Analysis of Cumulative Risk of Severe Maternal Morbidity in Brazil: The Need for New Indicators for Effective Surveillance and Maternal Health Promotion

Theoretical focus

Reducing preventable maternal deaths is a global priority, particularly in low- and middle-income countries, as highlighted in the Sustainable Development Goals (WHO, 2011, 2018). While there has been substantial progress in reducing maternal deaths in recent decades, sub-Saharan Africa still experiences high maternal mortality rates. In Brazil, after a significant decline in maternal deaths, progress has stagnated since mid-2015, and during the COVID-19 pandemic, the maternal mortality rate nearly doubled compared to 2019. Although the death of a woman during pregnancy or the puerperium is a tragic event, it is essential to recognize that maternal health encompasses conditions beyond mere survival.

According to Say et al. (2009), maternal death results from a continuum of complications, where timely and effective interventions could prevent severe outcomes such as maternal near misses—defined as a woman's survival after experiencing one or more serious complications—and death. In high-income countries, where the Maternal Mortality Ratio (MMR) remains within acceptable standards, severe maternal morbidity continues to be a concern. For instance, a study in Ireland found that for every death due to severe hemorrhage, there were 1,029 hospitalizations for the same condition (Leitao et al., 2022). This indicates that while these countries may be preventing deaths, the effects of severe maternal morbidity can impact physical health and reproductive behavior in the long term (Henriques et al., 2014; Aldrighi et al., 2018).

In Brazil, where the MMR has stagnated and significant disparities exist between and within macro-regions, it is crucial to implement supplementary indicators beyond the MMR. The establishment of Maternal Death Surveillance Committees has been vital in investigating cases and reviewing care protocols. However, given Brazil's large territorial size, the available data may not always be sufficient for thorough analysis. Thus, incorporating additional indicators, such as maternal near miss rates and serious maternal complications—events with higher incidence rates—can enhance the monitoring of determinants and factors associated with maternal health.

This study aims to estimate the cumulative risk of severe maternal morbidity throughout reproductive age, as proposed by Gazeley et al. (2024), using data from the Hospital Information System of the Unified Health System and fertility and mortality estimates from the United Nations World Population Prospects for 2019. Although this measure is specifically proposed for maternal near miss, additional indicators may be crucial in areas where both maternal near miss and death have low incidence rates, to effectively monitor the health conditions of women and their

offspring. Thus, the model will also incorporate the estimation of potentially life-threatening conditions, as defined by WHO (2011).

Data and Research Methods

Maternal near miss as a serious maternal outcome had its concept and diagnostic criteria standardized by the World Health Organization (WHO) in 2009 (Say et al., 2009). However, since this maternal event is not covered by the International Classification of Diseases and Related Health Problems (ICD), identifying cases remains complex. Consequently, researchers often use different criteria than those established by the WHO, which impedes comparisons between countries and the monitoring of case trends over time (Herdt et al. 2020; Geller et al. 2018; Geller et al. 2004).

In this study, we used data from the SUS Hospital Information System to identify cases of severe maternal morbidity—specifically maternal near miss and potentially life-threatening conditions—for the year 2019. This was done based on the compatibility of the diagnostic criteria standardized by the WHO with the ICD-10 codes proposed by Nakamura-Pereira et al. (2013). To estimate the indicators, we incorporated estimates from the United Nations World Population Prospects (Gazeley et al., 2024), as the cumulative risk of severe maternal morbidity includes fertility rates and women's survival rates.

According to Gazeley et al. (2024), the lifetime risk of maternal near miss (LTR-MNM), analogous to the lifetime risk of maternal death (LTR-MD) which measures the risk of maternal death during reproductive age, estimates the probability of a 15-year-old woman experiencing a maternal near miss during the same period. The LTR assumes that, given survival to age 15, the risk of severe maternal morbidity is associated with the fertility and mortality rates to which the woman is exposed between the ages of 15 and 49. Additionally, to calculate this indicator, it is necessary to have maternal near miss rates and, in this study, severe maternal complications that are representative of the population and categorized by five-year age groups or specific ages. Although the authors propose models for aggregate data for the 15-49 age group, due to data availability, the following equation was used to calculate the LTR-MNM:

$$LTR_{MNM} = \sum_{x}^{x+n} {}_{n}MNMRatio_{x} \cdot {}_{n}f_{x} \cdot \frac{{}_{n}L_{x}}{l_{15}}$$

where ${}_{n}f_{x}$ represents the fertility rate between ages x and x+n (where n is the length of the age interval), ${}_{n}L_{x}$ is the number of woman-years of exposure to the risk of dying from maternal or other causes between ages x and x+n, and l_{15} is the probability that a girl will survive to age 15 (Gazeley et al., 2024).

However, the MNM Ratio was replaced by the MNM Rate, which is calculated from the ratio between cases of maternal near miss and the number of hospitalizations for obstetric causes in the Unified Health System in 2019. We chose to use hospitalization data rather than birth data because, while institutional births are predominant in Brazil, some are conducted in the private sector, where data is not publicly available. To estimate the cumulative risk of potentially life-threatening conditions (WHO, 2011), the same database and equation were used, substituting the maternal near miss rate with the PLTC Rate.

Preliminary Findings and Research Agenda

In 2019, Brazil recorded 49,725 cases of maternal near miss (MNM) corresponding to rates of 20.16 and 37.73 cases per 1,000 hospitalizations for obstetric causes, respectively. According to Table 1 and Table 2, during this period, the risk of a 15-year-old woman experiencing an MNM during her reproductive years was 0.35%, or 1 in every 286 women, while the risk of experiencing a PLTC was 0.658%, or 1 in every 152 women.

Table 1. Lifetime risk of maternal near miss in Brasil in 2019

Age	MNM cases	Hospitalizations*	MNM Rate per 1000**	${}_nf_x$ **	l_{15}	${}_nL_x$	$\frac{L_x}{l_{15}}$	LTR-MNM
15 a 19	8010	430559	18,60	59,1	98405	491506	4,99	0,005493
20 a 24	12451	694204	17,94	87,5		490228	4,98	0,007820
25 a 29	10944	575906	19,00	83,1		488733	4,97	0,007844
30 a 34	9268	428074	21,65	68,5		486841	4,95	0,007341
35 a 39	6392	252563	25,31	38,6		484138	4,92	0,004806
40 a 44	2377	78756	30,18	10,3		480351	4,88	0,001522
45 a 49	283	5962	47,47	0,8		474672	4,82	0,000182
Total	49725	2466024	20,16					0,0000350
								(0,003501%) 1 in 286

SIH-SUS; United Nations World Population Prospects, 2019

Table 2. Lifetime risk of potentially life-threatening conditions in Brasil in 2019

Age	PLTC cases	Hospitalizations*	PLTC Rate per 1000**	${}_nf_x$ **	l_{15}	${}_nL_x$	$\frac{L_x}{l_{15}}$	LTR-PLTC
15 a 19	12923	430559	30,01	59,1	98405	491506	4,99	0,008862
20 a 24	22263	694204	32,07	87,5		490228	4,98	0,013982
25 a 29	21072	575906	36,59	83,1		488733	4,97	0,015102
30 a 34	18661	428074	43,59	68,5		486841	4,95	0,014781
35 a 39	13021	252563	51,56	38,6		484138	4,92	0,009791
40 a 44	4759	78756	60,43	10,3		480351	4,88	0,003048
45 a 49	420	5962	70,45	0,8		474672	4,82	0,000271
Total	93119	2466024	37,76					0,0000658
								(0,00658%) 1 in 152

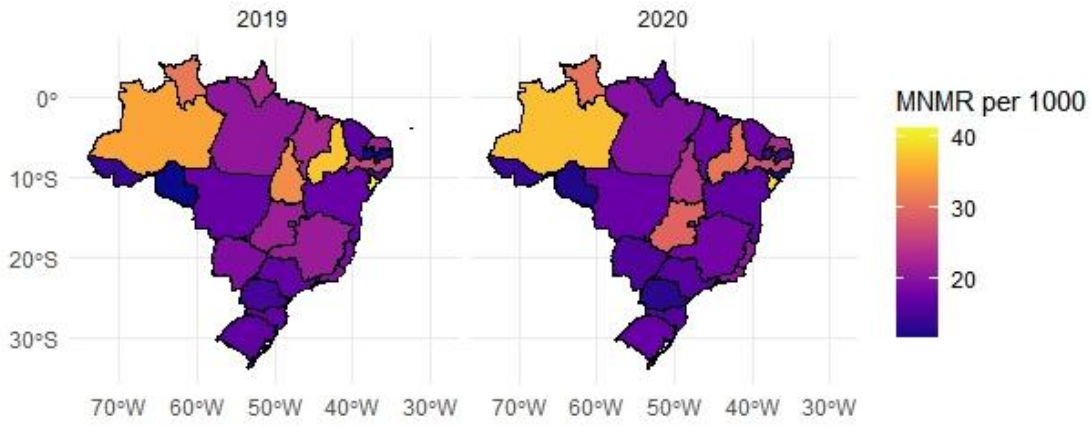
* Hospitalizations for Hospitalizations for Obstetric Causes
** Values expressed per 1000 are divided by 1000 before calculation

SIH-SUS; United Nations World Population Prospects, 2019

The LTR-MNM is a more effective indicator for analyzing the risk of maternal near miss compared to the MNM Rate, as it accounts for fertility rates and women's survival throughout the reproductive cycle. This helps prevent the overestimation of risk that can occur with advancing age. Thus, when examining the MNM Rate by age group (see Table 1 and 2), it is evident that the incidence of maternal near miss increases with reproductive age.

The results above summarize the cumulative risk of severe maternal morbidity in Brazil for 2019. However, according to Figure 2, there are significant differences in maternal near miss rates across the Brazilian Federative Units. Considering this, the next steps will include estimates for all the Federative Units and for the period from 2014 to 2023. Additionally, the cumulative risk of maternal death will be estimated for the same period and locations, to elucidate the evolution of these indicators over the past decade.

Figure 2. Maternal Near Miss Rate by State, Brazil, 2019 and 2020



SIH-SUS

Conclusion

This analysis is part of an ongoing study with a mixed-methods approach, which aims to analyze the survival of women who have experienced severe maternal morbidity, using linkage techniques of different secondary data sources from the Unified Health System (SUS). Additionally, the study seeks to investigate the effects of experiencing the event on sexual and reproductive behavior in women residing in the Southeast region of Brazil.

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