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Estimation of Adult Mortality in Nigeria in the Era of Sustainable Development Goals: Insights from Census-Based Methods

Chinonso Onyinyechi Okoro[1*] and Eleazar Chukwunenye Nwogu[2]

Abstract

This paper focuses on the estimation of adult mortality in Nigeria. The general objective is to obtain adult mortality levels for Nigeria which may be relevant in assessing the level of development and the progress of Sustainable Development Goals (SDGs) in that country. Census-based methods were applied to the 1991 and 2006 adjusted population census by age and sex to estimate adult mortality. The results of the study suggest that adult males in Nigeria have a higher life expectancy than their female counterparts in almost all age groups. At age 5-9, the life expectancy from the methods applied was below 60 years. The consequences of low life expectancy among adults include the early marriage of young girls, an increasing orphanhood burden, and high numbers of out-of-school children, which may hamper the achievement of SDGs in the country. Given that there is no consensus yet on the best approach for estimating adult mortality in developing countries, we recommend that census-based methods should be used for this task.

Keywords

Adult mortality; census; survival ratio; intercensal; life expectancy

Introduction

Mortality is one of the components of population change. It is completely out of human control and affects every segment of a population. Adult mortality rates are a serious health problem in developing countries although more emphasis has always been on infant and childhood mortality. The adult mortality rate is the probability that a 15-year-old person will die before reaching his/her 60th birthday if subjected to age-specific mortality rates between those ages for the specified year (World Bank, 2011). The causes, determinants, and preventive measures of under-five mortality (child mortality) are well known, but far less is known about adult mortality in the developing world. From age 5 and above, or 15 years and above (when adult mortality is often considered to apply) the main causes of deaths are difficult to determine. The estimation of adult mortality levels in the developing world still faces diverse challenges, such as poor data quality and unreliable civil registration systems. Still, in developing countries, adult mortality levels are being estimated in spite of these challenges. Life expectancy at birth, and at age 15 years and above, are important indicators used to measure health status and social development (Helleringer, Pison, Kanté, Duthé & Andro, 2014; Timaeus, 1991a). Although we now have improved estimates of child mortality,

1 Department of Statistics, Imo State University, Owerri
2 Department of Statistics, Federal University of Technology, Owerri
* Chinonso Onyinyechi Okoro, corresponding author. Email: chinonso.okoro@yahoo.com

it is dangerous to extrapolate adult mortality levels from information on child deaths. Only a comprehensive assessment of mortality patterns in a population and a genuine estimation of adult mortality can serve as a basis for effective planning.

Between 1990 and 2015 in Africa, adult mortality declined by 23%, and this may have contributed to the increase in population, from 319 million to 640 million, of people aged 15-59 years (United Nations, 2017). The World Health Organization (2017) has stated that adult mortality in 2016 was about 142 per 1,000 population. They observed also that adult mortality in 2016 was high in African regions even when compared to the rates in other regions in 2000. It was also reported that adult mortality rates were lowest in high-income countries and highest in low-income countries. The rates were higher for males than for females in all regions and in virtually all countries. Over the years, adult mortality rates have improved in Nigeria although the current levels are not within an acceptable range. Between 1990 and 2013, the probability of dying for Nigerian males between 15 and 60 years per 1,000 of the population decreased from 408 to 357 while for females it declined from 364 to 325 (World Health Organization, 2015).

It took the human immunodeficiency virus (HIV/AIDS) epidemic, and most especially its effects in developing countries, for world leaders to see the need for a greater public health focus on adult health. In Nigeria, the national prevalence rate of HIV as of 2012 was 3.4%, less than 2% of that found in the 2007 survey (Federal Ministry of Health, Nigeria, 2013). The prevalence of HIV by age group was highest among adults aged 35-39 years (4.4%) while by marital status the widowed (6.2%) recorded the highest prevalence (Federal Ministry of Health, Nigeria, 2013). Masquelier, Reniers, and Pison (2013) observed that the adult mortality in some African countries increased sharply in the 1990s, suggesting a high incidence of HIV, but then began to decline after massive anti-retroviral therapy programmes in those countries. Lankoande (2016) opines that adults in urban areas of Burkina Faso still have health-benefit advantages over their counterparts in rural areas; hence, the location of an adult in that country may affect the health of that adult. Adult mortality rates in Kenya have been estimated at 27%, compared to 37% in Nigeria and 43% in South Africa (United Nations, 2013). A high prevalence of HIV/AIDS may have contributed to the high adult mortality rate in South Africa. Other leading causes of adult mortality identified over the years in developing countries include deaths from maternal mortality, high blood pressure, tobacco, alcohol, diabetes, cardiovascular diseases, accidents, crime, high poverty levels, insurgence/terrorism, and ethno-religious fighting (Murray, Wang, Abajobir & Abate, 2017; Chukwu & Oladipupo, 2012; Gakidou, Hogan, & Lopez, 2004). The consequences of high adult mortality may lead to early marriage among young females, high levels of out-of-school children, and an increasing orphanhood burden (Beegle & Krutikova, 2007).

The changes in the age pattern of most developing countries coupled with the unacceptable levels of mortality that occur in adulthood as a result of chronic diseases have triggered a quest to obtain better estimates of adult mortality levels. The major sources of data for estimating adult mortality in developing countries are censuses and sample surveys. The classical approach (using direct methods) of estimating adult mortality does not work well in developing countries due to inefficient registration systems there. The civil registration systems or population registers are not available; therefore, data collected through these means are incomplete or unreliable and cannot be used to make reasonable estimates and projections. This forms a barrier to the estimation of adult mortality in developing countries in the era of SDGs. To close the information gap, indirect techniques for estimating adult mortality have been developed over the years. There are several direct and indirect methods available for estimating adult mortality in developing countries. In this paper, the emphasis is on indirect techniques (census-based methods) since direct methods, as mentioned, are known to be ineffective. It is worthy of note that there is not yet a consensus on the best approach to estimating adult mortality in developing countries because most of the known methods have their limitations and different data requirements. They include: (i) census survival methods, which are prone to age misreporting; (ii) growth balance (GB) methods that assume stable closed populations, which in many scenarios are inappropriate due to changing fertility and mortality levels; (iii) the extinct generations method, which is very similar to GB except for the assumption that under-reporting is constant or uniform above a certain specified age; (iv) estimates derived from information on the survival of parents, which are greatly affected by the unavailability of requisite data; and (v) estimates derived from information on the survival of siblings, which usually grossly underestimate the mortality levels due to difficulties interviewers face in the process of eliciting accurate information from respondents (United Nations, 2002). The application of any of these methods is based on the knowledge and discretion of experts and on data availability.

Therefore, the general objective of this study is to obtain adult mortality levels for Nigeria using the adjusted population census by age and sex from the 1991 and 2006 Nigerian censuses, which may be relevant in assessing the level of development and the progress of SDGs in Nigeria. The specific objectives are: (i) to apply the census-based method of estimating adult mortality to the adjusted census data; and (ii) to compare estimates obtained using other known sources.

Data Sources and Method

It has been shown that the quality of reported age and sex data from the Nigerian population censuses are grossly defective; adjustment has been recommended for any meaningful usage of the reported census data, especially for the estimation of demographic parameters and developmental planning implementation in Nigeria (Ekanem, 1972; Nwogu, 2006; 2011; Ohaegbulem, 2015; Nwogu & Okoro, 2017). Nwogu & Okoro (2017) adjusted the reported populations in the Nigeria censuses using mathematical methods (such as the Carrier Farrag method, the Newton Halving method, and the United Nations Five-point method etc.). We observe that mathematical methods appear to have smoothed out genuine age patterns. To address this limitation, Okoro and Nwogu (2019) applied a Y-transformation to the 1963, 1991, and 2006 Nigerian population censuses. Thereafter, the adjusted data was re-evaluated and the results showed a significant improvement in all accuracy indices as compared to results obtained using the mathematical methods mentioned above. Thus, to estimate adult mortality levels, the adjusted 1991 and 2006 age and sex data from the population model was used in the study.

Y-Transformation is used in most developing countries to adjust grossly defective age and sex data. It involves selecting an appropriate standard age distribution from a standard stable population if the growth rate is known and comparing it to the reported age distribution. This is followed by the adjustment of the standard age distribution to reflect the key characteristics of the reported one. The comparison of the model and reported distributions are simplified by the use of a Y-Transformation which linearizes the relationship between age and the cumulated proportion of the population under each age. The UN Manual X (1983) define Y-Transformation as

$$Y(x) = In\left(\frac{(1+C(x))}{(1-C(x))}\right) \tag{1}$$

where C(x) is the proportion of the population under the age of x. Values of Y(x) of the study population can be plotted against standard values, YS(x), for an appropriate standard stable population given as

$$Y^S(x) = In\left(\frac{(1+C^S(x))}{(1-C^S(x))}\right) \tag{2}$$

An adjusted age distribution can be obtained by fitting a curve to the points that appear less biased (usually 0–69 years for most developing countries) then reversing the transformation process to obtain a smooth cumulated age distribution (see UN Manual X, 1983; Okoro & Nwogu, 2019). The result should be an age distribution that is free of bias and has the main features of the reported age distribution.

We compared life expectancy from the Preston-Bennett (1983) method and the United Nations Synthetic Survival Ratio method (UN, 2002) with that of the World Health Organization (WHO). This was not a direct comparison of results but a way of assessing the performance of the methods applied in this study since the WHO uses different data and methods. It is worthy of note that the World Health Organization (2016) derived adult mortality estimates for the period 1990-2015 from life tables constructed using United Nations World Population Prospects data.

In this paper, to estimate adult mortality levels in Nigeria, census-based methods are applied to the adjusted population census data from 1991 and 2006 by age and sex. Section 2.1 is devoted to the Preston-Bennett (1983) method while section 2.2 presents the United Nations Synthetic Survival Ratio method (UN, 2002). These methods do not make reference to life tables (they are non-parametric) and are applied when the time interval between two censuses is not uniform (i.e. more than 10 years).

1) Preston-Bennett (1983) method

This method estimates the expectation of life at each age by using intercensal age-specific growth rates to convert a non-stable age distribution into a corresponding life-table population or stationary population. It requires only two census-age distributions, and one of the advantages of this method is that it can be applied to any intercensal interval although preferably one below 20 years (UN Manual X, 1983). By cumulating the observed age-specific growth rates of the study population, Preston and Bennett (1983) proposed estimating life expectancy at age x for both continuous and discrete forms. For the discrete form of the function, the expectation of life at age x using 5-year age groups is computed by

$$e_x = \frac{[\sum_{y=x}^{\omega} {}_5N_y \, exp[5.0\sum_{u=x}^{y-5} {}_5r_u + 2.5\,{}_5r_y\,]}{{}_5N_{x-5}\, exp[-2.5\,{}_5r_{x-5}\,] + {}_5N_x\, exp[2.5\,{}_5r_x\,] / 10} \tag{3}$$

where the numerator is an approximation of the general equation for the age distribution of a closed population while the denominator is the number of people aged x. For details of the method, see UN Manual X (1983) and Preston and Bennett (1983).

***Computational procedure*:**

Step 1: Compute the age-specific intercensal growth rates for the five-year age groups as

$$ {}_5r_x = In({}_5P2_x / {}_5P1_x) / t \tag{4}$$

where ${}_5r_x$ represents the intercensal growth rate of the five year age groups, ${}_5P2_x$ is the population aged x to x+4 at the second census; ${}_5P1_x$ is the population aged x to x+4 at the first census and t (15 years in this study) is the time interval in years between the two censuses.

Step 2: Computation of average intercensal age distribution is done by taking the mean of each of the first and second age distributions

$$ {}_5N_x = 0.5({}_5P1_x + {}_5P2_x) \tag{5}$$

Step 3: Cumulate the age-specific growth rates obtained by equation (4) from age 5 or 10 upward.

Step 4: Reduction of age distribution to a stationary form is done by multiplying each value of ${}_5N_x$ by the exponential of the inflation factor (R(x)) as

$$ {}_5L_x * = {}_5N_x \exp(R(x)) \tag{6}$$

Step 5: Calculate the life expectancy using equation (3).

2) United Nations Synthetic Survival Ratio (2002) method

The United Nations (2002) proposed another census-based method, the synthetic survival ratio method, for estimating adult mortality in developing countries. It is very similar to the Preston-Bennett method and also uses two census age distributions applied to an arbitrary intercensal interval. The key difference is that the synthetic survival ratio uses l_x (number of persons who reach the beginning of the indicated age interval each year) in deriving census survival ratios while the Preston-Bennett (1983) method uses ${}_nL_x$ (the number of persons in the population who at any moment are living within the indicated age interval). The United Nations (2002) propose a synthetic survival ratio as

$$ l_{x+5} / l_{2.5} = \frac{N(x+5,5)\exp[(2.5r(x+5,5)]}{N(x,5)\exp[(-2.5r(x,5)]} \tag{7}$$

where the denominator is an interpolated number of people aged x to x + 5 at time a – 2.5 years while the numerator is the interpolated number of people aged x + 5 to x + 10 at time a + 2.5 years. The value 'a' denotes the mid-point of the intercensal period. Age-specific growth projected forward by 2.5 years is represented by r(x + 5, 5). The assumption is that no migration occurs in the persons represented in the numerator as well as those for the denominator.

***Computational procedure*:**

Step 1: Computation of age-specific intercensal growth rates for the 5-year age groups using

$$ r(x,n) = In[P_2(x,n) / P_1(x,n)] / t \tag{8}$$

where $r(x,n)$ denotes the age-specific growth rate; $P_2(x,n)$ is the population aged x to x + 4 at the final census; $P_1(x,n)$ is the population aged x to x + 4 at the initial census, and t (15 years in this study) is the time interval in years between the two censuses.

Step 2: Calculate the average number of person-years lived by each 5-year age group in the interval under consideration as

$$N(x,5) = [P_2(x,5) - P_1(x,5)] / [tr(x,5)] \quad (9)$$

Step 3: Calculate the synthetic survival ratios using equation (7).

Step 4: Calculate the conditional survival schedule $(l_x / l_{2.5})$ using the formula

$$l_{x+5} / l_{2.5} = (l_{x+5} / l_x) / (l_x / l_{2.5}) \quad (10)$$

Step 5: Then, by linear interpolation, the probability of survival to age x is computed by

$$l_x / l_{2.5} = 0.5(l_{x-2.5} / l_{2.5} + l_{x+2.5} / l_{2.5}) \quad (11)$$

Step 6: While the person-years lived in each age group, derived from the conditional ${}_5L_x$ values, $({}_5L_x / l_{2.5})$ is estimated by

$$ {}_5L_x / l_{2.5} = 2.5(l_x / l_{2.5} + l_{x+5} / l_{2.5}) \quad (12)$$

for x = 5, 10, ..., 60.

Step 7: Compute the total person-years lived above age x by

$$T_{x-5} / l_{2.5} = T_{x-5} / l_{2.5} + {}_5L_{x-5} / l_{2.5} \quad (13)$$

Step 8: Compute the expectation of life e_x using the formula

$$e_x = (T_x / l_{2.5}) / (l_x / l_{2.5}) \quad (14)$$

Results

In this Section, equations (3) through (14) outlined in Section 2 were applied to the adjusted population census from 1991 and 2006 by age and sex to estimate the adult mortality levels in Nigeria. The life-table function estimates of the Preston-Bennett method and the UN Synthetic Survival Ratio method are given in Tables 2 through 5 (see appendix 1a – 1b and 2a – 2b). The estimated life expectancies using the two methods compared to WHO (2006) estimates of life expectancy for Nigeria are shown in Table 1. Table 1 shows that estimates of life expectancy from the two techniques for males aged 5-9 years were higher than the reported estimates by WHO for Nigeria in 2006 (57.8 vs. 50.0 years, respectively). The life expectancy estimates from the two adopted methods were consistently higher than WHO reported values for males up to the age group of 35-39. For females, the Synthetic Survival Ratio method and WHO estimates were almost equal for the first age group (5-9 years). Thereafter, the estimates using the Preston-Bennett and Synthetic Survival Ratio methods were very close for the 10-14 to 20-24 age groups but subsequently dropped rapidly. Overall, for females after the first and second age groups, it appears the WHO-reported life expectancies were greater than the estimates from the two techniques across the age groups.

Table 1: Distribution of Estimated Life Expectancies for Nigeria (Male and Female) using Preston-Bennett and Synthetic Survival Ratio Methods: 1991-2006.

Age Group	Male			Female		
	Preston-Bennett Method	Synthetic Survival Method	WHO 2006	Preston-Bennett Method	Synthetic Survival Method	WHO 2006
5-9	57.89	57.83	50.0	56.18	54.49	54.1
10-14	54.81	53.76	46.0	50.58	48.46	50.3
15-19	50.00	48.95	41.5	44.40	42.71	45.9
20-24	44.83	44.12	37.2	38.64	37.47	41.8
25-29	39.61	39.09	33.1	33.39	32.69	38.1
30-34	34.34	33.99	29.5	28.57	28.21	34.6
35-39	29.07	28.86	26.5	24.09	24.06	31.3
40-44	23.87	23.75	24.1	19.92	20.12	28.0
45-49	18.81	18.82	21.9	15.93	16.27	24.5
50-54	13.99	14.12	19.6	12.09	12.62	20.7
55-59	9.33	9.48	17.3	8.33	8.89	17.1
60-64	4.76	4.95	14.8	4.43	4.96	13.4

Source: Author computations from the adjusted Nigeria Census datasets. World Health Organization (WHO) life expectancy estimates retrieved from WHO Global Health Observatory Data Repository.

The mortality pattern of most African countries is said to follow the North model of the Coale-Demeny model life table or any other available model life tables such as UN model Life table for developing countries, Brass Logit System etc. (National Bureau of Statistics & UNICEF, 2011; Nwogu & Nweke, 2016). Using interpolation, we attempted to derive the mortality levels implied by the estimated life expectancies from the Preston-Bennett and synthetic survival methods. Table 2 shows that the average mortality level implied by the estimated life expectancies for males in age groups 5-9 through 15-19 is 16.30 for the Preston-Bennett method while it is 15.77 for the synthetic survival method. For females, the average mortality level is below 12.00 in that age range for both methods.

Table 2: Distribution of mortality levels derived from Coale-Demeny model life table (North model) using the estimated life expectancies.

Age Group	Male		Female	
	Preston-Bennett Method	Synthetic Survival Method	Preston-Bennett Method	Synthetic Survival Method
5-9	16.22	16.18	15.02	12.07
10-14	16.63	15.81	11.19	9.68
15-19	16.06	15.32	9.33	8.05

Source: Author computations.

Figure 1 shows that the male life expectancy estimates from WHO were below those calculated using other methods for age groups 5-9 through 35-39 and intersected them at the 40-44 age group; thereafter, they overlapped with them until the last age group. The life expectancy estimates for females showed the opposite pattern; at age 5-9 through 10-14 there were ties among the three methods after which the WHO estimates were greater than the estimates from Preston-Bennett and the synthetic survival methods. Figure 2 shows that in both sexes the estimate of survival ratios from the two methods adopted were higher than the WHO survival ratios for all age groups.

Figure 1: Plot of estimated life expectancies from the WHO, Preston-Bennett, and Synthetic Survival Methods against age for Nigeria: 1991 – 2006.

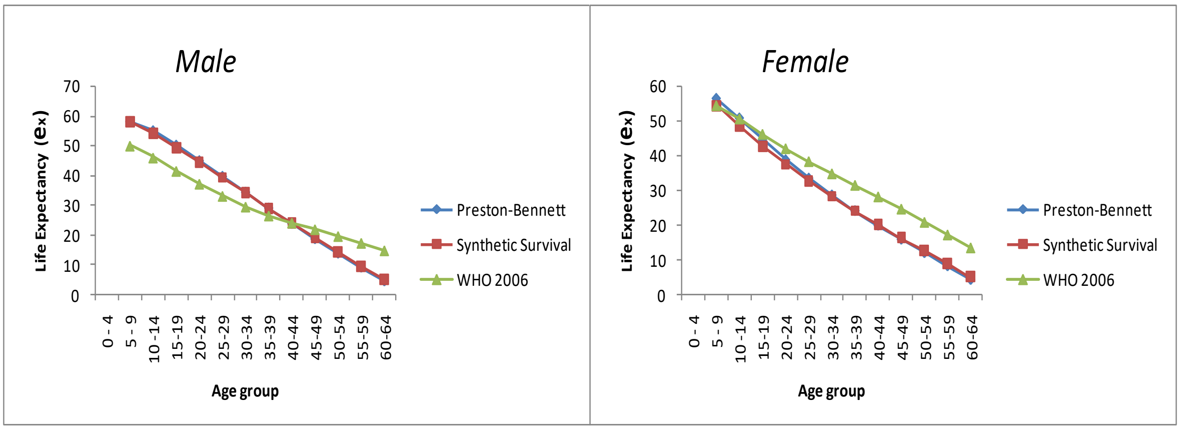
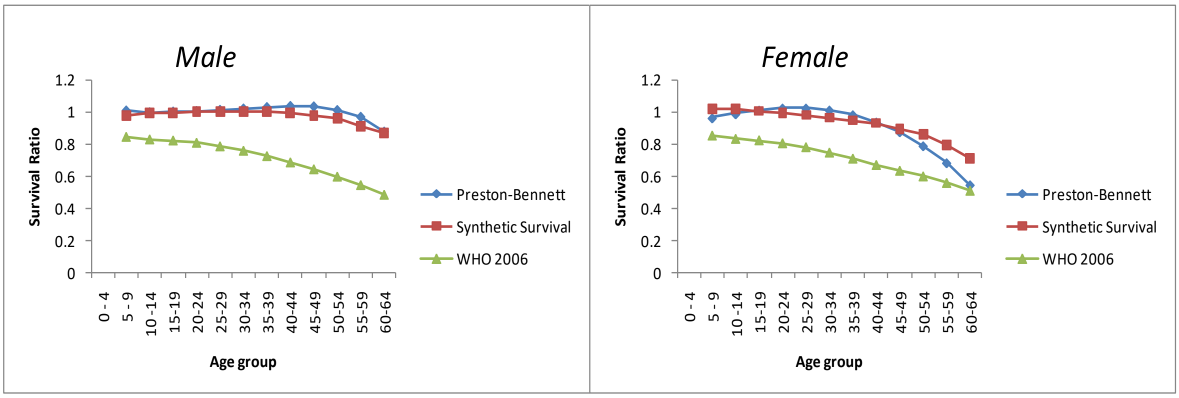


Figure 2: Plot of estimated survival ratios from the WHO, Preston-Bennett, and Synthetic Survival Methods against age for Nigeria: 1991 – 2006.



Discussion

In summary, judging from the estimates of life expectancies from the Preston-Bennett method and the Synthetic Survival Ratio method, males in Nigeria in 2006 had higher life expectancies than their female counterparts. By interpolation, the average mortality level implied by the (male and female) estimated life expectancies so far appears to be consistent with the work by Nwogu and Nweke (2016).

Using the Preston-Bennett method, the life expectancy estimates for males in the 5-9 age group are higher than the reported estimates for Nigeria by the WHO in 2006 (57.89 vs. 50) years respectively. The pattern continues up to the 35-39 age group. From the 45-49 age group and upwards, the WHO reported estimates are higher than the estimates calculated using the Preston-Bennett method. The results from the synthetic survival ratio follow the same pattern observed in the Preston-Bennett method. For females, estimates of life expectancy obtained from the two methods are higher than the WHO reported values in the first two age groups. Overall, it appears that life expectancies from the first seven age groups based on the WHO methods may have been underestimated for males if we assume that the estimates from the other two methods applied are accurate. On the other hand, the life expectancy estimates for the females from the two techniques adopted compare fairly well with the WHO estimates in the first three age groups; thereafter, the reported values from WHO are higher than that of the Preston-Bennett method and the synthetic survival ratio in all the remaining age groups.

It has been observed that intercensal interval methods are very sensitive to content errors such as age misreporting (Hill, 2003). This can also be affected by migration. One of the ways of addressing some of the limitations (age misreporting) is by adjusting age data before usage. This suggested the use of adjusted data in this study. WHO life expectancy estimates for its member states are from surveys/vital records (which are incomplete in most developing countries) or interpolated values from existing life tables (WHO, 2016; 2018). It has been shown that estimates of some demographic parameters, such as mortality rates from survey data, are susceptible to underestimation due to many factors, such as an inability of interviewers to elicit accurate information from respondents or the issue of the sample size adopted in the survey (Gakidou et al., 2004). The data used in preparing or deriving life table functions for most developing countries are often not from such countries. They are mere interpolated estimates which are prone to overstatement or understatement. The WHO (2018) states that although it applies standard methods in analysing data from member states, its estimates may vary from the official estimates of member states due to different projection methods as there is no consensus yet on the best approach to the estimation of adult mortality in developing countries. Therefore, the WHO estimates in this study is used to assess the performance of the methods adopted not necessarily as a direct comparison of level of performance due to the data sources and methods being different.

From the foregoing, it appears that life expectancy for adult males in Nigeria in 2006 may have been underestimated, judging from the WHO estimates, which gave the impression that adult females are expected to live longer than their male counterparts in Nigeria. The questionable quality of the female data may be a reason for this. However, the work by Chukwu and Oladipupo (2012) is consistent with our results. Using the Lee-Carter method, they observed that females had higher mortality rates than their male counterparts in Nigeria.

Conclusion and Recommendations

This study has discussed the estimation of adult mortality from adjusted age and sex data from the 1991 and 2006 censuses in Nigeria using census-based Methods. It was designed to obtain estimates of demographic parameters (mortality levels) which may be relevant in assessing the level of development and the progress of SDGs in Nigeria.

We applied the Preston-Bennett and United Nations Synthetic Survival Ratio methods to the adjusted population census data from 1991 and 2006 by age and sex to obtain estimates of adult mortality in Nigeria. We observed that males in Nigeria have a higher life expectancy than their female counterparts in almost all age groups, a result which seems to be consistent with other known studies.

For Nigeria to achieve the sustainable development goals (goal 3 & 5), there is need to improve the health status of those in the country especially of women and female children since they are at a higher risk of dying. Furthermore, improved health care systems should address the consequences of high adult mortality rates, such as the early marriage of young girls and the high levels of out-of-school children—reported to be 10.5 million in Nigeria (UNICEF, 2013)—to avoid these reaching epidemic levels.

Moreover, the estimation of adult mortality from indirect techniques should not overrule the need for effective vital registration systems nor replace the care and caution needed in the data collection process.

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Appendices

1a

Table 1: Life Table Functions of Adult Mortality for Males using Preston-Bennett Method: 1991-2006

Age	P1(x, x+4)	P2(x, x+4)	r(x, x+4)	N(x)	R(x+2.5)	l(x)	L(x, x+4)	T(x)	e(x)
0-4	8,099,643	12,045,609	0.02646	9,942,461	0.0661	-	10,622,361	-	-
5-9	6,519,740	9,937,638	0.0281	8,108,991	0.215	2,067,653	10,054,166	119,706,295	57.89
10-14	5,460,702	8,539,217	0.02981	6,885,642	0.3682	2,000,495	9,950,789	109,652,130	54.81
15-19	4,603,084	7,380,445	0.03147	5,882,901	0.5295	1,994,003	9,989,241	99,701,341	50.00
20-24	3,853,655	6,324,214	0.03302	4,987,364	0.698	2,001,271	10,023,469	89,712,100	44.83
25-29	3,221,664	5,397,376	0.0344	4,216,374	0.8729	2,011,721	10,093,742	79,688,631	39.61
30-34	2,686,524	4,580,200	0.03557	3,549,570	1.0531	2,026,840	10,174,659	69,594,889	34.34
35-39	2,237,360	3,867,486	0.03649	2,978,443	1.2371	2,043,730	10,262,638	59,420,229	29.07
40-44	1,859,656	3,245,585	0.03713	2,488,631	1.4235	2,059,458	10,331,938	49,157,592	23.87
45-49	1,534,914	2,691,118	0.03743	2,059,199	1.6104	2,063,772	10,305,782	38,825,654	18.81
50-54	1,249,143	2,186,411	0.03732	1,674,280	1.7953	2,038,742	10,081,635	28,519,873	13.99
55-59	1,006,578	1,744,415	0.03666	1,341,857	1.975	1,975,221	9,670,575	18,438,238	9.33
60-64	779,295	1,321,780	0.03522	1,026,763	2.1447	1,843,824	8,767,663	8,767,663	4.76
65-69	585,166	954,611	0.03263	754,881	-	-	-	-	-

Source: Author computations from the adjusted Nigeria Census datasets.

1b

Table 2: Life Table Functions of Adult Mortality for Females using Preston-Bennett Method: 1991-2006

Age	P1(x, x+4)	P2(x, x+4)	r(x, x+4)	N(x)	R(x+2.5)	l(x)	L(x, x+4)	T(x)	e(x)
0-4	7,445,058	10,857,274	0.02515	9,044,138	0.0629	-	9,631,102	-	-
5-9	6,434,665	9,521,849	0.02613	7,877,695	0.1987	1,924,038	9,609,275	108,094,195	56.18
10-14	5,696,550	8,569,787	0.02723	7,035,658	0.3378	1,947,207	9,862,794	98,484,920	50.58
15-19	4,996,337	7,650,970	0.02841	6,229,670	0.4829	1,995,942	10,096,630	88,622,126	44.40
20-24	4,308,137	6,719,261	0.02963	5,424,685	0.6341	2,032,391	10,227,276	78,525,496	38.64
25-29	3,644,415	5,789,485	0.03086	4,634,507	0.7914	2,045,299	10,225,710	68,298,220	33.39
30-34	3,029,081	4,899,204	0.03205	3,889,498	0.9545	2,032,835	10,102,637	58,072,511	28.57
35-39	2,461,158	4,049,791	0.03320	3,189,813	1.1232	1,991,056	9,807,926	47,969,874	24.09
40-44	1,954,160	3,268,073	0.03428	2,555,058	1.2971	1,915,649	9,348,560	38,161,948	19.92
45-49	1,515,351	2,572,610	0.03528	1,997,565	1.4759	1,808,743	8,738,870	28,813,388	15.93
50-54	1,126,915	1,939,511	0.03620	1,496,626	1.6589	1,660,105	7,862,178	20,074,518	12.09
55-59	802,943	1,398,736	0.03700	1,073,423	1.8455	1,465,862	6,796,441	12,212,340	8.33
60-64	526,430	926,353	0.03768	707,657	2.0351	1,221,234	5,415,899	5,415,899	4.43
65-69	307,678	545,360	0.03816	415,243					

Source: Author computations from the adjusted Nigeria Census datasets.

2a

Table 4: Life Table Functions of Adult Mortality for Males using Synthetic Survival Ratio Method: 1991-2006

Age	P1(x,5)	P2(x,5)	r(x,5)	N(x,5)	l(x+5)/l(x)	l(x+5)/l(2.5)	l(x)/l(2.5)	5Lx/l(2.5)	T(x)	e(x)
0-4	8,099,643	12,045,609	0.02646	9,942,461	0.9348	1.0000				
5-9	6,519,740	9,937,638	0.02810	8,108,991	0.9814	0.9348	0.9674	4.7337	54.0572	57.83
10-14	5,460,702	8,539,217	0.02981	6,885,642	0.9958	0.9174	0.9261	4.6039	49.3235	53.76
15-19	4,603,084	7,380,445	0.03147	5,882,901	0.9961	0.9136	0.9155	4.5682	44.7196	48.95
20-24	3,853,655	6,324,214	0.03302	4,987,364	1.0006	0.9100	0.9118	4.5552	40.1514	44.12
25-29	3,221,664	5,397,376	0.03440	4,216,374	1.0028	0.9106	0.9103	4.5554	35.5962	39.09
30-34	2,686,524	4,580,200	0.03557	3,549,570	1.0047	0.9131	0.9118	4.5678	31.0409	33.99
35-39	2,237,360	3,867,486	0.03649	2,978,443	1.0044	0.9174	0.9153	4.5867	26.4731	28.86
40-44	1,859,656	3,245,585	0.03713	2,488,631	0.9970	0.9214	0.9194	4.5987	21.8864	23.75
45-49	1,534,914	2,691,118	0.03743	2,059,199	0.9801	0.9187	0.9200	4.5740	17.2877	18.82
50-54	1,249,143	2,186,411	0.03732	1,674,280	0.9643	0.9004	0.9095	4.4847	12.7138	14.12
55-59	1,006,578	1,744,415	0.03666	1,341,857	0.9158	0.8682	0.8843	4.2901	8.2291	9.48
60-64	779,295	1,321,780	0.03522	1,026,763	0.8711	0.7952	0.8317	3.9390	3.9390	4.95
65-69	585,166	954,611	0.03263	754,881		0.6927	0.7439	-	-	-

Source: Author computations from the adjusted Nigeria Census datasets.

2b

Table 5: Life Table Functions of Adult Mortality for Females using Synthetic Survival Ratio Method: 1991-2006

Age	P1(x,5)	P2(x,5)	r(x,5)	N(x,5)	l(x+5)/l(x)	l(x+5)/l(2.5)	l(x)/l(2.5)	5Lx/l(2.5)	T(x)	e(x)
0-4	7,445,058	10,857,274	0.02515	9,044,138	0.9902	1.0000	-	-	-	-
5-9	6,434,665	9,521,849	0.02613	7,877,695	1.0205	0.9902	0.9951	4.9885	53.9555	54.49
10-14	5,696,550	8,569,787	0.02723	7,035,658	1.0176	1.0105	1.0003	5.0493	48.9670	48.46
15-19	4,996,337	7,650,970	0.02841	6,229,670	1.0068	1.0283	1.0194	5.1278	43.9177	42.71
20-24	4,308,137	6,719,261	0.02963	5,424,685	0.9938	1.0352	1.0317	5.1593	38.7899	37.47
25-29	3,644,415	5,789,485	0.03086	4,634,507	0.9822	1.0288	1.0320	5.1291	33.6306	32.69
30-34	3,029,081	4,899,204	0.03205	3,889,498	0.9654	1.0105	1.0196	5.0316	28.5015	28.21
35-39	2,461,158	4,049,791	0.03320	3,189,813	0.9482	0.9755	0.9930	4.8582	23.4699	24.06
40-44	1,954,160	3,268,073	0.03428	2,555,058	0.9303	0.9250	0.9503	4.6077	18.6116	20.12
45-49	1,515,351	2,572,610	0.03528	1,997,565	0.8958	0.8606	0.8928	4.2714	14.0039	16.27
50-54	1,126,915	1,939,511	0.03620	1,496,626	0.8613	0.7709	0.8157	3.8330	9.7326	12.62
55-59	802,943	1,398,736	0.03700	1,073,423	0.7946	0.6640	0.7174	3.2830	5.8996	8.89
60-64	526,430	926,353	0.03768	707,657	0.7093	0.5276	0.5958	2.6166	2.6166	4.96
65-69	307,678	545,360	0.03816	415,243		0.3742	0.4509	-	-	-

Source: Author computations from the adjusted Nigeria Census datasets.