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Retrospective Assessment of Low Birth Weight in Nigeria Using Life Table

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Authors' contributions

This work was carried out in collaboration among all authors. Author COO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors COO, UCI, FUM, BO and BU managed the analyses of the study. Authors UCI, FUM, BO and BU managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study focuses on low-birth-weight (LBW) in Nigeria. The main objective is to obtain the life table probability of a mother giving birth to a low-birth-weight child, which may be relevant in assessing the progress of Sustainable Development Goals in Nigeria. The descriptive statistics and method of life table analysis were applied to the dataset on birth weights from the Nigeria Demographic and Health Surveys (NDHS), 1990 to 2013. The result shows that on average, there are approximately 13 LBWs per 1000 live births among mothers aged 25 to 29, which is the highest while the rates declined rapidly in the older ages. The prevalence rate of LBW obtained for the period is slightly below 8.0% (7.9). The incidence rate increased from 7.0% in 1990 NDHS to 10.2% in 2003 NDHS and declined to 7.3% in 2013 NDHS. The consequences of low-birth-weight among women of childbearing age are increasing neonatal and infant mortality rates, which may

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hinder the achievement of SDGs in Nigeria. We recommend that the government should encourage mothers to deliver their babies in the approved health care facilities to ensure weight measurement at birth.

Keywords: Descriptive; mother; life table; low-birth-weight; survey.

1. INTRODUCTION

Low-birth-weight is still high among women of childbearing age in developing countries, World Health Organization [1]. According to the United Nations Children's Fund and World Health Organization [2], LBW is defined as a baby weighing less than 2500 grams (or 5.5 pounds) at birth. LBW is a vital public health indicator although it is not a comprehensive measure of maternal or perinatal health outcomes. The incidence rate of LBW is the live births that weigh less than 2500 grams out of the total live births during the same period [3,2], while the prevalence rate represents the old and new cases of LBW out of the total live births during the same period.

Globally, 20 million LBW babies are born each year, of which 96.5% of them are in developing countries while the prevalence of LBW is about 15.5%, World Health Organization [1]. In another study, the overall prevalence of LBW in developing countries was 15.9%, Rashidul et al. [4]. Ademola et al. [5] observed that the overall incidence of LBW in the Ogun State, Nigeria from 1991 to 1999 was 16.8%. This study was in agreement with the study in Ibadan, Nigeria that covered 1995 to 2005 which put the incidence rate of LBW at 16.8%, Amosu et al. [6]. The prevalence of LBW in Jos, Nigeria was 12.7%, Yilgwan et al. [7]. The rate was slightly higher in Enugu, Southeast, Nigeria, with an incidence of LBW of 14.2% Ndu et al. [8].

Different studies in Nigeria have shown some factors associated with LBW. According to the study by Ekwochi e al. [9], they discovered that LBW infants are associated with prematurity, exposure to malaria, and recurrent apnoea. Ndu et al. [8] observed that the determinants of LBW are the mother's educational status, height, HIV status, hypertension in pregnancy, prim parity, and health problems during pregnancy. Other factors include twin pregnancy, the maternal weight of less than 70 kg, delayed conception, inadequate antenatal care, low body mass index, and socioeconomic status [10,4].

LBW contributes to a wide range of child health consequences. They include foetal and neonatal mortality, morbidity, infant mortality, inhibited growth, and chronic diseases later in life, WHO [11]. By 2030, one of the objectives of Sustainable Development Goals (especially Goal 3) is to reduce neonatal mortality to 12 per 1000 live births, under-5 mortality to 25 per 1000 live births, and premature mortality from non-communicable diseases by one-third, United Nations [12].

To this end, there is a need to estimate the probability of a mother giving birth to a LBW child in Nigeria using the life table, since LBW appears to be one of the barriers to the achievement of SDGs in Nigeria. To study demographic parameters and health indicators in Nigeria, the life table has been useful [13,14]. More recently, Adewara et al. [15] used a life table to estimate the work-life expectancy in Kwara state, Nigeria. They observed that both the average work-life and average years lived followed the same pattern. This study aims to carry out a retrospective assessment of low-birth-weight in Nigeria using Life Table. The ultimate objective of this study is to obtain the life table probability of a mother giving birth to a low-birth-weight child, which may be relevant in assessing the progress of SDGs in Nigeria. The specific objectives are: (i) to examine the trends of LBW in Nigeria; (ii) to assess the descriptive properties of reported LBWs in Nigeria; (iii) to obtain the incidence and prevalence rates of low-birth-weight in Nigeria.

2. METHOD AND DATA SOURCE

The data for this study is a secondary data retrieved from the DHS program publications for different years in Nigeria (2013, 2008, 2003 and 1990). First, the descriptive properties of the low-birth-weight derived from data on children with reported birth weights. UNICEF and WHO [2] gave a measure of the incidence of low-birth-weight as:

$$\frac{\text{Number of live born babies with birthweight less than 2,500g}}{\text{Number of live births}} \times 100 \quad (1)$$

However, the denominator (number of live births) in equation (1) for most developing countries is

not reliable or incomplete when available. For this study, the incidence of low-birth-weight expressed as

$$\frac{\text{Number of live born babies with birthweight less than 2,500g}}{\text{Total number of births with reported weights}} \times 100 \quad (2)$$

on the assumption that any birth with weight record is a live birth because it is rare for a mother in most developing countries to keep a record of a baby, she lost five or six years preceding the survey due to many factors such as psychological effect, superstitions, trauma, delivery of other babies, etc. Furthermore, the prevalence rate in this study is

$$\frac{\text{Sum of all(old and new) live born babies with birthweight less than 2,500g}}{\text{Total number of births with reported weights}} \times 100 \quad (3)$$

We converted the age-specific percentages of low-birth-weight into life table functions. The life table was used to study the life history of mothers aged 15-19 through 45-49 who are experiencing age-specific LBW, as their numbers are depleted by force of LBW. The life table probability that a mother aged *x* years gives a low birth weight child before reaching age *x* + *n* years is given by

$${}_n q_x = \frac{2n({}_n m_x)}{2 + n({}_n m_x)} \quad (4)$$

Consequently, given the total number of mothers without low birth weight child at the exact age *x* years (l_x), the total number of mothers reaching exact age *x* + *n* years (l_{x+n}) without low birth weight is given as

$$l_{x+n} = l_x\left(1 - {}_n q_x\right) \quad (5)$$

Thus, the total person-years lived without giving low birth weight child between exact ages x and x+ n is given as

$${}_n L_x = \frac{n}{2}(l_x + l_{x+n}) \quad (6)$$

The total person-years lived without giving low birth weight child beyond age x is

$$T_x = \sum_{i=x}^{\infty} {}_n L_i \quad (7)$$

And the average number of years (e_x) a mother aged *x*-years expects to live before having a low birth child is given by

$$e_x = \frac{T_x}{l_x} \quad (8)$$

2.1 Assumptions

In constructing the life table functions the following assumptions holds

a) Only women of child bearing age (15 – 49 years) are involved
b) The population consists of a cohort of 10,000 mothers aged 15 - 49 years (i.e. a radix of $l_{15} = 10000$)
c) Low-birth-weight are the only source of decrement and all mothers aged 15 years are assumed to have survived throughout the age interval 15 – 49
d) The cohort is closed to migration (in or out)
e) Low-birth-weight is uniformly distributed within the age interval *x* – *x+n*
f) Low birth weight is according to a pre-determined schedule of age–specific low-birth-weight rates
g) The age –specific rates of low-birth-weight are relatively stable.

3. RESULTS

The methods outlined in section 2 applied to data on LBW in Nigeria. Section 3.1 presents the trends of low-birth-weight in Nigeria while section 3.2 considers the descriptive properties of reported low-birth weights in Nigeria and section 3.3 is devoted to the life-table analysis of low birth weight in Nigeria.

3.1 Trends of Low Birth Weight in Nigeria

The incidence of LBW has increased over the years. Fig. 1 shows that North-West had the highest incidence of reported LBW from 0.3% in 1999 to 27.2% in 2013 followed by North-East (0.4% to 13.6%) respectively. The zones with the least incidence of LBW over the years were South West (4.0%) and South East (4.4%) respectively.

The urban-rural comparison shows that the reported incidence of low birth weight was lower in a rural area in 1999 and 2003 (0.8% vs. 0.8%) but increased significantly to 9.7% in 2008 and decreased slightly to 9.6% in 2013. Overall, low birth weight increased from 0.8% to 9.7% in rural areas while it increased from 2.3% to 7.6% in urban areas.

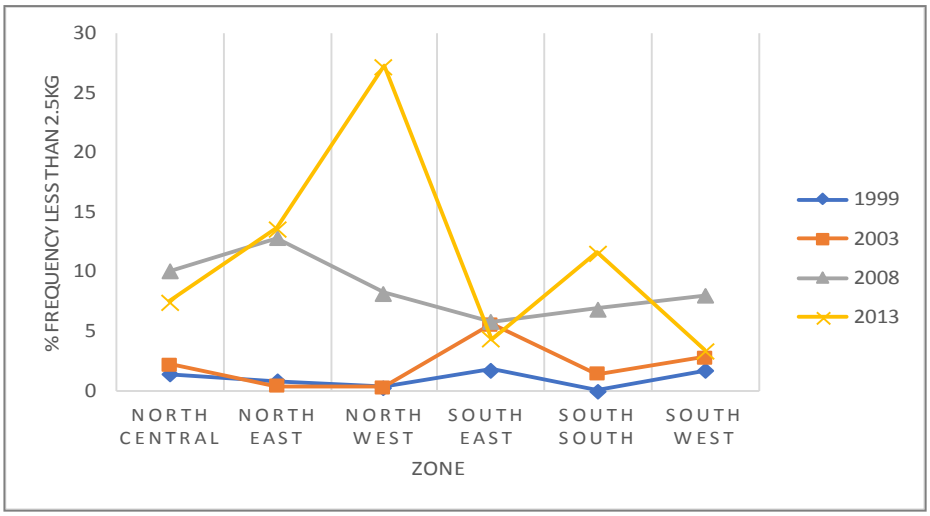

Fig. 1. Trends of low birth weight in Nigeria by zone

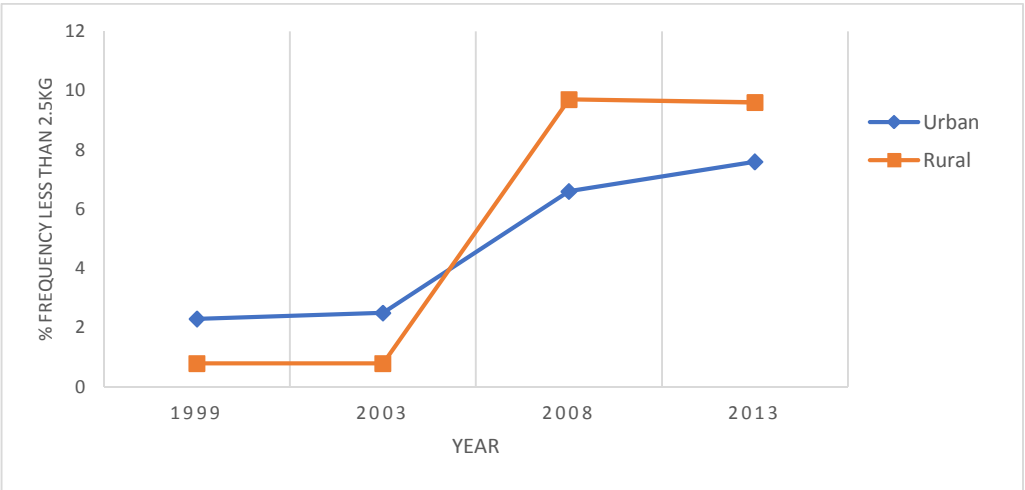

Fig. 2. Trends of low birth weight in Nigeria by residence

Table 1. Distribution of reported babies (less than 2.5 kg) by age of mother and year of survey

Age/year	2013	2008	2003	1990
15-19	13	5	2	1
20-24	58	53	11	19
25-29	115	112	27	22
30-34	103	96	23	15
35-39	64	51	12	5
40-44	20	27	7	6
45-49	4	7	3	2
Total (less than 2.5 kg)	377	351	85	70
Total (weighed at birth)	5189	4232	830	993
Incidence rate (%)	7.3	8.3	10.2	7.0
Prevalence rate (%)	(1990 to 2013)	7.9%		

Table 1 shows that the incidence rate increased from 7.0 in 1990 to 10.2 in 2003 dropped 8.3 in 2008 and declined further to 7.3 in 2013. The age group with the highest incidence of low birth

weight from 1990 to 2013 was 25-29 age groups (2.6%) followed by 30-34 age group (2.1%) while the oldest age group recorded about 0.1%.

3.2 Descriptive Characteristics of Reported Low Birth Weights (< 2.5 kg) in Nigeria

Table 2 shows, the mean rages from 1.9 kg to 2.0 kg for both sexes in all the surveys while the standard deviation dropped to 0.3 in 2013 from 0.5 in 1990 for both sexes. The skewness is negative in all the surveys indicating that the distributions of the data have a tail to the left. Overall, the mode is approximately 2.0 kg in all the surveys except for males in 2003 NDHS.

3.3 The Life-table Analysis of Low Birth Weight in Nigeria

Based on the assumptions in section 2, equation (1) through (6) applied to NDHS datasets on LBW. Table 2 shows the levels of probability that a mother aged x years gives a low birth weight ($_nq_x$) in Nigeria. At age groups, 25-29 and 30-34 the probabilities were high but dropped rapidly in the older ages may be due to the decline in fertility rate.

4. DISCUSSION

This study has discussed low-birth-weight (LBW) in Nigeria. The main objective is to obtain the probability of giving a low-birth-weight child, which may be relevant in assessing the progress of Sustainable Development Goals in Nigeria. The descriptive statistics and life table were applied to the dataset on birth weights from the Nigeria Demographic and Health Surveys (NDHS), 1990 to 2013. The result shows that on the average, there are approximately 13 LBWs per 1000 live births among mothers aged 25 to 29, which is the highest while the rates dropped rapidly in the older ages. The prevalence rate of LBW obtained for the period is slightly below 8% (7.9). The incidence rate increased from 7.0% in 1990 to 10.2% in 2003 and declined to 7.3% in 2013. We observed that North West had the highest incidence of LBW, ranging from 0.3% in 1999 NDHS to 27.2% in 2013 NDHS followed by North East (from 0.4% to 13.6%). The geo-political zones with the least incidence rate of LBW over the years were South West (4.0%) and South East (4.4%) respectively. By states, the incidence rates of LBW were not the same according to the 2013 NDHS. The states that may have contributed significantly to the difference in incidence rates are Niger State (14.2%) in North Central, Adamawa State (20.0%) in the Northeast, Kaduna (36.1%) in the North-West while in the South-South the state include Bayelsa (11.5%), Cross River (12.7%) and Rivers (17.5%) respectively. Every other State across the zones had LBW below (10.0%), National Population Commission, Federal Republic of Nigeria and ICF International [16]. The geo-political zones with a high incidence of LBWs are susceptible to violence due to militancy, insurgency and poverty, Uchechukwu et al. [17]. According to the National Population Commission et al. [16], only (16.0%) of babies were weighed at birth of which less than (8.0%) are reported as LBW. It is not surprising because a good number of births (63.0%) in 2013 NDHS did not take place in a health facility, National Population Commission et al. [16].

Table 2. Estimate of statistical properties of reported Low Birth Weights (< 2.5 kg)

Parameter/Sex	1990			2003			2008			2013		Both
	M	F	B	M	F	B	M	F	B	M	F	
Mean	1.9	1.9	1.9	1.9	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Median	2.0	2.0	2.0	2.1	2.2	2.1	2.0	2.0	2.0	2.1	2.0	2.0
Mode	2.0	2.0	2.0	2.3	2.0	2.4	2.0	2.0	2.0	2.0	2.0	2.0
Std.	0.4	0.5	0.5	0.6	0.4	0.5	0.4	0.3	0.3	0.3	0.3	0.3
Kurtosis	1.2	-0.1	0.3	0.3	2.2	1.3	5.9	5.2	5.4	3.7	4.9	4.5
Skewness	-1.1	-1.0	-1.1	-1.2	-1.7	-1.5	-2.3	-1.9	-2.1	-1.8	-1.8	-1.9
Range	1.6	1.8	1.8	1.9	1.7	1.9	1.9	1.9	1.9	1.8	1.5	1.8
Min	0.8	0.6	0.6	0.6	0.8	0.6	0.5	0.5	0.5	0.7	1.0	0.7
Max	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4

Note: M= Male, F= Female, B= Both sexes

Table 3. Levels of life table probability of giving a low-birth-weight ($_nq_x$) child in Nigeria

Age	2013	2008	2003	1990	Average	Average LBW per 1000 live births
15-19	0.0013	0.0006	0.0012	0.0005	0.0009	0.9
20-24	0.0056	0.0062	0.0066	0.0095	0.0070	7.0
25-29	0.0110	0.0132	0.0161	0.0110	0.0128	12.8
30-34	0.0099	0.0113	0.0138	0.0075	0.0106	10.6
35-39	0.0061	0.0060	0.0072	0.0025	0.0055	5.5
40-44	0.0019	0.0032	0.0042	0.0030	0.0031	3.1
45-49	0.0004	0.0008	0.0018	0.0010	0.0010	1.0

We observed that those with 'No Education' (15.2%)' had the highest reported LBW, National Population Commission et al. [16]. It appears there is an inverse relationship between LBW and the educational level of the mothers in all the surveys [18,19,20,21] because as wealth and educational level increases the incidence rate of LBW babies decreases, National Population Commission et al. [21]. The results further show that the most occurring LBW is 2.0 kg. For both sexes, the overall mean from the reported LBWs was below 2.04 kg in all the surveys while the standard deviation dropped to 0.3 kg in 2013 from 0.5 kg in 1990.

The prevalence rate of LBW (7.9%) obtained in this study is below the global estimate of 15.5% as of 2018 (www.who.int/maternal_child) [22]. However, while interpreting this result, it is worthy to note that only (16.0%) of babies were weighed at birth as of 2013 NDHS as mentioned above. Furthermore, there is still a wide difference in the incidence rate of low-birth-weight between advanced and emerging countries. In developing countries, the incidence rate of LBW on average is about 15% while their counterparts (developed countries) is about 7% Ramakrishnan [23]. The prevalence of LBW differs among countries in sub-Saharan Africa. In Ethiopia, the prevalence of LBW was about 28.3%, Assefa et al. [24] while in Nigeria five to six million babies suffer LBW every year, Olu Dunant et al. [25]. In Zimbabwe, according to Feresu et al. [26], there were 199 low-birth-weight infants per 1,000 live births. Furthermore, the study by Blencowe et al. [27] observed that the prevalence of LBW declined from 17·5% in 2000 to 14·6% in 2015 in the 148 countries included in the study. The results further show that the incidence rate of LBW is about 24% in sub-Saharan Africa, 91% for developing countries while 48% was observed in southern Asia, the highest rate in 2015. Again, these rates are higher than (7.9%) observed in Nigeria between 1990 and 2013.

For Nigeria to reduce the incidence and prevalence rates of LBW and the associated health consequences (foetal and neonatal mortality, morbidity, infant mortality, inhibited growth, etc.), more efforts and resources must be committed to addressing the determinants of LBW such as mothers' education, malnutrition, pre-natal, and health care services, Adam et al. [28].

5. CONCLUSION AND RECOMMENDATIONS

The prevalence rate (7.9%) of low-birth-weight obtained in this study for Nigeria between 1990 and 2013 using data from different rounds of Demographic and Health Surveys is below the global estimate of 15.5% as of 2018 by World Health Organization. The LBWs per 1000 live births obtained in this study is within the 2030 target of 25 or fewer deaths per 1000 live births for under-five mortality by the United Nations. Even at that, the reported number of babies weighed at birth is still poor in Nigeria according to 2013 NDHS, which means that the estimate for that country may have been under-reported or underestimated due to insufficient data. The zones in Nigeria that are prone to high poverty, militancy, terrorism, and insurgency appear to be contributing to the rate of the LBW in that country. Unless Nigeria Government improves the standard of living, girl child education, stamp out a rising level of militancy/terrorism, etc. the rate of LBW may not drop drastically.

We recommend that the government should encourage mothers to deliver their babies in the approved health care facilities to ensure weight measurement at birth. In addition, the government should strengthen the collaboration of the entire sister agencies in Nigeria to reduce LBW in that country. There should be synergy among the local, state, and federal agencies for effective data gathering, monitoring, and estimation of incidence and prevalence rates of LBW among others.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Appendix A: Life table of low birth weight in Nigeria, 1990-2013

NDHS 2013						
Age group	**$_nM_x$**	**$_nq_x$**	**l_x**	**$_nL_x$**	**T_x**	**e_x**
15-19	0.0003	0.0013	10000.0	49968.7	343006.0	34.30
20-24	0.0011	0.0056	9987.5	49798.3	293037.3	29.34
25-29	0.0022	0.0110	9931.8	49385.5	243239.1	24.49
30-34	0.0020	0.0099	9822.4	48869.3	193853.6	19.74
35-39	0.0012	0.0061	9725.4	48477.4	144984.2	14.91
40-44	0.0004	0.0019	9665.6	48281.4	96506.9	9.98
45-49	0.0001	0.0004	9647.0	48225.5	48225.5	5.00
			9643.2			
NDHS 2008						
Age group	**$_nM_x$**	**$_nq_x$**	**l_x**	**$_nL_x$**	**T_x**	**e_x**
15-19	0.00012	0.00059	10000.0	49985.2	342242.8	34.22
20-24	0.00125	0.00624	9994.1	49814.5	292257.6	29.24
25-29	0.00265	0.01315	9931.7	49332.1	242443.1	24.41
30-34	0.00227	0.01128	9801.2	48729.4	193111.0	19.70
35-39	0.00121	0.00601	9690.6	48307.5	144381.5	14.90
40-44	0.00064	0.00318	9632.4	48085.3	96074.0	9.97
45-49	0.00017	0.00083	9601.7	47988.7	47988.7	5.00
				9593.8		
NDHS 2003						
Age group	**$_nM_x$**	**$_nq_x$**	**l_x**	**$_nL_x$**	**T_x**	**e_x**
15-19	0.00024	0.00120	10000.0	49969.9	340630.6	34.06
20-24	0.00133	0.00660	9988.0	49774.9	290660.8	29.10
25-29	0.00325	0.01613	9922.0	49209.8	240885.9	24.28
30-34	0.00277	0.01376	9761.9	48473.7	191676.1	19.64
35-39	0.00145	0.00720	9627.6	47964.6	143202.4	14.87
40-44	0.00084	0.00421	9558.2	47690.7	95237.8	9.96
45-49	0.00036	0.00181	9518.0	47547.1	47547.1	5.00
				9500.8		
NDHS 1990						
Age group	**$_nM_x$**	**$_nq_x$**	**l_x**	**$_nL_x$**	**T_x**	**e_x**
15-19	0.00010	0.00050	10000.0	49987.4	342927.2	34.29
20-24	0.00191	0.00952	9995.0	49736.9	292939.8	29.31
25-29	0.00222	0.01102	9899.8	49226.3	243202.9	24.57
30-34	0.00151	0.00752	9790.7	48769.5	193976.5	19.81
35-39	0.00050	0.00251	9717.1	48524.3	145207.0	14.94
40-44	0.00060	0.00302	9692.6	48390.1	96682.7	9.97
45-49	0.00020	0.00101	9663.4	48292.7	48292.7	5.00
			9653.7			

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