Detecting and Correcting for Bias in DHS Infant and Child Mortality Estimates

Thomas W. Pullum, tom.pullum@mail.utexas.edu
Jeremiah M. Sullivan, jeremiah.m.sullivan@gmail.com

Introduction

Surveys conducted as part of the Demographic and Health Surveys (DHS) program are a major source of international indicators related to fertility, family planning, maternal and child health, and a variety of specific topics. Birth histories, collected as part of the surveys of women age 15-49, are primarily intended to measure levels, trends, and differentials in fertility. However, they are also used in country reports and comparative analyses to measure levels, trends, and differentials in infant and child mortality. This paper is an assessment of the quality of the mortality estimates, particularly with respect to possible biases.

In virtually all countries where these surveys are conducted, the vital statistics systems are inadequate for the estimation of either fertility rates or infant and child death rates. Despite the absence of solid reference values, with which the direct estimates of infant and child mortality using DHS birth histories can be compared and validated, the DHS estimates usually appear to be plausible.

In a recent assessment of the quality of age and date reporting in all DHS household surveys and surveys of women, Pullum evaluated DHS infant mortality rates by looking at correspondences in pairs of successive surveys. [This assessment appeared as DHS Methodological Report #5, published in December 2006. The following section, which serves as a motivation for the current paper, is largely drawn from section 4.5 of that report. That report looked at DHS surveys through 2003, but the PAA paper would include a few more recent surveys.]

Evidence of bias in DHS estimates of infant mortality

Two successive surveys in the same country can be compared in terms of their estimates of infant mortality for a reference period before the first survey. This comparison will be described for 66 pairs of successive DHS surveys in the same country, usually about five years apart. The reference period is the five calendar years prior to the year in which the fieldwork for the first survey began. The estimate from the first survey is taken as the reference value. The estimate from the second survey will be compared with the estimate from the first survey. It is generally thought that the estimate from the first survey would be more accurate and suffer less omission of events (particularly births of deceased children) as the recall period for respondents is shorter.

For about three-quarters of the comparisons, the second estimate is higher than the first estimate. The greatest arithmetic differences are 49 points for Nigeria (the 1999 and 2003 surveys) and 47 points for Mali (the1987 and 1995 surveys). The greatest relative difference, by far, is for

Colombia, where the 1995 survey estimate for 1985-89 was 102% greater than the 1990 survey estimate had been for the same period.

A *z* statistic can be calculated to test the null hypothesis that the two estimates are consistent. (This statistic is based on a pooling of each pair of individual-level files and is adjusted for sampling weights and geographic clustering.) Of the 66 pairs of surveys for which this statistic was computed, 53 are in a range from -2 to +2 and would be judged to be consistent. In several cases, the difference is fairly large, either arithmetically or relatively, but is not statistically significant. For example, the Dominican Republic 2002 survey gives an estimate for 1994-98 that is 40% higher than the 1999 survey. However, both of the estimates were fairly low (an IMR of 25 using the 1999 survey and 35 using the 2002 survey), so there were few deaths, and the z statistic was only 0.98.

Twelve pairs of surveys with significantly different estimates (at the .05 two-tailed level) are listed in table 1. One pair of surveys had a significant difference in a negative direction: the Namibia 2000 survey gave a lower estimate for 1987-91 than the 1992 survey. For the other eleven pairs of surveys in table 4.5.1, the second estimate was higher than the first. These include surveys from Bolivia (1989 and 1993), Comoros (1991 and 1998), Colombia (1990 and 1995), Egypt (1992 and 1995), Haiti (1994 and 2000), Indonesia (1997 and 2000), Mali (1987 and 1995), Nigeria (1999 and 2003), Niger (1992 and 1998), Nepal (1996 and 2001), and Tanzania (1996 and 1999). All geographical regions are represented on this list.

Table 1. Pairs of surveys with statistically significant (at the .05 level) discrepancies between their estimates of infant mortality during a reference period before the first survey.

Column (1): Country
Column (2): Median year of first survey
Column (3): Median year of second survey
Column (4): IMR estimate for reference period from first survey
Column (5): IMR estimate for reference period from second survey
Column (6): Arithmetic difference, (5)-(4)
Column (7): Relative difference (as a percentage), 100*(6)/(4)
Column (8): z statistic

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bolivia	1989	1993	83	97	15	17.84	2.02
Cameroon	1991	1998	62	79	18	28.41	2.03
Colombia	1990	1995	17	34	17	102.77	4.31
Egypt	1992	1995	63	78	15	23.48	3.07
Haiti	1994	2000	74	109	35	46.96	4.37
Indonesia	1997	2002	44	53	9	20.32	2.10
Mali	1987	1995	106	153	47	44.85	4.60
Namibia	1992	2000	58	42	-16	-27.81	-2.07
Nepal*	2052	2057	82	94	12	15.05	2.12
Niger	1992	1998	123	147	25	20.06	3.03
Nigeria	1999	2003	74	124	49	66.73	6.96
Tanzania	1996	1999	83	117	33	40.14	3.14

* The Nepalese surveys were conducted in 2052 and 2057 in the Nepalese calendar, 1996 and 2001 in the western calendar.

These results are contrary to expectation and suggest that some sort of systematic distortion is occurring in the observed data. In addition to the discrepancies between pairs of surveys, probable distortions can be found within single surveys. A recent example is the Cambodia 2005 survey. According to the main report on that survey (page 124), the IMR (1q0) declined from 109 (deaths per 1000 births), 5-9 years before the survey, to 66, 0-4 years before the survey . Such a rapid decline seems implausible, especially considering that the child mortality rate (4q1) only declined from 21 to 19 during the same interval of time and that the Cambodia 2000 survey indicated that the IMR was steady and, if anything, increasing. The estimate of 109 is probably too high, and the estimate of 66 is probably too low.

We have re-estimated the recent rates with a longer reference period, which extends back to January 1999, a full year prior to the cutoff date for the health questions (which in this survey was January 2000). A comparison of results between the published DHS rates and the re-estimated rates follows:

Table 2. Estimates of infant and child mortality in the Cambodia 2005 DHS survey. The published DHS estimates refer to 0-4 years before the survey. The re-estimates refer to 0-5 years before the survey.

Mortality rate	*DHS*	*Re-estimates*	*% change*
Neontal	28.4	33.3	+17.2
Post-neonatal	37.2	45.4	+22.0
1q0	65.6	78.7	+20.0
4q1	18.9	17.8	- 5.7
5q0	83.3	98.4	+14.2

The re-estimated rates pertain to a somewhat earlier time period. Nevertheless, these results leave little doubt that the DHS rates for the period closest to the survey are substantially too low. Similarly, re-estimation for the 5-year period January 1994 through December 1998 (7-11 years before the survey) shows lower mortality rates than those published by DHS rates for 5-9 years before the survey. Accordingly, the time trend of the re-estimated rates is markedly different than that shown on page 124 of the survey report.

Mechanisms behind the bias

DHS surveys include detailed questions about the health of young children, including immunizations, nutrition, and often some additional country-specific topics. In most surveys, these questions are asked about all children born during the five years before the survey. It has long been recognized that some interviewers, in some surveys, tend to displace children backwards, across the boundary of the health questions, typically January of the calendar year 5 or 6 years before the survey, to reduce their workload.

Most of the concern with such displacement has focused on how it affects fertility estimates. When it occurs, displacement is indicated by a dip in the reported number of births during the year after the boundary, and a bump in the reported number for the year before the boundary.

The result is an under-estimate of births 0-4 years before the survey, an over-estimate of births 5-9 years before the survey, and an over-estimate of any decline across the two intervals.

This phenomenon would not, in itself, distort mortality rates, because those rates are based on the children who are reported. A case that is lost to the denominator of a mortality rate will only affect that rate if children who died have a different probability of being transferred than children who survived. However, tables 1 and 2 above, other country-specific investigations of mortality trends, and a more detailed analysis of birth transfers, suggest that, indeed, deceased children have a higher probability of being transferred. We hope to better understand why such children are transferred at a higher rate. The reason is not immediately obvious; more health-related questions are asked about children who survived than about children who died. We have hypotheses but will not develop them here.

The PAA paper will focus on the pairs of surveys listed in table 1, then on surveys with internal evidence of displacement in births, and then on surveys, such as Cambodia 2005, that have shown suspiciously rapid recent declines in infant mortality. Our objectives are to see if there is differential birth displacement according to survivorship status, and to develop procedures to correct for any resulting bias in estimated mortality rates. We envision a series of graphs for ten or so countries depicting trends in mortality using DHS estimated rates for standard 5-year time periods, contrasted with trends based on modified time periods or adjusted rates.

Pullum has a great deal of experience with DHS data and is the author of Methodological Report #5, cited above, and of the forthcoming Methodological Report #6, on the quality of maternal and child health in DHS surveys conducted from 1993 through 2003. Sullivan developed well-known methods of indirect estimation and was a senior researcher with DHS until he recently retired. The *immediate* motivation for this paper is a concern about some DHS mortality estimates that were raised at an "Interagency Coordinating Group Meeting on Mortality Estimation" in July 2007, at which Sullivan represented DHS. This coordinating group includes representatives from the UN, UNICEF, CDC, the US Census Bureau, the World Bank, etc. There is widespread interest in the results. The authors will have complete access to DHS data and cooperation with DHS staff.