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Hospitalizations for Postpartum Hemorrhage and Maternal Mortality: A Time-Series Study in Espírito Santo, Brazil, From 2010 to 2024

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Abstract

Background

This study aimed to analyze the temporal trend in Sistema Único de Saúde (SUS)-funded hospitalizations with International Classification of Diseases, 10th Revision (ICD-10) category O72 as the principal diagnosis relative to live births and to describe maternal deaths attributed to O72 among residents of Espírito Santo, Brazil, from 2010 to 2024.

Methodology

An ecological time-series study was conducted using publicly available aggregated data from the Hospital Information System of the Brazilian Unified Health System (SIH/SUS), the Mortality Information System (SIM), and the Live Birth Information System (SINASC). Category O72 of the ICD-10 was selected. Hospitalization ratios per 10,000 live births and maternal mortality ratios per 100,000 live births were calculated. The hospitalization trend was estimated using Poisson regression with an offset for live births and covariance estimates robust to heteroskedasticity and autocorrelation. Sensitivity analyses and age standardization were performed.

Results

A total of 601 hospitalizations, seven deaths during these hospitalizations, 25 maternal deaths, and 806,313 live births were recorded. The hospitalization ratio increased from 3.86 to 10.41 per 10,000 live births, reaching a peak of 12.87 in 2018. The estimated annual percentage change was 9.36% (95% confidence interval (CI): 5.22-13.66), with the direction of the trend remaining consistent across sensitivity analyses. The maternal mortality ratio for the study period was 3.10 (95% CI: 2.01-4.58) per 100,000 live births.

Conclusions

The administrative ratio of SUS-funded hospitalizations with a primary diagnosis of postpartum hemorrhage increased overall, particularly during the earlier years, followed by fluctuations. This trend does not necessarily reflect an increase in clinical incidence. The findings provide a state-level descriptive reference for maternal health surveillance and support further investigation of hospitalization patterns and maternal outcomes.

Categories: Obstetrics/Gynecology, Epidemiology/Public Health
Keywords: health information systems, hospitalization, maternal mortality, postpartum hemorrhage, time-series studies

Introduction

Hemorrhage remains a priority in maternal health. A systematic analysis by the World Health Organization (WHO) estimated that hemorrhage accounted for 27% of maternal deaths worldwide from 2009 to 2020 [1]. This group encompasses causes beyond postpartum hemorrhage, for which timely recognition and treatment are central to preventing severe outcomes. The consolidated WHO guidelines, published in 2025, bring together recommendations for the prevention, diagnosis, and treatment of postpartum hemorrhage [2]. Epidemiological monitoring complements these recommendations by placing changes in these events over time in context and supporting priority setting in healthcare services.

In Brazil, national studies have documented persistent maternal mortality due to hemorrhage and regional differences, including those observed specifically for postpartum hemorrhage [3-5]. State-level analyses

bring this investigation closer to the geographic context in which healthcare networks are organized. The Hospital Information System of the Brazilian Unified Health System (SIH/SUS), the Mortality Information System (SIM), and the Live Birth Information System (SINASC) provide complementary public data sources for monitoring hospitalizations, deaths, and births [6-8].

Monitoring hospitalizations adds information to the study of deaths, which are less frequent within a single state. Annual denominators allow variations in the number of births to be taken into account, while age standardization and sensitivity analyses help assess the consistency of the trend. A national validation study of obstetric hospitalizations in the SIH/SUS demonstrated the potential usefulness of this data source and the need to improve diagnostic records [9]. Explicitly defining the selected events allows these data to be used for surveillance without conflating administrative records with the full range of clinical episodes.

In Espírito Santo, the combined analysis of these sources may provide a historical reference for maternal health surveillance, linking trends in SUS-funded hospitalizations with the description of cause-specific mortality. The objective of this study was to analyze the temporal trend in hospitalizations with a primary diagnosis of postpartum hemorrhage relative to live births and to describe maternal mortality with O72 as the underlying cause of death among residents of Espírito Santo from 2010 to 2024. This descriptive and exploratory study aimed to characterize temporal changes in defined administrative indicators rather than estimate the clinical incidence of postpartum hemorrhage or test a causal hypothesis.

Materials And Methods

Study design and data sources

An ecological time-series study was conducted using 15 annual observations from publicly available aggregated DATASUS tabulations. The study population was defined by residence in Espírito Santo across all three data sources. Data were extracted on September 29, 2026. The years 2010-2024 were included, ending the series before the years identified as preliminary in the vital statistics tabulations consulted. No individual-level data linkage was performed. The description of the procedures was guided by the RECORD recommendations for studies using routinely collected data [10].

In the SIH/SUS, hospital morbidity data were queried by place of residence, selecting “Postpartum hemorrhage” from the morbidity list, corresponding to O72. The “Hospitalizations” and “Deaths” measures were retrieved separately by year of care (“ano de atendimento”), rather than by year of processing [6]. To account for records processed after the provision of care, the available processing periods from January 2010 through July 2026 were consulted, retaining only records classified in years of care from 2010 to 2024. No other categories of obstetric hemorrhage were included. International Classification of Diseases, 10th Revision (ICD-10) category O72 comprises O72.0 (third-stage hemorrhage), O72.1 (other immediate postpartum hemorrhage), O72.2 (delayed and secondary postpartum hemorrhage), and O72.3 (postpartum coagulation defects). These subcategories were included together in the category-level tabulation rather than analyzed separately. The case definition was restricted to hospitalizations with O72 recorded as the principal diagnosis; events recorded exclusively under secondary diagnoses were outside the study definition.

In the SIM, “Maternal deaths,” underlying cause category O72, and year of death were selected from the state-level tabulation of deaths among women of reproductive age and maternal deaths. In the SINASC, live births were selected by maternal place of residence and year of birth, regardless of healthcare funding [7,8]. Hospitalizations and live births by age group were also extracted for sensitivity analysis.

Variables and indicators

Hospitalizations with a primary diagnosis of O72 were denoted by H, deaths during these hospitalizations by D, maternal deaths with O72 as the underlying cause by M, and live births by N. The primary indicator was H/N × 10,000. This is an administrative ratio of hospitalizations to live births, rather than a population incidence measure: the numerator is restricted to SUS-funded care, whereas the denominator includes births regardless of healthcare funding. Furthermore, the records do not identify unique women.

The postpartum hemorrhage-specific maternal mortality ratio, M/N × 100,000, and the proportion of deaths among the selected hospitalizations, D/H × 100, were calculated. The latter was termed recorded in-hospital case fatality and does not correspond to the case fatality of all postpartum hemorrhage cases. Deaths recorded in SIM and SIH/SUS were not added together, nor were deaths from SIM used as the numerator for in-hospital case fatality.

Data processing and statistical analysis

Aggregated annual and age-stratified tabulations were organized for statistical analysis. Totals, continuity of the annual series, agreement between age-specific tabulations and the main series, and consistency between deaths and hospitalizations were checked. The exact-zero symbol defined in the TabNet legend was converted to zero, without imputing missing values. Exact Poisson 95% confidence intervals (95% CIs) were

reported for count-based ratios, and exact binomial CIs were reported for case fatality. These intervals reflect uncertainty under the count models; they do not account for underreporting or classification errors.

The primary model was a Poisson regression with a log link, annual hospitalization counts as the outcome, year centered at 2010 as the predictor, and the logarithm of N as the offset. Pearson dispersion and first-order residual correlation were assessed. For inference, a heteroskedasticity- and autocorrelation-consistent covariance (HAC) matrix was used, employing the Newey-West estimator with one lag, a finite-sample correction, and a t distribution with 13 degrees of freedom [11]. Annual percentage change (APC) was estimated as $100 \times [\exp(\beta) - 1]$. This measure summarizes an overall log-linear trend and does not assume an increase in every year. The two-lag HAC specification was used as a sensitivity analysis to assess whether the estimated trend was robust to the covariance lag choice. Given the limited number of annual observations (n = 15), statistical inference was interpreted cautiously.

Sensitivity analyses included a quasi-Poisson model with the scale parameter estimated using the Pearson statistic, Prais-Winsten regression of the natural logarithm of the ratio, and robust covariance estimation with two lags. In the Prais-Winsten procedure, the first observation was retained, and first-order autocorrelation was estimated iteratively [12]. No constants needed to be added to the hospitalization ratios, as all were positive. The trend from 2010 to 2019 was also estimated as an exploratory analysis; this analysis was not treated as a test of the effect of the pandemic.

The influence of age was examined by restricting the analysis to ages 10-49 years and by direct standardization. Age groups were harmonized into 10-19, 20-29, 30-39, and 40-49 years. The standard population was defined as the cumulative distribution of live births across these age groups from 2010 to 2024; the same weights were applied to all years. The trend in the age-standardized ratio was estimated using Prais-Winsten regression. The analyses were presented together, without selecting results based on the smallest p-value.

Given the low frequency of maternal and in-hospital deaths, no trend regression models were fitted for these outcomes. Maternal mortality was described annually and across the five-year periods 2010-2014, 2015-2019, and 2020-2024. Two-sided inference with 95% CIs was adopted. The analyses were performed using Python, pandas, NumPy, SciPy, statsmodels, and Matplotlib, with software versions recorded in the reproducibility materials. ChatGPT (OpenAI) was used to assist with data extraction and organization and with programming the statistical analyses and figures. The reported statistical estimates were reproduced from the aggregated study tables using executable Python code. The analysis datasets, statistical code, model outputs, and software dependencies are publicly available in the supplementary repository (https://doi.org/10.5281/zenodo.23930266).

Research background and ethical considerations

This study represents a thematic continuation of the undergraduate research line “Obstetric Hemorrhage: Referral to the Urgent and Emergency Care Network Through SAMU 192 in Espírito Santo,” whose original project reports Research Ethics Committee (CEP) opinion No. 4,418,985. The present investigation has a different study design and uses exclusively publicly available aggregated DATASUS data; it does not directly use the SAMU database. The use of public information and aggregated datasets without the possibility of individual identification supports the rationale for not requiring separate review by the CEP/CONEP system, pursuant to Article 1, sole paragraph, of Brazilian National Health Council Resolution No. 510/2016 [13].

Results

A total of 601 hospitalization records with a primary diagnosis of postpartum hemorrhage, seven deaths during these hospitalizations, 25 maternal deaths with O72 as the underlying cause of death, and 806,313 live births to mothers residing in Espírito Santo were identified between 2010 and 2024. All 15 annual observations were available for all four series. All hospitalization records were classified as female. The age-specific tabulations reproduced the annual totals.

The hospitalization ratio was 3.86 per 10,000 live births in 2010 and 10.41 in 2024. The lowest value occurred in 2011 (2.07), and the highest in 2018 (12.87) (Table *1*). Following a value of 12.20 in 2019, the indicator decreased to 7.25 in 2020 and ranged from 9.47 to 10.41 between 2021 and 2024. The cumulative ratio for the period was 7.45 (95% CI: 6.87-8.07) per 10,000 live births. Figure *1* shows the observed trajectory, the age-standardized series, and the overall fitted trend. When grouped into five-year periods, the hospitalization ratios were 3.24 per 10,000 live births in 2010-2014 (87 hospitalizations/268,354 live births), 9.61 in 2015-2019 (267/277,846), and 9.50 in 2020-2024 (247/260,113). These descriptive findings indicate that the increase was more pronounced during the earlier years, followed by similar aggregate ratios in the last two periods.

Year	Live births	SIH/SUS hospitalizations	SIH/SUS deaths	SIM maternal deaths	Hospitalizations per 10,000 live births	Maternal deaths per 100,000 live births
2010	51,853	20	1	0	3.86	0.00
2011	53,053	11	0	2	2.07	3.77
2012	52,835	18	0	0	3.41	0.00
2013	54,065	22	0	0	4.07	0.00
2014	56,548	16	0	2	2.83	3.54
2015	56,941	39	1	0	6.85	0.00
2016	53,413	36	0	4	6.74	7.49
2017	55,846	52	0	2	9.31	3.58
2018	56,721	73	0	3	12.87	5.29
2019	54,925	67	0	1	12.20	1.82
2020	53,767	39	1	2	7.25	3.72
2021	52,493	53	2	3	10.10	5.72
2022	51,729	49	1	2	9.47	3.87
2023	52,187	54	0	2	10.35	3.83
2024	49,937	52	1	2	10.41	4.01
Total	806,313	601	7	25	7.45	3.10

TABLE 1: Hospitalizations and deaths due to postpartum hemorrhage and live births in Espírito Santo, 2010–2024 (601 hospitalizations and 25 maternal deaths).

The ratios in the Total row were calculated from the sums, rather than as simple averages of the annual ratios.

SIH/SUS: Hospital Information System of the Brazilian Unified Health System; SIM: Mortality Information System

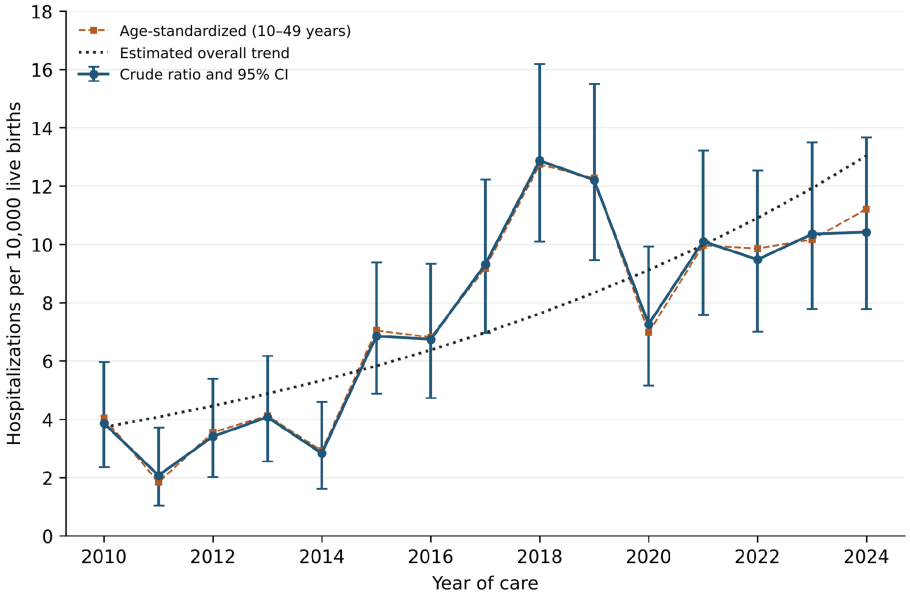


FIGURE 1: Hospitalization ratios for postpartum hemorrhage, Espírito Santo, 2010–2024 (601 hospitalizations).

Error bars indicate exact Poisson 95% confidence intervals (CIs) for the crude ratio. The age-standardized ratio includes 599 of the 601 (99.67%) hospitalizations among women aged 10–49 years and uses the cumulative number of live births in these age groups as the standard. The dotted line represents the overall trend estimated by the Poisson model; it is not a forecast and does not indicate uniform growth.

The APC estimated by the primary model was 9.36% (95% CI: 5.22-13.66; p < 0.001). Pearson dispersion was 4.35, and first-order residual correlation was 0.46, supporting the decision not to use the conventional Poisson model variance for inference. Sensitivity analyses consistently showed a positive temporal association (Table *2*). The Prais-Winsten model for the crude ratio yielded an APC of 10.78% (95% CI: 5.02-16.85), with an estimated autocorrelation of 0.26. The analysis restricted to 2010-2019 yielded an APC of 21.40% (95% CI: 14.67-28.52).

Analysis	APC (%)	95% CI lower	95% CI upper	P-value
Primary - Poisson HAC(1)	9.36	5.22	13.66	<0.001
Quasi-Poisson	9.36	4.57	14.37	<0.001
Prais-Winsten - crude ratio	10.78	5.02	16.85	0.001
Prais-Winsten - age-standardized ratio	11.18	5.67	16.98	<0.001
Poisson HAC(1) - ages 10–49	9.46	5.26	13.83	<0.001
Poisson HAC(1) - 2010–2019[a]	21.40	14.67	28.52	<0.001
Poisson HAC(2)	9.36	4.79	14.13	<0.001

TABLE 2: Annual percentage change in the hospitalization ratio for postpartum hemorrhage, Espírito Santo, 2010–2024 (15 annual observations).

Count models included the logarithm of live births as an offset. Standardization used the cumulative age distribution of live births aged 10–49 years.

[a]: Ten annual observations; exploratory analysis that does not estimate the effect of the pandemic.

APC: annual percentage change; CI: confidence interval; HAC: heteroskedasticity- and autocorrelation-consistent covariance, with one or two lags

Two of the 601 hospitalization records (0.33%) were outside the 10-49-year age range: one in the 70-79-year

group in 2011 and another in the 50-59-year group in 2017. No individual correction of these records was performed. The analysis restricted to ages 10-49 years included 599 hospitalizations and 806,228 live births, with an APC of 9.46% (95% CI: 5.26-13.83). The standardization weights were 14.69% (118,417/806,228), 48.55% (391,448/806,228), 33.66% (271,365/806,228), and 3.10% (24,998/806,228) for the age groups 10-19, 20-29, 30-39, and 40-49 years, respectively. The age-standardized ratio increased from 4.04 to 11.20 per 10,000 live births, with an APC of 11.18% (95% CI: 5.67-16.98). Age-specific data are provided in Appendix 1.

Annual maternal death counts ranged from zero to four, with no recorded deaths in four years. The cumulative maternal mortality ratio was 3.10 (95% CI: 2.01-4.58) per 100,000 live births. Of the 25 maternal deaths, four (16%) occurred in 2010-2014, 10 (40%) in 2015-2019, and 11 (44%) in 2020-2024. The corresponding ratios were 1.49 (95% CI: 0.41-3.82), 3.60 (95% CI: 1.73-6.62), and 4.23 (95% CI: 2.11-7.57). Figure *2* presents the estimates and their uncertainty; no trend test was performed for these deaths. The recorded in-hospital case fatality among the selected hospitalizations was 7/601 (1.16%; 95% CI: 0.47-2.38). Annual hospitalization and maternal mortality ratios with their confidence intervals are presented in Appendix 2, and annual in-hospital case fatality data are presented in Appendix 3.

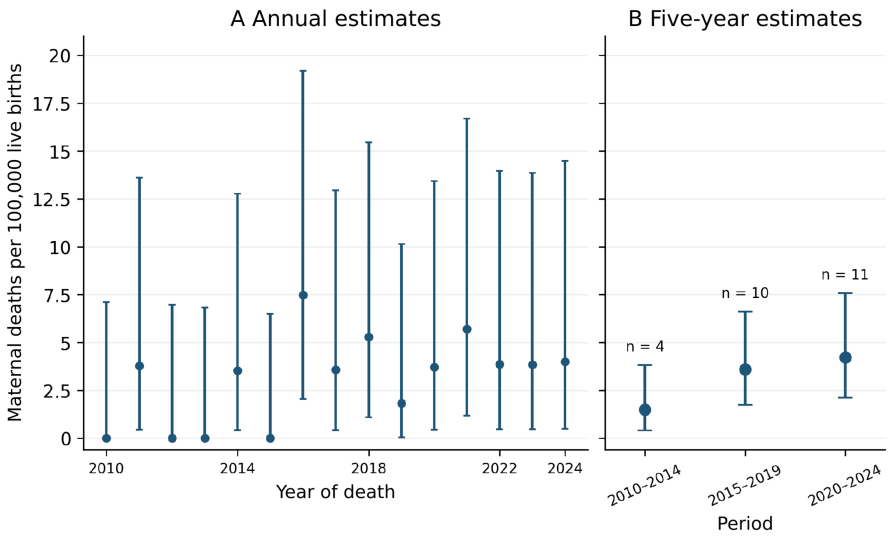


FIGURE 2: Annual and five-year maternal mortality ratios due to postpartum hemorrhage, Espírito Santo, 2010–2024 (25 maternal deaths).

Error bars indicate exact Poisson 95% confidence intervals. In Panel B, n represents the number of deaths in each five-year period. Years with zero deaths were retained. No trend model was estimated for mortality; the ordering of point estimates does not constitute a test of an increasing trend.

In Panel B, the three five-year periods accounted for 4/25 (16%), 10/25 (40%), and 11/25 (44%) of all maternal deaths in the study period; these percentages describe the distribution of deaths, not maternal mortality ratios.

Discussion

The increase in the hospitalization ratio for admissions with a primary diagnosis of postpartum hemorrhage was the main finding of this state-level time series. The positive trend persisted after age standardization and across different statistical specifications, indicating that the result did not depend solely on age distribution or a single model. By bringing together 15 years of hospitalization and mortality records with annual denominators, the study provides a reference for monitoring postpartum hemorrhage in Espírito Santo and identifying questions for further investigation through maternal health surveillance. Although the fitted annual percentage change was positive over the entire study period, this estimate summarizes the overall log-linear trend and does not imply a continuous increase in every year. The descriptive comparison across five-year periods suggests that the increase was concentrated in the earlier portion of the series, followed by fluctuations and relative stabilization. Furthermore, changes in SUS coverage, healthcare access, diagnostic recognition, and administrative coding may have contributed to the observed pattern. Consequently, the increase in recorded hospitalizations should not be interpreted as equivalent to an increase in the population incidence of postpartum hemorrhage.

The direction of this increase is consistent with that reported by Corbetta-Rastelli et al. in the United States, where the proportion of delivery hospitalizations with postpartum hemorrhage rose from 2.7% to 4.3% between 2000 and 2019 [14]. Across the full study period, approximately 2.3 million of 76.7 million delivery

hospitalizations (3.0%) involved postpartum hemorrhage [14]. These magnitudes are not directly comparable, as that study used delivery hospitalizations as its denominator and a different diagnostic selection. Of particular relevance is the coexistence in that series of a higher recorded frequency and a reduction in transfusions among cases in the later years [14]. Thus, an increase in hemorrhage records and worsening outcomes do not necessarily occur in parallel. This finding supports monitoring occurrence and severity indicators together rather than interpreting the rise in hospitalizations in isolation.

The persistence of the trend after age standardization indicates that changes in age composition within the analyzed age groups do not, by themselves, explain the state's trajectory. This finding is relevant because the Brazilian study by Knobel et al. identified higher obstetric hemorrhage mortality ratios with increasing maternal age [5]. In the present study, standardization makes comparisons over time more informative but does not identify the mechanisms behind the increase. Changes in obstetric profiles, healthcare service use, and diagnostic recognition are hypotheses for studies using individual-level data, not factors demonstrated by this time series.

In the validation study by Domingues et al., SIH/SUS captured 32,212 of 33,867 obstetric hospitalizations evaluated in the reference sample (95.1%) but showed underreporting of diagnoses and procedures [9]. Good capture of hospitalizations, therefore, does not imply complete identification of their complications. In Espírito Santo, part of the variation in O72 records may reflect changes in recognition and coding, as well as changes in clinical occurrence. The indicator's value lies in signaling a trajectory that warrants monitoring and comparison with medical records, secondary diagnoses, and procedures. Improving records and monitoring morbidity are complementary actions.

Mortality places this trajectory in a relevant clinical and public health context. The cumulative state-level ratio of 3.10 deaths per 100,000 live births was of a similar order of magnitude to the national ratio of 3.46 reported by Ciaravolo et al., who analyzed 2,394 deaths from postpartum hemorrhage during 2000-2023 [4]. This similarity provides context for the finding but does not constitute a formal risk comparison: the periods differ, and Espírito Santo is part of the national population. The regional differences identified in that study also illustrate why the national indicator cannot replace analyses at the territorial level.

Knobel et al. recorded 2,985 deaths from obstetric hemorrhage in Brazil during 2015-2024, with no statistically significant temporal change in the overall indicator [5]. Their study included hemorrhages occurring at different stages of pregnancy and childbirth and thus had a broader scope than O72. Together with the regional inequalities previously described by de Souza et al. [3], these findings indicate that different cause definitions and geographic scales address different questions. The present analysis adds state-level monitoring of hospitalizations for a specific cause alongside mortality. The five-year mortality ratios were progressively higher, but the small number of events precludes a firm conclusion about their trend.

Distinguishing outcomes across data sources is also important for surveillance. Michels et al. found different trajectories of postpartum in-hospital case fatality according to gestational risk and mode of delivery in Brazil [15]. Although not specifically a hemorrhage study, it illustrates how the composition of hospitalizations and the chosen denominator affect interpretation of the indicator. In this study, the seven deaths recorded in SIH/SUS describe the selected hospitalizations, whereas the 25 deaths recorded in SIM represent maternal deaths with O72 as the underlying cause. Considering the sources together broadens the picture without adding the events together or interpreting their difference as a measure of underreporting.

The annual trajectory provides information not fully captured by average growth. The peak in 2018, decline in 2020, and subsequent values below the peak help identify periods for investigating records and healthcare services. The positive trend between 2010 and 2019 indicates that the increase preceded the pandemic. The time series does not allow the 2020 decline to be attributed to a specific mechanism; rather, the finding raises a concrete question for studies of access, hospitalization composition, and coding during that period.

In the E-MOTIVE trial, conducted in hospitals across four African countries, early detection combined with a bundle of first-response treatments reduced the composite outcome of severe hemorrhage, laparotomy for bleeding, or death from bleeding after vaginal delivery: 794 of 48,678 patients (1.6%) in the intervention group versus 2,139 of 50,044 patients (4.3%) with usual care, with a risk ratio of 0.40 (95% CI: 0.32-0.50) [16]. The trial demonstrates the importance of organizing the care response, although its estimate cannot be directly extrapolated to Espírito Santo. In conjunction with WHO recommendations [2], it supports the relevance of complementing outcome surveillance with local evaluation of timely detection and treatment.

For SUS services, the immediate application of this time series is to establish a historical reference that can be updated. Periodic review of O72 records, together with death investigations and assessment of the quality of hospitalization authorization records, may help identify where further investigation is warranted. Future studies may incorporate severity-related procedures and process indicators, such as recognition of blood loss and initiation of treatment. These proposals arise from interpreting the findings in light of the literature; the present study did not evaluate protocol effectiveness or the performance of specific services.

The main limitations are the restriction of SIH/SUS coverage to SUS-funded care despite a denominator that includes all live births, and the selection of only O72 as the primary diagnosis. The ratio does not estimate the clinical incidence of postpartum hemorrhage and may be influenced by changes in coverage, access, and coding. Aggregated data do not allow the identification of readmissions, individual correction of age errors, or linkage of hospitalizations, births, and deaths. Selection by the underlying cause in SIM also does not capture all deaths in which hemorrhage contributed to the causal chain.

The 15 annual observations limit the precision of inference and assessment of autocorrelation; the low frequency of deaths restricted mortality to descriptive analysis. The ecological design does not allow causal attribution or conclusions about individual risk. Agreement across sensitivity analyses and age standardization reinforces the consistency of the hospitalization trend but does not eliminate these limitations. The study's contribution remains the temporal monitoring of well-defined and reproducible records, with the potential to guide local investigations.

Conclusions

Between 2010 and 2024, the ratio of SUS-funded hospitalizations with a primary diagnosis of postpartum hemorrhage to live births increased overall in Espírito Santo, with a more pronounced increase during the earlier years and subsequent fluctuations. The positive overall trend was consistent across statistical specifications and after age standardization, but it does not establish a corresponding increase in the clinical incidence of postpartum hemorrhage. Maternal mortality findings provide complementary descriptive information. These results contribute to the historical monitoring of maternal health indicators and support further investigations into hospitalization patterns, diagnostic coding, and maternal outcomes.

Appendices

Appendix 1

Year	10–19 years, hospitalizations	10–19 years, live births	20–29 years, hospitalizations	20–29 years, live births	30–39 years, hospitalizations	30–39 years, live births	40–49 years, hospitalizations	40–49 years, live births
2010	4	9,076	10	28,132	3	13,633	3	1,006
2011	0	9,085	8	28,040	2	14,868	0	1,052
2012	1	9,352	10	26,797	6	15,590	1	1,091
2013	4	9,764	12	26,684	4	16,397	2	1,212
2014	2	10,001	7	27,611	6	17,671	1	1,258
2015	6	9,543	10	27,616	19	18,368	4	1,411
2016	4	8,609	17	25,877	13	17,501	2	1,424
2017	5	8,187	23	26,573	18	19,487	5	1,595
2018	12	7,774	26	26,339	34	20,818	1	1,784
2019	17	7,266	22	25,318	27	20,411	1	1,926
2020	4	6,828	12	25,043	16	19,870	7	2,023
2021	9	6,486	17	24,634	22	19,184	5	2,185
2022	11	5,706	21	24,465	14	19,266	3	2,283
2023	5	5,549	25	24,639	19	19,589	5	2,403
2024	14	5,191	20	23,680	16	18,712	2	2,345
Total	98	118,417	240	391,448	219	271,365	42	2,4998

TABLE 3: Hospitalizations for postpartum hemorrhage and live births by age group, Espírito Santo, 2010–2024 (599 hospitalizations and 806,228 live births).

Hospitalizations with primary diagnosis O72 in SIH/SUS; births recorded in SINASC. All records refer to residents of Espírito Santo. Age groups were harmonized across the data sources.

Two hospitalization records outside the 10–49-year age range, one in 2011 (70–79 years) and one in 2017 (50–59 years), were retained in the primary analysis and excluded from analyses restricted to ages 10–49 years. The 85 live births outside the harmonized age groups (0.01% of the 806,313 total live births) are not included in this table.

Direct standardization weights: 10–19 years, 0.1468778063; 20–29 years, 0.4855301478; 30–39 years, 0.3365859285; 40–49 years, 0.0310061174. These correspond to the cumulative distribution of live births among women aged 10–49 years during the period.

Across the 599 age-restricted hospitalizations, 98 (16.36%), 240 (40.07%), 219 (36.56%), and 42 (7.01%) were recorded in the 10–19, 20–29, 30–39, and 40–49 age groups, respectively. The corresponding shares of the 806,228 live births were 14.69%, 48.55%, 33.66%, and 3.10%, respectively.

SIH/SUS: Hospital Information System of the Brazilian Unified Health System; SINASC: Live Birth Information System

Appendix 2

Year	Hospitalization ratio per 10,000 LB	Hospitalization 95% CI lower	Hospitalization 95% CI upper	Age-standardized ratio	Maternal mortality ratio per 100,000 LB	Maternal 95% CI lower	Maternal 95% CI upper
2010	3.86	2.36	5.96	4.04	0.00	0.00	7.11
2011	2.07	1.04	3.71	1.84	3.77	0.46	13.62
2012	3.41	2.02	5.38	3.55	0.00	0.00	6.98
2013	4.07	2.55	6.16	4.12	0.00	0.00	6.82
2014	2.83	1.62	4.59	2.91	3.54	0.43	12.78
2015	6.85	4.87	9.36	7.04	0.00	0.00	6.48
2016	6.74	4.72	9.33	6.81	7.49	2.04	19.17
2017	9.31	6.95	12.21	9.18	3.58	0.43	12.94
2018	12.87	10.09	16.18	12.73	5.29	1.09	15.46
2019	12.20	9.45	15.49	12.27	1.82	0.05	10.14
2020	7.25	5.16	9.92	6.97	3.72	0.45	13.44
2021	10.10	7.56	13.21	9.96	5.72	1.18	16.70
2022	9.47	7.01	12.52	9.85	3.87	0.47	13.97
2023	10.35	7.77	13.50	10.16	3.83	0.46	13.84
2024	10.41	7.78	13.66	11.20	4.01	0.49	14.47

TABLE 4: Hospitalization and maternal mortality ratios due to postpartum hemorrhage, Espírito Santo, 2010–2024 (601 hospitalizations and 25 maternal deaths).

Crude hospitalization and maternal mortality ratios and the lower and upper limits of their exact Poisson 95% confidence intervals are presented in separate columns. The age-standardized hospitalization ratio uses data and weights from Table 3. Hospitalizations cover SUS-funded care; the denominator includes all live births. These ratios do not estimate the clinical incidence of postpartum hemorrhage.

LB: live births; CI: confidence interval

Appendix 3

Year	In-hospital deaths (n)	Hospitalizations (N)	Case fatality (%)	95% CI lower (%)	95% CI upper (%)
2010	1	20	5.00	0.13	24.87
2011	0	11	0.00	0.00	28.49
2012	0	18	0.00	0.00	18.53
2013	0	22	0.00	0.00	15.44
2014	0	16	0.00	0.00	20.59
2015	1	39	2.56	0.06	13.48
2016	0	36	0.00	0.00	9.74
2017	0	52	0.00	0.00	6.85
2018	0	73	0.00	0.00	4.93
2019	0	67	0.00	0.00	5.36
2020	1	39	2.56	0.06	13.48
2021	2	53	3.77	0.46	12.98
2022	1	49	2.04	0.05	10.85
2023	0	54	0.00	0.00	6.60
2024	1	52	1.92	0.05	10.26

TABLE 5: Annual in-hospital case fatality among postpartum hemorrhage hospitalizations, Espírito Santo, 2010–2024 (7 deaths among 601 hospitalizations).

Deaths and hospitalizations are SIH/SUS records for the principal diagnosis O72. Percentages are calculated as deaths divided by selected hospitalizations for the corresponding year. Lower and upper limits of exact binomial 95% confidence intervals are presented in separate columns. Across the whole period, 7/601 hospitalizations ended in a recorded in-hospital death (1.16%; 95% CI: 0.47-2.38). These deaths must not be added to the maternal deaths recorded by SIM. Zero values are retained.

SIH/SUS: Hospital Information System of the Brazilian Unified Health System; CI: confidence interval

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

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