International Journal of Reproduction, Contraception, Obstetrics and Gynecology
Vodouhe TYS et al. Int J Reprod Contracept Obstet Gynecol. 2025 May;14(5):1425-1431
www.ijrcog.org
pISSN 2320-1770 | eISSN 2320-1789

DOI: https://dx.doi.org/10.18203/2320-1770.ijrcog20251220

Original Research Article

Determinants of in-hospital maternal mortality in the Atlantique department of Benin Republic from 2019 to 2022

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Received: 19 March 2025
Accepted: 09 April 2025

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ABSTRACT

Background: The decline of the maternal mortality ratio (MMR) in Benin is too slow to achieve the third sustainable development goal by 2030. The aim of the study was to identify the determinants of in-hospital maternal mortality in the Atlantique department of Benin Republic from 2019 to 2022.
Methods: The study was conducted in two district hospitals in the Atlantique department. It was a retrospective case-control study from 2019 to 2022. Cases included all in-hospital maternal deaths, while controls were survivors of obstetric complications. A multivariate analysis was performed with a significance threshold of 0.05.
Results: We identified 92 cases of maternal deaths and 276 controls. The maternal mortality ratio was 386 maternal deaths per 100,000 live births. The mean age of the cases was 28.67±6.54 years, while that of the controls was 26.46±6.60 years. Prenatal care was poorly followed (88.04% versus 79.71%), and most patients were referred (77.20% versus 76.10%). Several factors were associated with maternal death, including: presence of medical history (p=0.030), presence of pregnancy-related pathology (p=0.049), questionable treatment (p<0.001), inadequate monitoring (p<0.001), occurrence of maternal complications (p<0.001), indication for blood transfusion (p<0.001), in-hospital delay in providing emergency obstetric care (p<0.001).
Conclusions: Identifying the main determinants of in-hospital maternal death will help to target appropriate high-impact interventions and optimize their implementation in order to accelerate the reduction of maternal mortality.

Keywords: Maternal mortality ratio, Determinant, In-hospital maternal death, Atlantique department

INTRODUCTION

In 2020, 287,000 maternal deaths were recorded worldwide, approximately 800 deaths per day and one maternal death every two minutes. Nearly 99% of these deaths occurred in developing countries.[1] According to the fifth Demographic and Health Survey 2017-2018, the maternal mortality ratio in Benin in 2017 was 391 maternal deaths per 100,000 live births (LB).[2] In the Atlantique department, it was 157.7 deaths per 100,000 LB in 2021, according to the national health statistics yearbook of Benin.[3] The magnitude of this phenomenon highlights the

gaping and concerning disparity in sexual and reproductive health between low- and middle-income countries and developed countries. Yet, the majority of these deaths are preventable through the timely and strategic implementation of high-impact interventions.[4,5] However, the decline in the maternal mortality ratio (MMR) still seems too slow to achieve Target 1 of Sustainable Development Goal 3 (SDG3).[6] Understanding the factors that contribute to maternal deaths is essential to optimize the implementation of high-impact interventions to eliminate preventable maternal deaths. This study was therefore conducted with the aim of identifying the determinants of in-hospital maternal deaths in the Atlantique department of Benin from 2019 to 2022.

METHODS

The study was conducted in two of the four district hospitals in the Atlantique department: the Abomey-Calavi/Sô-Ava University Hospital Center (CHUZ-AS) and the Allada-Toffo-Zè Health Zone Hospital (HZ Allada). It was a retrospective case-control study covering the period from 01 January 2019 to 31 December 2022 (4 years). The cases were maternal deaths, as defined by the WHO that occurred in the hospital at least 30 min after admission during the study period. The controls were pregnant women and women who gave birth within the first 42 days postpartum, who were treated for an obstetric complication and survived. The minimum sample size (N) was calculated using the OpenEpi online software. A case-control ratio of 3.1 was chosen. In the study « Factors associated with maternal deaths in hospitals in Cotonou, Benin conducted by Agballa et al over the period 2020-2021, the reference factor was associated with maternal death ($p<0.001$).[7] The proportion of cases exposed (referred) was 34.85%, and the proportion of controls exposed (referred) was 54.55%. The minimum odds ratio (OR) to detect was 2. With a significance level $\alpha= 0.05$, a 95% confidence level (bilateral), and a power of 80%, we obtained a minimum sample size N=355, including 89 cases and 266 controls. We performed an exhaustive recruitment of cases meeting the selection criteria, and for each case, three controls were selected: two admitted immediately before the case of death and one admitted immediately after the death, according to the order of registration in the admission register. This process resulted in a sample size of 368, consisting of 92 cases and 276 controls. The dependent variable was maternal death, while the independent variables were related to the sociodemographic, clinical, therapeutic, and developmental characteristics of the patients. Data analysis was conducted using R 4.3.2 software. In the descriptive analysis, we calculated the mean and its standard deviation, or the median and interquartile range for quantitative variables, depending on the distribution. For qualitative variables, we calculated proportions. We then explored the association between maternal death and the explanatory variables using a bivariate analysis with appropriate statistical tests, with a retention threshold of 0.2, followed by a multivariate analysis in which a stepwise logistic regression was performed. The strength of the association was assessed using the adjusted Odds ratio (AOR) and its 95% confidence interval (CI 95%), with a significance level of 5% (p value<0.05). The validity of the final model was evaluated using the Hosmer-Lemeshow test.

RESULTS

Maternal mortality ratio (MMR) and maternal mortality rate (MMR)

The in-hospital maternal mortality ratio (MMR) was 617 deaths per 100,000 live births (LB) at the HZ-A, 284 deaths per 100,000 LB at the CHUZ-AS, and 386 deaths per 100,000 LB for both hospitals combined. Regarding the in-hospital maternal mortality rate from 2019 to 2022, it was 0.38% for the two hospitals combined. From a trend perspective, the MMR varied significantly over time at the HZ-A, with a peak in 2020. At the CHUZ-AS, it showed a slight increase with a peak in 2021. Overall, the MMR remained relatively stable at the departmental level, with a slight peak in 2022. The annual MMR evolution is presented in Figure 1.

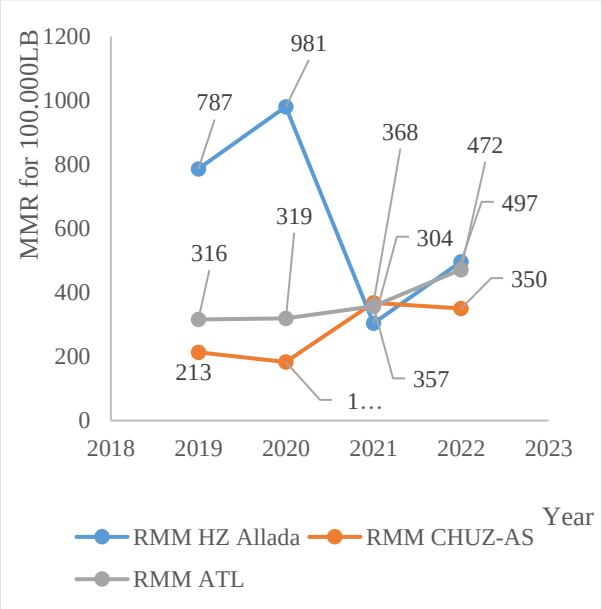

Figure 1: Evolution of the in-hospital MMR from 2019 to 2022 in the Atlantique department.

Note: RMM/MMR: Maternal mortality ratio; HZ Allada: Allada-Toffo-Zè Health Zone Hospital; CHUZ-AS: Abomey-Calavi/Sô-Ava University Hospital Center; ATL: Atlantique department.

Sociodemographic profile of deceased women

Age

The average age was 28.67±6.54 years, with extreme ages ranging from 16 to 44 years. The predominant age group was 20 to 34 years (71.74%), followed by those aged 35 and above (15.22%), and 14 to 19 years (9.78%).

Place of residence, distance from residence to hospital, occupation

The majority of women resided in peri-urban areas (59.80%), located more than 5km away from the hospital (84.78%). Most women were manual workers and artisans (32.61%), followed by merchants (26.28%).

Personal medical history of deceased women

No medical or surgical history was found for the majority of cases (88%). The average gestity (number of pregnancies) was 3.6±2.4, with extreme values ranging from 1 to 10, and the majority were multigestes (multiple pregnancies). The average parity (number of births) was 2.3±2.1, with extreme values ranging from 0 to 9, and the majority were multipares (multiple births) (46.70%).

The personal medical history is summarized in Table 1.

Table 1: Distribution of deceased women based on personal medical history in the Atlantique department, Benin, 2019-2022.

Parameters	N	%
Medical history	92	100
No medical history	81	88
Hypertension	1	1.10
Sickle cell disease	7	7.60
Unspecified	3	3.30
Surgical history	92	100
No surgical history	81	88
Cesarean section	11	12
Gestity	92	
Primigravida	24	26.09
Multigravida[1]	45	48.91
Grande multigravida[2]	23	25
Parity	92	100
Nullipara	25	27.20
Primipara	17	18.50
Multipara[3]	43	46.70
Grande multipara[4]	7	7.60

Note: Multigravida[1]: 2 to 5 pregnancies; Grand multigravida[2]: At least 6 pregnancies; Multipara[3]: 2 to 5 previous deliveries; Grand multipara[4]: At least 6 previous deliveries.

Pregnancy monitoring

It was assessed based on the number of antenatal care (ANC) visits completed for the term of pregnancy and the qualification of the healthcare provider conducting them. Thus, 12% of women had a normal number of ANC visits for the term of pregnancy, and 45.60% of these visits were conducted by a qualified healthcare provider (doctor, midwife, or maternity nurse). Pregnancy monitoring was of poor quality in 88.04% of deceased women.

Clinical characteristics at admission

The primary mode of admission was referral (77.20%). A referral was considered of good quality when pre-referral care was adequate and transportation was medicalized (9.90%), and of poor quality when at least one of these conditions was not met (90.10%).

Adequate pre-referral care was provided in only 9.90% of cases, and medicalized transport was used in 19.70% of referred patients. The main means of transport were motorcycles (38%), followed by personal cars or taxis (33.80%).

The diagnosis was correct in most cases (94.67%). The main diagnoses at admission were hypertensive disorders of pregnancy, as shown in Table 2.

Table 2: Distribution of in-hospital maternal deaths based on main admission diagnoses in the Atlantique department of Benin (2019-2022).

Diagnosis	N	%
Anemia during pregnancy or afterbirth	92	100
Complications of induced abortion	81	88
Complications of spontaneous abortion	1	1.10
Hypertension/preeclampsia/eclampsia	7	7.60
Labor with complications	3	3.30
First-trimester metrorrhagia[1]	92	100
Second and third-trimester metrorrhagia[2]	81	88
IPPH[3]	11	12
PROM[4] /PL[5]	92	
Ovular infection	24	26.09
Other	45	48.91

Note: First-trimester metrorrhagia[1]: Spontaneous abortion and ectopic pregnancy; Second and third-trimesters metrorrhagia[2]: Retroplacental hematoma, placenta previa, uterine rupture; IPPH[3]: Immediate postpartum hemorrhage; PROM[4]: Premature rupture of membranes; PL5: Preterm labor.

Causes of maternal deaths

Immediate postpartum hemorrhage (IPPH) was the leading cause of maternal death (29.35%), followed by severe preeclampsia and its complications (20.65%), third-trimester pregnancy hemorrhages (16.30%), and severe anemia (13.04%). Obstetric hemorrhages accounted for 63.04% of the causes of death (n=58/92).

Factors associated with in-hospital maternal death

Several factors were associated with in-hospital maternal death: The presence of medical history [p=0.030; AOR=6.55; 95% CI (1.26-39.65)], Presence of pathology during pregnancy (p=0.049; AOR=2.80; 95% CI [1.03-8.13)], Questionable treatment upon admission [p<0.001;

AOR= 18.04; 95% CI [3.93-92.99)], inadequate monitoring (p < 0.001; AOR=35.33; 95% CI [7.49-193]), Occurrence of maternal complications in the hospital (p<0.001; AOR=28.45; 95% CI [10.63-89.56]), Indication for blood transfusion [p<0.001; AOR=6.30; 95% CI (2.37-18.20)], The existence of the "third delay" or in-hospital delay in providing emergency obstetric care [p<0.001; ORA=13.69; 95% CI (5.05-41.88)] as shown in Table 3.

Table 3: Factors associated with maternal deaths based on main admission diagnoses in the Atlantique department of Benin (2019-2022).

Factors	AOR[1]	95% CI[2] ORA	P value
Medical history			0.025
No	1.00	-	
Yes	6.55	1.26-39.7	
Correct diagnosis at admission			0.093
Yes	1.00	-	
No	0.24	0.04-1.26	
Quality of treatment			<0.001
Adequate	1.00	-	
Questionnable	18.0	3.94-93.0	
Inadequate	2.11	0.58-8.01	
Quality of monitoring			<0.001
Adequate	1.00	-	
Questionnable	27.8	7.05-131	
Inadequate	35.3	7.49-193	
Occurrence of maternal complications			<0.001
No	1.00	-	
Yes	28.5	10.6-89.6	
Indication for blood transfusion			<0.001
No	1.00	-	
Yes	6.30	2.37-18.2	
Third delay			<0.001
No	1.00	-	
Yes	13.7	5.05-41.9	
Pathologies during pregnancy			0.044
No	1.00	-	
Yes	2.80	1.03-8.13	

Note: AOR[1]=Adjusted Odds ratio, CI[2]=Confidence interval.

DISCUSSION

Maternal mortality ratio and rate

The in-hospital maternal mortality ratio in the Atlantique department from 2019 to 2022 was 386 deaths per 100,000 LB, with a death rate of 0.38%. In Benin, the MMR was 410 deaths per 100,000 LB in 2011, compared to 391 deaths per 100,000 LB in 2018.[2,3] Several authors have reported higher in-hospital MMRs. For example, it was 905 deaths per 100,000 LB from 2015 to 2019 at CHU-MEL in Cotonou, 408.4 deaths per 100,000 LB at Mènontin Hospital from 2007 to 2011, and 1,173 deaths per 100,000 LB at Saint Jean de Dieu Hospital in Tanguiéta from 2015 to 2019, according to Aboubakar and al., Adadé and al., and Tshabu-Aguèmon and al.[8-10] At the regional level, the MMR was 2,512 deaths per 100,000 LB in Maradi, Niger Republic, 1,359 deaths per 100,000 LB in Nigeria (Ezegwui et al, 2013), 5,369 deaths per 100,000 LB in Burkina Faso (Zamané and al, 2018), and 2,906 deaths per 100,000 LB in teaching hospitals in Abidjan (Yopougon, Cocody, and Treichville) from 2004 to 2013. Lower MMRs have been reported in Saint Louis, Senegal (199 deaths per 100,000 LB) and in six health zones in eastern Democratic Republic of the Congo where it was 106.9 per 100,000 LB).[11-16]

Sociodemographic aspects

The deceased women in our study had an average age of 28.67±6.54 years. They were mainly workers and artisans (32.61%) and lived more than 5 km from the hospital (59.80%). In Agballa and al.'s study in Cotonou, the average age of deceased women was 30.27±6.49 years, most of them came from an urban area (82.20%) and were traders (37.88%).[7] At the Lagoon Mother and Child University Hospital Center (CHU-MEL) in Cotonou, Aboubakar and al. found an average age of 29.09±7.04 years, while Atadé and al reported a predominance of the 15 to 24 age group (53.1%), with housewives (72.1%) being the most affected. In Niger, Alkassoum and al. recorded an average age of 26 years.[8,11] In France, however, according to the Confidential National Survey on Maternal Deaths (ENCMM), most deceased women were older (35–39 years). This is possibly due to the high frequency of late pregnancies in Western societies and the increased risk of pregnancy-related conditions such as hypertensive disorders.[8,17] Age (<20 years and >35 years), low socioeconomic status (poverty), low educational level, and residence in rural areas are key social determinants of maternal death in both developed and developing countries.[17,18]

Mode of admission

The majority of deceased women were referred cases (77.20%), and the quality of referrals was poor in 90.10% of cases. This is a common issue in developing countries, with the main shortcomings including inadequate pre-referral care, non-medical transport, and delayed referrals.[8,9,15,16] These problems are linked to a lack of skilled human resources, insufficient continuing professional development policies, a lack of ambulances, and the high cost of referrals, which create barriers to timely and quality referrals.

Determinants of maternal deaths

Multivariate analysis identified several independent predictors of maternal mortality in hospitals in the Atlantique department. In order of importance, these include: quality of monitoring, occurrence of maternal complications within the hospital, quality of treatment

upon admission (questionable treatment), third delay, medical history, need for blood transfusion, presence of pregnancy-related conditions.

Medical history

Pre-existing conditions such as sickle cell disease, hypertension, and diabetes pose significant risks for both mother and fetus, and managing these conditions remains a challenge for healthcare teams. Similar findings were reported by Atadé and al. in Tanguiéta from 2015 to 2019 (OR 5.58, 95% CI [2.17-14.30]) and Nair and al. in the UK in 2015 (AOR=4.82, 95% CI [3.14-7.40]). In the UK, medical conditions such as asthma, autoimmune diseases, inflammatory/atopic disorders, mental health issues, chronic hypertension, hematological disorders, musculoskeletal conditions, and infections increased the risk of maternal death by 49%.[10,19] High-risk pregnancies require multidisciplinary follow-up, coordinated care by an obstetrician, early risk identification, adapted monitoring plans, planned deliveries, and anticipation of maternal and perinatal complications.

Pregnancy-related conditions

The presence of medical conditions during pregnancy was associated with maternal death in our study. The main conditions included obstetric hemorrhages (occurring in the second and third trimesters of pregnancy), hypertensive disorders of pregnancy, and pregnancy-related anemia. A multi-country study conducted in six lower-middle-income countries (Democratic Republic of the Congo, Guatemala, India, Kenya, Pakistan, and Zambia) on risk factors and trends in maternal mortality from 2010 to 2018 identified severe antepartum hemorrhage (RR 2.59; 95% CI [1.83–3.66]) and hypertensive disorders [RR 6.87 (5.05-9.34)] as obstetric conditions associated with maternal deaths.[20] The significant role of hypertensive disorders of pregnancy was also highlighted in the United Kingdom [AOR=2.44, 95% CI (1.31-4.52)].[19]

The quality of treatment upon admission and the third delay

When diagnoses were not the issue, treatment deemed "questionable" contributed to maternal deaths. This included, on the one hand, treatments that were coherent but not in accordance with national protocols or current international recommendations for the conditions in question. On the other hand, some treatments were prescribed following established protocols but were not fully executed, often due to a lack of essential health products such as labile blood products. Similar findings have been reported by several authors. At CHU-MEL in Cotonou, Dénakpo and al. had already noted in 2008 that inappropriate or insufficient therapy was observed in 20% and 80% of deceased women, respectively.[21] In the same center, from 2014 to 2019, Aboubakar and al. found that appropriate but insufficient therapy was recorded in 55.63% of deceased women, far ahead of diagnostic errors (5.30%), therapeutic errors (5.30%), and inappropriate therapy (9.27%).[8] Tshabu Aguèmon and al. at Mènontin Hospital reported inadequate treatment in 25.83% and insufficient treatment in 20.93% of deceased women.[9] In hospitals in Eastern DRC, Jean-Bosco Kahindo Mbeva and al. noted inadequate treatment in 83.1% of cases.[16] Deficiencies in treatment are attributable to several factors, including a lack of technical equipment, a shortage of competent human resources, insufficient continuous training, and the unavailability of essential medicines and health products, particularly labile blood products. Additionally, the lack of operating room availability contributes to treatment inadequacies.[8,16] These same factors contribute to the third delay, along with the internal organization of services and emergency care procedures. Delays in administering Emergency Obstetric Care (EOC) directly impact the quality of care provided and maternal survival.

Indication for blood transfusion

Among deceased women, the need for a blood transfusion was 6.30 times higher than among the control group. However, blood transfusion coverage was limited. Among the 58.70% of deceased women for whom a transfusion was indicated, only 33.30% actually received one. The primary reasons for failing to administer the transfusion were the unavailability of labile blood products (38.90%) and financial constraints (30.60%). Similar situations are described in the literature.[8,9] Hemorrhagic obstetric complications and anemia, which are particularly frequent, create a continuously growing demand for labile blood products, whose overall availability remains insufficient. Reducing maternal mortality linked to this factor requires interventions aimed at significantly reducing transfusion needs, improving the availability of labile blood products, and ensuring their rational use in hospitals.

Occurrence of maternal complications and quality of monitoring

The occurrence of maternal complications within the hospital increases the risk of death. This risk is even higher when the diagnosis is incorrect or delayed, and the treatment is inadequate or postponed. Therefore, the quality of patient monitoring is crucial during hospitalization. In our study, complications were diagnosed early and treated adequately. However, shortages of healthcare personnel, under-equipped facilities, and financial constraints preventing patients from undergoing necessary diagnostic tests may explain the inadequate monitoring of patients in hospitals in the Atlantique department, where the competence of healthcare providers is not the primary issue. Inadequate monitoring was observed by Aboubakar at CHU-MEL in Cotonou (38.41%) and by Tshabu-Aguèmon (21%) at Mènontin Hospital. Additionally, Agballa identified the occurrence of non-infectious maternal complications as a risk factor for maternal death in Cotonou.[7-9] In contrast, in

France and the United Kingdom, the quality of patient monitoring is not reported as a factor associated with maternal mortality, suggesting better performance of Western healthcare systems.[17,19]

CONCLUSION

The in-hospital maternal mortality ratio is high in the Atlantique department of Benin. Maternal death was predicted by both in-hospital and out-of-hospital factors. Accelerating the reduction of maternal mortality will require interventions aimed at improving the holistic quality of patient care, particularly by targeting these identified factors.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Vodouhe TYS, Aboubakar M, Ogoudjobi M, Dangbemey P, Vodouhe M, Aguemon CT, et al. Determinants of in-hospital maternal mortality in the Atlantique department of Benin Republic from 2019 to 2022. Int J Reprod Contracept Obstet Gynecol 2025;14:1425-31.