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ORIGINAL ARTICLE

ASSESSING THE IMPACT OF DEMOGRAPHIC CHANGE AND HIV/AIDS IN NIGERIA

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Abstract
This paper examines the impact of demographic change resulting from AIDS deaths on the population of Nigeria. The population of Nigeria is increasing annually at a growth rate of 3.2% and also with the increase in prevalence rate of HIV/AIDS. The purpose of this paper is to use a demographic dynamic microsimulation method to look at the impact of death resulting from AIDS given the fact that demographic variables such as fertility, mortality, migration and life expectancy influence population growth rate significantly. In order to determine the impact of birth and death rates resulting from HIV/AIDS and other causes on the population structure over time, a dynamic microsimulation model is used to capture these demographic trends. Dynamic microsimulation models focus on the simulation of behaviour over time. Micro-units are dynamically aged according to a life-cycle behavioural model. Each year individuals are born, become educated, leave home, obtain employment, cohabit and marry, have children, sometimes divorce, and die. Whenever one of these demographic events occurs in a given period, it affects the likelihood of subsequent events happening. From the result we observed that the impact of HIV/AIDS on the population is considerable. It is about 2% under the without HIV/AIDS and with HIV/AIDS scenarios. We also observed an increase in the number of women aged in their 30s giving birth and an increase in the dependency ratio of the old people to 4.2% by 2015. Finally we observed no significant change among the working age population.

Key words: *health; birth; demographics; HIV/AIDS; Nigeria*

INTRODUCTION

This paper examines the impact of demographic change resulting from AIDS deaths on the population of Nigeria. Nigeria's population is currently estimated at 171.5 million, growing at 3.2% annually; alongside a poor GDP growth rate of 3% respectively it implies a further declining low per capita income (ECA 2001, World Fact Book 2004). Nigeria is among the countries experiencing the highest population growth in the world. Nigeria's population is about 3% of the world population (ILO 2010). Also Nigeria is estimated to have the third highest number of people living with the HIV/AIDS epidemic in the world after South Africa and India (UNAIDS 2008). It is for these reasons this paper seeks to develop and use a demographic dynamic microsimulation model to simulate the most important demographic events such as birth, death and marriage using different policy scenarios under a combination of different assumptions to determine if there will be significant change resulting from AIDS deaths on the population structure of Nigeria over time.

Nigeria's birth rate is among the highest in the world. It is measured at an average of 5.7 children per women compared with the birth rate of many European countries which has fallen below 2.0 children per women (O'Donoghue 2001). The high incidence of birth in Nigeria usually reflects conditions whereby contraceptives are not being used in a widespread and effective manner (NPC 2004) leading to mis-timed pregnancies and contraction of sexually transmitted infection (STI) and HIV/AIDS that give rise to high youth dependency ratios (Caldwell et al. 1992). The high total birth rate has been hypothesized to negatively impact the population and economic growth by reducing the working age population, per capita income and increasing the dependency ratio and incidence of poverty.

Most studies on the impact of AIDS deaths on population growth have been in the form of macro-demographic models, and not pure macro-economic models, which enables counterfactuals simulations. Also, studies on the impact of AIDS deaths on the population of Nigeria have been far from definitive on micro-demographic variables. Thus, there is a gap in the literature of demographic studies concerning the quantitative relationship between population growth and micro-demographic variables in Nigeria which this study tends to fill. According to Schultz (2009), birth and death are mostly determined by the living conditions in the population, notably health facilities. With the appropriate health facilities and policies, birth and death rates can be managed to align with population and economic growth objectives, for instance with the impact of HIV/AIDS on the population as discussed below.

MATERIALS AND METHODS

HIV/AIDS

The problem of HIV/AIDS emerged in the 80s. By the year 2000, the epidemic has already reduced life expectancy at birth by an estimated four years (UNAIDS 2001). Reductions in life expectancy and increased mortality rates for adults have a serious impact on children. As the deaths of adults increase, children become more vulnerable as AIDS turns many into orphans. UNAIDS (2001) reported that the number of children younger than fifteen years orphaned by AIDS has been estimated to be one million children in Nigeria. Another recognised impact of the epidemic is the death of adults in their prime reproductive and economically productive years. Furthermore, increased mortality rates resulting from HIV/AIDS and other causes will lead to the reduction of life expectancy at birth of both males and females (Dorrington 2000, UNAIDS 2001) and decreases in fertility (Young 2005).

Given this background, this paper seeks to uses a demographic dynamic microsimulation technique to examine how changes in mortality resulting from AIDS affect population growth in Nigeria over time – an important issue that is yet to be tested within the context of demographic change in Nigeria. Microsimulation modelling is a simulation based method using micro-data that is typically used to assess the impact of policy changes. The models typically used use income uprating parameters and static ageing or reweighting to adjust the micro population to account for economic changes (Immervoll et al. 2006). This method intends to look at the effect of demographic change resulting from AIDS deaths on the population of Nigeria. The rest of the paper discusses the demographic characteristics in Nigeria, the methodology used, projection results and conclusions.

Demographic characteristics in Nigeria

The principal demographic trends include population growth, declines in life expectancy and dependency ratio. The following is an examination of these trends for Nigeria. The Nigerian population registered a decline in population from 64.7 million in 1961 to 57.2 million in 1971 as shown in Chart 1. The effects of the Nigerian civil war between 1967 and 1970 resulting from ethnic and political conflict led to starvation and genocide in some of the regions in south-east provinces in Nigeria, where the attempted secession bid started from, and was the reason for the decline in the population. Afterwards, an upward trend in population started. Natural increases are considered the only contributing factor to population growth in Nigeria since then.

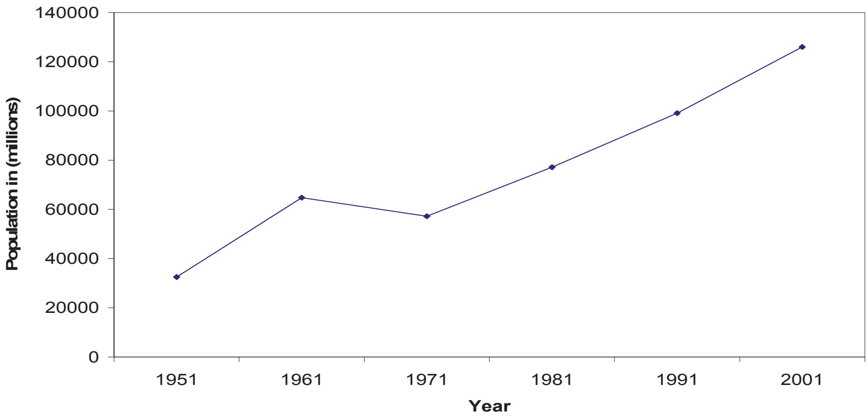

Chart 1 – Nigerian population 1951–2001 (U.S. Census Bureau 2001)

Table 1 describes the age and sex distribution of the population of Nigeria from 1961 to 2001. The data show a high number of children in the population. Those under 15 years of age constituted about 45% of the total population. The number of persons aged 65 years and above in the population constitutes only about 3.5% of the population. The trends in the age structure of the population in Table 1 below reflect the large number of children and the active working age of adults. The large number of the population aged below 15 years indicates a large number of potential parents. The data also demonstrate a high child (youth) dependency ratio which, when combined with the aged dependency ratio, given an overall dependency ratio of about 1 to 1. That is, for every supposedly active (i.e. productive) person in the population in the working age group of 25 to 64 years, one other person is a dependent.

Table 1 – Historical trends in population structure by sex, age and year
(U.S. Census Bureau 2001)

	Age group					
Male	***0–14***	***15–24***	***25–44***	***45–64***	***65+***	***Total***
1961	19,434,101	8,180,780	9,856,792	4,235,973	1,063,900	42,771,546
1971	13,435,488	5,567,499	6,842,210	2,911,346	699,780	29,456,323
1981	17,993,609	7,547,437	9,238,249	3,997,572	946,942	39,723,809
1991	22,770,821	9,994,813	11,347,421	5,294,571	1,279,317	50,686,943
2001	27,659,449	13,058,497	15,169,795	6,656,877	1,751,883	64,296,501
	Age group					
Female	***0–14***	***15–24***	***25–44***	***45–64***	***65+***	***Total***
1961	9,999,058	4,228,105	5,107,497	2,158,169	522,560	22,015,389
1971	12,718,677	5,216,433	6,345,054	2,771,166	724,560	27,775,890
1981	17,089,533	7,094,236	8,510,458	3,753,722	977,838	37,425,787
1991	21,684,844	9,453,063	10,908,717	5,032,848	1,326,084	48,405,556
2001	26,410,225	12,383,837	14,540,017	6,561,296	1,822,455	61,717,830

Due to an increase in interest in public health issues in the African region in general and in Nigeria in particular over the past three decades, the proportion of years an individual is expected to live increases from 38.8% in 1961 to 46.2% in 2001 as shown in Chart 2. The biggest health services related impact has been on infant, child, maternal health, nutrition and HIV/AIDS.

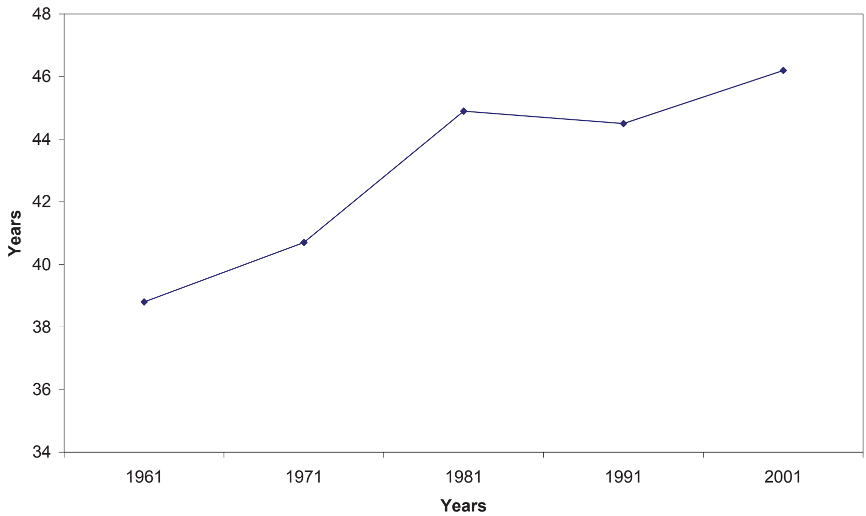

Chart 2 – Historical trends in life expectancy at birth in Nigeria (1961–2001)
(World Bank 2010)

The demographic indicator most commonly used to describe a country's birth situation is called the Total Fertility Rate (TFR). This measure is an indication of the average number of children the women would give birth to during their reproductive life (15–49 years of age). In the case of Nigeria, the initial level of total fertility rate was 6.55 and various factors accounted for this. These are early marriages which are still very common in many parts of the country. Also contraception use is fairly limited and there is still a high demand for children due to tradition, religion and high infant mortality in many parts of the country. Only 6% of married women (age 15–49) actually use any contraceptive methods (3.5% for modern methods and 2.5% for traditional methods) (ECA 2001). In summary, the key factors influencing fertility dynamics in Nigeria are education, age at first marriage, the place of residence (urban or rural) and the region of residence. However, available evidence suggests that there has been a decline in the fertility rate due to changes in some of these socio-cultural factors over time to 5.7% as in 2008.

Nigerian demographic dynamic microsimulation model

Demographics are usually the first step in dynamic microsimulation models. Microsimulation models rely on individuals; therefore it is important to estimate the number of individuals and their features adequately. Generally speaking demographic simulation in a dynamic microsimulation aims to reproduce accurately the whole distribution of a given event conditioned on choices and the past, not just its expected value (Klevmarken 2005).

However, there are numerous conceptual and practical differences between microsimulation methods and other methods of analysis, which have been frequently used as alternatives and are fully discussed by Van Imhoff and Post (1998). For example the cell-based models which mainly base their assumption on exogenous variables about future demographic trends. Other scenarios hypothesise and clearly do not model changes in individual behaviour.

Demographics in microsimulation models, as in other types of models, are responsible for the size and the structure of the population. Entries and exits in the population are related to demographic events in closed simulations models. Entries are made through birth and exit result from death. The structure of the population in the future will be determined by the changes that occur in the population at the starting point in time, through the events that occur (birth and death). This issue is particularly important when analyzing the impact of demographic shocks, as in for instance the HIV/AIDS epidemic, that affects the population age structure.

In designing a dynamic microsimulation model for Nigeria the framework of Orcutt et al. (1976) and Cogneau and Grimm (2002) were followed to analyze the AIDS-related changes in the population structure over time. The most important demographic events were simulated such as birth, risk of HIV infection and mortality. The modelling of our demo-economic variables in the following subsections are:

1. Birth

Given the current demographic trend in Nigeria the answer to the question of how large Nigeria's population would be depends on future fertility levels. In constructing a model of fertility, there are a number of characteristics one would like to include. Age is an important determinant. Other demographic factors that influence fertility include the number of previous children, duration since last birth, birth spacing and the duration of marriage. Unfortunately, detailed information is not available in the Nigeria dataset to incorporate all these features. It is also important to note that there exists some limited life event history in our survey data; hence the sample size is too small to look at fertility issues in detail. Therefore, detailed information available in our data for women between 15 and 49 years old were used to estimate the chances of a woman giving birth to a child (b) from 12 months preceding the survey. According to common theory in population economics, one assumed that the probability of a woman giving birth depends on age, marital status, education and rural/urban residence.

A random binary variable n was then generated which takes the values of 1 with the probability b. Then one selects all records with n equal to 1 and appends the new birth to the household of the mother. The sex of newborn babies is imputed according to the corresponding distribution by sex and no change in the sex distribution of newborns is assumed to occur in the simulation of the model for future years. The birth rate is given as the overall average for the entire female population of a particular age group. In validating the simulation, the overall birth rate needs to be consistent with those from external population projections.

2. Mortality and the risk of HIV/AIDS infection

In these sub-sections two kinds of AIDS simulations were designed. The first one is called without AIDS and the second one is with AIDS. The INDEPTH life table for Sub-Saharan Africa (2004) were used to account for the mortality projections, where the probability of dying of HIV/AIDS and other causes in each year only varies with sex and age. In the model, one also accounts for individual heterogeneity in the probability of getting AIDS, within each sex and age group. The individual risk factors are derived from variables in attitudes regarding HIV/AIDS collected for men and women aged 15–59 years old and 15–49 years old respectively. These risk factors are then calibrated on our mortality projections based on in-depth life tables. One then assumed at the individual level, that the probability of HIV/AIDS infection depends on the number of sexual partners, the frequency of unprotected sexual intercourse with each partner, and the average level of infection of chosen partners.

Following the lead of 'Susceptible-infected' (SI) model of Anderson and May (1992), adopted by Kremer (1996) and modified by Cogneau and Grimm (2002), written as:

$$P = \rho\beta\gamma \qquad (1)$$

Where P is the probability of getting infected over a given period, ρ is the number of sexual partners during this period, β is the transmission rate and γ is the average prevalence rate of partners. For men, the Nigeria Demographic and Health Survey in 2003 – NDHS (NPC 2004) provides the number of sexual partners during the last 12 months, which is used as a proxy for ρ. In the case of women, one can only rely on the variable which tells us the frequency of sexual intercourse for women during the last 12 months. For β, the frequency of condom use was analysed, assuming a constant frequency of sexual intercourse with each partner. The knowledge of the respondents' knowing someone that has HIV/AIDS was used for γ for both men and women, supposing that this gives a clue about the infection of the social network surrounding the individual.

We further estimated each of these variables separately for men and women on explanatory variables such as age, education, matrimonial status and regional (dummies). The use of the declared number of sexual partners in the last one year for men, and the frequency of sexual intercourse for women in equation β and γ is to check the impact of sexual activity on these variables. The estimated equation was used to predict individual risk factors and a simple binary logit model was also used for the estimation.

On the mortality side, the predicted individual risk factors P were calibrated on a dynamic mortality table for men and women, assuming that the risk of infection is proportional to the risk of dying through HIV/AIDS. The mortality tables were computed using the In-depth life table. In the table, one fixed the mortality rate beyond 100 years at one, such that there is no survivor at 101 years. The Life Tables' projections include with AIDS and without AIDS scenarios, allowing us to disaggregate the mortality tables into AIDS deaths and deaths due to other causes. In the mortality model, every year an individual in the sample faces the probability of dying (q), conditioned on his or her age and sex. Initial probabilities are taken from mortality tables estimated from the INDEPTH life tables for sub-Saharan Africa (2004). We then generated a random binary variable d, which takes the value 1 with probability of dying (q), conditional on his/her age and sex and the individual HIV/AIDS risk factors (such as condom use, frequency of sexual intercourse, number of sexual partners and knowing someone with HIV/AIDS). This variable was only applied to the mortality due to AIDS and deleted all records having d equal to 1.

The present demographic projection for Nigeria examined in this paper is for 2005–2015. Assumptions are used in relation to birth and death resulting from HIV/AIDS and other causes. Three variants were chosen: a low variant (B1); medium variant (B2) and high variant (B3) for this paper.

Data

Our simulation model is based on micro data from the National Living Survey – NLSS (2004) and the NDHS 2003 (NPC 2004) datasets. Both the NLSS and NDHS are national representative datasets with a sample of about 92610 individuals (19185 household) and 35173 individuals respectively. The demographic estimation such as fertility, risk of HIV infection such as frequency of sexual intercourse by women, number of sexual partners by men and knowing someone with HIV/AIDS are based on the NDHS 2003 (NPC 2004). These dependent variables are embedded in our household income microsimulation model constructed using the NLSS (2004) by predicting the estimated dependent variables with the same explanatory variables in the NLSS. We then used the INDEPTH life tables for sub-Saharan Africa (2004) as the basis for our age differential mortality. The life tables' projection includes with AIDS and without AIDS scenarios, which allows one to disaggregate deaths resulting from AIDS and death due to other causes.

RESULTS

Regression results: Birth, condom use, number of sexual partners, frequency of sexual intercourse and knowing somebody with HIV/AIDS

This section provides the demographic estimation in respect to birth, condom use by males and females, number of sexual partners by males, frequency of sexual intercourse by females and the probability of knowing somebody with HIV/AIDS or death resulting from AIDS.

The main characteristics of the estimated model as shown in Table 2 revealed that the birth probability decreases with education and rural residence. In contrast, it increases with marriage and the number of children and age. As for condom use, it decreases for both sexes with marriage and rural residence and conversely increases with education and age. For men, the place of residence emerges as significant. Also for men, the number of sexual partners is higher among men with higher education, age and marriage. In contrast, it decreases with rural residence and primary education. The frequency of sexual intercourse and the number of sexual partners is slightly higher in rural areas and among married women. For women, one observed roughly the same association between sexual activity and individual socio-economic characteristics.

In the case of both males and females, the probability of knowing somebody who is infected with HIV or who has died of AIDS is higher among the educated elite and married females. Conversely, living in rural areas has a significant positive effect on the probability of knowing infected people (among females rather than males). The interpretation may be that secrecy is better preserved in urban areas than in the rural areas where social networks are more intimate and less anonymous.

Table 2 – The probability of birth given by women, condom use, frequency of sexual intercourse, number of sexual partners and knowing somebody who has HIV/AIDS or has died of AIDS for males and females using Logit Estimation Procedure

	Birth	Condom use		Frequency of sexual intercourse	Number of sexual partners	Knowing somebody with HIV/AIDS or died of AIDS	
	Females	*Males*	*Females*	*Females*	*Males*	*Males*	*Females*
University	0.176 (0.270)	2.703[a] (0.124)	2.705[a] (0.128)	1.309[a] (0.343)	0.943[a] (0.134)	0.870[a] (0.075)	0.923[a] (0.082)
Upper secondary	1.212[a] (0.213)	2.457[a] (0.119)	2.571[a] (0.123)	0.710[b] (0.322)	0.385[a] (0.097)	0.344[a] (0.067)	0.520[a] (0.071)
Lower secondary	0.769[a] (0.200)	1.955[a] (0.117)	1.991[a] (0.118)	0.593[b] (0.325)	0.276[b] (0.104)	0.463[a] (0.062)	0.474[a] (0.063)
Primary	0.481 (0.367)	–1.301[a] (0.112)	–1.328[a] (0.119)	0.015 (0.555)	–0.064 (0.169)	0.446[a] (0.057)	0.281[a] (0.060)
Rural	–0.690[a] (0.171)	–0.187[a] (0.064)	–0.118 (0.071)	0.431[c] (0.249)	–0.064 (0.079)	–0.008[c] (0.048)	–0.026 (0.049)
Total number of children	0.149[a] (0.030)						
Marriage	5.021[a] (0.735)	–0.401[a] (0.108)	–0.158 (0.099)	–1.244[a] (0.260)	3.231[a] (0.109)	0.048 (0.074)	0.369[a] (0.064)
Age	0.094 (0.075)	0.002 (0.008)	0.001 (0.010)	–0.030 (0.032)	0.008 (0.010)	0.006 (0.004)	–0.010[b] (0.005)
Age 2	–0.030[c] (0.001)	–0.000 (0.001)	–0.000 (0.000)	0.000 (0.000)	–0.000 (0.000)	–0.000 (0.000)	0.000[b] (0.000)
Constant	–8.343 (1.204)	–3.225[a] (0.123)	–3.464[a] (0.137)	–3.714[a] (0.641)	–0.792[a] (0.212)	–1.159[a] (0.066)	–0.972[a] (0.067)
R 2	0.176	0.128	0.139	0.071	0.311	0.016	0.016
Num. of Obs.	6153	11904	11351	6880	6671	11904	11351

Note: [a] is significant at 1%; [b] is significant at 5%; [c] is significant at 10% level.

Projection results

The main aim of this final section is to present some basic results obtained from a baseline run of the dynamic micro-simulation model in terms of key demographic outputs between 2005 and 2015. The model output created for running the dynamic model is for 15 years (starting from 2005), given a number of inputs and assumptions which are meant to capture the population and economic characteristics of Nigeria. A baseline run uses the input dataset and simulated life transitions based on estimated and exogenous parameters, in order to generate a future distribution of some key variables.

The model is simulated taking 2004 as a base year, because the dataset in 2004 have some historical information (which is needed for historical back simulation, but also for enabling one to evaluate the performance of the model. Table 3 contains the population classified by broad age group, the derived young and old population under the various combinations of assumptions of five-year intervals from 2005–2015. The young population is effectively determined by birth and death. Under various combinations of these assumptions, the population 0–14 years is projected to increase, but slightly higher under the B2A2M2 scenarios than others. The old population, i.e. those aged 65 years and over, is projected to increase from 924,000 in 2005 to around 1.2 million by 2015 under the B2A2M2 scenarios.

Table 3 – Projected population of children, adults and 65+ under various scenarios in Nigeria (2005–2015)

		Population					
		0–14	*15–24*	*25–44*	*45–64*	*65+*	*Total*
	Year	Thousands					
B1A1M1	2005	10088	4350	5731	2914	944	24027
	2010	11107	5541	6091	3308	1101	27148
	2015	11988	6370	7070	3692	1222	30342
B2A2M2	2005	10173	4551	5607	3008	938	24277
	2010	11713	5596	5989	3363	1109	27770
	2015	12944	6400	7023	3733	1139	31239
B3A2M3	2005	10294	4524	5675	3011	864	24368
	2010	12149	5605	6004	3310	1016	28084
	2015	13676	6372	6989	3651	1093	31781
B1A1M2	2005	9958	4504	5541	2966	907	23876
	2010	10827	5553	5905	3350	1072	26707
	2015	11478	6336	6907	3742	1131	29594
B2A2M3	2005	10228	4398	5643	2997	878	24144
	2010	11657	5492	5885	3298	1073	27405
	2015	12786	6377	6838	3620	1120	30741
B1A2M3	2005	10108	4327	5655	2908	871	23869
	2010	11282	5484	5925	3236	997	26924
	2015	12093	6440	6812	3591	1052	29988

Note: B1A1M1: B1 = low variant birth; A1 = low variants HIV/AIDS; M1 = low variant mortality. **B2A2M2:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M2 = medium variant mortality. **B3A2M3:** B3 = high variants birth; A2 = medium variant HIV/AIDS; M3 = high variants mortality. **B1A1M2:** B1 = low variant birth; A1 = low variant HIV/AIDS; M2 = medium variant mortality. **B2A2M3:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M3 = high variant mortality. **B1A2M3:** B1 = low variant birth; A2 = medium variant HIV/AIDS; M3 = high variant mortality.

The projected population are expected to increase in the old dependency ratio (those aged 65 years and over as a percentage of those aged 15–64 years during the projection period). In contrast, the young dependency ratio (those aged 0–14 as a percentage of those aged 15–64) is projected to fluctuate, with most years seeing increases in the period 2005–2008 followed by subsequent declines as shown in Table 4. This reduction in the young dependency ratio will have a moderating effect on the increasing total dependency ratio. Movements in both ratios will be strongly affected by the denominator term (i.e. those aged 15–64). The total dependency ratio (young plus 65 relative to working age) will be at a minimum of 81.8% in 2005 but is projected to decrease thereafter to reach values of 67.5% by 2015 under the B1A1M1 scenario.

Table 4 – Dependency ratio

	Year	Young as a % of working age population 15–64 years old	Old as a % of not working age (retired from work and >65 years)	Total
B1A1M1	2005	77.6	7.3	84.9
	2010	74.3	7.4	81.7
	2015	69.9	7.1	77.0
B2A2M2	2005	77.3	7.2	84.5
	2010	78.4	7.4	85.8
	2015	75.4	6.6	82.0
B3A2M3	2005	77.9	6.5	84.4
	2010	81.4	6.8	88.2
	2015	80.4	6.2	86.6
B1A1M2	2005	76.5	6.9	83.4
	2010	73.1	7.2	80.3
	2015	67.6	6.7	74.3
B2A2M3	2005	78.4	6.7	85.1
	2010	79.4	7.3	86.7
	2015	75.9	6.6	82.5
B1A2M3	2005	78.4	6.8	85.2
	2010	77.0	6.8	83.8
	2015	71.8	6.2	78.0

Note: B1A1M1: B1 = low variant birth; A1 = low variants HIV/AIDS; M1 = low variant mortality. **B2A2M2:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M2 = medium variant mortality. **B3A2M3:** B3 = high variants birth; A2 = medium variant HIV/AIDS; M3 = high variants mortality. **B1A1M2:** B1 = low variant birth; A1 = low variant HIV/AIDS; M2 = medium variant mortality. **B2A2M3:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M3 = high variant mortality. **B1A2M3:** B1 = low variant birth; A2 = medium variant HIV/AIDS; M3 = high variant mortality.

Birth

As the population moves further into the future, one observes an increase of women aged in their late 20s and early 30s (amongst whom the age specific fertility rates are higher), which will result in a higher number of births as shown in Table 5. This table shows that women aged 15–24 initially experienced a significant increase in birth in 2005 and 2008. By 2015 there is a reduction in birth from 0.109 in 2005 to 0.100 under the B1A1M1 assumption. For all other assumptions one observes an increase in birth for those women between the ages of 25–29 and decrease in birth for those between 30–39 years of age; while future birth among women aged 40–44 are assumed to be relatively constant. This is in line with United Nations external age specific birth rate projections for Nigeria.

Table 5 – Simulated proportion of women giving birth under various scenarios in Nigeria (2005–2015)

		15–19	20–24	25–29	30–34	35–39	40–44	45–49
	Year	*Live births per 1,000 females at specified ages*						
B1A1M1	2005	0.126	0.229	0.255	0.195	0.126	0.044	0.009
	2010	0.117	0.238	0.289	0.204	0.118	0.041	0.014
	2015	0.124	0.211	0.273	0.240	0.133	0.049	0.013
B2A2M2	2005	0.152	0.241	0.284	0.223	0.135	0.049	0.011
	2010	0.125	0.257	0.316	0.237	0.149	0.055	0.008
	2015	0.116	0.225	0.294	0.252	0.139	0.052	0.015
B3A2M3	2005	0.156	0.265	0.296	0.249	0.144	0.052	0.008
	2010	0.143	0.243	0.342	0.245	0.149	0.055	0.012
	2015	0.123	0.238	0.310	0.272	0.149	0.057	0.013
B1A1M2	2005	0.119	0.208	0.246	0.193	0.148	0.052	0.013
	2010	0.129	0.206	0.258	0.192	0.122	0.056	0.007
	2015	0.119	0.221	0.257	0.207	0.124	0.049	0.013
B2A2M3	2005	0.149	0.255	0.263	0.228	0.123	0.050	0.009
	2010	0.126	0.254	0.312	0.219	0.140	0.055	0.014
	2015	0.120	0.215	0.291	0.261	0.129	0.054	0.014
B1A2M3	2005	0.117	0.251	0.253	0.198	0.136	0.056	0.009
	2010	0.115	0.215	0.300	0.216	0.120	0.052	0.014
	2015	0.117	0.204	0.273	0.253	0.129	0.051	0.013

Note: B1A1M1: B1 = low variant birth; A1 = low variants HIV/AIDS; M1 = low variant mortality. **B2A2M2:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M2 = medium variant mortality. **B3A2M3:** B3 = high variants birth; A2 = medium variant HIV/AIDS; M3 = high variants mortality. **B1A1M2:** B1 = low variant birth; A1 = low variant HIV/AIDS; M2 = medium variant mortality. **B2A2M3:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M3 = high variant mortality. **B1A2M3:** B1 = low variant birth; A2 = medium variant HIV/AIDS; M3 = high variant mortality.

HIV/AIDS

From the hypothesis building (as discussed in the methodology), two simulations were conducted: (i) with AIDS simulation in which risk of infection only depends on sex and age and (ii) without AIDS simulation. As mentioned previously, each of the two simulations were derived from the in-depth life table. According to the simulation in Table 6, the impact of HIV/AIDS on Nigeria's total population is considerable, and the average annual growth rate for 2005–2015 may be reduced by around 2% per year due to HIV/AIDS, an estimation that is consistent with the observed growth of 2.6 per annum between 1991 and 2007 population censuses.

Table 6 – Simulation results in terms of population and growth under B1A1M1 and B2A2M2 scenario in Nigeria (end of each year)

	2005	2010	2015	Growth P.A.
No. of individuals	***B1A1M1***			
With AIDS	1130	1279	1431	0.016
Without AIDS	22897	25869	28911	0.016
Average percentage of family size				
With AIDS	46.6	42.9	36.0	–0.017
Without AIDS	48.8	51.7	47.9	–0.001
Dependency ratio				
With AIDS	72.0	46.4	21.9	–0.076
Without AIDS	85.6	83.9	81.2	–0.004
No. of individuals	***B2A2M2***			
With AIDS	1145	1308	1479	0.017
Without AIDS	23132	26462	29793	0.017
Average percentage of family size				
With AIDS	46.2	42.3	33.4	–0.021
Without AIDS	49.2	52.2	48.5	–0.001
Dependency ratio				
With AIDS	68.7	47.9	19.1	–0.082
Without AIDS	85.3	88.4	87.3	0.002

Note: B1A1M1: B1 = low variant birth; A1 = low variants HIV/AIDS; M1 = low variant mortality. **B2A2M2:** B2 = medium variant birth; A2 = medium variant HIV/AIDS; M2 = medium variant mortality.

DISCUSSION

From the estimation of births given by women it was observed that educated women have fewer children, but the number of children increases with age of the women and with marriage. This observation was done in finding out if AIDS deaths have any significant impact on the population structure of Nigeria. This finding is consistent with the empirical evidence summarised by Cogneau and Grimm (2002). As Jejeebhoy (1995) puts it, "the enhancement of women's schooling is critical for a fertility reduction and is neither as strong nor as universal as is often implied, and the association between schoolings and fertility are not clearly understood". However, the relationship between women's schooling and fertility and the effect of a modest amount of schooling is highly context-specific; varying by the region of the world, level of development and time (United Nations 1987).

The use of a condom during sexual intercourse for the prevention of contracting HIV/AIDS is very low among married women and high among educated persons. This means that educated men have multiple sexual relationships. The increases in the number of sexual partners among married men mark the strong effect on the polygamous nature of Africans (particularly in Nigeria). The findings are also in agreement with the empirical findings by Cogneau and Grimm (2002) and the HSRC survey in South Africa (Shisana and Simbayi 2002) which shows that the educated people are more likely to have several sexual partners and that they act in a more risky social network. In the past one year period preceding the survey, one would expect the frequency of sexual intercourse of women, to be marked by a strong positive of the married woman effect, suggesting that this dichotomous variable is a proxy for the risk variable ρ. While knowing someone infected with HIV/AIDS is higher among educated elite in the population.

On the projection side, the dependency ratio among the elderly population is projected to increase from 924,000 in 2005 to around 1.2 million by 2015 under the B2A2M2 scenarios. Again, this finding is in line with the findings by the CIA World Fact Book (2016) that the aged population will increase by 5% in 2020. From the two simulations of with AIDS and without AIDS, it was observed that the population of Nigeria will be smaller by around a thousand persons, taking into account not only the deaths of infected persons, but also the birth rate which has recently decreased. Although HIV/AIDS primarily kills adults of a working age, the dependency ratio does not increase, but instead decreases. The number of households' decreases for those with AIDS and without AIDS by around 2%.

CONCLUSION

This study has estimated the demographic change in Nigeria in order to determine the impact of birth and death rates resulting from HIV/AIDS and other causes on the population structure over time. A dynamic microsimulation model was used to capture these demographic trends. A stand-alone simulation was established to illustrate some of the effects that will emerge in dynamic microsimulation models due to using different methods of simulating demographic trends. The first is the use of alignment technique, which ensures that the summed output aggregates of the model match external control totals and also to correct predictive failures of the econometric estimation.

The results obtained from the model estimation indicate that the probability of a woman giving birth decreases with education and rural residence, while condom use decreases with marriage and rural residence and increases with educational attainment. On the projection side, it is projected that there will be an increase in the number of women aged in their 30s giving birth and an increase in the dependency ratio of the old people to 4.2% by 2015. It was also observed that there was no significant change among the working age population. On the projected population with HIV/AIDS and without HIV/AIDS, the impact of HIV/AIDS on the population is considerable. It is about 2% under the without HIV/AIDS and with HIV/AIDS scenarios. This implies that without AIDS treatment, the population of Nigeria will be few thousand persons smaller by 2015 than it would have been in the absence of AIDS. This result is in line with the earlier findings of Thurlow (2007), who noted that the impact of AIDS on Botswana's total population falls from 2.0% in the without AIDS scenario to 0.9% in the with AIDS scenario. This implies that the population of Botswana will be 23% smaller in the absence of treatment by 2021. However, this model did not estimate the impact of treatment of HIV/AIDS on the population growth. Government treatment programs cannot eliminate the pandemic; it can only mitigate some of its detrimental impacts.

CONFLICT OF INTEREST

The authors have no conflict of interest to disclose.

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