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# RURAL-URBAN DIFFERENTIAL IN MATERNAL MORTALITY ESTIMATE IN NIGERIA, SUB-SAHARAN AFRICA

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## ABSTRACT

In developing countries, the traditional sources of demographic statistics in which the estimates of demographic indices are based are either non-existence or incomplete. Data requirements on maternal deaths are always very large and costly. The indirect method (sisterhood method) for estimating maternal deaths was designed primarily as check to these problems. The study used Nigeria Demographic and Health Survey (NDHS), 2008 data. A total of 18,250 (6,894 urban and 11,356 rural) adults responded to questions essential for the estimation of maternal mortality. The P/F ratio method was used to adjust the total fertility rates (TFR) in urban and rural areas. Thereafter, the life-time risks of maternal deaths (LTRMD) were estimated for the two areas. These were later converted to maternal mortality ratio (MMR). Data analyses revealed that the adjusted total fertility rates for urban and rural areas were 5.26 and 7.12 respectively. The LTRMD in urban was 0.0221 (1 in 45) whereas, in rural area it was 0.0309 (1 in 32). These results correspond to MMR of 424/100,000 and 440/100,000 live births in urban and rural areas respectfully. These are not far from the national estimate of 436/100,000 live births as evidence in this study. This method provided a robust estimate of MMR in both urban and rural areas and shows that the MMR in Nigeria is reducing. However, the figures at the two locations are still high. Government and international agencies should put appropriate mechanisms in place for further reduction in the prevalence.

**Keywords:** life-time risks, adjusted total fertility rate, maternal mortality.

## INTRODUCTION

Maternal mortality (MM) level is a part of indicators for assessing; overall health conditions, reproductive health programs and development status in any Nation. However, few countries have been able to establish a comprehensive reporting needed for its estimation. Maternal mortality remains a major challenge to health systems worldwide. Reliable information about its rates and trends is essential for resource mobilization and assessment of progress towards Millennium Development Goal 5, the target for which is a 75% reduction in the maternal mortality ratio (MMR) from 1990 to 2015.

The effort to lower maternal death rate in Nigeria has become a high government priority. This informed the launching of the National Programme for the Prevention of Maternal deaths. The aim was to expand and strengthen advocacy projects for safe motherhood. Therefore, in order for maternal health programmes to remain focused, and to make a quantitative evaluation of programme results, MM statistics are needed within segments of the population.

In most developing countries including Nigeria, the traditional sources of MM statistics (vital registration system and sample surveys) in which the estimate of MMR is based are unreliable and completely imperfect that the estimate obtained directly from such data are often flawed and misleading. Also, results from hospital based studies are rarely acceptable because the women who died in the facility are not representative of the population. Therefore, the MMR obtained from such data is most likely to be biased. In such situations, population-based surveys have to be used for its estimation.

In furtherance to these, it is understood that the best estimates of MM do not capture all deaths related to pregnancy. However, there is strong evidence that official statistics seriously under-estimate MM even in developed countries. While statistics on MMR are far from perfect, they provide evidence of its magnitude around the world. Moreover, data requirement on maternal deaths are always very large, which may involve 200,000 households and sometimes, follow up studies may be needed to track down the actual number. Such data are always difficult to generate in developing countries in terms of cost implication, time, and logistics and may be unrealistic in countries with small number of inhabitants.

These problems compelled demographers to search for more efficient, cost effective and refined means of measuring MM. One such method is the sisterhood method which was originally designed to curtail the problem of large data requirements and cost. It is an indirect method which based its analysis on four simple questions that asks adult respondents about how many of their sisters have died and whether those who died were pregnant at the time of death. The term indirect approach produces estimates of demographic indices based on data or information that is indirectly related to its value. It is the term used to describe estimation method that depends upon models or uses consistency checks, or indeed uses conventional data in an unconventional way [1].

The original (indirect) sisterhood method was developed in the late 1980s (Graham, et-al, 1988) as an efficient means of measuring MM through population-based surveys, generating a variety of indicators: the proportion of maternal deaths among female deaths, the MMR, the maternal mortality rate and the lifetime risk of maternal death (LTRMD). The first field trial of the method was carried out in September, 1987 in Gambia and has been used in many studies. Therefore, its reliability and validity have been evaluated at different international fora and conferences.

This current study adopted the sisterhood method to see rural-urban differential and national estimate of MMR in Nigeria using adjusted total fertility rate (Adj.TFR). These estimates will assist the planners and policy makers in their programs aimed at reducing MM in Nigeria. All the techniques involved were strictly indirect.

## Maternal Mortality in Nigeria

Most developing countries have no national statistics regarding MM and there are few studies on MM in Nigeria. Although different studies on MM have been carried out in sub-section of the country in the past, among which are the result of research from hospital records such as [2][3][4] Most births in Nigeria do not take place in hospitals; therefore, the reported statistics do not accurately reflect the numbers of deaths during pregnancy and childbirth. Hospital statistics in Nigeria also suffer serious biases owing to selectivity and often lead to over or under estimate of the level of MM.

Nigeria ranked second globally as the country with the highest estimated number of maternal deaths with 37,000 cases of maternal deaths. The trend has shown an evidence of reduction. For instance, in 2003 NDHS, it was estimated as 800/100 000 live births, whereas, in 2008 NDHS, the figure was 545/100 000 live births. Despite the reversal in the trend, the rate is still considered to be high as indicated by WHO MM estimation guideline, 1997.

The high rate of MM in Nigeria is due to numerous causes which can be classified as either direct or indirect obstetric. The direct obstetric causes are related to complications of pregnancy, labor or in the 42-day post-partum period (puerperium), from incorrect treatment or interventions e.g. haemorrhage, sepsis, eclampsia, obstructed labor, unsafe abortion. The indirect obstetric causes are those resulting from a pre-existing disease or one that developed during pregnancy and that is aggravated by pregnancy e.g. anemia, malaria, cardiovascular disease, hepatitis, diabetes etc.

Studies have shown that flaws in the health care system and hostilities between midwives and traditional birth attendants (TBAs) are contributing to the high rate of MM in Nigeria. While many existing formal maternity services are underutilized, women in rural areas remain under served. This reflects inaptness between the services being offered and the needs of women. Among barriers to maternal care are the poor quality of services received at health centers and attitudes of many health care providers. Health care providers are seen to be unnecessarily harsh.

Nigerian women have two maternal health care systems available to them. The orthodox or "modern" system of care is available in public and private maternity clinics, health centers, special maternity hospitals and maternity units of general and specialist hospitals. The traditional system comprises of healers and traditional birth attendants. Many women, especially in the rural areas, patronize traditional birth attendants (TBAs). Even where doctors are available, some women prefer TBAs because they are more familiar, accessible and often less expensive than modern practitioners. In Nigeria, the cost of seeking modern medical care is high and patients must often bring their own supplies to a hospital in order to be treated. Facilities are often overcrowded, under-staffed and poorly equipped. In some parts of Nigeria, women often prefer female health care providers and where they are not readily available, they would rather stay away than allow men to treat them. In effect, complicated cases are usually referred to hospital or health centers-often too late and many women do die there.

Some cultural practices also make child-bearing risky and expose women to the danger of death. There are other traditional beliefs and practice which contribute, less directly, to increase risk of MM. These include nutritional taboos during pregnancy forbidden pregnant women from eating some foods, early marriage, and early motherhood [5]. Many Nigerian women live and work under cultural/religious conditions that do not allow them to reach their full potential. They are not allowed to take decisions for their health needs or in their reproductive lives, nor do they enjoy good health care.

In Nigeria, the TFR is high (5.7, [6]), this shows the transition to low fertility is yet to begun. Nigerian society places great value on child bearing and parenthood and any couple which fails to procreate becomes stigmatized and losses self-esteem. Therefore, women may suffer from maternal depletion syndrome, whereby a woman's health is compromised by numerous and frequent pregnancies, food shortages and too much on child care and rearing.

**Literature Review**

The estimated number of maternal deaths for the world in 2000 was 529 000. These deaths were almost equally divided between Africa (251 000) and Asia (253 000), with about 4% (22 000) occurring in Latin America and the Caribbean and less than 1% (2 500) in the more developed regions of the world. In terms of the MMR, the world figure is estimated to be 400 per 100 000 live births. By region, the MMR was highest in Africa (830), followed by Asia (330), Oceania (240), Latin America and the Caribbean (190), and the developed countries (20).

A comparable country, regional, and global estimates of MMR for 2005 was done to assess trends between 1990 and 2005. The findings showed that there were 535 900 maternal deaths in 2005, corresponding to a MMR of 402 (uncertainty bounds 216–654) deaths per 100 000 live-births. Most maternal deaths in 2005 were concentrated in sub-Saharan Africa (270 500, 50%) and Asia (240 600, 45%). For all countries with data, there was a significant decrease of 2·5% per year in the maternal mortality ratio between 1990 and 2005; however, there was no evidence of a significant reduction in MMRs in sub-Saharan Africa in the same period. The study also revealed that, some regions have shown some progress since 1990 in reducing maternal deaths. Maternal mortality ratios in sub-Saharan Africa have remained very high, with little evidence of improvement in the past [6].

Between 1980 and 2008 a database of 2651 observations of MM for 181 countries was constructed using vital registration data, censuses, surveys, and verbal autopsy studies. They used robust analytical methods to generate estimates of maternal deaths and the MMR for each year between 1980 and 2008. The result of data analysis shows that there were 342 900 maternal deaths worldwide in 2008, down from 526 300 in 1980. The global MMR decreased from 422 in 1980 to 320 in 1990, and was 251 per 100 000 live-births in 2008. The yearly rate of decline of the global MMR since 1990 was 1·3%. During 1990–2008, rates of yearly decline in the MMR varied between countries, from 8·8% in the Maldives to an increase of 5·5% in Zimbabwe. More than 50% of all maternal deaths were in only six countries in 2008 (India, Nigeria, Pakistan, Afghanistan, Ethiopia, and the Democratic Republic of the Congo) [7].

The sisterhood method was applied to Djibouti population data. The survey was implemented in February 1989. The results of the 7408 females 15-49 years interviewed shows that the lifetime risk of dying of maternal causes were found to be 0.049 or 1 in 20.Using a total fertility rate of 6.8, the MMR was calculated to be 740 maternal deaths per 100 000 live births 11.6 years prior to the survey. The results of the assessment of the quality of the data showed underreporting of the youngest age groups, which suggest misreporting. In spite of the difficulties, the results are plausible and lend support to the method [8].

In Thyolo district in southern Malawi, 5 field teams used the sisterhood Method to interview 4124 people older than 15years in 7 traditional authorities to estimate the lifetime risk (LTR) of maternal death and the MMR in this area. The life time risk of maternal death stood at 1 in 36 (1.0282).The MMR was 409/100 000 live births. These findings prove useful to community and health leaders in designing intervention strategies to reduce MM in the area [9][10].

In another setting in Africa, the sisterhood method was used in a study carried out in rural Niger. It involved 3058 respondents who identified 5796 sisters, among whom 186 were reported to have died from maternal causes. Based on the study findings, the MMR was estimated at between 1030 and 1050 per 100 000 live births, significantly higher than the World Bank estimate of 700/100 000 live births for this part of Africa, but similar to rates obtained using the same method in other West African countries with deficient data collection.

The level of MMR estimated by the sisterhood method is presented for a rural district in the Morogoro region of Southeastern Tanzania and the main causes of maternal death were studied [11]. In this study, 4734 women in the Morogoro Region of Southeastern Tanzania were interviewed using the sisterhood method to estimate MM. The resulting MMR of 448 deaths per 100 000 live births is much higher than the Tanzanian government's estimate for the region, but much lower than the levels estimated by WHO and UNICEF. Advantages of its use in this setting are that it is relatively cheap and feasible to obtain and is useful for small areas where specific health information may not exist, such as the Kilombero valley.

Results of the sisterhood method have been proved to be fairly good when compared with those derived through longitudinal surveys. For example, in Mwanza and Tanzania, comparison of the MMR derived from a prospective community-based survey, the sisterhood method survey, and hospital data, showed that the sisterhood method was fairly close to the prospective community-based survey [12].

Studies on estimates of maternal mortality ratio carried out in two districts of the Brong-Ahafo region, Ghana using sisterhood method were reviewed in 2000 [13]. Indirect estimates of MMR were calculated from data collected in 1995 by family Health International (FHI) on 5202 women 15-49 years, using a household screen of randomly selected areas in the two districts. Based on the Family Health International data, the MMR was estimated to be 269 maternal deaths per 100 000 live births for both districts combined [14]. The national MMR for Ghana to be 214 MM per 100 000 live births, using indirect sisterhood data from a national representative survey conducted in 1992 [15]. This figures was lower than a recent estimates of Ghana's MMR 742 maternal deaths per 100 000 live births.

Lech used sisterhood method to estimate maternal mortality in Swaziland by obtaining data on 'sisterhood mortality from the 1993–1994 Multi-Purpose Household Survey carried out by the Central Statistics Office and Ministry of Health of Swaziland [16]. A total fertility rate of 6.36, as given in the 1986 Swaziland census, was used in estimating these indicators. Prior to this study, the maternal mortality rate (MMR) in Swaziland (based only on health facility data) was considered to lie within the range of 107–125 maternal deaths per 100 000 live births. The study revealed MMR to be 229 per 100 000 live births and the life-time risk of maternal death to be 1 in 69.

In a study conducted in Shagamu, western part of Nigeria by Oladapo and others in 2006 to investigate maternal deaths where all maternal deaths were recorded at Olabisi Onabanjo University Teaching Hospital, Sagamu Nigeria in 2005 were retrospectively reviewed [17]. Information was obtained from a combination of admission and discharge registers, labour and delivery records and retrieved case files from the Medical Records Department of the hospital. The study revealed sixty-three (84.0%) of the deaths were direct maternal deaths while 12 (16.0%) were indirect maternal deaths. Major causes of deaths were hypertensive disorders in pregnancy (28.0%), haemorrhage (21.3%) and sepsis (20.0%). Overall, eclampsia was the leading cause of deaths singly accounting for 24.0% of all maternal deaths. Abortion and HIV-related mortality accounted for 1.3% and 4.0% of maternal deaths, respectively. The research further showed that maternal mortality ratio of 2989.2 per 100 000 live births was significantly higher than that reported for 1988–1997 in the same institution.

A ten-year review of maternal death in the University College Hospital, Ibadan Nigeria 1974, showed that 820/100 000 maternal deaths occurred in the hospital during the period from January 1, 1962, and December 31, 1971. However, the number of maternal deaths recorded was not a true representative of what happens in the community since 60% of deliveries in Nigeria take place outside the health facility [18].

Ujah [19] reviewed all the records of all deliveries and case files of all women who died during pregnancy and childbirth between January 1, 1985 and December 31, 2001, in the maternity unit of Jos University Teaching Hospital, Jos, Nigeria. The study showed a detailed and comprehensive record-keeping of all deliveries, including complications and maternal deaths, kept in the labour, antenatal, postnatal and caesarean section wards. A total of 267 maternal deaths occurred among 36,768 deliveries over 17-year period, making the maternal ratio (MMR) 740/100000 total deliveries. The trend fluctuates between 450 in 1960 and 1010/100000 deliveries in 1994.

In Nigeria [20], all maternal deaths were recorded at Ebonyi state university Teaching Hospital (EBSUTH) Abakaliki, Nigeria; from January 2000 to December 2003. It was observed that 4192 live births were recorded, out of which 79 maternal deaths were obtained. It implies a maternal mortality ratio of 1884 per 100 000 live births. This finding far exceeds the Nigerian national average. The case records of only 49 (62%) of these maternal deaths were complete and included in this review. This shows one of the inadequacies of hospital data in estimating maternal mortality.

A population–based study was carried out to determine the incidence and causes of maternal mortality as well as its temporal distribution over the last decade (1990-1999) in Kano [21]. This was a retrospective study using information contained in the vital statistics register maintained by the research and statistics department of the Ministry of Health in Kano. The village or local government council also reported births and deaths that occurred at home to the Zonal council in charge of the area. All the maternal deaths recorded within the study period in the Kano state, Nigeria, were analyzed. A total of 4154 maternal deaths occurred among 171 621 deliveries, yielding a MMR of 2420 deaths per 100 000. Eclampsia, ruptured and aneamia were responsible for about 50% of maternal deaths. The highest maternal mortality ratio ever reported in the world was found.

## MATERIAL AND METHODS

### Sample Design

The data for this study is secondary and was obtained from ICF Macro Calverton, Maryland, USA. It is an NDHS data, 2008. A brief description of the methodology involved during data collection is discussed below.

The sample was designed to provide population and health indicators at the national, zonal, and state levels. The primary sampling unit (PSU), referred to as a cluster for the 2008 NDHS, was defined on the basis of Enumeration Areas (EAs) from the 2006 EA census frame. The 2008 NDHS sample was selected using a stratified two-stage cluster design consisting of 888 clusters, 286 in the urban and 602 in the rural areas. A representative sample of 36 800 households was selected, with a minimum target of 950 completed interviews per state. In each state, the number of households was distributed proportionately among its urban and rural areas.

All women age 15-49 and men age 15-59 who were either permanent residents of the households in the 2008 NDHS sample or visitors present in the households on the night before the survey were eligible to be interviewed. However, men were selected in a sub-sample of half of the households. Three questionnaires were used. These are; the Household Questionnaire, the Women's Questionnaire, and the Men's Questionnaire. These questionnaires were adapted to reflect the population and health issues relevant to Nigeria.

### Methods of Analysis

The method used in this study is multi-indirect which involves two procedures. First, the adjusted total fertility rate (Adj.TFR) was estimated using Coale and Trussell P/F ratio model, an indirect approach. The adjustment technique was based on questions on the total number of women in each five-year age group, the number of children ever born and the number of children born a year preceding the survey. The adjustment of the level of observed age-specific fertility rates is necessary since they are assumed to represent the true age pattern of fertility. This is done by combining the age pattern of the period fertility rates with the level implied by the average parities of younger women to obtain a set of fertility rates that is generally more reliable than either of its constituent parts.

Second, the life-time risk of maternal death was estimated using sisterhood method. The estimation was possible through questions asked from adult respondents (men and women aged 15 years and above) about the survival status of all their adult sisters born to the same mother and whether these dead sisters were pregnant at the time of death. These data were used to obtain the proportion of sisters dying during pregnancy, childbirth, or up to 6 weeks after the end of pregnancy. Thereafter, standard adjustment factors were used to transform those proportions into estimates of MM. The principal indicator obtained is the life-time risk of maternal death which was converted to an estimate of the MMR by using the adjusted total fertility rate. The formula is as shown below;

$$\mathrm{MMR} = 1 - (1 - \mathrm{LTRMD})^{1/\mathrm{adj.TFR}}$$

where, LTRMD is the life time risk of maternal deaths.

## RESULTS

Computational procedures for Adjusted Total Fertility Rate using P/F ratio:

Using this method the following steps were taken;

1. **Average parities reported P(i):**

$$\mathrm{P(i)} = \frac{\text{Total number of children ever born to women in age group (i)}}{\text{Total number of women in age group (i)}}$$

The denominator includes all women in age group i irrespective of the marital and fertility status of the women.

e.g $\mathrm{P}(1) = 1527/6493 = 0.2352;$ $\mathrm{P}(2) = 7310/6133 = 1.1919$

2. **Preliminary fertility schedule f(i):**

$$\mathrm{f(i)} = \frac{\text{Number of births in the year preceding the survey in age group (i)}}{\text{Total number of women in age group (i)}}$$

$$\mathrm{f}(1) = \frac{630}{6493} = 0.0970$$

$$\mathrm{f}(2) = \frac{1540}{6133} = 0.2511$$

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3. **Cumulated fertility schedule for a period $\Phi(\mathrm{i})$**

$$\Phi(\mathrm{i}) = 5 \times \left[\sum_{j=0}^{i} \mathrm{f(j)}\right]$$

$$\Phi(1) = 5 \times 0.0970 = 0.4850$$

$$\Phi(2) = 5 \times [0.0970 + 0.2511] = 1.7405$$

$$\Phi(3) = 5 \times [0.0970 + 0.2511 + 0.2935] = 3.2080$$

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4. **Average parity equivalents for a period (F(i)):**
F(i) are computed by interpolation using the period fertility rates f(i) and the cumulated fertility values $\Phi(\mathrm{i})$. Different techniques have been proposed for the interpolation. Among the contributors to the methods are; Brass, Coale and Trussel. While a simple polynomial model of fertility to know the relationship between cumulated fertility schedule and average parity for successive age groups was fitted by Brass. Coale and Trussel fitted a second degree polynomial which yielded equation (i) below.

$$\mathrm{F(i)} = \Phi(\mathrm{i}-1) + \mathrm{a(i)f(i)} + \mathrm{b(i)f(i+1)} + \mathrm{c(i)}\Phi(7) \qquad (1)$$

for $\mathrm{i} = 1,2,3, \ldots$ and $\mathrm{a(i)},\ \mathrm{b(i)}, \mathrm{c(i)}$ are constants and are shown in APPENDIX I

$$\mathrm{F(1)} = 0.0 + 2.531(0.0970) - 0.188(0.2511) + 0.0024(6.5655) = 0.2741$$

$$\mathrm{F(2)} = 0.4850 + 3.321(0.2511) - 0.754(0.2935) + 0.0161(6.5655) = 1.2033$$

$$\mathrm{F(3)} = 1.7405 + 3.265(0.2935) - 0.627(0.2868) + 0.0145(6.5655) = 2.6142$$

$$\mathrm{F(4)} = 3.2080 + 3.442(0.2868) - 0.563(0.2134) + 0.0029(6.5655) = 4.0941$$

$$\mathrm{F(5)} = 4.6420 + 3.518(0.2134) - 0.763(0.1187) + 0.0006(6.5655) = 5.3061$$

$$\mathrm{F(6)} = 5.7090 + 3.862(0.1187) - 2.481(0.0526) + 0.0001(6.5655) = 6.0363$$

However, for F(7) the value is computed using;

$$\mathrm{F(7)} = \Phi(6) + \mathrm{a(7)f(7)} + \mathrm{b(7)f(6)} + \mathrm{c(7)}\Phi(7)$$

$$\mathrm{F(7)} = 6.3025 + 3.828(0.0526) - 0.016(0.1187) + 0.0002(6.5655) = 6.5044$$

5. **Fertility Schedule for conventional five-year age groups** $(\mathbf{f^+(i)})$:

$\mathrm{f^+(i)}$ values are estimated by weighting the rates referring to unorthodox age groups using the equation below:

$$\mathrm{f^+(i)} = [1 - \mathrm{w(i-1)}]\mathrm{f(i)} + \mathrm{w(i)f(i+1)} \qquad (2)$$

Where; $\mathrm{w(i)} = \mathrm{x(i)} + \mathrm{y(i)} \times \frac{\mathrm{f(i)}}{\Phi(7)} + \mathrm{z(i)} \times \frac{\mathrm{f(i+1)}}{\Phi(7)}$

The values of x(i), y(i) and z(i) are constants and are shown in APPENDIX II

**NOTE:** Childbearing is assumed to cease after age 50; there is no weighting factor i = 7

$$\therefore \mathrm{f^+(7)} = [1 - \mathrm{w(6)}]\mathrm{f(7)}$$

$$\mathrm{w(1)} = 0.031 + 2.287 \times \frac{0.0970}{6.5655} + 0.114 \times \frac{0.2511}{6.5655} = 0.0692$$

$$\mathrm{w(2)} = 0.068 + 0.999 \times \frac{0.2511}{6.5655} - 0.233 \times \frac{0.2935}{6.5655} = 0.0957$$

$$\mathrm{w(3)} = 0.094 + 1.219 \times \frac{0.2935}{6.5655} - 0.977 \times \frac{0.2868}{6.5655} = 0.1058$$

$$\mathrm{w(4)} = 0.120 + 1.139 \times \frac{0.2868}{6.5655} - 1.531 \times \frac{0.2134}{6.5655} = 0.1200$$

$$\mathrm{w(5)} = 0.162 + 1.739 \times \frac{0.2134}{6.5655} - 3.592 \times \frac{0.1187}{6.5655} = 0.1535$$

$$\mathrm{w(6)} = 0.270 + 3.454 \times \frac{0.1187}{6.5655} - 21.497 \times \frac{0.0526}{6.5655} = 0.1605$$

The values of w(i) are then substituted in equation (2) to give the following results;

$$\mathrm{f^+(1)} = [1 - 0] \times 0.0970 + 0.0692 \times 0.2511 = 0.1144$$

$f^{+}(2) = [1 - 0.0692] \times 0.2511 + 0.0957 \times 0.2935 = 0.2618$
$f^{+}(3) = [1 - 0.0957] \times 0.2935 + 0.1058 \times 0.2868 = 0.2958$
$f^{+}(4) = [1 - 0.1058] \times 0.2868 + 0.1200 \times 0.2134 = 0.2821$
$f^{+}(5) = [1 - 0.1200] \times 0.2134 + 0.1535 \times 0.1187 = 0.2060$
$f^{+}(6) = [1 - 0.1535] \times 0.1187 + 0.1605 \times 0.0526 = 0.1089$
$f^{+}(7) = [1 - 0.1605] \times 0.0526 = 0.0442$

6. **Adjustment of period fertility schedule:**

This can be done by calculating the P/F ratios i.e average parity (column 5) divided by parity equivalent (column 9). For example, for age group,

15-19 $\frac{P(1)}{F(1)} = \frac{0.2352}{0.2141} = 1.0986$

20-24 $\frac{P(2)}{F(2)} = \frac{1.1919}{1.2033} = 0.9905$

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. .
. .

If the adjustment factor falls consistently between the age range 20-34, then the value of k would be estimated as the average of P(2)/F(2), P(3)/F(3), and P(4)/F(4). i.e.

$$k = \frac{P(2)/F(2) + P(3)/F(3) + P(4)/F(4)}{3}$$

Since, the adjustment factor does not fall consistently within this interval (i.e. 20-34). Then, k can be computed as weighted average of P(2)/F(2) and P(3)/F(3). The weights are the number of women in each age group as a proportion of women in both age groups

$$k = P(2)/F(2) \times \frac{FP(2)}{FP(2)+FP(3)} + P(3)/F(3) \times \frac{FP(3)}{FP(2)+FP(3)}$$
$$= 0.9905 \times \frac{6133}{6133+6309} + 0.9619 \times \frac{6309}{6133+6309} = 0.976$$

Then, the adjusted age-specific fertility rates for conventional age groups $f^{*}(i)$ can be estimated by simply multiplying the $f^{+}(i)$ values by the adjustment factor **k**. For example;

$f^{*}(1) = kf^{+}(1) = 0.976 \times 0.1144 = 0.1117$

$f^{*}(2) = kf^{+}(2) = 0.976 \times 0.2618 = 0.2555$

7. The adjusted total fertility rate for the total sample is then estimated as multiplying the sum of age-specific fertility rate $f^{*}(i)$ by 5

$TFR = 5 \times \sum f^{*}(i) = 5 \times 1.281 = 6.41$

The same procedures were used for the computations of adjusted TFR for both rural and urban areas. The values are shown in Tables 2 and 3.

**E 1**. REPORTED PERIOD AND ADJUSTED FERTILITY RATES FOR CONVENTIONAL AGE GROUPS, NIGERIA, NDHS, 2008

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | **11** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age group** | **CEB(i)** | **Births 1-year** | **FP(i)** | **P(i)** | **f(i)** | **Φ(i)** | **F(i)** | $f^{+}(i)$ | **P/F** | $f^{*}(i)$ |
| 15-19 | 1527 | 630 | 6493 | 0.2352 | 0.0970 | 0.4850 | 0.2141 | 0.1144 | 1.0986 | **0.1117** |
| 20-24 | 7310 | 1540 | 6133 | 1.1919 | 0.2511 | 1.7405 | 1.2033 | 0.2618 | 0.9905 | **0.2555** |
| 25-29 | 15864 | 1852 | 6309 | 2.5145 | 0.2935 | 3.2080 | 2.6142 | 0.2958 | 0.9619 | **0.2887** |
| 30-34 | 18256 | 1329 | 4634 | 3.9396 | 0.2868 | 4.6420 | 4.0941 | 0.2821 | 0.9623 | **0.2753** |
| 35-39 | 20578 | 835 | 3912 | 5.2602 | 0.2134 | 5.7090 | 5.3061 | 0.2060 | 0.9913 | **0.2011** |
| 40-44 | 18727 | 360 | 3032 | 6.1765 | 0.1187 | 6.3025 | 6.0363 | 0.1089 | 1.0232 | **0.1062** |
| 45-49 | 19651 | 151 | 2872 | 6.8423 | 0.0526 | 6.5655 | 6.5044 | 0.0442 | 1.0519 | **0.0431** |
| **TOTAL** | | | **33,385** | | **1.3131** | | | **1.3132** | | **1.2816** |
| **Total fertility rate............** | | | | | | | | | | **6.41** |

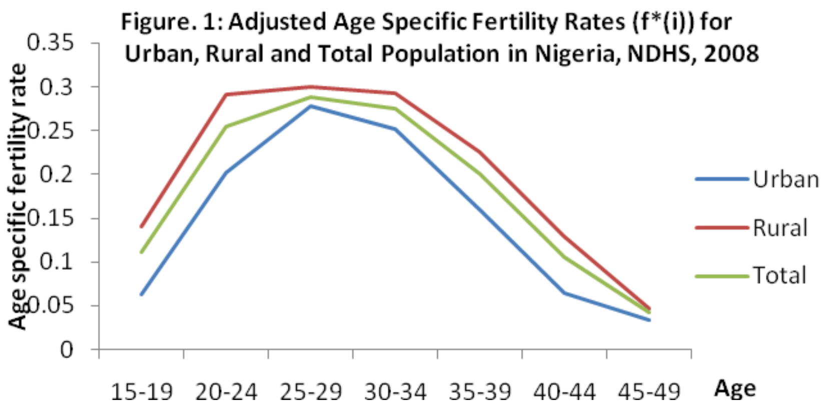
**E 2**. REPORTED PERIOD AND ADJUSTED FERTILITY RATES FOR CONVENTIONAL AGE GROUPS, **URBAN** NIGERIA, NDHS, 2008

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | **11** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age group** | **CEB(i)** | **Births 1-year** | **FP(i)** | **P(i)** | **f(i)** | **Φ(i)** | **F(i)** | $f^{+}(i)$ | **P/F** | $f^{*}(i)$ |
| 15-19 | 250 | 118 | 2268 | 0.1102 | 0.0520 | 0.2600 | 0.1086 | 0.0629 | 1.0147 | **0.0621** |
| 20-24 | 1791 | 430 | 2261 | 0.7921 | 0.1902 | 1.2110 | 0.7672 | 0.2048 | 1.0325 | **0.2023** |
| 25-29 | 4679 | 678 | 2432 | 1.9239 | 0.2788 | 2.6050 | 2.0338 | 0.2821 | 0.9460 | **0.2786** |
| 30-34 | 5436 | 449 | 1709 | 3.1808 | 0.2627 | 3.9185 | 3.4282 | 0.2556 | 0.9278 | **0.2525** |
| 35-39 | 5986 | 232 | 1354 | 4.421 | 0.1713 | 4.775 | 4.470 | 0.1616 | 0.989 | **0.159** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0 | | 0 | 2 | | 0 | **6** |
| 40-44 | 5533 | 73 | 1028 | 5.3823 | 0.0710 | 5.1300 | 4.9502 | 0.0651 | 1.0873 | **0.0643** |
| 45-49 | 5284 | 35 | 882 | 5.9909 | 0.0397 | 5.3285 | 5.2820 | 0.0335 | 1.1342 | **0.0331** |
| **TOTAL** | | | **11934** | | **1.0657** | | | **1.0656** | | **1.0525** |
| | | **Total fertility rate............** | | | | | | | | **5.26** |

**E 3**. REPORTED PERIOD AND ADJUSTED FERTILITY RATES FOR CONVENTIONAL AGE GROUPS, **RURAL** NIGERIA, NDHS, 2008

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | **11** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Age group** | **CEB(i)** | **Births 1-year** | **FP(i)** | **P(i)** | **f(i)** | **Φ(i)** | **F(i)** | $f^{+}(i)$ | **P/F** | $f^{*}(i)$ |
| 15-19 | 1273 | 512 | 4225 | 0.3013 | 0.1212 | 0.6060 | 0.2702 | 0.1424 | 1.1151 | **0.1400** |
| 20-24 | 5525 | 1110 | 3872 | 1.4269 | 0.2867 | 2.0395 | 1.4465 | 0.2952 | 0.9865 | **0.2902** |
| 25-29 | 11179 | 1174 | 3877 | 2.8834 | 0.3028 | 3.5535 | 2.9445 | 0.3046 | 0.9793 | **0.2994** |
| 30-34 | 12835 | 880 | 2925 | 4.3880 | 0.3009 | 5.0580 | 4.4772 | 0.2972 | 0.9801 | **0.2921** |
| 35-39 | 14591 | 603 | 2558 | 5.7041 | 0.2362 | 6.2390 | 5.7840 | 0.2296 | 0.9862 | **0.2257** |
| 40-44 | 13174 | 287 | 2004 | 6.5739 | 0.1432 | 6.9550 | 6.6479 | 0.1317 | 0.9889 | **0.1294** |
| 45-49 | 14444 | 115 | 1990 | 7.2583 | 0.0578 | 7.2440 | 7.1771 | 0.0482 | 1.0113 | **0.0474** |
| **TOTAL** | | | **21451** | | **1.4488** | | | **1.4489** | | **1.4242** |
| **Total fertility rate............** | | | | | | | | | | **7.12** |




**Computation of Maternal Mortality Ratio**

The data used for the analyses of MMR in NDHS 2008 survey are; How many sisters have you ever had, born to the same mother, who ever reached the age 15 (or who were ever married) including those who are now dead? How many of these sisters reaching age 15 are alive now? How many of these sisters are dead? How many of these dead sisters died during pregnancy or during childbirth, or during the six weeks after the end of the pregnancy? These questions are used to derive the proportions of adult sisters dying during pregnancy, childbirth or puerperium. Standard adjustment factors were used to convert these proportions into LTRMD which was later converted to MMR.

**TABLE 4**. ESTIMATION OF LIFE-TIME RISK OF MATERNAL DEATHS FOR CONVENTIONAL AGE GROUPS, FOR NIGERIA, NDHS, 2008

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Age group** | **Number of Respondents** | **Number of sisters 15 years and above** | **Maternal Deaths** | **Adjustment Factor** | **Sister Units of Risk Exposure** | **Life-Time Risk of Maternal Deaths** |
| 15-19 | 3,233 | **17,652*** | 68 | 0.107 | 1889 | 0.036 |
| 20-24 | 3,414 | **18,640*** | 157 | 0.206 | 3840 | 0.041 |
| 25-29 | 3,478 | 18,480 | 196 | 0.343 | 6339 | 0.031 |
| 30-34 | 2,684 | 14,912 | 191 | 0.503 | 7501 | 0.026 |
| 35-39 | 2,232 | 12,511 | 211 | 0.664 | 8307 | 0.025 |
| 40-44 | 1,684 | 9,362 | 184 | 0.802 | 7508 | 0.025 |
| 45-49 | 1,525 | 7,996 | 168 | 0.900 | 7196 | 0.023 |
| **TOTAL** | | | **1,175** | | **42,580** | **0.0276** |

***Derived by multiplying the number of respondents by the average number of ever-married sisters per respondent reported for the age groups 25+ i.e. 5.46. (Reported numbers: 15-19 = 12063, 20-24 = 15591)**

$$\square^{*} = \frac{\frac{18480}{3478}+\frac{14912}{2684}+\frac{12511}{2232}+\frac{9362}{1684}+\frac{7996}{1525}}{5} = 5.46$$

$$\text{Maternal Mortality Ratio} = 1 - [1 - \text{Lifetime risk of maternal deaths}]^{\frac{1}{\text{adj.TFR}}}$$
$$= 1 - [1 - 0.0276]^{\frac{1}{6.41}} = 436 \text{ per } 100\,000$$

**TABLE 5**. ESTIMATION OF LIFE-TIME RISK OF MATERNAL DEATHS FOR CONVENTIONAL AGE GROUPS, FOR **URBAN** NIGERIA, NDHS, 2008

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Age group** | **Number of Respondents** | **Number of sisters 15 years and above** | **Maternal Deaths** | **Adjustment Factor** | **Sister Units of Risk Exposure** | **Life-Time Risk of Maternal Deaths** |
| 15-19 | 1187 | **6647*** | 20 | 0.107 | 711 | 0.028 |
| 20-24 | 1358 | **7605*** | 48 | 0.206 | 1567 | 0.031 |
| 25-29 | 1417 | 7518 | 64 | 0.343 | 2579 | 0.025 |
| 30-34 | 1060 | 5842 | 66 | 0.503 | 2939 | 0.023 |
| 35-39 | 807 | 4678 | 68 | 0.664 | 3106 | 0.022 |
| 40-44 | 595 | 3352 | 46 | 0.802 | 2688 | 0.017 |
| 45-49 | 470 | 2703 | 42 | 0.900 | 2433 | 0.017 |
| **TOTAL** | | | **354** | | **16023** | **0.0221** |

***Derived by multiplying the number of respondents by the average number of ever-married sisters per respondent reported for the age groups 25+ i.e. 5.60. (Reported numbers: 15-19 = 3862, 20-24 = 6101)**

$$\text{Maternal Mortality Ratio} = 1 - [1 - \text{Lifetime risk of maternal deaths}]^{\frac{1}{\text{adj.TFR}}}$$
$$= 1 - [1 - 0.0221]^{\frac{1}{5.26}} = 424 \text{ per } 100\,000$$

**TABLE 6**. ESTIMATION OF LIFE-TIME RISK OF MATERNAL DEATHS FOR CONVENTIONAL AGE GROUPS, FOR **RURAL** NIGERIA, NDHS, 2008

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Age group** | **Number of Respondents** | **Number of sisters 15 years and above** | **Maternal Deaths** | **Adjustment Factor** | **Sister Units of Risk Exposure** | **Life-Time Risk of maternal deaths** |
| 15-19 | 2046 | **11028*** | 48 | 0.107 | 1180 | 0.0407 |
| 20-24 | 2056 | **11082*** | 109 | 0.206 | 2283 | 0.0477 |
| 25-29 | 2061 | 10962 | 132 | 0.343 | 3760 | 0.0351 |
| 30-34 | 1624 | 9070 | 125 | 0.503 | 4562 | 0.0274 |
| 35-39 | 1425 | 7833 | 143 | 0.664 | 5201 | 0.0275 |
| 40-44 | 1089 | 6010 | 138 | 0.802 | 4820 | 0.0286 |
| 45-49 | 1055 | 5293 | 126 | 0.900 | 4764 | 0.0265 |
| **TOTAL** | | | **821** | | **26570** | **0.0309** |

***Derived by multiplying the number of respondents by the average number of ever-married sisters per respondent reported for the age groups 25+ i.e 5.39. (Reported numbers: 15-19 = 8201, 20-24 = 9490)**

$$\text{Maternal Mortality Ratio} = 1 - [1 - \text{Lifetime risk of maternal deaths}]^{\frac{1}{\text{adj.TFR}}}$$

$$= 1 - [1 - 0.0309]^{\frac{1}{7.121}} = 440 \text{ per } 100\,000$$

## DISCUSSION

Sisterhood method was carried out for the first time in the Gambia (1987). The result indicates a lifetime risk of MM of 0.0584 or 1 in 17 which yielded a MMR of 1005 per 100 000 live births. This figure was higher than the previous estimate of MM in Gambia and the method provides an approach suited for estimating MM at a national and sub-national level. Sisterhood method of determining MM often provides data that are more comprehensive than facility-based records.

In Nigeria MM is known to be high, yet a major problem is unavailability of sufficient data to closely monitor the effectiveness of various interventions program [22]. This is because vital registration system (VRS) in Nigeria is poor, thus affecting the availability of data on MM. The VRS in Nigeria is poor because of its low level of completeness, reliability and validity. Unfortunately, only three national surveys had addressed the issue of MMR in Nigeria; the 1999 and 2008 NDHS and the multiple cluster indicator survey. This has posed numerous constraints on the effective; planning, management, monitoring and evaluation of maternal mortality reduction strategies. This paper therefore, used a sisterhood method which has one possible means of gauging the rural-urban MM level in Nigeria.

In developing countries, two methods are generally in use for the estimation of MMR. These are; the direct and the indirect [22], otherwise known as sisterhood method. In the NDHS 2008 report, direct method which was based on the report from reported survivorship of sisters for the six-year period before the survey was used to estimate MMR. Using the appropriate procedures, the MMR was 545/100 000 live births. However, due to deficiencies in the quality of data collection and reporting in developing countries like Nigeria, the present study was carried out. The data underwent series of demographic adjustments for the computation of TFRs that were used for the estimates. Moreover, the NDHS 2008 failed to address the urban-rural differential in MMR. This study therefore, adjusted the TFRs for both rural, urban and the total sample using the P/F ratio method. The results showed that the Adj.TFR for rural, urban and total were 7.12, 5.26 and 6.41 respectively. These were used for the estimation of MMR.

The LTRMD was 0.0309 (1 in 32) in rural and 0.0221 (1 in 45) in urban area. The estimated MMR displayed a plausible pattern, being higher in rural (440/100 000 live births) than urban (424/100 000) area. The national estimate of LTRMD and MMR were 0.0276 (1 in 36) and 436/100 000 live births respectively. If these figures are compared with international specification for high and low risks of maternal deaths that a lifetime risk of 1 in 3000 represents a low risk of dying from pregnancy and childbirth, while 1 in 100 is a high risk[13]. Therefore, the finding that for every 36 women, one will die of pregnancy and childbirth related conditions in Nigeria is highly frightening.

The MMR in Nigeria as shown in this study appears to be at pal with estimates obtained in other African countries. For instance, in year 2000, the estimate of MMR in Southeastern Tanzania, was 448 per 100 000 live births [23] while the estimates for the two samples of the population in rural Northern Tanzania were 362 and 444 per 100 000 live births respectively [24]. Also, the estimate of MMR carried out in two districts of the Brong-Ahafo region of Ghana in year 2000 was 269 maternal deaths per 100 000 live births for both districts combined (WHO 2001).

In conclusion, there is slight urban rural differential in MMR in Nigeria. However, the figures are still high at the two locations. Maternal mortality in Nigeria is reducing. Government and international agencies should put appropriate mechanisms in place for further reduction in the prevalence. The sisterhood technique is a simple and robust way of estimating MMR. The methodology was based on assumptions designed several years ago which may not really be applicable to the present time. Hence, the method should be refined to match on with the present day demographic system.

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## APPENDIX

**APPENDIX I:** COEFFICIENTS FOR INTERPOLATION BETWEEN CUMULATED FERTILITY RATES TO ESTIMATE PARITY EQUIVALENTS

| | | **Coefficients** | | |
|---|---|---|---|---|
| **Age Group** | **Index (i)** | **a(i)** | **b(i)** | **c(i)** |
| 15-19.............. | 1 | 2.531 | -0.188 | 0.0024 |
| 20-24.............. | 2 | 3.321 | -0.754 | 0.0161 |
| 25-29.............. | 3 | 3.265 | -0.627 | 0.0145 |
| 30-34.............. | 4 | 3.442 | -0.563 | 0.0029 |
| 35-39.............. | 5 | 3.518 | -0.763 | 0.0006 |
| 40-44................ | 6 | 3.862 | -2.481 | -0.0001 |
| 45-49.............. | 7 | 3.828 | 0.016* | -0.0002 |

**Adapted from United Nations Publication, Manual X**
***This coefficient should be applied to *f*(*i*-1), not *f*(*i*+1), that is, to *f*(6) instead of *f*(8)**

**APPENDIX II:** COEFFICIENTS FOR CALCULATION OF WEIGHTING FACTORS TO ESTIMATE AGE-SPECIFIC FERTILITY RATES FOR CONVENTIONAL AGE GROUPS FROM AGE GROUPS SHIFTED BY SIX MONTHS

| | | **Coefficients** | | |
|---|---|---|---|---|
| **Age Group** | **Index (i)** | **x(*i*)** | **y(*i*)** | **z(*i*)** |
| 15-19………….. | 1 | 0.031 | 2.287 | 0.114 |
| 20-24………….. | 2 | 0.068 | 0.999 | -0.233 |
| 25-29………….. | 3 | 0.094 | 1.219 | -0.977 |
| 30-34………….. | 4 | 0.120 | 1.139 | -1.531 |
| 35-39………….. | 5 | 0.162 | 1.739 | -3.592 |
| 40-44……………. | 6 | 0.270 | 3.454 | -21.497 |

**Adapted from United Nations Publication, Manual X**

***This coefficient should be applied to *f*(*i*-1), not *f*(*i*+1), that is, to *f*(6) instead of *f*(8)**