Mortality Decline in Kenya: In search of Explanations

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Background to the problem:

Kenya enjoyed a rather impressive and sustained decline in under 5 mortality rate (U5MR) of 3 percent to 4 percent per annum during the period from 1965 to 1980(Hill et al., 1998). This decline was almost twice the rate of the average country of sub-Saharan Africa during this period (Hill et al., 1998). The decline slowed to about 2 percent in the 1980s.

The 1998 Kenya Demographic and Health Survey (KDHS) provided the first clear evidence that the decline had not only slowed but had been reversed during the 1990s (National Council for Population and Development, Central Bureau of Statistics, and Macro International Inc., 1999). Data obtained from birth histories indicated a 24 percent increase in the U5MR from the mid-1980s to the mid-1990s with enormous regional differentials.

However, the recent 2008/9 KDHS showed a reversal in the 1990 and early 2000 levels and differentials. The under five mortality declined by 36 percent from 115 deaths per thousand to 74 deaths per thousand while the infant mortality declined by 32 percent from within a period of five 5 to 6 years. For the first time infant mortality was higher in urban areas compared to rural areas while infants for mothers with no education was less likely to die compared to women with some slight primary level of education. While the improvement was widely appreciated as resulting from the government improvement in services several questions emerge from the observations: Is the observed rapid change in mortality an artifact of data? Does the change in infant and under five mortality patterns indicate a change in the in factors influencing mortality regimes? These questions raise the important question that was the decline in under 5 mortality in Kenya real? There is a possibility of either the most recent survey under estimating the level of mortality or the previous survey over estimated level of mortality

There are several sources for which the observed data may be over stated or under stated. .. Underestimation of recent fertility in the first survey can potentially be due to birth

displacement and omissions. Overestimation in the second survey can also be due to the displacements of births from earlier periods. Finally, differences in sample implementation can also lead to overestimation or underestimation of fertility in both surveys. For instance, if educated women were accidentally over sampled in the first survey, fertility would be biased downward and hence mortality.

Births can be omitted for a variety of reasons, either deliberately or by accident. Deliberate omissions means there must be some incentive for interviewers or respondents to omit these births. The most obvious incentive for an interviewer to omit births is to reduce his/her workload. Each birth that occurred in the reference period for the health module leads to a lengthy battery of questions. Omitting one or several birth thus leads to a gain of time. Another incentive is to avoid embarrassing questions. For instance, interviewers may feel embarrassed by question about deceased children, and may be more likely to omit deceased children in order to avoid these questions. Deliberate omissions of births may also be due to respondents, who may be reluctant to mention recently deceased children.

Deceased children are more likely to be omitted than surviving children. The omissions parameters are less often significant among deceased children, because of larger sampling errors – but the average level of omissions is greater among them (15%) than among surviving children (9%). This is expected, as it probably 'easier' to omit a deceased child, notably because the child was not listed in the household questionnaire. It is also in line with the idea that people (interviewers, respondents) may be embarrassed by questions about deceased children and may be more likely to omit deceased children (Sullivan, 2008). One of the consequences of this result is that child mortality is most probably underestimated in many surveys in sub-Saharan Africa. Finally, omissions do not vary by gender: about 9 to 10% of males and females births are omitted on average

Preliminary Analysis

Question One: To what extent is U5MR estimate using 2008/9DHS data reliable?

Focus of the analysis is on bias due to reporting and survey errors such as displacement of births, omission or non reporting and which dates do these apply and do they vary by region and place of residence? How much variability is there in U5MR estimates calculated based on 0-4 and 5-9, 5-9 and 10-14 periods in DHS data?

Methodology

Estimate of 0-4 period for the earlier survey and a U5MR estimate of 5-9 period for the later survey, then the two U5MR estimates are exactly referring to the same time point. The relative difference which is defined as (100*(U5MR1-U5MR2)/U5MR1) estimates the extent of the differences.

Table 1a: Comparing U5MR for period 0-4 years prior to earlier survey to 5-9 and 10-14 in the last surveys

Period	Round	Date	U5M	Period	Round	Date	U5M	U5M Difference	U5M relative difference
0-4	1989	1986.7	90.0	5-9	1993	1985.9	90.0	0.0	0.0
0-4	1992	1990.9	96.0	5-9	1997	1990.8	99.0	-3.0	-3.1
0-4	1997	1995.8	111.0	5-9	2003	1995.9	110.0	1.0	0.9
0-4	2002	2000.8		5-9	2008/9				

Table 1b: Comparing U5MR for period 0-4 years prior to earlier survey (2003) to 5-9 and 10-14 in the 2008/9 survey

2008/9 KDHS			**2003 KDHS**			**Percent Difference (2003-2008)**	
Approximate years	**Infant mortality**	**U5M**	**Approximate years**	**Infant mortality**	**U5M**	**Infant mortality**	**U5M**
2004-2008	52	74	-	-	-	-	-
1999-2003	67	95	1998-2003	77	115	13.0 %	17.3 %
1994-1998	59	93	1993-1997	73	110	19.1%	15.5 %
				73	105	-	-

For the 2008/9 compared to 2003 0-4 and 5-9, (Table 1b), the U5MR calculated from 5-9 year period in 2008/9 is smaller than U5MR calculated from 0-4 period in 2003 by about 17 percent while the U5MR for 5-9 years in 2003 compared to 10-14 period 2008/9 is smaller by about 16 percent. In the ideal case the estimates should be approximately the same. There are four types of problems which can produce bias in U5MR estimation in DHS, which are structural biases (design of the survey and questionnaire).

- First structural bias is selection bias, that only surviving women can be interviewed in the survey.

- Second structural bias is truncation of data in the past because only women up to a certain age are interviewed, the sample of births becomes increasingly selective towards births to younger women further back in time), sample bias (sample design systematically omits certain groups of the populations),
- Sampling errors (inherent component of survey based rates),
- Reporting errors (errors in the responses given by the respondents).

Reporting errors include missing information for some questions, particularly date of birth and age at death, inaccurate reporting, such as misreporting of age at death, and omission (or erroneous inclusion) of births and deaths. Missing information is checked and handled by DHS.

Displacement when does displacement occur and how do know it has occurred?

1) The one DHS uses in its report is preferred both mathematically and practically is:
*Birth ratio=2*B5/(B4+B6)*

The other options are:

2) Displacement ratio=U5MR for 0-5 period/ U5MR for 0-4 period to measure the overall effect of birth displacement on U5MR estimates.

3) Comparison between U5MR estimates for 0-4 and 5-9 periods for two surveys apart 6 or more years can give an approximate measure of how 0-4 period estimate is underestimated due to birth displacement too.

Birth displacement analysis:

Birth displacement means that births are moved from the 5th calendar year to the 6th calendar year before the survey date. It is reported to be motivated to avoid questions about pregnancy, antenatal care and immunization. Birth displacement is measured by Birth ratios. There are three measures (birth ratios) for birth displacement (including both live births and dead births) used in literature.

Measure	**Formula**			Other comments
Birth ratio[1]1	=2*B5/(B4+B6)	>=0.95	No	Used in reports

[1] **** B4, B5, B6 are the number of births in the fourth, fifth and sixth calendar years preceding the defined start time of the survey. If we assume there is birth displacement during the 5th and 6th calendar years, then # of births for the 5th year should be smaller than normal year, and # of births for the 6th year should be larger than normal year. Then B5 should be smaller than B4 (the normal level), B6 should be larger than B4, and B5/(B4+B6) should be smaller than 0.5 and (B2+B5) should be smaller than (B3+B4). B5/B4 should be less than 1.

**** The criteria used here is also from literature, but it is somehow an arbitrary choice, and not mathematically proved.

			displacement	
		0.90<=&<0.95	Little birth displacement problem	
		<0.90	Serious birth displacement	
Birth ratio 2	(B2+B5)/(B3+B4)	>=0.95	No displacement	
		0.90<=&<0.95	Little birth displacement problem	
		<0.90	Serious birth displacement	
Birth ratio 3	=B5/B4	>=0.95	No displacement	
		0.90<=&<0.95	Little birth displacement problem	
		<0.90	Serious birth displacement	

Results

We have checked displacement and indications are that there is massive displacement that varies by region. In 2008/9 only Central and Nyanza, have birth ratios greater than 0.92 for birth ratio for measure 1 and 3 which are more robust for all and surviving the children. Among dead children it is only Nyanza, Nairobi and Western. Thus it is only Nyanza without displacement even when children are disaggregated by survival status. But trends are inconsistent; Central has massive displacement of only dead children. Rift valley and North Eastern is consistent displacement of all children irrespective of survival status. Any estimates based on 0-4 prior to survey will be biased by the effect of displacement.

Dead children have more birth ratios less than 0.9 than surviving children, especially when evaluated by birth ratio 1 and birth ratio 2, so birth displacement is more serious among dead children than surviving children when there is birth displacement. No matter which birth ratio measure is used, both 2003 and 2008/9 have birth ratio less than 0.9 in most regions.

**** Mathematically, birth ratio 2 is less sensitive due to the dilution effect of B2 in the numerator. That is the criteria are stricter for birth ratio 2 than birth ratio 1 and birth ratio 3. Birth ratio 3 is less stable than birth ratio 1 and 2 that is there may be more noise when we use birth ratio 3 to assess whether there is displacement problem. So birth ratio 1 should be preferred mathematically.

Birth Ratios

Measure	Region	All children		Surviving children		Dead children	
		2008-9	2003	2008-9	2003	2008-9	2003
Birth ratio1	Kenya	0.80	0.80	0.80	0.79	0.78	0.83
	Nairobi	0.75	0.75	0.74	0.71	1.00	1.29
	Central	1.01	0.81	1.04	0.83	0.55	0.60
	Coast	0.72	0.92	0.74	0.91	0.49	0.97
	Eastern	0.80	0.92	0.81	0.95	0.77	0.61
	Nyanza	1.00	0.75	1.00	0.75	0.96	0.77
	Rift Valley	0.75	0.74	0.75	0.74	0.83	0.78
	Western	0.75	0.74	0.73	0.71	0.97	0.95
	North Eastern	0.62	0.82	0.63	0.83	0.53	0.76
Birth ratio 2	Kenya	0.96	0.96	0.95	0.97	1.07	0.87
	Nairobi	0.95	0.97	0.93	0.94	2.00	1.25
	Central	1.01	0.94	1.01	0.97	1.00	0.58
	Coast	0.82	1.07	0.82	1.12	0.76	0.79
	Eastern	0.97	1.08	0.99	1.11	0.64	0.70
	Nyanza	1.06	0.88	1.04	0.88	1.25	0.86
	Rift Valley	0.96	0.96	0.94	0.94	1.47	1.21
	Western	1.02	0.91	1.01	0.92	1.13	0.86
	North Eastern	0.84	0.93	0.85	0.94	0.76	0.89
Birth Ratio 3	Kenya	0.85	0.85	0.85	0.85	0.87	0.87
	Nairobi	0.79	0.89	0.75	0.83	-	1.57
	Central	1.08	0.84	1.10	0.88	0.75	0.43
	Coast	0.74	0.98	0.76	1.02	0.60	0.83
	Eastern	0.90	0.94	0.92	0.97	0.63	0.64
	Nyanza	1.02	0.86	1.01	0.83	1.09	0.97
	Rift Valley	0.82	0.76	0.81	0.75	1.00	0.89
	Western	0.79	0.78	0.76	0.75	1.00	1.00
	North Eastern	0.66	0.88	0.68	0.90	0.45	0.81

How does displacement influence the measurement of U5Mortality?

The effect of birth displacement depends on the level of the displacement and whether or not it is related to the survival status of the birth, also different children morality indicator is affected by birth displacement differently. If surviving and dead children are displaced equally there will be little effect on mortality rate, if dead children are displaced more frequently, infant and child mortality will be underestimated for the 0-4 period, U5MR is built up on infant mortality is affected too. U5MR should be underestimated in surveys with more serious birth displacement among dead children. Correspondingly, infant and child mortality and U5MR will be overestimated for 5-9 period. The opposite will occur if surviving children are displaced more frequently.

Sullivan (2007) noted that the impact of birth displacement on DHS mortality estimates depends on several factors: the magnitude of birth transfers, the relative magnitude of transfers of births to deceased and surviving children and, for deceased children, whether or not both the birth and the death of the child are transferred out of (or into) a defined estimation period. The last condition is greater on neonatal and infant mortality rates than on under-five mortality rates. In addition, the birth transference of children who die in early infancy transfers both the birth and the death out of the last estimation period. While birth transfer of children dying at ages 2, 3 or 4 may leave the death within the last estimation period so that the impact on the estimated U5MR is minimal (Sullivan, 2007).

To investigate the effect of birth transference in the surveys, new estimates of U5MR should be made for redefined time periods: 1) the earlier boundary for the last estimation period set to begin one year before the health cutoff in each survey and compared with the actual estimate.

- If we use period 0-1, 0-2, 0-3 to calculate U5MR, then U5MR will be underestimated if there is birth displacement.
- If we use period 1-5 to calculate U5MR, then U5MR will be overestimated if there is birth displacement.
- If we use 0-4 period to calculate U5MR, then U5MR will be underestimated if there is birth displacement.
- If we use period 0-5 to calculate U5MR, birth displacement among 5th and 6th year will not affect U5MR estimates.

1) Calculate U5MR, IMR etc using 0-5 and 1-5 and 0-4 period before survey and compare the results for the 2 surveys.- the differences should give the relative effect

Table A13: Effect of birth displacement on U5MR estimate by periods used for the estimation

2008-09 KDHS

Age specific Mortality	0-1 period	0-2 period	0-3 period	0-4 period	0-5 period	1-5 period
0-1 year	0.0587	0.0624	0.0576	0.0627	0.0634	0.0647
1-2 year	0.0176	0.0139	0.0138	0.0133	0.0139	0.0129
2-3 year	0.0059	0.0061	0.0061	0.0047	0.0062	0.0063
3-4 year	0.0023	0.0024	0.0037	0.0034	0.0035	0.0038
4-5 year	0.0000	0.0012	0.0012	0.0012	0.0017	0.0022
U5MR	0.0845	0.0861	0.0824	0.0853	0.0888	0.0900

Published U5MR= 0.074

2003KDHS

Age specific Mortality	0-1 period	0-2 period	0-3 period	0-4 period	0-5 period	1-5 period
0-1 year	0.0666	0.0726	0.0729	0.0745	0.0736	0.0755
1-2 year	0.0158	0.0152	0.0159	0.0155	0.0138	0.0133
2-3 year	0.0095	0.0086	0.0088	0.0067	0.0093	0.0092
3-4 year	0.0024	0.0037	0.0041	0.0040	0.0047	0.0053
4-5 year	0.0024	0.0021	0.0016	0.0023	0.0025	0.0026
U5MR	0.0967	0.1021	0.1033	0.1030	0.1040	0.1059

Published U5MR= 0.115

The results in Table A13 above confirm that due to displacement or birth transference U5MR for the 2008/9data may have been underestimated due to birth displacement. However, for the 2003 data it appears that the published results may have been over estimated.

Conclusion

The nearly 35 percent declines in U5MR in Kenya may not reflect the true situation. It may have been that the results for the 2003 KDHS overestimated the mortality rate while the 2008/9KDHS was underestimated due to birth displacement thus exaggerating the rate of mortality decline.