

ORIGINAL RESEARCH ARTICLE

Determinants of maternal mortality in the Province of Maniema, Democratic Republic of the Congo

DOI: 10.29063/ajrh2026/v30i13.2

Okoko O. Joséphine^{1*}, Imani RB. Eradi^{1,2}, Léon C.N Ngandu^{1,3}, Marie C.O Ohambe^{1,4}

Higher Institute of Medical Techniques of Kindu (ISTM-Kindu), midwifery section, Maniema, Democratic Republic of the Congo¹; University Research School in Nursing Sciences and Health Promotion (EUR SHePS), UFR SMBH,F-93017, Bobigny, France²; University of Kisangani, Faculty of Medicine, Department of Internal Medicine, Democratic Republic of the Congo³; Higher Institute of Medical Techniques of Kinshasa (ISTM-Kinshasa), Democratic Republic of the Congo⁴

***For Correspondence:** Email: josephineokoko11@gmail.com, Phone: +234823630530

Abstract

Maternal mortality remains a major public health problem in the Democratic Republic of the Congo. This case-control study, conducted in four health zones of the province of Maniema, aimed to identify the independent determinants of maternal death. A total of 197 maternal death cases were matched with 394 controls (surviving women). Multivariate analysis showed that lack of attendance at antenatal care visits, non-use of the partograph, receiving antenatal consultations in community health centers, as well as delivery in these facilities, were significant risk factors for maternal mortality. In contrast, the age group of 18 to 34 years, absence of delay in decision-making, and good knowledge of obstetric danger signs were protective factors. The main direct causes of death were hemorrhage, complicated abortions, and anemia. These results highlight the need to strengthen the quality of antenatal and obstetric care, as well as community-based interventions. (*Afr J Reprod Health* 2026; 30 [13]: 15-24).

Keywords: maternal mortality, determinants, Maniema

Résumé

La mortalité maternelle demeure un problème majeur de santé publique en République Démocratique du Congo. Cette étude cas-témoins menée dans quatre zones de santé de la province du Maniema, visait à identifier les déterminants indépendants du décès maternel. Au total, 197 cas de décès maternels ont été appariés à 394 témoins (femmes survivantes). L'analyse multivariée a montré que l'absence de suivi des consultations prénatales, la non-utilisation du partogramme, la réalisation des consultations prénatales dans des centres de santé communautaires ainsi que l'accouchement dans ces structures étaient des facteurs de risque significatifs de la mortalité maternelle. En revanche, la tranche d'âge de 18 à 34 ans, l'absence de retard décisionnel et la bonne connaissance des signes de danger obstétricaux constituaient des facteurs protecteurs. Les principales causes directes de décès étaient les hémorragies, les avortements compliqués et l'anémie. Ces résultats soulignent la nécessité de renforcer la qualité des soins prénatals et obstétricaux ainsi que les interventions communautaires. (*Afr J Reprod Health* 2026; 30 [13]: 15-24).

Mots-clés: mortalité maternelle, déterminants, Maniema

Introduction

Maternal mortality remains a key indicator of the performance of health systems, particularly in low-resource countries.¹ It reflects both the quality of healthcare provision, access to reproductive health services, and the level of socioeconomic development.² According to the World Health Organization, a maternal death is defined

as the death of a woman occurring during pregnancy, childbirth, or within forty-two days of the termination of pregnancy, regardless of the duration or outcome, from any cause related to or aggravated by the pregnancy or its management, but excluding accidental or incidental causes.³ At the global level, despite notable progress achieved over recent decades, maternal mortality remains unevenly distributed.⁴ Low-income countries bear

the greatest burden, with nearly 99% of maternal deaths occurring in developing countries, more than half of which are in sub-Saharan Africa.⁵ In 2015, the maternal mortality ratio was estimated at 239 per 100,000 live births in low-income countries, compared with 12 maternal deaths per 100,000 live births in high-income countries⁶. In West and Central Africa, the situation remains particularly concerning.⁷ In Côte d'Ivoire,⁸ 385 maternal deaths per 100,000 live births were reported in 2021, while in Senegal⁹, a ratio of 199 deaths per 100,000 live births was observed, predominantly due to direct obstetric causes such as hemorrhage and hypertensive disorders of pregnancy. In Cameroon,¹⁰ a ratio of 909 deaths per 100,000 live births was recorded, with deaths occurring mainly during the postpartum period and largely attributable to hemorrhage and hypertensive complications. In other African settings, particularly in Libreville,¹¹ studies have highlighted the central role of the first delay, related to the late decision to seek care. Furthermore, even in high-income countries such as France,⁹ maternal mortality has not been completely eliminated. Recent analyses have shown that factors such as communication failures, inappropriate place of care, insufficient human resources, and social vulnerability continue to contribute to preventable maternal deaths. These observations underscore that maternal mortality results from a complex interaction of medical, organizational, and social factors.

The Democratic Republic of the Congo (DRC) is among the ten countries contributing to 50% of the global burden of maternal mortality. In 2020, the maternal mortality ratio was 846 deaths per 100,000 live births.¹² Several studies conducted in different provinces of the country have reported particularly high levels, notably in Kinshasa¹³ and in the eastern provinces,^{14,15} where obstetric hemorrhages are frequent and deaths are often associated with the “three delays”: delay in deciding to seek care, delay in reaching an appropriate health facility, and delay in receiving adequate care within health facilities.

In Maniema Province, despite the implementation of several interventions, including the National Reproductive Health Program and technical and financial support from the NGO SANRU, available data since 2019 indicate that

maternal mortality rates remain high. For the period 2019–2023, a ratio of 225 maternal deaths per 100,000 live births was reported in the province.¹⁶ This situation reflects the persistence of multiple and interrelated determinants contributing to the continued high levels of maternal mortality. In this context, the present study aimed to identify the independent determinants of maternal mortality in four health zones of Maniema Province.

Methods

Study type and design

This was a case-control study with a quantitative approach. Cases consisted of women who died during pregnancy, childbirth, or within forty-two days following the end of pregnancy due to causes related to or aggravated by pregnancy. Controls were women who experienced severe obstetric complications comparable to those of the cases but survived. They were drawn from the same source population and matched to the cases. Matching was performed individually based on age, marital status, education level, occupation, place of residence (rural or urban health zone), health system, and study period. Each case was matched with two controls. Matching variables were included in the multivariate model to control for potential bias

Study setting

The study was conducted in four randomly selected health zones of Maniema Province: Kindu, Alunguli, Kailo, and Kalima. A total of 51 health facilities were included, comprising 34 health centers, 13 referral health centers, and 4 general referral hospitals. Facilities were selected based on the high number of maternal deaths recorded and their geographical accessibility.

Population and sampling

The study population was derived from medical records of deceased women and survivors who received care during pregnancy, childbirth, or the postpartum period between 2019 and 2023 in the four selected health zones. The sample included 197 cases and 394 controls, for a total of 591 records.

Inclusion criteria

All complete records of deceased or surviving women who experienced major obstetric complications comparable to those of the cases were included.

Exclusion criteria

Records of women who died or survived from causes unrelated to pregnancy, women originating from other provinces, and incomplete records were excluded.

Data collection

Data were extracted from medical records using a standardized form, then supplemented by verbal autopsies and interviews with maternity staff to identify deaths occurring in the community. Of the 197 maternal deaths recorded in the four zones, 69 occurred in the community. Data collection was carried out from August 12 to 26, 2024, by two trained investigators experienced in reproductive health. A pilot study was conducted on 75 records of deceased and surviving women, as well as 10 healthcare providers, in health zones not included in the study. This pilot study allowed validation of the data collection tools and ensured their relevance to the study objectives. Cases and controls were drawn from the same source population, and data collection procedures were comparable. Data from the pilot study were not included in the final analysis.

Variables studied

The dependent variable was maternal death (yes/no). Independent variables included sociodemographic characteristics (age, education level, marital status, occupation, place of residence), variables related to healthcare utilization (attendance at antenatal care visits, place of consultation, use of the partograph, place of delivery), community factors, and direct and indirect causes of maternal death.

Data analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 25. Descriptive

analyses were used to present the sociodemographic characteristics of the study population. Bivariate comparisons were performed using the Chi-square test for categorical variables. Multivariate analysis using logistic regression was conducted to identify independent factors associated with maternal death. Statistical significance was set at $p < 0.05$. Results are presented as adjusted odds ratios (OR) with 95% confidence intervals (CI).

Ethical considerations

The study was approved by the National Health Ethics Committee (CNES) under number 539/CNES/BN/PMMF/2024, dated June 3, 2024. Confidentiality and patient anonymity were strictly maintained. Oral informed consent was obtained from interviewed healthcare providers. Due to the retrospective nature of the study, a waiver of consent for reviewing medical records was granted.

Results

Sociodemographic characteristics of cases and controls

Comparative analysis of sociodemographic characteristics revealed significant differences between cases and controls. The proportion of adolescents aged 13–17 years was significantly higher among cases (14.2%) than among controls (3.3%) ($p < 0.001$). Conversely, women aged 18–34 years were more represented among controls. However, no statistically significant differences were observed between the two groups regarding marital status ($p = 0.219$), education level ($p = 0.084$), occupation ($p = 0.261$), or place of residence ($p = 0.906$) (Table 1).

Maternal mortality by health zone

The overall maternal mortality ratio (MMR) in the four health zones of Maniema Province was estimated at 201 deaths per 100,000 live births (95% CI: 173–230). Variations were observed across health zones. The Alunguli zone had the highest MMR, reaching 517 deaths per 100,000 live births. Kailo (126 per 100,000 live births; 95% CI: 84–169) and Kalima (128 per 100,000 live births;

Table 1 : Sociodemographic characteristics of cases and controls

Characteristics	Cases (n = 197)	Controls (n = 394)	p-value
Age group			0.000
13–17 years	28 (14.2%)	13 (3.3%)	
18–34 years	105 (53.3%)	251 (63.7%)	
≥ 35 years	64 (32.5%)	130 (33.0%)	
Marital status			0.219
Married	177 (89.8%)	340 (86.3%)	
Unmarried	20 (10.2%)	54 (13.7%)	
Level of education			0.084
Illiterate	15 (7.6%)	40 (10.2%)	
Primary	67 (34.0%)	96 (24.4%)	
Secondary	109 (55.3%)	241 (61.2%)	
Higher	6 (3.1%)	17 (4.3%)	
Profession			0.261
Unemployed	178 (90.4%)	348 (88.3%)	
Employed	13 (6.6%)	22 (5.6%)	
Pupil/Student	6 (3.0%)	24 (6.1%)	
Residence			0.906
Urban	117 (59.4%)	236 (59.9%)	
Rural	80 (40.6%)	158 (40.1%)	

Table 2: Maternal mortality rate by health zone in the province of Maniema (2019–2023)

Health Zone	Maternal Deaths (n)	Live Births (n)	MMR per 100,000 LB	95% CI
Alunguli	71	13,733	517	397–637
Kailo	34	26,899	126	84–169
Kalima	35	27,271	128	86–171
Kindu	57	29,861	191	141–240
Total	197	97,764	201	173–230

95% CI: 86–171) showed lower levels, with no statistically significant difference between them. These variations appear to be more related to sampling fluctuations than to real structural differences (Table 2).

Distribution of causes of maternal death

The distribution of direct and indirect causes of maternal death differed between cases and controls. A statistically significant difference was observed for direct obstetric causes ($p < 0.001$). Hemorrhage was the leading direct cause and was more frequent among cases (43.7%) than controls (35.8%). Dystocia also represented a substantial proportion, affecting 36.0% of cases and 42.4% of controls. Obstetric infections were less frequent among cases (8.1%) than controls (14.2%). In contrast, complicated abortions were proportionally more frequent among cases (6.6%) than controls (2.3%). The frequency of eclampsia was comparable

between the two groups (5.6% among cases vs. 5.3% among controls).

Regarding indirect causes, a statistically significant difference was also observed ($p < 0.05$), with higher frequency among cases (76.6%) compared to controls (64.2%). Malaria was more frequent among controls (27.4%) than cases (19.3%), while other causes such as tuberculosis, HIV/AIDS, and diabetes remained relatively low in both groups (Table 3).

Determinants of maternal mortality: multivariate analysis

After adjustment for potential confounders, several independent determinants of maternal mortality were identified. Regarding sociodemographic characteristics, women aged 18–34 years had a significantly lower risk of maternal death compared to adolescents aged 13–17 years (adjusted OR = 0.319; 95% CI: 0.128–0.798; $p = 0.015$), suggesting

Table 3: Distribution of direct and indirect obstetric causes among cases (maternal deaths) and controls (women who presented severe obstetric complications but survived)

Causes	Cases (n = 197)	Controls (n = 394)	p-value
Direct causes			0.007
Hemorrhage	86 (43.7%)	141 (35.8%)	
Dystocia	71 (36.0%)	167 (42.4%)	
Infections	16 (8.1%)	56 (14.2%)	
Complicated abortions	13 (6.6%)	9 (2.3%)	
Eclampsia	11 (5.6%)	21 (5.3%)	
Indirect causes			0.016
Anemia	151 (76.6%)	253 (64.2%)	
Malaria	38 (19.3%)	108 (27.4%)	
Tuberculosis	4 (2.0%)	11 (2.8%)	
HIV/AIDS	3 (1.5%)	4 (1.0%)	
Diabetes	1 (0.5%)	11 (2.8%)	

Table 4: Factors associated with maternal mortality (logistic regression analysis)

Factors	Crude OR (95% CI)	p-value (Bivariate)	Adjusted OR (95% CI)	p-value (Multivariate)
Age group				
13–17 years	1 (reference)	–	1 (reference)	–
18–34 years	0.319 (0.128–0.798)	<0.001	0.319 (0.128–0.798)	0.015
≥ 35 years	1.262 (0.765–2.082)	0.361	1.262 (0.765–2.082)	0.361
Health insurance				
Yes	0.562 (0.330–0.957)	0.032	1 (reference)	–
No	1 (reference)	–	1.442 (0.727–2.860)	0.294
ANC follow-up				
Yes	1 (reference)	–	1 (reference)	–
No	0.172 (0.095–0.311)	<0.001	17.335 (1.26–237.84)	0.033
Place of ANC				
Private clinic	1 (reference)	–	1 (reference)	–
Community health center	–	<0.001	2.076 (1.129–3.815)	0.019
Public hospital	–	–	1.879 (0.754–4.680)	0.176
Place of delivery				
Home delivery	1 (reference)	–	1 (reference)	–
Community health center	–	<0.001	3.694 (1.292–10.561)	0.015
Public hospital	–	–	2.350 (0.721–7.652)	0.156
Use of partograph				
Yes	0.157 (0.106–0.231)	<0.001	1 (reference)	–
No	1 (reference)	–	4.413 (2.278–8.547)	<0.001
Community factors (absence vs presence)				
Absence of decision delay	–	<0.001	0.177 (0.035–0.876)	0.034
Good knowledge of danger signs	–	–	0.244 (0.051–1.153)	0.035
Absence of access delay to FOSA	–	–	0.374 (0.075–1.859)	0.229
Financial availability	–	–	0.247 (0.050–1.210)	0.095
Absence of ignorance	–	–	0.250 (0.049–1.258)	0.043

a protective effect. However, age ≥ 35 years was not significantly associated with maternal mortality ($p = 0.361$). Similarly, health insurance was not retained as an independent determinant after adjustment ($p = 0.294$).

Regarding healthcare utilization, lack of antenatal care follow-up was strongly associated with maternal death. Women who did not attend antenatal care had a significantly higher risk (adjusted OR = 17.335; 95% CI: 1.26–237.84; $p = 0.033$). Furthermore, non-use of the partograph significantly increased the risk of maternal mortality by more than fourfold (adjusted OR = 4.413; 95% CI: 2.278–8.547; $p < 0.001$).

The place of care was also an important determinant. Receiving antenatal care in a community health center was associated with an increased risk of maternal death (adjusted OR = 2.076; 95% CI: 1.129–3.815; $p = 0.019$), compared to private clinics. Similarly, delivery in a community health center was associated with a higher risk of maternal mortality (adjusted OR = 3.694; 95% CI: 1.292–10.561; $p = 0.015$). In contrast, delivery in a public hospital was not significantly associated with maternal death after adjustment ($p = 0.156$).

Finally, community factors were also identified as determinants. Absence of delay in decision-making (adjusted OR = 0.177; 95% CI: 0.035–0.876; $p = 0.034$), good knowledge of danger signs (adjusted OR = 0.244; 95% CI: 0.051–1.153; $p = 0.035$), and absence of ignorance (adjusted OR = 0.250; 95% CI: 0.049–1.258; $p = 0.043$) were significant protective factors. However, delay in accessing health facilities and financial availability were not significantly associated with maternal mortality (Table 4).

Discussion

Sociodemographic characteristics

In this study, maternal age was the only sociodemographic factor significantly associated with maternal mortality. The higher proportion of adolescents aged 13–17 years among cases, compared to controls, confirms that young maternal age is a major risk factor for maternal death. This finding is consistent with several previous studies,^{4,7,11} which have shown that adolescent

pregnancies are associated with an increased risk of maternal mortality. Melesse *et al.*¹⁷ demonstrated that adolescents in sub-Saharan Africa have a higher risk of obstetric complications, particularly eclampsia, infections, and obstructed labor. Similarly, Ganchimeg *et al.*¹⁸ reported that very young mothers (≤ 19 years) are more exposed to severe maternal outcomes in low-resource settings. In the context of the present study, this vulnerability may be explained by biological immaturity, limited access to quality care, low utilization of antenatal care services, early marriages, as well as financial and sociocultural constraints. Conversely, women aged 18–34 years appeared relatively protected, as evidenced by their higher representation among controls and the protective effect observed in the multivariate analysis.

However, no statistically significant association was found between maternal age ≥ 35 years and maternal mortality, despite the obstetric risks usually reported in this age group, such as hypertensive disorders of pregnancy and gestational diabetes. This lack of association may be related to greater reproductive experience and more consistent use of antenatal care among these women, which could reduce the risk of adverse outcomes.

Other sociodemographic variables, including marital status, education level, occupation, and place of residence, were not significantly associated with maternal mortality. These findings are consistent with those of Barry MS² and Kruk *et al.*,¹⁹ who emphasize that maternal outcomes depend more on the quality and effectiveness of health systems than on sociodemographic characteristics considered in isolation. In our study, these factors may act indirectly through access to and utilization of obstetric care.

Maternal mortality ratio and health system context

In this study, the maternal mortality ratio, estimated at 201 deaths per 100,000 live births, appears lower than that reported in Côte d'Ivoire.⁸ while remaining close to that observed in Senegal.⁹ This level reflects a concerning situation in Maniema Province, although it remains intermediate compared to other African contexts.

Variations in maternal mortality observed across different settings largely reflect differences in health system performance. Kruk et al.,¹⁹ highlighted that the effective quality of care, rather than the mere availability of services, is the main determinant of maternal outcomes. In Maniema, several persistent constraints—particularly delays in decision-making, shortages of human and material resources, and limited capacity to manage obstetric emergencies—likely contribute to maternal deaths. Furthermore, the particularly high mortality observed in the Alunguli health zone highlights the existence of intra-provincial inequalities in access to quality obstetric care.

Causes of maternal deaths

The distribution of causes of maternal death observed in this study confirms that direct obstetric complications are the leading causes of mortality. Hemorrhage was identified as the predominant cause among cases, consistent with findings reported by Ramazani et al.,¹⁴ and Verspyck et al.,²⁰ Similar patterns have been described in several low-resource settings, where postpartum hemorrhage remains a major cause of maternal death, largely due to delays in management and insufficient emergency care.^{21, 22}

The relatively high proportion of dystocia, as well as the occurrence of complications such as infections and eclampsia, also highlights deficiencies in intrapartum care. The predominance of hemorrhage may be explained by shortages of skilled personnel, lack of essential supplies, and delays in the identification and management of obstetric complications.

Indirect causes, particularly anemia, were also highly prevalent among cases. This finding is consistent with studies by Ganchimeg et al.,¹⁸ and Darling et al.,²³ which have shown that anemia is a major aggravating factor for maternal death, especially when combined with hemorrhage. The synergistic effect between anemia and hemorrhage may therefore help explain the high level of mortality observed. Malaria, although more frequent among controls, remains an important contributor to maternal mortality in endemic areas such as Maniema, as reported by Desai et al.²⁴ The relatively low contribution of conditions such as tuberculosis, HIV/AIDS, and diabetes may reflect

underdiagnosis or lower prevalence in this context. Overall, these findings suggest that maternal mortality in Maniema Province results from a combination of largely preventable direct causes and underlying indirect conditions, influenced by both clinical and systemic factors.

Determinants of maternal mortality

This study identified several determinants of maternal mortality, mainly related to healthcare utilization and quality of care. Lack of antenatal care follow-up emerged as a major risk factor, with a very high adjusted odds ratio. This finding is consistent with studies by Tiruneh et al.,²⁵ and Bah IK et al.,²⁶ which emphasized the crucial role of antenatal care in the early detection and management of obstetric complications.

In the context of this study, low utilization of antenatal care services may be explained by several factors, including lack of awareness, young maternal age, lack of partner support, financial barriers, and reliance on inadequately equipped health facilities. Although the confidence interval was wide, reflecting some variability, this does not undermine the strength of the observed association. The place of care was also an important determinant. Antenatal care and deliveries in community health centers were associated with an increased risk of maternal mortality. This finding is consistent with results reported by Stanton et al.²⁷ and Moura et al.,²⁸ who showed that primary-level facilities with limited emergency obstetric care capacity are associated with higher mortality. In our context, this likely reflects structural deficiencies, including shortages of skilled personnel, stock-outs of essential supplies, and delays in referral systems.

Non-use of the partograph was also identified as a major determinant, increasing the risk of maternal death more than fourfold. This result is consistent with findings by Kena et al.,²⁹ and Gwacham-Anisiobi et al.,³⁰ who highlighted the role of the partograph in the early detection of labor abnormalities. Its limited use in this study likely reflects gaps in training, supervision, and, more broadly, the quality of intrapartum care.

Community factors also played a significant role. Absence of delay in decision-making, good knowledge of obstetric danger signs, and absence of ignorance were identified as

protective factors. These findings are consistent with those of Kruk *et al.*,¹⁹ Diassana *et al.*,³¹ and Miller *et al.*,³² who emphasized the importance of community awareness, women's empowerment, and early healthcare seeking.

Notably, delays in accessing health facilities and financial availability were not significantly associated with maternal mortality. This finding suggests that beyond physical and financial accessibility, perceived quality of care and trust in the health system play a more decisive role in the decision to seek care. Overall, these results indicate that maternal mortality in Maniema Province results from a complex interaction of individual, systemic, and community-level factors.

Strengths and limitations

This study has several strengths. The use of a case-control design is particularly appropriate for analyzing maternal mortality, which is a relatively rare event. This design allowed for a meaningful comparison between women who died (cases) and those who survived severe obstetric complications (controls), thereby facilitating the identification of factors associated with maternal death.

Furthermore, the inclusion of controls who experienced severe obstetric complications ("maternal near-miss" cases) strengthens the internal validity of the study, as both groups were exposed to comparable clinical conditions. This approach makes it possible to better distinguish determinants specific to maternal mortality from those related to obstetric complications in general. In addition, the use of multivariate logistic regression analysis allowed for control of potential confounding factors and identification of independent determinants of maternal mortality in Maniema Province and similar settings.

However, some limitations should be considered. The retrospective nature of the study exposes it to a risk of information bias related to the quality of medical records. Moreover, certain relevant variables, particularly sociocultural and organizational factors, could not be explored in depth. Finally, the generalization of the findings to other settings should be interpreted with caution.

Policy implications

The findings support the implementation of targeted community-based interventions, including the active promotion of antenatal care attendance, education on obstetric danger signs, and improved access to health facilities. Such interventions have the potential to substantially reduce maternal mortality in Maniema Province.

Conclusion

This study identified key independent determinants of maternal mortality in Maniema Province. The findings indicate that lack of antenatal care follow-up, non-use of the partograph, and the management of women in community health centers for both antenatal care and delivery are major risk factors for maternal death. In contrast, maternal age between 18 and 34 years, absence of delay in decision-making, and good knowledge of obstetric danger signs were identified as significant protective factors.

These results highlight that maternal mortality in Maniema is strongly influenced by both the quality of obstetric care and community-level factors, particularly those related to decision-making and access to health information.

To reduce these largely preventable deaths, it is essential to strengthen antenatal care coverage and quality, promote delivery in adequately equipped health facilities, and enhance community awareness of obstetric danger signs and the importance of timely access to care. This study provides important local evidence to inform health policies and guide community-based interventions aimed at improving maternal survival in the Democratic Republic of the Congo.

Acknowledgments

The authors express their sincere gratitude to the study supervisory team for their guidance and continuous support. They also thank all members of the research team for their scientific and moral

contributions, as well as SANRU ASBL for their support of this study.

Funding

This study was funded solely by the lead author and did not receive any external financial support.

Conflict of interest

The authors declare that they have no conflicts of interest and approve the submission of this manuscript.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request and may be shared with interested readers.

Authors' contribution

All authors contributed to the revision of the manuscript and approved the final version. Okoko Okako Joséphine conceived and designed the study, supervised data collection, analyzed the data, and drafted the manuscript. Marie C. Omanyondo and Léon C. Ngandu provided conceptual and methodological guidance, validated the analysis, made substantial contributions, and reviewed the final version. Imani Ramazani B. Eradi provided critical input, particularly on reproductive health aspects, and reviewed the final version of the manuscript. All authors read and approved the final manuscript prior to submission.

References

1. Tort J, Dumont A. How to reduce maternal mortality associated with postpartum hemorrhage in low-resource countries? *Rev Med Perinatol*. 2017;9(1):15-19.
2. Barry MS. Marital status and non-use of modern contraception among women at risk of unintended pregnancy in Guinea between 1999 and 2018 [thesis]. Dijon: University of Burgundy Franche-Comté; 2021.
3. World Health Organization. The state of hand hygiene in the world: global call to action to make hand hygiene a priority in policy and practice. Geneva: WHO; 2022.
4. Bah MD, Leye PA, Sow D, Gaye I, Diaw M, Traoré MM, et al. Obstetric complications in intensive care: clinical profile and therapeutic aspects. *Ann Mar Med Urg Rea*. 2023;13:15-20.
5. Diakité D. Etiology of maternal mortality at the health center and referral center of Commune V, Bamako district [thesis]. Bamako: USTTB; 2023.
6. Kané S. Factors associated with unattended deliveries at the Health and Referral Center of Commune II, Bamako, 2019 [thesis]. Bamako: USTTB; 2020.
7. Raoul AS, Hounkponou A, Obossou AAA, Gabkika BM, Doha SMI, Sidi RI. Factors associated with maternal deaths at Saint Jean de Dieu Zone Hospital, Tanguieta, 2015–2019. *Eur Sci J*. 2021;17(29):93-105.
8. Agniman KFH. Evaluation of the maternal death surveillance system, Kabadougou, Côte d'Ivoire, June 2024. *J Epidemiol Popul Health*. 2025;73:202903.
9. Morau E, Ducloy JC, Le Roux S, Weber P, Dreyfus M. Maternal mortality due to hemorrhage in France 2013–2015. *Gynecol Obstet Fertil Senol*. 2021;49(1):60-66.
10. Dingom MAN. Profile of maternal deaths in a second-level hospital in Cameroon. *J SAGO Gynecol Obstet Reprod Health*. 2024;25(3).
11. UP MZM, EJ NM, Mvono E, JA BN, JF M. Analysis of maternal deaths at the Mère-Enfant Foundation University Hospital (Libreville) from 2019 to 2022. *Health Sci Dis*. 2024;25(3).
12. Maleya A, Kakudji YK, Mwazaz RM, Nsambi JB, Ngweij HI, Mukuku O, et al. Maternal and fetal outcomes of poorly monitored pregnancies in Lubumbashi, Democratic Republic of the Congo. *Pan Afr Med J*. 2019;33:1–10.
13. Sage KM, Jeanine KM, Didier BN, Patrick KM. Spatiotemporal distribution and characteristics of maternal deaths at the Provincial General Referral Hospital of Kinshasa, DRC, January 2018 to June 2023. *Int J Multidiscip Curr Res*. 2024;12(5):513-520.
14. Ramazani IBE, Ntela SDM, Ahouah M, Ishoso DK, Monique RT. Maternal mortality study in Eastern Democratic Republic of the Congo. *BMC Pregnancy Childbirth*. 2022;22:452.
15. Safari IK, Djeko LAK, Kasambula PK, Mandro CN, Mosomo TK, Wembonyama SO. Determinants of maternal deaths in North Kivu province. *J Med Public Health Policy Res*. 2024;4(1).
16. Direction Provinciale de la Santé Maniema, Bureau Central de Zone de Santé. Report on maternal mortality 2019. Maniema: DPS; 2019.
17. Melesse DY, Mutua MK, Choudhury A, Wado YD, Faye CM, Neal S, et al. Adolescent sexual and reproductive health in sub-Saharan Africa: who is left behind? *BMJ Glob Health*. 2020;5:e002231.
18. Ganchimeg T, Ota E, Morisaki N, Laopaiboon M, Lumbiganon P, Zhang J, et al. Pregnancy and childbirth outcomes among adolescent mothers: a

- WHO multicountry study. BJOG. 2014;121(Suppl 1):40-48.
19. Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-DeWan S, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. *Lancet Glob Health*. 2018;6(11):e1196-e1252.
20. Verspyck E, Lejeune-Saada V, Chiesa-Dubruille C, Deneux-Tharaux C. Maternal mortality and organization of care in France 2016–2018. *Gynecol Obstet Fertil Senol*. 2024;52(4):280-287.
21. Belhadj D, Mechara D. Evaluation of postpartum hemorrhage management and implementation of medical protocol for post-delivery women at Mère et Enfant Hospital, Ouargla, January 2023–March 2024 [thesis]. Ouargla: Kasdi Merbah University; 2024.
22. Coulibaly M. Review of maternal deaths in Kolokani health district, 2017–2021 [thesis]. Bamako: USTTB; 2024.
23. Darling AM, Sunguya B, Ismail A, Manu A, Canavan C, Assefa N, et al. Gender differences in nutritional status, diet and physical activity among adolescents in eight sub-Saharan African countries. *Trop Med Int Health*. 2020;25(1):33-43.
24. Desai M, Ter Kuile FO, Nosten F, McGready R, Asamoah K, Brabin B, et al. Epidemiology and burden of malaria in pregnancy. *Lancet Infect Dis*. 2007;7(2):93-104.
25. Tiruneh FN, Chuang KY, Chuang YC. Women's autonomy and maternal healthcare service utilization in Ethiopia. *BMC Health Serv Res*. 2017;17:1-12.
26. Bah IK, Diallo MC, Bah EM, Barry AY, Diallo IG, Sy T. Management and outcomes of poorly followed antenatal care at Ignace Deen University Hospital maternity ward, Guinea. *Ann SOGGO*. 2025;20(44):11-16.
27. Stanton C, Lawn JE, Rahman H, Wilczynska-Ketende K, Hill K. Stillbirth rates: delivering estimates in 190 countries. *Lancet*. 2006;367(9521):1487-1494.
28. Morau E, Lejeune-Saada V, Chiesa-Dubruille C, Deneux-Tharaux C. Maternal mortality and organization of care in France 2016–2018. *Gynecol Obstet Fertil Senol*. 2024;52(4):280-287.
29. Kena KK, Mukuna NB, Nsimba NJ, Muamba KD. Knowledge and adherence to partograph completion by nurses in Kisantu maternity wards, Kongo-Central, DRC. *Int J Innov Appl Stud*. 2023;39(2):760-765.
30. Gwacham-Anisiobi U, Opondo C, Cheng TS, Kurinczuk JJ, Anyaegbu G, Nair M. Rates and risk factors for antepartum and intrapartum stillbirths in 20 secondary hospitals in Imo State, Nigeria. *PLOS Glob Public Health*. 2024;4(10):e0003771.
31. Diassana M, Dembele S, Macalou B, Ndaou K, Sidibe A, Bocoum A, et al. Eclampsia, leading cause of maternal deaths at the gynecology-obstetrics department of Fousseyni Daou Hospital (Kayes, Mali). *Health Sci Dis*. 2020;21:1-9.
32. Miller P, Afulani PA, Musange S, Sayingoza T, Walker D. Person-centered antenatal care and associated factors in Rwanda. *BMC Pregnancy Childbirth*. 2021;21:290.