pdf.

[34] S. KC, B. Barakat, A. Goujon, V. Skirbekk, and W. Lutz, "Projection of populations by level of educational attainment, age, and sex for 120 countries for 2005-2050," *Demogr. Res.*, vol. 22, pp. 383–472, Mar. 2010, doi: 10.4054/DemRes.2010.22.15.

[35] S. J. Jejeebhoy, "Women's Education, Autonomy and Reproductive Behaviour: Experience from Developing Countries," *Oxford Clarendon Press*, 1995.

[36] M. Luy, M. Zannella, C. Wegner-Siegmundt, Y. Minagawa, W. Lutz, and G. Caselli, "The impact of increasing education levels on rising life expectancy: a decomposition analysis for Italy, Denmark, and the USA," *Genus*, vol. 75, no. 1, p. 11, Dec. 2019, doi: 10.1186/s41118-019-0055-0.

[37] U. Nations, *Population, Education and Development*. UN Department of Economics and Social Affairs, 2003.

[38] W. Lutz, "A Population Policy Rationale for the Twenty-First Century," *Popul. Dev. Rev.*, vol. 40, no. 3, pp. 527–544, Dec. 2014, [Online]. Available: http://www.jstor.org/stable/24027903.