Variations in mortality estimates over time in Nigeria: explanations and implications for programme planning

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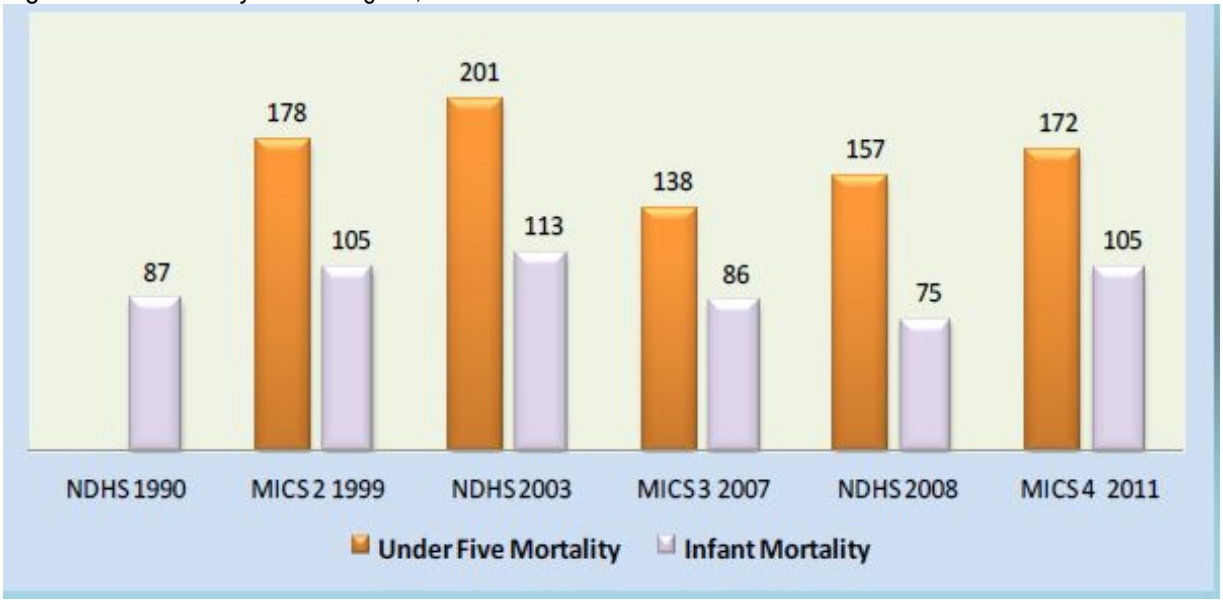
Introduction

One of the Millennium Development Goals calls for the reduction in under-five mortality by two-thirds between 1990 and 2015. Monitoring this goal is not only important but also a difficult task. Available data in Nigeria show that under-five mortality estimates have varied tremendously (Figure 1). These estimates have come from household survey responses of women of different age groups and at various points in time. Figure 1 shows that the Multiple Indicator Cluster Survey(MICS) estimates generally indicate an increase in infant mortality over time, and specifically between 2007 and 2011 (i.e., from 86 deaths per 1,000 live births to 105 deaths per 1,000 live births). Without further details, it is apparent that the estimates from the closest surveys are very different: the infant mortality rate from MICS 2007 was estimated at 86 deaths per 1,000 live births compared with 75 deaths per 1,000 live births from the 2008 Nigeria Demographic and Health Survey (DHS). When the Nigeria DHS and MICS data for consecutive periods are compared, results show that between 2003 and 2008, the DHS registered declines in under-five mortality as well as infant mortality rates whereas MICS 2007 and 2011 registered an increase in under-five and infant mortality rates.

Figure 1:Child mortality rates in Nigeria, 1990-2011



Source: National Bureau of Statistics, UNICEF, and UNFPA (2012, p.11), Figure CM2.

Why are these estimates different or fluctuating over time?

In order to explain the variations over time for the mortality estimates, it is important to reflect on data collection and estimation procedures used by the two major sources of child mortality data in Nigeria, MICS and DHS. It is important to note that technical experts for MICS and DHS belong to the United Nations Inter-agency Group for Child Mortality Estimation (CME). Formed in 2004, the CME Group shares data on child mortality, consolidates estimates within the United Nations system, improves estimation methods, reports progress towards the Millennium Development Goals and enhances country capacity to produce timely and properly assessed estimates of child mortality (UNICEF, et al. 2011). The CME Group comprises of leading academic scholars and independent experts in demography and biostatistics and provides guidance on estimation methods, technical issues, and strategies for data analysis and data quality assessment (UNICEF et al. 2011, p. 3).

It is well recognized that accurate estimates of child mortality cannot be generated from the largely high-quality deficient data in many developing countries due to the absence of complete vital registration systems. To overcome this, household surveys such as the UNICEF supported MICS and the USAID supported DHS have become the primary sources of data to estimate child mortality in many developing countries. Through the CME Group, UNICEF has since 2008 sent experts to about 10 countries to increase capacity in mortality estimation. Part of the variations in mortality estimates is, therefore, related to variations in data collection and estimation methods (Table 1).

Table 1: General comparison between the DHS and MICS on selected characteristics

Characteristics	Demographic and Health Survey	Multiple Indicator Cluster Survey
Sample size	Usually samples 5,000 to 30,000households although the sample size is sometimes larger than 30,000	Samples 4,000 to 5,000 households, although recent samples can range upto 30,000 households
Sample design in brief for Nigeria 2008 DHS and 2011 MICS	The primary sampling unit, 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.	The states within each zone were identified as the main sampling strata while the EAs within each state were identified as the main sampling units and the sample was selected in two stages. Within each state, 40 census EAs were selected systematically with equal probability. After a household listing was carried out within the selected EAs, a systematic sample of 20 households was drawn in each sample EA. All the 1,480 selected EAs were covered.
Data and calculation of mortality rates	• Sample survey collects birth histories, with a mother beingasked for information on the date of birth and, if relevant, the age at death of every live-born child she has had. • Using *direct methods*, both infant and under-five mortality rates can be calculated from the data, dividing deaths for given ages and time periods by exposure to risk in terms ofperson-years of life lived by the reported children. • *However, the collection of such information by surveys iscomplex and requires high levels of*	• Uses*indirect "Brass methods"* after Prof. William Brass who developedthe methodology. Each woman surveyed is asked for very simple information: her age, the total number of children she has borne, and the number of those children that have died. For a particular age group of women,the proportion of children dead depends primarily on two things: the level of under-five mortality, and thedistribution of the children by how long they have been exposed to risk. • The Brass method (and developments ofit) adjust the proportions dead by age group of mother for an estimated exposure distribution in order to arrive atpure measures of under-five mortality and of

	interviewer quality and training.	reference dates for these measures. *The adjustment processassumes certain patterns of fertility and under-five mortality by age, and results can be quite sensitive to thechoices made.*
Syntheses of direct and indirect methods	Mortality estimates from direct methods • Depends crucially on the quality of the data collected on women's last child born and their vital status. • Generally, evidence on data quality from developing country censuses (for estimates derived from censuses) is not encouraging.	Mortality estimates from indirect Brass methods • Still the standard indirect method of estimating child mortality. • Derivation of trends depends crucially on an assumption of underlying pattern of mortality o Many countries do not follow these model life table's mortality (e.g., Nigeria is assumed to follow North model based on MICS 2011 report). • Current research attempts to derive refinements to the method that compensates these flaws but progress has been slow.

Source: Compiled from various technical documents on demographic estimation.

One of the disadvantages of the indirect methods is their inability to locate their mortality estimates in time. Indirect methods estimate the probability of a child dying based onwomen's experience that can extend back as many as 20 years. Methods used toassign mortality estimates to a particular number of years before the survey assume thatthere has been little or no change in fertility levels and age patterns, and either no changeor a linear decline in mortality—which may or may not be true (Rutstein and Rojas,2006). Again, while an attempt to discuss all the technical details related to mortality estimation in the DHS and MICS is beyond the scope of this brief, it should be noted that estimates generated based on the comparison in Table 1 are bound to be different because surveys are technically different in terms of:

- Degree of sampling errors which has an implication on the size of the confidence intervals thereby making comparison of survey estimates somewhat problematic;
- Degree of non-sampling errors in part because they are dependent on women's ability to recall events that took place in the distant past;
- Omission of births and deaths, and the influence of survivor selection bias and age truncation;
- Misreporting of dates for events such as births and deaths;
- Age heaping, or preference for certain ages, which may lead to and transfer of deaths across one-year boundary and lead to underestimates of infant mortality rates. Hence, household surveys are considered to produce more robust estimates of under-five mortality rates than infant mortality rates.

Apart from variations or differences in methodological issues between surveys, under-five mortality rates can also be influenced by variations or trends in some determinants such as:

- % of mothers with schooling (for births last 5 years);
- % of deliveries with skilled attendance (for births last 5 years);;
- % of mothers receiving tetanus toxoid injections at least once during pregnancy (for births last 5 years);

- % of children received all childhood vaccines (for children 12-23 months);
- % of children ever breastfed (for births last 5 years);
- income per capita; and many others.

Understanding survey results on mortality estimates

(i) Use of confidence intervals

Confidence intervals provide information on the precision of mortality estimates and it is important to ensure that confidence limits for a mortality rate account for the survey design and utilize an acceptable methodology (Sullivan et al. 2010). Nevertheless, mortality estimates provided in large household survey reports lack confidence intervals. As a result, it is problematic to assess whether estimates from two surveys fall within the 'same' confidence interval. For example, the MICS 2007 under-five mortality was 138 whereas the corresponding rate in the Nigeria DHS 2008 was 157. While the Nigeria 2008 DHS is higher by 19 points, none of the two sources provided confidence intervals. It is possible that the confidence intervals for the two estimates may overlap.

(ii) Understanding trends

Based on the points highlighted earlier on some of the methodological challenges of households surveys and their comparison over time, it is unrealistic to expect the rates to be the same. The magnitude may always be different. Of importance is the direction of the trends. That is, point values are not the critical issue but how values are behaving over time or over periods of implementation of maternal and child health interventions. Going back to Figure 1, the DHS shows a decline in under-five mortality rate between 2003 and 2008 whereas MICS shows an increase in the same indicator between 2007 and 2011. Assuming the 2003, 2007, 2008, and 2011 data points come from the same source, it would be clear that under-five mortality rate declined between 2003 and 2007 and increased thereafter. For the infant mortality rate, one would see that it declined from 2003 and 2008 and increased in 2011. There seems to be a clear trend that between 2007 and 2011, under-five mortality rate had increased. Certainly, that's the key message for policy makers and other stakeholders.

(iii) Employing decomposition and other techniques to understand mortality trends

Unstable mortality rates over time make it very difficult to meaningfully interpret data and other techniques have to be applied in order to create a clearer picture of the pattern over time. One step towards improving the interpretability of the mortality rates is to transform them on a logarithmic scale. A log transformation of the data provides more appropriate and realistic results because it "flattens" the series of rates. While the overall shape of the trend is constant, the rate of increase of decrease is somewhat altered. For example, if rates are decreasing over time and no transformation is made, future projections will eventually predict the occurrence of zero health events, but the log transformation will slow the approach to zero (and in fact never reach zero) making any projection of future rates more reasonable. Other methods include moving averages, time series analysis, and regression methods.

However, to get a firmer understanding of explanations for unstable rates, public health specialists need to employ decomposition techniques (or simply, disaggregating the indicators by some socioeconomic or cultural determinants) that have been employed elsewhere (e.g., Kintner 1994) to examine changes in under-five or infant mortality rates. Decomposition or disaggregation techniques can unravel the effects of factors such as measures of economic development, access to medical care (e.g., skilled delivery), marital

fertility, population density, maternal and child welfare clinics, *etc*, on the areal and temporal variation in infant or under-five mortality. Most of the data are readily available for employing such methods. Thus, any rapid drop or increase in infant and under-five mortality should be viewed as a product of social, economic, demographic, medical, and public health variables (Kintner 1994). Unless such disaggregation methods are employed at the national or sub-regional level, understanding unstable trends in under-five mortality rates will always be a complex task in a complex environment.This was also echoed by Cornia and Mwabu (1997, p.19) who highlighted the eclectic model of mortality for low-income countries in sub Saharan Africa using the following equation:

IMR/U5MR/MMR = *f*(PCY, PHC, LIT, SHOCKS, RETI, U) ..... (1)

where;

IMR/U5MR/MMR = Infant, under-five, and maternal mortality rate/ratio;
PCY = per capita household income;
PHC = population health coverage indicators;
LIT = literacy rate, especially for females;
SHOCKS = exogenous shocks such as famines, wars, epidemics;
RETI = region- or time-specific factors;
U = disturbance term.

A detailed discussion of equation (1) has been presented by Cornia and Mwabu (1997). In brief, the model attempts to capture both the short- and the long-term effects on mortality. The effects of famine for example, may be short-lived while those of the literacy rates are long-lasting. As a result, the relative effect of each of the factors included in the model has a significant impact on mortality rates.

Implications of unstable trends in under-five mortality rates for programme planning

Majority of international donors are working in developing countries with complex socio-economic environments. Most of their programmes consist of interventions which are known to be very effective yet deployment of such interventions usually has less control over some of the factors contained in equation (1) above. Even if such programmes contain some interventions to address critical factors associated with equation (1), in many cases only a few of the problems/factors are addressed by the intervention packages. Therefore, donor agencies need to understand that the impact of their interventions may be affected by the national or state dynamics in socio-economic factors whichare often beyond their control. The key is to determine whether any observed unstable mortality estimates are within an acceptable range. In countries where most health metrics are obtained from household surveys - which are prone to a number of methodological challenges and coupled with a complex socio-economic environment - trends in unstable mortality rates may be inevitable. Efforts should be pursued to commission studies that attempt to disaggregate the observed mortality rates or any other health indicators. Such studies would be able to explain variations in the observed rates and provide a framework for reference on the progress made by donor programmes.

Conclusion

Child mortality rates in Nigeria have varied a great deal during the last decade and half. The mortality estimates have been derived from data generated from household surveys which are prone to sampling and

non-sampling errors. Although the sample designs and sizes have been generally consistent across the DHS and MICS, the methods used to generate the estimates have also been different with the DHS using more robust direct methods and the MICS using standard indirect methods. While efforts to seek explanations for the unstable trends are ongoing, it is imperative for stakeholders to seek studies that employ more detailed and robust disaggregation methods that take into account the relative impact ofsocial, economic, demographic, medical, and public health variables on mortality rates. This will be crucial in assessing the effectiveness of selected interventions in reducing mortality rates. To sum, unstable (or stable) trends in mortality rates should be interpreted within the context of the behavior of measures of socioeconomics and other determinants of maternal and child health.

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