

# Child Survival Dynamics in Nigeria: Is the 2006 Child Health Policy Target Met?

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## Abstract

**Background:** The childhood mortality rate in Nigeria continued to remain high. Unfortunately, information on the regional trajectories, progress, and sociodemographic determinants of childhood mortality in Nigeria are not readily available. The objectives of this study are to describe the childhood mortality trajectory in Nigeria, assess progress made toward achieving the 2006 child health policy targets, and determine the peculiar factors associated with childhood mortality in Nigeria regions. **Materials and Methods:** Birth history data from the Nigeria Demographic and Health Surveys for 1990, 2003, 2008 and 2013 were analysed. Childhood mortality levels were derived using indirect demographic techniques. Locally weighted scatterplot smoothing technique was employed to ascertain the childhood mortality trajectory. Weibull frailty models were fitted to determine the influence of unmeasured variables and factors associated with childhood death in each region. **Results:** Childhood mortality stagnated at 207/1000 live births until the year 2000, after which there was a linear decline to 137/1000 live births in 2010 at an annual rate of 4.91% (confidence interval: 4.52–5.29). The rate of decline was least in the South West (2.97%) and highest in the North Central (7.40%). Multivariate analysis revealed that unmeasured community factors played significant roles in North East and North West. Birth interval < 24 months, multiple births, and young maternal age were risk factors across all regions. **Conclusions:** Nigeria child survival dynamics differ between the Northern and Southern regions and rural and urban locations. Only the North Central and South-South regions are on course to achieve the 2006 targets for under-five mortality reduction. Multiple birth, short birth intervals, and young maternal age at child's birth were risk factors for childhood mortality in the six geo-political regions in Nigeria.

**Key words:** Child health policy, child mortality, dynamics, Nigeria, predictors, trajectory

**How to cite this article:** Akinyemi JO, Adebawale AS, Bamgboye EA, Ayeni O. Child survival dynamics in Nigeria: Is the 2006 child health policy target met?. *Niger J Health Sci* 2015;15:18-26.

## INTRODUCTION

The prevailing high level of under-five mortality in all the geo-political regions in Nigeria is a matter of public health concern. The average annual rate of reduction in under-five mortality between 1990 and 2000 was 0.3%; a rate that made it impossible for the country to achieve the Millennium Development Goal (MDG) 4.<sup>1</sup> Empirical data from the Nigeria Demographic and Health Survey (NDHS) showed that under-five mortality declined from 201 to 128 deaths per 1000 live births between 2003 and 2013.<sup>2</sup> This translates to 3.6% annual decline which is far from the benchmark decline rate of 11.0% per annum required to attain the MDG 4 in West and Central Africa.<sup>3</sup>

Unfortunately, the inconsistencies identified with the series of estimates provided from some national surveys contribute

to challenges with determining true estimates on childhood mortality rates in Nigeria. A study which utilized NDHS 1999 data showed that Nigeria had a statistically significant reduction in under-five mortality between 1990 and 1999.<sup>4</sup> The base data were later found to have under-estimated childhood mortality.<sup>5</sup> Another study on health transitions in sub-Saharan Africa between 1950 and 2000 suggested that childhood mortality has remained steady in Nigeria between 1985 and 2003.<sup>6</sup> This might have been an artifact of the data and/or the method of mortality estimation as it is unlikely for mortality to have remained the same for 18 years during a period of diverse changes in the socioeconomic and health indices of the country. These inconsistencies were not limited to the NDHS data alone. Rates estimated from the Multiple

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Indicator Cluster Surveys for 1995, 2000, 2007, and 2011 also suffer the same fate.<sup>7-9</sup>

The main reasons for the observed inconsistencies in the estimates of trends in infant and child mortality rates in Nigeria might conveniently be attributed to the different estimation procedures and other factors.<sup>10</sup> However, an assessment of both direct and indirect estimates of under-five mortality from 12 DHS datasets (including Brazil, Ghana, Senegal, Zimbabwe, and Sri Lanka) have been shown to yield plausible levels and trends in under-five mortality.<sup>11,12</sup> There could be distortions when the quality of summary birth history data is compromised or where there has been substantial decline in fertility.<sup>11-13</sup> While evidence shows that fertility is virtually constant in Nigeria, data quality problems are more common due to field work related challenges.<sup>14</sup> Alternative means of estimating childhood mortality levels and trends are the use of the indirect method, an appropriate demographic techniques for countries with deficient or inaccurate data like Nigeria.

Furthermore, wide variations in the mortality rates among different parts of the country especially rural versus urban and North versus South are notable. One theory suggests that such regional disparities and the rural-urban gap as seen in Nigeria can be explained in terms of contextual and compositional factors.<sup>15</sup> A few studies have investigated the regional variations in childhood mortality in Nigeria with very similar findings. Antai and Antai,<sup>16,17</sup> and Adedini *et al.*<sup>18</sup> have employed multilevel analysis techniques to investigate the individual and contextual determinants of regional variations based on 2003 and 2008 NDHS data, respectively. Their findings showed that contextual characteristics are important in explaining regional inequalities. Adedini *et al.* further revealed that community factors are more critical for mortality between first and fifth birthdays. A comparative survival analysis of infants mortality in the North Eastern and South West (SW) regions also identified factors such as education, maternal care utilization, and other characteristics as reasons for the wide difference between the two regions.<sup>19</sup> Though these studies have been helpful in providing explanations for regional differences, information on regional progress in child survival is lacking.

These variations (across regions and type of residence) have serious implications for policies and intervention programs. Policies are usually made at the national level and they are expected to apply equally to all regions/geo-political zones and locations (rural/urban). Such policies, if implemented may not yield the desired results across the entire country because of possible misinformation due to inaccurate reflections of the peculiarities in the different parts of the country. In fact, the failure of Nigeria population policies has been attributed to its monolithic structure with no provisions for the sociocultural diversities that exist in the country.<sup>20</sup>

In 2003, a National Policy on Population for Sustainable Development was formulated with a primary objective of

improving the quality of life and standard of living of the Nigerian population.<sup>21</sup> Specifically, the policy aimed at reducing Infant Mortality Rate to 35/1000 live births by 2015; under-five mortality rate to 45/1000 live births by 2015. Also, the Federal Ministry of Health produced a draft policy on child health in 2006 whose targets were to reduce infant mortality rate by half of 1990 (126/1000 live births) estimate by the year 2015 and to reduce under-five mortality rate by two-third of the 1990 rate (213/1000) by the year 2015.<sup>22</sup> Now that the year 2015 is here, it is of public health and policy significance to assess the extent to which these targets have been met. To achieve this purpose, plausible and consistent estimates of childhood mortality are required.

Changes in childhood mortality rates in developing countries have been found to be driven by changes in socioeconomic and health-related factors.<sup>23</sup> In Nigeria, we have previously reported that the changes in childhood mortality in Nigeria are driven by the interplay of different determinants such as environmental/sanitary factors and healthcare utilization.<sup>24</sup> Considering the wide regional differences in Nigeria, a clearer understanding of the childhood mortality trajectory across the regions is necessary for tailored intervention programs. Though progress is being made in child survival in Nigeria, in this study, we hypothesized that there are regional differences in the dynamics. Therefore, the purpose of this study is to describe the childhood mortality trajectory for the six regions of Nigeria using refined estimates of the probability of death before exact age 5 years. We also conducted an in-depth analysis of the peculiar factors associated with childhood deaths in each region.

## MATERIALS AND METHODS

This study utilized data on individual women, aged 15–45 years in 1990, 2003, 2008, and 2013 NDHS. Also, data on under-five children from 2008 and 2013 NDHS were used for in-depth survival analysis. The NDHS involve a nationally representative sample of women aged 15–49 years and men aged 15–59 years who were selected using a stratified two-stage cluster sampling technique. Data were collected on key reproductive health issues by trained field workers via structured interviewer-administered questionnaires. The survey has used a consistent, comparative methodologies, and instrument over the years. Such consistency makes it possible to pool the data together and investigate trends in different maternal, child, and reproductive health indices. Detailed description of the methods and sample design of the surveys are available in the published full reports.<sup>5,25,26</sup>

### Estimation of under-five mortality rates

Under-five mortality rates were derived using the indirect demographic techniques that involved calculating proportions of children ever born and those who died. The proportions were converted into probability of death using Brass/Trussell demographic models. Probability of death was refined by linear regression using a one-parameter relational logit system

and the general African standard life table.<sup>27,28</sup> The indirect estimation of childhood mortality was carried out according to the following procedure as outlined by the United Nations Population division.<sup>29</sup>

### Step 1: Calculation of average parity per woman

Average parity is the average number of children ever born by women in a given 5-year age group. It was calculated as:

$$P(i) = \frac{CEB(i)}{FP(i)} \quad (1)$$

where P(i) is the average parity of women of age group i, CEB(i) is the total number of children ever borne by these women, and FP(i) is the total number of women in the age group.

### Step 2: Calculation of the proportions dead among children ever born

The proportion of children dead is given simply by the ratio of the total number of dead children to the total number of children ever born (including those who have died) for each age group. Thus,

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

Where D(i) is the proportion of children dead for women of age group i, CD(i) is the number of children dead reported by those women, and CEB(i) is the total number of children ever born by those women.

### Step 3: Calculation of multipliers, k(i)

The basic estimation equation for the Trussell method is:

$$q(x) = k(i)D(i) \quad (3)$$

where

$$k(i) = a(i) + b(i) \frac{P(1)}{P(2)} + c(i) \frac{P(2)}{P(3)} \quad (4)$$

The coefficients  $a(i)$ ,  $b(i)$ , and  $c(i)$  are provided in the UN guidelines.<sup>29</sup>

### Step 4: Calculation of the probabilities of dying by agex, q(x)

Estimates of  $q(x)$  were obtained as already indicated in equation 3

$$q(x) = k(i)D(i)$$

### Step 5: Calculation of the reference dates for q(x), t(i)

Under conditions of steady mortality change, a reference time, t(i), was estimated for each q(x) obtained in step 4. The reference time was expressed in terms of number of years before the survey and is estimated through the use of coefficients applied to parity ratios. As before, the coefficients are provided in the guideline.<sup>29</sup> The estimating equation was:

$$t(i) = e(i) + f(i) \frac{P(1)}{P(2)} + g(i) \frac{P(2)}{P(3)} \quad (5)$$

Values of  $t(i)$  were converted into actual dates by subtracting them from the reference date of the survey.

The Brass one-parameter model ( $Y = \alpha + Y_s$ ) adjustment procedures are briefly described below.

The procedure involved the use of logit equation:

$$\text{logit} \{l(x)\} = \frac{1}{2} \log \left\{ \frac{1-l(x)}{l(x)} \right\} \quad (5)$$

This was transformed to Brass relational system of life tables;  $\text{logit} (l[x]) = \alpha + \text{logit} (ls[X])$  often written as  $Y = \alpha + \beta Y_s$ . The logit relational system was used to smooth the estimated values of  $l(x)$  (survival probability) against the values from the model life table.

Therefore, if  $\beta = 1$ ,  $\hat{\alpha} = Y(x) - Y_s(x)$ , thus producing:

$$Y(1) = \hat{\alpha}_1 + Y_s(1); Y(2) = \hat{\alpha}_2 + Y_s(2); \dots; Y(20) = \hat{\alpha}_{20} + Y_s(20)$$

Estimate of  $\hat{\alpha}$  was obtained by taking the average values at  $x = 2$ ,  $x = 3$ , and  $x = 5$  which are known to produce reliable values of  $l(x)$ . Therefore, if  $\bar{Y}$  is the average of  $Y(2)$ ,  $Y(3)$ , and  $Y(5)$  and  $\bar{Y}_s$  is the average of  $Y_s(2)$ ,  $Y_s(3)$ , and  $Y_s(5)$ ,  $\hat{\alpha} = \bar{Y} - \bar{Y}_s$ . This was used to generate the adjusted survival probabilities at childhood.

### Assessment of dynamics

Indirect estimate of under-five mortality rates for different reference periods was obtained from repeated surveys. In order to properly explore the dynamics, the estimates were chained and smoothed using locally weighted scatterplot smoothing (LOWESS) regression techniques. LOWESS was proposed by Cleveland and Devlin in 1979 as a multivariate smoothing technique.<sup>30</sup> The procedure pays greater attention to local data points, that is, the smoothed value of  $y$  corresponding to a data point  $x_i$  is obtained on the basis of data points around it within a certain bandwidth. In this study,  $y_i$  is the probability of death before exact age 5 years ( $q_x$ ) while  $x_i$  refers to the period (years) to which the estimate refers. The data points within the specified bandwidth were assigned weights in a way that  $x_i$  has the highest weight while weights for the other data points decline with their distance from  $x_i$  according to a weight function. The under-five mortality trajectory was described according to regions, residence, and educational attainment using line graphs.

### Rate of change and assessment of progress toward 2015 targets

Graphical description of the childhood mortality trajectory since the year 2000 suggests a linear pattern. Consequently, the annual rate of change in the probability of death was estimated between the year 2000 and 2010. This was obtained from a simple linear regression of the form:

$$y = \xi_0 + \xi_1 x \quad (6)$$

Where  $y$  is the logit of the probability of death obtained from LOWESS procedure;  $\xi_0$  is the intercept, and  $\xi_1$  is the

slope (rate of change) while  $x$  represent the reference period. The rate of change with its 95% confidence interval (CI) was reported as percentages. Based on the assumption that the mortality pattern between 2000 and 2010 will subsist until 2015, the regression parameters were used to forecast the probability of death for 2015. The forecasted rates were related to the 2006 child health policy targets to determine the progress achieved so far.

### Multivariate survival analysis

In order to provide in-depth information on the factors influencing childhood mortality in each region, the 2008 and 2013 NDHS children recode data were pooled together and subjected to multivariate Weibull hazard regression with shared frailty at the community level. The Weibull model is well-known to be suitable for modeling death in human populations.<sup>31</sup> The model is of the form:<sup>32</sup>

$$h_{ij}(t/x_{ij}, \alpha_j) = \alpha_j \exp(\beta'x_i) \lambda \gamma t^{\gamma-1} \quad (7)$$

$i$  and  $j$  refer to children and communities (clusters) respectively.  $h_{ij}(t/x_{ij})$  is the hazard of child death at time  $t$  (in months).  $x_{ij}$  is a vector of covariates with parameters  $\beta$ .  $\gamma$  is an ancillary shape parameter estimated from the data while the scale parameter is parameterized as  $\lambda \exp(\beta'x_i)$ . The frailty,  $\alpha_j$  is a random positive quantity shared within communities measured by its variance, and it is assumed to have a mean of one and variance  $\theta$ . It is hypothesized that this variance is zero which imply that unmeasured and unmeasurable factors shared by communities do not affect the risk of death and that children in all communities have the same risk. In essence, we assessed the extent to which unmeasured (or unobserved) community factors affect childhood death independent of observed variables. The observed covariates include maternal education, bio-demographic characteristics, healthcare-related factors, and environmental/sanitary factors. Models were fitted using Stata version 12.0 ([www.stata.com](http://www.stata.com)).

### Ethical considerations

Permission to use the NDHS data was obtained from ORC Macro International, the agency responsible for the worldwide Demographic and Health Surveys. A larger study from which the analysis reported in this study was extracted, received approval from the Ethical Committee of the University of Ibadan/University College Hospital, Ibadan.<sup>33</sup> Informed consent was obtained by the data originators from the respondents during NDHS data collection. The retrieved NDHS data were in anonymous format as identifying information was not collected during the survey.

## RESULTS

### Childhood mortality trajectory

The results shown in Figure 1 depict childhood mortality trajectory in Nigeria, rural, and urban locations between 1998 and 2010. Two phases could be identified from the trend over this period with a wide gap between rural and urban areas. The first phase which covered the late 1990s (1998–2000)

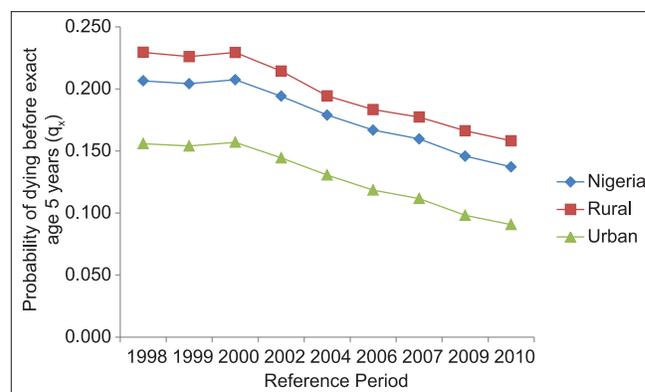


Figure 1: Childhood mortality trajectory in Nigeria, rural and urban areas.

was characterized by stagnation of childhood mortality at high levels while in the second phase (2000–2010), there was a constant linear decline in the mortality rates.

Figure 2 shows the trajectory for the six geo-political regions. The North West (NW) and North East (NE) regions with the poorest child survival had similar trajectories between 1998 and 2004 after which the NE began to decline at a much faster rate. The North Central region followed a similar pattern as the entire country. Following a stagnation in the late 1990s, the region experienced constant decline since 2000. The three Southern regions had different trajectories. In the SW, childhood mortality stagnated between 128 and 141/1000 live births between the late 1990s and 2004. Subsequently, it declined gradually to 99/1000 live births in 2010. The South East had a pattern similar to the SW in the late 1990s and also recorded a constant decline between 2000 (163/1000 live births) and 2010 (119/1000 live births). Of all regions, the South-South region has the greatest reduction between 2000 (143/1000 live births) and 2004 (98/1000 live births) after which there was a slow decline until 2010.

The educational trajectory for childhood mortality in Nigeria [Figure 3] showed that the wide gap between the levels of maternal education in the late 1990s seems to be getting narrowed. Across the four categories of educational attainment, there was a stagnation in the late 1990s albeit at different levels with higher education being the lowest (51/1000 live births). Between 2000 and 2010, none, primary, and secondary education have recorded constant decline in childhood mortality though at different rates. The mortality rates among children born to those with higher education have remained stagnated at about 68/1000 live births since 2004.

### Rates of childhood mortality change and progress toward 2006 policy targets

The trajectories described in the preceding section showed that there was a linear decline in childhood mortality since the year 2000. Consequently, we estimated the annual rate of change and used it to project the mortality levels for 2015 (target year for the 2006 child health policy).

The findings are summarized in Table I. Overall, since the year 2000, the annual rate of change in childhood mortality rate in Nigeria was 4.91% (CI: 4.52–5.29) with a projected childhood mortality of 113/1000 live births for 2015. This translate to 63% progress toward the policy target of 71/1000 live births (2/3 of the 1990 rate). The rate of decline is higher in urban than rural areas, and same apply to the progress achieved.

Across the educational categories, the rate of decline were none (4.30%), primary (5.18%), and secondary (5.04%). In the regions, the rate of decline ranged from 2.97% in the SW to 7.40% in the North Central. It is forecasted that only the North Central (105.6%) and South-South (112.3%) would achieve the policy target for child survival in 2015. Other regions (NW, South East, and SW) would barely be halfway in attaining the target, but NE would be far behind (42.1%).

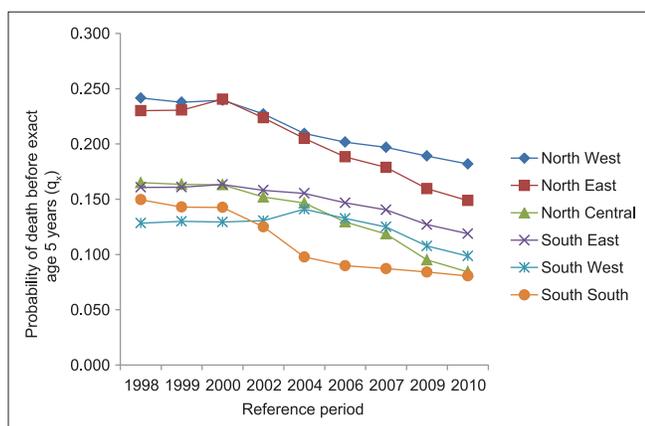


Figure 2: Childhood mortality trajectory in Nigeria geo-political regions.

### Factors associated with childhood deaths in each region

The hazard ratio (HR) and their 95% CI for the factors associated with childhood deaths in each region are summarized in Table II. In the NW, maternal education and most of the health-related factors did not attain statistical significance in their association with childhood death. The results also show that children born to urban women (HR = 0.59, CI = 0.46–0.78) and those currently married (HR = 0.61, CI = 0.40–0.93) had lower risk of death before age five. In contrast, the factors found to increase the risk of death were multiple birth (HR = 5.62, CI = 4.21–7.51), male sex (HR = 1.17, CI = 1.00–1.35), short birth interval - <24 months (HR = 1.58, CI = 1.35–1.85), small birth size (HR = 1.38, CI = 1.07–1.79), and young maternal age at birth - <18 years (HR = 1.38, CI = 1.07–1.79). The results for NE followed a pattern similar to the NW both in magnitude and direction. North Central region was slightly different from the

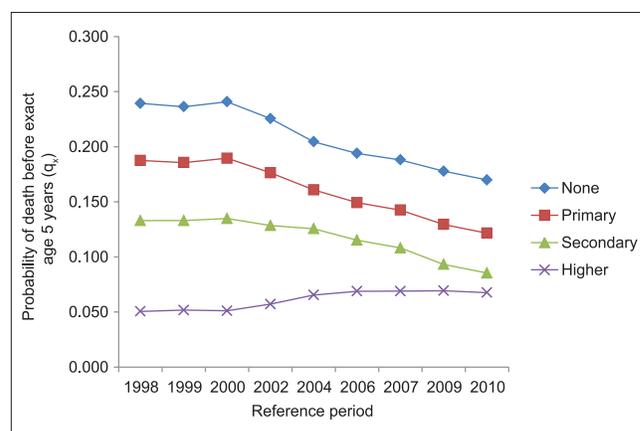


Figure 3: Childhood mortality trajectory in Nigeria according to maternal education.

**Table I: Annual rate of change (%) in the probability of death before exact age 5 in Nigeria years since the year 2000 and forecasted achievement of 2015 policy target**

| Sub-group     | Rate of change (95% CI) | Direction of change | 2015 Forecast | 1990 rate | 2015 policy target | Forecasted 2015 progress (%) |
|---------------|-------------------------|---------------------|---------------|-----------|--------------------|------------------------------|
| Nigeria       | 4.91 (4.52-5.29)        | Decline             | 113           | 214       | 71                 | 63.0                         |
| Residence     |                         |                     |               |           |                    |                              |
| Rural         | 4.52 (4.14-4.89)        | Decline             | 131           | 236       | 79                 | 60.3                         |
| Urban         | 6.19 (5.58-6.81)        | Decline             | 70            | 152       | 51                 | 72.4                         |
| Education     |                         |                     |               |           |                    |                              |
| None          | 4.30 (3.84-4.76)        | Decline             | 141           | 233       | 78                 | 54.9                         |
| Primary       | 5.18 (4.83-5.52)        | Decline             | 98            | 179       | 60                 | 60.9                         |
| Secondary     | 5.04 (3.29-6.79)        | Decline             | 72            | 140       | 47                 | 64.8                         |
| Higher        | 3.03 (1.14-4.94)        | Increase            | 83            | 73        | 24                 | 29.2                         |
| Region        |                         |                     |               |           |                    |                              |
| North West    | 3.39 (2.94-3.84)        | Decline             | 158           | 269       | 90                 | 56.8                         |
| North East    | 5.88 (5.31-6.45)        | Decline             | 118           | 149       | 50                 | 42.1                         |
| North Central | 7.40 (4.93-9.87)        | Decline             | 65            | 207       | 69                 | 105.6                        |
| South East    | 3.61 (2.34-4.87)        | Decline             | 106           | 164       | 55                 | 51.5                         |
| South West    | 2.97 (-0.03-5.97)       | Decline             | 95            | 166       | 55                 | 58.0                         |
| South-South   | 6.37 (4.11-8.64)        | Decline             | 56            | 190       | 63                 | 112.3                        |

CI: Confidence interval

**Table II: Selected factors associated with under-five death in the six regions of Nigeria, NDHS 2008-2013**

| Variables                     | North West<br>(n=17,853) | North East<br>(n=13,076) | North Central<br>(n=9660) | South East<br>(n=5266) | South West<br>(n=7200) | South-South<br>(n=7074) |
|-------------------------------|--------------------------|--------------------------|---------------------------|------------------------|------------------------|-------------------------|
| Maternal education            |                          |                          |                           |                        |                        |                         |
| None                          | 1.00                     | 1.00                     | 1.00                      | 1.00                   | 1.00                   | 1.00                    |
| Primary                       | 1.15 (0.89-1.46)         | 0.97 (0.75-1.26)         | 1.23 (0.92-1.64)          | 1.45 (0.87-2.40)       | 1.25 (0.75-2.08)       | 0.76 (0.48-1.19)        |
| Secondary                     | 0.71 (0.46-1.08)         | 0.81 (0.56-1.18)         | 1.07 (0.75-1.52)          | 1.40 (0.79-2.48)       | 1.21 (0.72-2.05)       | 1.12 (0.70-1.77)        |
| Higher                        | 1.28 (0.58-2.82)         | 0.54 (0.21-1.35)         | 0.64 (0.32-1.25)          | 1.02 (0.46-2.25)       | 0.93 (0.45-1.94)       | 0.90 (0.40-2.03)        |
| Health-related                |                          |                          |                           |                        |                        |                         |
| Antenatal care                | 0.86 (0.64-1.15)         | 0.91 (0.66-1.25)         | 0.82 (0.58-1.18)          | 0.88 (0.48-1.59)       | 1.21 (0.59-2.48)       | 0.76 (0.51-1.13)        |
| skilled delivery              | 1.29 (0.96-1.74)         | 1.28 (0.94-1.73)         | 1.17 (0.88-1.55)          | 1.04 (0.73-1.48)       | 1.09 (0.74-1.59)       | 0.75 (0.52-1.08)        |
| Tetanus toxoid injection      | 0.91 (0.68-1.24)         | 0.91 (0.66-1.25)         | 0.93 (0.67-1.29)          | 0.69 (0.41-1.14)       | 0.86 (0.52-1.41)       | 0.84 (0.58-1.21)        |
| Contraceptive use             | 0.63 (0.35-1.14)         | 0.55 (0.30-1.02)         | 0.58 (0.40-0.85)*         | 0.56 (0.38-0.83)*      | 0.42 (0.29-0.62)*      | 0.54 (0.37-0.79)*       |
| Environmental factors         |                          |                          |                           |                        |                        |                         |
| Urban residence               | 0.59 (0.46-0.78)*        | 0.72 (0.54-0.97)*        | 1.01 (0.72-1.42)          | 0.70 (0.52-0.95)*      | 0.97 (0.66-1.44)       | 0.79 (0.54-1.16)        |
| Improved water source         | 1.06 (0.90-1.24)         | 0.96 (0.78-1.18)         | 0.79 (0.61-1.04)          | 0.94 (0.69-1.29)       | 0.77 (0.54-1.09)       | 1.17 (0.85-1.59)        |
| improved toilet facilities    | 0.98 (0.84-1.15)         | 0.98 (0.79-1.21)         | 1.00 (0.76-1.33)          | 0.97 (0.69-1.35)       | 1.24 (0.85-1.81)       | 0.87 (0.61-1.22)        |
| Bio-demographic               |                          |                          |                           |                        |                        |                         |
| Multiple birth                | 5.62 (4.21-7.51)*        | 3.74 (2.49-5.62)*        | 5.07 (3.26-7.87)*         | 2.25 (1.21-4.18)*      | 4.62 (2.82-7.57)*      | 2.80 (1.57-4.98)        |
| Male sex                      | 1.17 (1.00-1.35)*        | 1.29 (1.08-1.56)*        | 1.25 (0.99-1.58)          | 1.12 (0.83-1.50)       | 1.24 (0.91-1.69)       | 1.37 (1.04-1.81)*       |
| Short birth interval          | 1.58 (1.35-1.85)*        | 1.41 (1.16-1.73)*        | 1.85 (1.44-2.39)*         | 1.87 (1.37-2.56)*      | 1.75 (1.23-2.49)*      | 1.50 (1.11-2.03)*       |
| Birth size                    |                          |                          |                           |                        |                        |                         |
| Large                         | 1.000                    | 1.000                    | 1.000                     | 1.000                  | 1.000                  | 1.000                   |
| Average                       | 1.07 (0.90-1.27)         | 1.11 (0.90-1.37)         | 1.18 (0.89-1.53)          | 0.85 (0.61-1.17)       | 1.37 (0.96-1.96)       | 0.83 (0.61-1.14)        |
| Small                         | 1.63 (1.34-1.97)         | 1.06 (0.82-1.37)         | 1.57 (1.15-2.16)          | 1.18 (0.77-1.81)       | 3.25 (2.15-4.90)*      | 1.76 (1.21-2.56)        |
| Maternal age at child's birth |                          |                          |                           |                        |                        |                         |
| <20 years                     | 1.38 (1.07-1.79)*        | 1.38 (0.98-1.96)         | 0.96 (0.54-1.69)          | ++                     | 1.14 (0.36-3.66)       | 1.05 (0.48-2.29)        |
| 20-35 years                   | 1.00                     | 1.00                     | 1.00                      | 1.00                   | 1.00                   | 1.00                    |
| ≥36 years                     | 1.22 (0.40-0.93)*        | 1.67 (1.35-2.06)*        | 0.99 (0.74-1.87)          | 2.05 (1.49-2.81)*      | 1.79 (1.29-2.48)*      | 1.55 (1.13-2.13)*       |
| Currently married             | 0.61 (0.40-0.93)*        | 0.98 (0.58-1.66)         | 1.03 (0.57-1.87)          | 0.53 (0.35-0.78)*      | 0.39 (0.22-0.71)*      | 1.08 (0.67-1.75)        |
| Model parameters              |                          |                          |                           |                        |                        |                         |
| Log-likelihood                | -3447.2443               | -2371.529                | -1580.0506                | -930.42                | -947.1373              | -1115.956               |
| Theta: Variance (SE)          | 0.06911 (0.0439)         | 0.0922 (0.0595)          | 0.1150 (0.0979)           | 0.0207 (0.1083)        | 0.1449 (0.1421)        | 0.05697 (0.09748)       |
| $\chi^2$ (P) for theta=0      | 3.09 (0.039)             | 3.26 (0.035)             | 1.75 (0.093)              | 0.04 (0.422)           | 1.35 (0.123)           | 0.40 (0.265)            |

NDHS: Nigeria Demographic and Health Survey, SE: Standard error; \*( $P < 0.05$ )

other two Northern regions in terms of the factors associated with childhood death. Contraceptive use (HR = 0.58, CI = 0.40–0.85), multiple birth (HR = 5.07, CI = 3.26–7.87), short birth interval (HR = 1.85, CI = 1.44–2.39), and small birth size (HR = 1.57, CI = 1.15–2.16) were independent predictors of childhood death. In the Southern regions, maternal contraceptive use remained as a protective factor against childhood death while the urban advantage was significant only in the South East (HR = 0.70, CI: 0.52–0.95). Risks associated with multiple births was higher in the SW (HR = 4.62, CI = 2.82–7.57) than the South East (HR = 2.25, CI = 1.21–4.18) and South-South (HR = 2.80, CI = 1.57–4.98). The effects of male sex and short birth interval, birth size and maternal age at child's birth in the South were similar to those of the Northern regions. In the South East (HR = 0.53, CI = 0.35–0.78) and SW (HR = 0.39, CI = 0.22–0.71) unlike South-South (HR = 1.08, CI = 0.67–1.75), children of currently married women had lower risk of death. Results of the frailty effects showed a significant community frailty in the NW and NE only.

## DISCUSSION

In the present study, we explored the dynamics of child survival in Nigeria by describing the childhood mortality trajectory for the country, disaggregating same by residence, geo-political region, and educational attainment. We also provided insight on the factors driving childhood mortality in each region between 2008 and 2013.

The regional differences in the childhood mortality trajectory found in the present study further re-emphasized the fact that the entire country cannot be treated as a monolithic structure where one policy fits all. Though all regions recorded decline in childhood mortality levels since the year 2000, the rate of decline however varied across the six regions. The 2006 child health policy actions did not recommend any regional steps, so it would have been expected that all regions declined at a relatively similar rate. The reasons why this was not so were beyond the scope of the present study. A few possibilities underlining this pattern are hereby briefly highlighted.

First, it was possible that each region had enjoyed different degrees of child survival intervention programs because nongovernment organizations and international donors work in different parts of the country. Second, it might be that each region responded differently to the intervention programs depending on their cultural beliefs, norms and values. Available evidence actually showed that there were regional differences in utilization of different arrays of maternal and child health services that should have enhanced survival of children.<sup>34-36</sup>

Our results further showed that educational gap in child mortality was gradually getting narrowed. Faster reductions in childhood deaths were being recorded among children born to women with at most a secondary education while there was a stall in decline among those with higher education. While this may seem surprising, it was not unexpected. Women with higher education are known to be better empowered to take advantage of child survival interventions. Their maternal and child healthcare utilization probably had remained at a reasonably high level over time and therefore not appearing to be benefiting from any new intervention. It should, however, be worrisome that such population sub-group did not seem to show capacity to lower their childhood mortality. The unusual lack of decline in child deaths in this group may be a pointer to the fact that higher education alone may not proffer any child survival advantage in the face of universal coverage of child survival interventions.

Assessment of progress toward the attainment of the 2006 child health policy targets revealed that apart from the North Central and South-South, other regions and the country as whole were not on course in achieving the targets. Sustained efforts are required post 2015 to achieve these targets in Nigeria just like many other developing countries that could not achieve the MDG 4.<sup>23</sup>

The Weibull frailty models revealed that the effects of unmeasured factors were substantial and that child mortality risks correlated with risk factors among communities in the NW and NE regions. There is, therefore, a need for a deeper understanding about these unobserved community factors that exert such influence to make childhood death a clustered within communities in these regions.

Results from the regional multivariate survival models were similar albeit with some differences especially between the North and the South. The roles of most bio-demographic variables such as multiple birth, short birth interval, and young maternal age at child's birth as risk factors were consistent across all regions. The main antidote to the risk posed by these factors is universal coverage in family planning and maternal/child healthcare services. These might explain why the HRs for these bio-demographic variables were much lesser in the southern regions. The need to further increase the uptake of health care services for child health is reflected by the nonsignificance of many of the healthcare-related variables. Many of these variables did not have significant effect because of their sub-optimal coverage.

A critical question from theoretical and policy perspective is "why is childhood mortality so high in a cultural environment that places such a high value on children?" Obviously, this question is a line of discourse that will require qualitative research approaches for proper elucidation. An attempt can only be made to scratch the issue on the surface based on available empirical evidence mostly from quantitative researches in the subject area.

In the Nigerian setting, similar social, cultural, and economic factors, norms, values, and beliefs influence both fertility, child care practices, morbidity and mortality.<sup>37-39</sup> It could, therefore, be argued that in spite of the high premium on children, some of the cultural beliefs and practices did not favor child survival. This gap between value for children and their survival is a lacuna that deserves the attention of child health policy makers. Examples of these unfavorable beliefs and child care practices were: Poor women education; non-utilization of modern/technological advancement for maternal and child health care and high-risk fertility behavior. Male dominance in decision making does not usually allow women to take initiative for quick interventions when a child becomes ill. Even when children are ill, rather than take them to health facilities for prompt attention, most indigenous people tend to believe that such illnesses are caused by 'spirits' which need to be appeased.<sup>39</sup> As a result, they resort to crude and unhealthy practices in caring for the children. Such children may eventually die. In some parts of Nigeria, mostly in the Northern region, high-risk fertility behavior is prevalent.<sup>25</sup> The most common are young maternal age at child's birth below the age of 18 years; very short birth interval <24 months; and high parity. These behaviors are deeply rooted in the culture and are well-known risk factors for childhood mortality. Moreover, many of the women involved in the risky fertility behaviors do not use antenatal and skilled delivery services.

From a policy point of view, education and sociocultural advocacy are two strategies that can correct the anomaly. Education empowers women to make rational decision and take advantage of modern practices that enhance child survival. The sociocultural re-orientation should not attempt to change the people's beliefs and values but rather enlighten them on the obvious consequences of some risky practices and availability of better alternatives that promote child survival. This point had been canvassed about three decades ago by Parry who submitted as follows:<sup>40</sup>

"Society's attitudes to health and disease are closely bound up with its culture. However, this culture is rarely static and can usually accommodate new ideas if they do not appear to threaten it. Whatever changes health workers introduce, they should always harmonize their activities with the culture in which they find themselves."

Some limitations need to be borne in mind in the interpretation of the findings in the present study. The probability of death used in describing the childhood mortality trajectory was estimated. The true mortality rates could only be obtained from

a vital registration system, but this is poorly implemented in the country at the moment. One strength of the current study lies in the fact that it represented a noble attempt to provide a vivid description of child survival dynamics across Nigeria geo-political regions.

## CONCLUSION

Childhood mortality is an indicator of health and socioeconomic development of a country. The findings from the present study added substantially to the current understanding of the dynamics of child survival in Nigeria. The dynamics differ between the Northern and Southern regions and rural and urban locations. Only the North Central and South-South regions were on course in achieving the 2006 targets for under-five mortality reduction. The roles of bio-demographic variables such as multiple birth, short birth interval, and young maternal age at child's birth as risk factors for childhood death were consistent across all the six geo-political regions of Nigeria. Such variables should be kept in focus while designing strategies aimed at reducing childhood mortality in Nigeria. Further studies are recommended on adequate knowledge about the barriers to the uptake of child survival interventions in each region so that policies and programs can be designed to overcome such obstacles.

## Acknowledgments

We thank the ORC Macro and National Population Commission (Nigeria) for permission to use the NDHS data. "This research was supported by a fellowship award to the first author (JOA) from the Consortium for Advanced Research Training in Africa (CARTA). CARTA is jointly led by the African Population and Health Research Center and the University of the Witwatersrand and funded by the Wellcome Trust (UK) (Grant No: 087547/Z/08/Z), the Department for International Development (DfID) under the Development Partnerships in Higher Education (DePHE), the Carnegie Corporation of New York (Grant No: B 8606), the Ford Foundation (Grant No: 1100-0399), Google. Org (Grant No: 191994), Sida (Grant No: 54100029) and MacArthur Foundation Grant No: 10-95915-000-INP.

## Financial support and sponsorship

Nil

## Conflicts of interest

There are no conflicts of interest.

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