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Maternal mortality risk indicators: Case-control study at a referral hospital in Guinea

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ABSTRACT

Objective: This study aimed to describe intrapartum and postpartum exposures possibly associated with the risk of in-hospital maternal mortality in Guinea.
Study Design: Data were collected in the Western Sub-Saharan Africa setting at the university hospital in Conakry, Guinea, during 2016−2017. Case-control study design was applied. The cases comprised all intrapartum and postpartum maternal deaths recorded during the study period. The controls were selected by random sampling from patients discharged alive following hospitalization due to vaginal delivery or cesarean section. Maternal mortality ratio (MMR) was defined as a quotient of the number of maternal deaths per 100,000 live births. Multivariable logistic regression was applied to generate odds ratios (OR) and 95 % confidence intervals (95 %CI).
Results: A total of 10,208 live births and 144 maternal deaths were recorded. The MMR was at 1411 per 100,000 live births. The main causes of maternal death included postpartum hemorrhage (56 %), retroplacental hematoma (10 %), and eclampsia (9%). The ORs of maternal death were significantly elevated in case of transfer from another hospital (OR 24.60, 95 %CI 11.32–53.46), misoprostol-induced labor (OR 4.26, 95 %CI 2.51–7.91), non-use of partogram (OR 3.70, 95 %CI 1.31–5.20), duration of labor ≥24 h (OR 2.87, 95 %CI 1.35–5.29), and positive history of cesarean section (OR 2.54, 95 %CI 1.12–6.19).
Conclusion: To stop preventable maternal mortality in Sub-Saharan Africa, continued efforts are needed to provide perinatal monitoring, to reorganize the obstetric reference system, and to decrease the number of avoidable cesarean sections. Furthermore, the internal supervision of misoprostol doses used for labor induction should be a priority.

Introduction

According to the World Health Organization, 99 % of global maternal deaths occur in low- and middle-income countries. Two-thirds of these deaths are recorded in Sub-Saharan Africa [1]. Guinea is a Western Sub-Saharan African country, in 2016 classified by the World Bank as 174/195, according to the gross domestic product per capita [2]. According to the Guinean demographic and health survey carried out in 2012, the maternal mortality ratio (MMR) was at 724/100,000 live births. Such a ratio is considered one of the highest in the world [3].

Since it is considered preventable in around 50 % of cases, maternal mortality is one of the obstetric care quality indicators in the field of public health [4]. Implementing effective strategies toward ending preventable maternal mortality in Western Africa requires identifying its risk factors.

In Sub-Saharan Africa, the risk factors of intrapartum maternal death have not been explored extensively, due to the lack of documentation of delivery conditions. The majority of the recorded maternal deaths are caused by direct obstetric causes, namely postpartum hemorrhage, placental vascular pathologies, abortion, and infections [5]. Several additional socio-demographic and obstetric exposures associated with maternal mortality include transfer from another hospital, inadequate prenatal care, maternal age under 18 or over 35 years, multiparity, and lack of education [6–10]. Other risk factors encompass low access to healthcare services providing obstetric and emergency care [11,12]. However, it is unclear if these risk factors also apply to West African university hospitals.

Abbreviations: CI, confidence intervals; MMR, maternal mortality ratio; OR, odds ratios.

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In this study, we aimed to describe exposures possibly associated with the risk of intrapartum and postpartum maternal death in a Guinean university hospital setting.

Materials and methods

Study population and study design

Data were obtained at the Ignace Deen National Hospital in Conakry, Guinea, over 22 months, i.e., between the 1st of January 2016, and the 31st of October 2017. Case-control study design was adopted.

The cases included all maternal deaths registered at the hospital. Women who died in the intra- or postpartum service due to a direct or indirect obstetric cause were included in the study. Women who died on the ward, but had been transferred to the Ignace Deen Hospital after giving birth elsewhere, or due to objectively non-obstetric cause, were not included.

The controls included women discharged alive after the hospitalization due to a vaginal delivery or a cesarean section. They were selected by systematic random sampling. First, the sampling interval was calculated (dividing the total number of deliveries recorded during the study period by the number of cases needed for the sample). Second, a random start (control case number 1) was chosen between 1 and the sampling interval. Then the sampling interval was repeatedly added to select subsequent cases.

The data were collected from patients' medical records, according to previously prepared forms, listing socio-demographic, obstetrical, and intrapartum exposures. Socio-demographic exposures included: maternal age [years], profession [student, freelancer, housewife, state employee], level of education [non-educated, educated], and marital status [single, married]. Obstetric exposures encompassed mode of admission [transferred from another hospital, self-referred], history of cesarean section [yes, no], prenatal consultations [number], and parity [0, 1, 2−3, ≥4]. All transfers from other hospitals regarded women with intrapartum complications after the onset of labor. Maternal vital status [alive, deceased], was assessed, as well as intrapartum exposures including use of partogram [yes, no], mode of delivery [vaginal delivery, cesarean section], episiotomy [yes, no], perineal tear [yes, no], manual removal of retained placenta [yes, no], induction of labor [misoprostol-induced, spontaneous], oxytocin use [yes, no], artificial rupture of membranes [yes, no], duration of labor [<24 h, ≥24 h], and time of admission [night, day].

Statistical analysis

MMR was defined as the number of maternal deaths per 100′000 live births [13].

Logistic regression was applied to describe exposures possibly connected with increased risk of maternal death.

In the first step, simple logistic regression model was fitted for each independent variable. All of the models included maternal vital status as a dependent variable. The simple univariate analysis identified the following covariates as potential candidates for the multivariable model at the 0.20 alpha level based on the Wald chi-squared statistics: maternal age, level of education, mode of admission, history of cesarean section, prenatal consultations, parity, partogram use, mode of delivery, episiotomy, perineal tear, manual removal of retained placenta, induction of labor, oxytocin use, artificial rupture of membranes, duration of labor, and time of admission. The significance level of 0.20 was recommended by Mickey and Greenland [14].

Subsequently, multivariable logistic regression was applied to generate odds ratios (OR) and 95 % confidence intervals (95 %CI). The final main effect model was fitted using stepwise regression with a backward elimination approach and included mode of admission, history of cesarean section, prenatal consultations, parity, partogram use, mode of delivery, manual removal of retained placenta, induction of labor, oxytocin use, duration of labor, and time of admission.

For categorical variables we applied Pearson's chi-squared test. To evaluate the robustness of our inferences, a *posthoc* conservative Bonferroni procedure was adopted for multiple analyses. The Bonferroni-corrected significance threshold was at 0.005. Hence, in this study, the associations were considered significant at the overall alpha level set at <0.005.

Data management and statistical analysis were performed deploying R (version 3.4.2).

Compliance with ethical standards

The study was approved by the Bioethical Committee of Ignace Deen National Hospital in Conakry, Guinea. Individual-level data were used solely for scientific purposes, following legal regulations on privacy applicable in Guinea. Strict rules to secure complete confidentiality and protection of individuals were respected.

This study was conducted according to the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guidelines [15].

Results

During the study period, a total of 10,208 live births and 144 cases of maternal decease in the ante-, intra-, and postpartum periods were recorded. The MMR was at 1411 maternal deaths per 100,000 live births. Out of the recorded deaths, 17 occurred during pregnancy and the remaining 127 during labor and delivery (Fig. 1). Table 1 provides summary statistics for the causes of maternal deaths. The socio-demographic and obstetrical characteristics are

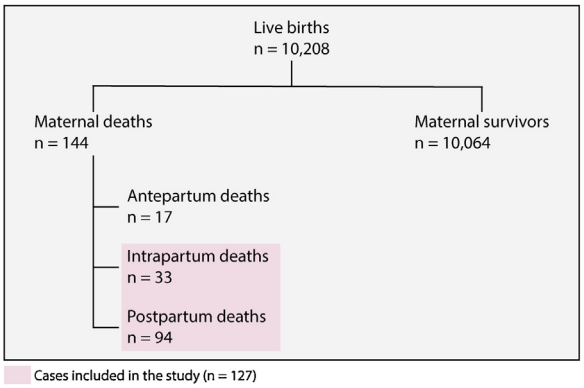

Fig. 1. Study population.

Table 1
Maternal fatal cases registered during the study (n = 127), by cause of death.

Cause of death	n (%)
Postpartum hemorrhage	71 (55.9)
Retroplacental hematoma	12 (9.5)
Eclampsia	11 (8.7)
Severe preeclampsia	8 (6.3)
Severe anemia	7 (5.5)
Uterine rupture	6 (4.7)
Puerperal infection	5 (3.9)
Malaria	4 (3.2)
Pulmonary edema	2 (1.6)
Anesthesia accident	1 (0.8)

Table 2
Socio-demographic and obstetrical characteristics of the study population.

Characteristic	Cases (n = 127) n (%)	Controls (n = 254) n (%)	*P* value*
I. Socio-demographic characteristics			
Age [years]			<0.001
≥30	60 (47.2)	62 (24.4)	
Profession			0.020
Housewife	64 (50.4)	104 (40.9)	
State employee	16 (12.6)	26 (10.2)	
Student	11 (8.7)	42 (16.5)	
Freelancer	36 (28.4)	82 (32.3)	
Level of education			<0.001
Non-educated	82 (64.6)	101 (39.8)	
Marital status			0.900
Married	116 (91.3)	234 (92.1)	
Mode of admission			
Transferred from another hospital	112 (88.2)	71 (28.0)	<0.001
Self-referred	15 (11.8)	183 (72.1)	
II. Obstetrical characteristics			
History of cesarean section			0.006
Yes	22 (15.3)	64 (22.2)	
Prenatal consultation [n]			<0.001
≤3	109 (85.8)	147 (57.9)	
Parity			<0.001
0	29 (22.8)	90 (35.4)	
1	23 (18.1)	64 (25.2)	
2–3	32 (25.0)	63 (24.8)	
≥4	43 (32.9)	37 (14.6)	

*calculated with Wald chi-squared test.

shown in Table 2. Intrapartum-related history characteristics are presented in Table 3.

The adjusted odds of maternal death were significantly increased in case of transfer from another hospital, misoprostol-induced labor, non-use of partogram, duration of labor ≥24 h, and positive history of cesarean section (Table 4).

Discussion

Main findings of the study

The observed MMR (1411/100,000) was two-fold higher than the reported national MMR (724/100,000; (3)) and one-and-a-half-fold higher than MMR recorded at the same hospital in 2006 (839/100,000; (7)). It was also higher than MMR observed at the maternity wards in Nigeria (217/100,000 in 2017; (6)), Senegal (1310/100,000 (9)), and Mali (1130/100,000; in 2013 (9)).

Table 3
Intrapartum history-related characteristics of the study population.

Characteristic	Cases n (%)	Controls n (%)	*P* value*
Partogram	n = 127	n = 254	<0.001
No	108 (85.0)	152 (59.8)	
Mode of delivery	n = 94	n = 254	<0.001
Cesarean	36 (38.3)	154 (59.0)	
Episiotomy	n = 58	n = 107	0.060
Yes	17 (29.3)	19 (17.8)	
Perineal tear	n = 58	n = 107	<0.001
Yes	21 (36.2)	10 (9.4)	
Manual removal of retained placenta	n = 58	n = 107	0.100
Yes	11 (19.0)	13 (12.2)	
Induction of labor	n = 127	n = 254	<0.001
Misoprostol-induced	34 (26.8)	19 (7.3)	
Antepartum oxytocin use	n = 127	n = 254	<0.001
Yes	53 (41.7)	29 (11.1)	
Artificial rupture of membranes	n = 127	n = 254	0.040
Yes	51 (40.2)	72 (28.4)	
Duration of labor [hours]	n = 127	n = 254	<0.001
≥24	90 (70.9)	105 (41.3)	
Time of admission	n = 127	n = 254	0.010
Night	71 (55.9)	99 (39.0)	

*calculated withWald chi-squared test.

Table 4
Odds ratios (OR) and 95 % confidence intervals (95 %CI) of intra- and postpartum maternal death associated with socio-demographic and obstetric exposures and intrapartum exposures.

Characteristic	OR (95 %CI)	*P* value†
Manual removal of retained placenta		0.300
Yes	0.9 (0.4–5.3)	
Mode of admission		<0.001
Transferred from another hospital	24.6 (11.3–53.5)	
Mode of delivery		0.057
Cesarean	1.6 (0.7–3.2)	
Parity		0.040
≥ 4	1.7 (1.1–4.9)	
Induction of labor		<0.001
Misoprostol-induced	4.3 (2.5–7.9)	
Antepartum oxytocin use		0.064
Yes	1.1 (0.5–2.2)	
Partogram		0.001
No	3.7 (1.3–5.2)	
Duration of labor [hours]		0.002
≥24	2.9 (1.4–5.3)	
Time of admission		0.070
Night	1.1 (0.2–4.5)	
History of cesarean section		0.002
Yes	2.5 (1.1–6.2)	
Prenatal consultation [n]		0.031
≤3	1.9 (1.1–5.3)	

† - Pearson's chi-squared test.

Such a high observed MMR can be partly explained by the fact that Ignace Deen National Hospital is a tertiary hospital providing healthcare services on referral from all national public and private maternity wards. Previously, the mortality of women transferred from other hospitals in the same service was evaluated at 5.5 % [16]. These results are consistent with other studies that found the risk of death during childbirth among transferred patients 13–25 times higher than in the case of self-referred patients [6,17].

More than half of maternal deaths (seven out of ten) registered in the Ignace Deen National Hospital maternity ward appeared after childbirth. Consistent with the literature [5,7,18–20], they were primarily due to direct obstetric causes such as hemorrhage, severe preeclampsia / eclampsia, and puerperal infections. The observed pattern of mortality causes reflects the one reported in Senegal and Mali, where postpartum hemorrhages were responsible for one in three maternal deaths [21].

A further result of this study indicates that misoprostol-induced labors were associated with a four-fold higher risk of maternal death. In 2011, similar results were reported by Baldé et al. [16], based on the data from the same department. These findings are likely to be related to the fact that when the right dose of misoprostol used for cervical maturation (25 μg) is unavailable, a quarter or a half of a 200 μg dose is used, i.e., 50 or 100 μg of misoprostol, respectively. Such inadequately large doses can cause hyperkinesia, uterine rupture, and postpartum uterine atony following its overdistension.

In accordance with the previous literature [9], the increased risk of maternal death was associated with the history of cesarean section. Such findings are likely to be related to a higher incidence of placenta praevia, placenta accreta, and uterine rupture, which can lead to potentially fatal hemorrhages [9,22]. In contrary, findings were presented by Zongo et al. [23], who reported higher mortality in the case of vaginal delivery and Kaboré et al. [24], who found no association between mode of delivery and maternal mortality.

Furthermore, this study confirms that women without partogram monitoring are at higher risk of intra- and postpartum death. Similar findings were reported by Diallo et al., who suggested that

absence of partogram monitoring during childbirth prevented early identification of any potentially fatal anomalies [25]. The evidence of both studies suggests that internal supervision should be reinforced in order to improve partogram monitoring in this service.

Finally, prolonged labor (≥24 h) was also associated with an increased risk of maternal death. A similar observation was made by Huchon et al., who found the risk of maternal death three-fold higher in case of prolonged labor [26].

Implications for the field of study

The current study found that most of the recorded fatal cases were preventable if equitable access to obstetrical services was provided. Particularly postpartum hemorrhage, the leading cause of maternal death, remains the most preventable cause [27]. Full access to reproductive, maternal, and newborn services should be ensured to end preventable maternal mortality [28].

Another important finding is that while the use of misoprostol for the prevention or treatment of postpartum hemorrhage decreases the risk of maternal mortality, its use for the induction of childbirth must be carried out with great precautions and dose reduction has to be implemented.

The findings of this study have many important implications for future educational campaigns for healthcare providers in Guinea. Ensuring appropriate educational support for employees of obstetrical services should be a priority for the Guinean National Directorate of Reproductive Health. Further research needs to be conducted to determine priorities of professional training provided by the Guinean Society of Gynecology-Obstetrics and the Association of Midwives of Guinea.

Limitations of the study

Being limited to the referral hospital setting, this study lacks information on women who gave birth at home or other healthcare facilities. Hence, the described risk indicators of maternal mortality may not be population-representative. The presented results were meant to be beneficial for healthcare providers and policymakers aiming at the reduction of hospital-based maternal mortality in Western Sub-Saharan Africa.

Conclusions

To end preventable maternal mortality in Sub-Saharan Africa, greater efforts should focus on promoting widespread use of perinatal monitoring, reorganization of the obstetric reference system, and decrease of avoidable cesarean sections. Moreover, continued efforts are needed to provide access to reproductive services and antenatal consultations. Finally, there is a definite need for internal supervision of misoprostol doses used for labor induction.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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