Estimating Maternal Mortality in Kenya from Reported Households Deaths

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Abstract

The paper seeks to evaluate the utility of using reported household deaths in the last 12 months to estimate maternal mortality at sub national levels using data from the 2009 Kenya Population Census. The results show that pregnancy-related deaths accounted for 18 % of deaths in the household. This proportion varies from about 8 % in Central region of Kenya to over 50% in the Northern part of Kenya. National level estimate are within expected range (497 deaths per 100000 live births) but with wide differentials ranging from 160 in urban Nairobi to a high of 2451 deaths per 100,000 live births in Northern part of Kenya. The age specific maternal mortality ratios for most regions form a J shaped curve and similar to estimates observed elsewhere. Use of recent household deaths has great potential for providing timely levels and differentials in maternal mortality but some limitations require further research.

Introduction

Interventions to reduce maternal deaths have for decades been a focal point of international agreements and a priority for women's rights and health because a maternal death is one of life's most tragic outcomes. Consequently, maternal mortality has been considered as one of important indicators of reproductive health status of a given population. The accurate estimation of mortality levels, trends, causes, and differentials is a cornerstone of public health (Mathers and Boerma, 2010). The 2011 report of the Commission on Information and Accountability for Women's and Children's Health, established by the Secretary-General of the United Nations, reaffirmed the importance of timely reporting on maternal mortality ratio as one of 11 indicators of maternal, newborn, and child health. It is thus clear that the measurement of maternal mortality has a very high priority.

However, measuring maternal mortality remains a challenge with no consensus on the best method to use. Accurate measurement of maternal mortality requires large samples data sets due to rarity of such events. The preferred source of maternal mortality data is prospective measurement through continuous registration of deaths as is done in civil registration systems. However, these systems are usually incomplete in many developing countries. Instead, retrospective measurement through household surveys is the principal source for data in countries with poorly developed statistical systems, (Hill et al 2009). In recent past, maternal mortality estimates for sub-Saharan Africa provided in a recent summary report (Hemed et al., 2009) showed that 44 percent of country estimates were not based on data at all, but rather statistical models. In a number of other countries in Sub Saharan Africa, the only available source of maternal mortality estimates remains the Demographic and Health Surveys. However, this source of data can only provide national level data and therefore masks sub regional differentials in the burden of maternal deaths. Sub-national estimates are essential for setting priorities, allocating resources and targeting areas where maternal mortality is high. Thus, the evidence base for the effectiveness of maternal mortality interventions in sub Saharan Africa remains incomplete. Many intervention strategies in maternal health programmes are often implemented in small geographical areas. Consequently, programmes implementers are often

unable to monitor progress towards reducing maternal mortality in the intervention areas or to set specific measureable targets. In order to help improve on the quantity and quality of data needed in the estimation of maternal mortality, the United Statistics Statistical Division (UNSD) encouraged many developing countries to include questions on pregnancy related deaths in the 2010 round of censuses.

This approach, involve asking respondents about recent deaths(past 1-2 years prior to survey date) in the household and, when deaths are identified in women of reproductive age, extra questions about the timing of the death in relation to pregnancy are asked. These methods can also be used to generate estimates with a reference period of about 2–3 years before the survey and therefore providing recent estimates rather than those based on indirect methods. However, an important criticism of this method is that data on deaths in the last 12 months tend to underestimate mortality levels because of omissions in reporting of the events. Secondly, there is a possibility that some of these deaths will include some deaths that are unrelated to the pregnancy (and thus should not be considered maternal deaths) and therefore overestimate the level of maternal mortality. On the other hand, the time of death questions may omit some maternal deaths in early pregnancy, simply because the pregnancy was not known to the respondent However, it is possible that the over-reporting of maternal deaths resulting from the inclusion of incidental deaths may cancel out the exclusion of maternal deaths for which the pregnancy was not declared (Hill et al., 2001). The main objective of this paper is to appraise the potential of this source of in providing estimates for maternal mortality at sub national levels.

Measurement of maternal mortality

Levels and trends in maternal mortality are often interpreted in light of both the risk per woman and the risk per birth, and take account of changes in fertility and the distribution of deaths by cause. Thus, measures of maternal mortality often reflect the: annual risk of maternal death per woman (MMrate); obstetric risk (MMratio); overall level of fertility (general or total fertility rates); overall level of mortality in the population and its distribution by age, sex

and cause (PMDF). Several indicators are therefore used to measure maternal mortality in order to display sources of different risks as well as interventions. The term **Pregnancy-related death** is ussually used when there is lack information on cause of death but the only available information is all maternal deaths as an outcome from pregnancy. **Pregnancy-related death** is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death. Incase information on the cause of death is available, then we have **maternal death** which is the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. However, AbouZahr (2010) noted that there is still no clear consensus exists on whether pregnancy related deaths, as recorded by surveys or censuses overestimate or underestimate 'true' maternal deaths.

Indicators of maternal Mortality

For comparison purposes between different contexts due to differences in the risk of pregnancy, maternal mortality ratio (MMR) is often used. Maternal mortality ratio (MMR) is the number of maternal deaths during a given time period per 100,000 live births during the same time period. MMR captures the risk of death in a single pregnancy or a single live birth or in technical terms it measures the extent of obstetric risk. The second commonly used indicator is the proportion of maternal deaths among deaths of females of reproductive age (PMDF) and the maternal mortality ratio. The PMDF is calculated as the number of pregnancy-related deaths divided by the total deaths among women aged 15–49.

Finally, maternal mortality rate (MMrate) is obtained by age standardizing the maternal mortality rates using the age distribution of women. Maternal mortality rate (MMrate) measures the risk of maternal death among women of reproductive age. Maternal mortality rate is closely linked with maternal mortality ratio where MMRatio can be obtained by dividing the MMRate by the General Fertility Rate (GFR). The GFR is the annual number of births per 1,000 women aged 15–49 and is calculated using data from birth histories.

Data and methods

In the last round of censuses(2010 round of censuses), the United Statistics Statistical Division (UNSD) encouraged many developing countries to include questions on pregnancy related deaths as a way of helping improve on the quantity and quality of data needed in the estimation of maternal mortality in the world. This was subsequently adopted in the 2009 Kenya Population and Housing census. Respondents were asked to report any death in the household in the last 12 months prior to enumeration. These were subsequently named the recent deaths in the household. Among the deceased females age 12 to 49 subsequent questions were asked on whether the female deaths were pregnancy related (i.e. during pregnancy, during delivery or within two months after delivery). An advantage of census data is the lack of sampling uncertainty in the results and that estimates can be obtained for subgroups unlike sibling histories (Hill et al 2009). Also, given the need to evaluate, and often adjust, data from census questions, any estimates will still be subject to considerable uncertainty (Hill et al 2009). The derived estimates are based on the assumption that there is no effect of household dissolution arising from death of a member and that any omission of deaths does not vary with whether or not the deaths are pregnancy-related.

Data Requirements

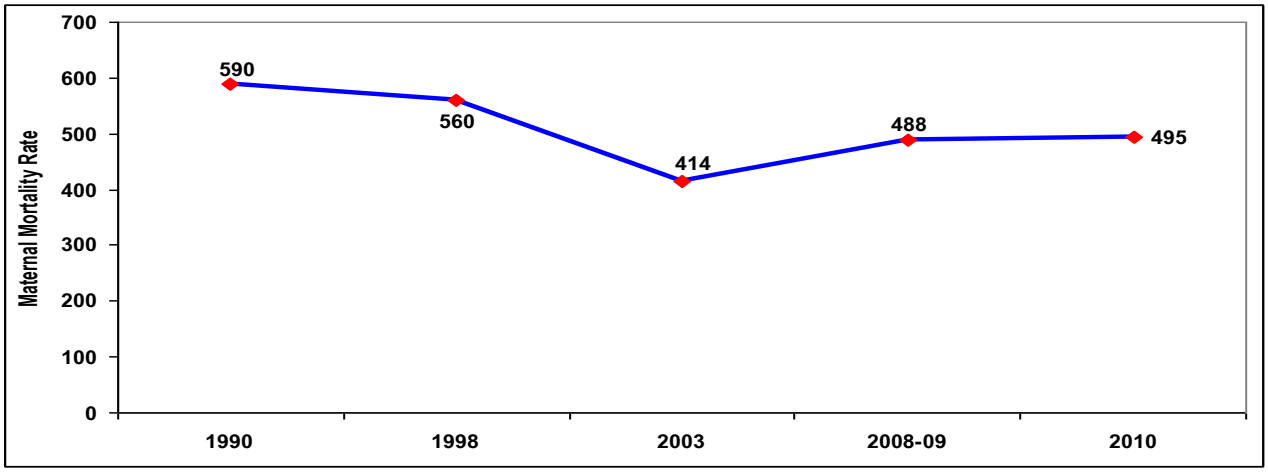
- Number of women, by five-year age group.
- Number of household deaths in the previous 12 months by age and sex.
- Number of deaths of women of reproductive age (usually 15 to 49), by whether the death occurred during pregnancy, delivery or 42 days/2 months post-partum.
- Age-specific fertility rates and General Fertility Rate for the time period.

Preliminary Results

Trends in Maternal Mortality Ratio

Figure 1 shows trends in maternal mortality ratio from various sources. The estimates show unchanging burden of maternal mortality cross the country however, no previous studies have provided estimates at sub national levels. Most of the maternal mortality estimates have been based on DHS data. Due to wide confidence levels, trend data shows that the levels of maternal mortality have not changed.

Figure 1: Trends in Maternal Mortality Ratio, Kenya, 1990-2010



Sources: WHO/UNICEF/UNFPA/World Bank, 2012; Kenya Demographic and health surveys; 2009 Kenya Census Analytical Report on Mortality.

Utilization of Recent Household deaths to estimate pregnancy related deaths

a) Proportion of pregnancy related deaths to total female Deaths of reproductive age

Table 1a shows the share of pregnancy related deaths by age to the total deaths for women age 15-49. The proportion of pregnancy related deaths is about 18 % representing nearly 8434 deaths including those with missing information. This is higher than estimates from 2008-09 Kenya Demographic and Health Survey where maternal deaths represent about 15 percent of all deaths to women aged 15-49 in Kenya. The number of reported deaths is higher than those reported from 2008-09 Kenya Demographic and Health Survey. About 13.2 % of deaths have

missing information on age while about 10 % of the cases were misclassified but still identified as pregnancy related death. In all the regions (except North Eastern region), the proportion of pregnancy-related deaths peaks at age 20-24 coinciding the peak of childbearing age in Kenya. The patterns for Nairobi and Central regions appear to have similar peak at around age 20-29 followed by sharp decline. In contrast, the proportion of mortality related deaths is spread from age 15-19 to 30-34 in all other regions. The data from North Eastern region appears distorted impliying that major cause of deaths are pregnancy related and all other causes of death is small. The proportion of pregnancy related deaths is similar in other regions with similar high maternal mortality rate.

Table 1a: Proportion of pregnancy related deaths to total deaths by age and region

	Kenya	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western
15-19	26.1	8.8	7.4	24.1	19.4	63.5	19.0	23.7	15.1
20-24	29.1	15.2	14.5	29.2	19.5	77.7	20.4	25.1	21.0
25-29	24.1	13.5	12.6	24.3	16.1	75.9	17.2	21.4	19.2
30-34	21.3	9.6	9.9	22.0	14.5	76.6	15.5	18.7	17.0
35-39	17.3	8.6	8.1	10.9	9.9	78.9	11.7	15.0	10.5
40-44	11.9	2.9	3.8	6.8	9.4	67.6	6.7	7.9	8.3
45-49	5.5	2.1	1.9	1.7	3.8	60.8	4.4	3.8	4.2
age unknown	13.2	10.0	6.7	9.9	9.2	28.9	9.5	15.2	11.6
other misclassified	9.8	2.9	5.2	4.5	6.4	22.2	11.3	10.5	2.6
% 15-49	18.2	9.5	8.1	15.0	11.9	61.7	13.9	16.5	13.3
Number of reported deaths in the household	46284	2561	4288	2923	6653	4534	8880	12190	4255

Tables 1b-1d show the proportion of deaths by time of occurrence related to total pregnancy related deaths by age. The proportion dying during pregnancy is almost similar across the regions (Table 1b) except for North eastern. Results show that almost one quarter of deaths occur during pregnancy. There are no clear cut age patterns although among teenagers, the highest proportion is in Coastal region and lowest in Nairobi. Among the older persons, age group 45-49 there is apparently no deaths during pregnancy however, Nyanza records the highest proportion. Deaths during pregnancy are more likely to be omitted since it is difficult to ascertain death during early stages of pregnancy.

Table 1b: Proportion of deaths during pregnancy to total pregnancy related deaths by age

	Kenya	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western
15-19	31.3	11.1	35.0	37.5	36.5	35.0	27.7	27.0	26.4
20-24	27.1	31.9	22.8	27.4	25.9	29.3	22.7	24.8	33.3
25-29	23.3	18.0	29.4	25.6	18.7	24.0	19.8	25.0	28.1
30-34	25.0	18.2	20.5	24.4	23.7	27.3	21.6	28.5	21.6
35-39	23.2	50.0	16.7	11.8	23.1	25.3	17.5	23.8	20.0
40-44	26.7	16.7	30.0	18.8	23.7	29.8	32.5	17.2	26.7
45-49	19.7	0.0	25.0	0.0	16.7	14.5	33.3	29.2	15.4
age unknown	20.5	25.0	29.3	22.6	15.6	26.6	14.0	20.5	15.5
other misclassified	32.5	0.0	66.7	25.0	23.1	44.0	25.6	28.4	40.0
% 15-49	25.0	24.6	25.4	24.7	22.4	28.1	21.6	23.9	24.3
Number of deaths during pregnancy	2105	60	88	108	178	787	267	480	137

Table 1c shows the proportion who die during delivery. Nationally, this proportion increase by age but there are no clear regional patterns by age. For most regions except Nairobi and Nyanza, those dying during delivery constitute the highest proportions. For most regions the proportion is erratic except Coast where the proportion declines with age. Rift valley and Western have the highest proportion among teenagers

Table 1c: Proportion of deaths during delivery to total pregnancy related deaths by age

	Kenya	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western
15-19	47.5	44.4	35.0	37.5	44.6	49.1	40.0	51.9	54.7
20-24	48.5	34.0	22.8	27.4	51.7	55.4	38.8	51.0	35.2
25-29	46.6	42.0	29.4	25.6	44.0	59.6	33.3	44.5	35.4
30-34	46.3	39.4	20.5	24.4	46.7	56.5	32.4	41.6	45.4
35-39	50.7	29.2	16.7	11.8	46.2	62.5	32.0	49.0	41.8
40-44	53.4	50.0	30.0	18.8	45.8	60.1	40.0	60.3	43.3
45-49	52.6	27.6	25.0	0.0	61.1	72.6	14.3	41.7	38.5
age unknown	53.4	0.0	29.3	66.7	61.1	72.6	14.3	29.2	38.5
other misclassified	52.6	26.7	66.7	50.0	53.8	40.0	48.8	40.3	20.0
% 15-49	40.5	34.8	42.7	38.6	46.5	56.6	35.8	44.9	40.6
Number of deaths during delivery	3929	85	148	169	369	1583	443	903	229

Tables 1d shows the proportion who die after child birth. This is the time when a number of deaths may include as maternal even if the death occurred outside two months and therefore prone to misclassification. At national level about one third occurs within two months after delivery. The highest proportions are Nairobi and Nyanza.

Table 1d: Proportion of deaths within 2 months after delivery to total pregnancy related deaths by age

	Kenya	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western
15-19	21.2	44.4	15.0	32.5	18.9	15.9	32.3	21.1	18.9
20-24	24.4	34.0	26.3	29.8	22.4	15.3	38.5	24.1	31.4
25-29	30.0	40.0	32.4	29.3	37.3	16.5	46.8	30.5	36.5
30-34	28.7	42.4	32.9	35.4	29.6	16.2	45.9	29.9	33.0
35-39	26.2	20.8	38.9	47.1	30.8	12.2	50.5	27.2	38.2
40-44	19.9	33.3	20.0	50.0	30.5	10.1	27.5	22.4	30.0
45-49	27.6	100.0	25.0	33.3	22.2	12.9	52.4	29.2	46.2
age unknown	39.0	48.3	46.3	47.3	40.7	19.5	50.9	39.8	45.5
other misclassified	25.7	66.7	16.7	25.0	23.1	16.0	25.6	31.3	40.0
% maternal (15-49)	28.5	40.6	32.0	36.8	31.1	15.3	42.6	31.2	35.1
Number deaths within 2 months after delivery	2400	99	111	161	247	429	527	628	198

b) Maternal Mortality Ratios

Table 2 provides estimates of maternal mortality ratio (using pregnancy related deaths as a proxy for maternal deaths). The national estimates are within the rage obtained form 2008-9 Kenya demographic Survey that estimated maternal mortality to lie between 300 to 600 deaths per 100,000 live births. For all the regions (except North eastern, Nyanza and Coast), MMR forms a J shaped curve - slightly higher among women age 15-19 declines to lowest level at age 20-24 and then rises. For Nyanza region, MMR rises throughout with age. In Coast low MMR at age 45-49 may be indicative of underreporting of deaths at the older ages while Nyanza and North eastern may be indicative of under reporting of deaths at the earliest ages or age misreporting. However, the observed pattern for Nyanza is similar to that observed for Bangladesh in 2010 where MMR rose with age and did not display J shaped curve. The sub regional estimates by age are similar to estimates observed elsewhere- high risk at older ages and low risk in the age group 20-24. The regions that may not show this pattern may partly reflect possibility of omission of deaths. However, Blanc et al (2013) in a study using DHS data from 38 countries acknowledge that excess risk among adolescents may be of a much lower magnitude than is generally assumed

Table 2 Maternal mortality ratios by age and province Kenya 2009

	Kenya	Nairobi	Central	Coast	Eastern	North Eastern*	Nyanza	Rift Valley	Western
15-19	669	189	183	213	331	2299	306	428	144
20-24	362	115	138	192	186	2384	311	205	118
25-29	399	140	183	229	251	2044	441	237	157
30-34	566	187	321	361	394	2305	594	337	275
35-39	680	339	438	298	401	2828	608	373	281
40-44	986	360	483	431	920	4143	731	422	450
45-49	1076	884	830	293	953	6467	1383	593	802
Total	**497**	**160**	**232**	**249**	**307**	**2451**	**410**	**288**	**184**

North eastern values have been revised for under reporting of births [4]

c) Maternal Mortality Rates and Lifetime Risk

Table 3 shows the maternal mortality rates per 1000 women by age. The mortality rate at national level peaks at age 30-34 except Nairobi and North eastern where the peak is slightly at an older age. Maternal mortality rate by age distribution shows completely the opposite curve for maternal mortality ratio. MMRates is only influenced by age distribution and frequency of deaths unlike maternal mortality ratio which is influenced by both deaths and births. Maternal Mortality Rate tends to be more stable over age than Maternal Mortality Ratio (Wilmoth 2009). In addition estimates of MMratio is influenced by not only reporting of age and deaths but also completeness of reporting of births.

The last row of Table 3 is estimates of lifetime risks. Lifetime risk is estimated as = ((T15-T50)/ l15) multiplied by maternal mortality rate (second last row of Table 3). T15 – T50 is a life-table quantity representing the number of woman-years lived between ages 15 and 50. This definition implies a conditional probability in which the pool of women at risk includes only those who survived to the age when reproduction starts (15 years) (Wilmoth 2009). The lifetime risk of maternal mortality, describes the cumulative loss of life due to maternal deaths over the female life course, is an important summary measure of population health (Wilmoth 2009. In our case it represents the fraction of adolescent females who would die eventually from maternal causes when competing causes of death are taken into account.

[4] Births in North Eastern province was under reported by 43.6 %. In the same province the difference between enumerated and expected population (2310757 vs 1394367) was 916390. The excess population enumerated was mainly for adults.

Age group	15-19	20-24	25-29	30-34	35-39	40-44	45-49	TFR
Estimated ASFR using Gompertz relational model	0.146	0.321	0.339	0.289	0.219	0.112	0.039	7.3
Reported	0.034	0.162	0.226	0.193	0.147	0.082	0.05	4.5

Both indicators show high maternal mortality in the North eastern part of the country and in Nyanza. The lowest maternal mortality rates are in urban Nairobi and Central parts of Kenya. These levels are also consistent with levels of under-five mortality. Regions with highest under-five mortality also do have highest maternal mortality.

Table 3: Maternal mortality rates (per 1000 women of reproductive age) age and province Kenya 2009

	Kenya	Nairobi	Central	Coast	Eastern	North Eastern	Nyanza	Rift Valley	Western
15-19	0.486	0.117	0.097	0.232	0.245	1.266	0.494	0.445	0.169
20-24	0.769	0.177	0.264	0.459	0.462	1.960	0.929	0.556	0.357
25-29	0.851	0.220	0.329	0.534	0.588	2.233	1.172	0.620	0.447
30-34	0.994	0.234	0.430	0.717	0.723	2.765	1.204	0.725	0.631
35-39	0.832	0.254	0.378	0.407	0.502	2.791	0.787	0.595	0.446
40-44	0.584	0.105	0.179	0.278	0.517	2.071	0.418	0.337	0.314
45-49	0.239	0.073	0.082	0.062	0.165	0.675	0.229	0.159	0.142
Total 15-49	0.708	0.185	0.261	0.419	0.456	1.929	0.795	0.527	0.349
Lifetime risk	0.022	0.006	0.008	0.013	0.015	0.110	0.024	0.016	0.011

Evaluating the Classification of Deaths as Pregnancy-Related

As suggested by Hill et al (2001), a way of checking the plausibility of results is to compare share of deaths by age to age specific birth rates. However, there are no established methods for this evaluation, and very little knowledge of empirical regularities against which observations can be compared (Hill et al 2001). A best proposal is to simply look at patterns by age group. The proportion of deaths due to maternal causes is generally expected to follow the age-specific fertility distribution, but to be rather higher at both very young and older ages to reflect the greater obstetric risks for women in these categories (Hill et al 2009). Thus plotting the Pregnancy related maternal deaths against fertility rates by age group may allow some weak check on data quality. These are provided in annex Tables a1 to a6 and are almost similar including north eastern with bad data.

Discussion

A major advantage for census data is that it allows the identification of deaths in a household in a relatively short reference period (1–2 years), and thereby provides estimates of recent maternal mortality (Stanton et al 2001). The census data also provides a complete picture of the whole population, and therefore avoids issues of representativeness. It can further allow for estimation of the indicators at sub national levels. However, the results must be adjusted for the completeness of births and deaths declared in the census, and for distortions in age structures, to produce reliable estimates (WHO et al 2010).

Available methods for adjusting age distribution however suffer from strong assumptions with regard to migration hence their utility at sub national levels maybe questionable. In particular available methods for adjustment assume rate of migration is small. This thereof makes it difficult to adjust sub national data that are subject to high rates of migration.

Currently, no methods can quantify the uncertainty of estimates of maternal mortality derived from census data (Hill et al 2009). Uncertainty may arise from a combination of under or over-reporting of adult deaths and by extension maternal deaths Underreporting can also occur because a census will miss deaths in single-person households. It is also possible that over reporting may occur if deaths are reported as pregnancy-related to avoid mentioning potentially stigmatising conditions such as HIV/AIDS or in cases where a death occurred after 42 days. .

We tend to find data from North Eastern part of Kenya show abnormally high age specific mortality ratio at all ages. This is indicative of poor quality data. The analysis of the census data (not presented here) indicated that it had inflated population size by age especially in adulthood and low reporting of birth rates. Furthermore the extent of underreporting of birth was too high. Correction for under reporting substantially changed the estimates of maternal mortality ratio indicating the high sensitivity of this indicator to the level of fertility.

Notwithstanding data quality issues; North eastern and Nyanza are regions with high maternal mortality Nyanza is also the region e highest childhood and adult mortality. The region is known to suffer from being a malaria endemic region and high HIV prevalence. Malaria and HIV related factors may partly explain the highest maternal deaths in Nyanza region while high maternal deaths in the Northern region may be due to lack of utilization of maternal health services partly from access related factors and partly culturally related. The region has lowest FP uptake lowest skilled delivery uptake in the country. Despite factors relating to use of services, additionally large differentials may be due to data related errors.

Conclusion

Although use of resent household deaths in census or surveys has a great potential for providing levels, trends and differentials in maternal mortality it has a number of limitations as any other method. The first is correcting for omissions and biases in reporting of deaths in the reference period. This becomes more difficult if estimates are to be provided at sub national levels. However, use of recent deaths still has potential in providing estimates of maternal mortality particularly if verbal autopsy is used to verify maternal deaths. It is also possible to test the methodology using surveillance data.

One of the key issues with this approach is how well available methods are able to adjust for omissions deaths and births. A second issue warranting further research and discussion is the assumption that the number of deaths reported as pregnancy-related approximates the number of true maternal deaths which implies to apply the method; deaths reported in the households should be followed by verbal autopsies. Godefay et al (2015) report that with well planned and supervised survey followed by verbal autopsy the method can be useful to obtain estimates and differentials even at sub national levels. They conclude from their study that the method can be able provide timely data on possible local variations in MMR and their determinants at sub national level to monitor and evaluate maternal health service interventions.

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Figure a1: age specific fertility rates and pregrancy related maternal mortality rates by age (Kenya, 2009)

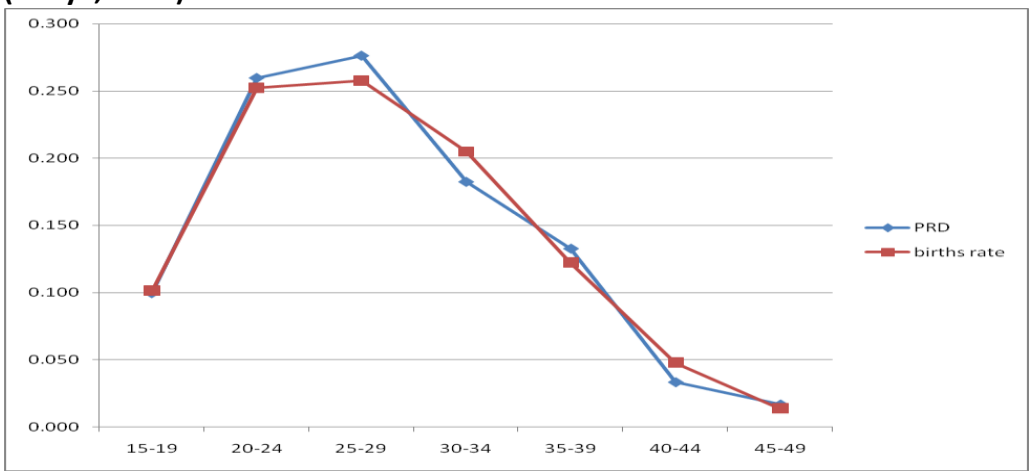

Figure a2: age specific fertility rates and pregrancy related maternal mortality rates by age (Nairobi, 2009)

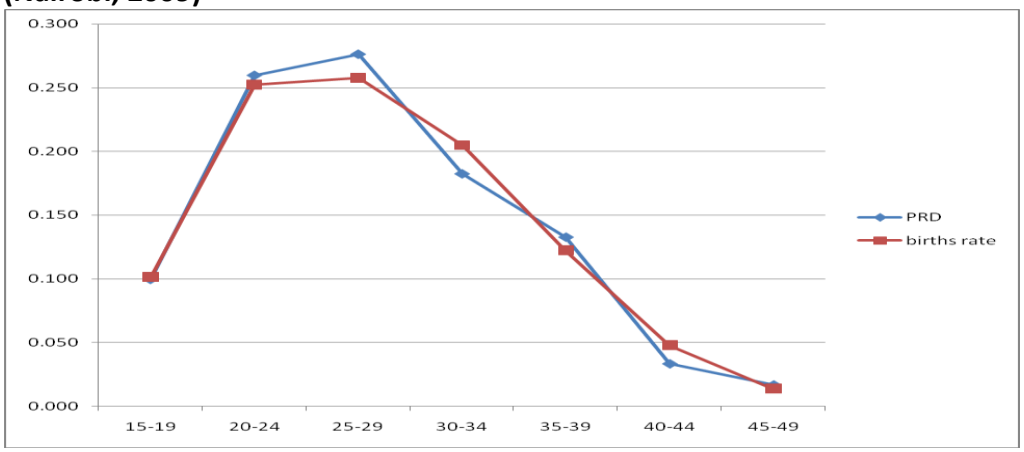

Figure a3: age specific fertility rates and pregrancy related maternal mortality rates by age (Central province , 2009)

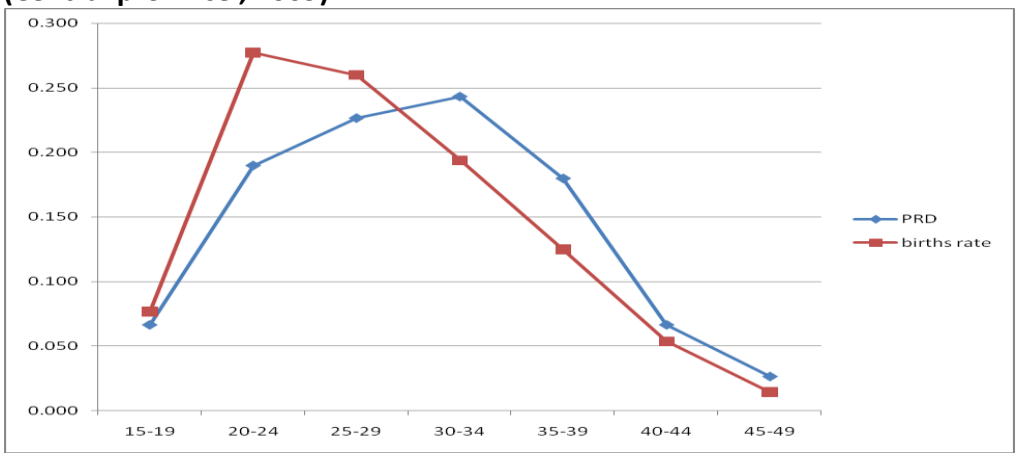

Figure a4: age specific fertility rates and pregrancy related maternal mortality rates by age (Coast province , 2009)

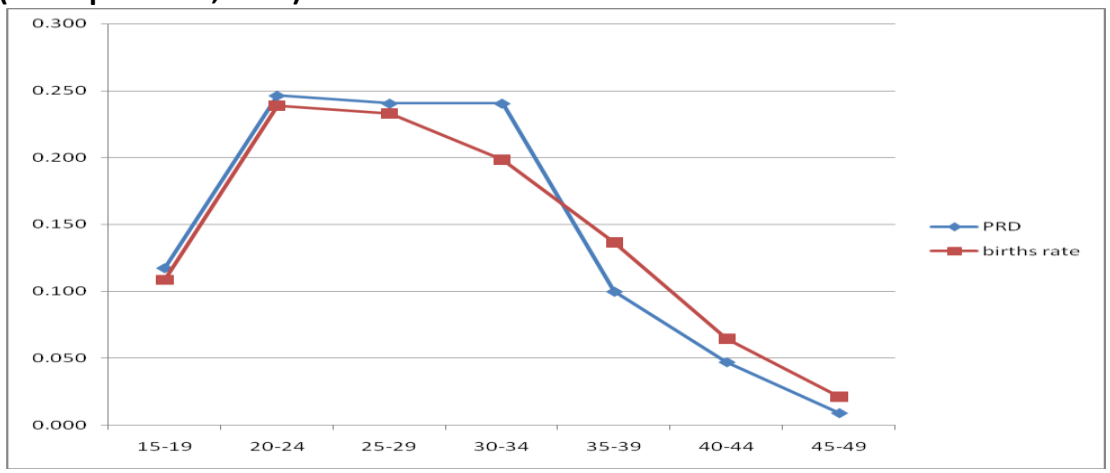

Figure a5: age specific fertility rates and pregrancy related maternal mortality rates by age (eastern province , 2009)

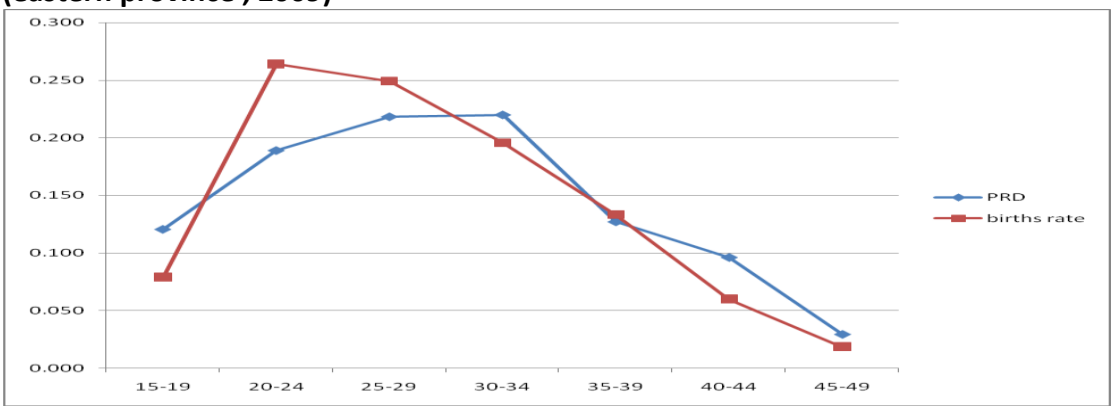

Figure a6: age specific fertility rates and pregrancy related maternal mortality rates by age (North Eastern , 2009)

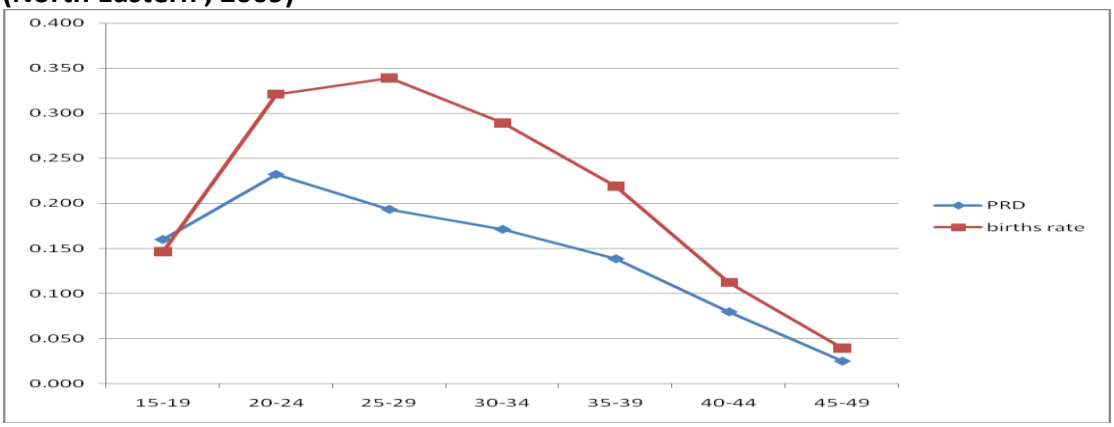

Figure a7: age specific fertility rates and pregrancy related maternal mortality rates by age (Nyanza, 2009)

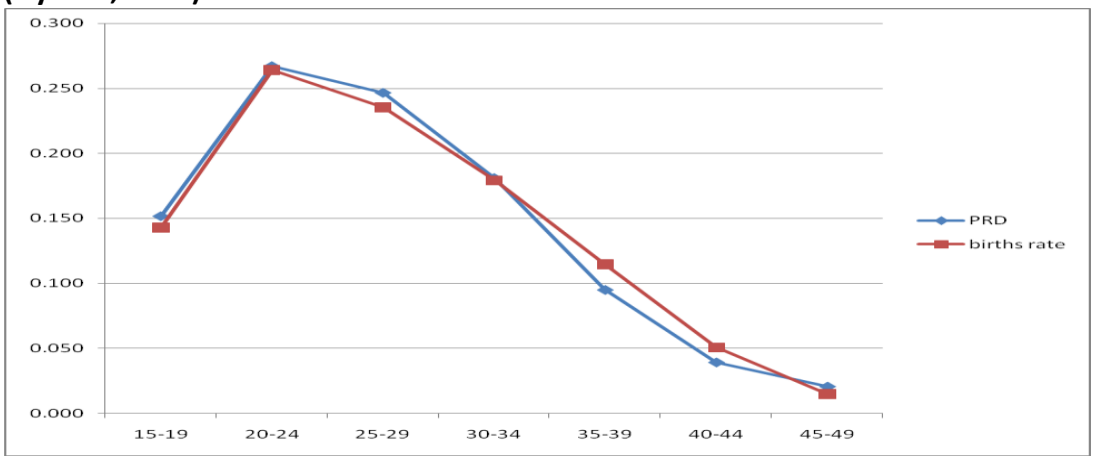

Figure a8: age specific fertility rates and pregrancy related maternal mortality rates by age (Rift valley, 2009)

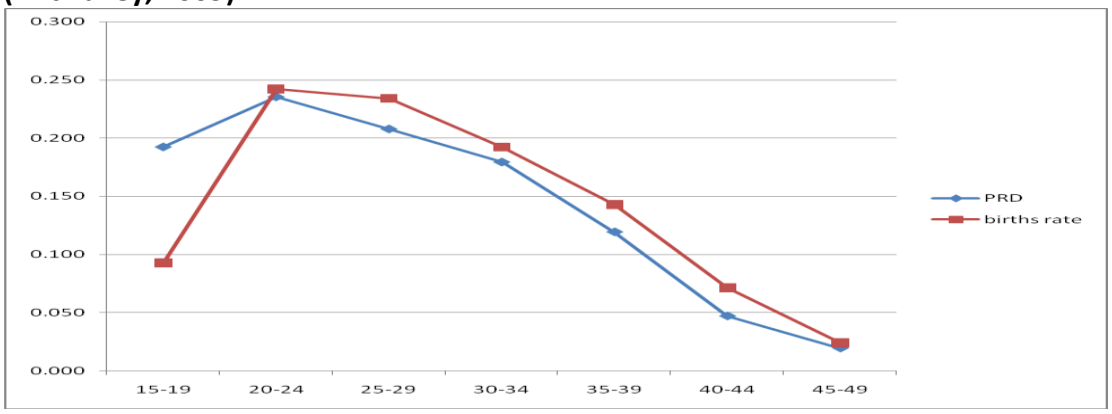

Figure a9: age specific fertility rates and pregrancy related maternal mortality rates by age (Western , 2009)