



www.ijgo.org

Contents lists available at ScienceDirect

International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo



CLINICAL ARTICLE

Acknowledging HIV and malaria as major causes of maternal mortality in Mozambique

Kavita Singh^{a,b,*}, Allisyn Moran^c, William Story^a, Patricia Bailey^d, Leonardo Chavane^e^a MEASURE Evaluation/Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA^b Department of Maternal and Child Health, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA^c Global Health Fellows Program II, United States Agency for International Development (USAID), Washington DC, USA^d FHI 360, Durham, NC, USA^e Maternal and Child Health Integrated Program, Jhpiego, Maputo, Mozambique

ARTICLE INFO

Article history:

Received 16 December 2013

Received in revised form 24 April 2014

Accepted 10 June 2014

Keywords:

HIV

Malaria

Maternal health

Maternal mortality

Mozambique

ABSTRACT

Objective: To review national data on HIV and malaria as causes of maternal death and to determine the importance of looking at maternal mortality at a subnational level in Mozambique. **Methods:** Three national data surveys were used to document HIV and malaria as causes of maternal mortality and to assess HIV and malaria prevention services for pregnant women. Data were collected between 2007 and 2011, and included population-level verbal autopsy data and household survey data. **Results:** Verbal autopsy data indicated that 18.2% of maternal deaths were due to HIV and 23.1% were due to malaria. Only 19.6% of recently pregnant women received at least two doses of sulfadoxine-pyrimethamine for intermittent preventive treatment, and only 42.3% of pregnant women were sleeping under an insecticide-treated net. Only 37.5% of recently pregnant women had been counseled, tested, and received an HIV test result. Coverage of prevention services varied substantially by province. **Conclusion:** Triangulation of information on cause of death and coverage of interventions can enable appropriate targeting of maternal health interventions. Such information could also help countries in Sub-Saharan Africa to recognize and take action against malaria and HIV in an effort to decrease maternal mortality.

© 2014 International Federation of Gynecology and Obstetrics. Published by Elsevier Ireland Ltd. All rights reserved.

1. Introduction

WHO estimates that 82% of maternal deaths worldwide are due to direct causes such as hemorrhage, sepsis, pre-eclampsia or eclampsia, obstructed labor, and unsafe abortion, whereas approximately 18% are due to indirect causes, including chronic and infectious diseases [1]. These global estimates overshadow the importance of infectious disease as a major cause of maternal mortality in some regions of the world.

HIV and maternal mortality have been called intersecting epidemics in Sub-Saharan Africa—a region that contains 14% of the world's population but accounts for 59% of maternal deaths [2], and is home to over 90% of the global population of pregnant women and children with HIV [3]. It has been estimated that, in regions where the prevalence of HIV among pregnant women is 15% or more, HIV may be responsible for up to 50% of all pregnancy-related deaths [4]. In some African settings, HIV/AIDS is responsible for more maternal deaths than are direct obstetric causes [5]. HIV/AIDS can lead to maternal mortality through manifestations of the disease and through opportunistic infections such as *Pneumocystis carinii* pneumonia and tuberculosis. HIV also

contributes to maternal mortality by increasing the likelihood of pregnancy complications, such as anemia and puerperal sepsis [5–7].

Increasing evidence indicates that malaria is also a major cause of maternal mortality. In a malaria-endemic region of rural Tanzania, for example, cerebral malaria accounts for 44% of all maternal deaths [8]. Pregnant women who are HIV-positive are also at increased risk of malaria [6,9]. Malaria may contribute to maternal death through resulting anemia [10] and is of concern in both high (or stable) and low (or epidemic) transmission areas; women living in low-transmission areas have little acquired immunity against malaria.

Prevention and treatment of infectious causes of maternal mortality are important to reduce the number of maternal deaths. Routine prenatal care is a means to provide pregnant women with vital health services, including intermittent preventive treatment of malaria (IPTp), education on use of insecticide-treated nets (ITNs), ITN distribution, and HIV counseling and testing. The current WHO guidelines for IPTp recommend four doses of sulfadoxine-pyrimethamine during prenatal care in areas that have moderate or high transmission of malaria [11]. Encouraging pregnant women to sleep under ITNs is another key malaria prevention strategy because an ITN serves as a protective barrier. An essential step in both HIV prevention and treatment is getting individuals tested and aware of their status. For pregnant women, testing during prenatal care is a first step in linking women to services for

* Corresponding author at: CB# 8120, UNC-Chapel Hill, Chapel Hill, NC 27516, USA. Tel.: +1 919 966 9668; fax: +1 919 966 2391.

E-mail address: kavita_singh@unc.edu (K. Singh).

the prevention of mother-to-child transmission of HIV and life-long antiretroviral treatment.

The promotion of skilled delivery in a health facility is a key strategy to prevent direct causes of maternal mortality during labor, delivery, or the immediate postpartum period. The rate of cesarean delivery may be used as a proxy indicator for access to comprehensive emergency obstetric care. The general consensus is that a cesarean delivery rate of 5%–15% is most closely associated with maximum reduction of maternal mortality [12].

Examining the causes of maternal death at a regional or provincial level can enable programs and policy-makers to focus appropriate interventions on particular areas of a country. However, many countries that measure maternal mortality have not been able to obtain such data at a subnational level [13]. Many countries lack complete vital registration systems and often rely on household surveys with direct questions about death or questions focused on the sisterhood method, which entails asking respondents about the survival status of their sisters. However, because maternal mortality is a relatively rare event, even the largest of these surveys cannot accurately estimate maternal mortality at the subnational level and may not provide information on location of death [14].

Some studies have used expensive techniques such as surveys on reproductive-age mortality and case finding [14–17]. Model-based approaches have also been used to obtain subnational estimates in Bangladesh [14], and some countries are including questions on maternal mortality in their national censuses. All these methods provide valuable information on the magnitude of maternal mortality, but do not present data on the causes of maternal deaths [13].

According to WHO [2], Mozambique has experienced a 46% reduction in maternal mortality, from 910 maternal deaths per 100 000 live births in 1990 to 490 maternal deaths per 100 000 live births in 2010. However, data from the 2003 Demographic and Health Survey (DHS) and the 2011 DHS both indicate a ratio of 408 per 100 000, suggesting that there has been little change during this period [18]. Mozambique has been classified as making progress in efforts to achieve the fifth Millennium Development Goal—a three-quarters reduction in maternal mortality from 1990 to 2015. Data from Mozambique's routine health information system indicate that 12% of in-hospital maternal deaths are due to HIV/AIDS and 9% are due to malaria [19]. In addition, studies of Maputo Central Hospital have shown that a high proportion of maternal deaths are due to HIV (12.9%) and malaria (12.2%), and also indicate that there is seasonal variation in cause of death, whereby higher proportions of maternal deaths due to malaria occur in the rainy season [20,21].

The aim of the present study was to assess data from three national sources to provide evidence regarding both the extent to which infectious diseases contribute to maternal mortality in Mozambique and

the need to scale-up coverage of maternal health services focused on HIV and malaria.

2. Materials and methods

In a descriptive analysis, national data on maternal deaths from separate surveys carried out between 2007 and 2011 in Mozambique were evaluated. As a secondary analysis, the study was exempt from needing institutional review board approval from the University of North Carolina at Chapel Hill, NC, USA.

The study data came from three sources: (1) the 2007–2008 Post Census Mortality Verbal Autopsy Survey, or Inquérito Sobre Causas de Mortalidade (INCAM-VA) [22]; (2) the 2009 National Survey on Prevalence, Behavioral Risks and Information about HIV and AIDS, or AIDS Indicator Survey (AIS) [23]; and (3) the 2011 DHS [18]. The INCAM-VA data were used to determine causes of maternal death at a national and provincial level, whereas the AIS and DHS data were used to determine health service coverage at these levels.

The INCAM-VA was conducted in conjunction with Mozambique's national census in 2007, and was designed to be representative at national and provincial levels and to yield cause-of-death estimates consistent with the international classification system developed by WHO [24]. First, a sample of clustered enumeration areas from the census were randomly selected, and then households reporting a death in these sample areas were identified so that more information about the deaths could be gathered via a detailed WHO-endorsed verbal autopsy questionnaire. The verbal autopsy interview was conducted with a respondent who lived with or cared for the deceased, and was focused on the cause of death and events leading up to the death. Twenty-two physicians were trained to determine the underlying and direct causes of death, and two physicians reviewed each verbal autopsy interview. A total of 10 080 deaths were certified and coded between August 1, 2006, and July 31, 2007, and 213 maternal deaths were identified [23].

The AIS and DHS were population-based household surveys providing essential service coverage data. These surveys used a two-stage cluster sampling design. The 2009 AIS was administered to 6097 households, including 6413 women aged 15–64 years and 4799 men aged 15–64 years. This survey was focused largely on knowledge, practices, and attitudes regarding HIV, and included HIV testing of respondents [24]. The 2011 DHS was administered to 13 919 households, including 13 745 women aged 15–49 years and 4035 men aged 15–64 years [18], and gathered information on socioeconomic factors, health outcomes, and use of services. For the present analysis, data on HIV prevalence among women aged 15–49 years were obtained from the AIS, and those on maternal health coverage indicators among currently pregnant or recently pregnant (in the past 2–3 years) women aged 15–49 years were obtained from the DHS.

Table 1
Population, numbers of deaths and maternal deaths, and proportions of maternal deaths due to each cause by province.

Province	Population size (×1000) ^a	Total valid deaths ^b	Unweighted maternal deaths ^b	Weighted maternal deaths ^b	Direct cause (%) ^{b,c}	Indirect cause (%) ^{b,c}		
						HIV	Malaria	Other
Niassa	1178	561	13	122	55.5	11.4	32.7	0.0
Cabo Delgado	1633	1040	22	281	60.6	9.5	30.2	0.0
Nampula	4077	886	16	485	63.9	11.2	24.9	0.0
Zambezia	3893	1182	36	681	53.9	18.0	20.9	7.1
Tete	1832	783	20	195	57.7	7.4	30.2	4.7
Manica	1419	974	17	145	56.0	18.5	25.1	0.4
Sofala	1654	1153	24	168	44.2	29.0	24.2	2.7
Inhambane	1267	665	12	39	17.6	64.0	7.7	10.8
Gaza	1219	1002	12	90	77.6	14.1	8.3	0.0
Maputo	1260	801	19	117	48.5	19.9	20.3	11.2
Maputo City	1099	1033	22	99	55.6	17.4	21.3	5.6
Total	20 531	10 080	213	2421	54.7	18.2	23.1	4.0

^a Source: 2007 National Census [25].

^b Source: 2007 Inquérito Sobre Causas de Mortalidade [22].

^c Percentages calculated with weighted numbers of deaths.

The coverage measures evaluated from the 2009 AIS and 2011 DHS were the percentage of women attending at least one prenatal care visit with a skilled birth attendant (SBA), delivery by a SBA, and cesarean delivery. Provision of the following services during prenatal care was specifically assessed: IPTp for malaria; use of ITNs, which are often distributed as part of prenatal care or immunization programs; and HIV counseling, testing, and receipt of results.

The study data are presented as simple descriptive statistics, summarizing the cause of maternal death, overall cause of death, and coverage of key maternal health services at both the national and provincial level. Each data source employed a survey approach which included a random

selection of clusters and then a random selection of household within the clusters. To ensure that the data were as representative of the population as possible, weighted data are presented here. Each data source included the survey weights that were used in our analyses.

3. Results

Table 1 and Fig. 1 present the numbers of maternal deaths and causes of death for each of the 11 provinces from the 2007–2008 INCAM-VA. Direct causes accounted for 54.7% of the maternal deaths recorded nationally. Overall, HIV accounted for 18.2% of the weighted

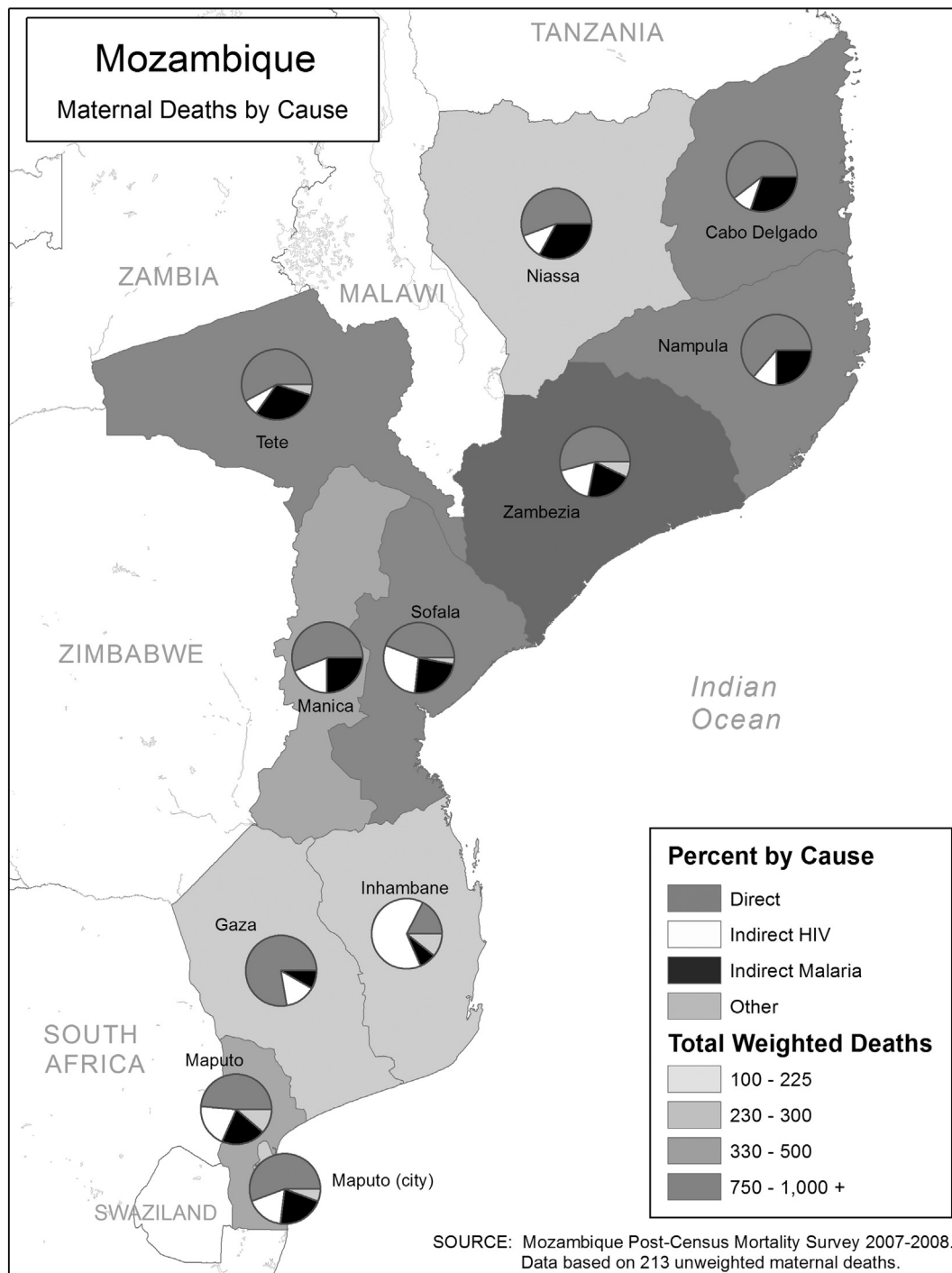


Fig. 1. Number of maternal deaths and causes of death (source: 2007–2008 Post-Census Survey [22]). The pie charts shown within each province highlight the proportions of maternal deaths due to each cause.

Table 2
Direct cause of death and maternal health indicators among women with a live birth in the past 3 years by province.^a

Province	Maternal mortality due to direct causes ^b			Maternal health service utilization ^c			
	% of maternal deaths by province	% of maternal deaths due to direct obstetric complications	% of non-facility maternal deaths	No. of women respondents	% of women who received PNC from an SBA ^d	% of deliveries attended by an SBA	% of deliveries by cesarean
Niassa	5.0	55.5	57.0	402	90.2	62.4	1.8
Cabo Delgado	11.6	56.5	61.6	541	96.4	36.3	1.5
Nampula	20.0	63.9	81.6	945	92.7	55.7	3.8
Zambezia	28.1	48.5	68.5	1273	75.2	31.9	1.1
Tete	8.1	57.7	77.4	862	89.3	53.4	3.6
Manica	6.0	56.0	65.8	473	99.2	75.6	3.8
Sofala	6.9	35.0	45.4	619	95.4	72.5	6.8
Inhambane	1.6	17.6	53.0	352	96.7	62.8	6.8
Gaza	3.7	43.9	85.7	360	96.4	85.3	4.7
Maputo	4.8	48.5	35.1	376	99.4	89.3	9.5
Maputo City	4.2	55.6	3.9	238	97.3	90.5	12.8
Total/average	100.0	50.4	63.4	6443	90.6	56.1	4.0

Abbreviations: PNC, prenatal care; SBA, skilled birth attendant.

^a Values are weighted percentages.^b Source: 2007–2008 Inquérito Sobre Causas de Mortalidade [22].^c Source: 2011 Demographic and Health Survey [18].^d Percentage of women attending at least one PNC visit with an SBA.

deaths, whereas malaria accounted for 23.1%. Ten women who died from direct causes were also HIV-positive. If these deaths were to be included in HIV-related maternal mortality, HIV would account for 23.1% of the weighted deaths. Notably, the number of unweighted maternal deaths was 20 or more in only five of the 11 provinces (Table 1). Focusing specifically on these five provinces, there was considerable variation in the proportion of maternal deaths due to HIV, ranging from 7.4% in Tete to 29.0% in Sofala (Table 1). The variation in these provinces was smaller for malaria, ranging from 20.9% in Zambezia to 30.2% in both Cabo Delgado and Tete (Table 1).

Table 2 shows provincial-level differences in key maternal health outcomes. The percentage of deaths due to direct causes occurring in non-facility environments ranged from 3.9% in Maputo City to 85.7% in Gaza. There were also large variations in maternal health coverage outcomes (Table 2). In particular, Zambezia had the lowest percentage of women receiving prenatal care from an SBA (75.2%). Both Zambezia Province and Cabo Delgado lagged behind other provinces in terms of delivery with a SBA and cesarean delivery, whereas Maputo Province and Maputo City had the best outcomes (Table 2). Notably, only four of the 11 provinces achieved the recommended level of 5%–15% of cesarean deliveries (Table 2).

Malaria, as an overall cause of death among all age groups, ranged from 11.4% in Maputo to 36.1% in Nampula (Table 3). Coverage of IPTp (defined as at least two doses of sulfadoxine-pyrimethamine as per

the guideline at the time of the 2011 DHS) was low in all provinces (Table 3): only 3.7% of recently pregnant women were covered in Niassa; and only 7.7% in Zambezia, one of the provinces where malaria is most endemic. Use of ITNs by currently pregnant women was also low, ranging from 8.7% in Gaza to 52.2% in Nampula.

The proportion of deaths caused by HIV among all age groups varied from 18.4% in Nampula to 40.7% in Gaza (Table 4). The overall prevalence of HIV among women aged 15–49 years was 13.1%, ranging from 3.3% in Niassa to 29.9% in Gaza. The percentage of pregnant women who underwent HIV testing and counseling, and who received test results was under 50% in six of the 11 provinces, including Gaza (Table 4). The lowest percentages were recorded for Nampula, which had an HIV prevalence of 5.5%, and Zambezia, which had a much higher prevalence of 15.3%.

4. Discussion

Estimates of maternal mortality and information on cause of death at a subnational level can be difficult to obtain for many countries, but such information is vital in assisting efforts to target maternal health interventions [13]. Often, countries only have national estimates, which then must be used uniformly throughout a country. In the present study, existing population-level verbal autopsy data and household

Table 3
Malaria mortality and malaria preventive behaviors among pregnant and recently pregnant women by province.^a

Province	% of maternal deaths by province ^b	% of maternal deaths due to malaria ^b	% of all deaths due to malaria ^b	% of recently pregnant women who received ≥ 2 doses of SP for IPT ^c	% of currently pregnant women who slept under an ITN on previous night ^c
Niassa	5.0	32.7	32.9	3.7	34.9
Cabo Delgado	11.6	30.2	30.6	24.9	38.4
Nampula	20.0	24.9	36.1	36.1	52.5
Zambezia	28.1	20.9	29.8	7.7	27.5
Tete	8.1	30.2	31.6	8.7	22.2
Manica	6.0	25.1	28.8	32.5	38.8
Sofala	6.9	24.2	29.8	31.9	40.8
Inhambane	1.6	7.7	25.5	11.9	33.5
Gaza	3.7	8.3	18.8	20.3	8.7
Maputo	4.8	20.3	11.4	27.7	23.9
Maputo City	4.2	21.3	13.1	16.6	33.4
Total/average	100.0	23.1	28.8	19.6	34.3

Abbreviations: IPT, intermittent preventive treatment; ITN, insecticide-treated net; SP, sulfadoxine-pyrimethamine.

^a Values are weighted percentages.^b Source: 2007–2008 Inquérito Sobre Causas de Mortalidade [22].^c Source: 2011 Demographic and Health Survey [18].

Table 4
HIV/AIDS mortality and HIV/AIDS testing behaviors among women of reproductive age and pregnant or recently pregnant women by province.^a

Province	Maternal mortality and HIV-related mortality			HIV prevalence and testing	
	% of maternal deaths by province ^b	% of maternal deaths due to HIV/AIDS ^b	% of all deaths due to HIV/AIDS ^b	% prevalence of HIV/AIDS among women ^c	% of recently pregnant women who were counseled, tested, and received an HIV test result ^d
Niassa	5.0	11.4	24.9	3.3	39.9
Cabo Delgado	11.6	9.5	20.7	9.5	24.0
Nampula	20.0	11.2	18.4	5.5	16.3
Zambezia	28.1	18.0	26.4	15.3	20.5
Tete	8.1	7.4	22.7	8.0	58.3
Manica	6.0	18.5	30.6	15.6	27.7
Sofala	6.9	29.0	31.1	17.8	64.2
Inhambane	1.6	64.0	30.6	10.0	61.1
Gaza	3.7	14.1	40.7	29.9	40.7
Maputo	4.8	19.9	38.9	20	55.8
Maputo City	4.2	17.4	33.3	20.5	54.4
Total/ average	100.0	18.2	26.9	13.1	37.5

^a Values are weighted percentages.

^b Source: 2007–2008 Inquérito Sobre Causas de Mortalidade [22].

^c Source: 2009 AIDS Indicator Survey [23].

^d Source: 2011 Demographic Health Survey [18].

survey data were used to derive a nuanced picture of the importance of HIV and malaria as causes of maternal mortality in Mozambique.

Data from the INCAM-VA indicated that both HIV and malaria account for a considerable proportion of maternal deaths: 18.2% in the case of HIV, and 23.1% in the case of malaria. When the deaths of HIV-positive women who were classified as dying of direct maternal causes were also included as HIV-related maternal deaths, then the contribution of HIV rose to 23.1% of maternal deaths. These percentages are higher than estimates provided by facility-level sources in Mozambique [19–21], thus highlighting the importance of capturing cause of death for maternal deaths that occur at home or in non-facility environments. The present study adds to other studies documenting HIV [4–7] and malaria [6–10] as significant contributors to maternal mortality. The present descriptive summary of cause of death by province also indicates provincial variation, although this subanalysis is limited by the small sample size of only 213 maternal deaths in total.

In terms of the coverage of maternal health interventions in Mozambique by province, it is clear that not enough women have access to delivery with an SBA and/or in a health facility. Regarding malaria interventions in particular, both IPTp and use of ITNs were low across the country overall. Malaria is endemic throughout Mozambique on a seasonal basis, and in parts of Zambezia, Nampula, and Cabo Delgado, transmission occurs for 7–12 months of the year. As a result, efforts are needed to rapidly scale up these interventions. In many provinces, higher proportions of pregnant women were getting tested and counseled for HIV than were receiving malaria interventions. Nevertheless, in six of the provinces, the percentages of women being tested for HIV were below 50%. Getting more women tested and aware of their status is crucial in the effort to improve maternal health and prevent mother-to-child transmission of HIV.

The present study has a few limitations. First, the number of maternal deaths assigned by the INCAM-VA at the provincial level was small. Second, the INCAM-VA data referred to a slightly earlier time period (2006–2007) than the coverage indicators from both the AIS (2009) and DHS (2011). Maternal health coverage data from the DHS referred to women who were currently pregnant or had been pregnant in the past 2–3 years (and thus a time period of 2008–2011). Finally, cause of death was assigned solely on the basis of the INCAM-VA data, and might have been affected by recall bias among the respondents and by coding errors among the physicians.

In summary, the use of population-based data on maternal deaths in conjunction with coverage data on preventive behaviors at a subnational level provides information necessary to understand the most important causes of maternal mortality. Such information is crucial for

national and provincial authorities in their efforts to reduce maternal mortality. In addition, malaria and HIV must be acknowledged and addressed as major contributors to maternal mortality.

Acknowledgments

The study was funded by the US Agency for International Development (USAID) through a cooperative agreement (GHA-A-00-08-00003-00) with MEASURE Evaluation. The views expressed in this paper do not necessarily reflect those of USAID. This work was also supported in part by a NIH R24 Center Grant to the Carolina Population Center at the University of North Carolina at Chapel Hill.

Conflict of interest

The authors have no conflicts of interest.

References

- [1] UNICEF, Childinfo. A global overview of maternal mortality. http://www.childinfo.org/maternal_mortality.html. Published June 2012. Accessed November 26, 2013.
- [2] World Health Organization, Unicef, UNFPA, The World Bank. Trends in maternal mortality: 1990 to 2010. http://whqlibdoc.who.int/publications/2012/9789241503631_eng.pdf. Published 2012. Accessed November 26, 2013.
- [3] Joint United Nations Programme on HIV/AIDS (UNAIDS). Global report: UNAIDS report on the global AIDS epidemic 2012. http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2012/gr2012/20121120_UNAIDS_Global_Report_2012_with_annexes_en.pdf. Published 2012. Accessed November 26, 2013.
- [4] Calvert C, Ronsmans C. The contribution of HIV to pregnancy-related mortality: a systematic review and meta-analysis. *AIDS* 2013;27(10):1631–9.
- [5] McIntyre J. Maternal health and HIV. *Reprod Health Matters* 2005;13(25):129–35.
- [6] McIntyre J. Mothers infected with HIV. *Br Med Bull* 2003;67:127–35.
- [7] Calvert C, Ronsmans C. HIV and the risk of direct obstetric complications: a systematic review and meta-analysis. *PLoS One* 2013;8(10):e74848.
- [8] Olsen BE, Hinderaker SG, Bergsjø P, Lie RT, Olsen OH, Gasheka P, et al. Causes and characteristics of maternal deaths in rural northern Tanzania. *Acta Obstet Gynecol Scand* 2002;81(12):1101–9.
- [9] ter Kuile FO, Parise ME, Verhoeff FH, Udhayakumar V, Newman RD, van Eijk AM, et al. The burden of co-infection with human immunodeficiency virus type 1 and malaria in pregnant women in sub-Saharan Africa. *Am J Trop Med Hyg* 2004;71(2 Suppl.):41–54.
- [10] McDermott JM, Slutsker L, Steketee RW, Wirima JJ, Breman JG, Heymann DL. Prospective assessment of mortality among a cohort of pregnant women in rural Malawi. *Am J Trop Med Hyg* 1996;55(1 Suppl.):66–70.
- [11] World Health Organization, Global Malaria Programme. Intermittent Preventive Treatment of malaria in pregnancy using Sulfadoxine-Pyrimethamine (IPTp-SP). http://www.who.int/malaria/iptp_sp_updated_policy_recommendation_en_102012.pdf. Updated October 2012. Accessed November 26, 2013.
- [12] AbuZahr C, Wardlaw T. Maternal mortality at the end of a decade: signs of progress? *Bull World Health Organ* 2001;79(6):561–8.

- [13] Cross S, Bell JS, Graham WJ. What you count is what you target: the implications of maternal death classification for tracking progress towards reducing maternal mortality in developing countries. *Bull World Health Organ* 2010;88(2):147–53.
- [14] Ahmed S, Hill K. Maternal mortality estimation at the subnational level: a model-based method with an application to Bangladesh. *Bull World Health Organ* 2011;89(1):12–21.
- [15] Rahman MH, Akhter HH, Khan Chowdhury ME, Yusuf HR, Rochat RW. Obstetric deaths in Bangladesh, 1996–1997. *Int J Gynecol Obstet* 2002;77(2):161–9.
- [16] Betran AP, Wojdyla D, Posner SF, Gulmezoglu AM. National estimates for maternal mortality: an analysis based on the WHO systematic review of maternal mortality and morbidity. *BMC Public Health* 2005;5:131.
- [17] Graham WJ, Ahmed S, Stanton C, Abou-Zahr C, Campbell OM. Measuring maternal mortality: an overview of opportunities and options for developing countries. *BMC Med* 2008;6:12.
- [18] Ministerio da Saúde (MISAU), Instituto Nacional de Estatística (INE), ICF International (ICFI). Mozambique Demographic and Health Survey 2011. <http://dhsprogram.com/pubs/pdf/FR266/FR266.pdf>. Published 2013. Accessed April 2, 2014.
- [19] Government of Mozambique. Report on the Millennium Development Goals. http://www.undp.org/content/dam/undp/library/MDG/english/MDG%20Country%20Reports/Mozambique/mozambique_september2010.pdf. Published 2010. Accessed November 26, 2013.
- [20] Menendez C, Romagosa C, Ismail MR, Carrilho C, Saute F, Osman N, et al. An autopsy study of maternal mortality in Mozambique: the contribution of infectious diseases. *PLoS Med* 2008;5(2):e44.
- [21] Romagosa C, Ordi J, Saute F, Quinto L, Machungo F, Ismail MR, et al. Seasonal variations in maternal mortality in Maputo, Mozambique: the role of malaria. *Trop Med Int Health* 2007;12(1):62–7.
- [22] Mozambique National Institute of Statistics, US Census Bureau, MEASURE Evaluation, US Centers for Disease Control and Prevention. Mortality in Mozambique: Results from a 2007–2008 Post-Census Mortality Survey. <http://www.cpc.unc.edu/measure/publications/tr-11-83>. Published 2012. Accessed April 12, 2014.
- [23] Instituto Nacional de Saúde (INS), Instituto Nacional de Estatística (INE), ICF Macro. National Survey on Prevalence, Behavioral Risks and Information about HIV and AIDS in Mozambique 2009. <http://dhsprogram.com/pubs/pdf/AIS8/AIS8.pdf>. Published 2010. Accessed April 2, 2014.
- [24] World Health Organization. Verbal autopsy standards: ascertaining and attributing causes of death. <http://www.who.int/healthinfo/statistics/verbalautopsystandards/en/index1.html>. Published 2007. Accessed April 2, 2014.
- [25] Instituto Nacional de Estatística. Women and men in Mozambique. <http://www.ine.gov.mz/en/ResourceCenter/DownloadFile?id=1006>. Published 2008. Accessed April 3, 2014.