Association between near miss maternal with sociodemographic factors and health assistants

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Abstract

Objectives: evaluate the association between the maternal near miss rate (TNMM) and sociodemographic and health care factors.

Methods: this is an aggregated, cross- sectional epidemiological survey, with regression analysis and spatial analysis, with the units of analysis being the 399 municipalities that make up the four health macro- regions in the state of Paraná, Brazil. Data from the years 2018 to 2021 were obtained through the state maternal near miss report and monitoring system.

Results: the state's total TNMM was 6.4 per 1,000 live births, with an increasing trend during the studied period ($p<0.001$). Sociodemographic and healthcare factors were not associated with TNMM, except for municipalities with a higher degree of urbanization (β adjusted=0.022; CI95%=0.002-0.041) and located in the northern health macro-region (β adjusted=12.352; CI95%= 10.779-15.099), demonstrated by clusters with high and positive associations (high-high).

Conclusion: the lack of association with sociodemographic and care factors may be due to their low effect on near miss, or the underreporting of near miss cases in the state. The differences found can be justified by the organization of health services and the intense regionalization of municipalities belonging to the macronorth, which have a better near miss report culture.

Key words *Near miss, Sociodemographic factors, Quality, access and evaluation of health care, Regionalization of health, Report*

http://dx.doi.org/10.1590/1806-9304202400000128-en

Introduction

The Sustainable Development Goals institute mother and child care as one of their principal goals.[1] Although the reduction of mortality is more emphasized, the improvement of maternal care constitutes a more complex challenge, passing through morbidity indicators, especially in low income countries and/or countries with unfavorable sociodemographic conditions.[2,3] In this way, investigations on maternal near miss (MNM) stood out, due to its potential in helping the understanding of the maternal mortality phenomenon. Also, the capability of generating evidence that can be used for establishing strategies of reduction of both occurrences.[4,5]

MNM can be understood as a near death situation during pregnancy, delivery or up to 42 days after the end of pregnancy,[6] which is characterized by the presence of clinical, management and laboratory criteria, as instituted by the World Health Organization (WHO).[7] Many of the MNM criteria are avoidable, mainly due to the improvement of social and economic conditions, as well as those related to healthcare.[8] Therefore, as well as occurs with maternal mortality, the MNM rates (MNMR) are higher in developing countries than in developed countries.[5]

Since it is a subject not yet consolidated in health services, broad and standardized surveys regarding MNM are infrequent. Studies from countries with better social conditions and health care indicate lower MNMTs,[9,10] however, without the comprehension of the effect of each factor, such as income, education, health and prenatal assistance. This gap impairs the adoption of policies and actions that may prevent MNM, mainly when considering the need for optimization of resources in developing countries.

In this regard, considering the importance of the improvement of maternal care and the need of broad surveys concerning MNM, the present study aimed to assess the association of MNMR with sociodemographic and assistance factors in the state of Paraná, in the period between 2018 and 2021.

Methods

Aggregate epidemiological survey, cross-sectional, with spatial analysis and regression analyses. The analysis units of the study were the 399 municipalities of the state of Paraná, located in the South Region of Brazil, with an estimated population of 11.8 million inhabitants in 2022. The state is organized into 22 Health Regions (HR) and these, in turn, are organized into 4 health macro-regions (HM).

Secondary data related to MNM reports, executed in the period between January 2018 and December 2021, were extracted from the Research Electronic Data Capture platform (REDCap). The REDCap is used by the secretariat of health of the state of Paraná for the organization of the information system of reports of MNM. The monitoring started in 2017, after qualifications and trainings in the whole state, and nowadays it is implemented in every health institution, private or public. Obtained data were screened for identification of repeated reports, using as criterion the number of the national health card of the patient. The number of live births (LB) of each municipality was obtained from the Liver Births Information System (Sinasc – Portuguese acronym), from the Department of Informatics of the Unified Health System (DATASUS – Portuguese acronym).

The dependent variable, MNMR, was calculated by means of the division of the number of MNM reports of women residing in each municipality, by the number of live births of women residing in the respective municipality, multiplied by 1000.[8] Besides the MNMR of each municipality, the calculation was performed in the entire state. The rates were calculated by year (2018, 2019, 2020 and 2021) and for all the period of analysis (2018-2021). The alteration of the MNMR was evaluated with the chi-square test for linear trend (Mantel-Haenszel), with the OpenEpi software.

The size of municipality; the degree of urbanization (DU) – which is the percentage of inhabitants living in the urban area; the Human Development Index (HDI);Gini Index (GI); the distance traveled by the woman from the municipality of origin to the hospital of MNM report; the coverage of Basic Care (BC) and the quality of prenatal care, measured by the amount of pregnant women with six or more consultations were considered as independent variables.

The variables size of municipality, DU, total HDI and respective dimensions were obtained at the Paraná Institute of Social and Economic Development (IPARDES – Portuguese acronym), referring to the year 2010, the most recent available datum. The Gini Index was extracted from the DATASUS databases, being also the most recent available datum, from the year 2010. The size of the municipality was categorized based on the residing population into size 1) <25,000 inhabitants, size 2) 25,000 to 99,999 inhabitants and size 3) ≥ 100,000 inhabitants. The distance between the municipality of residence and the notifying hospital was estimated by the Google maps software, considering data from the municipality of residence and the hospital available on REDCap.

The coverage of BC comprehended the percentage of the population of each municipality that possessed coverage of the Family Health Team and the Basic Care, based on data from January 2020 (half of the period of data collection). The coverage of pregnant women with six or more prenatal consultations was calculated by means of the division of the number of pregnant women with ≥ 6 consultations by the number of live births, and then multiplied by 100%. The BC coverage for January 2020 and the number of pregnant women with ≥ 6 prenatal consultations per each year of study were obtained from the Information and management system of the basic care – E- manager.[11]

The description of study variables was made by means of the presentation of the mean and total standard deviation and was stratified by size and MR, which were submitted, for non parametric data, in the Kolmogorov-Smirnov test, the Kruskal-Wallis test with pairwise comparison, and the Bonferroni correction. The analysis of factors associated with MNMR (from the total period of collection, 2018-2021) was performed by means of linear regression in order to obtain the beta quotient (β) and 95% confidence interval (CI95%). Adjusted analysis was performed by the statistically significant variables in the crude model (Gini index, degree of urbanization, coverage of ≥6 prenatal consultations and macro-regional) for achieving the adjusted β. The regression analyses were performed with the SPSS version 25.0 software.

The spatial analysis aimed to verify the presence of possible spatial clusters from the Moran Index (ANSELIN, 2020) applied to MNMR for the period between 2018 and 2021. The spatial analyses were performed with the GeoDa version 1.18.10 software. The results of the Moran's Index varied from -1 to 1, being the positive values indicators of positive self-correlation (high-high) and the negative values, of negative self-correlation (low-low). All results passed by pseudo-significance tests, in which permutations were performed in order to verify the p-value for $p<0.001$.

The study was approved by the Research and Ethics Committee of the State University of Londrina (opinion number 4.793.951, CAAE: 46693821.4.0000.5231 of June 21, 2021) and the Research and Ethics Committee of the Health Secretariat of Paraná State (opinion number 4.952.539, CAAE: 46693821.4.3001.5225, September 3, 2021).

Results

In the study period, 3926 MNM reports were performed, which after the exclusion of the repeated ones, resulted in a 3893 MNM reports sample. Of the 399 municipalities of the state, in 72 municipalities, no resident was notified as MNM case in the four years of study, being all of them size 1 municipalities, with less than 18,000 inhabitants in the 2022 census.

The total MNMR of the state was 6.4MNM/1000LB. The MNMRs were 3.71/1000LB, 6.6/1000LB, 7.0/1000LB and 8.5/1000LB, in the years 2018, 2019, 2020 and 2021, respectively. It was observed an increasing trend in the study period ($p<0.001$), including between the years 2019 to 2021 ($p<0.001$).

The stratification of research variables by the size of municipalities evidenced important differences in relation to the sociodemographic and assistance factors, in which, in comparison with municipalities of size 1, the municipalities of sizes 2 and 3 demonstrated, generally, higher DU ($p<0.001$) and better total HDI indicators ($p<0.001$), however, with less coverage in the basic care ($p<0.001$). Still in comparison with municipalities of size 1, the municipalities of size 2 demonstrated lower coverage for prenatal consultations ($p<0.002$) (Table 1). In turn, the stratification by HM indicated higher heterogeneity, especially for MNMR, which was higher in the North HM than in the other HMs ($p<0.001$) (Table1). Differences were also found between DU, basic care coverage and coverage of ≥6 prenatal consultations. In adjusted analyses, the North and West HMs demonstrated higher MNMR, compared to East HM, in which the capital of the state is located (Table 2).

The spatial analysis of the MNMRs demonstrated that, with the exception of the rates referring to 2018 (non-demonstrated data), the North macro-region presented the highest MNMR registries for the four years analyzed (Figure 1).

The analysis of the Moran's Index evidenced the spatial dependence between municipalities and neighboring areas (Figure 2). That is, municipalities with high MNMR also presented neighboring municipalities with high MNMR (high – high) and still, municipalities with low MNMR are also neighbored by municipalities with low MNMR (low-low). The analysis over the years of study (supplementary material) identified an increase in the self-correlation index over time, being considered low (0.187) in 2018, with an increasing trend in the following years (0.214, 0.377 and 0.344, respectively, in 2019, 2020 and 2021).

Table 1

Characterization of aggregate sociodemographic and assistance factors of municipalities from Paraná and maternal *near miss* rate in the period 2018-2021.

Variables, $\bar{x}$ ± SD	Size of municipalities				Kruskal-Wallis *p*
	Total	1 (n=293)	2 (n=68)	3 (n=38)	
Maternal near-miss rate (per 1000 live births)	7.6 ± 8.7	8.1 ± 9.2	5.4 ± 5.5	6.4 ± 7.5	0.438
HDI* total	0.702 ± 0.039	0.696 ± 0.036	0.717 ± 0.038	0.749 ± 0.031	<0.001[a.b.c]
HDI* education	0.611 ± 0.062	0.605 ± 0.061	0.623 ± 0.064	0.666 ± 0.053	<0.001[b.c]
HDI* longevity	0.820 ± 0.021	0.817 ± 0.020	0.828 ± 0.019	0.849 ± 0.010	<0.001[a.b.c]
HDI* income	0.692 ± 0.038	0.685 ± 0.035	0.715 ± 0.032	0.745 ± 0.038	<0.001[a.b]
Gini Index	0.466 ± 0.057	0.461 ± 0.057	0.492 ± 0.052	0.471 ± 0.051	0.001[a]
Degree of urbanization (%)	51.9 ± 35.0	44.6 ± 34.7	77.9 ± 14.8	92.7 ± 2.7	<0.001[a.b.c]
Distance from the hospital of report (Km)	61.0 ± 54.8	65.9 ± 53.9	52.4 ± 57.7	8.1 ± 14.7	<0.001 [a.b.c]
Coverage of the basic care in 2020 (%)	92.7 ± 13.8	95.4 ± 11.5	84.8 ± 15.4	72.6 ± 15.9	<0.001[a.b.c]
Coverage of ≥6 prenatal consultations (%)	87.5 ± 6.5	88.2 ± 6.4	85.4 ± 6.9	86.8 ± 5.9	0.002[a.b]
Variables, $\bar{x}$ ± SD	**Health macro-region**				**Kruskal-Wallis *p***
	North (n=95)	**Northwest (n=115)**	**West (n=97)**	**East (n=92)**	
Maternal near-miss rate (per 1000 live births)	16.9 ±11.4	5.2 ± 5.2	5.6 ± 5.8	3.2 ± 3.0	<0.001[f.h.i]
HDI* total	0.701 ± 0.032	0.711 ± 0.028	0.713 ± 0.037	0.679 ± 0.048	<0.001[d.e.f]
HDI* – education	0.614 ± 0.051	0.631 ± 0.047	0.626 ± 0.058	0.567 ± 0.074	<0.001[f.h.i]
HDI* – longevity	0.819 ± 0.019	0.819 ± 0.019	0.823 ± 0.021	0.819 ± 0.023	0.532
HDI* – income	0.686 ± 0.034	0.695 ± 0.028	0.707 ± 0.038	0.678 ± 0.046	<0.001[d.e.i]
Gini Index	0.460 ± 0.056	0.432 ± 0.055	0.482 ± 0.049	0.497 ± 0.044	<0.001[d.f.g.h.i]
Degree of urbanization (%)	55.4 ± 34.6	57.3 ± 35.1	43.4 ± 34.5	50.3 ± 34.8	0.002[e.f]
Distance from the hospital of report (Km)	54.4 ± 32.2	51.5 ± 35.7	67.3 ± 67.9	82.3 ± 78.6	0.077
Coverage of basic care in 2020 (%)	93.4 ±13.9	95.6 ± 10.6	94.9 ± 11.3	85.9 ± 16.9	<0.001[d.e.f]
Coverage of ≥6 prenatal consultations(%)	90.0 ± 3.9	88.2 ± 5.6	87.4 ± 6.9	84.2 ± 7.8	<0.001[d.e.f.h]

*HDI= Human Development Index.

[a] significant difference between size 1 and 2 in the pairwise test with Bonferroni correction;

[b] significant difference between size 1 and 3 in the pairwise test with Bonferroni correction;

[c] significant difference between size 2 and 3 in the pairwise test with Bonferroni correction;

[d] significant difference between macro-regional East and North west pairwise test with Bonferroni correction;

[e] significant difference between macro-regional East and West pairwise test with Bonferroni correction;

[f] significant difference between macro-regional East and North pairwise test with Bonferroni correction;

[g] significant difference between macro-regional Northwest and West pairwise test with Bonferroni correction;

[h] significant difference between macro-regional Northwest and North pairwise test with Bonferroni correction;

[i] significant difference between macro-regional West and North pairwise test with Bonferroni correction.

Lastly, the spatial distribution of the Moran's Index about the MNMR of the municipalities identified positive (high-high) and negative (low-low) spatial associations, in agreement with the Health Regionals (HR), especially with consolidated data from 2018 to 2021 (Figure 3), but also in the analyses of each year (data not shown). We highlight the clusters with high and positive associations referring to the municipalities of the North HM, encompassing the 17th and 18th HRs, besides part of the 19th HR. Similarly, 59 municipalities composed clusters of low-low correlation, in four HRs that compose East HM (1st, 2nd, 3rd and 5th) and one HR (10th HR) that composes the West HM.

Table 2

Adjusted linear regression between sociodemographic and assistance factors aggregated in relation to maternal *near-miss* rate per 1000 live births in the municipalities with reports .Paraná/Brazil, 2018-2021.

Variables	β (CI95%)	βaj (CI95%)
HDI* total	9.940 (-12.295; 32.175)	-5.570 (-26.321; 15.180)
HDI* – education	6.362 (-7.279; 20.003)	-6.634 (-18.994; 5.726)
HDI* – longevity	18.402 (-22.492; 59.297)	15.215 (-19.234; 49.665)
HDI* –income	3.716 (-18.717; 26.149)	-0.346 (-22.246; 21.554)
Gini Index	-18.388 (-33.380; -3.396)	-12.352 (-25.664; 0.961)
Degree of urbanization (%)	0.028 (0.004; 0.052)	0.022 (0.002; 0.041)
Distance from the hospital of report (Km)	-0.015 (-0.030; 0.001)	-0.002 (-0.016; 0.011)
Coverage of basic care in 2020 (%)	-0.009 (-0.071; 0.054)	-0.031 (-0.085; 0.024)
Coverage of ≥6 prenatal consultations (%)	0.222 (0.093; 0.352)	0.038 (-0.072; 0.149)
Size 1 (<25,000 inhabitants)*	1.673 (-2.077; 5.423)	1.50 (-1.771; 4.772)
Size 2 (25,000 a 99,999 inhabitants)*	-1.036 (-5.341; 3.268)	-0.079 (-3.394; 3.553)
Macro-regional North**	13.721 (11.722; 15.721)	12.352 (10.779; 15.099)
Macro-regional Northwest**	2.023 (0.111; 3.935)	0.886 (-1.275; 3.048)
Macro-regional West**	2.467 (0.477; 5.907)	2.357 (0.324; 4.390)

*HDI= Human Development Index;

Baj= adjusted regression model by Gini Index, Degree of urbanization, coverage of ≥6 prenatal consultations and macro-regional;

*In comparison with municipalities of size 3 (≥100,000 inhabitants);

**In comparison with East macro-region;

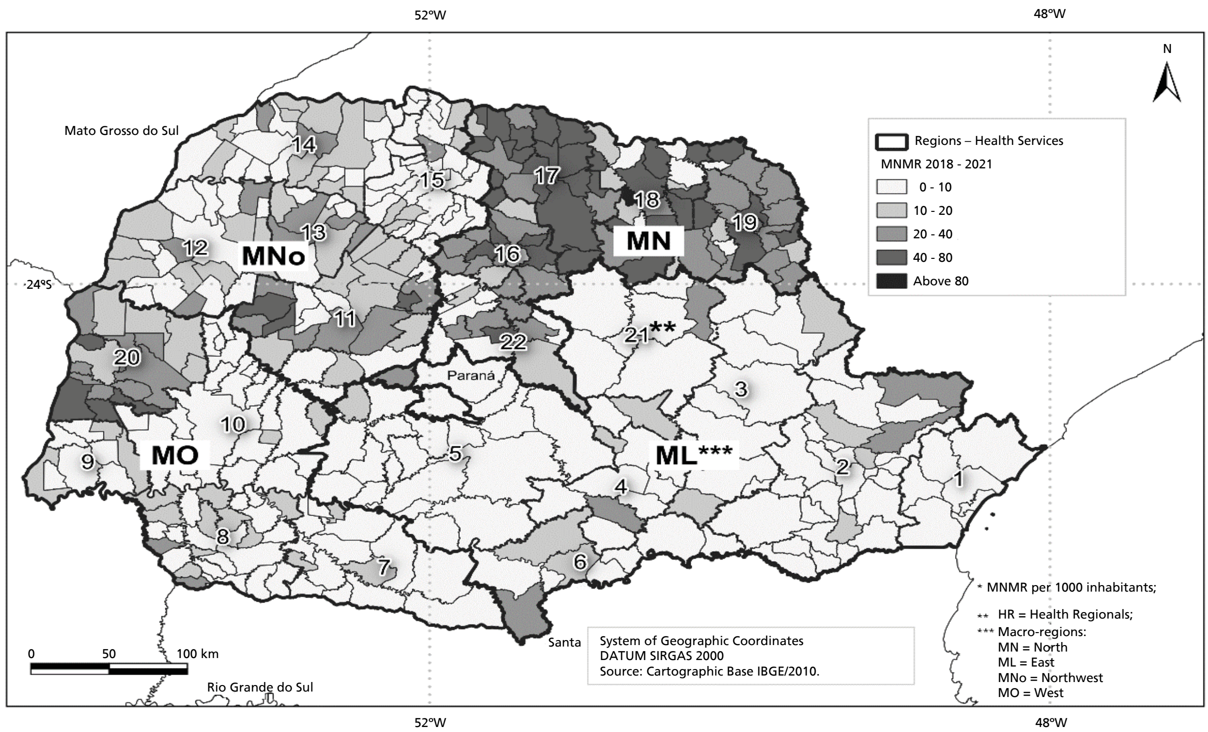
Underlined values: p<0.050;

Values in bold: p<0.010;

Underlined and bold values: p<0.001.

Figure 1

Spatial distribution of maternal near-miss rates Paraná/Brazil, 2018 -2021.



MNMR= maternal near miss rate.

Figure 2

Dispersion of values from the Moran's Index on the maternal near miss rates, Paraná/Brazil, 2018-2021.

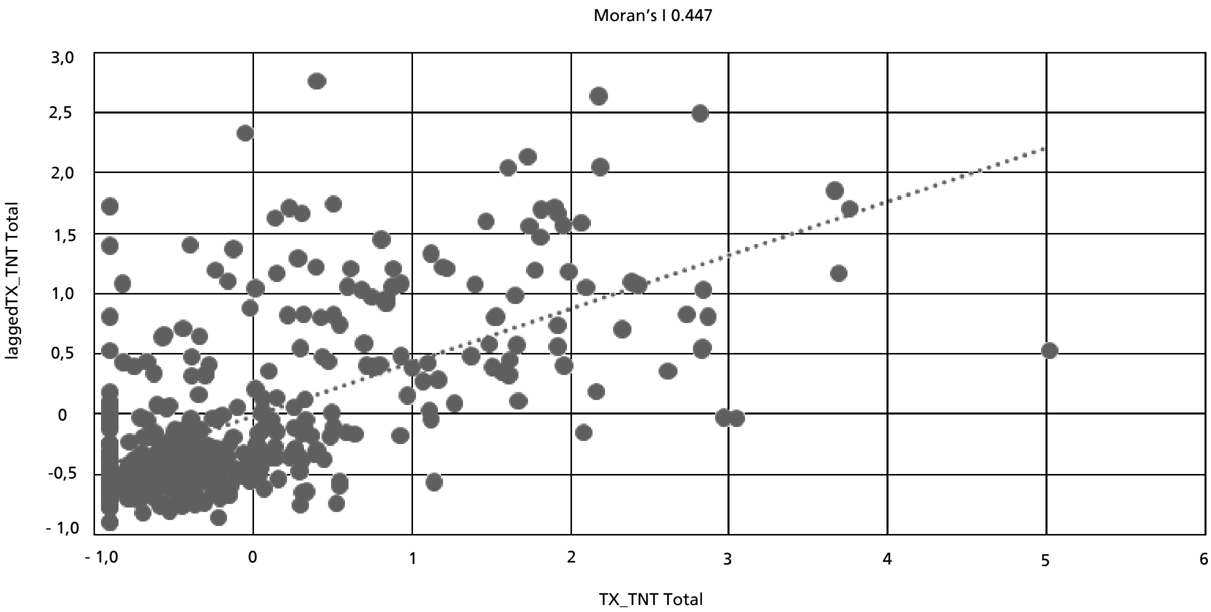
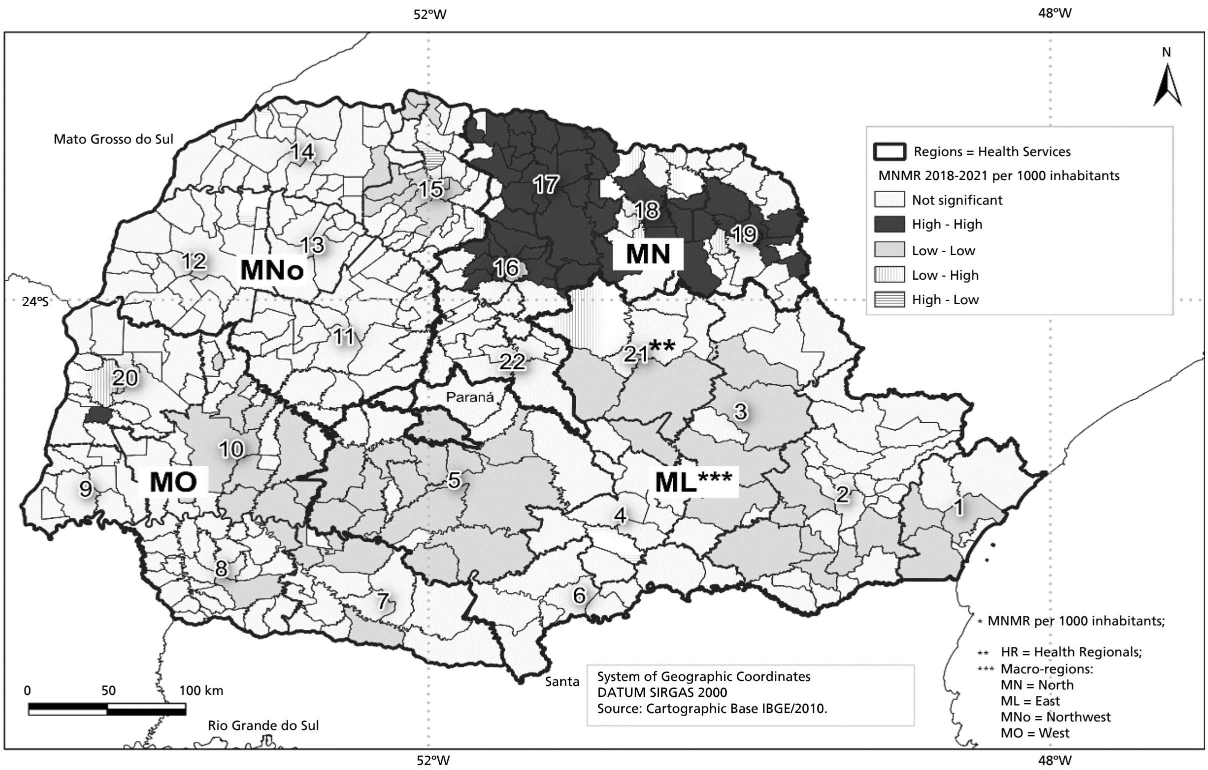


Figure 3

Spatial distribution of the maternal near miss rate, according to univariate analysis of the Local Moran's Index, Paraná/Brazil, 2018-2021.



MNMR= maternal near miss rate.

Discussion

The present study verified an increasing trend on the MNM reports during the 4 years of study, with mean MNMR of 6.4 MNM/1000LB. Sociodemographic and economic variables such as HDI, Gini Index, distance from the municipality of origin to the municipality of report, size of the municipality, coverage of basic care and prenatal consultations were not associated with MNMR, however higher MNMR were observed in municipalities with higher DU located in the North health macro-region.

The increase of MNMR over the period of data collection is a phenomenon observed in another study of temporal analysis,[12] and may be explained due to the greater discussion about the subject, the diffusion of the MNM conceptualization and the execution of qualifications and training for health professional teams. Considering that the phenomenon of the increase of reports occurs due to cultural issues related to training, it is expected that the same would occur homogeneously in the entire study region, obtaining similar values than other surveys about the subject in developing countries.

However, the values found were more approximated to that of surveys carried out in countries of medium income (mean MNMR of 7.8/1000LB), than those found in low/medium income countries (mean MNMR of 15.9/1000LB)[5], or in Brazil (MNMR varying from 9.4 to 10.2/1000LB).[13,14] These findings may be explained due to methodological differences, observing that Brazilian studies used incidence ratio to determine MNMR,[13,14] with a potential underreporting of MNMR cases in the system of report used in the present study, since the sociodemographic and economic conditions did not justify the differences found between the municipalities nor in relation to what is found in the literature.[8,12,15,16]

The non-association between MNMR with HDI and GI contradicted all results of analyses that associated higher income with lower MNMR, which is justified by the interaction of higher education and income, mainly in locations with low inequality, which may promote higher opportunities of care.[17-19] Possibly, the characteristics found in this study may be associated with higher late pregnancy and cesarean rates, confounding the benefic effects, besides limiting the sensibility of aggregate surveys carried out in more homogeneous locations, regarding such characteristics.

The distance to a high-complexity service,[20] the lower BC coverage (representative of the structuration of the health service)[21]and lower PN coverage[22] may represent higher risk of aggravation of health conditions of the pregnant/puerperal woman, and consequently higher MNMR.[20,22,23] Nevertheless, the structuration of the health service, with the regionalization and the early referral,[24] as well as the assistance coverage and priority care for regions with higher social vulnerability[25,25] may, as occurs with what is reported for economic and social variables, have diminished the effect of these variables about MNMR.

The DU of a given municipality represents, directly, the percentage of the population of the municipality residing in the urban area. However, the DU possesses several non-observable variables, such as economic structure of the municipality/region, presence or not of job opportunities in the urban area and, even not uniformly, the health assistance structure.[27] Notwithstanding, since municipalities with higher DU generally are central regional cities or neighbor of these, these municipalities tend to possess higher structure for healthcare.[28] Thus, considering that the performed analysis model adjusted the effect of DU by socioeconomic and assistance issues, the association found may come from a trend of MNM underreporting for women residing in municipalities with lower DU. In this case, since the analyses were adjusted by distance between the municipalities of residence and the report municipality, the association may be specifically due to the identification of these cases in rural areas, and not necessarily because of limitations of the referral of women.

The spatial analyses and those regarding HM, identified higher MNMR mainly in municipalities from the North macro-region of the state. Such differences seem to occur due to characteristics of the organization of health services,[29] since the analyses were adjusted for social and assistance confounding factors, and other spatial conditioning factors that may influence the occurrence of MNM were not identified. These findings demonstrate that municipalities belonging to North HM (18^{th}, 19^{th} and 22^{th} HR), present better structure for the collection of report of MNM cases, with potential underreporting for the other macro-regions, and, as mentioned above, in a more elevated rate in municipalities with lower DU.

We consider as a limitation in this study the fact of being carried out based on secondary data on MNM reports, which, as discussed above, may contain an important underreporting bias.

In addition, the study relied on a design that avoided a clear definition of causality (cross-sectional data) and the extrapolation of aggregate results for individuals (ecological fallacy), which lead the careful interpretation of findings to be necessary. However, we highlight the high number of reports performed, the adoption of international criteria for the identification of MNM, the execution of adjusted and spatial analyses, which tried to indicate explicative hypotheses for the results found.

Lastly, the results of the present study demonstrate that there was an increase in MNMR in the years between 2018 and 2021, which was strongly influenced by two demographic factors, the rate of urbanization of municipalities and residing in the North health macro-region.

MNM stands out as a sentinel event for the reduction of maternal deaths, since knowing the factors that determine it, as well as study the regions of occurrence, help managers in the decision making process regarding the elaboration of effective public policies for the reduction of this condition, that is still high, even though it is an unacceptable event nowadays.

Author's contribution

Curan FMS: study planning, data organization, elaboration of spreadsheets, data analysis, writing and critical reading of the manuscript.

Rodrigues R: elaboration of spreadsheets, data analysis, writing and critical reading of the manuscript.

Gioia TB: data analysis, critical reading of the manuscript.

Osis GG: study planning, data organization, writing and critical reading of the manuscript.

Pimenta RA, Pieri FM, Maciel SM and Pelloso SM: writing and critical reading of the manuscript.

Cardelli AAM: study planning, data analysis, reading and critical reading of the manuscript.

All authors approved the final version of the article and declare no conflicts of interest.

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Received on April 17, 2023
Final version presented on February 9, 2024
Approved on February 15, 2024

Associated Editor: Luciana Dubeux