ORIGINAL RESEARCH ARTICLE

Exploring maternal mortality and associated factors in the Centre-East region of Burkina Faso: A case-control study

DOI: 10.29063/ajrh2025/v29i12.21

Ourohiré Millogo[1,2], Mamadou Ouattara[2], Thierry Nkurabagaya[3], Marie Antoine Nyambré[3], Oumarou Thiombiano[4] and Ali Sié[2]*

Institut de Recherche en Sciences de la Santé/Centre National de Recherche Scientifique et Technologique, Ouagadougou, Burkina Faso[1]; Centre de Recherche en Santé de Nouna/Institut National de santé Publique, Ouagadougou, Burkina Faso[2] ; Agence belge de développement- Enabel, Ouagadougou, Burkina Faso[3]; ministère de la Santé, District sanitaire de Do, Bobo Dioulasso, Burkina Faso[4]

***For Correspondence:** Email: *ourohire2001@yahoo.fr*; Phone: +22670110424

Abstract

Maternal mortality remains a major public health issue in Burkina Faso. We analyzed data from the Centre-East health region, a setting with a high maternal mortality rate to identify the underlying driving factors. We conducted a case-control study with 1:2 matching ratio. Cases (deceased women) were randomly selected from a registry of maternal deaths, while the controls were selected from hospital logs of uncomplicated deliveries between January 1st, 2020, and June 30th, 2022. We fitted logistic regression to identify associated factors, considering differences significant when the 95% confidence intervals of the odds ratio do not include 1. Overall, among deceased women, 81% were referred, 33% were aged between 19 and 24 years, 82.4% were illiterate, 47% attended less than 4 antenatal care visits, and 39% came from the Ouargaye health district. Fever was associated with an increased odd of maternal death, with an adjusted odds ratio (aOR) of 2.94 (95%CI: 1.47-5.90). women with a normal coloration of conjunctivae during labor were less likely to die compared to those with conjunctival pallor: aOR =0.02 (95%CI: 0.004-0.11). These results suggest that preventing and treating fever and infections could help to reduce maternal deaths during delivery in the Centre-East region, Burkina Faso. *(Afr J Reprod Health 2025; 29 [12]: 217-229).*

Keywords: Maternal mortality rate, associated risk, factors Case control study, Centre-East region', Burkina Faso

Résumé

La mortalité maternelle est un problème majeur de santé publique au Burina Faso. Notre étude visait à identifier les potentiels facteurs associés à ces décès spécifiquement dans la région sanitaire du Centre-East. Il s'agissait d'une étude cas-témoins avec 1 cas pour 2 témoins choisis dans une liste de décès maternels et d'accouchement non compliqués survenus entre le 1er janvier 2020 et le 30 juin 2022, dans la région sanitaire du Centre-Est. La régression logistique a été utilisée pour déterminer les facteurs associés potentiels. Parmi les femmes décédées, 39 % provenaient du district sanitaire de Ouargaye, 33 % étaient âgées entre 19 à 24 ans, et 47 % avaient réalisé moins de 4 consultations prénatales (CPN). La fièvre était associée a une augmentation du risque de décéder des femmes, avec un odds ratio ajusté (ORa) de 2,94 (95%IC :1,47-5,90). En revanche, la coloration conjonctivale était protectrice, avec un ORa de 0,02 (95%IC :0,004-0,11). La prévention et le traitement efficace de la fièvre pourraient contribuer à réduire les décès maternels au cours de l'accouchement dans les formations sanitaire de la région du Centre-East au Burkina Faso. *(Afr J Reprod Health 2025; 29 [12]: 217-229).*

Mots-clés: Taux de mortalité maternelle, facteurs de risques associés, étude cas-témoins, Centre-Est, Burkina Faso

Introduction

The tragedy of maternal deaths remains a sad reality, particularly in sub-Saharan Africa. In 2020, 287,000 women died worldwide with sub-Saharan Africa bearing 70% of the burden.[1] Most maternal deaths are preventable through interventions and tools[2,3] for treating hemorrhage, infection, high blood pressure during pregnancy, childbirth complications, and complications from unsafe abortion which, combined, account directly for 75% of maternal deaths. [4–6] The indirect causes, which account for 15% of maternal deaths are linked to women's autonomy over their sexual and reproductive health and rights (SRHR), the performance of the health care system, the level of

maternal education, the economic development of the country, the prevailing social and the political environment, and existence of armed conflict.[8,9]

Despite a decrease by 34% worldwide between 2000 and 2020, the maternal mortality ratio remains unacceptably high particularly in sub-Saharan Africa. Achieving the sustainable development goal on maternal death is a challenge for many countries, including Burkina Faso[1]. Indeed, between 2010 and 2019, the maternal mortality ratio in Burkina Faso decreased moderately from 366 to 222.9 per 100,000 live births.[10,11] To speed up the pace of reduction, the country undertook financial reforms of sexual and reproductive health (SRH) services with user fees removal in 2016 to augment women's access to life-saving SRH alongside the woman at reproductive age life cycle. User fee removal constituted the third reforms after the introduction of subsidized emergency obstetric and neonatal care in 2006 and the results-based financing in 2010.[12,13] These reforms contributed to increasing the coverage of SRH interventions, including skilled birth attendance, antenatal and postnatal care, and family planning.

In 2021, 72% of pregnant women attended four or more ANC visits compared to 33% in 2010. The coverage of skilled birth increased from 73% in 2010 to 94% in 2021.[14] Despite these achievements, the quality of maternal health care and services is still an issue. According to the 2020 Harmonized Health Facility Assessment (HHFA), of the 82% of health facilities delivering family planning services, only 11% provide all the services. The availability of the antenatal visits service is 80%, with an operational capacity of 63%. Regarding childbirth, just 11% of health facilities can offer all basic emergency obstetric and neonatal care, and 58% provide comprehensive emergency obstetric care. Post-abortion care is available in 74% of health facilities, while 31% offer safe abortion services, with only 24% having the required medications in stock. Blood transfusion was possible in 58% of health facilities expected to provide it.[15] In 2020, only 30% (330/1111) of maternal deaths were audited.[16]

Alongside improving the coverage and quality of maternal health care and services, empowering women regarding their sexual and reproductive rights is essential. Indeed, 15% of women's needs for family planning are not met, 41% of married women rely on their husbands or partner for family planning, whereas 32% decide themselves.[14] To address the situation, Burkina Faso benefited from support of the Belgian cooperation through a program centered on promoting sexual and reproductive health and rights (SRHR) for women of reproductive age in the Centre-East region.[17] The program targeted four key domains including family planning, sexual and reproductive health and rights (SRHR) for youth and adolescents, gender-based violence, and maternal mortality. The program contributed to constructing, renovating, and equipping health centres to improve the geographical accessibility of health centers to mothers and children. The project also trained health providers to improve the quality of service delivery, and to enhance better communication on SRHR, empowering women and adolescents. However, after two years of implementation, there has been no reduction in maternal deaths in the Centre-East region. The intra-hospital number of maternal death increased from 84 (11/54) live births to 116.5 for 100000.[16,18] The rise may be attributed to several factors, including deficiencies in the health system's performance—such as the quality of care as mentioned above, delays in community access to services, and individual health issues.[7,19–21] In 2015, Somé et al. have identified 4 factors that prevent women's use of maternal care in this region. The factors include cultural, geographical, financial and poor organization and quality of care provided to women.[22] More recently, the insecurity in the region, resulting in the displacement of populations, has worsened the accessibility to health facilities. In October, 2020, 5.4% (11/205) of peripheral health facilities covering 32079 persons, were closed or functioning at minimum.[23] In general, women are the most affected in conflict settings.[24,25]

In this study, we analyzed data from the assessment of the program. We aimed to analyze the maternal deaths with the aim of identifying the underlying associated factors from conception to the delivery. We believe that the results will add relevant evidence to enable local health stakeholders improve the maternal health delivery in the Centre-East region of Burkina Faso.

Methods

Study setting

The study was carried out in all health facilities across the Centre-East health region of Burkina Faso. Covering 15,288 km², the Centre-East region

is bordered by the East health region to the east and northeast, the Centre-Sud and Plateau Central regions to the west and northwest, the Centre-Nord region to the north, and the countries of Togo and Ghana to the south.

The health system in the region follows the pyramidal structure of the national health system organization, comprising three levels: i) the peripheral level, which includes two tiers (peripheral health facilities and district hospitals), ii) the intermediate level (regional hospital), and iii) the tertiary level (Teaching hospitals). Patients, firstly visit the peripheral health facilities, depending on their diagnosis, may be referred to a district hospital. From there, they may be referred to the regional hospital, and lastly, to the teaching hospital, the highest level of care. Referrals in districts without a district hospital are made directly to the regional hospital.

In 2020, the Centre-East region had an estimated total population of 1,704,810, with a birth rate of 41 per 1,000. The number of women of reproductive age was 399,328, making up 23.4% of the population. Since April 2016, Burkina Faso has removed user fees for all services related to childbirth including hospitalization, medications, consumables, medical procedures, consultations, post-surgical care, laboratory tests, and transportation. In 2020, 80.6% of births were attended by qualified personnel (76.6% with a partogram); antenatal care (ANC) was provided in 41.5% of cases; and contraceptive prevalence rate was 17.7%. Postnatal consultations were conducted for 48.9% of women on the 6th day and for 27.1% at 6 weeks[16].

The Centre-East region comprises six health districts: Tenkodogo, Koupela, Zabré, Ouargaye, Pouytenga and Bittou. As of October 25, 2020, 3 out of 205 health facilities (1.5%) were closed, and 8 (3.9%) were operating at minimal capacity, serving a total of 32,079 people due to the insecurity. The health district of Ouargaye was one of the most impacted.

Study design

We conducted a case-control study matching 1 case to 2 controls. Cases included women who died between January 1st, 2020, and June 30th, 2022, in any health facility of the Centre-East region and meeting the definition of maternal deaths. Controls were women who delivered in health facilities without life-threatening complications. The matching criteria were i) the age within a ±2-year range, ii) the place of residency, iii) the gravidity, and iv) the parity.

We extracted data from medical records, consultation logs, hospitalization registers of women who were pregnant or had delivered in maternity wards between January 2020 and June 2022 to fill the Dumont et al. audit form, specifically adapted for data collection in health centers.[26] Variables collected included socio-demographic information, pre-existing medical conditions, reasons for consultation, details of the death or the delivery, antenatal care and risk factors, results of biological exams, results of physical examination on admission, vital signs, antepartum complications, details of delivery, the puerperal period events, and obstetric interventions.

Sample size

The sample size required in each group (case and control) was derived from the formula below.[27] Postpartum hemorrhage was the main risk factor for maternal death, accounting for approximately 25% of maternal deaths.[24,25] We therefore considered a prevalence of at least 20% as exposure among deceased women. We estimated that we could detect a difference of 15%, giving a maximum prevalence among controls of 5%.
In addition, to increase the power of the tests, we opted for two controls for one case.

$$n = \frac{(z_{\frac{\alpha}{2}} * \sqrt{(1+r) * p * (1-p)} + z_{(1-\beta)} * \sqrt{p_1 * (1-p_1) * r p_2 * (1-p_2))^2}}{(p_1 - p_2)^2}$$

n = minimum size of each group,
$z_{\frac{\alpha}{2}}$=1.96 for error α=5%,
p_1 =20%: prevalence of post-partum haemorrhage in women who have died,
p_2 =5%: prevalence of postpartum haemorrhage in normal deliveries,
$p = \frac{(p_1+p_2)}{2} = \frac{(0.20+0.05)}{2} = 0.125$: weighted prevalence of post-partum haemorrhage
r= case/control ratio, we took 2 controls for one case,
$z_{(1-\beta)}$=0.84 for a power of 80%,

$$n = \frac{(1.96 * \sqrt{(3) * 0.125 * (0.875)} + 0.84 * \sqrt{0.05 * (0.95) * 0.40 * (0.80)})^2}{(0.05-0.25)^2}$$

=66≈70.

Our sample consisted of 70 cases and 140 controls. A random selection of 70 cases was made without applying exclusion criteria from the list of all maternal deaths that occurred in the Centre-East

region. Two (02) controls were selected for each death, by convenience and in compliance with the matching criteria.

Statistical analysis

We used numbers, proportions, means and standard deviations to describe our sample by type of variables. Chi-square test was to compare each independent variable between women who died (cases) and women who gave birth normally (controls). The exact test of Fisher's was used as alternative if a cell in the contingency table contains a count less than 5.

We computed crude odds ratios and their 95% confidence intervals for each independent variable in bivariate analysis. Variables associated at the 5% level were included in multivariate analysis to calculate adjusted odds ratios and their 95% confidence intervals.

Analyses were performed with Stata 15 software (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

Ethical considerations

The study received the approval of the Ethics Committee for Health Research (CERS) under deliberation no. 2022-08-183 on the 3rd August 2022. We use health facility records and the list of maternal death, and we anonymized all records to ensure the confidentiality. Only study members could access the records.

Results

From January 1st, 2020, to June 30th, 2022, a total of 169,767 women gave birth in the Centre-East region, with 184 maternal deaths recorded, resulting in an in-hospital mortality rate of 108.4 per 100,000 live births. Of the 70 maternal deaths randomly selected, 68 (97.14%) were audited. The leading diagnosis of maternal deaths were anemia in 29.4% (20/68), eclampsia in 16.2% (11/68), and infections in 16.2% (11/68) of the cases.

Characteristics of the cases and controls

Table 1 summarizes the characteristics of the sample. The 19-24 years age group was most represented in our sample, with 63 (46%) among controls and 24 (35%) among cases. The age groups, the gravidity, and the place of residency were similarly distributed within the cases and the controls while the parity differed significantly (P=0.003). Women with 1 to 3 pregnancies, 1 to 3 deliveries, and those from the Ouargaye health district were the most represented in both the cases and the controls.

All controls were married (100%), compared to 66 (97%) of cases, and were mostly in monogamous households, with 79 (57%) of controls and 24 (35%) of cases. The marital status differed significantly between the two groups (P=0.001). the proportion of illiteracy was statistically significant (P<0.001) between the controls 56% (77) and the cases 82% (56). The ethnic group of Mossi was predominant in both groups, with 85 (62%) of the controls and 34 (50%) of the cases. Most of the women were housewives, with similar distribution of occupation in both groups. Muslim religion was the most common with 110 (80%) of the controls and 59 (87%) of the cases. There was no significant difference distribution of the religion between the two groups.

Gynecological, obstetrical, and medical history

The history of at least one stillbirth was statistically significant among the women who died, 20 (29%), compared to 4 (3%) (P<0.001) in the control group. There were no statistically significant differences between cases and controls regarding histories of spontaneous or induced abortion, cesarean sections, or complications in previous pregnancies. None of the women in the control group have had a caesarean section compared to 3 women in the case group that had previous caesarean section. Regarding the medical history of women of our sample, we reported two cases of hypertension, one of anemia, one of hepatitis, and one of cardiac pathology among the deceased women. No diabetes, HIV/AIDS, or tuberculosis were recorded in our sample. Details of the results are summarized in Table 1 in the supplementary file.

Pregnancy and related events

Approximately one-third (33%) of women had fewer than 4 antenatal care (ANC) visits. Among the controls, the number of women having fewer than 4 ANC visits 26% (36/138) differed significantly from that in deceased women 47% (32/68) (P=0.004).

Pregnancies were mainly monitored by midwives. Among the women who died, 19%

Table 1: Background characteristics of the sample

Items	Total N=206 (%)	Controls N=138 (%)	Cases N=68 (%)	p-value
Age group (years)				0.43
< 19	14 (6.8)	9 (6.5)	5 (7.4)	
19-24	87 (42.2)	63 (45.7)	24 (35.3)	
25-29	43 (20.9)	30 (21.7)	13 (19.1)	
30-34	34 (16.5)	18 (13.0)	16 (23.5)	
35-39	22 (10.7)	14 (10.1)	8 (11.8)	
40-44	4 (1.9)	2 (1.4)	2 (2.9)	
>=45	2 (1.0)	2 (1.4)	0 (0.0)	
Number of pregnancies				0.21
1-3	124 (60.2)	88 (63.8)	36 (52.9)	
4-5	49 (23.8)	32 (23.2)	17 (25.0)	
6-8	33 (16.0)	18 (13.0)	15 (22.1)	
Number of deliveries				0.003
0	31 (15.0)	15 (10.9)	16 (23.5)	
1-3	113 (54.9)	84 (60.9)	29 (42.6)	
>=4	59 (28.6)	39 (28.3)	20 (29.4)	
Unknown	3 (1.5)	0 (0.0)	3 (4.4)	
Provenance				1.00
Regional hospital	4 (1.9)	2 (1.4)	2 (2.9)	
Koupela	32 (15.5)	22 (15.9)	10 (14.7)	
Ouargaye	63 (30.6)	42 (30.4)	21 (30.9)	
Zabré	30 (14.6)	20 (14.5)	10 (14.7)	
Tenkodogo	15 (7.3)	10 (7.2)	5 (7.4)	
Pouytenga	30 (14.6)	20 (14.5)	10 (14.7)	
Garango	14 (6.8)	10 (7.2)	4 (5.9)	
Bittou	18 (8.7)	12 (8.7)	6 (8.8)	
Marital status				0.11
Married	204 (99.0%)	138 (100.0%)	66 (97.1%)	
Single	2 (1.0%)	0 (0.0%)	2 (2.9%)	
Type of union				0.001
Monogamy	103 (50.0%)	79 (57.2%)	24 (35.3%)	
Polygamy	44 (21.4%)	30 (21.7%)	14 (20.6%)	
Indetermined	57 (27.7%)	29 (21.0%)	28 (41.2%)	
Single	2 (1.0%)	0 (0.0%)	2 (2.9%)	
Occupation				0.52
At home	192 (93.2%)	128 (92.8%)	64 (94.1%)	
Merchant	10 (4.9%)	8 (5.8%)	2 (2.9%)	
Others	4 (1.9%)	2 (1.4%)	2 (2.9%)	
Ethnic group				0.005
Mossi	119 (57.8%)	85 (61.6%)	34 (50.0%)	
Bissa	70 (34.0%)	47 (34.1%)	23 (33.8%)	
Gourmantché	2 (1.0%)	2 (1.4%)	0 (0.0%)	
Others	15 (7.3%)	4 (2.9%)	11 (16.2%)	
Religion				0.17
Traditionalist	3 (1.5%)	1 (0.7%)	2 (2.9%)	
Muslim	169 (82.0%)	110 (79.7%)	59 (86.8%)	
Catholic	33 (16.0%)	26 (18.8%)	7 (10.3%)	
Protestant	1 (0.5%)	1 (0.7%)	0 (0.0%)	
Educational level				<0.001
None	133 (64.6%)	77 (55.8%)	56 (82.4%)	
Primary	38 (18.4%)	31 (22.5%)	7 (10.3%)	
Secondary	27 (13.1%)	25 (18.1%)	2 (2.9%)	
Unknown	8 (3.9%)	5 (3.6%)	3 (4.4%)	

(13/68) had risk factors, compared to about 1.4% (2/138) of those with normal deliveries. Hypertension and anemia were the main risk factors. Lower limbs Edema was observed in 10% of the cases group, compared to less than 1% in the controls group.

The coverage of the intermittent preventive treatment of malaria during pregnancy (IPTg) and the anti-tetanus vaccination (ATV), were significantly different among women who died compared to the control groups (P<0.001). However, the number of required doses (5 for IPTg and 2 or more for ATV) was similar in both groups. Biological tests were performed for 26% of women during the pregnancy. Nearly 72% of women who died had a complete blood count (CBC), compared to only 4% of those with normal deliveries. The mean hemoglobin level was 8.7 (±5.5) g/dl for deceased women versus 10.9 (±1.5) g/dl for controls. Anemia was present in 57% (39/68) of the cases compared with 3% (4/138) of controls (P<0.0001).

The average number of platelets per microliter did not differ significantly between both groups, with an average of 182,857.3 platelets/ml (SD: 125,015.5) and 295,500.0 platelets/ml (SD: 23,334.5) (P=0.21) for case and controls respectively.

Other biological examinations included PMTCT screening tests for 80% (165/206) of women, with 72% (49/68) among the deceased and 84% (116/138) among the controls. Glycemia and creatininemia tests were mainly performed among women who died. The results are displayed in Table 2 in the supplementary file.

Reasons for consultation

Abdominopelvic pain (labor pain) represented nearly 45% of the reasons of consultation. It was reported in 19% of cases compared to 58% in the controls (P<0.001). Respiratory distress, hemorrhage, convulsions, and disturbances of consciousness were present in 14.7% (10/68), 13.2% (9/68), 8.8% (6/68), and 10.3% (7/68) of the deceased women, respectively, but were absent in the controls. Details of the results are presented in the Table 3 of the supplementary file.

Results of the examination on admission

At admission, conjunctival pallor was observed in one in five women, with a notable difference between both groups: nearly 60% (41/68) in deceased women and only 4% (5/138) of the control (P<0.001). Almost 53% (56/68) of the deceased women had consciousness disorders (coma and obnubilation), compared to less than 1% of the controls (P<0.001).

Deceased women were more frequently malnourished (17.6% vs. 0%) and dehydrated (14.7% vs. 0%). Their average heart pulse rate was significantly higher (109 vs. 93.7, P<0.001), like their axillary temperature (37.3 vs. 36.8, P<0.001). There was no statistical difference in the average respiratory rate (77.0 vs. 74.0, P=0.61), systolic blood pressure (SBP) (103.8 vs. 100.3, P=0.63), and diastolic blood pressure (DBP) (79.3 vs. 64.1, P=0.097). Edema of the lower limbs was observed in 10.3% of the deceased cases compared to 0.7% of controls.

The average time from admission to delivery or death was longer for the deceased women, at 8.8 hours (SD: 6.9), compared to 5.8 hours (SD: 5.9) for the controls (P<0.001). Pathological conditions were found in over half of the women, affecting 85% of the deceased and 38% of the controls (P<0.001). Eclampsia (26.5%), anemia (19.1%), hemorrhage (8.8%), and dystocia (6%) were the main pathological issues among the deceased women.

Four out of five women who died were referred, compared to less than one in ten among the controls (P<0.001). Detailed results are summarized in Table 4 in the supplementary file.

Delivery and immediate post-delivery period

At admission, most of deceased women were in the third stage of labor, whereas controls were admitted in roughly equal proportions across all three stages (P<0.001). Childbirth complications such as eclampsia/pre-eclampsia (5/68) and fetal death (7/68) were observed among the deceased women while controls had no complications at admission. Common complications during labor included stationary dilatation and hypo/hyperkinesia.

Cephalic presentations were more frequent in controls (99%) compared to the deceased women (61%) (P<0.001). Partograms were used in 87% (120/138) of the controls but only in 20.6% (14/68) of the deceased women (P<0.001). The average duration of the labor was longer in deceased women, 6.5 hours (SD: 8.1) compared to 4.8 hours (SD: 4.9) in controls. Both groups had similar gestational ages, averaging 37 weeks' amenorrhea.

Table 2: Results of bivariate and multivariate analyses

Variables	OR (95%IC)	P-value	aOR (95%IC)
Social and demographic items			
Occupation (N=206)			
Housewife	1		-
merchant/other	0.8 (0.24-2.65)	0.715	-
Age group (N=206)			
less de 25	1		
25 and more	1.47 (0.82-2.63)	0.199	-
Number of pregnancies (N=206)			
1-3	1		
4-5	1.29 (0.64-2.63)	0.467	-
6-8	2.04 (0.93-1.47)	0.077	-
Number of live birth (N=206)			
0	1		
1-3	0.32 (0.14-0.74)	0.007	0.45 (0.07-2.82)
4 and more	0.55 (0.23-1.32)	0.183	1.21 (0.22-6.73)
residency (N=206)			
District/Hospital Tenkodogo	1		-
Koupela	0.45 (0.05-3.70)	0.682	-
Ouargaye	0.5 (0.07-3.80)	0.778	-
Zabré	0.5 (0.06-4.09)	0.802	-
Pouytenga	0.5 (0.06-4.09)	0.802	-
Garango	0.4 (0.04-3.90)	0.619	-
Bittou	0.5 (0.06-4.45)	0.823	-
Marital status (N=206)			
Monogamy	1		
Polygamy	1.54 (0.70-3.36)	0.282	-
Indetermined/single	3.17 (1.59-6.34)	<0.001	-
Ethnics (N=206)			
Mossi	1		
Bissa	1.22 (0.64-2.31)	0.536	-
Other	4.58 (1.57-13.38)	0.005	-
Religion (N=206)			
Christians/other	1		
Muslim	1.67 (0.74-3.77)	0.218	-
Level of instruction (N=206)			
None	1		1
Instructed	0.22 (0.10-0.49)	<0.001	0.25 (0.04-1.50)
Gynecology and obstetrics antecedents			
History of stillbirth (N=188)			
No	1		
At least one	15.5 (5.00-48.04)	<0.001	-
History of spontaneous abortion (N=198)			
Yes	1		
No	0.41 (0.14-1.17)	0.096	-
History of induced abortion (N=197)			
Yes	1		
No	0.25 (0.02-2.77)	0.256	-
History of spontaneous miscarriages (196)			
Yes	1		
No	0.24 (0.02-2.72)	0.251	-
history of family planning. (N=91)			
Yes	1		

Variables	OR (95%IC)	P-value	aOR (95%IC)
No	2.20 (0.58-8.33)	0.248	-
Pregnancy development			
ANC (N=206)			
4 ANC or more	1		1
Less than 4 ANC	2.52 (1.37-4.63)	0.003	2.85 (0.83-9.73)
Anti-malarial chemoprophylaxis (N=206)			
Yes	1		
No	7.92 (2.97-21.09)	<0.001	1,57 (0.47-5.20)
Number of IPTp (N=182)			
Less than 5 doses	1		
5 doses and more	0.88 (0.17-4.49)	0.873	-
History of ATV (N=206)			-
Yes	11.67 (3.22-42-22)	<0.001	
No			
Number of ATV doses (N=188)			
Less than 2 doses	1		
2 doses and more	1.59 (0.17-14.54)	0.682	-
History of PMCT (N=206)			
Yes	1		
No	2.04 (1.01-4.11)	0.045	0.55 (0.15-2.05)
Existing of risk factor (N=206)			
Yes	1		
No	0.06 (0.01-0.28)	<0.001	0.30 (0.04-1,94)
Women perform hemoglobin exam (N=54)			
Yes	1		
No	0.02 (0.007-0.05)	<0.001	-
hemoglobin rate (N=54)	0.94 (0.85-1.04)	0.217	-
Women underwent the TPHA exam (N=206)			
Yes	1		
No	1.31 (0.65-2.65)	0.451	-
Women underwent the VDRL (N=206)			
Yes	1		
No	1.39 (0.70-2.76)	0.344	-
Motives of entry			
Pain			
Yes	1		
No	0.17 (0.09-0.34)	<0.001	0.61 (0.11-3.41)
General examination funding			
Conjunctivae coloration (N=206)			
Pallor	1		
Normal colored	0.04 (0.008-0.07)	<0.001	**0.02 (0.004-0.11)**
Heart Pulse	1.04 (1.01-1.06)	0.002	-
Fever	2.00 (1.17-340)	0.011	**2.94 (1.47-5.90)**
excessive uterine height			
Yes	1		
No	0.98 (0.48-1.97)	0.948	-
Information gathered at admission			
Delay form admission to delivery/death (N=206)	1.07 (1.02-1.12)	0.002	1.03 (0.95-1.11)
Gestational age	0.69 (0.56-0.84)	<0.001	0.64 (0.38-1.08)
Pathological condition at admission (N=206)			
No	1		
Yes	9.30 (4.37-19.08)	<0.001	-

Variables	OR (95%IC)	P-value	aOR (95%IC)
Women referred (N=206)			
Yes	1		
No	0.02 (0.009-0.05)	<0.001	-
Delivery operation			
Use of partogram (171)			
Yes	1		
No	9.04 (3.86-21.21)	<0.001	-
Duration of the labor	1.05 (0.98-1.13)	0.163	-
Duration of rupture of the members	0.98 (0.72-1.35)	0.918	-
Dystocia			
Yes	1		
No	0.05 (0.02-0.12)	<0.001	-
Active management of the third Stage of childbirth			
Yes	1		
No	3.37 (1.43-7.93)	0.005	-

We observed eclampsia in 11.8% (8/68) and in 8.8% (6/68) during labor and after delivery among the deceased women, whereas no cases were observed among the controls. The practice of Active management of the third stage of labor (AMTSL) in 85% of the controls compared to 30.9% (21/68) of the deceased women was statistically significant (P<0.001). The detailed results are shown in Table 5 of the supplementary file.

Bivariate analysis

The bivariate analysis come out with several factors associated with maternal mortality in the Centre-East region. Women who have had 1-3 births have 68% had lower odds of death compared to nulliparous (OR: 0.32, 95% CI: 0.14-0.74). Educated women had 78% lower odds of dying compared to uneducated women (OR: 0.22, 95% CI: 0.10-0.49). The history of stillbirth significantly increases the odds of death (OR: 15.5, 95% CI: 5.00-48.04).

Absence of malaria chemoprophylaxis during pregnancy is associated with a higher likelihood of death (OR: 7.92, 95% CI: 2.97-21.09) as similar to absence of anti-tetanus vaccination (OR: 11.67, 95% CI: 3.22-42.22). Women with no initial risk factors had better survival likelihood (OR: 0.06, 95% CI: 0.01-0.28). Absence of pain is a protective factor, reducing the chance of death by 83% (OR: 0.17, 95% CI: 0.09-0.34).

Several general symptoms were negatively associated with women's survival. The normal coloration of the conjunctivae reduces the mortality odds by 4% (OR: 0.04, 95% CI: 0.008-0.07). Each one-degree Celsius increase in temperature, doubles the odds of death (OR: 2.00, 95% CI: 1.17-3.40). Women with a pathological condition on admission have a higher mortality odds compared to those without such conditions. Non-referred patients were less likely to die than those referred (OR: 0.02, 95% CI: 0.009-0.05).

Delivery-related factors increasing the odds of maternal mortality include non-use of the partogram (OR: 9.04, 95% CI: 3.86-21.21) and absence of the active management of the third stage of labor (OR: 3.37, 95% CI: 1.43-7.93) The absence of dystocia was associated with 95% lower odds to death compared to women with dystocia (OR: 0.05, 95% CI: 0.02-0.12).

Multivariate analysis

After adjusting for the matching variables and the socio-demographic factors, fever remained associated with maternal death in the Centre-East region, with an adjusted odds ratio (aOR) of 2.94 (95% CI: 1.47-5.90). Women with an elevated temperatures during labor are approximately two times more likely to die compared to those with normal temperature. Conversely, the normal coloration of conjunctivae during the delivery was a protective factor, with an aOR of 0.02 (95% CI: 0.004-0.11). This indicates that women with a normal coloration of conjunctivae during the labor had 98% lower odds of death than those with a conjunctival pallor. Table 2 summarizes the results.

Discussion

The study aimed to identify the underlying factors that drive the persistent high maternal mortality ratio in the Centre-East health region. Our findings

highlight the critical importance and need for high quality of health care and services. Fever, likely due to infection, was the leading cause of death observed in the delivery room. In the Burkina Faso's health system, the itinerary of women is that from the point of contact, they can be referred to the district hospitals and then, to regional hospitals if needed. As most women died at the regional hospital, fever may reflect delayed care-seeking decision-making, an insufficient logistic of evacuation and transportation of women in labor, a prolonged labor (6.8 hours in controls group vs. 8.8 hours in cases group), and inadequate monitoring of the childbirth process (87% of the controls vs. 21% of the cases use of the partogram), multiple digital vaginal examinations or preexisting infections.[28] Infection is a leading cause of preventable maternal deaths through sepsis and organ failure.[29] Malaria is one of leading causes of maternal infection in Burkina Faso.[16] Unfortunately, our results show that the coverages of the malaria preventive interventions during pregnancy and the antenatal consultations visit were lower in women who died compared to those with uncomplicated deliveries. This may indicate inefficient decision-making by women (lack of instruction, poverty), low accessibility to these services. All these conditions have been worsened by the insecurity, particularly in the Ouargaye health district, where nearly a third (31%) of the deceased women come from. By November 2020, Ouargaye was the only district where health facilities were operating at minimal capacity or closed.[23] In response, national health authorities have implemented strategies to bolster the resilience of health services in insecure areas to mitigate the impact of these challenges.[30] Indeed, the monitoring of women for infections during pregnancy and labor is crucial.[31] Women are admitted in critical conditions with conjunctival pallor, respiratory distress, hemorrhage, disturbed consciousness, and convulsions. Managing these severe conditions is crucial to preventing deaths in the delivery room.[32–36] Unfortunately, health facilities lack the essential equipment and supplies, such as oxygen, respirators, and blood products. According to the Harmonized Health Services Assessment (HHFA) survey in 2021, only 56% of the health facilities of the Centre-East region have met the operational capacity for basic emergency obstetric and neonatal care, compared to the national average of 63%. For the comprehensive emergency obstetric and neonatal care, only 44% of facilities met the standards, compared to a national average of 58%.[37]

A major contributor factor to the women death in the Centre-East health region is the conjunctival pallor, which is one of clinical markers of anemia. Conjunctival pallor serves as an important clinical assessment of anemia in peripheral health centers where there are no biological capacities to assess the hemoglobin level. Here again, malaria attributed anemia is important in Burkina Faso. Anemia reduces the transport of oxygen to organ, increases hemorrhage and sepsis risk and organ failure.[38–41] Monitoring this indicator from admission through delivery and the postpartum period is crucial. It can prompt timely evacuation, as conjunctival pallor may be due an acute complication such as hemorrhage (e.g., uterine rupture, placenta previa, retained placenta, coagulation disorders). Indeed, a qualitative and effective continuum of care for pregnant women including skilled preventive care to identify pregnant women at high-risk earlier (e.g., placental insertion, anemia due to malaria), proper and adequate monitoring of the labor (e.g., uterine rupture, placenta previa), and qualitative postpartum management (e.g., retained placenta), as well as the availability of blood supplies for transfusions is crucial.[42–44] However, the availability of such capacities, the shortages of medical products and supplies, lack of competent human resources is a challenge in health centers, district and regional hospitals in Burkina Faso. The regional blood transfusion center, intended to cover the need of bloods supplies of the seven health' districts of the Centre-East region operate merely as a depot and relies on blood products from the nearby region of Fada regional blood center. Sustainable strategies for the blood collection, the processing, and the storage are needed to ensure the availability in the district' and the regional hospitals of Centre-East region.

The quality of sexual and reproductive health care closely influences to the maternal survival in the Centre-East health region. The clinical examination at admission often reflects the insufficiencies and the incompleteness of the required care and services during the prenatal period, with some women receiving fewer than the recommended eight antenatal care visits. In 2020, only 39% of pregnant women were seen in their first trimester.[16] This shortfall affects other preventive services, including the prevention of

malaria during the pregnancy, tetanus vaccination, and early detection of high-risk conditions like pre-eclampsia. We observed that 10% and 9% of deceased women were admitted with consciousness disorders and convulsions, respectively, possibly due to worsening of pre-eclampsia. Additionally, 10% of the deceased women have had lower limb edema during pregnancy, a clinical symptom of pre-eclampsia.

Our bivariate analysis results demonstrate the influence of individuals (instruction, history of stillbirth, no preexisting risk factor), SRH care quality (less than 4 ANC, no malaria prevention during pregnancy, presence of dystocia, no use of partogram, no active management of third stage of labor) and system wide factors (delay of admission in labor room, being referred). They did not appear associated in multivariate analysis in our case but several studies have confirmed their tight association with maternal death in similar of Mali, Senegal, Kenya and Sub-Saharan Africa in general.[45–48]

These factors constitute the foundation of the profile of the deceased women in our study. They include being a young woman (aged 19-24 years), having between 1 to 3 pregnancies and births, coming from the Ouargaye health district, most often uneducated, having attended less than 4 antenatal visits, and being frequently anemic. Despite the free healthcare and services policy for pregnant women, it is of importance to improve the quality of reproductive health care, particularly from the antenatal period onwards. This involves a capacity building to enhancing the professional competencies for detecting and managing critical signs such as fever during childbirth and strengthening health infrastructure with adequate equipment and health supplies in the Centre-East region.

Study strengths and limitations

Our study has limitations inherent to case–control designs, particularly related to data collection bias. Indeed, the patients' records were often poorly documented, which considerably reduced the statistical power for certain variables. Consequently, several variables were excluded from the multivariable regression analysis. Nevertheless, our results remain robust, as each case was matched with two controls to mitigate data limitations. Moreover, our findings are generally consistent with those reported in the literature.

Conclusion

A targeted capacity building and an adequate equipment of health centers is necessary to increase the access of women to qualitative health care and to reduce the maternal death in the Centre-East region of Burkina Faso. Furthermore, resilient and adaptative measures are needed to cope with the growing insecurity issue in the region.

Availability of data and materials

Data used in this work can are accessible via request to the author

Competing interests

Authors declare no conflict of interest

Funding

The research project was financed by Enabel, the Belgian cooperation, Burkina Faso through its "Health, sexual and reproductive rights" project in the Centre Est health region.

Acknowledgments

We thank the Belgian Cooperation, through its "Health, sexual and reproductive rights" project in the Centre Est health region, for funding this assessment of the project of which results this paper is derived. We also thank the regional health authorities of the Centre hospitaller regional de Tenkodogo and the Direction Régionale de la Santé du Centre Est for facilitating the survey.
The author's views expressed in this study do not represent the views of the Enabel or the Belgian Government. The funders did not intervene in the designing of the study, the data collection and analysis, the decision to publish, or the writing of the manuscript.

Authors' contributions

Conceptualization, data curation and analysis, writing the original first draft: Ourohiré Millogo, Writing, review & editing: Ourohiré Millogo, Ouattara Mamadou, Thierry Nkurabagaya, Nyambré Marie Antoine, Thiombiano Oumarou, Sié Ali.

References

1. WHO, UNICEF, UNFPA, World Bank Group, and UNDESA/Population Division. Trends in maternal

mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division [EN/AR/RU/ZH] - World | ReliefWeb.
2. von Dadelszen P and Magee LA. Preventing deaths due to the hypertensive disorders of pregnancy. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2016;36:83-102.
3. Bergevin Y, Fauveau V, McKinnon B. Towards Ending Preventable Maternal Deaths by 2035. *Semin Reprod Med*. 2015;33(1):23-29.
4. Kurjak A, Stanojević M and Dudenhausen J. Why maternal mortality in the world remains tragedy in low-income countries and shame for high-income ones: will sustainable development goals (SDG) help? *Journal of Perinatal Medicine*. 2023;51(2):170-181.
5. Kvåle G, Olsen BE, Hinderaker SG, Ulstein M and Bergsjø P. Maternal deaths in developing countries: A preventable tragedy. *Norsk Epidemiologi*. 2005;15(2).
6. Musarandega R, Nyakura M, Machekano R, Pattinson R and Munjanja SP. Causes of maternal mortality in Sub-Saharan Africa: A systematic review of studies published from 2015 to 2020. *J Glob Health*. 11:04048.
7. Say L, Chou D, Gemmill A, Tunçalp Ö, Moller AB, Daniels J, Gülmezoglu AM, Temmerman M, Alkema L. Global causes of maternal death: a WHO systematic analysis. *The Lancet Global Health*. 2014 June 1;2(6):e323–33.
8. World Health Organization. Maternal mortality.
9. Souza JP, Day LT, Rezende-Gomes AC, Zhang J, Mori R, Baguiya A, Jayaratne K, Osoti A, Vogel JP, Campbell O, Mugerwa KY, Lumbiganon P, Tunçalp Ö, Cresswell J, Say L, Moran AC, Oladapo OT. A global analysis of the determinants of maternal health and transitions in maternal mortality. *The Lancet Global Health*. 2024 Feb 1;12(2):e306–16.
10. Institut National de la Statistique et de la Démographie. Cinquième Recensement Général de la Population et de l'Habitation du Burkina Faso, SYNTHÈSE DES RÉSULTATS DÉFINITIFS. Published online 2022.
11. Institut National de la Statistique et de la Démographie (INSD) Ministère de l'Économie et des Finances Ouagadougou, Burkina Faso ICF International. Calverton, Maryland, USA. Enquête Démographique et de Santé et à Indicateurs Multiples (EDSBF-MICS IV). Published online 2012.
12. Ridde V, Richard F, Bicaba A, Queuille L and Conombo G. The national subsidy for deliveries and emergency obstetric care in Burkina Faso. *Health Policy and Planning*. 2011;26(suppl_2):ii30-ii40.
13. Samb OM and Ridde V. The impact of free healthcare on women's capability: A qualitative study in rural Burkina Faso. *Social Science & Medicine*. 2018;197:9-16.
14. Ouagadougou, Burkina Faso et Rockville, Maryland, USA : INSD et ICF. Enquête Démographique et de Santé du Burkina Faso 2021. Published online 2021.
15. Ministère de la santé, secrétariat général, direction générale des études et des statistiques sectorielles, direction des statistiques sectorielles. Évaluation harmonisée des établissements de santé : Thématique iii services de santé de la reproduction, du nouveau-né, de l'enfant et de l'adolescent. Published online 2021.
16. Direction générale des études et des statistiques sectorielles MDLS. annuaire statistique 2020. Published online 2020.
17. Renforcement des droits sexuels et reproductifs - Santé & Droits sexuels et reproductifs. Open.Enabel.
18. Ministere de la sante et de l'hygiène publique. Annuaire Statistiques 2018.
19. Muriithi FG, Banke-Thomas A, Gakuo R, Pope K, Coomarasamy A and Gallos ID. Individual, health facility and wider health system factors contributing to maternal deaths in Africa: A scoping review. *PLOS Global Public Health*. 2022;2(7):e0000385.
20. Shoo RS, Mboera LEG, Ndeki S and Munishi G. Stagnating maternal mortality in Tanzania: what went wrong and what can be done. *Tanzania Journal of Health Research*. 2017;19(2).
21. Bucagu M, Kagubare JM, Basinga P, Ngabo F, Timmons BK and Lee AC. Impact of health systems strengthening on coverage of maternal health services in Rwanda, 2000–2010: a systematic review. *Reproductive Health Matters*. 2012;20(39):50-61.
22. Somé DT, Sombie I and Meda N. What prevent women for a sustainable use of maternal care in two medical districts of Burkina Faso? A qualitative study. *Pan Afr Med J*. 2014;18:43.
23. Ministere De La Sante C. Burkina Faso, Bulletin N°12 Du Cluster Santé Novembre 2020. Published online 2020.
24. Zhang T, Qi X, He Q, Hee J, Takesue R, Yan Y, Tang K. The Effects of Conflicts and Self-Reported Insecurity on Maternal Healthcare Utilisation and Children Health Outcomes in the Democratic Republic of Congo (DRC). *Healthcare*. 2021 July;9(7):842.
25. Ekanga MD, Simon P, Coppieters Y, Delbaere A, Lamy C, Zhang WH, Hakizimana K, Kinja J, Katerekwa A, Kapungwe MIK, Kyembwa M, Kabuseba RK. The Impact of Insecurity on the Care of Pregnant Women in the Democratic Republic of the Congo: A Cross-Sectional Study. *Obstetrics and Gynecology Research*. 2023 July 13;6(3):188–96.
26. Alexandre Dumont ; Mamadou Traoré, Jean-Richard Dortonne. Audit des décès maternels dans les établissements de santé. Guide de mise en oeuvre. Published online 2014.
27. Serhier Z, Bendahhou K, Abdelaziz AB, Othmani MB and Réseau Maghrébin PRP2S. Fiche Méthodologique n°1 : Comment calculer la taille d'un échantillon pour une étude observationnelle ? Methodological sheet n°1: How to calculate the size of a sample for an observational study? *LA TUNISIE MEDICALE*. 2020;98:7.
28. Traoré FB, Sidibé CS, Diallo EHM, Camara BS, Sidibé S, Diallo A, Diarra NH, Ly BA, Ag Ahmed MA, Kayentao K, Touré A, Camara A, Delamou A, Sangho H, Terera I. Prevalence and factors associated with maternal and neonatal sepsis in sub-Saharan Africa: a systematic review and meta-analysis. *Front Public Health*.24;12.
29. Maternal infections in health facilities.

30. Ministere de la sante. strategie de resilience du systeme de sante en zone de securite precaire au Burkina Faso. Published online 2019.
31. World Health Organization. *WHO Recommendations for Prevention and Treatment of Maternal Peripartum Infections*. World Health Organization; 2015.
32. Diana S, Wahyuni CU and Prasetyo B. Maternal Complications and Risk Factors for Mortality. *Journal of Public Health Research*. 2020;9(2):jphr.2020.1842.
33. Ahmadzia HK, Phillips JM, Kleiman R, Gimovsky AC, Bathgate S, Luban NLC, Amdur RL. Hemorrhage Risk Assessment on Admission: Utility for Prediction of Maternal Morbidity. Am J Perinatol. 2021 Sept;38(11):1126–33.
34. Espinoza ISR. Obstetric Hemorrhage, its role in maternal morbidity and mortality and the importance of its diagnosis, prevention and timely management. *Mexican Journal of Medical Research ICSA*. 2020;8(15):37-44.
35. Goffman D, Nathan L and Chazotte C. Obstetric hemorrhage: A global review. *Seminars in Perinatology*. 2016;40(2):96-98.
36. Haeri S and Dildy GA. Maternal Mortality From Hemorrhage. *Seminars in Perinatology*. 2012;36(1):48-55.
37. Ministère de la santé. Évaluation harmonisée des établissements de santé ; thématique III : services de santé de la reproduction, du nouveau-né, de l'enfant et de l'adolescent. Published online 2021.
38. Ouédraogo S, Koura GK, Accrombessi MMK, Bodeau-Livinec F, Massougbodji A and Cot M. Maternal Anemia at First Antenatal Visit: Prevalence and Risk Factors in a Malaria-Endemic Area in Benin. *The American Journal of Tropical Medicine and Hygiene*. 2012;87(3):418-424.
39. Brabin BJ, Hakimi M and Pelletier D. An Analysis of Anemia and Pregnancy-Related Maternal Mortality. *The Journal of Nutrition*. 2001;131(2):604S-615S.
40. Nair M, Choudhury MK, Choudhury SS, Kakoty SD, Sarma UC, Webster P, Knight M. Association between maternal anaemia and pregnancy outcomes: a cohort study in Assam, India. *BMJ Glob Health*. 2016;1(1).
41. The global prevalence of anaemia in 2011.
42. Aksünger N, Sanctis TD, Waiyaiya E, Doeveren R van, Graaf M van der and Janssens W. What prevents pregnant women from adhering to the continuum of maternal care? Evidence on interrelated mechanisms from a cohort study in Kenya. *BMJ Open*. 2022;12(1):e050670.
43. Tiruneh GT, Demissie M, Worku A and Berhane Y. Predictors of maternal and newborn health service utilization across the continuum of care in Ethiopia: A multilevel analysis. *PLOS ONE*. 2022;17(2):e0264612.
44. Sserwanja Q, Mukunya D, Nabachenje P, Kemigisa A, Kiondo P, Wandabwa JN, Musaba MW. Continuum of care for maternal health in Uganda: A national cross-sectional study. *PLOS ONE*. 2022 Feb 24;17(2):e0264190.
45. Musarandega R, Nyakura M, Machekano R, Pattinson R and Munjanja SP. Causes of maternal mortality in Sub-Saharan Africa: A systematic review of studies published from 2015 to 2020. *J Glob Health*. 2021;11:04048.
46. Tort J, Rozenberg P, Traoré M, Fournier P and Dumont A. Factors associated with postpartum hemorrhage maternal death in referral hospitals in Senegal and Mali: a cross-sectional epidemiological survey. *BMC Pregnancy and Childbirth*. 2015;15(1):235.
47. Garenne M, Mbaye K, Bah MD and Correa P. Risk factors for maternal mortality: a case-control study in Dakar hospitals (Senegal). *Afr J Reprod Health*. 1997;1(1):14-24.
48. Yego F, D'Este C, Byles J, Williams JS and Nyongesa P. Risk factors for maternal mortality in a Tertiary Hospital in Kenya: a case control study. *BMC Pregnancy and Childbirth*. 2014;14(1):38.