**Futo Journal Series (FUTOJNLS)**
e-ISSN :2476-8456 p-ISSN : 2467-8325
Volume-2, Issue-1, pp- 205 - 217
www.futojnls.org

Research Paper July 2016

# Levels, Trend and Age Pattern of Under-Five Mortality in Nigeria: Evidence from NDHS Data

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## Abstract

*This study has discussed the levels, trend and age-pattern of under-five mortality in Nigeria. The aim is to provide information that could be used to determine future health and population policy directions, targets and implementation strategies. The Trussell variant of the original Brass method was used to derive estimates of the under-five mortality from the reported proportions of children dead among children ever born in the most recent surveys in Nigeria, while comparing them with results from previous surveys and data from some selected countries of the world. The results of the analyses indicate that the age pattern implied in the 2003, 2008 and 2013 NDHS data is the pattern in the North family of the Coale-Demeny model life tables. Estimate of under-five mortality index ( ${}_5q_0$ ) is about 0.1481 from this family. The North family has therefore, been recommended for calculation of estimates of demographic parameters for Nigeria until other results prove otherwise.*

**Keywords**: *Age pattern, indirect technique Under-five, mortality level, and mortality trend.*

## 1.0. Introduction

Mortality, as one of the components of population change, plays an important role in determining the growth rates, age structure and in assessment of quality of health care delivery of a population. Information on mortality levels and trend forms an indispensable part of population projections and estimation of other demographic parameters necessary for development plans, determining housing, educational, health and social needs of a population. It is also essential for disease control, evaluation of public health programmes, determining policy guidelines and actions needed to improve public health.

The incidence of death has been shown to vary with age. Results of many studies have shown that a wide range of death rates are found at ages less than five years. In developing countries, about half of all deaths occur among children of pre-school age (UN, 1973 and PRB, 2001)). The highest rates of under-five mortality are found mostly in sub-Saharan Africa where one in every nine (9) children dies before age five.

This rate is more than 16 times the average (1 in 152 children) for developed region of the World (UN, 2012). This emphasizes the need for this study.

Under-five mortality is conditioned by biological, political, social factors and culturally defined behaviour and attitude which characterized the stage of the development of a country. Among the factors which are associated with reduction in under-five mortality are adequate and access to medical/health, social services for pregnant women and newborns, immunization, improved feeding and environmental conditions and improved level of education of mothers. On the other hand, factors that contribute to early childbearing (especially by women under 18 years), late child bearing (especially by women aged 50 years+), preterm/low birth weight, intra-partum-related complications, pneumonia, diarrhea, respiratory disease syndrome, congenital anomalies, diseases/infections and malaria, poor feeding and environmental conditions and illiteracy among mothers. [Moser *et al*, 2005; Fenn *et al*, 2007; Gwantkin *et al*, 2007; Nwogu, 2004)].

Being conscious of these factors, efforts have been made globally and in Nigeria in particular to address under-five mortality by governments, agencies, organizations and individuals. A lot of resources are being committed to health care delivery, awareness and education, provision of facilities to improve environmental conditions, immunization and disease control, to mention but a few. In 2012, the Nigerian government launched the "Saving One Million Lives by 2015"**.** This was an ambitious initiative to expand access to essential primary health services to women and children, providing telephone lines to health workers, equipment to prevent mother-to-child HIV transmission, and provision of mosquito bed nets and other life-saving tools (M DG, 2013; UN, 2014). All these and more are also embedded in millennium Development Goals (MDGs).

With these efforts, there has been an overall improvement globally in the level and trend of under-five mortality. The number of under-five deaths worldwide has declined from about 12 million in 1990 to about 6.9 million in 2011, which translates to a reduction of about 14,000 children dying every day between 2011 and1990.

However, while there is clear evidence that under-five is declining in the developed and some developing countries of the world, the same cannot be said about most sub-Saharan African countries in general and Nigeria in particular. Available evidence from the PRB (2001: 2013) indicates that infant mortality rate increased from about 75 per 1000 in 2001 to about 97 per 1000 in 2013. Using the Brass (1964) method, Nwogu (1998: 2004) observed that under-five mortality increased from about 148 per 1000 in 1981/82 NFS data to about 224 per 1000 in the 2003 NDHS.

Therefore, the main objective of this study is to examine the levels of under-five mortality implied by the 2003, 2008 and 2013 Nigeria Demographic and Health Survey (NDHS) data which may be useful in formulation, implementation and monitoring of maternal and child health care delivery in the country. Specifically, the study (i) calculated estimates of under-five mortality from the 2003, 2008 and 2013 NDHS data, while comparing them with evidence from other countries of the world., (ii) determined the appropriate pattern(s) of the Coale-Demeny model life table that best describes the mortality pattern(s) in the study data and (iii) discussed the trend of the under-five mortality by comparing the results of the current study with results from the previous studies in the country. Based on the results recommendations are made.

## 2.0. Methodology

The Trussell (UN (1983)) variant of the original Brass (1964) method was used to obtain the estimates of under-five mortality from the proportions of children dead (CD) among children ever born (CEB) in the 2003, 2008 and 2013 NDHS. This method was adopted because of the defective nature and poor quality of the data as well as to allow for comparison with the result of previous NDHS.

The Brass model for estimation of probabilities of dying between birth and exact age j ($_jq_0$) is given by

$$_jq_0 = k(i)D(i), \quad (j=1, 2, 3, 5, 10, 15 \text{and } 20) \qquad 1$$

where for the $i^{th}(i = 1, 2, \ldots 7)$ age group of mothers

$$D(i) = \frac{CD(i)}{CEB(i)} \qquad 2$$

is the proportion of children dead [CD(i)] among children ever born [CEB(i)].

$$k(i) = a_i + b_i\left(\frac{P_1}{P_2}\right) + c_i\left(\frac{P_2}{P_3}\right) \qquad 3$$

is the multiplier used to convert the proportions of children dead (D (i)) to life table probabilities of dying ($_jq_0$) between ages zero and $j, P_i, (i = 1, 2, 3)$ are the mean parities of women in the age groups 15-19, 20-24 and 25-29 and $a_i, b_i$ and $c_i$ are the Trussell [UN (1983)] variant coefficients used in determining the multipliers [$k(i)$].

The life table probabilities of surviving to exact age j from birth ($l_j$) corresponding to $_jq_0$ are obtained from the Coale-Demeny (1983) by subtraction as

$$l_j = 1 - {}_jq_0 \qquad 4$$

Using the $l_j$, the mortality levels and expectation of life at birth ($e_0$) implied by $_jq_0$ are obtained from the Coale-Demeny (1964 ) model life tables by interpolation.

The periods, $T_i$, (i.e. number of years before the survey), to which $_jq_0$ refer are estimated using the expression,

$$T_i = a'_i + b'_i\left(\frac{P_1}{P_2}\right) + c'_i\left(\frac{P_2}{P_3}\right) \qquad 5$$

where $a'_i, b'_i$ and $c'_i$ are the Trussell [UN (1983)] variant coefficients used in determining the reference periods.

The Brass (1964) method assumes that fertility and mortality in the study population have remained constant in the years preceding the surveys. This assumption is not likely to be true in recent times in most developing countries. Hence, the Trussell variant coefficients ($a_i, b_i$ and $c_i$) and ($a'_i, b'_i$ and $c'_i$) of the original Brass (1964) were used to determine $k(i)$ and $T_i$ respectively because the variant has been shown to be robust for moderate changes in fertility [Venkatacharya (1989)]. It is also assumed that the age pattern of mortality of the study population agrees with one of the patterns of the Coale-Demeny (1983) model life tables.

To choose the appropriate pattern of the Coale-Demeny (1983) that best describes the pattern in the study data the methods of Minimum Range of $e_0$ implied by $_jq_0$, $j = 2,3$ and $5$ and the Minimum Mean

Absolute Deviations (MAD) of the expected $(D^s(i))$ from the observed $(D(i))$ proportions of children dead proposed by Teklu (1989) was used. To apply the method of Minimum Mean Absolute Deviations (MAD), the expected proportions of children dead are determined from the live tables using either ${}_2q_0$, ${}_3q_0$ or ${}_5q_0$ as entry parameter. From the mortality level implied by the selected entry parameter, the probabilities of surviving to exact age j from birth ($l_j^s$) are selected and used to determine the expected probabilities of dying as

$$ {}_jq_0^s = 1 - l_j^s \qquad 6$$

Hence, the expected proportions of children dead $(D^s(i))$ are given by

$$D^s(i) = \frac{{}_jq_0^s}{k(i)} \qquad 7$$

The estimates of the life table probabilities of dying ($_jq_o$) and their implied mortality levels and $e_0$ were used to discuss the levels and trend of mortality.

## 3.0. Estimation of Levels, Age Pattern and Trend of Under-Five Mortality from the 2003, 2008 and 2013 NDHS.

This section is devoted to estimation of levels and choice of appropriate age pattern of under-five mortality that best describes the 2003, 2008 and 2013 NDHS data and trend of under-five mortality in Nigeria.

### 3.1. Estimation of Levels and Choice of Appropriate Age Pattern of Mortality.

The result of the application of the Trussell variant of the Brass method to estimate under-five mortality from the 2003, 2008 and 2013 NDHS data are presented in Tables 1 through 3.3 respectively for the four families of the Coale – Demeny (1983) model life tables. As Table 1 shows, the index of infant mortality (${}_1q_0$) for the 2003 NDHS, ranges from about 122.2 per 1000 live births in the South to about141.3 per 1000 live births in the East families, the index of childhood mortality (${}_4q_1$) ranges from about 95.7 per 1000 live births in the East to about 120.5 per 1000 live births in the South families, while the index of mortality among children under five years (${}_5q_0$) ranges from about 222.1 per 1000 live births in the North to about 228 per 1000 live births in the South models. For the 2008 NDHS the index of infant mortality (${}_1q_0$) ranges from about 79.5 per 1000 live births in the South to about 87.6 per 1000 live births in the East families. The index of childhood mortality (${}_4q_1$) ranges from about 98.1 per 1000 live births in the East to about 108.9 per 1000 live births in the South families, while the index of mortality among children under five years (${}_5q_0$) ranges from about 173.9 per 1000 live births in the North to about 179.7 per 1000 live births in the South models.

For the 2013 NDHS data in Table 3 shows that the index of infant mortality (${}_1q_0$) ranges from about 92.0 per 1000 live births in the South to about 99.6 per 1000 live births in the East families. The index of childhood mortality (${}_4q_1$) ranges from about 57.0 per 1000 live births in the East to about 67.3 per 1000 live births in the South families, while the index of mortality among children under five years (${}_5q_0$) ranges from about 148.1 per 1000 live births in the North to about 153.1 per 1000 live births in the South models.

In the three surveys, it is clear that the three mortality indices are not the same for the four families. Therefore, we need to identify the family which best describes the situation in the study data. Tables 1 through 3.3 show the result of the application of methods of minimum range of expectation of life at birth ( $e_0$) , while Tables 3.4 through 3.6 show the application of method of mean absolute deviations of expected ( $D_s(i)$ ) from the observed ( $D(i)$ ) proportions of children dead in the 2003, 2008 and 2013 NDHS data. As the Tables show, the choice is based on ${}_jq_0$ (j = 2, 3, 5) because of the problem of high estimate of ${}_1q_0$ as reported by many researchers, (UN (1983), Kpedekpo (1982), Venkatacharya (1989), Yohannes (1990) and Tamen (1992)) who attribute it to inconsistencies in the reports by mothers aged 15-19 years. As a consequence, Kpedekpo (1982) and Venkatacharya (1989) advised that estimates of infant mortality derived from reports by women aged 15-19 years should not be regarded seriously because of the basic weakness of the method of estimation at this point.

For the 2003 NDHS, Table 1 shows that the range of $e_0$ implied by ${}_jq_0$ (j = 2, 3, 5) is least in the West family (with about 1.82 years), followed closely by the North family with about 1.84 years. However, the mean absolute deviation of $D_s(i)$ from D(i) shown in Table 4 is minimum (with about 3.7) in the North Family. These suggest that the age pattern of mortality implied by 2003 NDHS data may best be described by the North Family of the Coale-Demeny life table. For the 2008 NDHS data, Table 2 shows that the range of $e_0$ implied by ${}_jq_0$, $j = 2,3$ and $5$ is least in the East family (with about 2.13 years), while Table 5 shows that the mean absolute deviation of $D_s(i)$ from $D(i)$ is also minimum (with about 6.2) in the East and West families. Thus, the age pattern of mortality implied by the 2008 NDHS data may best be described by the pattern in the East family of the Coale-Demeny model life tables.

From Table 3 the range of $e_0$ implied by ${}_jq_0$, $j = 2,3$ and $5$ computed from the 2013 NDHS data is least in the North family (with about 0.49 years) while Table 5 shows that the mean absolute deviation of $D_s(i)$ from $D(i)$ is minimum in North family as well with about 0.14%. These results suggest that the age pattern of mortality in the 2013 NDHS data is best described by the North family of the Coale-Demeny model life tables. Previous studies by Nwogu (1998 and 2004) have shown that the East family best describes the mortality pattern implied by the 1981/82 NFS data, the 1999 NDHS and 1991 PES data, while the mortality pattern implied by the 1990 NDHS data is best described by the North family. The East pattern, it could be recalled, is characterized by high infant mortality rate and increasingly high mortality at older ages (50 years and above), while the North family is characterized by high child mortality, relatively low infant mortality, low old age mortality especially at age above 60 and relatively high adult mortality between 40- 60 years.

**Table 1: Estimation of Infant and Childhood Mortality implied by the 2003 NDHS data**

| Age Group | j | Mean No. of Children Ever-Born $CEB(i)$ | Dead $CD(i)$ | Proportion of children Dead $D(i)$ | North | | | | | South | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $k(i)$ | ${}_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ | $k(i)$ | ${}_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ |
| 15-19 | 1 | 0.26 | 0.04 | 0.1538 | 0.8328 | 0.1281 | 0.8719 | 11.94 | 45.70 | 0.7948 | 0.1222 | 0.8778 | 14.61 | 52.50 |
| 20-24 | 2 | 1.18 | 0.21 | 0.1780 | 0.9695 | 0.1726 | 0.8274 | 11.48 | 44.56 | 1.0181 | 0.1812 | 0.8188 | 13.23 | 49.19 |
| 25-29 | 3 | 2.74 | 0.51 | 0.1861 | 0.9756 | 0.1816 | 0.8184 | 12.22 | 46.40 | 1.0385 | 0.1933 | 0.8067 | 13.71 | 50.36 |
| 30-34 | 5 | 4.35 | 0.94 | 0.2161 | 1.0279 | 0.2221 | 0.7779 | 11.69 | 45.08 | 1.0552 | 0.228 | 0.772 | 12.82 | 48.24 |
| 35-39 | 10 | 5.93 | 1.39 | 0.2344 | 1.0979 | 0.2574 | 0.7426 | 11.67 | 45.03 | 1.0758 | 0.2522 | 0.7478 | 12.55 | 47.60 |
| 40-44 | 15 | 6.62 | 1.71 | 0.2583 | 1.0821 | 0.2795 | 0.7205 | 11.50 | 44.61 | 1.0524 | 0.2718 | 0.7282 | 12.16 | 46.68 |
| 45-49 | 20 | 7.03 | 1.98 | 0.2817 | 1.0549 | 0.2972 | 0.7028 | | | 1.0355 | 0.2917 | 0.7083 | | |
| | | | | | | | | Range | 1.84 | | | | Range | 2.12 |

| | East | | | | | West | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $k(i)$ | ${}_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ | $k(i)$ | ${}_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ |
| | 0.9189 | 0.1413 | 0.8587 | 14.22 | 51.28 | 0.8749 | 0.1346 | 0.8654 | 12.62 | 47.56 |
| | 1.0316 | 0.1836 | 0.8164 | 13.37 | 49.25 | 1.0241 | 0.1823 | 0.8177 | 11.89 | 45.72 |
| | 1.0223 | 0.1902 | 0.8098 | 13.61 | 49.81 | 1.0191 | 0.1897 | 0.8103 | 12.31 | 46.78 |
| | 1.0341 | 0.2235 | 0.7765 | 12.76 | 47.75 | 1.0396 | 0.2247 | 0.7753 | 11.58 | 44.96 |
| | 1.0583 | 0.2481 | 0.7519 | 12.46 | 47.03 | 1.0626 | 0.2491 | 0.7509 | 11.38 | 44.46 |
| | 1.0423 | 0.2692 | 0.7308 | 12.03 | 46.00 | 1.0522 | 0.2718 | 0.7282 | 11.06 | 43.68 |
| | 1.0314 | 0.2905 | 0.7095 | | | 1.0432 | 0.2939 | 0.7061 | | |
| | | | | Range | 2.06 | | | | Range | 1.82 |

**Table 2: Estimation of Infant and Childhood Mortality implied by the 2008 NDHS data**

| Age Group | j | Mean No. of Children Ever-Born $CEB(i)$ | Dead $CD(i)$ | Proportion of children Dead $D(i)$ | North $k(i)$ | $_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ | South $k(i)$ | $_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1 | 0.23 | 0.02 | 0.0870 | 0.9491 | 0.0826 | 0.9174 | 15.98 | 55.09 | 0.9138 | 0.0795 | 0.9205 | 19.23 | 63.67 |
| 20-24 | 2 | 1.19 | 0.18 | 0.1513 | 0.9762 | 0.1477 | 0.8523 | 12.95 | 48.21 | 1.0218 | 0.1546 | 0.8454 | 14.95 | 53.30 |
| 25-29 | 3 | 2.51 | 0.37 | 0.1474 | 0.9521 | 0.1403 | 0.8597 | 14.47 | 51.91 | 1.0157 | 0.1497 | 0.8503 | 16.21 | 56.29 |
| 30-34 | 5 | 3.95 | 0.69 | 0.1747 | 0.9952 | 0.1739 | 0.8261 | 13.86 | 50.42 | 1.0286 | 0.1797 | 0.8203 | 15.21 | 53.92 |
| 35-39 | 10 | 5.26 | 1.00 | 0.1901 | 1.0609 | 0.2017 | 0.7983 | 13.85 | 50.40 | 1.0486 | 0.1993 | 0.8007 | 14.88 | 53.14 |
| 40-44 | 15 | 6.17 | 1.27 | 0.2058 | 1.0469 | 0.2155 | 0.7845 | 13.88 | 50.47 | 1.0271 | 0.2114 | 0.7886 | 14.69 | 52.69 |
| 45-49 | 20 | 6.86 | 1.64 | 0.2391 | 1.0254 | 0.2452 | 0.7548 | 13.41 | 49.33 | 1.0131 | 0.2422 | 0.7578 | 13.91 | 50.84 |
| | | | | | | | | Range | 3.70 | | | | Range | 2.99 |

| | East $k(i)$ | $_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ | West $k(i)$ | $_jq_0 = D(i)k(i)$ | $l_j = 1 - {}_jq_0$ | LVL | $e_0$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0071 | 0.0876 | 0.9124 | 17.82 | 59.98 | 0.9815 | 0.0854 | 0.9146 | 16.41 | 56.78 |
| | 1.0335 | 0.1564 | 0.8436 | 14.74 | 52.53 | 1.0273 | 0.1554 | 0.8446 | 13.29 | 49.25 |
| | 1.0056 | 0.1482 | 0.8518 | 15.61 | 54.64 | 0.9993 | 0.1473 | 0.8527 | 14.39 | 51.94 |
| | 1.0136 | 0.1771 | 0.8229 | 14.73 | 52.51 | 1.0147 | 0.1773 | 0.8227 | 13.60 | 50.02 |
| | 1.0363 | 0.1970 | 0.8030 | 14.45 | 51.83 | 1.0350 | 0.1967 | 0.8033 | 13.46 | 49.67 |
| | 1.0205 | 0.2100 | 0.7900 | 14.25 | 51.35 | 1.0236 | 0.2106 | 0.7894 | 13.38 | 49.47 |
| | 1.0108 | 0.2417 | 0.7583 | 13.54 | 49.64 | 1.0153 | 0.2428 | 0.7572 | 12.83 | 48.10 |
| | | | | Range | 2.13 | | | | Range | 2.6 |

**Table 3: Estimation of Infant and Childhood Mortality implied by 2013 NDHS**

| Age Group | i | j | Mean No of children Ever Born | Dead CD(i) | Proportion of children Dead D(i) | North K(i) | ${}_jq_o$ = D(i)K(i) | $l_j$ = $1-{}_jq_o$ | Level | $e_o$ | South K(i) | ${}_jq_o$ = D(i)K(i) | $l_j$ = $1-{}_jq_o$ | Level | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15-19 | 1 | 1 | 0.21 | 0.02 | 0.0952 | 0.9995 | 0.0952 | 0.9048 | 14.79 | 52.68 | 0.9655 | 0.0920 | 0.9080 | 17.96 | 58.06 |
| 20-24 | 2 | 2 | 1.21 | 0.14 | 0.1157 | 0.9921 | 0.1148 | 0.8852 | 15.12 | 53.51 | 1.0366 | 0.1199 | 0.8801 | 17.38 | 56.69 |
| 25-29 | 3 | 3 | 2.6 | 0.36 | 0.1385 | 0.9558 | 0.1323 | 0.8677 | 14.94 | 53.05 | 1.0182 | 0.1410 | 0.8590 | 16.74 | 55.17 |
| 30-34 | 4 | 5 | 3.96 | 0.59 | 0.1499 | 0.9941 | 0.1481 | 0.8519 | 15.14 | 53.55 | 1.0273 | 0.1531 | 0.8469 | 16.63 | 54.91 |
| 35-39 | 5 | 10 | 5.25 | 0.86 | 0.1638 | 1.0576 | 0.1733 | 0.8268 | 15.06 | 53.35 | 1.0461 | 0.1714 | 0.8286 | 16.21 | 53.92 |
| 40-44 | 6 | 15 | 5.9 | 1.08 | 0.1831 | 1.0434 | 0.1910 | 0.8090 | 14.87 | 52.87 | 1.0246 | 0.1875 | 0.8125 | 15.76 | 52.86 |
| 45-49 | 7 | 20 | 6.76 | 1.56 | 0.2308 | 1.6173 | 0.3738 | 0.6268 | | | 1.0111 | 0.2337 | 0.7663 | | |
| | | | | | | | | | Range | 0.50 | | | | Range | 1.78 |

| East K(i) | ${}_jq_o$ = D(i)K(i) | $l_j$ = $1-{}_jq_o$ | Level | $e_o$ | West K(i) | ${}_jq_o$ = D(i)K(i) | $l_j$ = $1-{}_jq_o$ | Level | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|
| 1.0463 | 0.0996 | 0.9004 | 16.96 | 58.06 | 1.0283 | 0.0979 | 0.9021 | 15.37 | 54.30 |
| 1.0440 | 0.1208 | 0.8792 | 16.65 | 57.32 | 1.0402 | 0.1204 | 0.8796 | 15.33 | 54.20 |
| 1.0075 | 0.1395 | 0.8605 | 16.04 | 55.89 | 1.0017 | 0.1387 | 0.8613 | 14.86 | 53.05 |
| 1.0131 | 0.1509 | 0.8491 | 15.91 | 55.59 | 1.0146 | 0.1512 | 0.8488 | 14.84 | 53.01 |
| 1.0344 | 0.1694 | 0.8306 | 15.60 | 54.84 | 1.0328 | 0.1692 | 0.8308 | 14.64 | 52.54 |
| 1.0184 | 0.1864 | 0.8136 | 15.19 | 53.88 | 1.0210 | 0.1869 | 0.8131 | 14.33 | 51.82 |
| 1.0090 | 0.2332 | 0.7668 | | | 1.0129 | 0.2341 | 0.7659 | | |
| | | | Range | 1.73 | | | | Range | 1.19 |

**Table 4: Calculation of the Mean Absolute Deviations of $D_s(i)$ from $D(i)$ in the 2003 NDHS data. (Entry Parameter = ${}_5q_0$)**

| Family | Proportion of Children Dead | Age of Mother 20-24 | 25-29 | 30-34 | 35-39 | MAD ($^0/_{00}$) |
|---|---|---|---|---|---|---|
| | Observed: $D(i)$ | 0.1780 | 0.1861 | 0.2161 | 0.2344 | |
| | Expected $D^s(i)$ | 0.1743 | 0.1967 | 0.2161 | 0.2339 | |
| North | $\lvert D(i)-D^s(i)\rvert$ | 0.0037 | 0.0106 | 0.0000 | 0.0005 | 3.7 |
| | Expected: $D^s(i)$ | 0.1843 | 0.2020 | 0.2162 | 0.2284 | |
| South | $\lvert D(i)-D^s(i)\rvert$ | 0.0063 | 0.0159 | 0.0001 | 0.0060 | 7.1 |
| | Expected: $D^s(i)$ | 0.1904 | 0.2047 | 0.2162 | 0.2268 | |
| East | $\lvert D(i)-D^s(i)\rvert$ | 0.0124 | 0.0186 | 0.0001 | 0.0001 | 9.7 |
| | Expected: $D^s(i)$ | 0.1839 | 0.2015 | 0.2160 | 0.2296 | |
| West | $\lvert D(i)-D^s(i)\rvert$ | 0.0059 | 0.0154 | 0.0001 | 0.0048 | 6.5 |

**Table 5: Calculation of the Mean Absolute Deviations of $D_s(i)$ from $D(i)$ in the** 2008 NDHS data. (Entry Parameter = $_5q_0$)

| | **Proportion of Children Dead** | **Age of Mother** 20-24 | 25-29 | 30-34 | 35-39 | |
|---|---|---|---|---|---|---|
| Family | Observed: $D(i)$ | 0.1513 | 0.1474 | 0.1747 | 0.1901 | MAD (%) |
| North | Expected $D^s(i)$ | 0.13689 | 0.1586 | 0.1748 | 0.1899 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0144 | 0.0112 | 0.0001 | 0.0002 | 6.475 |
| South | Expected: $D^s(i)$ | 0.1476 | 0.1640 | 0.1746 | 0.1833 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0037 | 0.0166 | 0.0001 | 0.0068 | 6.800 |
| East | Expected: $D^s(i)$ | 0.1515 | 0.1654 | 0.1747 | 0.1835 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0002 | 0.0180 | 0.0000 | 0.0066 | 6.200 |
| West | Expected: $D^s(i)$ | 0.1454 | 0.1627 | 0.1747 | 0.1867 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0059 | 0.0153 | 0.0000 | 0.0034 | 6.200 |

**Table 6: Calculation of the Mean Absolute Deviations of $D_s(i)$ from $D(i)$ in the 2013 NDHS data. (Entry Parameter = $_5q_0$)**

| | **Proportion of Children Dead** | **Age of Mother** 20-24 | 25-29 | 30-34 | 35-39 | |
|---|---|---|---|---|---|---|
| Family | Observed: D(i) | 0.1157 | 0.1385 | 0.1490 | 0.1638 | MAD (%) |
| North | Expected: $D^s(i)$ | 0.1154 | 0.1349 | 0.1490 | 0.1621 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0003 | 0.0036 | 0.0000 | 0.0017 | 0.140 |
| South | Expected: $D^s(i)$ | 0.1258 | 0.1402 | 0.1490 | 0.1557 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0101 | 0.0018 | 0.0000 | 0.0081 | 0.500 |
| East | Expected: $D^s(i)$ | 0.1284 | 0.1410 | 0.1490 | 0.1566 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0127 | 0.0026 | 0.0000 | 0.0072 | 0.563 |
| West | Expected: $D^s(i)$ | 0.1234 | 0.1393 | 0.1489 | 0.1596 | |
| | $\lvert D(i)-D^s(i)\rvert$ | 0.0077 | 0.0008 | 0.0000 | 0.0042 | 0.318 |

From the results of the analysis, it is clear that the choice of appropriate age pattern of mortality for Nigeria lies between the North and East families of the Coale-Demeny model life tables. However, if we ignore the unusually high mortality level implied by the $_2q_0$, it is clear that the appropriate age pattern of mortality implied by the 2008 NDHS is also the North family. Therefore, further discussions in this study will be based on the North family of the Coale-Demeny model life tables.

### 3.2 Levels and Trend of Under-Five Mortality in Nigeria

The estimates of under-five mortality ($_5q_0$), their implied mortality levels, expectations of life at birth ($e_0$) and reference period for the North family in the current and previous surveys in the country are shown in Table 3.7. As Table 7 shows, the value of under-five mortality in Nigeria from the most recent survey (2013 NDHS) is about 0.1481. This indicates that given the prevailing circumstances, the probability a new born will survive to celebrate the fifth birthday is about 0.8519. The corresponding mortality level (15.14) and expectation of life at birth (53.55 years) refer to about 6.14 years before the 2013 survey, (i.e., between December, 2006 and January, 2007 since the survey was conducted between February and May 2013).

The index of the under-five mortality ($_5q_0$) for the three recent surveys indicate that mortality levels may be declining. The value of $_5q_0$ declined from about 0.2221 in 2003 to about 0.1481 in 2013. The corresponding mortality level declined from 11.69 in 2003 to 15.14 in 2013, while the implied expectation of life at birth increased from about 45.08 years in the 2003 NDHS to about 53.55 years in 2013 NDHS. Adetoro and Amoo (2014) observed that under-five mortality in Nigeria increased from 138 per 1,000 live births in 2007 to 158 per 1,000 live births in 2011 against the Millennium development.

**Table 7: Estimate of Under-Five Mortality ($_5q_0$), their implied age pattern and levels of mortality and expectation of life at birth ($e_0$) by year in the North family.**

| Year/Source | Under-Five Mortality | Implied Level | Implied $e_0$ | Reference Period (T) |
|---|---|---|---|---|
| 1981/82 NFS | 0.1429 | 15.41 | 54.25 | 7.00 |
| 1990 NDHS | 0.1968 | 12.80 | 47.87 | 6.09 |
| 1999 NDHS | 0.1398 | 15.57 | 54.61 | 5.88 |
| 2003 NDHS | 0.2221 | 11.69 | 45.08 | 5.74 |
| 2008 NDHS | 0.1739 | 13.86 | 50.42 | 6.19 |
| 2013 NDHS | 0.1481 | 15.14 | 53.55 | 6.14 |

When compared with the results of the surveys before 2003 NDHS, there appears to be no definite pattern in the variation of $_5q_0$ (and hence in the corresponding mortality level and expectation of life at birth) over the years. The values of $_5q_0$ observed in the 1990 NDHS appear to be higher than those of the 1981/82 NFS and 1999 NDHS. Furthermore, the relatively low values of $_5q_0$ for the 1999 NDHS may be more due to under-reporting of proportion of children dead among children ever born. It could be recalled that the Brass (1964) method, used in this study, assumes that fertility and mortality have remained constant before the surveys, which may not be true for Nigeria within the period under consideration (1981/82 to 2013). However, the problem may be more due to poor data quality than violation of the underlying assumptions of the method. The Trussell variant of the original Brass (1964) method used is only robust to moderate changes in mortality and fertility and not to differences in data quality.

## 4.0 Conclusion

This study has examined the levels; age-pattern and trend of under-five mortality implied by the 2003, 2008 and 2013 NDHS data while comparing them with the previous surveys (1981/82 NFS, 1990 NDHS and 1999 NDHS). The aim is to provide information that could be used to assess the impact of the measures already taken to address the problem of under-five mortality in Nigeria and determine future health and population policy directions, targets and implementation strategies. The Trussell variant of the original Brass method was used to derive estimates of the under-five mortality from the reported proportions of children dead among children ever born classified by age of mother. The methods of minimum range of expectation of life at birth ($e_0$) and mean absolute deviations of the expected from the observed proportions of children dead were used to determine the appropriate patterns implied in the data. These methods were adopted to provide results that are compatible with results from previous works.

The results of the analyses indicate that the age pattern of mortality in the 2003, 2008 and 2013 NDHS data can best be described by the pattern in the North family of the Coale-Demeny model life tables. These results are consistent with some of the results from some previous studies in Nigeria. The results further indicate that the estimate of under-five mortality index ($_5q_0$) is about 0.1481. Thus, given the prevailing circumstances, the probability that a new born will survive to its fifth birthday is about 0.8519. The corresponding mortality level (15.14) and expectation of life at birth (53.55 years) refer to about 6.14 years before the 2013 survey. The mortality level dropped from 12.76 in the 2003 NDHS to 15.91 in the 2013 NDHS, while the implied expectation of life at birth increased from about 47.75 years in the 2003 NDHS to about 53.55 years in the 2013 NDHS.

In view of these results, the following recommendations are considered relevant. Estimates of under-five mortality and other demographic parameters for Nigeria should be based on the North pattern of the Coale-Demeny model life tables. Although there are indications that level of under-five mortality appear to be declining, it still appears very high when compared with the levels in other countries within and outside the sub-region.

The rate of decline is also not commensurate with the huge amount of resources purported to be devoted annually to health care delivery, disease control and immunization. Therefore, there is need to ascertain how much of these resources released annually actually get to the target population and how well the resources mapped out for maternal and child health care (treatment of pregnancy complications, adequate nutrition during pregnancy, improved care at delivery, better care of infants and children under five years and adequate supervision of all deliveries by well-trained attendants) are utilized in Nigeria. As earlier noted, most of the causes of death in this age range have to do with poor maternal health, adverse social conditions and inadequate care during pregnancy, delivery and the immediate postpartum periods. Proper implementation of these suggestions would help to accelerate the decline of under-five mortality to the desired level if considered and implemented.

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