Community-based monitoring of safe motherhood in the United Republic of Tanzania

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Objective To examine the progress made towards the Safe Motherhood Initiative goals in three areas of the United Republic of Tanzania during the 1990s.

Methods Maternal mortality in the United Republic of Tanzania was monitored by sentinel demographic surveillance of more than 77 000 women of reproductive age, and by prospective monitoring of mortality in the following locations: an urban site; a wealthier rural district; and a poor rural district. The observation period for the rural districts was 1992–99 and 1993–99 for the urban site.

Findings During the period of observation, the proportion of deaths of women of reproductive age (15–49 years) due to maternal causes (PMDF) compared with all causes was between 0.063 and 0.095. Maternal mortality ratios (MMRatios) were 591–1099 and maternal mortality rates (MMRates; maternal deaths per 100 000 women aged 15–49 years) were 43.1–123.0. MMRatios in surveillance areas were substantially higher than estimates from official, facility-based statistics. In all areas, the MMRates in 1999 were substantially lower than at the start of surveillance (1992 for rural districts, 1993 for the urban area),although trends during the period were statistically significant at the 90% level only in the urban site. At the community level, an additional year of education for household heads was associated with a 62% lower maternal death rate, after controlling for community-level variables such as the proportion of home births and occupational class.

Conclusion Educational level was a major predictor of declining MMRates. Even though rates may be decreasing, they remained high in the study areas. The use of sentinel registration areas may be a cost-effective and accurate way for developing countries to monitor mortality indicators and causes, including for maternal mortality.

Keywords Maternal mortality; Maternal age; Women; Cause of death; Socioeconomic factors; Urban population; Rural population; Sentinel surveillance; Prospective studies; United Republic of Tanzania (*source: MeSH, NLM*).

Mots clés Mortalité maternelle; Edad de la madre; Femmes; Cause décès; Facteur socioéconomique; Population urbaine; Population rurale; Surveillance par système sentinelle; Etude prospective; République-Unie de Tanzanie (*source: MeSH, INSERM*).

Palabras clave Mortalidad materna; Edad de la madre; Mujeres; Causa de muerte; Factores socioeconómicos; Población urbana; Población rural; Vigilancia de guardia; Estudios prospectivos; República Unida de Tanzanía (*fuente: DeCS, BIREME*).

Introduction

In 1987, the World Bank, WHO, and the United Nations Population Fund launched the Safe Motherhood Initiative (SMI), in response to the burden of maternal mortality in developing countries (*1*). The aim was to reduce maternal mortality ratios (i.e. the number of maternal deaths per 100 000 live births) by at least 50% by the year 2000. In 1997, the United Republic of Tanzania formally adopted a strategy for accomplishing this goal that included raising the status of women, increasing the amount of health education, and improving access to family planning and emergency obstetric services (*2*).

The Ministry of Health of the United Republic of Tanzania is currently establishing a national sentinel system, based on demographic surveillance, to monitor cause-specific mortality in several districts. Indicators of maternal mortality can be derived from this system. In 1992–93, three sentinel districts were established and since then all-cause and cause-specific mortality information for all ages and both sexes has been collected. Between 1992–93 and 1999, more than 1% of

the Tanzanian mainland population participated in the surveillance.

Methods

Measures of maternal deaths
The main measures of maternal deaths were:
i) The proportion of deaths among women of reproductive age owing to maternal causes (PMDF);
ii) Maternal death rates (MMRates) (calculated as deaths due to maternal causes per 100 000 women of reproductive age); and
iii) Maternal mortality ratios (MMRatios) (the number of maternal deaths per 100 000 live births).

The MMRatio is the indicator preferred by WHO (3), while Hill et al. have advocated PMDFs (4). This section describes methods used to obtain the data used to calculate these outcome measures.

Surveillance areas
Full descriptions of the surveillance areas and methods have been published previously (5–7). Briefly, the urban surveillance area is in Dar es Salaam, the country's largest city. The resident population of the surveillance area as of the mid-period date (31 March 1996) was 64 024, 18 638 (29.1%) of whom were women aged 15–49 years. In 1987, the MMRatio for Dar es Salaam was 44 (8), although more recent estimates cite levels of 220 and 399 for 1992 and 1993, respectively (9).

The two rural surveillance areas are in Hai District (Kilimanjaro Region), and Morogoro District (Morogoro Region). Hai District lies on the south-western slopes of Mount Kilimanjaro and has an economy based on the production of cash crops, mainly coffee. The project surveillance area, which includes 51 of the 61 villages in the district, had a mid-period population of 145 822, of whom 34 449 (23.6%) were women aged 15–49 years. Kilimanjaro Region is one of the most developed rural areas of the country. In 1987, the MMRatio was reported to be 105 (8) and estimates for 1992 and 1993 were 42 and 47, respectively (9).

Morogoro District is situated 180 km to the west of Dar es Salaam. The population comprises mostly subsistence farmers or workers on sisal plantations. The project surveillance area covers 61 of the 215 villages in the district. The mid-period population was 103 337, of whom 24 377 (23.6%) were women aged 15–49 years. In 1987 the reported regional MMRatio was 155. Official estimates for 1992 and 1993 were 264 and 172, respectively (9).

Data collection
Methods for counting the population and attributing the cause of death in the project areas have been also described elsewhere in detail (10, 11). The populations of the surveillance areas were determined by regular census updates and mortality surveillance used an active reporting system based on a network of respected individuals within each community. Cause of death was determined through a "verbal autopsy" interview with family members of the deceased. In all cases of death among women aged 15–49 years, relatives were routinely asked if the deceased had been pregnant, and if so, at what time during the pregnancy death had occurred. If the deceased was not pregnant at the time of death, the relatives were asked if death

had occurred postpartum and if so, by how many weeks. Verbal autopsies were usually conducted within 2–4 weeks of death. This system was well established in the sentinel areas and we believe the enumeration of adult mortality events was thorough and complete. A panel of physicians coded the verbal autopsies according to a classification system based on the tenth revision of the *International statistical classification of diseases and related health problems* (12).

A principal use of the verbal autopsy technique has been to identify the cause of maternal death (13, 14), and the technique can be expected to perform well in identifying direct obstetric causes in particular (15). The sensitivity and specificity of verbal autopsies are too limited to determine the precise causes of death at the individual level. The strength of the technique is its ability to describe accurately the cause structure of mortality in settings where vital registration systems are nonfunctioning or moribund, rather than its ability to determine cause of death on an individual basis (16, 17). For this reason, the analysis of predictors of MMRates described below was carried out at the community, rather than the individual level.

Because voluntarily induced abortion is illegal in the United Republic of Tanzania and is often connected to stigmatized prenuptial pregnancies, verbal autopsies may underreport deaths due to this cause. In addition, it was not possible to assess the role of human immunodeficiency virus/ acquired immunodeficiency syndrome (HIV/AIDS) in maternal mortality, because of the lack of serological data. Despite these limitations, we believe our attributions of the causes of maternal death are as reliable as those of other community-based studies that employed verbal autopsies.

Less certain is whether the reporting of pregnancies and births is as complete as our mortality enumeration, both because of events missed during the inter-censal period and due to errors in recalling the timing of the states/events of interest (pregnancy, birth and maternal death). Based on comparisons with Tanzanian Demographic and Health Surveys (18, 19), we believe that the fertility rates observed in the rural sentinel areas were too low. If unadjusted, this undercounting of births would have biased the estimate of MMRatios upward, but would not have affected other measures of maternal mortality. We adjusted estimates of fertility used in MMRatio calculations using procedures developed for the project (20).

Data analysis
We analysed all deaths (*n* = 31 940) recorded in Morogoro and Hai Districts from July 1992 to December 1999 and in Dar es Salaam from January 1993 to December 1999, and conducted a detailed review of all verbal autopsy forms coded as "maternal death" (*n* = 441) for women aged 15–49 years. A maternal death was defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes (12). PMDFs and MMRates were calculated according to the definitions provided above and trends in MMRates were analysed using the Cox & Stuart test.

MMRatios were calculated from the number of births for the three project areas, allowing for an estimate of missed infant deaths and misreported infant ages from 0 to 2 years (20). We also calculated an "official" estimate of the number of

births using the 1991–92 official Tanzanian crude birth rate of 43 per 1000 population (*21*), and estimated the expected number of maternal deaths in each project area during the period from official MMRatios.

Because the primary purpose of the demographic surveillance system used by districts in the national sentinel system using Adult Morbidity and Mortality Project (AMMP) demographic surveillance was to focus on cause-specific mortality, parity and pregnancy status of resident women was not routinely collected. To examine the relationship between age and risk of maternal mortality, therefore, the number of pregnant women expected in each age group in the project populations was calculated using the age-specific proportions in the 1994 Tanzania Knowledge, Attitudes and Practices survey (*22*). The number of "expected" maternal deaths in each 10-year age group was then calculated, from which an age-standardized ratio of observed-to-expected deaths was then estimated.

To analyse specific causes, we subdivided the maternal deaths into "direct" and "indirect" obstetric deaths. A direct obstetric death was defined as one resulting from obstetric complications of the pregnant state (pregnancy, labour, and the puerperium) and included interventions, omissions, and incorrect treatment; or from a chain of events resulting from any of the above. An indirect obstetric death was defined as one resulting from a previous existing disease which progressed during pregnancy, or which was not due to direct causes, but which was aggravated by the physiological effects of pregnancy.

Finally, we analysed the effects of education, the occupational class of the household head, and place of delivery on the risk of maternal death at the community, or "ward" level. This analysis served as a rough proxy for studying the effects of relative socioeconomic advantage on MMRates. We adapted Breslow & Clayton's spatial aggregation model (*23*) (see Annex 1). The data were modelled using the BUGS software package (*24*) with an initialization period (to reach a steady-state in the Monte Carlo process) of 20 000 iterations and data collected from the subsequent 30 000 iterations. The analysis provided 95% predictive intervals (i.e. a range of values that had a 95% probability of containing the true value) for both the value of the MMRate at the ward level during the period of observation, and for the effect of each covariate on MMRates after controlling for the effects of all the others.

Results

Trends in MMRates

Maternal death rates were substantially lower in 1999 compared with the first year of surveillance (Table 1). Strong evidence for a decline in maternal mortality over the entire period of observation (Fig. 1), however, was shown only in Dar es Salaam at the 90% significance level as measured by the Cox & Stuart test for trend ($P = 0.005859$). Changes in MMRates over time in Hai ($P = 0.290527$) and Morogoro Districts ($P = 0.387207$) were not statistically significant.

Of 31 940 total deaths recorded in the surveillance areas during the entire period of study, 31.4% were in women 15 years of age and older (2030 in Dar es Salaam, 3759 in Hai District, and 4257 in Morogoro District). In Dar es Salaam, 73.8% of all female deaths over the age of 15 occurred in women aged 15–49 years, a substantially higher proportion than in either Hai District (46.2%) or Morogoro District

Table 1. **MMRates[a] in the study areas**

Study area	1992–93	1999	Change (%)
Dar es Salaam (1993)	134	37	−72.3
Hai District (1992)	51	30	−40.8
Morogoro District (1992)	179	108	−39.5

[a] MMRates (maternal mortality rates) defined as deaths due to maternal causes per 100 000 women of reproductive age (15–49 years).

Fig. 1. **Trends in maternal mortality rates and 95% predictive interval in the study areas, 1992–99**

a. Dar es Salaam 1993–99 (*P*<0.01)
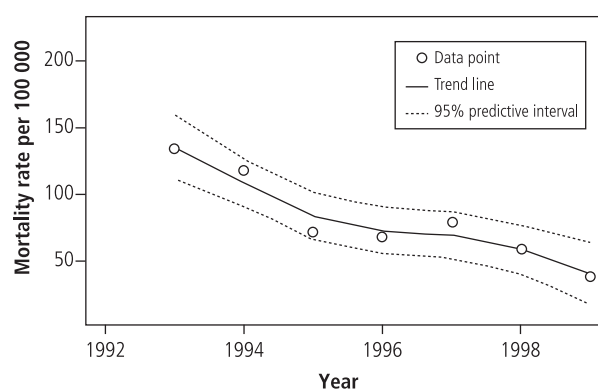
b. Hai District 1992–99 (*P* >0.01)

c. Morogoro District 1992–99 (*P* >0.01)

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(55.4%). PMDFs for the period were 0.071 ($n = 107$) in Dar es Salaam, 0.063 ($n = 110$) in Hai District and 0.095 ($n = 224$) in Morogoro District.
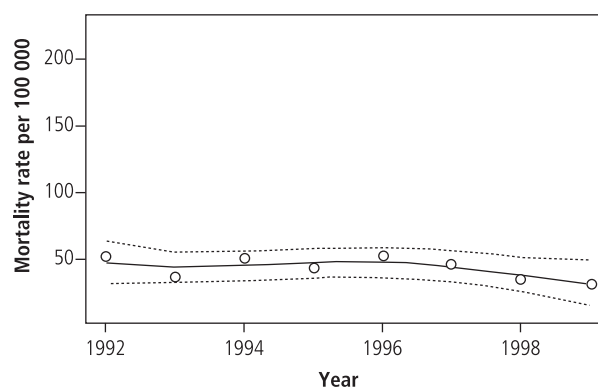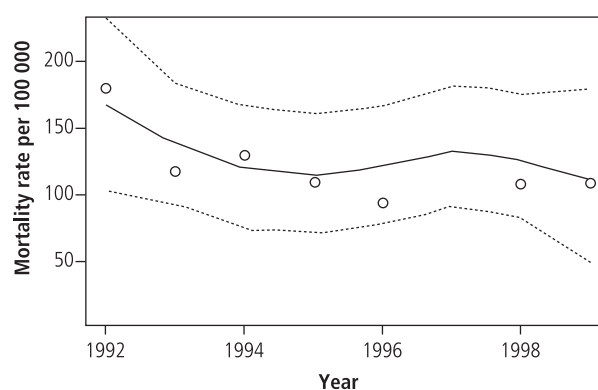
Table 2 shows PMDFs, MMRates, and MMRatios for both sentinel demographic surveillance areas and the "official" regional estimates (9). Shown also are the number of births expected in AMMP/national sentinel system populations, assuming the official birth rate estimate of 43 per 1000 population (21), and the number of maternal deaths expected on this basis (the "official" estimate). Estimated MMRates for the entire period of observation were 77.2 (95% confidence interval (CI) = 63.3–92.5) for Dar es Salaam, 43.1 (95% CI = 35.3–51.4) for Hai District, and 123.0 (95% CI = 107.5–139.3) for Morogoro District. Sentinel demographic surveillance estimates of MMRatios were 591, 348, and 1099 in Dar es Salaam, Hai District, and Morogoro District, respectively.

Timing and place of maternal death

Half (50.1%) of the 441 maternal deaths recorded occurred in women in their twenties. In each area, both the PMDFs and the MMRates were highest for the 20–24 and 25–29 year-old age groups. The available data did not allow analysis by parity.

Table 3 shows the timing and place of maternal death. In Dar es Salaam and Morogoro District the highest proportion of deaths occurred in the postpartum period, in contrast to Hai District, where more deaths occurred during pregnancy (due to the number of unsafe abortions carried out there). In Dar es Salaam and Hai District, over 70% of deaths occurred in hospital, while in Morogoro District less than half of all maternal deaths occurred in a health facility.

Specific causes

HIV/AIDS, with or without tuberculosis, was the most common cause of death in women of reproductive age in the three surveillance areas during the 1990s, and by 1999 it

accounted for 35–45% of all deaths of adult women in the sentinel demographic surveillance areas. In Hai District, acute febrile illness including malaria, injuries (intentional and unintentional), and cancer all accounted for higher proportions of female deaths than did maternal deaths. In Morogoro District, acute febrile illness including malaria was the second most common cause of death after HIV/AIDS, and diarrhoeal diseases accounted for 10.4% of the female mortality cases, nearly as great as the proportion due to maternal causes.

In Dar es Salaam, direct maternal causes accounted for 67.3% of the maternal deaths, with just three specific causes (hypertensive disorders, postpartum haemorrhage, and sepsis) accounting for 42.0% of the deaths (Table 4). The most significant indirect cause was anaemia, which accounted for just over 10% of maternal deaths. In Hai District, 79.1% of maternal deaths were due to direct causes, with induced abortion being the leading cause (22.7%). Hypertensive disorders and postpartum haemorrhage together accounted for more than 23% of the observed deaths. In Morogoro District, 87.9% of the maternal deaths were due to direct causes, with postpartum haemorrhage alone accounting for 29.0% of them. Spontaneous and unspecified abortion, and complications of labour and delivery were responsible for another 29.0% of maternal deaths.

In the absence of evidence about the serostatus of the deceased women, the verbal autopsies cannot adequately describe the role of HIV/AIDS in maternal mortality in the study areas. Only women who exhibited clinical signs and symptoms of advanced HIV disease or AIDS and also fitted the criteria for a maternal death contributed to the proportions under "HIV/AIDS" in Table 4. Consequently, the role of AIDS in maternal deaths appears small relative to other specific causes.

Table 2. **Demographic parameters for women aged 15–49 in the study areas[a]**

Study area maternal	PMDF[b]	MMRate[c]	MMRatio[d]	Estimated births (n)	Expected deaths (n)	Observed maternal deaths (n)	Observed/ expected maternal deaths[e]
Dar es Salaam (1993–99)							
AMMP/NSS[f]	0.071 (0.065–0.078)[g]	77.2 (63.3–92.5)	591 (489–714)	18 090	56	107	1.9
Official[h]	–	–	310	20 648	64	–	1.7
Hai District (1992–99)							
AMMP/NSS	0.063 (0.057–0.069)	43.1 (35.3–51.4)	348 (289–420)	31 578	14	110	7.9
Official	–	–	44	47 028	21	–	5.3
Morogoro District (1992–99)							
AMMP/NSS	0.095 (0.089–0.101)	123.0 (107.5–139.3)	1099 (964–1253)	20 375	44	224	3.1
Official	–	–	218	33 326	73	–	5.0

[a] Demographic parameters are for women in the Adult Morbidity and Mortality Project/national sentinel system areas. See Table 4 for causes included in analyses.

[b] PMDF = proportion of deaths in women aged 15–49 years due to maternal causes.

[c] MMRate = Maternal death rate (i.e. number of deaths due to maternal causes per 100 000 women of reproductive age (15–49 years)).

[d] MMRatio = Maternal mortality ratio (i.e. number of maternal deaths per 100 000 live births). Adult Morbidity and Mortality Project/national sentinel system MMRatios were calculated from the observed maternal deaths and the project estimate of the number of births.

[e] Ratio of observed to expected maternal deaths relates the observed maternal deaths to either the official number of maternal deaths or the project estimate of the number of maternal deaths. The official estimates of observed to expected maternal deaths use the number of events observed in the sentinel surveillance.

[f] AMMP/NSS = Adult Morbidity and Mortality Project/national sentinel system.

[g] Data in parentheses are 95% confidence intervals.

[h] Official MMRatios given here are the mean of official estimates for 1992 and 1993 for the regions of Dar es Salaam, Kilimanjaro, and Morogoro (which include the surveillance areas).

Table 3. **Time and place of maternal deaths in the study areas**

Study area	Time of death (%)			Place of death (%)	
	Pregnancy	Labour and delivery	Postpartum period	Hospital	Home
Dar es Salaam (1993–99)	38.3	13.1	48.6	71.0	29.0
Hai District (1992–99)	48.2	16.4	35.5	78.2	21.8
Morogoro District (1992–99)	36.2	23.7	40.2	43.7	56.3

Socioeconomic disadvantage and maternal mortality

At the community level educational attainment is strongly related to lower MMRates (Fig. 2). The plot shows the distribution of the multiplicative factors by which changes in covariates affect MMRates. Using the model described in Annex 1, in two districts where the average educational attainment of household heads differed by one year, while other factors in the model were held constant, the maternal death rate in the "more-educated" district was only 38% of that in the "less-educated" district. This effect is multiplicative: if the average education level in two districts differed by two years, the MMRate in the more-educated district would be 14% (i.e. 38% x 38%) of the rate in the less-educated district. A 10% change in either the proportion of household heads with an income, or in the proportion of home births, did not significantly change the MMRate, since the distributions of these parameters are very diffuse and centred at a multiplier of 100%.

Discussion

In the study areas, PMDFs for most of the 1990s were less than 0.10, within the range reported for sub-Saharan African countries (0.093–0.34) (*4, 9, 25–29*), but somewhat lower than the 0.26 figure reported for the United Republic of Tanzania in 1995 (*4*). The range of MMRatios for sentinel areas under AMMP surveillance (591–1099) is consistent with that found in other population-based studies in sub-Saharan Africa from the 1980s to the 1990s (241–2362) (*30*). A 1997 MMRatio estimate for Africa (878) (*31*) also falls within the range of values seen in the project areas, but a more recent figure for 2001 (530) fell just outside this range (*32*). The estimates for Dar es Salaam and Hai District were low compared to that for the East African Region (1061) (*31*) and to an adjusted estimate for the United Republic of Tanzania (1059) (*4*), but were similar to other recent estimates (*33*).

According to WHO, five specific causes account for 72% of maternal deaths globally: haemorrhage, sepsis, obstructed labour, eclampsia, and unsafe abortion (*34*), all of which are amenable to improvements in quality and access to health services. In the surveillance populations, 47.9% of maternal deaths in Dar es Salaam, 66.3% in Hai District, and 71.6% in Morogoro District could have been prevented by adequate antenatal and obstetric care. In Dar es Salaam, indirect causes accounted for nearly one-third of maternal deaths. An estimated 70 000 women globally die each year from unsafe abortions (*34*), although data on unsafe abortion and maternal deaths are difficult to obtain (*35*), especially from countries such as the United Republic of Tanzania where voluntary abortion is illegal (*36*). Despite this potentially negative influence on reporting, 23% of maternal deaths in Hai District were attributed to induced abortion.

Table 4. **Direct and indirect causes of maternal death in the study areas**

Cause of death	Dar es Salaam (1993–99)	Hai District (1992–99)	Morogoro District (1992–99)
Direct causes	*n*	*n*	*n*
Induced abortion	8 (7.5)[a]	25 (22.7)	14 (6.3)
Spontaneous and unspecified abortion	5 (4.7)	7 (6.4)	34 (15.2)
Hypertensive disorders of pregnancy	15 (14.0)	11 (10.0)	11 (4.9)
Antepartum haemorrhage	3 (2.8)	4 (3.6)	2 (0.9)
Complications in labour and delivery[b]	6 (5.6)	10 (9.1)	31 (13.8)
Postpartum haemorrhage	15 (14.0)	15 (13.6)	65 (29.0)
Puerperal sepsis	15 (14.0)	8 (7.3)	15 (6.7)
Other direct	5 (4.7)	7 (6.4)	25 (11.2)
Total	**72 (67.3)**	**87 (79.1)**	**197 (87.9)**
Indirect causes			
Anaemia	11 (10.3)	7 (6.4)	17 (7.6)
HIV/AIDS[c]	7 (6.5)	4 (3.6)	1 (0.4)
Other indirect	17 (15.9)	12 (10.9)	9 (4.0)
Total	**35 (32.7)**	**23 (20.9)**	**27 (12.1)**
Overall total	**107 (100.0)**	**110 (100.0)**	**224 (100.0)**

[a] Figures in parentheses are percentages.
[b] Includes ruptured uterus.
[c] Human immunodeficiency virus/acquired immunodeficiency syndrome.

There has been considerable debate as to how maternal mortality might be reduced by medical means (*37, 38*). It is clear from this analysis that most deaths could be prevented by adequate medical care. It will become increasingly important to understand this issue given the increasing weight placed on process measures, such as the proportion of deliveries by trained attendants (*39*) and the lack of association between home births and maternal mortality found in the present study.

It has been argued that maternal mortality data obtained by demographic surveillance cannot be generalized to national populations and that census-based methods are superior (*40*), although this has not yet been tested. Although we do not believe that data from a single, geographically restricted area represent a national point-estimate of maternal mortality, the idea that weighted national figures could be derived from sentinel site demographic data deserves consideration. This use of sentinel demographic surveillance sites is akin to the sentinel vital registration used in China and India. With intensive follow-up methods and frequent use of verbal autopsy, demographic surveillance probably provides more accurate estimates of cause-specific mortality (including

Fig. 2. **Effects of covariates on maternal mortality at the ward level in the study areas**
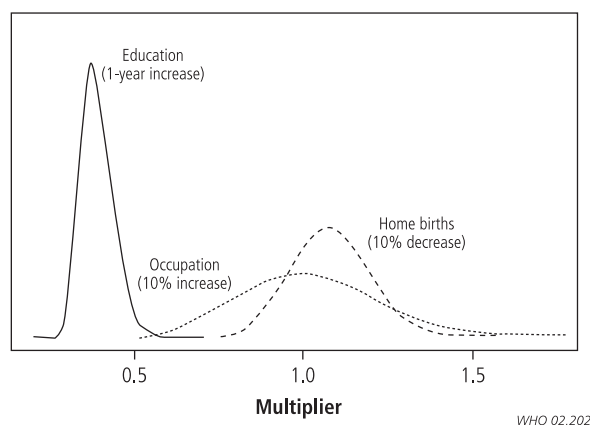
maternal mortality) than survey techniques based on recall. The census method promoted by Stanton et al. (*40*) and special survey techniques, such as the sisterhood method, all require more correction of the data on reported births and deaths than the demographic surveillance methods reported here (*4*). Even a single site, if well chosen, might provide an accurate picture of more general trends, if not an accurate estimate of the general level of maternal mortality.

A further strength of the Tanzanian national sentinel system of linked demographic surveillance sites is its ability to provide robust estimates of health outcomes, including maternal mortality, at a small-area level. Such specificity, while potentially useful in deriving valid national averages, may be even more important for understanding the diversity of health outcomes in developing countries. This is vital for monitoring inequalities in health outcomes at a subnational level and tracking the impact and use of health services among the poor. At the other end of the spectrum, initiatives such as INDEPTH, a network of demographic surveillance sites (*41*), are seeking ways to extrapolate demographic surveillance data on a cross-national basis by pooling data. Such exercises have recently produced a new set of empirically based life tables for sub-Saharan Africa (*42*).

Conclusions

Based on an analysis of MMRates (as opposed to MMRatios) as the outcome measure, the goal of reducing maternal death rates by 50% during the 1990s was accomplished in Dar es Salaam. Reductions may also be occurring in the rural sentinel areas, but more observation time is required to determine whether they are statistically significant. A re-emphasis within the health sector on providing basic family planning and obstetric services and removing obstacles to their use may further reduce maternal death. Given the apparent direction of MMRates during the 1990s and the frequency of maternal deaths relative to other preventable causes of death, it may be helpful to reaffirm priorities for addressing the maternal health needs of Tanzanian women while balancing the need to address other more common causes of death among women that are also preventable and treatable.

MMRatios in all three areas exceeded official regional estimates, partly because official systems for reporting maternal deaths include only hospital deaths (*2*). This underscores the value of community-based sentinel surveillance for deriving accurate mortality estimates. Our data also showed that an increased level of education for household heads lowered risk of maternal death at the community level, after controlling for other factors. The dangers of focusing narrowly on education as a pathway to lower mortality have been noted (*43*). In this context, and with further study, increasing education levels may be best understood as just one part of a dynamic relationship among deprivation, development, and mortality. ∎

Résumé

Suivi local de la maternité sans risque en République-Unie de Tanzanie
Objectif Examiner les progrès accomplis dans la réalisation des objectifs de l'initiative pour la maternité sans risque dans trois régions de la République-Unie de Tanzanie au cours des années 90.
Méthodes On a mesuré la mortalité maternelle au moyen d'un système de surveillance démographique sentinelle couvrant plus de 77 000 femmes en âge de procréer et d'un système de surveillance prospective de la mortalité dans trois contextes : site urbain, site rural relativement favorisé et site rural pauvre. Les observations ont eu lieu de 1992 à 1999 sur les sites ruraux et de 1993 à 1999 sur le site urbain.

Résultats Pendant la période d'observation, la proportion de décès ayant une cause liée à la maternité parmi les femmes en âge de procréer (15-49 ans) a été comprise entre 0,063 et 0,095. Les rapports de mortalité maternelle (RMM) étaient de 591–1099 et les taux de mortalité maternelle (nombre de décès maternels pour 100 000 femmes de 15 à 49 ans) de 43,1–123,0. Dans les régions sous surveillance, les RMM observés ont atteint une valeur nettement plus élevée que celle obtenue à partir des statistiques officielles données par les établissements. Dans tous les sites, la mortalité maternelle en 1999 était sensiblement plus faible qu'au

début de la surveillance (1992 pour les districts ruraux et 1993 pour le site urbain), les tendances pour la période considérée n'étant statistiquement significatives avec un niveau de confiance de 90 % que pour le site urbain. Une année supplémentaire consacrée à l'éducation des chefs de famille a permis d'observer une baisse du taux de mortalité maternelle de 62 %, après avoir contrôlé certaines variables communautaires, comme la proportion des naissances à domicile ou la classe professionnelle.

Conclusion Le niveau d'instruction est le facteur prédictif majeur de la baisse de la mortalité maternelle. Bien que les taux aient diminué, ils restent malgré tout élevés dans les sites étudiés. Le recours à des zones sentinelles peut s'avérer, avec sa précision et son rapport coût-efficacité, un bon moyen de surveiller les taux et les causes de mortalité, notamment maternelle, dans les pays en développement.

Resumen

Vigilancia comunitaria de la maternidad sin riesgo en la República Unida de Tanzanía

Objetivo Analizar los progresos logrados hacia las metas de la Iniciativa Maternidad sin Riesgo en tres zonas de la República Unida de Tanzanía durante los años noventa.

Métodos Se procedió a controlar la mortalidad materna en la República Unida de Tanzanía mediante un sistema de vigilancia demográfica centinela de más de 77 000 mujeres en edad fecunda y mediante vigilancia prospectiva de la mortalidad en los siguientes lugares: un sitio urbano, un distrito rural rico, y un distrito rural pobre. Los periodos de observación fueron los años 1992–1999 para los distritos rurales, y 1993–1999 para el sitio urbano.

Resultados Durante el periodo de observación, la proporción de defunciones por causas maternas entre las mujeres en edad fecunda (15–49 años) se situó en el intervalo de 0,063-0,095. Las razones de mortalidad materna (RMM) fueron de 591–1099, y las tasas de mortalidad materna (TMM; defunciones maternas por 100 000 mujeres de 15 a 49 años) de 43,1–123,0. Las RMM en las áreas de vigilancia fueron sustancialmente mayores que las estimaciones de las estadísticas oficiales basadas en centros. En todas las áreas, las TMM en 1999 fueron considerablemente menores que al comienzo de la vigilancia (1992 en los distritos rurales, 1993 en la zona urbana), si bien las tendencias durante el periodo analizado sólo fueron estadísticamente significativas al nivel del 90% en el sitio urbano. En el plano de la comunidad, cada año adicional de instrucción del cabeza de familia se asociaba a una reducción del 62% de la tasa de mortalidad materna, después de ajustar en función de variables de nivel comunitario como la proporción de nacimientos en el hogar y la categoría profesional.

Conclusión El nivel educativo fue un importante factor predictivo de la disminución de las TMM, pero esas tasas, aunque con tendencia a disminuir, seguían siendo altas en las zonas estudiadas. El recurso a áreas de registro centinela podría ser una alternativa costoeficaz y precisa para los países en desarrollo a la hora de controlar los indicadores y las causas de mortalidad, incluida la mortalidad materna.

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Annex 1.
Bayesian analysis of predictors of MMRates at the community level

We assumed that the number of maternal deaths in each ward (D_i) can be modelled as conditionally independent Poisson variables, with means (μ_i) that are a function of the number of women of childbearing age in the ward (W_i), a random effect for the baseline maternal mortality rate in the surrounding areas (b_i), the percentage of household heads in the ward who are engaged in work for which they receive a cash income (O_i), the average educational attainment of household heads within the ward (E_i), and the percentage of home births (H_i). Formally, the model has the following structure:

$$D_i \sim Poisson(\mu_i)$$
$$\log \mu_i = \log W_i + b_i + \alpha_1 E_i + \alpha_2 O_i + \alpha_3 H_i$$
$$b_i | b_{j \in \aleph_i} \sim N(\overline{b_{j \in \aleph_i}}, \tau/n_i)$$

The set $\aleph$ defines the neighbouring wards of ward i, and n_i is the number of neighbouring wards for ward i. This is the conditional autoregressive prior of Besag et al. (44), which allows the modelling of spatially smoothed random effects. To fully specify this Bayesian model, we introduced noninformative vague priors for the α coefficients (i.e. we assume that $\alpha_{i,i=1,..3} \sim N(0, 0.0001)$, and that $\tau \sim Gamma(2,2)$). The model also included terms for area of residence and ward population size.