Assessment of maternal mortality and late maternal mortality among a cohort of pregnant women in Bamako, Mali

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Objective   Few prospective studies have been undertaken of maternal mortality in sub-Saharan Africa. National statistics are inadequate, and data from hospitals are often the only source of information available. Reported maternal mortality ratios may therefore show large variations within the same country, as in Mali. This study was designed to produce an estimate of the maternal mortality ratio for the population of Bamako.

Design   Prospective cohort study.

Setting   Bankoni (population 59,000), a district of Bamako (population 700,000).

Population   5782 pregnant women identified during quarterly household visits.

Methods   After enrolment, two follow up visits, at six weeks and one year after delivery, were performed to collect information on the pregnancy, its outcome, the method of delivery, the puerperium and the first year after birth. Detailed inquiries on deaths were undertaken in the community, the maternity units and the reference hospital.

Main outcome measures   Maternal mortality ratio, late maternal mortality, likely cause of death.

Results   Complete data at follow up were available on 4717 women (82%) (4653 single and 64 twin pregnancies). Most of the women had antenatal care were and delivered in a district maternity hospital. There were 4580 live births (96%). Fifteen maternal deaths were recorded, yielding an overall maternal mortality ratio of 327 per 100,000 live births. Hypertensive disorders and haemorrhage were the main causes of death. Five more deaths occurred within 42 days or one year after delivery.

Conclusions   This study gave an estimate of the maternal mortality ratio for the population of Bamako, and stressed the need of better emergency obstetric care and the importance of late maternal mortality.

INTRODUCTION

It has been stated recently that the best estimations of maternal mortality in the developing world are 'merely estimates pieced together from multiple sources of varying degrees of reliability'[1] and 'even when they appear in prestigious secondary sources, they [the data] should be presumed guilty until found innocent'[2]. Problems in gathering information and in measuring maternal mortality explain these statements, so that no estimates of maternal mortality in Sub-Saharan Africa should be considered to be nationally representative[3]. West Africa has the highest rate of maternal mortality due to a combination of the highest total fertility rate and highest risk of death due to pregnancy, measured by the maternal mortality ratio. Reasonable estimates of the total fertility rate fall between 6·5 and 7·5[4], and the maternal mortality ratio is 700 maternal deaths per 100,000 live births[3,5].

An extreme example of the variation in estimates of the maternal mortality ratio is in Mali in West Africa[2]. A literature search of the period 1974–1984 showed that the range of estimates of the maternal mortality ratio varied from 11 to 2325 per 100,000 live births, depending on the source of the information (vital statistics, hospital data, health centre registers), the setting (capital, urban districts, regional), the design of the study (retrospective, prospective), the definition of the maternal death (not stated precisely, exclusion of deaths in the puerperium) and the denominator (deliveries, live births)[6–15]. The highest estimate, of 2325 deaths per 100,000 live births, was reported in the 1993 World Development Report[14], based on a report issued in 1987

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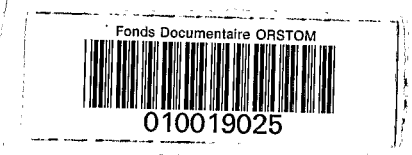
by the Ministry of Health[7], while, at the same time, national hospital-based estimates, known to overstate the problem, were between 1000 and 1251 per 100,000 live births[6,9,11]. The lowest estimate, of 11 deaths per 100,000 live births, was reported by a single district maternity hospital in Bamako, but it is likely that obstetric complications were referred to a larger hospital[7]. Moderate estimates of between 80 and 200 per 100,000 live births, were derived from health services registers, mostly located in urban areas[7,10,13]. A survey in the Koulikoro Region yielded a more realistic estimate for a rural area of 744 deaths per 100,000 deliveries, recorded by the public health services[12]. In Bamako, Blum and Fargues used data from deaths registers over a 10 year period to estimate the maternal mortality ratio to be between 205 and 399 per 100,000 live births[8]. With the exception of one prospective hospital based-study, all these studies used registers as the source of their information[11]; there has been no prospective community-based estimate of the maternal mortality ratio.

We report on a prospective study to measure maternal mortality in a population in a district of the capital of Mali. We followed up the women for one year after their delivery.

METHODS

Setting

Bankoni is a district of the capital of Mali, Bamako, located in the north-east quadrant of the city and is divided into six sectors. Its population in March 1989 was estimated at 59,000[16]. The population consists mainly of rural immigrants, and has the largest growth rate of the capital with an increase of 82% between 1976 and 1987[16]. In 1987, each household was numbered by the Direction Régionale de l'Urbanisme et de la Construction and a detailed map with household numbers was made. Since March 1989 a community health centre (Association de Santé Communautaire de Bankoni), managed by a physician, has served the district. In early 1990, a maternity ward opened within the centre, staffed by one full-time, and several part-time, trained midwives. In the neighbouring districts of Sikoroni, Missira and Korofina, there are one community health centre, two public health centres and a private clinic. Two national teaching hospitals are in Bamako. Blood transfusion and surgery are available in the public health centres and in the clinic, but not in the community health centres.

Design

The study took place in three phases: the pregnant women residing in Bankoni were identified and enrolled into the study; the women were visited six weeks and

one year after delivery. Using the maps of the district, three midwives, each one in charge of two sectors, performed the three visits at home, under the supervision of a full-time physician. The midwives undertook weekly duties at the maternity unit of the district and were well known to the population.

Enrolment

Between March 1989 and September 1992, pregnant women were identified by quarterly visits. The approximate dates of conception and delivery were estimated by interview. Each woman was identified by her name and age, the name of her husband, the name of the householder, a unique identification number, the sector number and the household number. Given the length of the recruitment phase, a woman could be enrolled twice.

Follow up visits

At least six weeks after the likely date of delivery it was ascertained if the women were alive, and the women (her relatives if dead) were interviewed, using a structured questionnaire, about her reproductive history, socio-demographic features, course and outcome of pregnancy, precise date and conditions of delivery and the puerperium. About half the interviews were carried out within four months of delivery, with a delay for the 1992 births due to an interruption of the field work between January and June 1993 for administrative reasons. One year after delivery, it was again ascertained whether the women were alive. The deliveries occurred between April 1989 and December 1992, while the follow up visits took place between November 1989 and August 1994. If a woman was not at home another visit was arranged. If she had moved house within Bankoni district she was visited at her new address. If the death of a woman was notified, information on the date, place and circumstances of death was collected at that time. If a stillbirth was notified a questionnaire aiming to distinguish between stillbirths and neonatal deaths was used.

Assessment of the cause of deaths

In December 1993 two senior midwives made additional enquiries concerning each recorded death. During this survey, clinical information was collected at different levels: households (relatives), maternity wards in Bankoni and neighbouring districts, and the two main public hospitals, Gabriel Touré Hospital (maternity, accident and emergency, departments of medicine, surgery and obstetrics and gynaecology, mortuary) and Point G Hospital (register of admissions, departments of medicine, surgery and psychiatry). Only one case was

not directly investigated by our team, where, after antenatal care in Bamako, the woman was delivered in a public rural maternity hospital and the investigations were carried out by the local staff.

To classify deaths as maternal or non-maternal, the 10th revision of The International Classification of Diseases of the WHO was used[17]. The causes of maternal death were divided into direct and indirect obstetric causes. The diagnosis relied on the available clinical information at the time of the enquiries. In the 10th revision, compared with the 9th revision, the definition of maternal death remains unchanged, but a definition of late maternal death is introduced: the death of a woman from direct or indirect obstetric causes more than 42 days, but less than one year, after the termination of pregnancy.

Data management and statistical calculations

Data were organised by visit and files were linked by the identification number, sector and household number. Great attention was devoted to distinguishing between successive pregnancies, twin pregnancies and duplicate records.

The maternal mortality ratio (MMR) was expressed as the number of maternal deaths divided by the number of live births within the cohort. A second estimate of the maternal mortality ratio, accounting for late maternal deaths, was also calculated. A rough estimate of the lifetime risk of maternal death ($R_{15-49 \, years}$) given a total fertility rate (TFR) of 7, was produced using the following formula, assuming a constant risk of maternal death throughout the reproductive period:

$$R_{15-49} = 1 - (1 - MMR)^{TFR \times 1 \cdot 2}$$

where the TFR is multiplied by $1 \cdot 2$ to make allowance for pregnancies not ending in live births.

RESULTS

Response rate and characteristics of the women

By 31 December 1994, 4717 of the 5782 enrolled women had been traced up to one year after delivery (82%). The distribution of the pregnancies by sector did not differ from the distribution of the general population by sector, and half of the women had settled in Bankoni during the previous 14 years (Table 1). More than 95% of the women were married and Muslim, and two thirds did not have to share their husband with a co-wife. The age range was 12–52 years (mean 25·6, median 25), the number of previous pregnancies ranged from 0 to 15 (median 3); one sixth of the women were primiparous and over one quarter of the women were highly multiparous (five or more previous pregnancies).

Table 1. Demographic characteristics of the 4717 pregnant women of the cohort, Bankoni, Bamako, Mali, 1989–1994.

Variable	n (%)
Age (years)	
<15	23 (<1)
15–19	861 (18)
20–24	1218 (26)
25–29	1313 (28)
30–34	729 (15)
35–39	446 (10)
40+	88 (2)
Unknown	39 (<1)
Parity	
0	747 (16)
1	732 (16)
2	690 (15)
3	626 (13)
4	535 (11)
5+	1387 (29)
Marital status	
Married	4602 (98)
Single	107 (2)
Divorced	4 (<1)
Widowed	2 (<1)
Unknown	2 (<1)
No. of co-wives	
0	3077 (65)
1	1090 (23)
2	374 (8)
3	55 (1)
4	4 (<1)
Single, widowed, divorced	113 (2)
Unknown	4 (<1)
Time of settlement in Bankoni (years)	
<1	107 (2)
1–4	782 (17)
5–14	1511 (32)
15+	2298 (49)
Unknown	19 (<1)
Sector of residence	
Zeguenekorobougou	1083 (23)
Plateau	1036 (22)
Flabougou	907 (19)
Dianguinébougou	730 (15)
Salembougou	518 (11)
Laybougou	443 (9)

Use of health services

Two indicators assessing the use of services during pregnancy were used: the proportion of women having had at least one antenatal visit, and the proportion of women being immunised. They showed that most of the women had contact with a health facility during pregnancy (Table 2). The health centres were primarily close first-line centres, either for antenatal care (86%) or delivery (79%). Home delivery accounted for only 10%. Excluding women who had no antenatal care, or had used several different antenatal centres or an unknown centre, and women who were delivered at home or out

Table 2. Use of health services, cohort of 4717 pregnant women, Bankoni, Bamako, Mali, 1989–1994.

Variable	n (%)
Antenatal care (at least one visit)	
Yes	3731 (79)
No	984 (21)
Unknown	2 (<1)
Immunisation during pregnancy (tetanus toxoid)	
Yes	3641 (77)
No	1058 (22)
Unknown	18 (<1)
Health centre used for antenatal care	
Health centre of neighbouring districts	
(Missira, Korofina, Sikoroni)	1656 (35)
Community health centre of Bankoni (ASACOBA)	1581 (33)
Other health centres	472 (10)
Several centres used	28 (<1)
No antenatal care	984 (21)
Unknown	11 (<1)
Place of delivery	
Maternity unit of community health centre of	
Bankoni (ASACOBA)	1860 (40)
Maternity unit of health centre of neighbouring	
districts (Missira, Korofina, Sikoroni)	1799 (38)
At home in Bamako	464 (10)
Teaching hospital maternity units	249 (5)
Other maternity units in Bamako	202 (4)
Out of Bamako	63 (1)
Unknown	80 (2)*

*72 late abortions, 2 hospitals (unspecified), 6 missing data.

of Bamako (1375 observations, 29% of the data set), 79% of the women who had used the ASACOBA health centre in Bankoni for antenatal care were delivered there, and 66% of the women who had used the health centres in neighbouring districts were delivered in these centres (Table 3). For the other centres in Bamako with a much lower activity, the percentage decreased to 42%. Conversely, depending upon the type of health centre considered, 24%, 32% and 55% of the women being delivered had not previously used the maternity unit of

the health centre for antenatal care, and so were not known to the staff.

Outcome of pregnancy and maternal mortality

At the end of follow up of the 4717 women, 4580 live births and 198 late abortions or stillbirths were recorded. There were 64 twin pregnancies, one woman died undelivered and the outcome of the pregnancy was unknown in two cases. A caesarean section was performed in less than 1% (42 cases). Fifteen maternal deaths were observed. The maternal mortality ratio was 327 per 100,000 live births, with a lifetime risk of maternal death of 2·7%. Five late maternal deaths were recorded. When these maternal deaths are added to the 15 other maternal deaths, the maternal mortality ratio is 436 per 100,000 live births and the lifetime risk is 3·6%. Late maternal deaths explained a quarter of the total maternal mortality.

Causes of maternal deaths

Direct causes accounted for thirteen deaths and indirect causes for one. One case was difficult to classify (history of epilepsy, epilepsy during pregnancy and labour, postpartum haemorrhage followed by an epileptic state). Seven deaths were due to haemorrhage (including one abortion and two cases of ruptured uterus); four from hypertensive disorders in pregnancy; three from sepsis after caesarean section (including two cases of obstructed labour), and one from hepatic coma due to hepatitis. Six women were delivered and died in a national teaching hospital; five were delivered in a district maternity hospital and were referred to a national teaching hospital where they died; one was delivered in a rural maternity hospital and three at home. Hypertensive disorders in pregnancy were the main underlying cause of death (four out of thirteen) and, except for a case of eclampsia in a twin pregnancy, deaths from hypertension occurred well after delivery during the second, fourth and fifth weeks after childbirth.

Table 3. Cross-use of the health centres after exclusion of 1375 observations corresponding to women with no antenatal care, having used several different antenatal centres or an unknowed centre and women who delivered at home or out of Bamako, Bankoni, Bamako, Mali, 1989–1994. Values are given as n (%).

Health centre used	Women having used the centre for antenatal care	Deliveries in the centre	Women delivering in same health centre as antenatal care	Women delivering who had not used that centre for antenatal care
Community health centre of Bankoni (ASACOBA)	1388	1453	1101 (79)	352 (24)
Health centre of neighbouring districts (Missira, Korofina, Sikoroni)	1532	1499	1016 (66)	483 (32)
Other centres (teaching hospitals, private clinics)	422	390	176 (42)	214 (55)

Causes of late maternal deaths

The cause of death was not established for two women; of the other three, one woman died of suicide, one of tuberculosis and one from cardiac failure.

DISCUSSION

We performed a prospective study in the community to estimate the maternal mortality ratio of Bamako, the capital of Mali. This study has great strengths: the estimate is less prone to selection bias than studies in hospital where there is selective referral; the capture of deaths and births is more complete than with routinely gathered statistics; the puerperium and the period beyond 42 days after delivery were studied. However, the design of our study suffers from a number of drawbacks. We had to include a large number of women to produce precise estimates, and so the study may be too long and too expensive for developing countries; the sisterhood method provides a reasonable alternative for the immediate past period[3]. Prospective studies in the community are therefore the exception[18–20]. In Bankoni, it took more than three years to enrol enough women to produce a reasonably precise estimate of the maternal mortality ratio. The conditions at enrolment could alter how the study population was representative of the target population. Pregnancies were likely to be notified only after the first trimester or even at the end of the second trimester and maternal deaths resulting from early, clandestine, abortions were not counted. Our study population consisted of pregnant women who were alive at the time of enrolment. Our estimate of maternal mortality ratio pertains only to the population in our study, and the true maternal mortality ratio in the population will be larger since the number of live births remains the same. The difference between the two estimates will reflect the proportion of abortions resulting in a maternal death. As in any fixed cohort study, the losses to follow up could bias the estimate of the maternal mortality ratio. In our study 18% of the pregnant women were lost to follow up. In contrast to previous prospective studies, all performed in a rural Sub-Saharan area with the period of follow up ending 42 days after delivery, the Bankoni cohort was established in an urban area and the follow up period was extended until one year after delivery. The high mobility of the urban population, combined with an interruption of the field operations during six months in 1993 and the long period of follow up largely explain this attrition, discussed in a previous paper on the Bankoni cohort[21]. The influence of the losses to follow up on the estimate depends on their distribution with respect to the outcome: if these women were at the same risk as women with complete follow up, the maternal mortality ratio would be unchanged.

As expected, our estimate of the maternal mortality ratio for Bamako (327 per 100,000 live births) is much lower than estimates based on hospital populations[9–11]; it is also lower than the estimate of the Koulikoro Region, which is a rural area, and where the study was not population based[12]. Interestingly, it falls within the range of the rapid estimations generated by Blum and Fargues for the period 1974–85, using registers of deaths in Bamako[8]. Our estimate falls between those derived from larger studies in Conakry (559) and Abidjan (234–260), two other West African capitals, during the same period[22,23]. Hence, our study provides a reasonable estimate of the magnitude of maternal mortality in Bamako which is consistent with other approaches or regional estimates in equivalent urban settings. Although 80% of the pregnant women had at least one antenatal visit and almost 90% of them were delivered in a maternity unit in Bamako, these indicators reflect ease of access to care rather than quality of care. In addition, we showed that up to one third of the pregnant women being delivered in a Bamako maternity unit did not go to the unit they had used for antenatal visits, and their delivery was managed without the benefit of information related to their antenatal visits.

Causes of maternal death assigned retrospectively by interview should be interpreted cautiously. One of the two women who was delivered in a district maternity hospital had a ruptured uterus and died from haemorrhage in a national teaching hospital, having been transferred only on day two. The two cases of obstructed labour occurred in primiparous women who died from sepsis after a caesarean section in a national teaching hospital. Apart from the case of eclampsia, deaths from hypertension occurred in the puerperium, up to day 35, and were consequent upon a stroke. Although our series is obviously too small to allow reliable comparisons, our findings are consistent with those of a study in Bamako based in hospital (6567 live births, 76 maternal deaths, 1988–89), where hypertensive disorders in pregnancy also ranked first and explained one third of the deaths[11].

This study revealed the importance of late maternal mortality, according to the definition of the 10th revision of the International Classification if Diseases of the WHO. These deaths would not have been detected without an extended period of follow up after delivery, and are generally not considered by retrospective studies. In a prospective study in rural Malawi, 15 maternal deaths and 12 deaths quoted as 'nonmaternal' were recorded between 6 weeks and 12 months after delivery[20]. As in our study, the causes of these late deaths were not precisely ascertained, although half of the deceased women were positive for the human immunodeficiency virus. In the different setting of a developed country, the underestimation of maternal mortality, due to late deaths not being reported, was also stressed in relation to suicide[24].

In conclusion, this prospective study in the community has provided reliable and precise estimates of the maternal mortality ratio in Bamako, the capital of Mali. Despite 80% of the women having at least one visit to an antenatal clinic, and almost 90% of the women being delivered in a maternity hospital, the level of maternal mortality is unacceptably high, suggesting that improvement in the quality of maternity care is required.

Acknowledgements

References

1 Walsh JA, Feifer CH, Measham AR, Gertler PJ. Maternal and perinatal health. In: Jamison DT, Mosley WH, Measham AR, Bobadilla JL, editors. *Disease Control Priorities in Developing Countries.* New York: Published for The World Bank, Oxford University Press, 1993: 363–390.

2 Mauldin WP. Maternal mortality in developing countries: a comparison of rates from two international compendia. *Pop Develop Rev* 1994; **20**: 413–421.

3 Graham WJ. Maternal mortality: levels, trends, and data deficiencies. In: Feachem RG, Jamison DT, editors. *Disease and Mortality in Sub-Saharan Africa.* Oxford: Published for The World Bank, Oxford University Press, 1991: 101–116.

4 United Nations. *World population prospects 1992.* New York: 1993.

5 Royston E, Lopez AD. On the assessment of maternal mortality. *Wld Hlth Statist Quart* 1987; **40**: 214–224.

6 Sissoko M. *Approche épidémiologique de la mortalité maternelle liée à la gravido-puerpéralité à Bamako 1975–1979* (thèse de doctorat ès médécine). Bamako: ENMP, 1981.

7 AbouZahr C, Royston E. *Maternal Mortality: A Global Factbook.* Geneva: WHO, 1991.

8 Blum A, Fargues P. Rapid estimations of maternal mortality in countries with defective data. An application to Bamako (1974–1985) and other developping countries. *Pop Stud* 1990; **44**: 155–171.

9 Djilla A. *Contribution à l'étude de la mortalité maternelle à l'hôpital Gabriel Touré* [dissertation]. Bamako: ENMP, 1979.

10 Dakouo G. *Contribution à l'étude de la mortalité maternelle liée à la grossesse et à l'accouchement–Bilan de 10 ans d'observation (1980–1989)* [dissertation]. Bamako: ENMP, 1990.

11 Traoré AF. *Etude des complications obstétricales et de la mortalité maternelle à l'hôpital Gabriel Touré* [dissertation]. Bamako: ENMP, 1988.

12 Tall FS. *Contribution à l'étude de la mortalité féminine liée à la grossesse et à l'accouchement dans les centres de santé de cercle de la deuxième région du Mali (1987–1990)* [dissertation]. Bamako: ENMP, 1991.

13 Malle D, Ross DA, Campbell OMR, Huttly SRA. Institutional maternal mortality in Mali. *Int J Gynecol Obstet* 1994; **46**: 19–26.

14 The World Bank. *World development report 1993: investing in health.* New York: Published for The World Bank, Oxford University Press, 1993.

15 United Nations Development Programme. *Human development report 1993.* New York: Oxford University Press, 1993.

16 Diarra T, Diakité BD, Traoré S, Pairault C. *Les conditions de vie, les dépenses de santé et les recours aux soins dans le quartier de Bankoni,* Tome 1. République du Mali/Ministère de la Santé Publique et des Affaires Sociales/Institut National de Recherche en Santé Publique, November 1990.

17 WHO. ICD-10: *The International Statistical Classification of Diseases and Related Health Problems,* tenth revision. Genève: WHO, 1992.

18 Greenwood AM, Greenwood BM, Bradley AK, Williams K, Shenton FC, Tulloch S et al. A prospective survey of the outcome of pregnancy in a rural area in the Gambia. *Bull Wrld Hlth Org* 1987; **65**: 635–643.

19 Walraven GEL, Mkanje RJB, van Roosmalen J, van Dongen PWJ, Dolmans WMV. Assessment of maternal mortality in Tanzania. *Br J Obstet Gynaecol* 1994; **101**: 414–417.

20 McDermott JM, Slutsker L, Steketee RW, Wirima JJ, Breman JG, Heyman DL. Prospective assessment of mortality among a cohort of pregnant women in rural Malawi. *Am J Trop Med Hyg* 1996; **55**: 66–70.

21 Kodio B, Etard JF. Evolution récente de la mortalité infantile à Bamako, Mali. *Population* 1997; **2**: 381–398.

22 Toure B, Thonneau P, Cantrelle, Barry TM, Ngo-Khac T, Papiernik E. Level and causes of maternal mortality in Guinea (West Africa). *Int J Obstet* 1992; **37**: 89–95.

23 SMI-France. Recherche operationnelle sur la mortalité maternelle dans l'agglomeration urbaine d'Abidjan (Cote d'Ivoire), May 1993.

24 Shing-Kai Yip, Tony Kwok-Hung, Chung, Tak-Shing Lee. Suicide and maternal mortality in Hong Kong. *Lancet* 1997; **350**: 1103.