

## Determining the Level of Maternal Mortality in Eritrea using RAMOS (Reproductive Age Mortality Study).

Mismay Ghebrehwet, MD, MPH, PhD<sup>1</sup> and Richard H. Morrow MD<sup>2</sup>.

Institutional affiliation:

<sup>1</sup>Advisor to the Minister of Health State of Eritrea.

<sup>2</sup>Professor of International Health, Bloomberg School of Public Health, Johns Hopkins University

Corresponding author: Dr Mismay Ghebrehwet, email address: gmismay@yahoo.com

### Abstract

**Objective:** To determine the current estimate for the Maternal Mortality Ratio in Eritrea.

**Methods:** The study used RAMOS (Reproductive Age Mortality Study), which is a methodology of identifying all deaths of women in reproductive age as a source for identifying maternal deaths. All female deaths with in reproductive age were first identified in a nationally representative sample of 42 communities, which was followed by identifying maternal deaths among the female deaths, through verbal autopsy.

**Findings:** In the 42 selected communities, a total of 46,684 households were visited and a total of 248 female deaths within the reproductive age group (15-49 years) were identified. Among the 248 female deaths 41 were found to be maternal deaths. For calculating the maternal mortality ratio, the number of deaths was directly used as the numerator while the denominator was obtained using the fertility rates from a recent Demographic and Health Survey. This gave a maternal mortality ratio estimate of 752 per 100,000 live births and a lifetime risk for maternal mortality of 1 in 28, for the country.

**Conclusion:** The level of maternal mortality in Eritrea is still very high. RAMOS can be effectively and efficiently used to determine Maternal Mortality Ratio and the other measures for the level of maternal mortality.

**Keywords:** RAMOS, Maternal Mortality Ratio, Maternal Mortality Rate, Life Time Risk for Maternal Death, Demographic and Health Survey, Fertility Rates (Crude Birth Rate and General Fertility Rate, Total Fertility Rate), effective, efficient.

### Introduction

A maternal death 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 causes<sup>1</sup>.

Maternal mortality risks are conventionally defined in three distinct measures, namely: maternal mortality ratio, maternal mortality rate and lifetime risk of maternal mortality<sup>2,3,4,5</sup>. The Maternal Mortality Ratio, which is defined as the ratio of the number of maternal deaths to the number of pregnancies, is an indicator of the risk of dying that a woman faces for each pregnancy she undergoes. Although conceptually the denominator should include all pregnancies, operationally, because of the difficulty of counting miscarriages and induced abortions, the denominator used is live births<sup>3,4,5</sup>. The Maternal Mortality Rate, which is defined as the number of maternal deaths divided by the number of women of reproductive age, is a composite measure that is the product of maternal mortality ratio (deaths/births) and the birth rate in the reproductive age group<sup>3,4,5</sup>. Lifetime risk of maternal death takes into account both the probability of becoming pregnant and the probability of dying as a result of the pregnancy cumulated across a woman's reproductive years. It is again a composite measure that takes in to account not only the maternal mortality risk per pregnancy but also factors in the cumulative exposure to pregnancy that an individual women experiences<sup>3-7</sup>.

World wide at least 529,000 women die each year due to maternal causes of which 99 percent take place in low-and-middle-income (developing) countries<sup>8</sup>. In 2,000, the United Nations General

Assembly acknowledged that despite progress in some countries, rates of maternal mortality and morbidity remain unacceptably high<sup>9</sup>. Every minute of every day, somewhere in the world, a woman dies as a result of complications arising during pregnancy and childbirth, the majority of which are avoidable. For every woman who dies, approximately 20 more women suffer injuries, infection and disabilities during pregnancy or childbirth<sup>2</sup>.

About 75 to 80 percent of maternal deaths in the low and middle-income countries result from, in approximate order of importance, hemorrhage, sepsis, hypertensive disorders of pregnancy (eclampsia), complications of unsafe abortion and obstructed or prolonged labor<sup>10</sup>.

The vast majority of the maternal deaths can be attributed to three causes: hemorrhage, sepsis and eclampsia. Attribution of causes of death is complicated by the fact that in most cases unsafe abortion and obstructed or prolonged labor eventually cause death due to hemorrhage or sepsis<sup>4</sup>. The remaining 20-25% of maternal deaths can be attributed to illnesses aggravated by pregnancy<sup>11</sup>.

The Millennium Development Goals have placed maternal and newborn health firmly on the international agenda. But there remains the need to develop firm evidence to convince policy-makers and donors that interventions to improve maternal and newborn health are a worthwhile investment that will actually reduce poverty. Target 6 of the MDGs states "Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio."

The 1995 Eritrean Demographic and Health Survey (EDHS) revealed an extremely high level of maternal mortality ratio of 998 per 100,000 live births<sup>12</sup>. Understandably, there are caveats (wide confidence

JOURNAL OF ERITREAN MEDICAL ASSOCIATION JEMA interval and old data pertaining 10 years prior to 1995), for using the 1995 data as the current estimation of maternal mortality for the country. Additionally, a lot of improvement was demonstrated in the levels of child mortality as well as in child and maternal health services, which led to expectations of concomitant improvement in the level of maternal mortality.

The investigation of a group of deaths of women of reproductive age and in-depth study of those identified as maternal deaths is generally known as a Reproductive Age Mortality Study (RAMOS). This involves identifying and investigating the causes of all maternal deaths among deaths of women of reproductive age<sup>13</sup>.

The investigation of a group of deaths of women of reproductive age and in-depth study of those identified as maternal deaths is generally known as a Reproductive Age Mortality Study (RAMOS)<sup>13</sup>. This involves identifying and investigating the causes of all maternal deaths among deaths of women of reproductive age and has been used successfully in countries as different as Egypt, Honduras and Jamaica<sup>4,7</sup>. How the deaths were identified in the studies differ according to the records and/or the types of knowledgeable informants available. RAMOS approaches can, when competently handled, provide valuable insights into the circumstances leading to maternal deaths. They did not usually provide good data on levels of maternal mortality, because of the difficulties encountered in matching the numerator with an appropriate denominator<sup>7</sup>.

## Materials and Methods

The sampling of maternal deaths was conducted in the following two steps, based on RAMOS methodology.

### 1. Identify all female deaths with in reproductive age:

The Government of Eritrea has structured all villages (or areas of towns) in the country into 704 administrative units, called village administration (or administration areas), which were the sampling units for this study. The list of all administrative areas was obtained from the Ministry of Local Government. The Zones were taken as clusters and 7 administrative areas were randomly selected from the list of the administrative areas in each Zoba.

A total of 42 communities (7 randomly selected communities from each of the 6 Zobas), were included in the study. Two people from each selected community after appropriate training undertook census house-to-house visit, marked (ticked with a chalk) all households visited, tallied the number of households visited and listed the names of females with in the reproductive age groups (15-49) who died within one year prior to the study.

Procedurally the work of the two local people is described as follows: visit every house and ask if there is female death in the past year and a half (Since 1<sup>st</sup> of January 2002). If there are no female deaths since January 1<sup>st</sup> 2002, they just tick the house and tally it and pass to the next house. If they encounter a house

with female death since 1<sup>st</sup> January 2002, they verify whether it is with in one year (From June 1<sup>st</sup> 2002 to 31<sup>st</sup> May 2003) and the age whether the age is with in 15-49, if one of these the date or the age is not with in the range, they again mark the house, tally it and pass, until they find a house with female death with in the reproductive age in the time range, which they then have to write the names of the deceased person and the head of the household and the location of the house, besides marking (ticking) the house and tallying it.

### 2. Identify Maternal Deaths among the female deaths:

Once all deaths of female within the reproductive age (15-49) were identified in step 1, the trained interviewers identified the maternal deaths among all female deaths within the reproductive age, through verbal autopsy.

The principal investigator trained the data collectors. The importance of not missing maternal deaths was emphasized during the training. Hence, the interviewers visited every female death within the reproductive age in the community, even when it seemed unlikely to be a maternal death.

A checklist was prepared to assist the interviewers, to identify maternal deaths among all female deaths with in the reproductive age group, during the verbal autopsy. The interviewers were trained on use and interpretation of the checklist, which was field-tested and accordingly amended during the training. The checklist is presented in annex1. The number of births in a year for each Zone and for the selected communities was calculated from the total population and the Crude Birth Rates. The total population of each Zone was an estimate by the Ministry of Local Government for 2002, while the Crude Birth Rate for each Zone was estimated by the 2002 Eritrean Demographic and Health Survey.

## Results

As depicted in table 1, a total of 46,684 households were visited in the 42 selected communities, from which 248 female deaths within the reproductive age group (15-49 years) were identified. Forty-one maternal deaths were then identified among the 248 female deaths within reproductive age. This gives a 16.5 percent proportionate mortality ratio for maternal death among women within the reproductive age group. The maternal deaths occurred during pregnancy in 16 percent of the cases, during delivery in 48 percent of the cases and in 36 percent of the cases with in 45 days after termination of pregnancy.

Table 1: Number of households visited, number of women deaths 15-49 years and maternal deaths identified in the sampled communities.

Zone (Zoba)	No. of communities sampled	No. of Households Visited	No. of population	No. of female deaths (15-49)	No. of maternal deaths identified
Maakel	7	18,580	79,760	48	1
Debub	7	4,500	16,910	12	4
Anseba	7	5,350	26,380	45	10
G-Barka	7	7,770	31,110	72	11
NRS	7	5,874	32,470	37	8
SRS	7	4,610	16,330	34	7
Total	42	46,684	202,960	248	41

Table 2: Number of estimated births and identified maternal deaths in the selected communities by Zone.

Zone (Zoba)	Total Population Of the Zone	Crude Birth Rate per 1,000 population	Number of births per year In the Zone	Population of the selected communities	Number of births per year in the selected communities	No of maternal deaths in the selected communities	MMR Per 100,000 Live births in the selected communities
Maakel	552,540	27	14,919	79,760	2,154	1	46
Debub	779,060	34	26,488	16,910	575	4	696
Anseba	448,910	35	15,712	26,380	923	10	1,083
G-Barka	578,900	34	19,683	31,110	1,058	11	1,040
NRS	479,600	33	15,827	32,470	1,072	8	747
SRS	68,300	34	2,322	16,330	555	7	1,261
Total				202,960	6,495	41	631*
National	3,139,160	32	100,453				752**

\*631 is the maternal mortality ratio per 100,000 live birth for the 42 communities studied.

\*\* 752 is the maternal mortality ratio per 100,000 live births, estimated for the whole country adjusted for the Zonal variations in number of births.

Table 2 presents the total population of each Zone as estimated by the Ministry of Local Government for 2002, Crude Birth Rate for each Zone as estimated by the 2002 Eritrean Demographic and Health Survey (12) (less than a year prior to this study), and the number of maternal deaths identified in this study. The number of births in a year for each Zone and for the selected communities was calculated from the total population and the Crude Birth Rates.

Using the information on table 2, an estimation of maternal mortality ratio is directly calculated using the following formula:

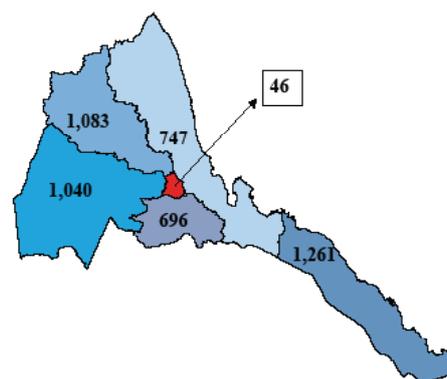
Maternal Mortality Ratio=	$\frac{\text{All maternal deaths Occurring in one year}}{\text{Number of live births occurring in the same year}} \times 100,000$
---------------------------	---

As revealed in table 2, the maternal mortality ratio for the whole country, adjusted for Zonal variation in number of birth is 752 per 100,000 live births. The 95 percent confidence interval for the estimate of the 752 per 100,000 live birth is  $\pm 210$  per 100,000 (i.e 542

per 100,000 to 962 per 100,000).

Although it needs to be interpreted with caution due to the above-mentioned wide confidence intervals, as revealed in table 2 and figure 1, this study revealed wide Zonal variation in maternal mortality ratio, ranging from 46 per 100,000 in Zoba Maakel to 1,261 per 100,000 live births in Zoba Southern Red Sea. Three of the six Zones in Eritrea (Anseba, Gash Barka and Southern Red Sea) were found to have a maternal mortality ratio of around or over 1,000 per 100,000 live births.

Fig. 1: Maternal Morality Ratio Per 100,000 Livebirths by Zoba



N.B. This map is not an official map for international boundaries.

Taking the General Fertility Rate (GFR) or the birth rate of 153 per 1,000 women as revealed by the 2002 EDHS <sup>12</sup> and a Maternal Mortality Ratio of 752 per 100,000 livebirths revealed from this study, the Maternal Mortality Rate is calculated as 115 maternal deaths/100,000 women.

With the current maternal mortality ratio and fertility rate, the Lifetime Risk for Maternal Mortality in Eritrea is calculated at 0.036, which is equivalent to 1 in 28.

## Discussion

All maternal deaths that occurred within one year prior to the study were identified using RAMOS, which first identifies all deaths of women of reproductive age as a source of identifying maternal deaths, as described below.

RAMOS approaches can, when competently handled, provide valuable insights into the circumstances leading to maternal deaths. They did not usually provide good data on levels of maternal mortality, because of the difficulties encountered in matching the numerator with an appropriate denominator <sup>4,7</sup>. In this study, however, we succeeded in determining maternal mortality ratio because of were able to obtain estimates of the denominator, due to a well structured Local Government Administration with a fairly reliable population size for each village administration and the availability of Crude Birth Rates for each zone from a recent Demographic and Health Survey, which was conducted only 9 months prior to this study.

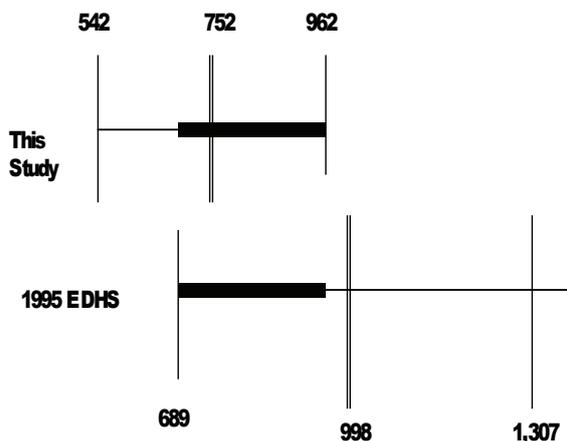
As precise estimation of maternal mortality from either sisterhood or household surveys require large sample sizes, the 95 percent confidence interval of maternal mortality estimation are usually very wide <sup>2-4,6,7,14</sup>. For example analysis of Demographic and health surveys, which use sisterhood method, have shown 95 percent confidence intervals around maternal mortality rates to be plus or minus 31 percent, on average. The issue of wide sampling error also pertains to direct techniques of determining maternal mortality ratio, not just the sisterhood method <sup>7,14-16</sup>. The Addis Ababa household survey interviewed 32,300 households and identified 45 deaths and produced an estimated maternal mortality ratio of 480 per 100,000 live births for the population of Addis Ababa. At the 95 percent level of significance this gave a sampling error of about 30 percent, i.e. the ratio could be anywhere between 370 and 660 <sup>16</sup>.

The calculated 95 percent confidence interval for the 752 per 100,000 maternal mortality estimates in our study was also equally wide with plus or minus 28 percent. Hence, the actual figure could be as low as 542 or as high as 962 per 100,000 live births.

The current estimate (752 per 100,000) is 25 percent less than the 1995 EDHS estimate for maternal mortality ratio (998 per 100,000) <sup>12</sup>. However, although that may be the case, it is difficult to conclude whether there actually was a 25 percent reduction in maternal mortality ratio or not because as depicted by the heavy

line in fig. 2 the 95 percent confidence intervals for the current estimate of 752 overlap between 689 and 962. Hence, there may as well be no difference between the current and the 1995 EDHS <sup>12</sup> estimates of maternal mortality ratio for the country. Chance cannot be excluded as a likely explanation for the difference due to the wide 95 percent confidence interval.

Fig 2: Overlap of the 95 percent Confidence intervals of this study and the 1995 EDHS estimates of Maternal Mortality Ratio.



The 752 estimation of maternal mortality ratio in Eritrea, although lower than the average for Sub-Saharan Africa, estimated at 980 per 100,000 <sup>17</sup>, is still very high. The maternal mortality ratio in Eritrea is 1.5 times the average for the low-and middle- income countries, which is estimated at 480 per 100,000 live births and is 28 times the average for industrialized countries, which is estimated at 27 maternal deaths per 100,000 live births <sup>4</sup>. The lifetime risk for a woman in Eritrea of dying due to maternal causes calculated from the estimation of maternal mortality ratio in this study is 0.036, which is about 1 in 28, which is half of the 1995 EDHS estimate of 1 in 14 <sup>12</sup>.

Cost had always been raised as a major impediment for conducting household surveys to directly determine maternal mortality ratio <sup>7,14</sup>. Hence, a very important methodological lesson learned from this study is that the task at the initial level can be made simple to be undertaken by local people and the cost of under taking a household survey, could be minimized drastically. The salary paid to the local personnel was 50 ERN (Equivalent to 3.3 USD) as opposed to 250 ERN (16.5 USD) per day for the trained health workers. Additionally the trained personnel would have required transportation, which would have cost an additional 1,100 ERN per day (60 USD). The local personnel did not need any transportation. The trained health workers may need translators and local guides, while the local people do not.

Hence, the identification of deaths of all female with in reproductive age cost around 15 percent of the estimated cost if we were to use qualified health workers. As the identification of all female deaths with in reproductive age constitute the major portion of the whole expense of a household survey for maternal mortality, over all the cost can be reduced by as much as two third.

## Conclusion

The following are the conclusions of the study:

- With the current estimation of maternal mortality ratio at 752 per 100,000 live births, maternal mortality in Eritrea is very high and accordingly should be seen and treated as a priority among priorities.
- RAMOS can be effectively and efficiently used to determine the levels of maternal mortality.

## Acknowledgments

This study was funded by US-AID funded project of the Ministry of Health of the state of Eritrea, which was administered by TASC-JSI. Hence, I would like to thank the Ministry of Health, US-AID Eritrea and TASC-JSI.

## References

1. World Health Organization. Indicators to Monitor Maternal Health Goals. Report of a Technical Working Group, Geneva November 1993. Document FHE/MSM/94.14.
2. World Health organization. Verbal autopsies for maternal deaths. WHO/FHE/MSM/95.15 WHO, Geneva, 1987.
3. World Health organization. Reduction of maternal mortality. A joint WHO/UNFPA/World Bank publication; Geneva: World Health Organization; 1999.
4. World Bank, Koblinsky M. Editor, Reducing Maternal Mortality. Learning from Bolivia, China, Egypt, Honduras, Indonesia, Jamaica, and Zimbabwe. Human Development Network, Health, Nutrition, and Population Series. The World Bank, Washington D.C. 2003 (b).
5. Menken J., & Rahman M.O., Reproductive Health. In: Merson M.H., Black R.E., & Mills A.J. eds. International Public Health: Diseases, Programs, Systems and Policies. United States of America: Aspen Publishers, Inc., 2001: 79-138.
6. National Statistics and Evaluation Office, Asmara, Eritrea and ORC Macro Calverton, Maryland USA. Eritrea Demographic and Health Survey 2002. May 2003.
7. Abouzahr C., in Critical issues in safe motherhood , page 110- 134, Geneva, WHO, 1999.
8. World Health Organization (WHO), United Nations Children's fund (UNICEF) and United Nations Population Fund (UNFPA,;Estimates Developed by WHO, UNICEF and UNFPA (Geneva: WHO, 2005)
9. United Nations, (UN), report of the Adhoc committee of the whole of the Twenty-third Special Session of the General Assembly (2000), supplement No. 3 (A/S-23/10/Rev.1), accessed online at [www.un.org/womenwatch/confer/beijing5](http://www.un.org/womenwatch/confer/beijing5), 2001.
10. World Health Organization & UNICEF. Revised estimates of maternal mortality: a new approach by WHO and UNICEF. Geneva ,Switzerland; 1996.
11. Jamison, D.T. Mosley, W.H., Measham, A.R., & Bobadilla, J.L. 1993. Disease control priorities in developing countries. Published for the World Bank. New York: Oxford University Press.
12. National Statistics and Evaluation Office, Eritrea and Macro Int. Inc. Demographic and Health Survey 1995. National Statistics Office, March 1997.
13. World Health organization. Verbal autopsies for maternal deaths. WHO/FHE/MSM/95.15 WHO, Geneva, 1987.
14. Koblinsky M. Safe Motherhood Indicators – Lessons learned in measuring progress. In: Mother Care Matters

May 1999 Vol.8(1).

15. Stanton, Cynthia, Kenneth Hill, Carla Abouzahar, and Tessa Wordlaw 1996. Strategies for model based estimates of maternal mortality. Paper presented at the IUSSP seminar on Innovative Approaches to the Assessment of Reproductive Health, Manila, Philippines. September 24-27, 1996.
16. Kwast BE et al, 1985, Epidemiology of a maternal mortality in Addis Ababa: a community based study. Ethiopian Medical Journal. 23:7-16.
17. World Health Organization (WHO), United Nations Children's fund (UNICEF) and United Nations Population Fund (UNFPA, Maternal mortality in 1995;Estimates Developed by WHO, UNICEF and UNFPA (Geneva: WHO, 2001).

## Annex 1: Checklist for the Verbal Autopsy To identify Maternal Deaths

1. Name of deceased woman \_\_\_\_\_
2. Date of death of (Name) \_\_\_\_\_
3. How old was (Name) when she died? \_\_\_\_\_ years
4. Was (Name) pregnant when she died?  
a.  Yes b.  No  I don't know
5. Did (Name) die during childbirth?  
a.  Yes b.  No
6. Did (Name) die within 6 weeks (42 days) after the end of a pregnancy or childbirth?  
a.  Yes b.  No
7. Was her death due to complications of pregnancy or childbirth?  
a.  Yes b.  No

If No, specify the cause \_\_\_\_\_

Use your (the interviewers) professional judgment and knowledge about direct and indirect causes of maternal death and non maternal causes e.g. Accidents and cancer) to judge whether the cause could be classified as maternal or non maternal.

8. Your (the interviewers) judgment: -  
a.  Maternal (direct or indirect)  
b.  Non maternal

## Conclusion

If the answer of both questions 4, 5 and 6 is No: Conclude the death is not maternal death.

*If the answer to question number 7 is No and in your judgment (question number 8) the cause is Non maternal: Conclude the death is not maternal death.*

*If the answer to any one or more of the questions 4, 5 or 6 is Yes and in your judgment (question number 8) you judged it is maternal: Conclude the cause is maternal.*

If the answer to question number 4 is I don't know

proceed with questions 9 to 13 as follows:-

First ask the interviewee/s if they could imagine of any person that may possibly know, whether the woman was pregnant or not (e.g. if she was not married try to find if she had a boy friend, or somebody she might have consulted for help or advice (e.g. a mother, a close friend, a health provider, an abortionist etc., or somebody else the interviewers may come up with).

9. Was any person who might possibly know whether the woman was pregnant identified?

Yes  No

10. If somebody was identified what is his/her relation with (Name)?\_\_\_\_\_

11. Was the identified person found?

Yes  No

If the identified person was found ask him/her the following three questions:-

12. Was (Name) pregnant when she died?  
 Yes  No  I don't know

13. Was her death due to complications of pregnancy or childbirth?  
 Yes  No

If No, specify\_\_\_\_\_

14. Your (the interviewers) judgment: -

Maternal (direct or indirect)

Non maternal

Conclusion: If the answer to questions 12 is yes and in your judgment (question 14) the cause is Maternal: Conclude it is maternal death.