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# Mortality after near-miss obstetric complications in Burkina Faso: medical, social and health-care factors

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**Objective** To investigate mortality in women in Burkina Faso in the 4 years following a life-threatening near-miss obstetric complication and to identify the medical, social and health-care-related causes of death.

**Methods** In total, 1014 women were recruited after hospital discharge and followed for up to 4 years: 337 had near-miss complications and 677 had uncomplicated pregnancies. Significant differences in mortality between the groups were assessed using Fisher's exact test. The medical causes of death were identified from medical records and verbal autopsy data; social and health-care-related factors associated with death were identified from interviews with the deceased women's relatives.

**Findings** In the 4 years, 15 (5.3%) women died in the near-miss group and 5 (0.9%) died after uncomplicated pregnancies ( $P < 0.001$ ). More than half the deaths after a near miss, but none after an uncomplicated delivery, were pregnancy-related. Indirect factors contributed to many of these deaths, particularly human immunodeficiency virus infection. Relatives' accounts suggested that the high cost and poor quality of health care, a lack of follow-up care and an unmet need for contraception contributed to the excess mortality in the near-miss group.

**Conclusion** Women in Burkina Faso who initially survived a near-miss obstetric complication had an increased risk of all-cause and pregnancy-related death in the ensuing 4 years. The likelihood of survival over the longer term could be increased by offering a continuum of care that addresses the indirect and social causes of death and supplements the emergency intrapartum obstetric care provided by current safe motherhood programmes.

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## Introduction

International discussions about maternal health in low-income countries tend to focus on maternal deaths. However, there is increasing concern that these deaths are only the tip of the iceberg in terms of the health effects of the poor availability and quality of maternity services.<sup>1</sup> In addition, countries with high maternal mortality also have a large burden of pregnancy-related complications and associated disabilities. It is estimated that "for every woman who dies from a pregnancy-related cause, about 20 more – roughly 7 million women yearly – experience injury, infection, disease or disability".<sup>1</sup> Of growing interest are "near-miss" obstetric complications – complications so severe that they would probably have killed the woman had she not received timely medical care.<sup>2</sup>

In low-income countries, near misses are often considered obstetric successes because ultimately the woman's life was saved by a focused medical intervention.<sup>2,3</sup> However, little is known about long-term outcomes following these complications.<sup>4</sup> Recent studies document a substantial degree of physical and psychological morbidity in their aftermath<sup>5–10</sup> and the high cost of emergency obstetric care has serious social and economic consequences.<sup>11,12</sup> Although women's lives are known to remain at risk for several months beyond the 42-day cut-off used in standard definitions of maternal death,<sup>13</sup> few studies have examined survival beyond this period in women who experience severe obstetric complications.

To what extent does surviving a near-miss obstetric complication mean that a maternal death has actually been averted? Our aim was to investigate maternal mortality in the 4 years

after hospital discharge following a near-miss complication in Burkina Faso. We used data from a longitudinal, mixed-methods, cohort study to describe patterns of mortality and analysed the medical, social and health-care-related causes of death after near-miss complications. Finally, we considered the implications of our study findings for strategies that promote safe motherhood.

## Methods

### Study setting

Burkina Faso is an impoverished country in western Africa that is ranked 177th out of 182 countries in terms of human development; 81% of the population live on less than 2 United States dollars a day.<sup>14</sup> The country's scores on reproductive health indicators are among the worst in the world. The fertility rate is 6.2 children per woman.<sup>15</sup> According to the most recent national census,<sup>16</sup> the maternal mortality ratio is 307 per 100 000 live births, and the World Health Organization's estimate is 560 per 100 000 live births.<sup>17</sup> Burkina Faso's district health system functions poorly and existing safe motherhood programmes do not address the availability of comprehensive obstetric care.<sup>18</sup> Only 73.2% of births are assisted by a skilled birth attendant – a figure that hides significant regional and socioeconomic disparities.<sup>19</sup> User fees for maternal health care, especially emergency care, are often unaffordable.<sup>11</sup> In 2007, the health ministry introduced an 80% subsidy for facility-based delivery to reduce out-of-pocket expenditure,<sup>20</sup> but its effect is still unclear.<sup>21,22</sup>

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## Data collection

We followed a cohort of 1014 women for 4 years after they were discharged from seven hospitals across Burkina Faso between November 2004 and March 2005. Women were recruited at hospital discharge to avoid exposure misclassification.<sup>23</sup> Of the 1014 women in the cohort, 337 had experienced a near-miss obstetric complication: the pregnancy ended in a live birth in 199 cases, in a perinatal death in 74 and in a miscarriage, ectopic pregnancy or abortion in 64. For each woman who had a near miss, we recruited an average of two unmatched controls from the seven hospitals. Usually the next two women to have an uncomplicated live delivery, as confirmed by medical notes, were selected, though some hospitals recruited more controls than others. The total number of controls was 677.

Trained lay interviewers made six follow-up visits: on day three after discharge, at 3 months, 6 months and 12 months, and in the third and fourth years after the end of the pregnancy. We investigated whether any woman not found for the interview had moved away or died. Interviews explored women's health, reproductive history, socioeconomic status, experience of health care, and health-care costs. Medical information was extracted from routine hospital records at discharge and from reports of medical examinations conducted 6 and 12 months later. In parallel, anthropologists carried out a detailed follow-up of a subsample of 82 women: 64 had near misses and 18 had uncomplicated deliveries. Findings from the first year of follow-up have been reported elsewhere.<sup>8,11,12</sup>

We used the verbal autopsy method to make detailed enquiries about any woman who died. This approach determines the cause of death by asking lay respondents about the signs exhibited and the symptoms experienced by the deceased and is used when data from routine information systems are incomplete.<sup>24</sup> Generally, respondents were the woman's husband, relatives who had participated closely in the woman's care and, when possible, health workers. A physician conducted verbal autopsies at the end of the first year, and the anthropologist conducted interviews at the end of follow-up. Additionally, an open-ended in-depth interview or social autopsy<sup>25,26</sup> was carried out to identify any social or health-care-related factors that could have contributed to the death.

## Data analysis

The proportion of women who survived at each follow-up visit was calculated for women who experienced near misses and for those who had uncomplicated deliveries. We used Fisher's exact test to determine whether the post-discharge mortality rate differed significantly between the two groups. We compared the marital status, age and parity at baseline of women who survived and who died within 4 years of follow-up in both the group of women who had uncomplicated deliveries and in the group that had near misses. We used the chi squared test to assess the association between baseline characteristics and death.

The most likely medical cause of death was assigned independently and agreed on by two clinical researchers on the basis of data from the verbal autopsy combined with additional information from medical records and reports of medical examinations (Table 1, available at: <http://www.who.int/bulletin/volumes/90/6/11-094011>). Comorbid conditions that may have contributed to the death were taken into account. In addition, we analysed records of the in-depth interviews thematically to derive non-medical causes of death.<sup>27</sup> This analysis was guided by our knowledge of the social circumstances of women in Burkina Faso and the health systems they use, gained over the course of the study.<sup>11,12</sup> Moreover, two of the deceased women belonged to the anthropologists' subsample and had participated in several interviews before their deaths.

## Ethical approval

The study was approved by the ethics committees of the London School of Hygiene and Tropical Medicine, United Kingdom of Great Britain and Northern Ireland, and the Ministry of Health of Burkina Faso. Study participants gave their free and informed consent.

## Results

### Mortality

Fig. 1 shows the number of participants included at each stage of the study. Of the 1014 women recruited, 695 attended the final interview at the end of the 4-year follow-up and 20 had died. Post-discharge mortality was significantly higher among women who had a near-miss obstetric complication than among controls who had uncomplicated deliveries ( $P < 0.001$ ).

Fig. 2 shows the proportion of women who survived at each follow-up visit. Six (1.9%) women in the near-miss group died within 1 year, and none died in the control group. The corresponding figures at the end of the 4-year follow-up period were 15 (5.3%) and 5 (0.9%) in the two groups, respectively.

No significant difference was found in age ( $P = 0.47$ ) or parity at baseline ( $P = 0.42$ ) between women in the near-miss group who died and those who survived and completed follow-up. However, women who died were more likely to be single at baseline ( $P = 0.001$ ; Table 2). We could draw no such comparisons in the control group because of the small number of deaths.

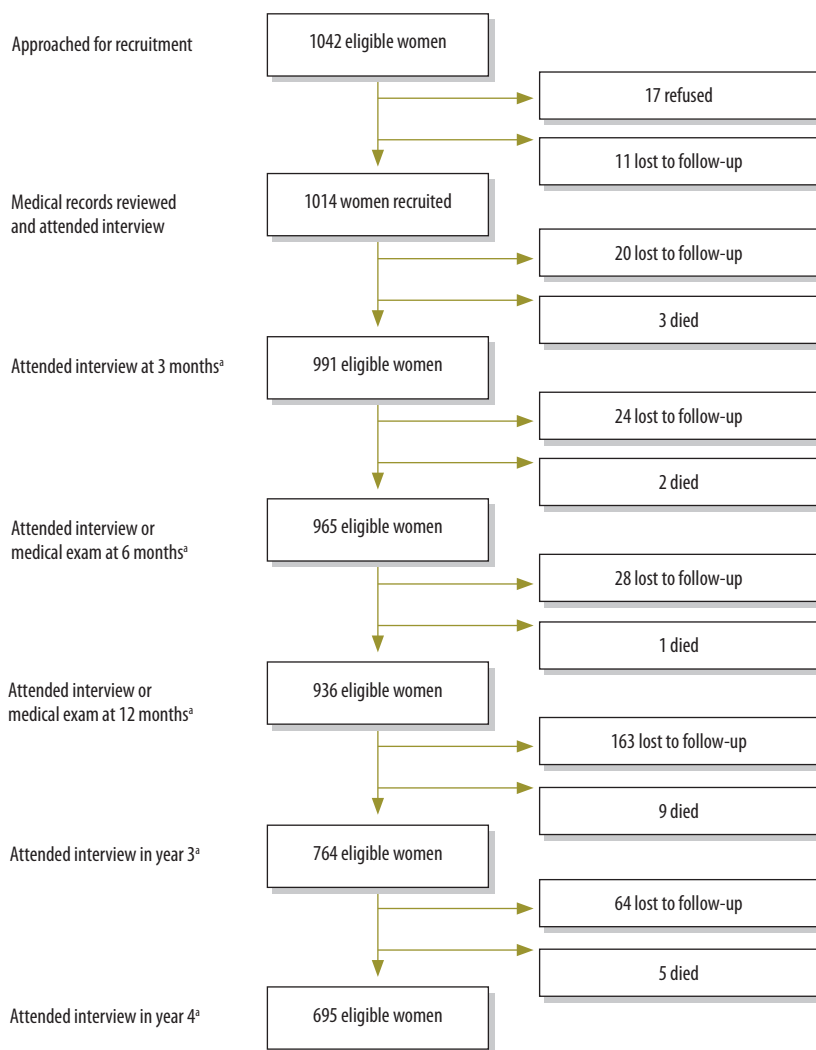
### Medical causes of death

Verbal autopsy data were available for 18 of the 20 deaths (Table 1). The relatives of the remaining two women could not be located.

In the near-miss group, 9 of the 15 deaths (60%) were pregnancy-related, compared with none in the control group (Table 1). Moreover, six of these nine pregnancy-related deaths occurred within 1 year of the near-miss obstetric complication or the end of the pregnancy. The most likely medical causes of these six deaths were: organ failure following septic abortion in one woman with a human immunodeficiency virus (HIV) infection; tuberculosis related to HIV infection in one woman with puerperal sepsis; anaemia with possible sepsis or immunity problems in one woman; probable anaemia in one; infection in one; and hypertension (i.e. eclampsia) in one. The remaining three pregnancy-related deaths in the near-miss group occurred within 42 days of a subsequent pregnancy: one was due to hypertension, one to septic abortion and one to haemorrhage following caesarean section suture complications. At least three of the nine women who died from a pregnancy-related cause were HIV-positive. The causes of the remaining six deaths in the near-miss group were: HIV infection in one, hypertension in one, possible infection related to tuberculosis in one, a suspected traffic accident in one and unknown due to insufficient data in two.

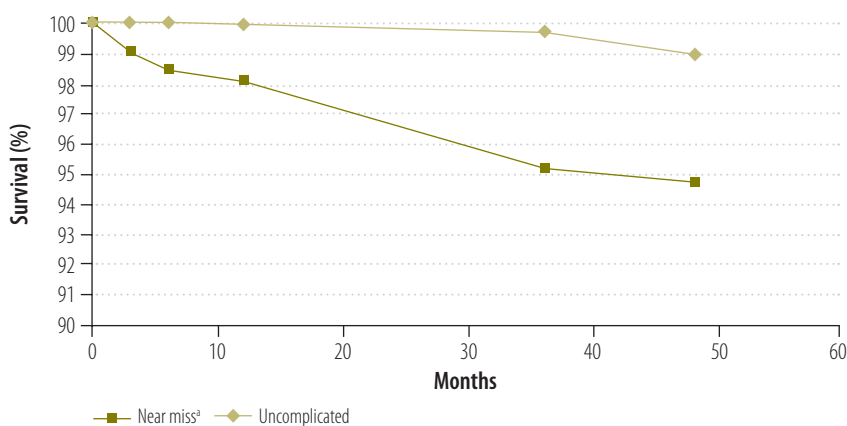
Of the five deaths in the control group, one was caused by malaria and three by acquired immunodeficiency syndrome (AIDS); the cause of one death remained undetermined due to insufficient data. The contribution of

Fig. 1. Study participants, maternal mortality in the 4 years after pregnancy, Burkina Faso, 2004–2009



<sup>a</sup> Some women missed one interview but attended a later one, so were not counted as being lost to follow-up.

Fig. 2. Maternal survival after the end of pregnancy, by pregnancy outcome, Burkina Faso, 2004–2009



<sup>a</sup> A near-miss complication is a severe obstetric complication that would probably kill the woman without timely medical care.

HIV infection and tuberculosis to deaths in the two groups is notable.

By the end of follow-up, three of the seven babies born to women who had a near-miss complication and who subsequently died had also died. One of the babies died a few days before his mother, at the age of 28 days. This baby was probably born with intrauterine growth retardation. The other two died after their mothers: one from malnutrition at 5 months and one from an unknown cause at 15 months. No deaths occurred among the five babies born to women in the control group who subsequently died. These babies were older at the time of their mothers' deaths and therefore less vulnerable.

### Health-care-related and social causes of deaths

Relatives of the women who died within a year of a near-miss complication believed the women had been discharged prematurely. Correspondingly, 17% of these women had not fully recovered when discharged, according to medical records.<sup>8</sup> Some left hospital because they could no longer afford to pay for care or to remain absent from their regular activities. Inadequate follow-up of unresolved health problems may have compounded the burden of premature discharge, as in the case of a 25-year-old woman who died of sepsis 7 months after an unsafe abortion (Box 1). As a whole, respondents noted that poor links between different parts of the health-care system (e.g. between a district hospital and a national hospital) delayed or prevented access to care.

Similarly, relatives of the three women in the near-miss group who died of pregnancy-related causes after a subsequent pregnancy identified a range of health-care-related contributing factors. None of these women received specific follow-up during antenatal care despite having had a near-miss complication in a recent pregnancy. The reason may be that in Burkina Faso no midwife and certainly no specialist normally participates in antenatal care, which is often delivered in a ritualistic way without addressing chronic ailments or risk factors. An unmet need for contraception, which is costly and poorly available, contributed to one of the maternal deaths because it led to an unwanted pregnancy. According to this woman's husband, the new pregnancy exacerbated the hypertension that resulted in the near miss less than 2 years earlier (Box 2). Both relatives and health-

Table 2. **Maternal mortality in the four years after pregnancy, by pregnancy outcome, age, parity and marital status, Burkina Faso, 2004–2009**

| Characteristic               | Pregnancy outcome                   |      |                           |       |                                      |      |                                     |                        |      |                           |      |                                      |      |                       |
|------------------------------|-------------------------------------|------|---------------------------|-------|--------------------------------------|------|-------------------------------------|------------------------|------|---------------------------|------|--------------------------------------|------|-----------------------|
|                              | Uncomplicated pregnancy             |      |                           |       |                                      |      | Near-miss complication <sup>a</sup> |                        |      |                           |      |                                      |      |                       |
|                              | Women alive at 4 years <sup>b</sup> |      | Women deceased at 4 years |       | Women lost to follow-up <sup>c</sup> |      | <i>P</i> <sup>d</sup>               | Women alive at 4 years |      | Women deceased at 4 years |      | Women lost to follow-up <sup>e</sup> |      | <i>P</i> <sup>d</sup> |
|                              | No.                                 | %    | No.                       | %     | No.                                  | %    |                                     | No.                    | %    | No.                       | %    | No.                                  | %    |                       |
| <b>Age (years)</b>           |                                     |      |                           |       |                                      |      |                                     |                        |      |                           |      |                                      |      |                       |
| < 20                         | 90                                  | 18.7 | 0                         | 0     | 37                                   | 19.6 |                                     | 36                     | 17.0 | 2                         | 13.3 | 36                                   | 33.0 |                       |
| 20–24                        | 135                                 | 28.1 | 0                         | 0     | 71                                   | 37.6 |                                     | 61                     | 28.8 | 2                         | 13.3 | 36                                   | 33.0 |                       |
| 25–29                        | 117                                 | 24.3 | 4                         | 80.0  | 45                                   | 23.8 |                                     | 44                     | 20.8 | 5                         | 33.3 | 18                                   | 16.5 |                       |
| ≥ 30                         | 139                                 | 28.9 | 1                         | 20.0  | 36                                   | 19.1 | NA                                  | 71                     | 33.5 | 6                         | 40.0 | 19                                   | 17.4 | 0.47                  |
| <b>Parity</b>                |                                     |      |                           |       |                                      |      |                                     |                        |      |                           |      |                                      |      |                       |
| 0                            | NA                                  | NA   | NA                        | NA    | NA                                   | NA   |                                     | 20                     | 9.4  | 3                         | 20.0 | 17                                   | 15.5 |                       |
| 1–3                          | 344                                 | 71.4 | 4                         | 80.0  | 155                                  | 82.0 |                                     | 132                    | 62.3 | 8                         | 53.3 | 72                                   | 65.5 |                       |
| 4+                           | 138                                 | 28.6 | 1                         | 20.0  | 34                                   | 18.0 | 0.67                                | 60                     | 28.3 | 4                         | 26.7 | 21                                   | 19.1 | 0.42                  |
| <b>Marital status</b>        |                                     |      |                           |       |                                      |      |                                     |                        |      |                           |      |                                      |      |                       |
| Married or in a relationship | 446                                 | 92.5 | 5                         | 100.0 | 167                                  | 88.4 |                                     | 191                    | 90.1 | 9                         | 60.0 | 90                                   | 81.8 |                       |
| Single                       | 36                                  | 7.5  | 0                         | 0     | 22                                   | 11.6 | NA                                  | 21                     | 9.9  | 6                         | 40.0 | 20                                   | 18.8 | 0.001                 |

NA, not applicable.

<sup>a</sup> A near-miss complication is a severe obstetric complication that would probably kill the woman without timely medical care.

<sup>b</sup> Data were missing on age for two women, on parity for one and on marital status for one.

<sup>c</sup> Data were missing on age for two women, on parity for two and on marital status for two.

<sup>d</sup> *P*-values were calculated using the chi squared test, where possible, for differences between women who died and those who were alive and completed follow-up. Due to the small number of deaths among women with an uncomplicated delivery, it was not possible to calculate a *P*-value for the difference in age or marital status between women who died and those who survived.

<sup>e</sup> Data were missing on age for three women, on parity for two and on marital status for two.

care workers strongly believed that better care could have saved the woman, who died of haemorrhage following caesarean section suture complications. She was discharged from hospital prematurely – within 24 hours of the emergency caesarean section – and was left untreated overnight, then readmitted with heavy bleeding and an open caesarean section wound the following evening. She died the next morning.

Relatives regarded the women's deaths as particularly tragic in light of the resources initially invested in saving them after the near miss and in treating subsequent associated health problems. Cost barriers disrupted referral chains for these women and impeded access to care for chronic health complaints, which may have indirectly or directly contributed to their deaths (Box 1). The cost barrier was particularly high for women with chronic health conditions. Lack of or inadequate treatment of pregnancy-related ailments, such as puerperal infection and anaemia, or of underlying infections or chronic conditions, such as hypertension, HIV infection, tuberculosis or malaria, appear to have contributed to several maternal

#### Box 1. **Example of a late pregnancy-related death after a near-miss complication,<sup>a</sup> Burkina Faso, 2005**

The 25-year-old woman<sup>b</sup> moved from a rural village to a town to work in a bar. She became pregnant while in a relationship with a visiting bureaucrat. Her partner revealed he was married with children, pressured her to terminate the pregnancy and paid for an illegal abortion. She was hospitalized with a near-miss septic abortion after intense stomach aches resulting from the botched abortion, underwent manual vacuum aspiration for the incomplete abortion and was treated for infection before discharge. She suffered stigmatization, lost her income and job and became disillusioned. An unresolved abortion-related infection left untreated due to the cost of care resulted in another hospitalization 6 months after discharge. The woman's brothers paid for her hospitalization for more than 1 month but were unable to afford prescribed referral to a tertiary hospital in a major city 170 km away. The woman died at her brothers' home 7 months after the septic abortion. The brothers had substantial financial problems even 3 years after the woman's death: they were in debt, had lost income and their farm's yield was reduced because they had to sell some animals to cover the health-care costs.

<sup>a</sup> A near-miss complication is a severe obstetric complication that would probably kill the woman without timely medical care.

<sup>b</sup> Woman 4 in Table 1 (available at: <http://www.who.int/bulletin/volumes/90/6/11-094011>).

deaths. These difficulties were exacerbated by social disadvantage, including a lack of social and material support, especially among single women.

## Discussion

Our findings show that the limited availability and poor quality of maternal health-care services can lead not only

to immediate death or longer-term disability or illness in women who experience a near miss from severe pregnancy complications, but also to an increased risk of death as long as 4 years after the event. Although targeted emergency care initially saved many women who experienced obstetric complications, those who had a near miss were significantly more likely to die within the



### Box 2. Example of a maternal death from a new pregnancy after a near-miss complication,<sup>a</sup> Burkina Faso, 2006–8

The 23-year-old Muslim woman<sup>b</sup> divorced after the death of her first child and was betrothed to a subsistence farmer, a relative, as his second wife. She experienced a stillbirth after a near-miss delivery involving eclampsia; the resulting health-care expenditure was “catastrophic” for the household. She had difficulty participating in household activities due to chronic ill health related to hypertension that started in pregnancy. The support of her partner and his co-wife enabled the woman to be temporarily absent from subsistence agricultural work and domestic chores. She took medication only on alternate weeks due to its cost. She wanted to delay a new pregnancy but was unable to acquire appropriate contraception because it was costly and unavailable at the local health centre. She had a new pregnancy within 1 year of the near-miss complication. The new pregnancy was difficult because of hypertension and she had a hospital delivery. She became ill in the postpartum period and died while asleep 28 days after delivery, most likely from hypertensive disease. The baby died shortly afterwards. Her husband was financially “ruined” by the health-care expenditure, which was exacerbated by new responsibilities for the widow and three children of a brother who had died.

<sup>a</sup> A near-miss complication is a severe obstetric complication that would probably kill the woman without timely medical care.

<sup>b</sup> Woman 8 in Table 1 (available at: <http://www.who.int/bulletin/volumes/90/6/11-094001>).

next 4 years than those who had an uncomplicated hospital delivery. Notably, these women had a higher risk of dying from a pregnancy-related cause, whether associated with the initial near miss or with the complications of a subsequent pregnancy. Single women were at a particularly high risk, perhaps because of poor material and social support. In addition, an infant born to a woman who had a near miss and subsequently died was also at an increased risk of death. The risk was higher both after the mother's death and before, as the mother may have been too sick or poor to produce breast milk or to properly care for her infant.<sup>28</sup> By contrast, no women with an uncomplicated delivery died from a pregnancy-related cause, and the babies of those who did die survived. Although we lack survival data on women lost to follow-up, we observed that those who had a near miss were more often lost to follow-up than those who did not. Consequently, unrecorded deaths were more likely among these women than among controls.

The verbal autopsy approach used in this study has well-known limitations, including recall bias, since data are sometimes collected months or years after a death.<sup>24,29</sup> The validity and reliability of lay respondents' reports of medical symptoms can also be problematic; their descriptions can be vague and non-medical and can point to a diagnosis that differs from the physician's. Moreover, respondents cannot provide information on signs that are not detectable without laboratory testing or clinical autopsy. Although verbal autopsies cannot unequivocally identify

the immediate cause of death or exclude competing causes, they can indicate the most likely contributing factors. In the absence of death registries, verbal autopsies provide the best means of identifying the likely medical cause of death.

Women clearly remain at risk of a pregnancy-related death for longer than the 42 days used in standard definitions of maternal death.<sup>30</sup> Consequently, the contribution of pregnancy-related deaths to mortality among women of reproductive age is likely to be underestimated. Indeed, extending the definition to include all deaths within 3 months of delivery increases current estimates of maternal mortality in low-income settings by 10% to 15%.<sup>30–32</sup> Incorporating late maternal deaths within 1 year of the end of pregnancy would further increase the figure.

Current assessment methods may underrepresent indirect causes of maternal death, which could be aggravated by pregnancy.<sup>33</sup> Our study showed that comorbid conditions, such as HIV/AIDS, and diseases of poverty, such as anaemia, contributed to late pregnancy-related deaths after a near miss. Except for direct obstetric complications, HIV infection was the most important contributor to pregnancy-related deaths in our study. This finding supports recent analyses that highlight the contribution of HIV infection to high maternal mortality rates in Africa.<sup>34</sup>

Our analysis of the structural constraints that limited access to health care and reduced the quality of the care received by women in our study helped us to understand the broader circumstances leading to their deaths. The relatives of women who died highlighted

various possible contributing factors: premature hospital discharge; poor postpartum follow-up; inadequately treated underlying conditions; unmet need for contraception; lack of appropriate antenatal care, and inadequate emergency obstetric care in subsequent pregnancies.<sup>35</sup> Although firm general conclusions about the health-care system cannot be drawn without supporting data from health-care providers and other stakeholders, studies from Burkina Faso<sup>11,18</sup> and other high-mortality countries<sup>36</sup> support our informants' reports that poor service supply and demand act as barriers to maternal health care, both during and after pregnancy.

### Policy implications

Because most maternal and neonatal deaths occur around the time of delivery,<sup>13</sup> the maternal health strategy throughout the world has long emphasized intrapartum care. This includes skilled birth attendance for all women and emergency obstetric care to prevent maternal death from direct causes such as haemorrhage, obstructed labour, hypertension, infection and anaemia.<sup>37</sup> However, although good intrapartum care can ensure safe delivery, it does not suffice to prevent death in the aftermath of severe complications, sometimes over the long term.

Our study findings on the indirect causes of maternal death, the weaknesses in the health-care system and the social and structural barriers to health care suggest the need for a more comprehensive, life-cycle approach to women's health. The solution may be longer and more differentiated clinical management, including family planning. Moreover, we also found that underlying chronic health problems increase the risk of maternal death. The solution may be integrated health care, with integration across the entire reproductive cycle (i.e. family planning, pregnancy and delivery care, and postpartum care) and across different vertical treatment programmes, and with integration of specialist and generalist care.

It has become evident in recent years that a well-functioning health-care system and the provision of a continuum of care are essential for achieving the United Nations Millennium Development Goals pertaining to health. For instance, international policy-makers postulate a continuum of care for maternal, neonatal and child health that

involves integrating health care for these different groups across time and place.<sup>38</sup> Such a continuum would include post-partum care as a priority and provide links between reproductive and sexual health-care services and maternal health care. In addition, ways of simultaneously addressing the social and economic determinants of health are receiving increasing attention.<sup>39</sup>

Despite these policy changes and the greater priority afforded to maternal health both internationally and nationally,<sup>40</sup> achieving a comprehensive continuum of care remains challenging. For example, few health-care services address the specific needs of women in the year following childbirth.<sup>5</sup> More often, safe motherhood programmes in low-income countries, including Burkina Faso, are implemented vertically and focus almost exclusively on the birth period. They rarely address the underlying factors that undermine

health, such as economic and social disadvantage, chronic health problems and poor access to individual, continuous and preventive health care.

In conclusion, surviving a near-miss obstetric complication is no guarantee that a pregnancy-related death has been averted. In Burkina Faso, women who experienced a near-miss complication had a higher risk of all-cause and pregnancy-related death, even 4 years later, due to a combination of medical, social and health-care-related factors. Current safe motherhood programmes emphasize emergency intrapartum obstetric care that targets the direct causes of maternal mortality. These programmes are insufficient for tackling excess mortality over the longer term. Survival in this period requires the introduction of a comprehensive continuum of care that addresses the indirect and social causes of death. ■

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**Competing interests:** None declared.

## ملخص

معدل الوفيات بعد مضاعفات الولادة الوشيكية في بوركينا فاسو: العوامل الطبية والاجتماعية وعوامل الرعاية الصحية (الاحتمال > 0.001). وكانت ما يزيد عن نصف حالات الوفاة بعد حالة وشيكة مرتبطة بالحمل، في حين لم يرتبط بالحمل أي من حالات الوفاة بعد الولادة غير المصحوبة بأعراض. وساهمت العوامل غير المباشرة في العديد من حالات الوفاة هذه، وبالأخص عدوى فيروس العوز المناعي البشري. وأفادت تقارير الأقارب بأن التكلفة الباهظة للرعاية الصحية وضعف جودتها، والافتقار إلى رعاية المتابعة والحاجة التي لم يتم تلبيتها لوسائل منع الحمل ساهمت في زيادة معدل الوفيات في الفئة الوشيكية. الاستنتاج تعرضت السيدات في بوركينا فاسو اللواتي نجين من مضاعفات الولادة الوشيكية إلى خطورة زائدة للوفاة الناتجة عن جميع الأسباب والمرتبطة بالحمل في الأعوام الأربعة التالية. ويمكن زيادة احتمالية النجاة على المدى الطويل عن طريق توفير استمرارية الرعاية التي تعالج الأسباب غير المباشرة والاجتماعية للوفاة، وتدعم رعاية التوليد في الحالات الطارئة أثناء الوضع المقدمة من جانب برامج الأمومة المأمونة الحالية.

الغرض بحث معدل الوفيات لدى النساء في بوركينا فاسو في الأعوام الأربعة التالية لحدوث إحدى مضاعفات الولادة الوشيكية المهددة للحياة وتحديد أسباب الوفاة الطبية والاجتماعية وذات الصلة بالرعاية الصحية. الطريقة تم اختيار ما إجماليه 1014 سيدة بعد خروجهن من المستشفى ومتابعتهن لمدة 4 سنوات: كانت لدى 337 سيدة مضاعفات وشيكة وكانت حالات حمل 677 سيدة غير مصحوبة بمضاعفات. تم تقييم الاختلافات الجوهرية في معدل الوفيات بين المجموعات باستخدام اختبار فيشر الدقيق. وتم تحديد الأسباب الطبية للوفاة من السجلات الطبية وبيانات التشريح اللفظية؛ وتم تحديد العوامل الاجتماعية والعوامل ذات الصلة بالرعاية الصحية المرتبطة بالوفاة من المقابلات التي أجريت مع أقارب السيدات المتوفيات. النتائج خلال 4 سنوات، توفيت 15 (5.3%) سيدة في الفئة الوشيكية و5 سيدات (0.9%) بعد حمل غير مصحوب بمضاعفات

## 摘要

### 布基纳法索濒临死亡分娩并发症导致的死亡率:医疗、社会和保健因素

**目的** 调查布基纳法索患有威胁生命的濒临死亡并发症的女性在随后4年中的死亡率并确定医疗、社会和保健相关的死亡原因。

**方法** 总计招募了1014名出院后的产妇,并跟踪达4年:337名产妇患有濒临死亡的并发症,677名女性无妊娠期并发症。使用Fisher精确检验评估两组间死亡率的明显不同。根据医疗记录和文字尸检数据确定死亡的医疗原因;通过对已故产妇亲属的访谈确定死亡相关的社会和医疗因素。

**结果** 在4年中,濒临死亡组中有15(5.3%)名产妇死亡,无妊娠期并发症的有5(0.9%)名产妇死亡( $P < 0.001$ )。濒临死亡后

的死亡有半数以上是因为与怀孕相关的间接因素造成了很多这种死亡,尤其是艾滋病毒感染,而无妊娠期并发症生产后的死亡都不存在这样的因素。亲属的说明显示高成本和低质量医疗保健、缺少后续照顾以及避孕需求没有得到满足导致了濒临死亡组的过高死亡率。

**结论** 在布基纳法索,最初从濒临死亡的产科并发症中幸存的产妇,在随后4年中会面临更高因各种原因以及与怀孕相关的原因而死亡的风险。通过提供连续照顾来消除间接和社区的死亡原因,以及通过当前的安全妈妈计划为紧急分娩产科护理提供补充,可提高在更长的时间里生存的可能性。

## Résumé

### Mortalité suite aux complications obstétricales évitées de justesse au Burkina Faso: facteurs médicaux, sociaux et sanitaires

**Objectif** Explorer la mortalité chez les femmes du Burkina Faso durant les 4 années suivant une complication obstétricale fatale évitée de justesse ("near-miss") et identifier les causes médicales, sociales et sanitaires du décès.

**Méthodes** Au total, 1 014 femmes ont été recrutées après la sortie de l'hôpital et suivies durant 4 ans: 337 ont vécu des "near-miss" et 677 ont eu des grossesses sans complications. Des différences significatives de mortalité entre les groupes ont été identifiées en utilisant le test exact de Fisher. Les causes médicales du décès ont été identifiées à partir des dossiers médicaux et des données verbales d'autopsie; les facteurs sociaux et de soins de santé liés au décès ont été constatés à partir d'entretiens avec les proches des femmes décédées.

**Résultats** Durant les 4 années, 15 (5,3%) femmes sont mortes dans le groupe "near-miss" et 5 (0,9%) sont décédées après des grossesses sans

complication ( $P < 0,001$ ). Plus de la moitié des décès après un "near-miss", mais aucun après un accouchement sans complications, étaient liés à une grossesse. Des facteurs indirects ont contribué à bon nombre de ces décès, en particulier les infections par le HIV. Les comptes rendus des proches font supposer que le coût élevé et la mauvaise qualité des soins de santé, un manque de suivi des soins et un besoin non satisfait de contraception ont contribué à la mortalité augmentée dans le groupe "near-miss".

**Conclusion** Les femmes au Burkina Faso qui ont initialement survécu à une complication obstétricale évitée de justesse présentaient un risque accru de décès pour toute cause ou lié à la grossesse les 4 années suivantes. La probabilité de survie sur le long terme pourrait être augmentée en offrant un continuum de soins qui s'attaque aux causes indirectes et sociales des décès et complémente les soins obstétricaux d'urgence fournis par les programmes actuels de maternité sans risque.

## Резюме

### Смертность после родовых осложнений, связанных с угрозой жизни, в Буркина-Фасо: медицинские, социальные и медико-санитарные факторы

**Цель** Изучить смертность среди женщин в Буркина-Фасо в течение 4 лет после родовых осложнений, связанных с угрозой жизни, а также медицинские, социальные и медико-санитарные факторы смертности.

**Методы** В общей сложности исследование охватывает 1 014 женщин, которые наблюдались в течение 4 лет с момента выписки из больницы: у 337 родов сопровождалось осложнениями, связанными с угрозой жизни, а у 677 беременность прошла без осложнений. Значимость разницы в уровне смертности между группами оценивалась с помощью точного критерия Фишера. Медицинские причины смерти выявлялись на основе медицинских документов и устных сведений о вскрытии; социальные и медико-санитарные факторы, связанные со смертью, определялись с помощью интервью с родственниками умерших женщин.

**Результаты** В течение 4 лет умерли 15 (5,3%) женщин из группы, в которой роды сопровождалось осложнениями, связанными с угрозой жизни, и умерли 5 (0,9%) женщин, у которых роды прошли без осложнений ( $P < 0,001$ ). С беременностью были связаны более половины смертей после родов, сопровождавшихся

осложнениями, связанными с угрозой жизни, и ни одной после не осложненных родов. Многим из этих смертей способствовали косвенные факторы, особенно вирус иммунодефицита человека. Информация, полученная от родственников, свидетельствует, что высокой смертности в группе женщин, у которых роды сопровождалось осложнениями, связанными с угрозой жизни, способствовала дороговизна и низкое качество медицинского обслуживания, отсутствие амбулаторного наблюдения и неудовлетворенная потребность в контрацептивах.

**Вывод** Женщины в Буркина-Фасо, которые выжили после родовых осложнений, связанных с угрозой жизни, в последующие 4 года сталкиваются с повышенным риском смерти как от общих причин, так и от причин, связанных с беременностью. Шансы на выживание в долгосрочной перспективе могут быть увеличены за счет предоставления постоянной помощи, направленной борьбу с косвенными и социальными причинами смерти. Такая помощь должна дополнять экстренную родовую помощь, предусмотренную действующими программами безопасного материнства.

## Resumen

### La mortalidad después de complicaciones obstétricas graves en Burkina Faso: factores médicos, sociales y sanitarios

**Objetivo** Investigar la mortalidad entre mujeres en Burkina Faso en los cuatro años posteriores a una complicación obstétrica potencialmente mortal e identificar las causas médicas, sociales y sanitarias relacionadas con el fallecimiento.

**Métodos** Se realizó un seguimiento durante un máximo de cuatro años a un total de 1014 mujeres inscritas después de haber recibido el alta médica: De ellas, 337 habían sufrido complicaciones obstétricas graves y 677 habían disfrutado de embarazos sin complicaciones. Se empleó el test exacto de Fisher para evaluar las diferencias significativas en la mortalidad entre ambos grupos. Las causas médicas de la mortalidad se identificaron a través de los historiales médicos y los datos de autopsias verbales. Las entrevistas con los familiares de las mujeres fallecidas permitieron identificar los factores sociales y sanitarios vinculados con el fallecimiento.

**Resultados** Durante esos cuatro años, fallecieron 15 (5,3%) mujeres del grupo con embarazos con complicaciones y cinco (0,9%) del grupo con embarazos sin complicaciones ( $P < 0,001$ ). Más de la mitad de los

fallecimientos después de una complicación obstétrica grave estuvieron relacionados con el embarazo, pero ninguno después un parto sin complicaciones. Factores indirectos, en particular una infección con el virus de la inmunodeficiencia humana, contribuyeron a muchos de esos fallecimientos. Las explicaciones de los familiares sugirieron que los altos costes y la baja calidad de la asistencia sanitaria, la falta de un seguimiento y las necesidades desatendidas en materia de anticoncepción contribuyeron a esa elevada mortalidad en el grupo con complicaciones obstétricas graves.

**Conclusión** Las mujeres en Burkina Faso que inicialmente sobrevivieron a una complicación obstétrica grave presentaron un riesgo mayor de fallecer en los cuatro años siguientes. La probabilidad de supervivencia a largo plazo podría aumentar si se ofreciera una asistencia continuada que abordara las causas indirectas y sociales de la mortalidad y que complementara la atención obstétrica de emergencia durante el parto que proporcionan los programas actuales de maternidad sin riesgo.



## References

- Paxton A, Wardlaw T. Are we making progress in maternal mortality? *N Engl J Med* 2011;364:1990–3. doi:10.1056/NEJMp1012860 PMID:21612467
- Ronsmans C, Filippi V. Reviewing severe maternal morbidity: learning from women who survive life-threatening complications. In: Lewis G, editor. *Beyond the numbers: reviewing maternal deaths and complications to make pregnancy safer*. Geneva: World Health Organization; 2003.
- Kessels-Habraken M, Van der Schaaf T, De Jonge J, Rutte C. Defining near misses: towards a sharpened definition based on empirical data about error handling processes. *Soc Sci Med* 2010;70:1301–8. doi:10.1016/j.socscimed.2010.01.006 PMID:20153573
- Pacagnella RC, Cecatti JG, Camargo RP, Silveira C, Zanardi DT, Souza JP et al. Rationale for a long-term evaluation of the consequences of potentially life-threatening maternal conditions and maternal “near-miss” incidents using a multidimensional approach. *J Obstet Gynaecol Can* 2010;32:730–8. PMID:21050503
- Chersich MF, Kley N, Luchters SM, Njeru C, Yard E, Othigo MJ et al. Maternal morbidity in the first year after childbirth in Mombasa Kenya; a needs assessment. *BMC Pregnancy Childbirth* 2009;9:51. doi:10.1186/1471-2393-9-51 PMID:19891784
- Murphy DJ, Charlett P. Cohort study of near-miss maternal mortality and subsequent reproductive outcome. *Eur J Obstet Gynecol Reprod Biol* 2002;102:173–8. doi:10.1016/S0301-2115(01)00320-7 PMID:11950486
- Wilson RE, Salihu HM. The paradox of obstetric “near misses”: converting maternal mortality into morbidity. *Int J Fertil Womens Med* 2007;52:121–7. PMID:18320871
- Filippi V, Ganaba R, Baggaley RF, Marshall T, Storeng KT, Sombié I et al. Health of women after severe obstetric complications in Burkina Faso: a longitudinal study. *Lancet* 2007;370:1329–37. doi:10.1016/S0140-6736(07)61574-8 PMID:17933647
- Filippi V, Goufodji S, Sismanidis C, Kanhonou L, Fottrell E, Ronsmans C et al. Effects of severe obstetric complications on women’s health and infant mortality in Benin. *Trop Med Int Health* 2010;15:733–42. doi:10.1111/j.1365-3156.2010.02534.x PMID:20406426
- Ganaba R, Marshall T, Sombié I, Baggaley RF, Ouédraogo TW, Filippi V. Women’s sexual health and contraceptive needs after a severe obstetric complication (“near-miss”): a cohort study in Burkina Faso. *Reprod Health* 2010;7:22. doi:10.1186/1742-4755-7-22 PMID:20799964
- Storeng KT, Baggaley RF, Ganaba R, Ouattara F, Akoum MS, Filippi V. Paying the price: the cost and consequences of emergency obstetric care in Burkina Faso. *Soc Sci Med* 2008;66:545–57. doi:10.1016/j.socscimed.2007.10.001 PMID:18061325
- Storeng KT, Murray SF, Akoum MS, Ouattara F, Filippi V. Beyond body counts: a qualitative study of lives and loss in Burkina Faso after ‘near-miss’ obstetric complications. *Soc Sci Med* 2010;71:1749–56. doi:10.1016/j.socscimed.2010.03.056 PMID:20541307
- Hurt LS, Alam N, Dieltiens G, Aktar N, Ronsmans C. Duration and magnitude of mortality after pregnancy in rural Bangladesh. *Int J Epidemiol* 2008;37:397–404. doi:10.1093/ije/dym274 PMID:18276635
- Human Development Report 2009. Overcoming barriers: human mobility and development*. New York: United Nations Development Program; 2009.
- Institut National de la Statistique et de la Démographie. *Recensement général de la population et de l’habitation de 2006 (RGPH-2006). Thème 6: natalité - fécondité*. Ouagadougou: Ministère de l’Économie et des Finances du Burkina Faso; 2009.
- Institut National de la Statistique et de la Démographie. *Recensement général de la population et de l’habitation de 2006 (RGPH-2006). Thème 7: la mortalité*. Ouagadougou: Ministère de l’Économie et des Finances du Burkina Faso; 2009.
- Trends in maternal mortality 1990 to 2008: estimates developed by WHO, UNICEF, UNFPA and World Bank*. Geneva: World Health Organization; 2010.
- Hounton SH, Meda N, Hussein J, Sombié I, Conombo G, Graham WJ. Describing safe motherhood programs for priority setting: the case of Burkina Faso. *Int J Gynaecol Obstet* 2005;91:97–104. doi:10.1016/j.ijgo.2005.06.027 PMID:16115635
- Ministère de la santé du Burkina Faso. *Annuaire statistique 2009*. Ouagadougou: Ministère de la Santé du Burkina Faso; 2010.
- Ministère de la Santé du Burkina Faso. *Stratégie nationale de subvention des accouchements et des soins obstétricaux et néonataux d’urgence au Burkina Faso*. Ouagadougou: Ministère de la Santé du Burkina Faso; 2006.
- De Allegri M, Ridde V, Louis VR, Sarker M, Tiendrebéogo J, Yé M et al. Determinants of utilisation of maternal care services after the reduction of user fees: a case study from rural Burkina Faso. *Health Policy* 2011;99:210–8. doi:10.1016/j.healthpol.2010.10.010 PMID:21056505
- Ridde V, Richard F, Bicaba A, Queuille L, Conombo G. The national subsidy for deliveries and emergency obstetric care in Burkina Faso. *Health Policy Plan* 2011;26(Suppl 2):ii30–40. doi:10.1093/heapol/czr060 PMID:22027917
- Stewart MK, Festin M. Validation study of women’s reporting and recall of major obstetric complications treated at the Philippine General Hospital. *Int J Gynaecol Obstet* 1995;48(Suppl):S53–66. doi:10.1016/0020-7292(95)02320-C PMID:7672175
- Beyond the numbers: reviewing maternal deaths and complications to make pregnancy safer*. Geneva: World Health Organization; 2004.
- D’Ambruso L, Byass P, Qomariyah SN, Ouédraogo M. A lost cause? Extending verbal autopsy to investigate biomedical and socio-cultural causes of maternal death in Burkina Faso and Indonesia. *Soc Sci Med* 2010;71:1728–38. doi:10.1016/j.socscimed.2010.05.023 PMID:20646807
- Kalter HD, Salgado R, Babelle M, Koffi AK, Black RE. Social autopsy for maternal and child deaths: a comprehensive literature review to examine the concept and the development of the method. *Popul Health Metr* 2011;9:45 PMID:21819605
- Bernard HR. *Research methods in anthropology: qualitative and quantitative approaches*, 5th edition. Walnut Creek: Alta Mira Press; 2011.
- Ronsmans C, Chowdhury ME, Dasgupta SK, Ahmed A, Koblinsky M. Effect of parent’s death on child survival in rural Bangladesh: a cohort study. *Lancet* 2010;375:2024–31. doi:10.1016/S0140-6736(10)60704-0 PMID:20569842
- Soleman N, Chandramohan D, Shibuya K. Verbal autopsy: current practices and challenges. *Bull World Health Organ* 2006;84:239–45. doi:10.2471/BLT.05.027003 PMID:16583084
- Høj L, da Silva D, Hedegaard K, Sandström A, Aaby P. Maternal mortality: only 42 days? *BJOG* 2003;110:995–1000. PMID:14592584
- Hurt LS, Ronsmans C, Campbell OM, Saha S, Kenward M, Quigley M. Long-term effects of reproductive history on all-cause mortality among adults in rural Bangladesh. *Stud Fam Plann* 2004;35:189–96. doi:10.1111/j.1728-4465.2004.00022.x PMID:15511062
- Pradhan EK, West KP Jr, Katz J, Christian P, Khatri SK, Leclercq SC et al. Risk of death following pregnancy in rural Nepal. *Bull World Health Organ* 2002;80:887–91. PMID:12481211
- Menéndez C, Romagosa C, Ismail MR, Carrilho C, Saute F, Osman N et al. An autopsy study of maternal mortality in Mozambique: the contribution of infectious diseases. *PLoS Med* 2008;5:e44. doi:10.1371/journal.pmed.0050044 PMID:18288887
- Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM et al. Maternal mortality for 181 countries, 1980–2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 2010;375:1609–23. doi:10.1016/S0140-6736(10)60518-1 PMID:20382417
- Storeng KT, Drabo S, Filippi V. Too poor to live: a case study of vulnerability and maternal mortality in Burkina Faso. *Glob Health Promot* 2012. Forthcoming doi:10.1146/annurev-publhealth-031210-101220 PMID:21219162
- Koblinsky M, Matthews Z, Hussein J, Mavalankar D, Mridha MK, Anwar I et al. Going to scale with professional skilled care. *Lancet* 2006;368:1377–86. doi:10.1016/S0140-6736(06)69382-3 PMID:17046470
- Campbell OM, Graham WJ. Strategies for reducing maternal mortality: getting on with what works. *Lancet* 2006;368:1284–99. doi:10.1016/S0140-6736(06)69381-1 PMID:17027735
- Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet* 2007;370:1358–69. doi:10.1016/S0140-6736(07)61578-5 PMID:17933651
- Friel S, Marmot MG. Action on the social determinants of health and health inequities goes global. *Annu Rev Public Health* 2011;32:225–36. doi:10.1146/annurev-publhealth-031210-101220 PMID:21219162
- Analysing commitment to advance the global strategy for women’s and children’s*. Geneva: Partnership for Maternal, Newborn & Child Health (PMNCH); 2011. Available from: [http://www.who.int/pmnch/topics/part\\_publications/2011\\_pmnch\\_report/en/index.html](http://www.who.int/pmnch/topics/part_publications/2011_pmnch_report/en/index.html) [accessed 3 February 2012].

Table 1. Women who died within four years of the end of a pregnancy, Burkina Faso, 2004–2009

| Case | Date of end of pregnancy | Woman's age and no. of pregnancies at study recruitment | Marital status at recruitment | Pregnancy outcome, known medical condition                            | Time woman reported as lost to follow-up | Time of woman's death after the end of pregnancy       | Medical cause of death <sup>a</sup>   | Status of index child at last interview                   | No. of pregnancies since index pregnancy |
|------|--------------------------|---|-------------------------------|---|--|--|---|---|--|
| 1    | 26 January 2005          | 23 years, first pregnancy                               | Single                        | Near-miss complication, <sup>b</sup> live birth, hypertension         | Year 4 interview                         | 2 years and 5 months                                   | Hypertension, possible hypertensive stroke unrelated to pregnancy   | Alive   | 0  |
| 2    | 27 January 2005          | 25 years, first pregnancy                               | Married                       | Near-miss complication, live birth, infections                        | Year 3 interview                         | Unknown, 1–3 years                                     | Unknown   | Unknown   | Unknown                                  |
| 3    | 13 March 2005            | 26 years, third pregnancy                               | Single                        | Near-miss complication, early pregnancy loss, haemorrhage, infections | Year 3 interview                         | 2 years and 5 months                                   | Possible traffic accident   | NA  | 0  |
| 4    | Around 9 February 2005   | 25 years, third pregnancy                               | Single                        | Near-miss complication, early pregnancy loss, sepsis, HIV+            | Month 12 interview                       | 7 months   | Septic abortion with general infection complicated by organ failure, HIV infection (late pregnancy-related death) | NA  | 0  |
| 5    | 17 March 2005            | 30 years, fourth pregnancy                              | Married                       | Near-miss complication, live birth, dystocia                          | Year 3 interview                         | 1 year and 2 months                                    | Unknown   | Alive   | 0  |
| 6    | 26 March 2005            | 34 years, eighth pregnancy                              | Single                        | Near-miss complication, live birth, infections, HIV+                  | Month 3 interview                        | 35 days  | Tuberculosis, HIV infection (late pregnancy-related death)  | Dead at 28 days, possible intrauterine growth retardation | 0  |
| 7    | 30 December 2004         | 30 years, first pregnancy                               | Single                        | Near-miss complication, perinatal death, infections                   | Year 3 interview                         | 2 years and 12 months                                  | Sepsis, organ failure, HIV/AIDS   | NA  | 0  |
| 8    | 26 January 2005          | 23 years, second pregnancy                              | Cohabiting (polygamy)         | Near-miss complication, perinatal death, hypertension                 | Year 3 interview                         | Between 1 and 3 years (the date provided was unlikely) | Essential hypertension, possible HELLP syndrome, maternal death in new pregnancy (possibly pregnancy-related)     | NA  | 1  |
| 9    | 2 March 2005             | 40 years, sixth pregnancy                               | Married (polygamy)            | Uncomplicated birth   | Year 4 interview                         | Around 4 years   | Tuberculosis, HIV/AIDS, organ failure   | Alive at year 3 interview                                 | 0  |
| 10   | 25 February 2005         | 32 years, sixth pregnancy                               | Married (polygamy)            | Near-miss complication, early pregnancy loss, haemorrhage             | Year 3 interview                         | 1 year and 6 months                                    | Septic abortion, organ failure, maternal death in new pregnancy   | NA  | 1  |

(... continued)

| Case | Date of end of pregnancy | Woman's age and no. of pregnancies at study recruitment | Marital status at recruitment | Pregnancy outcome, known medical condition   | Time woman reported as lost to follow-up | Time of woman's death after the end of pregnancy | Medical cause of death <sup>a</sup>  | Status of index child at last interview | No. of pregnancies since index pregnancy |
|------|--------------------------|---|-------------------------------|--|--|--|--|---|--|
| 11   | 15 March 2005            | 26 years, eighth pregnancy                              | Married (polygamy)            | Near-miss complication, live birth, anaemia  | Month 3 interview                        | 2 months   | Anaemia, possible immune problems, possible sepsis, (late pregnancy-related death)                                     | Dead at 5 months                        | 0  |
| 12   | 7 March 2005             | 30 years, fourth pregnancy                              | Married (polygamy)            | Near-miss complication, early pregnancy loss, haemorrhage, infections, organ failure | Year 3 interview                         | 3 years  | Caesarean complication involving haemorrhage, suture failure and subsequent infection, maternal death in new pregnancy | NA                                      | 2  |
| 13   | 23 December 2004         | 29 years, fourth pregnancy                              | Married                       | Uncomplicated birth  | Year 4 interview                         | Between 3 and 4 years                            | Malaria  | Alive at verbal autopsy in 2010         | 0  |
| 14   | 25 December 2004         | 38 years, seventh pregnancy                             | Married (polygamy)            | Near-miss complication, perinatal death, infections                                  | Year 3 interview                         | 2 years and 1 month                              | Chronic infection possibly related to tuberculosis, sepsis, renal failure  | NA                                      | 0  |
| 15   | 10 January 2005          | 26 years, second pregnancy                              | Cohabiting (polygamy)         | Uncomplicated birth  | Year 3 interview                         | 2 years and 4 months                             | Sepsis with chronic infection or immune dysfunction, possibly related to HIV infection                                 | Alive at verbal autopsy interview       | 0  |
| 16   | 19 January 2005          | 17 years, first pregnancy                               | Single                        | Near-miss complication, perinatal death, anaemia                                     | Month 6 interview                        | 4 months   | Infections (late pregnancy-related death)  | NA                                      | 0  |
| 17   | 19 February 2005         | 25 years, second pregnancy                              | Married                       | Near-miss complication, live birth, sepsis, HIV+                                     | Month 3 interview                        | 40 days  | Possible anaemia (late pregnancy-related death)  | Dead at 15 months                       | 0  |
| 18   | 23 February 2005         | 29 years, fourth pregnancy                              | Married                       | Uncomplicated birth  | Year 4 interview                         | Unknown, 1–3 years                               | Unknown  | Alive at year 2 interview               | 0  |
| 19   | 10 March 2005            | 27 years, third pregnancy                               | Married                       | Uncomplicated birth  | Year 4 interview                         | 3 years and 11 months                            | Tuberculosis or possible HIV infection   | Alive at verbal autopsy interview       | 1  |
| 20   | 22 February 2005         | 18 years, first pregnancy                               | Cohabiting                    | Near-miss complication, live birth, pre-eclampsia                                    | Month 6 interview                        | Unknown, within 6 months                         | Coma, possible eclampsia (late pregnancy-related death)  | Alive at verbal autopsy interview       | 0  |

AIDS, acquired immunodeficiency syndrome; HIV human immunodeficiency virus; NA, not applicable.

<sup>a</sup> The medical cause of death was determined from verbal autopsy data, medical records and reports of medical examinations.<sup>b</sup> A near-miss complication is a severe obstetric complication that would probably have killed the woman had she not received timely medical care.