

# Improved access to comprehensive emergency obstetric care and its effect on institutional maternal mortality in rural Mali

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**Objective** To evaluate the effect of a national referral system that aims to reduce maternal mortality rates through improving access to and the quality of emergency obstetric care in rural Mali (sub-Saharan Africa).

**Methods** A maternity referral system that included basic and comprehensive emergency obstetric care, transportation to obstetric health services and community cost-sharing schemes was implemented in six rural health districts in Kayes region between December 2002 and November 2005. In an uncontrolled "before and after" study, we recorded all obstetric emergencies, major obstetric interventions and maternal deaths during a 4-year observation period (1 January 2003 to 30 November 2006): the year prior to the intervention (P-1); the year of the intervention (P0), and 1 and 2 years after the intervention (P1 and P2, respectively). The primary outcome was the risk of death among obstetric emergency patients, calculated with crude case fatality rates and crude odds ratios. Analyses were adjusted for confounding variables using logistic regression.

**Findings** The number of women receiving emergency obstetric care doubled between P-1 and P2, and the rate of major obstetric interventions (mainly Caesarean sections) performed for absolute maternal indications increased from 0.13% in P-1 to 0.46% in P2. In women treated for an obstetric emergency, the risk of death 2 years after implementing the intervention was half the risk recorded before the intervention (odds ratio, OR: 0.48; 95% confidence interval, CI: 0.30–0.76). Maternal mortality rates decreased more among women referred for emergency obstetric care than among those who presented to the district health centre without referral. Nearly half (47.5%) of the reduction in deaths was attributable to fewer deaths from haemorrhage.

**Conclusion** The intervention showed rapid effects due to the availability of major obstetric interventions in district health centres, reduced transport time to such centres for treatment, and reduced financial barriers to care. Our results show that national programmes can be implemented in low-income countries without major external funding and that they can rapidly improve the coverage of obstetric services and significantly reduce the risk of death associated with obstetric complications.

Une traduction en français de ce résumé figure à la fin de l'article. Al final del artículo se facilita una traducción al español. الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

## Introduction

Maternal mortality is a major public health problem, particularly in sub-Saharan Africa, where half (50.4%) of all maternal deaths worldwide occur.<sup>1</sup> One objective of the Millennium Development Goals is to reduce maternal mortality by 75% between 1990 and 2015.<sup>2</sup> In 2005, the maternal mortality ratio in sub-Saharan Africa, estimated at 900 maternal deaths per 100 000 live births, was by far the highest in the world.<sup>1</sup> Unlike other regions, sub-Saharan Africa has not seen improvements in indicators linked to maternal mortality, leading to fears that the Millennium Development targets will not be met.<sup>3</sup> In response to this disquieting situation, many African countries have adopted measures towards reducing maternal mortality.

The context and causes of maternal mortality and morbidity are well known,<sup>4</sup> and strategies to ameliorate them were recently reported.<sup>5</sup> One proven effective strategy is to provide access to basic emergency obstetric services (parenteral oxytocics, antibiotics and anticonvulsants; assisted deliveries; manual extraction of the placenta; removal of retained products) and, if necessary, to comprehensive emergency obstetric services (basic services plus Caesarean sections and blood transfusions).<sup>6</sup> Access to these services is a key element

of the WHO Making Pregnancy Safer programme.<sup>7</sup> Ensuring timely Caesarean delivery when needed is a priority in sub-Saharan Africa.

In western Africa, maternal mortality is highest in rural areas where access to emergency obstetric care is limited by large geographic distances to health facilities and scarce resources.<sup>8</sup> While progress has been made in reducing maternal mortality rates in urban areas, the situation in rural areas is not improving. In Mali, for example, the population-based rate of Caesarean delivery in urban areas rose from 1.6% to 3.5% between 1991 and 1998, while in rural areas it remained unchanged (1.6% and 1.5%, respectively).<sup>9</sup> Implementing emergency obstetric care programmes, and maternity referral systems in particular, is complicated in settings where resources are scarce.<sup>10</sup> In western Africa, where the Bamako Initiative has made cost recovery in health care the standard,<sup>11</sup> the costs of comprehensive emergency obstetric care represent a major outlay for households<sup>12,13</sup> and several strategies have been attempted to reduce this financial burden.<sup>14,15</sup>

In 2002, the Government of Mali launched a nationwide maternity referral system<sup>16</sup> aimed at improving the quality and accessibility of comprehensive emergency obstetric care services and at reducing the danger of death associated with obstetric

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complications. In this study, we aim to evaluate the effects of the system in a rural population of more than one million inhabitants.

## Methods

### Setting

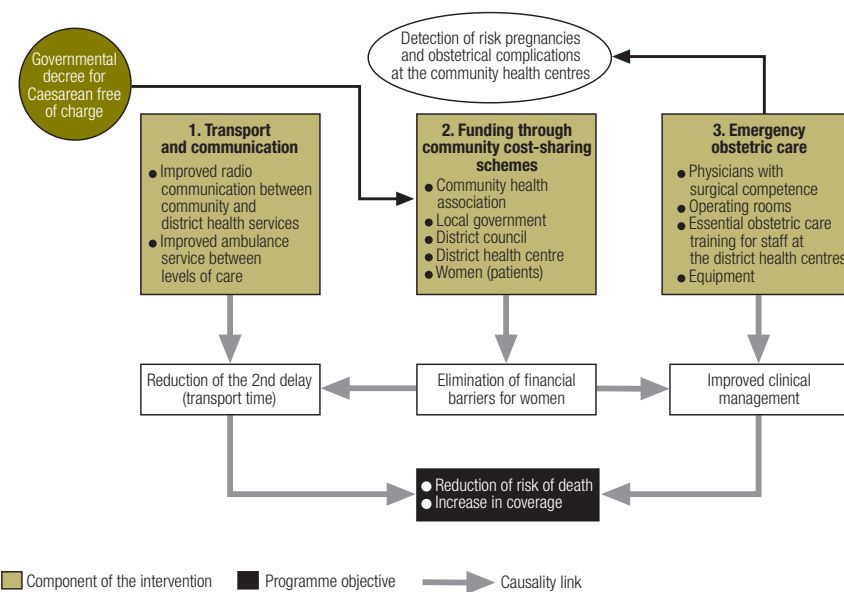
Of 177 countries on the Human Development Index for 2005, Mali was ranked 173rd<sup>17</sup> and had the 17th highest maternal mortality ratio<sup>1</sup>. The health region of Kayes, situated in the west of Mali, has nearly 1.7 million inhabitants unevenly distributed over 120 760 km<sup>2</sup>. Rugged terrain and periods of intense rain with flooding make communications difficult. The study area consists of six of the region's seven districts. The provincial district was excluded because it is more urban. The study area contains just over 1.25 million inhabitants, and the population density of the districts varies between 9.7 and 26.2 inhabitants per km<sup>2</sup> (mean of 14.7 inhabitants per km<sup>2</sup>).

Despite efforts in recent years, the geographic accessibility of health services remains poor: the distance from home to a primary health care centre is more than 5 km for 56% of the population and more than 15 km for 30%. The public health system, which is almost the only provider of modern health-care services, has few resources (one doctor per 28 000 and one midwife per 96 000 inhabitants). The study area has 101 community health centres (15 to 20 in each district) and six district health centres. Whereas the latter offer comprehensive emergency obstetric care, community health centres provide basic obstetric services, including assisted deliveries. When an emergency complication arises at the community health centre, the patient is referred to a district health centre. The overall utilization rate of reproductive health services in the study area resembles the national average for rural areas in Mali.<sup>18</sup>

### Intervention

The maternity referral system is a national programme launched in 2002 to reduce the risk of maternal death associated with obstetric complications.<sup>16</sup> The system relies on three main components (Fig. 1). First, it seeks to improve communication and transport opportunities to eliminate delays in the

Fig. 1. Components and function of referral system for comprehensive emergency obstetric care, Mali, 2003–2006



■ Component of the intervention ■ Programme objective → Causality link

delivery of emergency obstetric services. Funds from overseas donors are used to improve radio communications between community health facilities and district health services, as well as ambulance transport between them. Second, alternative funding options, including community cost-sharing schemes, are accessed to eliminate financial barriers to obstetric care. Community-funded schemes receive funds from the local government, local health services and community health associations and then reimburse health providers for all services they give to women, who contribute only a small co-payment. Third, training and equipment are provided to improve the clinical management of obstetric emergencies.

The programme was designed in accordance with national guidelines but is implemented with adaptations for regional contexts in cooperation with local health partners. In the study area, the start-up period was between 2002 and 2005, depending on the district.

Two categories of women use the programme's obstetric services: (i) those with obstetric complications who are referred by community health centres and have benefited from all components of the system, and (ii) those who are self-referred to the district health centre.

There are six categories of obstetric emergency, defined on the basis of the medical diagnosis or the reason for referral: haemorrhage, uterine rupture, pre-eclampsia/eclampsia, dys-

toxic labour, infection and other (for other obstetric emergencies that cause maternal death directly, such as abortion, or indirectly, mainly malaria and anaemia).<sup>19</sup>

### Study design and statistical analysis

In 2004, a system for ongoing registration of obstetric emergencies was set up in all districts of the Kayes region. During an initial pilot phase, data collection was supported and supervised by the Regional Health Authority of Kayes and the research team. The system allowed for the documentation of each patient deemed to be an obstetric emergency, and the data collected included the sociodemographic characteristics of the woman, the obstetric diagnosis and outcome, pregnancy follow-up, etc. Data were collected retrospectively for the period from 1 January 2003 to 30 June 2004, after which the data were collected prospectively until 30 November 2006. All cases with direct and indirect obstetric complications were recorded and classified in accordance with accepted standards.<sup>19</sup>

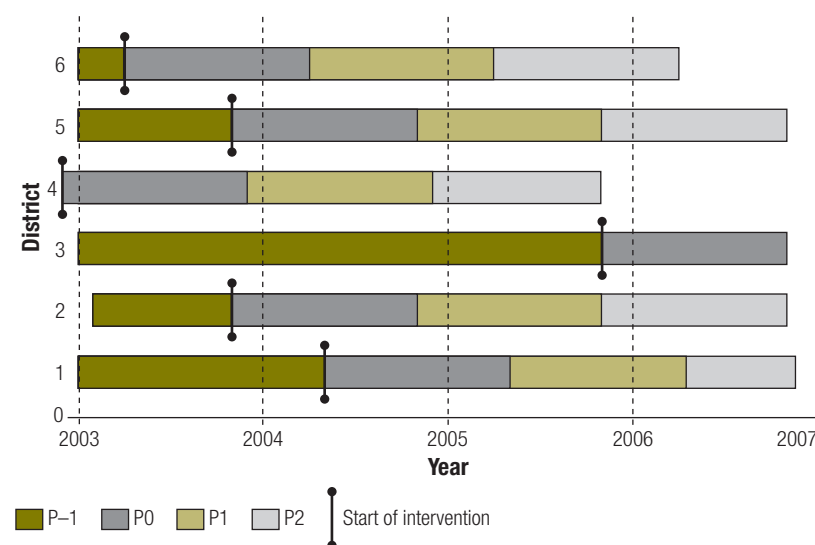
Because the maternity referral system is a national programme that all regions must implement, it was neither ethical nor practical to include a control group that would be denied access to this programme in our study design. Therefore, we used a quasi-experimental uncontrolled before-and-after study design. The main criterion to assess the effects of the intervention is the risk of

death among obstetric emergency cases. To evaluate the efficacy of the maternity referral system, we considered four periods: before the intervention (P-1), the year during which the intervention was implemented (P0) and two 12-month post-intervention periods (P1 and P2). Data availability and start date of intervention by district is shown in Fig. 2.

The maternity referral system was implemented on a different date in each of the six districts of the study area. As a result, the P-1 period lasted from 3 to 34 months, with a mean of 12.2 months; the P0, P1 and P2 periods all lasted 1 year, except in district 4, where P0 lasted 11 months, and for district 1, where P2 lasted 7 months. District 3 had no P1 or P2 while the study lasted since implementation of the programme was delayed because of the time it took to reach a consensus regarding community cost-sharing schemes.

We checked for group comparability for the main known risk factors for maternal death (age, cause of obstetric complications). Patients came from districts where access to health services varies greatly. Districts were classified according to the percentage of the population living within 15 km from a primary health care centre (good accessibility: > 85%; average accessibility: from 60 to 85%; poor accessibility: < 60%). We compared the risk of death

Fig. 2. Data availability, by period and district, in referral system for comprehensive emergency obstetric care, Mali, 2003–2006



P-1, year before the intervention; P0, year of the intervention; P1, 1 year after the intervention; P2, 2 years after the intervention.

among obstetric emergency cases across the different periods of the study by calculating odds ratios (ORs) and their 95% confidence intervals (CIs). To evaluate the potential effects of the intervention at different periods, adjusted ORs were calculated using various logistic regression models supported by Stata software, version 9.1 (Stata Corporation, College Station, TX, United States of America). Confounding variables included in the model were age,

previous Caesarean section, diagnosis, district accessibility, Caesarean delivery and transfusion.

## Results

Table 1 presents data on obstetric activities in the study area. During the study, the rate of institutional deliveries and the number of obstetric emergencies treated in district health centres increased. The proportion of deliveries

Table 1. Characteristics of the study area and of the obstetric care delivered before, during and after the adoption of a national maternity referral programme, Mali, 2003–2006

Variable	P-1 No. (%)	P0 No. (%)	P1 No. (%)	P2 No. (%)
Population covered (both sexes)	1 040 917 (NA)	1 169 061 (NA)	1 037 367 (NA)	976 927 (NA)
Expected deliveries <sup>a</sup>	52 046 (NA)	58 453 (NA)	51 868 (NA)	48 846 (NA)
Institutional deliveries <sup>b</sup>	9 871 (19.0)	15 576 (26.6)	16 573 (32.0)	19 235 (39.4)
<b>Obstetric emergencies treated</b>	475 (0.9)	658 (1.1)	571 (1.1)	913 (1.9)
Women referred <sup>c</sup>	143 (0.27)	273 (0.47)	246 (0.47)	452 (0.93)
Women not referred	332 (0.64)	385 (0.66)	325 (0.63)	461 (0.94)
<b>Major obstetric interventions<sup>d</sup></b>	120 (0.23)	273 (0.46)	292 (0.56)	396 (0.81)
Absolute maternal indications <sup>e</sup>	66 (0.13)	124 (0.21)	156 (0.30)	225 (0.46)
Non-absolute maternal indications	33 (0.06)	107 (0.18)	92 (0.18)	144 (0.29)
Unknown	21 (0.04)	42 (0.07)	44 (0.08)	27 (0.06)

NA, not applicable; P-1, year before the intervention; P0, year of the intervention; P1, 1 year after the intervention; P2, 2 years after the intervention.

<sup>a</sup> Calculated as 5% of the population; this number has been used as a denominator to calculate percentages.

<sup>b</sup> Includes deliveries at community and district health centres.

<sup>c</sup> Women with obstetric complications who were referred by a community health centre to a district health centre.

<sup>d</sup> Includes Caesarean section, hysterectomy, laparotomy, internal version and craniotomy/embryotomy.

<sup>e</sup> Includes severe antepartum and incoercible postpartum haemorrhage, uterine prerupture/rupture, major cephalopelvic disproportions, abnormal presentations (transverse and brow).

Table 2. Characteristics of women with obstetric emergencies before, during and after the adoption of a national maternity referral programme, Mali, 2003–2006

Characteristic	P-1 <i>n</i> = 475 No. (%)	P0 <i>n</i> = 658 No. (%)	P1 <i>n</i> = 571 No. (%)	P2 <i>n</i> = 913 No. (%)	P-value (DF)
<b>Age in years</b>					
≤ 16	64 (13.5)	95 (14.4)	83 (14.5)	125 (13.7)	} < 0.01 (9)
17–34*	300 (63.2)	435 (66.1)	370 (64.8)	664 (72.7)	
≥ 35*	93 (19.6)	105 (16.0)	107 (18.7)	114 (12.5)	
Unknown*	18 (3.8)	23 (3.5)	11 (1.9)	10 (1.1)	
<b>Previous Caesarean section</b>	15 (3.2)	17 (2.6)	24 (4.2)	46 (5.0)	0.07 (3)
<b>Diagnosis</b>					
Haemorrhage*	115 (24.2)	163 (24.8)	135 (23.6)	140 (15.3)	} < 0.01 (15)
Dystocic labour*	107 (22.5)	232 (35.3)	189 (33.1)	351 (38.4)	
Uterine rupture	12 (2.5)	18 (2.7)	10 (1.8)	16 (1.8)	
Pre-eclampsia/eclampsia**	59 (12.4)	47 (7.1)	49 (8.6)	91 (10.0)	
Infection**	11 (2.3)	5 (0.8)	3 (0.5)	12 (1.3)	
Other	171 (36.0)	193 (29.3)	185 (32.4)	303 (33.2)	
<b>Referred women<sup>a</sup></b>	143 (30.0)	273 (41.5)	246 (43.1)	452 (49.5)	< 0.01 (3)
<b>Accessibility of primary health care services<sup>b</sup></b>					
Good*	40 (8.4)	176 (26.7)	198 (34.7)	300 (32.9)	} < 0.01 (6)
Average*	354 (74.5)	225 (34.2)	166 (29.0)	284 (31.1)	
Poor*	81 (17.1)	257 (39.1)	207 (36.3)	329 (36.0)	
<b>Caesarean delivery</b>	112 (23.6)	258 (39.2)	286 (50.1)	383 (41.9)	< 0.01 (3)
<b>Transfusion</b>	11 (2.3)	17 (2.6)	19 (3.3)	22 (2.4)	0.70 (3)

\*  $\chi^2$  level of significance < 0.05; \*\*  $\chi^2$  level of significance < 0.01.

DF, degrees of freedom; P-1, year before the intervention; P0, year of the intervention; P1, 1 year after the intervention; P2, 2 years after the intervention.

<sup>a</sup> Women with obstetric complications who were referred by a community health centre to a district health centre.

<sup>b</sup> Accessibility was categorized according to the percentage of the population in a woman's district of residence that lived within 15 km from a primary health care centre: good accessibility, over 85%; average accessibility, from 60% to 85%; poor accessibility, less than 60%.

benefiting from major obstetric interventions for absolute maternal indications increased markedly: from 0.13% (95% CI: 0.10–0.16) at P-1 to 0.46% (95% CI: 0.26–0.66) at P2.

To take into account the sharp increase in the number of institutional deliveries during the study period, we performed calculations with institutional deliveries as a denominator. These calculations showed little change in the rate of obstetric emergencies treated (P-1 versus P2; 4.8% and 4.7%, respectively) while the rate of major obstetric interventions has increased (25% to 43%, respectively). Also of note is that there is little change in the percentage of major obstetric interventions performed for absolute maternal indications (55% in P-1 and 57% in P2).

During the study, 2617 obstetric emergency patients received care in district health centres and benefited from all or some components of the maternity referral system. Across the different periods, they differed significantly in terms of age, diagnosis, previous obstet-

ric history and case management (Caesarean section), as well as in geographical access to primary care services in their district of residence (Table 2).

Table 3 shows the causes of maternal death in the different study periods. The crude case fatality rate (defined as the ratio of total deaths observed, regardless of cause among cases, to the total number of cases observed) also decreased from 10.1% to 5.13% between P-1 and P2. Nearly half the reduction in mortality could be attributed to fewer deaths from haemorrhage. Overall, the risk of death decreased, and among women with haemorrhage, the reduction in risk was nearly three-fold and was statistically significant (OR: 0.37; 95% CI: 0.17–0.79). The decrease in the risk of death from haemorrhage was greater among referred women and was also statistically significant (OR: 0.17; 95% CI: 0.04–0.68).

Table 4 presents the adjusted odds ratios between the pre-intervention, implementation and two post-intervention

periods. The risk of death was reduced by about half for all women, and the reduction was statistically significant between P-1 and P1 ( $P = 0.027$ ) and between P-1 and P2 ( $P = 0.002$ ). The reduction was even more marked among referred women, for whom the risk of death was three times lower in P2 than in P-1 ( $P = 0.002$ ). The statistical tests for trends in case fatality rates did not yield significant results.

## Discussion

This study had the advantage of being set within a national programme, so that the measurement of its effects and the analysis of processes allowed us to draw lessons that are directly applicable not only to Mali but also to other resource-poor countries in sub-Saharan Africa. Existing studies on the implementation of transport systems, emergency loans, community financing, communications, or various combinations of these elements<sup>20–22</sup> offer few or no empirical data on whether they



Table 3. Case fatality rates (CFRs) and crude odds ratios, by cause of death,<sup>a</sup> before, during and after the adoption of a national maternity referral programme, Mali, 2003–2006

Cause of death	P-1		P0		P1		P2		P-1 versus P2		
	Deaths	CFR	Deaths	CFR	Deaths	CFR	Deaths	CFR	Absolute change <sup>b</sup>	Attributable <sup>c</sup>	Crude odds ratio (95% CI)
<b>Haemorrhage</b>	18	3.79	16	2.43	13	2.28	13	1.42	-2.37	47.5	0.37 (0.17–0.79)
Referred	7	4.89	8	2.93	5	2.03	7	1.55	-3.34	35.4	0.17 (0.04–0.68)
Not referred	11	3.31	8	2.08	8	2.46	6	1.30	-2.01	57.4	0.38 (0.13–1.13)
<b>Dystocic labour</b>	8	1.68	11	1.67	13	1.23	8	0.88	-1.81	16.2	0.52 (0.18–1.52)
Referred	6	4.19	7	2.56	2	0.81	5	1.11	-3.08	32.7	0.26 (0.07–0.96)
Not referred	2	0.60	4	1.04	5	1.54	3	0.65	0.05	-1.42	1.08 (0.15–9.27)
<b>Uterine rupture</b>	4	0.84	2	0.30	1	0.18	4	0.44	-0.40	8.1	0.52 (0.11–2.47)
Referred	2	1.40	1	0.37	1	0.41	3	0.66	-0.74	7.9	0.47 (0.06–4.06)
Not referred	2	0.60	1	0.26	0	0.00	1	0.22	-0.38	10.9	0.36 (0.01–5.04)
<b>Pre-eclampsia/eclampsia</b>	10	2.11	10	1.52	8	1.40	9	0.99	-1.12	22.5	0.46 (0.17–1.24)
Referred	5	3.50	3	1.10	5	2.03	8	1.77	-1.73	18.3	0.50 (0.14–1.78)
Not referred	5	1.51	7	1.82	3	0.92	1	0.22	-1.29	36.9	0.14 (0.01–1.25)
<b>Infection</b>	2	0.42	2	0.30	0	0.0	3	0.33	-0.09	1.9	0.78 (0.11–6.67)
Referred	0	0.00	1	0.37	0	0.0	2	0.44	0.44	-4.67	NA
Not referred	2	0.60	1	0.26	0	0.0	1	0.22	-0.38	10.9	0.36 (0.01–5.04)
<b>Other</b>	6	1.26	9	1.37	6	1.05	10	1.07	-0.19	3.8	0.87 (0.29–2.69)
Referred	2	1.40	5	1.83	2	0.81	2	0.44	-0.96	10.2	0.31 (0.03–3.14)
Not referred	4	1.20	4	1.04	4	1.23	8	1.74	0.54	-15.4	1.45 (0.39–5.76)
<b>Total</b>	48	10.1	50	7.59	35	6.14	47	5.13	-4.98	100.0	0.48 (0.31–0.75)
Referred	22	15.4	25	9.16	15	6.09	27	5.97	-9.43	100.0	0.35 (0.18–0.66)
Not referred	26	7.83	25	6.50	20	6.15	20	4.33	-3.50	100.0	0.53 (0.28–1.01)

CFR, case fatality rate; CI, confidence interval; P-1, year before the intervention; P0, year of the intervention; P1, 1 year after the intervention; P2, 2 years after the intervention.

<sup>a</sup> Total number of obstetric emergency cases for P-1 = 475; P0 = 658; P1 = 571; P2 = 913.

<sup>b</sup> The difference between CFR P2 and CFR P-1 for a specific cause (e.g. 1.42 - 3.79 = -2.37 for haemorrhage).

<sup>c</sup> Absolute change in maternal mortality for a specific cause (e.g. -2.37 for haemorrhage) expressed as a percentage of the total absolute change in maternal mortality rates (-2.37 ÷ -4.98 = 47.5).

reduce institutional maternal mortality. Furthermore, the usefulness of data from these studies is limited by study designs that are less than robust.

Our data show that Mali's national maternity referral system increases the coverage of obstetric emergencies and reduces the risk of death among women delivering with obstetric complications. This risk reduction is achieved primarily in those with haemorrhage, whose prognosis is directly related to whether appropriate care is received within 2 hours or not.<sup>23</sup> Furthermore, the reduction in risk among women with haemorrhage is distinctly more marked in those who are referred by community health centres than in those who come to the district health centre on their own. This point is particularly important because the referred women have benefited from all components of the intervention, particularly faster

modes of communication and transport that reduce treatment waiting times. Thus, improved access to comprehensive emergency obstetric care and to Caesarean sections has contributed to the programme's success.

The effects of the intervention were quick to be noted because there were considerable unmet needs in emergency obstetric care and baseline case fatality rates were very high. Over the study period, the number of women attending community health centres for normal deliveries increased progressively. Furthermore, obstetric complications became more likely to be diagnosed at an earlier stage in the labour or postpartum stages, allowing more women to benefit from the intervention sooner. Indeed, the number of obstetric emergencies and of major obstetric interventions performed in reference health centres increased dramatically during

the study period. However, 2 years after implementation of the referral system, the rates of major obstetric interventions performed for absolute maternal indications remained low (0.46%) by comparison to rates reported in 2003 from a study in an urban setting in neighbouring Burkina Faso. In that study, the number of major obstetric interventions for absolute maternal indications increased significantly (from 0.75% to 1.42%) the year after implementation of a cost-sharing mechanism for emergency obstetric care.<sup>15</sup>

An analysis of the conditions in which the intervention described herein was implemented made it possible to identify its strengths and weaknesses.<sup>10,24</sup> One of its strengths was the sustained political support it received at both the regional and national levels. Reproductive health is a major component of Mali's national health plan, and the

regional authorities have made the required investments. A further strength of the programme was its reliance on the establishment of community cost-sharing schemes, which not only reduce financial barriers to care, but also help to ensure programme sustainability by eliminating the need for financial contributions from outside the community. The last strength was the organization of the referral system and the collaboration among various partners. The programme was unique in that its general framework was defined at the national level, while regions supported the districts, which in turn designed their own local system. This method has the occasional drawback of slowing down implementation in areas where local dynamics are unfavourable; however, it generally has the advantage of producing a system that is supported by the community and local actors. In the Kayes region, implementation of these systems at the district level took 3 years (from December 2002 to November 2005). In Mali, the availability of Caesarean sections at the district level is made possible by a programme of surgical qualification for general practitioners that allows them to perform Caesarean deliveries. Neighbouring countries with greater resources have had difficulty achieving surgical training for general practitioners, resulting in reduced or non-existent access to surgical services in rural areas. The implementation of the system for ongoing registration of obstetric emergencies will yield the data necessary for continuous monitoring of the effectiveness of the maternity referral system. Data collection also serves as a stimulus and a performance incentive for those locally responsible for reproductive health services.

Areas for additional improvement include the availability and quality of basic emergency obstetric treatment at the first level of care. Most deliveries in community health centres are performed by poorly qualified birth attendants who fail to detect obstetric complications early enough. Furthermore, at district health centres more patients could be saved if the currently inadequate supplies of blood for transfusion were increased.

This study has some limitations. It had no control group or randomization and was constrained by the fact that the maternity referral system is a national

Table 4. Adjusted odds ratios for comparisons of risk of death between different periods before, during and after the adoption of a national maternity referral programme, Mali, 2003–2006

Comparison	All women OR <sup>a</sup> (95% CI)	Referred women OR <sup>a</sup> (95% CI)	Non-referred women OR <sup>a</sup> (95% CI)
P0 versus P–1	0.72 (0.45–1.13)	0.62 (0.31–1.22)	0.76 (0.41–1.43)
P1 versus P–1	0.57 (0.35–0.94)	0.40 (0.19–0.84)	0.69 (0.35–1.36)
P2 versus P–1	0.48 (0.30–0.76)	0.34 (0.18–0.70)	0.60 (0.31–1.18)

CI, confidence interval; OR, odds ratio; P–1, year before the intervention; P0, year of the intervention; P1, 1 year after the intervention; P2, 2 years after the intervention.

<sup>a</sup> Adjusted for age, previous Caesarean, diagnosis, health-centre accessibility, Caesarean delivery and transfusion.

programme whose effects should be evaluated under normal conditions of implementation. The absence of a control group made it impossible to control for other interventions or effects that could have modified the outcome of obstetric emergencies over time. However, the study area did not undergo any important social or economic changes during the study period. Changes to the health-care system in connection with obstetric emergencies were made within the framework of the maternity referral system being evaluated. The only notable modification to health services outside of the programme was the government's decision to provide Caesarean sections free of charge. This decision completely eliminated the woman's financial contribution, which had already been considerably reduced by community cost-sharing schemes associated with the intervention.

The second limitation of the study was the variability of data quality, which showed improvements over time in tandem with improvements in the monitoring system (for example, missing data for age decreased from 3.8% in P–1 to 1.1% in P2). Decreases in case fatality rates could be linked to an increase in the registration of less severe cases resulting from better case registration overall and the detection of complications at an earlier stage.

The limitations of the study were mitigated by the methods of analysis, which allowed us to control for the principal cofactors pertaining to patients' personal characteristics and obstetric history (age, previous Caesarean section), case mix (diagnosis), case management (Caesarean section and transfusion) and geographical accessibility. Given the constraints linked to the evaluation of a non-pilot referral system, the design and

methods of analysis chosen provided the most robust results possible.<sup>25</sup>

Our results show that in poor countries, programmes to reduce barriers to comprehensive emergency obstetric medical care can substantially decrease deaths associated with obstetric emergencies. Furthermore, they show that such programmes can be implemented on a large scale without major external funding. Our results were observed in a very poor country and in a region where the geographic accessibility of health-care services is among the poorest. Therefore, the system should be applicable to most rural African contexts, where most maternal deaths occur.

Furthermore, our results allow us to draw lessons not only about the intervention, but also about the research methods applied. More in-depth research should be carried out on the effects of this intervention on the population, especially related to geographical accessibility. The effects observed so quickly after this intervention were the result of the programme's response to important unmet needs. However, efforts to satisfy such needs will be limited by geographic accessibility; any future effects of the intervention could be diminished unless patient recruitment is extended to those living far from community health centres. Studies are currently under way to model accessibility, not in terms of distance, but rather of time, taking into account the seasons and the modes of transport being used. A better understanding of the causes of the first delay in seeking services<sup>26</sup> will also help improve access to the system.

In contexts where the rate of institutional deliveries is low, improvements in emergency obstetric care will enhance the effects of the maternity

referral system on maternal mortality. However, to achieve a more comprehensive approach for monitoring deliveries<sup>27</sup> that will ensure better maternal outcomes, the rate of institutional deliveries must be increased. In turn, this necessarily calls for improvements in service quality at all levels of the health system, some of which can derive from the successes of the maternity referral system. Our results suggest that part of the success of the intervention was linked to increased rates of institutional deliveries during the study period. ■

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**Competing interests:** None declared.

## Résumé

### Amélioration de l'accès à des soins obstétricaux d'urgence complets et effets sur la mortalité maternelle en milieu hospitalier, dans une région rurale du Mali

**Objectif** Évaluer les effets d'un système national d'aiguillage visant à réduire les taux de mortalité maternelle à travers une amélioration de l'accessibilité et de la qualité des soins obstétricaux d'urgence dans une région rurale du Mali (Afrique sub-saharienne).

**Méthodes** Un système d'aiguillage maternel, comprenant la prestation de soins obstétricaux d'urgence de base et complets, le transport dans un centre de santé dispensant des soins obstétricaux et des systèmes de partage des coûts dans la collectivité, a été mis en œuvre dans six districts sanitaires ruraux de la région de Kayes, entre décembre 2002 et novembre 2005. Dans le cadre d'une étude « avant et après » non contrôlée, nous avons enregistré toutes les urgences obstétricales, les interventions obstétricales majeures et les décès maternels sur une période d'observation de 4 ans (du 1<sup>er</sup> janvier 2003 au 30 novembre 2006), couvrant l'année avant l'intervention (P-1), l'année de l'intervention (P0) et les années débutant 1 an et 2 ans après l'intervention (P1 et P2 respectivement). La principale mesure de résultat était le risque de décès chez les patientes présentant une urgence obstétricale, calculé à partir des taux de létalité et des odds ratios bruts. Les résultats des analyses ont été ajustés par régression logistique pour tenir compte des facteurs de confusion.

**Résultats** Le nombre de femmes recevant des soins obstétricaux d'urgence a doublé entre P-1 et P2 et le taux d'interventions

obstétricales majeures (principalement des césariennes), pratiquées pour des indications maternelles absolues, est passé de 0,13 % en P-1 à 0,46 % en P2. Pour les femmes prises en charge pour une urgence obstétricale, le risque de décès 2 ans après l'intervention était inférieur de moitié à celui enregistré avant l'intervention (odds ratio, OR : 0,48 ; intervalle de confiance à 95 %, IC : 0,30-0,76). Les taux de mortalité maternelle ont diminué plus fortement parmi les femmes aiguillées vers des soins obstétricaux d'urgence que parmi celles s'étant présentées dans des centres de santé de district, sans aiguillage. Près de la moitié (47,5 %) de cette baisse de mortalité était attribuable à la diminution des décès par hémorragie.

**Conclusion** On a observé pour cette intervention des effets rapides, imputables à la disponibilité des interventions obstétricales majeures dans des centres de santé de district, à la réduction du temps de transport dans ces centres pour y recevoir un traitement et à la réduction des obstacles financiers à la dispensation des soins. Nos résultats montrent que les programmes nationaux sont applicables dans les pays à faible revenu sans apport financier externe majeur et qu'ils peuvent améliorer rapidement la couverture des services obstétricaux et diminuer notablement le risque de décès associé aux complications obstétricales.

## Resumen

### Mejora del acceso a atención obstétrica de urgencia integral y efecto sobre la mortalidad materna institucional en zonas rurales de Malí

**Objetivo** Evaluar el efecto de un sistema nacional de derivación concebido para reducir las tasas de mortalidad materna mediante la mejora del acceso a la atención obstétrica de urgencia y de la calidad de la misma en el Malí rural (África subsahariana).

**Métodos** Entre diciembre de 2002 y noviembre de 2005 se implantó en seis distritos de salud rurales de la región de Kayes un sistema de derivación para atención de maternidad que incluía atención obstétrica de urgencia básica e integral, transporte a servicios de obstetricia y planes comunitarios de participación en la financiación de los gastos. Mediante un estudio « antes y después » no controlado, registramos todas las urgencias obstétricas, las intervenciones obstétricas mayores y las defunciones maternas

a lo largo de un periodo de observación de 4 años (1 de enero de 2003 a 30 de noviembre de 2006): el año previo a la intervención (P-1); el año de intervención (P0), y al cabo de 1 y 2 años de la intervención (P1 y P2, respectivamente). La variable principal de valoración fue el riesgo de defunción entre las pacientes con urgencias obstétricas, calculado mediante las tasas brutas de letalidad y las razones de posibilidades brutas. Los análisis se ajustaron por variables de confusión mediante regresión logística.

**Resultados** El número de mujeres que recibieron atención obstétrica de urgencia se duplicó entre P-1 y P2, y la tasa de intervenciones obstétricas mayores (principalmente cesáreas) para indicaciones maternas absolutas aumentó de 0,13% en

P-1 a 0,46% en P2. En las mujeres tratadas por una urgencia obstétrica, el riesgo de muerte a los 2 años de la intervención se redujo a la mitad respecto a antes de la intervención (razón de posibilidades, OR: 0,48; intervalo de confianza, IC, del 95%: 0,30–0,76). Las tasas de mortalidad materna disminuyeron más entre las mujeres derivadas para atención obstétrica urgente que entre las que acudieron al centro de salud de distrito sin derivación previa. Casi la mitad (47,5%) de la reducción de la mortalidad es atribuible al menor número de defunciones por hemorragia.

**Conclusión** La intervención tuvo efectos rápidos debido a la

disponibilidad de intervenciones obstétricas mayores en los centros de salud de distrito, la disminución del tiempo de transporte hasta esos centros para recibir tratamiento y la disminución de las barreras financieras a la atención. Nuestros resultados muestran que es posible aplicar programas nacionales en los países de ingresos bajos sin necesidad de fondos externos importantes, y que dichos programas pueden mejorar rápidamente la cobertura de servicios obstétricos y reducir de forma considerable el riesgo de defunción asociada a complicaciones obstétricas.

## ملخص

### تحسين سبل الوصول إلى الرعاية الشاملة للحالات التوليدية الطارئة، وتأثيرها على وفيات الأمهات التي تحدث في المرافق الصحية الحكومية في ريف مالي

في المدة بين العام السابق للمداخلة، وبعد المداخلة بعامين، وزاد معدل التدخلات التوليدية الرئيسية (الجراحة القيصرية بشكل أساسي) المجرأة وفقاً للمؤشرات المطلقة للأمهات من 0.13% قبل المداخلة بعام إلى 0.46% بعد مرور عامين على المداخلة. وانخفض خطر تعرض النساء اللاتي يعالجن من الطوارئ التوليدية، للوفاة بعد مرور عام على تنفيذ المداخلة، إلى نصف معدل الخطر المسجل قبل المداخلة (نسبة الأرجحية 0.48 بفاصل ثقة 0.30 – 0.76). كما انخفضت معدلات وفيات الأمهات بصورة أكبر بين النساء المحالات إلى الرعاية التوليدية الطارئة، أكثر من النساء اللاتي يحضرن إلى المراكز الصحية بالمنطقة بدون إحالة. ويعزى نحو نصف هذا الانخفاض في الوفيات (47.5%) إلى قلة عدد الوفيات الناجمة عن النزف.

**الاستنتاج:** أظهرت المداخلة حدوث تأثيرات سريعة بسبب إتاحة التدخلات التوليدية الرئيسية في المراكز الصحية بالمنطقة، وبسبب انخفاض الوقت اللازم للانتقال لمثل هذه المراكز للمعالجة، وبسبب تقلص العوائق المالية التي تواجه الرعاية. وتظهر نتائجنا أن البرامج الوطنية يمكن أن تنفذ في البلدان المنخفضة الدخل دون الحاجة إلى تمويل خارجي كبير ومن شأنها تحسين التغطية بالخدمات التوليدية سريعاً، وتقليل خطر الوفيات المصاحبة للمضاعفات التوليدية بشكل كبير.

**الهدف:** تقييم أثر نظام الإحالة الوطني الذي يهدف إلى تقليص معدلات وفيات الأمهات من خلال تحسين جودة رعاية الحالات التوليدية الطارئة، وسبل الوصول إليها في ريف مالي (جنوب الصحراء الأفريقية).

**الطريقة:** نفذ نظام لإحالة الأمهات، يتضمن الرعاية الأساسية والشاملة للحالات التوليدية الطارئة، وسبل الانتقال إلى الخدمات الصحية التوليدية، والنظم المجتمعية للتشارك في تحمل التكاليف، في ست مناطق صحية ريفية في إقليم كايس في المدة من كانون الأول/ديسمبر 2002 إلى تشرين الثاني/نوفمبر 2005. من خلال دراسة غير مضبطة للوضع قبل المداخلة وبعدها، سجّل الباحثون جميع وفيات الأمهات، والتدخلات التوليدية الكبرى خلال مدة الملاحظة التي استمرت أربع سنوات (من 1 كانون الثاني/يناير 2003 إلى 30 تشرين الثاني/نوفمبر 2006) وشملت العام السابق للمداخلة (العام -1)؛ و عام المداخلة (العام 0) وبعد المداخلة بعام (العام 1) وبعد المداخلة بعامين (العام 2). وأشارت النتائج الأولية إلى خطر الوفاة بين من يعانين من الحالات التوليدية الطارئة محسوبة بالمعدل الخام للحالات المميتة، ونسب الأرجحية الخام. وعُدلت التحليلات بالنسبة للمتغيرات المسببة للالتباس باستخدام التحوف اللوجستي.

**الموجودات:** تضاعف عدد النساء اللاتي تلقين الرعاية التوليدية الطارئة

## References

1. *Maternal mortality in 2005: estimates developed by WHO, UNICEF, UNFPA and the World Bank*. Geneva: World Health Organization; 2007.
2. *Health and the Millennium Development Goals*. Geneva: World Health Organization; 2005.
3. AbouZahr C, Wardlaw T. Maternal mortality at the end of a decade: signs of progress? *Bull World Health Organ* 2001;79:561-8. PMID:11436479
4. Ronsmans C, Graham WJ. Maternal mortality: who, when, where and when. *Lancet* 2006;368:1189-200. PMID:17011946 doi:10.1016/S0140-6736(06)69380-X
5. Campbell OMR, Graham WJ. Strategies for reducing maternal mortality: getting on with what works. *Lancet* 2006;368:1284-99. PMID:17027735 doi:10.1016/S0140-6736(06)69381-1
6. Paxton A, Maine D, Freddman L, Fry D, Lobis S. The evidence for emergency obstetric care. *Int J Gynaecol Obstet* 2005;88:181-93. PMID:15694106 doi:10.1016/j.ijgo.2004.11.026
7. Weil O, Fernandez H. Is safe motherhood an orphan initiative? *Lancet* 1999;354:940-3. PMID:10489970 doi:10.1016/S0140-6736(99)02369-7
8. Ronsmans C, Etard J-F, Walraven G, Høj L, Dumont A, de Bernis L, et al. Maternal mortality and access to obstetric services in West Africa. *Trop Med Int Health* 2003;8:940-8. PMID:14516306 doi:10.1046/j.1365-3156.2003.01111.x
9. Stanton CK, Holtz SA. Levels and trends in cesarean birth in the developing world. *Stud Fam Plann* 2006;37:41-8. PMID:16570729 doi:10.1111/j.1728-4465.2006.00082.x
10. Murray SF, Pearson SC. Maternity referral systems in developing countries: current knowledge and future research needs. *Soc Sci Med* 2006;62:2205-15. PMID:16330139 doi:10.1016/j.socscimed.2005.10.025
11. Palmer N, Mueller DH, Gilson L, Mills A, Haines A. Health financing to promote access in low income settings - how much do we know? *Lancet* 2004;364:1365-70. PMID:15474141 doi:10.1016/S0140-6736(04)17195-X
12. Ensor T, Ronih J. Effective financing of maternal health services: a review of the literature. *Health Policy* 2005;75:49-58. PMID:16298228 doi:10.1016/j.healthpol.2005.02.002
13. Borghi J, Hanson K, Adjei Acquah C, Ekanmian G, Filippi V, Ronsmans C, et al. Costs of near-miss obstetric complications for women and their families in Benin and Ghana. *Health Policy Plan* 2003;18:383-92. PMID:14654514 doi:10.1093/heapol/czg046
14. Borghi J, Ensor T, Somanathan A, Lissner C, Mills A. Lancet Maternal Survival Series steering group. Mobilising financial resources for maternal health. *Lancet* 2006;368:1457-65. PMID:17055948 doi:10.1016/S0140-6736(06)69383-5



15. Richard F, Ouédraogo C, Compaoré J, Dubourg D, De Brouwere V. Reducing financial barriers to emergency obstetric care: experience of cost-sharing mechanism in a district hospital in Burkina Faso. *Trop Med Int Health* 2003;12:972-81.
16. *The health of the people: African regional health report*. Geneva: World Health Organization, Regional Office for Africa; 2006.
17. *Human development report 2007/2008: fighting climate change: human solidarity in a divided world*. New York: Palgrave Macmillan; 2007.
18. *Mali demographic and health survey 2006*. Calverton, MD: CPN/DNSI and Macro International, Inc.; 2007.
19. Maine D, Akalin MZ, Ward VM, Kamara A. *The design and evaluation of maternal mortality programs*. New York: Center for Population and Family Health, School of Public Health, Columbia University; 1997.
20. Krasovec K. Auxiliary technologies related to transport and communication for obstetric emergencies. *Int J Gynaecol Obstet* 2004;85 Suppl 1:S14-23. PMID:15147850 doi:10.1016/j.ijgo.2004.02.007
21. Samai O, Sengeh P. Facilitating emergency obstetric care through transportation, Bo, Sierra Leone. *Int J Gynaecol Obstet* 1997;59 Suppl 2:S157-64. PMID:9389627 doi:10.1016/S0020-7292(97)00161-6
22. Fofana P, Samai O, Kebbie A, Sengeh (the BO PMM Team). Promoting the use of obstetric services through community loan funds, Bo, Sierra Leone. *Int J Gynaecol Obstet* 1997;59 Suppl 2:S225-30. PMID:9389635 doi:10.1016/S0020-7292(97)00169-0
23. *World health report 2005: making every mother and child count*. Geneva: World Health Organization; 2005.
24. Tourigny C, Fournier P, Sangaré K, Laplante O, Coulibaly D, LaBossière F, et al. Évaluation de l'impact d'une intervention visant à réduire la mortalité maternelle en milieu rural en Afrique (Kayes, Mali) [in French]. *Canadian Public Health Association, 97th Annual Conference, Vancouver, Canada, 30 May 2005*.
25. Ross L, Simkhada P, Smith WCS. Evaluating effectiveness of complex interventions aimed at reducing maternal mortality in developing countries. *J Public Health (Oxf)* 2005;27:331-7. PMID:16234263 doi:10.1093/pubmed/fdi058
26. Thaddeus S, Maine D. Too far to walk: maternal mortality in context. *Soc Sci Med* 1994;38:1091-110. PMID:8042057 doi:10.1016/0277-9536(94)90226-7
27. Koblinsky M, Matthews Z, Hussein J, Mavalankar D, Mridha MK, Anwar I, et al; Lancet Maternal Survival Series steering group. Going to scale with professional skilled care. *Lancet* 2006;368:1377-86. PMID:17046470 doi:10.1016/S0140-6736(06)69382-3