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Derivation and appraisal of maternal mortality estimates in Nigeria from the 2012 National HIV/AIDS and Reproductive Health Survey

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Abstract

Background: Despite the huge burden of in Nigeria, accurate and reliable data for maternal mortality measurement are lacking. The Federal Ministry of Health in collaboration with development partners included questions that allow indirect estimation of maternal mortality in its 2012 National HIV/AIDS and Reproductive Health Survey (NARHS). The aim of this paper was to derive estimates of Maternal Mortality Ratio (MMR) and Lifetime Risk of maternal death (LTR) from the 2012 NARHS data.

Methods: This was a secondary analysis of data from the maternal mortality module of NARHS 2012. During the survey, respondents (men aged 15-59 years and women aged 15-49 years) were selected via a multi-stage cluster sampling technique and data collected by trained field workers. In this study, report on survival or otherwise of adult female siblings were analysed to derive estimates of life time risk of maternal death using the indirect sisterhood method.

Results: Data from 15, 596 men and 15, 639 women were analysed. A total of 12,810 adult female siblings had been exposed to the risk of death out of which 377 (2.9%) have died. Of the 377 adult female deaths, 70 (18.6%) were pregnancy-related. The estimates of LTR and MMR were 1 in 71 women and 256 (95% CI: 196 – 316) maternal deaths per 100,000 livebirths respectively. There were north-south and rural-urban differences.

Conclusion: The high level of maternal mortality is worrisome, concerted efforts aimed at reduction and provision of routine data for its measurement should be intensified.

Keywords: *National HIV/AIDS and Reproductive Health Survey, Maternal mortality, Sisterhood method, Nigeria*

Résumé

Contexte: Malgré l'énorme fardeau au Nigeria, des données précises et fiables pour la mesure de la mortalité maternelle sont insuffisantes. Le ministère fédéral de la Santé, en collaboration avec les partenaires du développement, a inclus des questions qui permettent une estimation indirecte de la mortalité maternelle dans son Sondage Nationale sur le VIH / Sida et la Santé Reproductive (NARHS) de 2012. L'objectif de cet article était de tirer des estimations du Ratio de Mortalité Maternelle (RMM) et du Risque à Vie de mortalité maternelle (RV) à partir des données de NARHS 2012.

Méthodes: Il s'agissait d'une analyse secondaire des données du module de mortalité maternelle de NARHS 2012. Au cours du sondage, les répondants (hommes âgés de 15 à 59 ans et femmes âgés de 15 à 49 ans) ont été sélectionnés par une technique d'échantillonnage en groupe à plusieurs étapes et les données recueillis par des agents de terrain qualifiés. Dans cette étude, le rapport sur la survie ou autrement des sœurs adultes a été analysé afin de déterminer les estimations du risque à vie de mort maternelle en utilisant la méthode de la fraternité féminine indirecte.

Résultats: Les données provenant de 15.596 hommes et 15.639 femmes ont été analysées. Un total de 12.810 sœurs adultes avait été exposé au risque de décès, dont 377 (2,9%) sont décédés. Des 377 décès de femmes adultes, 70 (18,6%) étaient liés à la grossesse. Les estimations de RV et RMM étaient de 1 femme sur 71 et 256 (95% IC: 196 - 316) de décès maternels pour 100.000 naissances vivantes respectivement. Il y avait des différences nord-sud et rurales-urbaines.

Conclusion: Le taux élevé de mortalité maternelle est inquiétant, des efforts concertés visant à réduire et à fournir des données de routine pour sa mesure devraient être intensifiés.

Mots-clés: *Sondage Nationale sur le VIH / Sida et la Santé Reproductive, Mortalité maternelle, méthode de la fraternité féminine, Nigéria*

Introduction

In the last two decades, international efforts such as the safe motherhood initiative, International Conference on Population and Development,

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Millenium Development Goals (MDG) and several other initiatives have concentrated on the improvement of maternal and child health. India (19%) and Nigeria (14%) accounted for a third of global maternal deaths with an estimated risk of 1 in 31 women dying of pregnancy-related complications in Nigeria [1]. Thus, reduction of maternal mortality remains a top priority in the health development agenda for Nigeria and many other developing countries. However, the dearth of relevant, accurate, complete and reliable data has been the bane in the calculation of accurate mortality levels in Nigeria. An accurate estimation of the magnitude of maternal death is the first step towards reducing maternal morbidity and mortality [2]. The appropriate and most reliable data source for producing mortality estimates is a vital statistics registration system (VRS) with death certification. The lack of good quality vital resgistration system in most developing countries and indeed in Nigeria constitute a major impediment to accurate measurement of maternal mortality [1, 3, 4].

Due to poorly developed VRS, maternal mortality estimates in Nigeria could be attributed to three main alternative sources. The first and the most common estimates are those from health facility statistics/studies. These do not require special collection strategies and provide data on cause(s) of death. The limitations are obvious- they capture facility deaths only and thus may not adequately represent the population. Given the poor utilization of maternal care services in Nigeria, maternal deaths could have occurred outside the health facilities without being captured in facility records. Secondly, most facility-based studies that provided maternal mortality estimates were conducted in tertiary facilities which provide specialist/referral services [5-7]. Thus, there is likelihood that these figures are based on patients with higher obstetric risks than what obtains in the general population. Further evidence in support of this is the fact that more than 50% of maternal deaths occur among unbooked patients [5-9]. This selection bias may be one of the reasons for very high MMR reported in many of these facility-based studies.

The second source are those derived from statistical models by international agencies such as WHO and UNICEF. Such have been produced for 1990, 1995, 2000, 2005, 2008, 2010 and 2013. Maternal mortality ratio in Nigeria have ranged from 1200 in 1990 to 560 in 2013 [1]. Based on this, the country had an average annual decline of 3.1% between 1990 and 2013 and thus rated as making progresss but not on target to acheive MDG 5 [1]. Though, the models have been improved over the years, however, sub-national estimates have never been produced.

The third source of maternal mortality estimates in Nigeria are population-based surveys. Multiple Indicator Cluster Survey (MICS) and Nigeria Demographic and Health Survey (NDHS) are the only examples in this category. It is notable that most MICS conducted in Nigeria have rarely reported maternal mortality estimates even when requisite data have been collected. This is due to poor quality of data required for estimation- the commonest data quality problem being omission or under-reporting of births and deaths [10-12]. In 2008, the NDHS included a maternal mortality module for the first time in its eighteen year history. A MMR of 545 per 100,000 live births was estimated using the direct sisterhood method [13]. Government and several agencies were excited about this sharp decline from the 1100 model-based estimate for 2005. NDHS 2013 report showed that MMR for seven years preceding the survey is 576 with a comment that there was not much difference from the 2008 estimate [14]. There have been very few local household surveys in which the indirect sisterhood method has been employed to estimate MMR. The evidence from these studies however, varied widely from 450 in Lagos [15], 6525 in Ibadan [16] and 1400 in Kaduna [17].

The Federal Ministry of Health in collaboration with some international partners has conducted the National HIV/AIDS and Reproductive Health Survey (NARHS) since 2003. The survey has been repeated in 2005, 2007 and 2012. The main objective was to provide updated information on sexual and reproductive health in Nigeria as well as the factors influencing them [18]. In an effort to contribute to the empirical evidence on maternal mortality in Nigeria, a maternal mortality module similar to that in the NDHS was introduced in the 2012 round of NARHS. In this paper, we analysed the 2012 NARHS data to derive the MMR and lifetime risk of maternal death in Nigeria. We also provide estimates for the north, south regions, rural and urban settings. A critical appraisal of some of the factors that affect the accuracy and consistency of maternal mortality estimates in Nigeria was also undertaken.

Materials and method

The 2012 National HIV/AIDS and Reproductive Health and Serological Survey (NARHS Plus) was a cross-sectional study covering men and women of reproductive age. It involved a nationally representative sample of females aged 15-49 years and males aged 15-64 years living in households in rural and urban areas in Nigeria in all the 36 states and the Federal Capital Territory (FCT).

Multi-stage cluster sampling was used to select eligible persons. Stage 1 involved the selection of one rural and urban local government area (LGA) from each state and the FCT. Stage 2 involved the selection of Enumeration Areas (EA) within the selected rural and urban LGAs. Stage 3 involved the listing and selection of households while stage 4 involved selection of individual respondents for interview. Thirty- two individuals were sampled from each of the 30 sampled EA (clusters) from each state. Overall, 35,520 individual respondents were selected for final interview of which 31,235 individuals (88%) were successfully interviewed. The data was weighted to reflect differences in population sizes of the states.

Maternal mortality module in the NARHS 2012 questionnaire

The maternal mortality section of the questionnaire consisted of basic sibling survivorship questions such as: how many children did your mother give birth to, including you. For each sibling, respondents were asked about the name, gender, current age (if alive) and age at death (if dead). For every female sibling who was dead, questions were asked about circumstances surrounding death – whether pregnant; during childbirth; or within two months after a pregnancy/childbirth.

Estimation procedure

An indirect demographic estimation technique, the sisterhood method, was applied to obtain the life time risk of maternal death [19]. The method uses the proportions of adult female siblings (sisters) dead from pregnancy-related causes reported during a single round demographic survey to derive estimates of life-time risk of maternal death as follows:

Life-time risk of maternal death (LTR)

Numerator: number of female siblings of respondents who died during pregnancy, delivery or within two months of delivery by five–year age group of respondent.

Denominator: number of years of sister-units of exposure of female siblings of respondents by five-year age group of respondent.

Sisters-units of exposure was calculated by applying an adjustment factor to the number of sisters who were exposed to pregnancy risk. Sisters exposed to pregnancy risk are female siblings who were alive and aged at least 15 years or females who died at age 12 years and above from pregnancy-related causes.

The total life time risk of maternal mortality was obtained by the quotient of the sums of the age specific numerators and denominators.

Table 1: Socio-demographic characteristics of respondents, NARHS 2012, Nigeria

Variable	Male n(%)	Female n(%)
Age group		
15 - 19	2473 (15.9)	2770 (17.7)
20 - 24	2035 (13.0)	2813 (18.0)
25 - 29	2098 (13.5)	2902 (18.6)
30 - 34	1987 (12.7)	2349 (15.0)
35 - 39	1696 (10.9)	1761 (11.3)
40 - 44	1533 (9.8)	1561 (10.0)
45 - 49	1143 (7.3)	1483 (9.5)
50 - 54	1101 (7.1)	-
55+	1530 (9.8)	-
Residence		
Rural	10724 (68.8)	10733 (68.6)
Urban	4872 (31.2)	4906 (31.4)
Education		
No formal education	2810 (18.1)	4846 (31.0)
Quranic only	1358 (8.7)	900 (5.8)
Primary	2644 (17.0)	2620 (16.8)
Secondary	6403 (41.1)	5769 (36.9)
Higher	2349 (15.1)	1486 (9.5)
Marital status		
Married/Co-habiting	9229 (59.6)	10714 (69.1)
Never married	5774 (37.3)	3850 (24.8)
Separated/divorced	222 (1.4)	377 (2.4)
Widowed	147 (0.9)	499 (3.2)
No response	109 (0.7)	59 (0.4)
Region		
North Central	3055 (19.6)	2953 (18.9)
North East	2526 (16.2)	2349 (15.0)
North West	3116 (20.0)	3036 (19.4)
South East	2024 (13.0)	2258 (14.4)
South West	2468 (15.8)	2532 (16.2)
South South	2407 (15.4)	2511 (16.1)

Maternal mortality ratio (MMR)

This was calculated using the equation

$$MMR = 100{,}000 * [1 - [1 - LTR]^{(1/TFR)}]$$

TFR= total fertility rate

Though the LTR for the age groups could be utilised to investigate trends, the sample size was not sufficient for such investigation in this paper. Due to the very small number of cases of maternal deaths reported, it is preferrable to rely on the overall estimate of the life time risk of maternal mortality (using data for age group 15-49). The 95% confidence intervals (CI) for MMR was estimated using a procedure suggested by Hanley *et al* [20]. Standard errors, lower and upper confidence limits were obtained for LTR. These were then substituted into the MMR formular to obtain its lower and upper limits.

Results

The socio-demographic characteristics of the respondents are summarised in table 1. The sex distribution was balanced between male (49.9%) and

Table 2: Estimates of life-time risk of maternal death and maternal mortality ratio according to location, NARHS 2012, Nigeria

Population sub-group	Life-time risk of maternal death	Maternal Mortality Ratio (95% CI)*
Rural	0.0160 (1 in 63)	260 (190 - 330)
Urban	0.0101 (1 in 100)	215 (113 - 317)
North	0.0206 (1 in 49)	341 (251 - 432)
South	0.0067 (1 in 149)	150 (77 - 223)
Nigeria	0.0140 (1 in 71)	256 (196 - 316)

* per 100,000 live births

the sample with proportions ranging from 13.7% for South East to 19.7% for North West.

Maternal mortality estimates

A total of 12,810 adult female siblings had been exposed to the risk of death out of which 377 (2.9%) have died. Of the 377 adult female deaths, 70 (18.6%) were pregnancy-related. The distribution of adult female deaths and proportion of pregnancy-related deaths varied widely between the north (23.7%) and the south (10.7%) and between rural (20.7%) and urban (14.0%) settings.

Table 3. Maternal mortality estimation for Rural and Urban Nigeria using the indirect sisterhood method, NARHS 2012.

	Age group of respondents (1)	No of respondents (2)	No of sisters exposed (3)	Adult female deaths (4)	Maternal deaths (5)	Adjustment factor (6)	Sist unit of risk exposure (7) = (3) x (6)	LTR (8) = (5)/ (7)
	15-19	1638	796	15	6	0.107	85	0.0704
	20-24	1537	736	19	2	0.206	152	0.0132
	25-29	1707	821	27	4	0.343	282	0.0142
	30-34	1524	638	18	0	0.503	321	0.0000
	35-39	1150	479	12	5	0.664	318	0.0157
	40-44	955	341	13	0	0.802	273	0.0000
	45-49	858	288	17	0	0.900	259	0.0000
	Total			121	17		1690	0.0101
Rural	15-19	2983	1716	16	1	0.107	184	0.005
	20-24	2674	1505	25	7	0.206	310	0.023
	25-29	2731	1505	56	13	0.343	516	0.025
	30-34	2322	1171	42	15	0.503	589	0.025
	35-39	1945	903	35	8	0.664	600	0.013
	40-44	1718	703	31	5	0.802	564	0.009
	45-49	1514	604	51	4	0.900	544	0.007
	Total			256	53		3306	0.0160
Overall	15-19	4553	2512	31	7	0.107	269	0.026
	20-24	4134	2241	44	9	0.206	462	0.019
	25-29	4369	2326	83	17	0.343	798	0.021
	30-34	3788	1809	60	15	0.503	910	0.016
	35-39	3064	1382	47	13	0.664	918	0.014
	40-44	2644	1044	44	5	0.802	837	0.006
	45-49	2341	892	68	4	0.900	803	0.005
	Total			377	70		4996	0.0140

LTR – Life time risk of maternal death

female (50.1%). A larger proportion were in age group 25-29 years (male – 13.5%, female-18.6%) while about one third were living in rural areas. More females (31.0%) than males (18.1%) had no formal education but overall, about half of males (56.2%) and females (47.4%) had at least a secondary education. Table 1 also shows that all the six geo-political zones (regions) are evenly represented in

Table 2 shows the estimates of life-time risk of maternal deaths and maternal mortality ratio according to location and region (North and South). In rural locations, 1 in every 63 women were estimated to be at risk of death during pregnancy, childbirth or the puerperium in the reproductive life time. This is higher than the estimate for urban locations where the risk was 1 in every 100 women.

The corresponding MMR were 260 (95% CI: 190 – 330) and 215 (95% CI: 113 – 317) maternal deaths per 100, 000 live births in the rural and urban locations respectively. In the Northern regions (North West, North East and North Central), the MMR was estimated as 341(95% CI: 251 – 432) maternal deaths per 100,000 live births compared to 150 (95% CI: 77 – 223) per 100,000 in the Southern regions of Nigeria. The overall MMR and LTR for the entire nation were estimated as 256 (95% CI: 196 – 316) per 100, 000 and 1 in 71 women respectively. Details of the computations are shown in tables 3 and 4.

Differences in base data

Data differences could arise if the questionnaire used for data collection has substantial variations. Therefore, the logical approach to systematically assess data differences is to compare the questionnaire module for collecting maternal mortality in the NARHS 2012 with that of the NDHS 2008 and 2013. It is observed that both NARHS 2012 and NDHS 2013 used sibling history approach in data collection. However, the questions in NARHS 2012 were slightly different and this could have contributed to differences in the estimates of MMR

Table 4. Maternal mortality estimation for Northern and Southern Nigeria using the indirect sisterhood method

	Age group of respondents (1)	No of respondents (2)	No of sisters exposed (3)	Adult female deaths (4)	Maternal deaths (5)	Adjustment factor (6)	Sist unit of risk exposure (7) = (3) x (6)	LTR (8) = (5)/ (7)
North	15-19	1638	1187	18	2	0.107	127	0.0157
	20-24	1537	1200	20	8	0.206	247	0.0324
	25-29	1707	1265	56	16	0.343	434	0.0369
	30-34	1524	993	38	15	0.503	499	0.0300
	35-39	1150	736	30	8	0.664	489	0.0164
	40-44	955	555	28	3	0.802	445	0.0067
	45-49	858	418	38	2	0.900	376	0.0053
	Total			228	54		2618	0.0206
South	15-19	2983	1325	13	5	0.107	142	0.035
	20-24	2674	1041	24	1	0.206	214	0.005
	25-29	2731	1061	27	1	0.343	364	0.003
	30-34	2322	816	22	0	0.503	410	0.000
	35-39	1945	646	17	5	0.664	429	0.012
	40-44	1718	489	16	2	0.802	392	0.005
	45-49	1514	474	30	2	0.900	427	0.005
	Total			149	16		2378	0.0067

Discussion

The MMR of 256 per 100,000 live births obtained in this study is lower than estimates from the NDHS 2013 and WHO estimates for 2013 as well as other evidence from local community studies [15, 21, 22]. However, the LTR of 1 in 71 obtained in this study is lower than the 1 in 38 for Sub-Saharan Africa [1]. An important question for further consideration is: why is the NARHS 2012 estimates low compared to those from other national surveys such as NDHS 2008 (545 per 1000 livebirths) and 2013 (576 per 1000 livebirths)? The discrepancies could be due to : (i) differences in the base data; (ii) data quality or (iii) differences in method of estimation. Each of these reasons are briefly expantiated.

from NARHS 2012 and NDHS 2013. The first question in the NARHS 2012 maternal mortality module is : *"How many children did your mother give birth to including you?"*. If the respondent is the only child of his mother, the section is ended on that note but if there are two or more births, interviewers proceeded to complete the sibling history by asking the next question which was " *How many of these births did your mother have before you were born*?".

In the NDHS 2008/2013, after this question, interviewers proceeded to collect detailed sibling history where questions were asked about name, sex, current age of living sibling, age at death and years since death of dead siblings. Respondents were also asked whether death of female siblings occur in pregnancy, child birth or six weeks after pregnancy/ childbirth. Following the second question, NARHS

2012 had an additional instruction which the NDHS did not have. The instruction was that interviewers should *skip the sibling history questions if the respondent is oldest child.* The implication of this is that NARHS 2012 only collected sibling history data from respondents who were not the oldest children of their mother. In other words, first born respondents were excluded from data collection in the maternal mortality module. A further check on the frequency distribution of the number of preceding births as collected in the survey revealed that out of 27,077 respondents whose mothers had two or more births, 10, 252 (38%) were first births and subsequently exempted from reporting on the survival or otherwise of their siblings. This exclusion definitely reduced the number of siblings (brothers and sisters reported), the number exposed to the risk of death and ultimately, the number alive/dead. It is expected that first born respondents would have had more siblings. Therefore, excluding them must have resulted in omission/ under-reporting of births and deaths which eventually would cause any mortality estimate to be biased downward.

Data quality

Under-estimation of maternal mortality could also be as a result of data quality problems. We conducted some internal data quality checks on the NARHS 2012 sibling history data. For instance the sex ratio (male to female) of all siblings, living siblings and dead siblings were 1.24, 1.23 and 1.25 respectively. In Nigeria, evidence from NDHS shows that sex ratio among adult usually ranges between 0.97 and 1.02 [13, 14]. Based on this widely accepted demographic norm, female siblings were likely to have been under-reported. This could have resulted in under-estimation of MMR. Efforts should be made to overcome this weak points in future surveys in the country.

Diferences in method of estimation

The different methods of estimation ever used for maternal mortality in Nigeria have been summarised in the background section of this paper. Field experience from Nigeria and other countries showed that the direct and indirect method of estimating MMR from household survey data may yield different estimates[23, 24]. Adebowale *et al* (2011) computed an indirect estimate of MMR as 436; this was lower than the direct estimates in the NDHS 2008 report [25]. On the other hand, it appears there is convergence of evidence between maternal mortality estimates from NDHS 2008/2013 and those by WHO/UNICEF. This is premised on the closeness of NDHS 2013 MMR estimates (576) and model-based estimate of 560 from the WHO/UNICEF group[1]. The WHO model consisted of indicators such as general fertility rate (GFR), gross domestic product and proportion of births with skilled attendants at delivery. Evidence from 2013 NDHS showed that no improvement has been recorded in GFR and skilled attendants at delivery since 2003[14]. Same pattern was observed for antenatal care and other maternal and child health care services. This fact that not much success has been recorded in health systems improvement may be further credence to the near stagnation of maternal mortality at higher levels as shown by NDHS 2013 and 2008 estimates.

Suggestions for improving maternal mortality measurement in Nigeria

Maternal mortality estimates have been one of the most controversial health indicators in Nigeria. Any effort targeted at accurate measurement of mortality should be commended and supported by all stakeholders to provide plausible and incontrovertible estimates for Nigeria. One major lesson from NARHS 2012 maternal mortality estimated in this paper is the need to ensure that good quality data are collected. Collection of sibling history data is quite tasking given the level of literacy especially in the rural communities. Proper training and thorough monitoring of data collection processes can guarantee a better quality data in future surveys.Questionnaire modules that require special demographic techniques for analysis should be reviewed for correctness before field work.

Possible strategies to improve maternal mortality statistics in Nigeria [26] and other developing countries[4] have been suggested in the past. The first approach is to improve VRS. This is a long term strategy that requires necessary investment, strong political will, cooperation of all stakeholders such as National population Commission, National Bureau of Statistics, community leaders, religious leaders and others. Further practical steps for improving VRS in Nigeria are available from several sources[27, 28].

The second suggested strategy is to include questions on maternal deaths in the next population census scheduled for 2016. This could be followed up with verbal autopsy to ascertain the probable cause of death in the households. The next census provides a good opportunity for Nigeria as the extra cost of the additional questions would be very minimal compared to a dedicated survey on maternal mortality. Maternal mortality has been estimated

from censuses in Benin and Zimbabwe with very rich information provided[2, 29]. Nigeria could learn a lot from the experiences of these countries.

Another approach is the conduct of a nationwide maternal health survey with very large household size (range of 100,000 household). Such a large household sample survey would guarantee better precision and possibility of obtaining sub-national estimates which are seriously needed in Nigeria. The survey in Bangladesh[3, 30] is a good reference for this approach. The only challenge is the technical and financial resources that will be required but this should not be a limitation. The National Bureau of Statistics (NBS), National Population Commission(NPC), Federal Ministry of Health (FMoH) and international partners could pool resources together. Currently, NBS, NPC, FMoH - three government agencies conduct health-related surveys and all attempt to provide mortality estimates. These three can combine their resources and expertise to mount a big nationwide survey that can address their diverse data needs.

The fourth suggestion is continuation of facility-based studies. However, these should be improved upon to move it further from mere ocassional retrospective review of patients records for mortality to periodic audit inquiries to monitor quality of care and assess measures to reduce hospital mortality. It is also suggested that the culture of death certification be improved by re-training physicians and other health management information personnels on the correct use of International Classification of Disease codes.

Conclusion

Even though NARHS 2012 data may have under-estimated maternal mortality in Nigeria, the high level of maternal mortality is still worrisome considering the numerous intervention strategies by the government of Nigeria. Future surveys should design and implement field procedures that assure complete reporting of events and good data quality. The next population census should include questions to bridge the gap in maternal mortality estimation in Nigeria.

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