Concepts, prevalence and characteristics of severe maternal morbidity and *near miss* in Brazil: a systematic review

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Abstract

Objective: to analyze frequency, characteristics and causes of severe maternal morbidity (maternal near miss) in Brazil.

Methods: a systematic review on quantitative studies about characteristics, causes, and associated factors on severe maternal morbidity (maternal near miss). The search was done through MEDLINE (maternal near miss or severe maternal morbidity and Brazil) and LILACS (maternal near miss, maternal morbidity). Data were extracted from methodological characteristics of the article, criteria for maternal morbidity and main results. Near miss ratios and indicators were described and estimated.

Results: we identified 48 studies: 37 were on hospital based; six were based on health surveys and five were based on information systems. Different definitions were adopted. Maternal near miss ratio ranged from 2.4/1000 LB to 188.4/1000 LB, depending on the criteria and epidemiological scenario. The mortality rate for maternal near miss varied between 3.3% and 32.2%. Hypertensive diseases and hemorrhage were the most common morbidities, but indirect causes have been increasing. Flaws in the healthcare were associated to near miss and also sociodemographic factors (non-white skin color, adolescence/ age≥ 35 years old, low schooling level).

Conclusions: the frequency of maternal near miss in Brazil is high, with a profile of similar causes to maternal mortality. Inequities and delays in the healthcare were identified as association.

Key words *Women's health, Complications at pregnancy, Health inequalities*

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Introduction

Women and children health is a worldwide priority, and the losses in puerperal pregnancy period and at childhood are considered devastating for the family and the society. Maternal mortality ratio reflects on the socioeconomic indicators as well as the quality in the offered healthcare, and its decrease in Brazil and in the world was included in the Millennium Goals, and it remains in the Sustainable Development Goals.[1] The previous goal did not achieve its two-thirds reduction on Maternal Mortality Ratio (MMR), and for Brazil, the challenge is to reduce the MMR from 20/100,000 live births until 2030.[1]

Despite the high maternal mortality rates, maternal death is an infrequent event in absolute numbers, making local studies and basic causes difficult to understand. In addition, there is a spectrum of morbid conditions between healthy gestation and maternal death ranging from mild to extremely severe conditions.[2]

In this context, the World Health Organization (WHO) defined the criterion of severe maternal morbidity or "maternal *near miss*" as "a woman who almost died but survived a serious maternal complication during pregnancy, childbirth, or within 42 days of completion of pregnancy."[3] These women have survived severe maternal complications or "life-threatening conditions" due to adequate healthcare services.[3] There is a list of life-threatening conditions (LTC) acknowledged by clinical, laboratorial or even management characteristics that support this classification established by WHO in order to unify the diagnostic criteria.[3]

Prior to WHO, there were other criteria for this outcome, ranging from the admission at the Intensive Care Unit to organ dysfunction, with different accuracy measurements.[4] Life-threatening conditions are the extreme of potential life-threatening conditions (PLTC) or maternal complications and that relates to some organ dysfunction feature.[2]

Several indicators derived from the *near miss* concept and can be used in research and obstetrical audits. The maternal *near miss ratio* (MNMR) refers to the number of maternal *near miss* cases by the number of live births (by 100,000); severe maternal outcomes (or life-threatening condition) includes cases of *near miss* and maternal death; maternal *near miss* mortality ratio and maternal death (MNM: MD); and the mortality rate (MR), which refers to the proportion of maternal deaths from the total sever outcomes. The latter two reflect the effectiveness on care in preventing a severe case evolving in death, and expecting a high MNM: MD and a low MR.[3]

In addition to women's commitment, severe maternal morbidity/maternal *near miss* has an impact on fetal and neonatal outcomes, including neonatal *near miss*.[5]

We have not identified reviews on severe maternal morbidity/*near miss* in Brazil, and the most recent international review published in 2013, included a few Brazilian studies.[6] Considering this gap and the relevance that deaths and other maternal outcomes such as abortion, hypertensive diseases, hemorrhages and infections have an effect on women and children's health, the objective of this article was to review Brazilian medical literature on maternal *near miss*.

Methods

A systematic review of the literature on severe maternal morbidity/maternal *near miss* in Brazil was carried out, without date restriction and completed search was in October 2016.

Regarding eligibility criteria, we considered two main approaches for articles inclusion on: descriptive studies (description of maternal morbidity/near-miss rates, description of causes); studies on factors associated to maternal morbidity/*near miss* outcomes (cross-sectional or longitudinal).

Case reports, studies with specific pathological morbidity groups not directly related to maternal morbidity and mortality and studies where maternal morbidity was the exposure variable and not an outcome, were excluded.

Review studies were initially included to widen the identification of original studies and subsequently were excluded. We also excluded letters, editorials, dissertations and theses, prioritizing full-text articles already published in scientific journals. We adopted as an exclusion criterion articles in which Brazil was not the only country addressed, in order to emphasize national approaches on the theme.

The bibliographic search was performed using LILACS databases (through Virtual Health Library) and MEDLINE (through PubMed), without language restriction. The terms severe maternal morbidity and *near miss* still do not exist as descriptors in scientific literature bases.

In LILACS, the search strategy was performed in two stages (the use of Boolean operator OR joining the two terms resulted in a fewer number of articles) using the terms: severe maternal morbidity and maternal *near miss*, at each stage. For

MEDLINE, the strategy was: (*near miss* or severe morbidity) and maternal and Brazil.

The search was performed independently by JMPS (first author) and SCF (second author), and the disagreements were solved by consensus. An additional manual search in the bibliographic references of the articles included was carried out.

Initially the titles of the articles were evaluated and the titles rejected by both researchers were excluded. The titles approved by at least one of the authors went through a second stage, reading the abstracts. In this stage, the studies with abstracts approved by both authors were included.

From the selected abstracts, the full-text articles were read to confirm eligibility and to collect relevant information. For the reading and synthesis stages, besides the first and second authors, other authors have participated (academics in their last periods in Medicine, with interest in the area of Obstetrics). Each article was read by at least two authors (always the first or second author, plus a third one) independently, and the disagreements were solved by consensus. The reasons for the final exclusion are listed in the flowchart, as recommended by PRISMA.[7]

The data - author, location, population characteristics, guidelines, data source, severe maternal morbidity/*near miss* criteria and the main results – were collected according to a pre-established spreadsheet. At least two of the authors read and analyzed all the articles. Among the results, the following quantitative indicators were highlighted: ratio or *near miss* incidence, MNM/MD and mortality rate. When the indicators were not described, but contained the necessary information for its calculation, it was estimated and added to the results in the review.

The methodological quality was not an inclusion/exclusion criterion in the analysis, considering that the purpose was to analyze a broad spectrum of studies on severe maternal morbidity, and to point out aspects referring to the methodology used. An experienced obstetrician on the subject also evaluated the summarization and the analysis of articles.

In order to organize the categories of the articles by prioritizing the data source, as proposed by Cecatti *et al.*[8] "studies on hospital population, studies on type of surveys and studies based on information systems".

This review is part of a study approved by the Ethics Committee of the Universitário Antônio Pedro on November 14, 2016, document number 1826053, to study the relation between *near miss* and neonatal outcomes.

Results

209 titles were identified in the MEDLINE search and 113 (considering the two combinations) in LILACS. After the exclusion of duplicates, selection and full reading of the articles, 48 studies for the systematic review were selected (Figure 1).

Tables 1 to 4 show that the studies are organized according to the data source type: hospital based (local and national), population surveys and information systems. Each category was preserved the chronological order of the publication, although there are some differences between this date and the moment of the implementation of the studies.

The 48 studies found were divided in: 37 hospital based; six were based on health surveys and five were based on information systems. The total number of the articles, 30 (62.5%) were published in international journals, all in English, 22 belonged in the Gynecology and Obstetrics and Reproductive Health areas. Among the 18 national publications, the most frequent journals were on Public Health (8), followed by Internal Medicine (7) and Gynecology-Obstetrics (3). Of the national internal medicine articles, four were exclusively published in English.

Local hospital based studies

In this category (Table 1), 22 studies were identified[9-30] originated from the Southeast (11) and Northeast (11) regions. Of these, 12 were cross-sectional studies, in which nine were only descriptive studies. The case-control type was a design of four studies and five of cohort studies, in which three were retrospective. One study was longitudinal, but just descriptive.

Most of the studies used the terminology "maternal *near miss*". Regarding to the criteria used for the definitions of *near miss* and severe maternal morbidity, 10 (44%) used the WHO criteria, 10 (40%) of Waterstone,[31] eight (32%) of Mantel,[32] three (16%) for the ICU admission, two (8%) the criteria proposed by Reichenheim *et al.*,[4] two (8%) used life-threatening conditions as a criteria and only one used Geller's criteria.[33] It is worth mentioning that most of the studies included more than one criterion in their analysis. Morse *et al.*[15] study compared three criteria, becaming the first one to use the WHO criteria in Brazilian studies.

Considering studies that adopted the WHO criteria, management and laboratorial criteria were the most prevalent, each being the most prevalent in two studies. Severe preeclampsia was the most common criterion identifier ever.

Figure 1

Flowchart on the selection of articles.

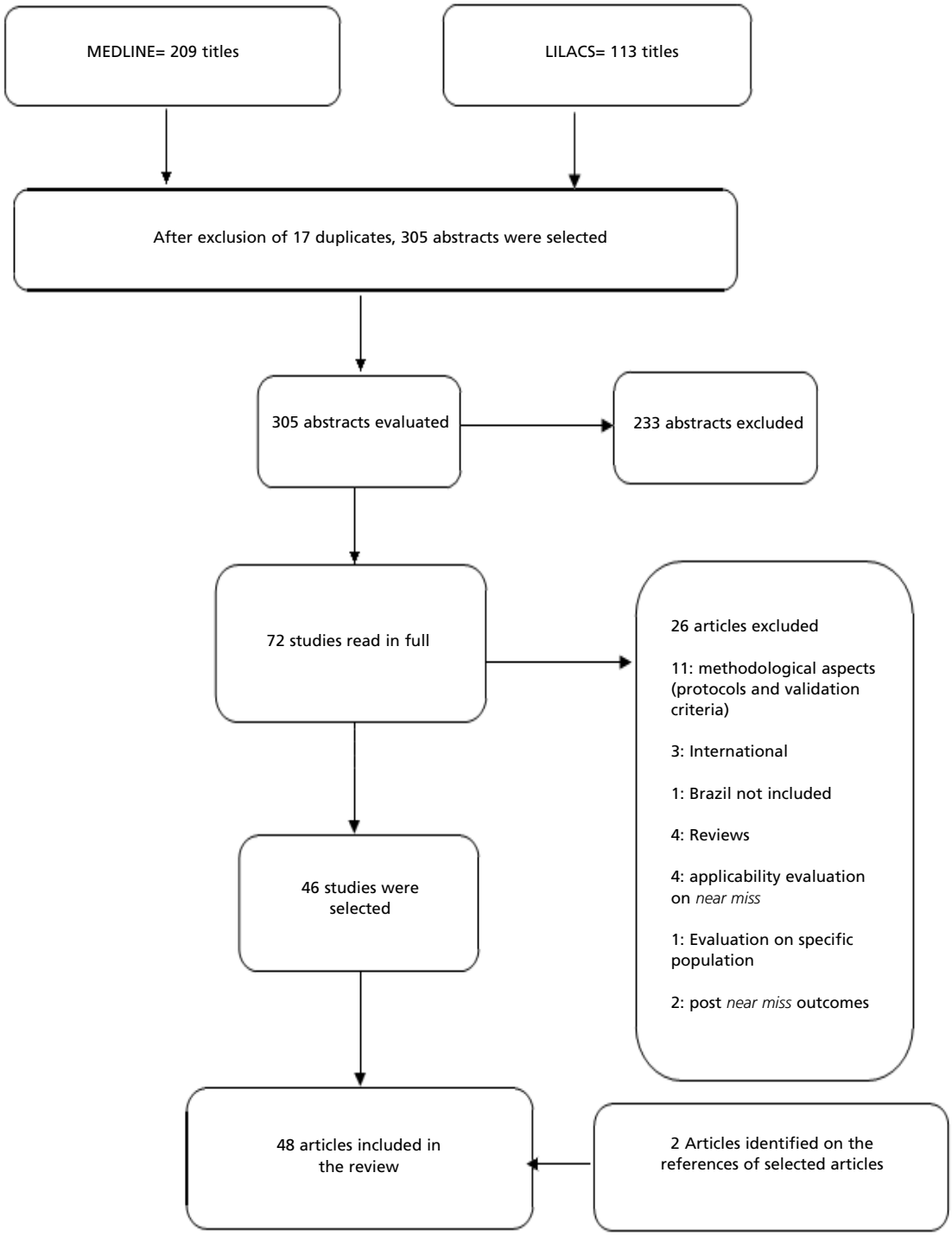

Table 1

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Souza *et al.*[9] 2005	Campinas, São Paulo	From July 2003 until June 2004	-Case-control -Bivariate analysis	- 124 women with severe maternal morbidity at a University maternity	-Mantel *et al.*[32] or Waterstone *et al.*[31] -Additional: Geller *et al.*[33]	-Severe maternal morbidity (SMM): 124 cases (Mantel or Waterstone criteria). SMM ratio: 42/1,000 childbirths -*Near miss ratio* (Geller[33] criteria): 6,8/1,000 childbirths; 20 women with very severe maternal morbidity (Cases) and 104 controls "with others severe morbidities" (Control) - Previous abortion was the only association with SMM (OR=3.41; 95%CI=1.08-10.79). -Hypertension was the only clinical condition most frequent for SMM, while hemorrhage predominated on the *near miss* group
Souza *et al.*[10] 2007	Campinas, São Paulo	From July 2003 until June 2004	-Cross-sectional descriptive -Daily visits: delivery rooms, ICU, Ward. Review on medical files after hospital leave.	- 2929 childbirths in a university maternity	-Mantel *et al.*[32] or Waterstone *et al.*[31]	-Total: 124 cases of SMM (SMM ratio= 42/1000 childbirths). - 2 maternal deaths. MNM/MD ratio 62 - Waterstone's criteria= 86 (SMM ratio = 38/1000), which pre-eclampsia was the most frequent; - Mantel's criteria= 62 (SMM ratio= 31/1000), which ICU admission was the most frequent - Most common conditions= Hypertension (57.3%), non-obstetrics (21%) and hemorrhage (13.7%)
Amorim *et al.*[11] 2008	Recife, Pernambuco	2003-2007	-Cross-sectional descriptive -Review on medical files	- 291 women with *near miss* criterion admitted in the obstetrics ICU	-Mantel *et al.*[32]	- Of the 291= hypertension (78.4%) was the main cause for admission, followed by hemorrhage - Most common clinical diseases: heart diseases (5.8%), chronic arterial hypertension (5.1%), chronic liver diseases (3%) and diabetes mellitus (2.4%) - Eclampsia was present in 38.8%, HELLP syndrome in 28,2% and hemorrhagic shock in 27.1% of the patients - Most common invasive procedures: blood transfusion (36%), profound venous puncture (13.4%), vasoactive drugs (10.8%) and assisted mechanical ventilation (9.1%)

continues

PLTC= Potential life-threatening conditions; SMO= severe maternal outcome=MNM+MD; HA= hypertension; HELLP= hemolysis elevated liver enzymes low platelet; CI= confidence interval; MD= maternal death; SMM= severe maternal morbidity; MNM= maternal *near miss*; LB= live births; WHO= World Health Organization; OR= *odds ratio*; MMR= maternal mortality ratio; SMMR= severe maternal morbidity ratio; PR= prevalence ratio; RR= relative risk; SUS= Public Health System; ICU= intensive care unit.

Table 1 **continuation**

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Luz *et al.*[12] 2008	Campinas, São Paulo	2005-2006	-Cross-sectional -Review on medical files -Non-adjusted prevalence ratio	- 2207 childbirths - 114 women with SMM	-Mantel *et al.*[32] -Waterstone *et al.*[31]	- SMM = 114 cases (15 of extremely severe morbidity ESMM and 99 of other morbidities) - ESMM rate= 6.8/1,000 childbirths; Rate of others maternal morbidities= 44.9/1,000 childbirths - Most common conditions of ESMM= post-childbirth hemorrhage (46.7%), insufficiency respiratory (13.4%), hypertension (13.3%) and pre-childbirth hemorrhage (13.3%); without any association with the variables in the study
Oliveira-Neto *et al.*,[13] 2009	Campinas, São Paulo	2002-2007	-Retrospective cohort -Bivariate analysis	- 673 women in the ICU obstetric at the University maternity	-ICU admission	- Of the 673 women, 18 cases of MD and 655 of SMM. - SMM ratio = 46.6/1,000 LB; MMR=124/100,000 LB -Causes of MNM and SMM/MD ratio= Hypertension: 322 cases, ratio 321:1 / Hemorrhage: 92 cases, ratio 30:1 / Infections: 17 cases, ratio 6:1 Non-obstetrics: 230 cases, ratio 25:1 -Interventions/procedures associated to death: reanimation, mechanical ventilation, vasoactive drugs use, cardioversion, blood transfusion
Amaral *et al.*,[14] 2011	Campinas, São Paulo	From October 2005 until December 2005	-Cross-sectional descriptive -Daily collection of medical files and hospital registration –MD committee evaluation	-All cases of severe acute maternal morbidity/ *near miss* in the city. - 4,491 live births	-Mantel`*et al.*[32] adapted criteria -Waterstone *et al.*[31]	- MNM total cases= 95 / Maternal death total = 4 MNM ratio= 21.2/1,000 live births MNM/MD ratio= 23.7:1; mortality rate= 4.04% - Causes= hypertension diseases (57.8%); post-childbirth hemorrhage (17.9%) - Delays for care= 34% of the cases (most frequent after admission in maternities, in relation to management, like the use of magnesium sulfate and post-childbirth hemorrhage prophylaxis)

continues

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Table 1 **continuation**

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Morse *et al.*,[15] 2011	Niterói, Estado do Rio de Janeiro	2009	-Cross-sectional descriptive -Review on medical files	- 1.554 childbirths in a referral public maternity hospital for, high-risk in the metropolitan region II of Rio de Janerio	-Mantel *et al.*[32] -Waterstone *et al.*[31] -WHO[3]	- MNM cases, considering any criteria: 89 cases; by WHO criteria, 10 cases. Three cases of MD - MNMR= - WHO – 9.4/1,000 live births; Waterstone – 81.4/1,000 live births; - Mantel – 13.1/1,000 live births -Mortality rate (WHO) = 23%; MNM/MD ratio = 3.3 Most frequent markers were: severe preeclampsia (68.5%), severe hemorrhage (19.1%) and ICU admission (10.1%)
Moraes *et al.*,[16] 2011	São Luiz, Maranhão	2009-2010	-Longitudinal descriptive -Search on medical files and interviews with health professionals at the health units -Fisher test, χ^2, t - Student test and Mann-Whitney	- 8493 childbirths	-Mantel *et al.*[32] -Waterstone *et al.*[31]	- 127 women presented one of the analyzed criteria -Incidence rate of severe maternal morbidity= Total: 15/1,000 childbirths; Waterstone: 14.1/1,000 childbirths Mantel: 3.4/1,000 childbirths - At admission, 84% of the women presented hypertension disorders, 11.4% hemorrhagic disorders, 2.5% infected abortion and 1.6% other causes -Significant association with ESMM cases: longer hospitalization time (*p*-value = <0.001) e hemorrhage (*p*-value = <0.01)
Lotufo *et al.*,[17] 2012	Limeira, São Paulo	2004-2007	-Cross-sectional -Multivariate regression	- 158 women admitted at an obstetric ICU at a general teaching hospital	-WHO[3] -ICU admission	ICU admission immediately after childbirth (87%) – From the total, 5 MD, 43 MNM, 110 PLTC - MNM ratio= 4.4/1,000 live births; Mortality rate=10.6% (higher for clinical-surgical conditions and infections) - MNM/MD= 8.6 - Most common management criteria, outlining vasoactive drugs, hysterectomy and blood transfusion; among the laboratory, the PaO2/Fio2<200 ratio was the most present and, among the clinical criteria, shock. – The only association between MNM and MD: cesarean section (OR=0.03; CI=0.002-0.49)

continues

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Table 1 **continuation**

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Moraes *et al.*,[18] 2013	São Luiz, Maranhão	2009-2010	-Case-control -Health professionals' report	-Two high-risk maternities and two referral obstetric ICU - 122 MNM cases at the ICU and 244 controls (maternities)	-Mantel *et al.*[32] -Waterstone *et al.*[31]	Total of cases: 122 - 66.4% presented severe pre-eclampsia, 11.5% eclampsia, 11.4% obstetric hemorrhage, 5.7% HELLP syndrome, 2.5% infected abortion, 1.6% pre-eclampsia overlapped chronic hypertension and 1.6% obstetrics complications - Statistically significant association with SMM: age ≥35 years old (OR=3.11), previous hypertension (OR=2.52), < 4 prenatal consultations (OR=1.89)
Lobato *et al.*,[19] 2013	Rio de Janeiro, Estado do Rio de Janeiro	2008	-Cross-sectional descriptive -Review on medical files	- 1,163 women in University maternity hospital	-Waterstone *et al.*[31] -WHO[3] -Reichenheim *et al.*,[4] 2009 criteria	Total of cases (considering any criteria): 157 - MNMR were: 33.2/1,000 live births by WHO; 155.2/1,000 live births by Waterstone 188.4/1,000 live births by Reichenheim criteria 2009 - 2.3% of the cases presented WHO criteria, 10.8% Waterstone criteria and 13.2% Reichenheim criteria 2009 - From 27 cases of WHO, 77.8% were positive in other classification, 14.8% were exclusive of WHO (thrombocytopenia) - From 25 cases classified as exclusively by Reichenheim 2009, 80% presented severe hypertension, 68% were admitted to ICU, 20% received blood transfusion, 4% had pulmonary edema and 4% developed hemorrhage - The cases classified by Reichenheim 2009 and by Waterstone (105), 94.3% were pre-eclampsia, eclampsia and HELLP syndrome
Oliveira & Costa,[20] 2013	Recife, Pernambuco	2007-2010	-Cross-sectional descriptive -Review on medical files	-Maternities and obstetric ICU admissions at a tertiary public unit - 19,940 live births and 2,997 ICU admissions	-WHO[3]	*Near miss* cases= 255 – MNMR= 12.8/1,000 live births - Hypertensions disorders occurred in 62.7%, mainly severe pre-eclampsia (49%) and eclampsia (13.7%) - The most frequent infection was endometritis (25.1%), followed by pneumonia (19.6%) - 35.3% of postpartum hemorrhage was also identified - Laboratory criteria was present in 59.6% of the participants, while clinical and management criteria occurred in 50.2% and 49%, respectively.

continues

PLTC= Potential life-threatening conditions; SMO= severe maternal outcome=MNM+MD; HA= hypertension; HELLP= hemolysis elevated liver enzymes low platelet; CI= confidence interval; MD= maternal death; SMM= severe maternal morbidity; MNM= maternal *near miss*; LB= live births; WHO= World Health Organization; OR= *odds ratio*; MMR= maternal mortality ratio; SMMR= severe maternal morbidity ratio; PR= prevalence ratio; RR= relative risk; SUS= Public Health System; ICU= intensive care unit.

Table 1 **continuation**

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Amorim *et al.*,[21] 2014	Recife, Pernambuco	2008-2009	-Cohort -Bivariate analysis: RR complication according to the type of childbirth -Multivariate analysis: OR of complication according to the type of childbirth	- 500 severe pre-eclampsia patients, without other clinical conditions, admitted at a tertiary hospitals	-PLTC	- Global PLTC according to the type of childbirth: cesarean section – 54% and vaginal – 32.7% - Conditions associated to cesarean section in women with severe pre-eclampsia: RR (95%CI) - Post-childbirth hemorrhage: RR=9.8 (2.4-39.9) -Hypertensive crisis: 1.58 (1.22-2.06) - Associated factors with PLTC in 500 women: Cesarean section – OR=1,91 (1.52-4.57) Pre-childbirth HELLP syndrome– OR=3.91 (1.55-9.88)
Galvão *et al.*,[22] 2014	Sergipe	2011-2012	-Case-control incidence -Medical files, prenatal care cards and interviews	-Two referral maternities for the whole State -16,243 live births	-WHO[3]	-Total of SMM (or PLTC): 1,102 cases -*Near miss* cases: 77/Maternal deaths: 17 - MNMR: 4.7/1,000 live births; SMMR: 67.8/1,000 live births - Mortality rate: 18%; MNM/MD ratio=4.5 - Most frequent morbidities: 67.5% hypertensive disorders, 15.4% hemorrhagic disorders and 61.7% one of the critical interventions defined by WHO; - Most frequent criteria: 87.1% ≥1 management criteria, 41.4% ≥1 clinical criteria and 21.4% ≥1 laboratorial criteria - Statistically significant association to near-mis: previous abortion (OR=2.68), previous cesarean section (OR=1.64) and current (2.36) and conscience alteration (OR=15.18)

continues

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Table 1 **continuation**

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Menezes *et al.*,[23] 2015	Sergipe	2011-2012	-Cross-sectional descriptive -Hospital files	- 20,435 women admitted in two maternities, 1,196 with potential life threatening conditions (PLTC)	-Waterstone *et al.*[31] -WHO[3] -Reichenheim *et al.*[4] 2009 criteria	- MNMR= Reichenheim *et al.*[4] 2009= 59/1,000 LB Waterstone *et al.*[31]= 24.8/1,000 LB WHO[3]= 4.7/1,000 LB - 6.4% of the cases were compatible with WHO criteria, 33,8% compatible with Waterstone and 80,2% compatible with Reichenheim 2009 - Of the 77 WHO cases, 4 were exclusive, 72 were positive also by Reichenheim 2009 and 37 also positive by Waterstone; - The most frequent criteria according to Reichenheim 2009 were: 54.8% severe hypertension, 28.3% blood transfusion and 7.5% ICU admission - The most frequent criteria according to Waterstone were: 71.6% severe pre-eclampsia, 13% eclampsia and 7.6% HELLP syndrome
Pacheco *et al.*,[24] 2014	Vale de São Francisco, Pernambuco	2011	-Retrospective cohort -Prenatal care cards, medical files -Multivariate analysis -Logistic regression	- 2,291 women	-WHO[3]	- 400 (17.5%) of severe maternal morbidity cases and 24 (1.1%) cases with one or more criteria of maternal *near miss* were identified - Association to severe maternal morbidity and/or maternal *near miss*= previous history on cesarean section (RR:1.43), presence of chronic hypertension (RR:6.78), current cesarean section (OR:2.6), presence of comorbidity (OR:3.4) and less than 6 pre-natal consultation (OR:1.13)
Souza *et al.*,[25] 2015	Natal, Rio Grande do Norte	2013-2014	-Cross-sectional -Review on medical files - χ^2 tests	- 492	-Waterstone*et al.*[31] -Geller *et al.*[33]	- There were more *near miss* cases when woman presented= 1) hypertensive disorders (50.0%); 2) severe sepsis (23.8%); 3) severe hemorrhage (21.4%) - Clinical conditions with significant relative risk for MNM: first childbirth (OR=3.1), hypertensive gestational disorders (OR=8.0) and cesarean section (OR=39.2)

continues

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Table 1 **continuation**

Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Oliveira & Costa,[26] 2015	Recife, Pernambuco	2007-2010	-Cross-sectional descriptive -Review on medical files	- 2,997	-WHO[3]	- MNMR: 12.8/1,000 LB - The main disorders presented were: hypertensive, hemorrhagic and infectious -Among the hypertensive disorders cases: 42.3% severe pre-eclampsia, 13.7% eclampsia and 6.7% gestational aggravated chronic hypertension; HELLP syndrome in 41.2% of the participants - 59.6% presented one or more laboratorial criteria, 50.2% presented one or more clinical criteria and 49% presented one or more of management criteria - Clinical and laboratorial criteria appeared mostly during pregnancy (42.2 clinical and 57.9% laboratorial), while the management criteria occurred mainly in postpartum (45.6%)
Madeiro *et al*.[27] 2015	Teresina, Piauí	2012-2013	-Cross-sectional descriptive -Review on medical files -Multivariate analysis	- 5,841	-WHO[3]	- MNMR: 9.6/1,000 LB; - SMMR: 11.3/1,000 LB - MNM/MD ratio: 5.6:1; - Mortality rate: 15.2% - Main determinants of severe maternal morbidity (*near miss*) and maternal death: hypertension (86.1%), hemorrhage (10%) and infectious diseases (2.9%). Severe pre-eclampsia, eclampsia and HELLP syndrome were the main causes of maternal *near miss* -Association with MNM: caesarean section (OR=6.2) and " 5 days hospitalization (OR=6.7)
Barbosa *et al.*,[28] 2015	Sorocaba, São Paulo	4 anos (não informado)	-Retrospective cohort	- 1,501 women in a referral hospital: Chronic arterial hypertension (564), pre-eclampsia (579), eclampsia (74) and pre-eclampsia / eclampsia overlapping chronic arte-rial hypertension (284)	-WHO[3]	- MNM R of all hypertensive = 5,4/1,000 LB - MNM highest ratio for isolated or overlapping eclampsia, - MNM lowest ratio for chronic hypertension and pre-eclampsia. Prenatal and maternal *near miss* association: (p< 0,01): - " 6 consultations: MNMR=3.05/1,000 LB - < 6 consultations: MNMR =8.27/1,000 LB - Without prenatal care: MNMR=9.48/1,000 LB

continues

PLTC= Potential life-threatening conditions; SMO= severe maternal outcome=MNM+MD; HA= hypertension; HELLP= hemolysis elevated liver enzymes low platelet; CI= confidence interval; MD= maternal death; SMM= severe maternal morbidity; MNM= maternal *near miss*; LB= live births; WHO= World Health Organization; OR= *odds ratio*; MMR= maternal mortality ratio; SMMR= severe maternal morbidity ratio; PR= prevalence ratio; RR= relative risk; SUS= Public Health System; ICU= intensive care unit.

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Local hospital based studies.

Author and year of article	Study location	Studied Period	Type of study/ source/ analysis	Population	Criteria	Results
Ferreira *et al.*,[29] 2015	Campinas, São Paulo	2009-2013	-Cross-sectional descriptive -Review on medical files	- 12,771 women admitted at a referral University hospital	-ICU admission	-*Near miss* incidence: 50.5/1,000 childbirths -Vaginal section: 16/1,000 childbirths -Cesarean section: 91/1,000 childbirths -OR cesarean and *near miss* association: 6.24 (95% CI 5.06-7.69)
Vidal *et al.*,[30] 2016	Barbacena, Minas Gerais	2014 (Feb-Aug)	-Case-control -Interview and medical files	- 92 cases and 184 controls -Santa Casa Maternity (SUS)	-Life threatening conditions	-MNM indicators not described. -Associated factors: previous hypertension – OR=14.3 (CI=4.5-45.5); cesarean section– OR=3.2 (1.6-6.3)

PLTC= Potential life-threatening conditions; SMO= severe maternal outcome=MNM+MD; HA= hypertension; HELLP= hemolysis elevated liver enzymes low platelet; CI= confidence interval; MD= maternal death; SMM= severe maternal morbidity; MNM= maternal *near miss*; LB= live births; WHO= World Health Organization; OR= *odds ratio*; MMR= maternal mortality ratio; SMMR= severe maternal morbidity ratio; PR= prevalence ratio; RR= relative risk; SUS= Public Health System; ICU= intensive care unit.

Table 2

National hospital based studies / "Born in Brazil" study and "Multicenter study of the National Surveillance Network on Severe Maternal Morbidity".

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Dias *et al*.[5] 2014	-Brazil	2011-2012	-"Born in Brazil" -Cross-sectional -Descriptive	- 23.940 puerperal had live birth or stillborn	-WHO[3]	- MNM total of cases: 243 cases (23,747 cases estimation for the country) - MNM ratio: 10.2/1,000 live births - Among 243 women, most of them presented only one (67%) or two (20%) diagnostic criteria according to WHO - Most frequent criteria: clinical – respiratory frequency > 40 or < 6 per minute cycles; laboratorial – acute thrombocytopenia (platelets < 50,000); management – 5 or more red blood cell units transfusion
Domingues *et al*.[34] 2016	-Brazil	2011-2012	-"Born in Brazil" -Cross-sectional -Multivariate lo-gistic regression	- 23.940 puerperal had live birth or stillborn	-WHO[3]	- MNMR for women withoutt prenatal care: 27.9/1,000 LB - Women 35 years or more presented more clinical or obstetrics complications and had more elective cesarean sections and women with a previous cesarean section presented more complications during pregnancy -Association with maternal *near miss* = Prenatal care absence (OR:4.65;1.51–14.31), -Pilgrimage for 2 or more services (OR:4.49;2.12–9.52) -Obstetric complications (OR: 9.29; 6.69–12.90) -Type of childbirth: Elective cesarean section (OR:2.54; 1.67–3.88) and forceps (OR:9.37; 4.01–21.91)
Santana *et al*.,[37] 2012	-Brazil -27 referral maternities in five regions	2009-2010	-"Multicenter stu-dy of the National Surveillance Network on Severe Maternal Morbi-dity" -Multicenter cross-sectional -Multivariate ana-lyses by Poisson regression	- Of the 9,555 women, 237 cases of abortion	-WHO[3]	-Compared to the 9,318 other women, maternal *near miss* risk was higher in women who suffered abortion (PR=1.93; 1.12–3.31). -The WHO management criteria were more common in insecure abortion cases. - Factors associated to abortion complications: previous maternal conditions (sickle-cell anemia, low weight and neoplasia) and previous uterine scar

continues

PLTC (Potential life threatening conditions); SMO (Severe Maternal Outcome=MNM+MD); H1N1 (virus); HA (Hypertension); MD (maternal death); CI (confidence interval); SMM (severe maternal morbidity); MNM (Maternal *Near Miss*); LB (Live births); WHO (World Health Organization); OR (*odds ratio*); MMR (maternal mortality ratio); PR (Prevalence ratio); MNMR (Maternal *Near Miss Ratio*); HDI (Human Development Index).

Tabela 2 **continuation**

National hospital based studies / "Born in Brazil" study and "Multicenter study of the National Surveillance Network on Severe Maternal Morbidity".

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Giordano *et al.*,[39] 2014	-Brazil - 27 referral maternities in five regions	2009-2010	"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analyses by Poisson re-gression for 321 cases with complete information.	-Of the 9,555 women, 6,280 had hypertensive diseases and 426 cases of eclampsia	-WHO[3]	-Eclampsia prevalence: 5.2/1,000 LB - Specific MDR= 19.5/100,000 LB; Severe maternal outcomes (SMO) among 426 cases: MNM=70 and maternal death=16; - Mortality rate = 19% -Eclampsia indicators, according to Brazilian regions with the best IDH (South and Southeast) and the worse IDH (North, Northeast and Central-west), respectively: MNM ratio= 0.5/ 1,000LB and 1.2/1,000 LB MNM/MD = 3.4: 1 and 11:1; - Mortality rate = 22.6% and 8.33% Associated factors with SMO: Inadequate monitoring (PR =2.31; 1.48-2.59); any previous disease (PR=1.82; 1.26-2.64); sepsis (PR=2.75; 1.35-5.61)
Oliveira Jr *et al*.[36] 2014	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analyses by Poisson regression to evaluate factors related to severity (SMO vs PLTC) in two age groups	- 9,555 had complication	-WHO[3]	-Maternal *near miss ratio* for age groups and adjusted PR (95%CI) to SMO (MNM+MD), considering 20-34 years as reference: - 40-49 years old: 31.4/1,000 LB; PR=1.52 (1.19-1.93); 35-39 years old: 17.5/1,000 LB; PR=1.19 (1.00-1.41); 20-34 years old: 8.39/1,000 LB; 10-19 years old: 7.14/1,000 LB; PR=0.89 (0.77-1.04)-Other factors statistically associated to SMO: In the 35-49 age group: age (PR=1.25); prenatal care at another service (PR=1.28); any delay on care (PR=2.03); previous morbidities (PR=2.23); infection (PR=4.71); surgical conditions (PR=3.94); hemorrhage (PR=3.06). Obesity (PR=0.59) and absent partner (PR=0.52) were protectors In the 10-19 age group: prenatal care at another service (PR=1.28); any delay on care (PR=2.11); previous morbidities (PR=2.03); infection (PR=5.23); surgical conditions (PR=4.58); hemorrhage (PR=2,75); non-white skin color (PR=1,36). Obesity (PR=0.52) -Adolescents had less hemorrhage and more delay on care. In the 10-14 age group, a MNM/MD ratio was very low

continues

PLTC (Potential life threatening conditions); SMO (Severe Maternal Outcome=MNM+MD); H1N1 (virus); HA (Hypertension); MD (maternal death); CI (confidence interval); SMM (severe maternal morbidity); MNM (Maternal *Near Miss*); LB (Live births); WHO (World Health Organization); OR (*odds ratio*); MMR (maternal mortality ratio); PR (Prevalence ratio); MNMR (Maternal *Near Miss Ratio*); HDI (Human Development Index).

Table 2 **continuation**

National hospital based studies / "Born in Brazil" study and "Multicenter study of the National Surveillance Network on Severe Maternal Morbidity".

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Pacagnela *et al.*,[46] 2014	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analyses by Poisson regression to evaluate factors related to the delay	- 9,555 had complication	-WHO[3]	-Delays on obstetric care: 58% of some kind;- Related to Users: 10.2% -Access related: 34.6% (Most frequent in the 9,555 women – absence or inappropriate prenatal care); - Management quality related: 25.7% -Frequency according to severity: In the PLTC cases :52%, in the MNM cases: 68%; in maternal deaths: 84% - Increasing association between delay and severity, especially in management – 23.6% for PLTC, 42.3% for MNM and 65% for MD - Associated factors with delay: Adolescence (PR=1.09; 1.02-1.15); non-white skin color (PR=1.22; 1.07-1.39); low schooling (PR=1.45; 1.15-1.84), public hospital (PR=1.98; 1.40-2.79); absence of prenatal care (PR=1.66;1.26-2.19) and public prenatal care (PR =1.31; 1.03-1.67)
Rocha-filho *et al.*,[38] 2014	-Brasil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analyses by Poisson regression to evaluate severity of the cases	- Of the 9,555 women, 312 had ectopic pregnancy cases (EP)	-WHO[3]	-PLTC=286; MNM=25. MD =1 - MNM ratio= 0.3/1,000 LB; MNM/ MD ratio= 25:1; Mortality rate= 3.8% - There were no factors associated to severity

continues

PLTC (Potential life threatening conditions); SMO (Severe Maternal Outcome=MNM+MD); H1N1 (virus); HA (Hypertension); MD (maternal death); CI (confidence interval); SMM (severe maternal morbidity); MNM (Maternal *Near Miss*); LB (Live births); WHO (World Health Organization); OR (*odds ratio*); MMR (maternal mortality ratio); PR (Prevalence ratio); MNMR (Maternal *Near Miss Ratio*); HDI (Human Development Index).

Table 2 **continuation**

National hospital based studies / "Born in Brazil" study and "Multicenter study of the National Surveillance Network on Severe Maternal Morbidity".

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Zanette *et al.*,[40] 2014	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analyses by Poisson regression	- Of the 9,555 women, 6,315 had hypertensive disease	-WHO[3]	- Severe hypertension was associated to 70% of hospital admissions. MNM cases= 349 cases - MNM ratio=4.2/1,000 LB; -MNM/MD ratio= 8.3:1; -Mortality rate= 10.7% - Most frequent management criteria: the use of magnesium sulfate (68.4%) - Most frequent complication: post-childbirth hemorrhage (4%) - Association to SMO: age ≥40 years old (PR=1.67; 1.21–2.31); non-white skin color (PR= 0.66; 0.48 – 0.91); absence of partner (PR= 0.53; 0.37–0.76); previous diseases (renal, cardiac and collagenases) with PR >4.0. Post-childbirth occurrence: PR= 11.82 (7.59 – 18.43); Elective cesarean section (1.75 1.11 – 2.76); abortion (2.63 1.05–6.59). Delays on care: services (2.86 1.89–4.33) and professionals (2.45 1.53–3.92)
Campanharo *et al.*,[45] 2015	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Prevalence ratio adjusted by cluster effect	- Of the 9,555 women, 293 cases of cardiac diseases	-WHO[3]	-Heart disease patients' profile: older, low weight, prenatal care at a public hospital, <37 weeks for admission. prolonged hospitalization time. PLTC= 235 cases; MNM= 44 cases MD= 14 cases MNMR= 0.5/1,000 LB; MNMR: MD= 3.1:1; Mortality rate= 24% -Predominant clinical (76%) and management (64%) criteria -Comparing women with heart disease and those without, as for SMO: PR=2.2 (1.7-2.8); MNM: PR=2.0 (1.3-3.2); MD: PR =3.7 (2.0-6.9);
Ferreira *et al.*,[47] 2015	-Brazil -27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Descriptive	-Of the 9,555 women, those who had an abortion, ectopic pregnancy or missing data were excluded -Analysis of 7,247 puerperals	-WHO[3]	- PLTC and SMO according to Robson`s classification (RTGCS): Global: SMO/PLTC=1:12. Groups with the worse performance–7.8.9.10 (presentation of anomalous, multiple pregnancy and prematurity) - Among the women who had cesarean: SMO/PLTC =1:11. Groups with the worse performance –7.8.9.10 and 3 (multiparas with cephalic single fetus >36 weeks) - Main causes: hypertension (77.4%) and hemorrhage (21.4%). In groups 3, 7 and 9 hemorrhage was >30%

continues

PLTC (Potential life threatening conditions); SMO (Severe Maternal Outcome=MNM+MD); H1N1 (virus); HA (Hypertension); MD (maternal death); CI (confidence interval); SMM (severe maternal morbidity); MNM (Maternal *Near Miss*); LB (Live births); WHO (World Health Organization); OR (*odds ratio*); MMR (maternal mortality ratio); PR (Prevalence ratio); MNMR (Maternal *Near Miss Ratio*); HDI (Human Development Index).

Table 2 **continuation**

National hospital based studies / "Born in Brazil" study and "Multicenter study of the National Surveillance Network on Severe Maternal Morbidity".

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Rocha Filho *et al*.[41] 2015	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analyses by Poisson regression	-Of the 9,555 women, analyses of 767 puerperals had hemorrhage before and during childbirth	-WHO[3]	-PLTC: 613 cases; MNM:140 cases; MD:14 cases Mortality rate: 9% -Most common causes: premature placental abruption (50% of MNM and MD cases) -Among all women with SMO: 73 (52.1%) presented one of the clinical criteria. 45 (32.1%) presented one of the laboratorial criteria and 109 (77.9%) presented one of the management criteria - Associated factors with SMO: age (PR =1.03; 1.01-1.04) and previous cesarean section (PR =1.85; 1.28-2.66)
Rocha Filho *et al*.[42] 2015	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Multivariate analysis by Poisson regression	- Of the 9,555 women, 1,192 puerperals had post-childbirth hemorrhage	-WHO[3]	PLTC: 981 cases; MNM= 181 cases; MD= 30 cases; Mortality rate= 15% - Of all 181 MNM cases, 78.5% presented one of the management criteria. 54.7% presented one of the clinical criteria and 35.4% presented one of the laboratorial criteria - Associated factors with SMO= maternal age (PR= 1.03; 1.01-1.04); gestational age at admission (PR= 2.99; 1.76-5.07); cesarean section (PR= 2.31; 1.27-4.21); previous uterine scar (PR= 2.57; 1.07-6.17).
Cecatti *et al*.[35] 2016	-Brazil -27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Descriptive	-All the 9,555 women	-WHO[3]	-MNMR= 9.37/1,000 LB; MDR= 170/100,000; MNM/ MD ratio= 5.5:1; Mortality rate= 15.4% - Hemorrhage was the most frequent for MNM and MD, in comparison to PLTC; the same occurred for infection. Hypertension was more prevalent in PLTC and declined as the outcome became more severe - The most frequent *Near miss* criteria was management (58.3%) followed by clinical (50.3%) and laboratorial (50%) - In the presence of only 1 criteria, the. probability of MD was small and in the presence of 3 criteria, it was high -Indirect causes represented 46% of the maternal deaths.

continues

PLTC (Potential life threatening conditions); SMO (Severe Maternal Outcome=MNM+MD); H1N1 (virus); HA (Hypertension); MD (maternal death); CI (confidence interval); SMM (severe maternal morbidity); MNM (Maternal *Near Miss*); LB (Live births); WHO (World Health Organization); OR (*odds ratio*); MMR (maternal mortality ratio); PR (Prevalence ratio); MNMR (Maternal *Near Miss Ratio*); HDI (Human Development Index).

Tabela 2 **concluded**

National hospital based studies / "Born in Brazil" study and "Multicenter study of the National Surveillance Network on Severe Maternal Morbidity".

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Pfitscher *et al.*,[43] 2016	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Two-dimensional analyses with adjusted prevalence ratio calculated	-Of the 9,555 women, 502 had severe infection	-WHO[3]	- PLTC cases: 255; MNM: 182; MD: 65 – MNMR= 2.2/1,000 LB; MNMR:MD= 2.8:1; Mortality rate of 26.3%. Among the 770 MNM cases. ¼ was sepsis -Statistically significant factors associated with SMO: Delay on care (PR= 1.93. 1.36–2.74); Spontaneous access (PR 0.42 0.29–0.59); Previous diseases (diabetes -PR =1.82; low weight -PR=2.17; cancer -PR =1.73 and drugs use- PR= 1.65)
Pfitscher *et al.*,[44] 2016	-Brazil - 27 referral maternities in five regions	2009-2010	-"Multicenter study of the National Surveillance Network on Severe Maternal Morbidity" -Two-dimensional analyses with adjusted prevalence ratio calculated	- Of the 9,555 women, 485 had severe respiratory disorder.	-WHO[3]	-206 were suspected of having H1N1 (49 confirmed). Confirmed cases had higher frequency of MNM -Mortality rate: 32.2% -Of the 770 MNM cases. ¼ had respiratory diseases (44 were suspected of having H1N1 and 13 were confirmed) -Of the 49 women with H1N1, 13 were MNM and 14 had MD. - 55% of the women with respiratory disorders presented 3 or more *near miss* criteria and 24% just one criterion - Statistically significant factors associated with SMO: Age under 19 (PR= 0.73) and ≥35 (PR= 1.32); absence of partner (PR= 0.56); first pregnancy (PR= 0.65); previous cesarean section (PR=1.46); drug use (PR= 2.09); inadequate prenatal care (PR =0.75); private hospital (PR= 2.54); delay on care (PR= 1.74)

PLTC (Potential life threatening conditions); SMO (Severe Maternal Outcome=MNM+MD); H1N1 (virus); HA (Hypertension); MD (maternal death); CI (confidence interval); SMM (severe maternal morbidity); MNM (Maternal *Near Miss*); LB (Live births); WHO (World Health Organization); OR (*odds ratio*); MMR (maternal mortality ratio); PR (Prevalence ratio); MNMR (Maternal *Near Miss Ratio*); HDI (Human Development Index).

The MNMR varied from 4.4/1,000 LB, according to the WHO criteria, the 188.4/1,000 LB, according to a criterion proposed by Reichenheim *et al.*[4] MNM: MD ratio was 3.3 cases/1 death to 8.6 cases/1 death, while the mortality rate was 10.6% to 23%.

The most frequent causes of MNM were the hypertensive disorders, such as severe pre-eclampsia and HELLP syndrome. The factors associated to maternal morbidity were: maternal age equal to or greater than 35 years, current or previous cesarean delivery, chronic hypertension, < 6 pre-natal consultations.

National hospital based studies

Among hospital based articles (Table 2), 15 presented national data, all were cross-sectional studies. They were organized in two research groups. The first refers to two articles from the "*Nascer no Brasil*" ("Born in Brazil") study,[5,34] the second reports 13 articles from the Multicenter Study of the "*Rede Nacional de Vigilância de Morbidade Materna Grave*"[35-47] ('National Surveillance Network on Severe Maternal Morbidity"). All articles of national scope used the WHO criteria for *near miss*.

"*Nascer no Brasil*" (Born in Brazil") research was a hospital based study, covering all the Brazilian regions, but including only hospitals with more than 500 births per year and excluding cases of abortion and hospitalization during pregnancy, which did not apply to the main goal of the study.[5]

The sample had 243 maternal *near miss* cases with an estimated 23,747 occurrences of maternal *near miss* in the Country, resulting in an incidence of 10.2/1,000 live births.[5] The incidence of maternal *near miss* was higher in women over 35 years of age, low schooling, previous cesarean history, complications during pregnancy, without prenatal care and with current cesarean section. Factors associated to statistical significance were: absence of prenatal care, obstetric complications, cesarean section and pilgrimage before the delivery.[34]

The multicenter study of the *Rede Brasileira de Vigilância da Morbidade Materna Grave* (Brazilian Surveillance Network on Severe Maternal Morbidity) evaluated twenty-seven hospitals distributed throughout all regions of Brazil[35] between 2009 and 2010. A prospective data collection used the WHO criteria for *near miss* and potentially life-threatening conditions. This research methodology was similar to most articles (Table 2).

From 82,144 deliveries with live fetuses, 9,555 (11.6%) women were classified as having some kind of a severe outcome: 8,645 (90.5%) presented severe complications, 770 (8.1%) were classified as maternal *near miss* (WHO criteria) and 140 (1.5%) died.[35] Several articles originated from this population data, although there were no comparative studies among these 9,555 women and those who had their childbirths in the 27 units, however presenting no complications. The aspects that differ from the methodology of the study are shown in Table 2, along with each of the 13 articles. Cecatti *et al.*[35] present overall results, and the other articles explore MNM according to age group[36] and with specific conditions: abortion,[37] ectopic pregnancy,[38] hypertensive diseases,[39,40] hemorrhage,[41,42] infections,[43,44] heart diseases.[45] Healthcare factors were also analyzed, such as quality of care[46] and the association with cesarean section[47] based on Robson's Classification.

Hypertensive disease was the main cause of maternal *near miss* (45%) and maternal death (30%), followed by hemorrhage (40.5% of maternal *near miss* and 26% of maternal deaths). More than 75% of the maternal death cases observed, more than one *near miss* criterion defined by WHO was found. The highest maternal *near miss ratio* occurred in women aged 40-49 (31.4/1,000 LB), followed by the age of 35-39 (17.5/1,000 LB), and 35-49 years old (20.55/1,000 LB), compared to adolescents with a ratio of 7.14/1,000 LB.[36]

Population survey based studies

Six studies (Table 3) were based on the population surveys, selecting or creating questions to enable the capture of cases during the interviews with the women.[48-53]

The oldest article[48] used as a criterion only complications such as prolonged labor, excessive hemorrhage, high fever, seizures. The other articles[49-53] used, with some adaptations, maternal conditions/complications and interventions, evaluating history of eclampsia, hysterectomy, blood transfusion and ICU admission, previously validated criteria.

Four studies relied on the 1996 and 2006 national surveys (DHS), with home interviews of women with live births in the previous five years[48-50] and women with history of abortion.[51] Cecatti *et al.*[52] used data from a vaccination campaign survey for women in the Amazon and the Northeast regions, while Rosendo and Roncalli[53] conducted a home survey in Natal City in Rio Grande do Norte State.

Table 3

Population survey based studies.

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Souza *et al.*,[48] 2008	Brazil: seven locations – São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo, Midwest, South, Northeast and North regions	1996	-Survey - DHS 1996 -Household interviews in census sectors -Multivariate logistic regression	- 3,761 women had live births in the last five years - 5,045 LB	-Complications: Prolonged labor, excessive hemorrhage, high fever, seizures	-Presence of complications during pregnancy: 4.8% prolonged labor, 10.3% hemorrhage, 5.4% fever, 3.7% seizures: 2.7% - Significant association found with SMM: hemorrhage associated to non-white skin color (OR=1,72); any complication associated to previous children (OR=1.33), and the North (OR=2.00) and Midwest (OR=1.33) regions
Souza *et al.*,[49] 2010b	Brazil: five regions	2006-2007	-Survey - DHS 2006 -Household interviews in census sectors -Multivariate logistic regression	- 5,025 women had live births in the last five years - 5,045 LB	-Eclampsia, hysterectomy, blood transfusion and ICU admission	-Presence of complications during pregnancy: 2%. Most frequent: hemorrhage -Criteria: eclampsia – 0.6%; hysterectomy – 0.2%; blood transfusion – 0.8% and ICU – 0.5%. - Population estimates: Number of maternal *near miss* cases: around 70,000 MNM Ratio: 21.1/1,000 LB MNM/MD Ratio=28.4; Mortality rate= 3.3% -Association with age 40-49 years old (OR=9.60) and low schooling (OR=2.18)
Oliveira Jr *et al.*,[50] 2013	Brasil: cinco regiões	2006-2007	-Survey - DHS 2006 -Household interviews in census sectors -Multivariate logistic regression	- 5,025 women had live births in the last five years - 6,833 pregnancies	-Eclampsia, hysterectomy, blood transfusion and ICU admission	-Maternal *near miss* ratio by age: 15-19 years: 5.9/1,000 LB (most frequent: eclampsia) 20-34: 19.9/1,000 LB (most frequent: blood transfusion) 35-49; 28.3/1,000 LB (most frequent: eclampsia) -For age group of 35-49 years old, association with low schooling and pregnancy complications (OR=5.23)
Camargo *et al.*,[51] 2011	Brasil: cinco regiões	2006-2007	-Survey - DHS 2006 -Household interviews in census sectors	- 15,542 women who had an abortion	-Eclampsia; hemorrhage; infection; hysterectomy; blood transfusion; ICU admission; mechanical ventilation	-Comparing women who had an abortion with those who had not, there was a higher prevalence of hemorrhage (PR= 2.54; 1.85-3.49); infection (PR= 2.89; 1.34-6.24); hysterectomy (PR= 5.37; 0.83-34.93), severe maternal morbidity (SMM) criteria. Global association abortion/SMM= 2.29 (1.73-3.04)

continues

DHS= demographic and health survey; MD= maternal death; SMM= severe maternal morbidity; MNM= maternal *near miss*; LB= live births; OR= *odds ratio*; RN= Rio Grande do Norte; PR= prevalence ratio; ICU= intensive care unit.

Table 3 **concluded**

Population survey based studies.

Author and year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Cecatti *et al.*,[52] 2015	-Amazônia and Northeast	2010	-Secondary analysis of the survey "*Chamada Neonatal*" performed during vaccination campaign -Poisson regression	- 13,044 women with childbirth history of previous year	-Eclampsia, hysterectomy, blood transfusion; ICU admission	- Maternal *near miss ratio*: 31.5/1,000 LB -Amazônia – 36.3/1,000 LB (higher in Roraima – 57.9/1,000 LB and lower in Rondônia – 6.7/1,000 LB); Northeast – 29.6/1,000 LB (higher in Alagoas and Pernambuco- about 40/1,000 LB and lower in Maranhão-16.3/1,000 LB) - Most frequent complication: hemorrhage and infection. - Most frequent MNM criteria: eclampsia and blood transfusion - Significant association with MNM: indigenous ethnicity (PR= 2.77), prenatal care at a public health service (PR=1.95), pregnancy pilgrimage (PR= 1.49) and cesarean childbirth (PR= 2.56).
Rosendo & Roncalli,[53] 2015	-Natal, RN	2014	-Household survey Difference in proportions (Chi-square test)	- 848 (15-49 years old, reported pregnancy in the last five years) in 8,227 households	-Hysterectomy, blood transfusion, ICU admission and eclampsia (criteria proposed by Souza *et al.*,[54])	- Maternal *near miss ratio*: 41.1/1,000 LB. -Most referred criteria identified: ICU admission (19.1/1,000 LB) and eclampsia (13.5/1,000 LB), followed by blood transfusion (11.3/1,000 LB), hysterectomy (2.3/1,000 LB). - Clinical conditions mostly reported: hemorrhage (10.7%) and urinary infection (10.7%); most frequent intervention: hospital stay >7 days postpartum (5.4%) - Increased prevalence of MNM in mixed/black women, although with significance border (p=0.052)

DHS= demographic and health survey; MD= maternal death; SMM= severe maternal morbidity; MNM= maternal *near miss*; LB= live births; OR= *odds ratio*; RN= Rio Grande do Norte; PR= prevalence ratio; ICU= intensive care unit.

Table 4

Information systems based studies on SIH-SUS and SIM.

Author and, year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Sousa *et al.*, [54] 2008	Brazil (Brazilian capitals and the Federal District)	2002	-SIH and SIM -Descriptive	- 32,379 women with diagnosis of severe maternal morbidity	-Mantel *et al.*[32] -Waterstone *et al.*[31]	- MNMR was 44.4/1,000 LB - The most frequent maternal *near miss* criteria were: Severe pre-eclampsia (30.6%), Sepsis (23.7%) and Hemorrhage (20.3%)
Magalhães *et al.*,[57] 2012	-Juiz de Fora, MG	2006-2007	-SIH -Prevalence ratio	- 8,690 hospitalized women with diagnosis from chapter XV of ICD-10 and/or obstetrics procedures	-WHO[3]	- The prevalence of Extremely Severe Maternal Morbidity was 37.8/1,000 women - The most frequent procedures/conditions were: blood transfusion (15.7/1,000), increased length of hospital stay (9.5/1,000) and severe pre-eclampsia/eclampsia (8.2/1,000) - Predicting factors for ESMM: hospital stay length higher than 4 days (PR= 14.32), more than one hospitalization (PR= 5.1) and stillbirth (PR= 4.86).
Nakamura-Pereira *et al.*,[58] 2013	-Rio de Janeiro, RJ	2008	-SIH -Review on medical files -Descriptive	-221 cases	-WHO[3]	-MNMR: 33.2/1,000 LB - 58.8% of the women presented clinical conditions compatible to non-*near miss* maternal morbidity; 12.2% presented clinical condition compatible to *near miss* - The main determinants of *near miss* occurrence: hemorrhage (40.7%) and hypertensive syndrome (29.6%) - Most frequent clinical conditions: severe thrombocytopenia (40.7%), shock (37%) and creatinine >= 3.5 mg/mL (18.5%)

continues

PHC= primary healthcare; FHS= family health strategy; HELLP= hemolysis elevated liver enzymes low platelet; MD= maternal death; SMM= severe maternal morbidity; ESMM= extremely severe maternal morbidity; MNM= maternal *near miss*; LB= live births; WHO= World Health Organization; PN= prenatal; HYPDR= MNM ratio for hypertensives diseases; HR= MNM ratio for hemorrhage; MNMR= maternal *near miss ratio*; PR= prevalence ratio; RR= relative risk; SIH= hospital information system; SIM= mortality information system; SUS= Public Health System; ICU= intensive care unit.

Table 4 **concluded**

Information systems based studies on SIH-SUS and SIM.

Author and, year of the article	Study location	Studied period	Type of study/ source/ analysis	Population	Criteria	Results
Rosendo & Roncalli, [55] 2016	- 167 cities in Rio Grande do Norte, Brazil	2008 -2012	-Ecologic study -SIH -Multiple linear regression	-Women 15-49 years old, residents in RN, hospitalized for obstetrics procedures at SUS-hired or associated units. Cities grouped (Skater method) in 63 clusters.	Waterstone *et al.*, [31] excluding HELLP syndrome (for not having the corresponding ICD-10 code) .	- MNMR average: 36.67/1,000 women (SD: 17.90). According to the markers condition, the higher ratio was for pre-eclampsia (24.66), hemorrhage (4.55) and sepsis (4.29). Hypertensive diseases: group with the highest average MNMR (27.65) - For MNMR, positive correlation with % households with high density (p=0.049) and % mothers head of the household with low schooling (p=0.032) and negative correlation with % of families benefited by "*Bolsa Família*" grant program (p=0.001) - For HYPDR: positive correlation with % households with high density (p=0,021); and negative correlation with % of families benefited by "Bolsa Família" grant program (p=0.001); for RH: positive correlation with child mortality (p=0.041) - Lack of variables correlation in primary healthcare as prenatal consultations and Family Health Strategy.
Silva *et al.*,[56] 2016	-Paraná	2010	-Descriptive -Source: SIH	- 111,409 women aged 10-49 years old hospitalized at SUS with pregnancy, childbirth and puerperium complications.	-Waterstone *et al.* [31] -Mantel *et al.*[32] -Established criteria by Sousa *et al*.[54]	- Global rate of SMM: 52.9/1,000 childbirths -Absolute number: 4,890 cases, 4,225 were identified by the main diagnosis, 424 by procedures, 216 by ICU admission and 25 by secondary diagnosis - Rate by age group: 43.5 for 10-19 years old, 51.6 for 20-34 years old and 88.6 for 35-49 years old - Rate by criteria: Pre-eclampsia (14.9) and eclampsia (5.1); severe hemorrhage (12.5); immune disorder (7.4); severe sepsis (5.5); heart disorder (2.7) and ICU admission (2.3)

PHC= primary healthcare; FHS= family health strategy; HELLP= hemolysis elevated liver enzymes low platelet; MD= maternal death; SMM= severe maternal morbidity; ESMM= extremely severe maternal morbidity; MNM= maternal *near miss*; LB= live births; WHO= World Health Organization; PN= prenatal; HYPDR= MNM ratio for hypertensives diseases; HR= MNM ratio for hemorrhage; MNMR= maternal *near miss ratio*; PR= prevalence ratio; RR= relative risk; SIH= hospital information system; SIM= mortality information system; SUS= Public Health System; ICU= intensive care unit.

The MNMR varied from 21.2/1,000 LB to 41.1/1,000 LB. Among the criteria used for MNM, the most observed were eclampsia and blood transfusion, except in the study in Natal City, where ICU hospitalization was more frequent.[53] Hemorrhage was the clinical complication most commonly reported by women.

Age ≥ 35 years old, low schooling and non-white skin color were the most frequent socioeconomic factors associated. Other cited factors were absence of prenatal and pilgrimage for childbirth.

Information systems based studies

Of the five studies (Table 4), only one evaluated the national data.[54] Regarding the criteria, three[54-56] used Waterstone and Mantel's criteria,[54-56] and two [57,58] used the WHO criteria with some adaptations. Women with a history of gestation, delivery and puerperium, women diagnosed with severe maternal morbidity, and women hospitalized for obstetric procedures were included. Pre-eclampsia was the most frequent indicator by Waterstone and Mantel's criteria.

The authors used both maternal *near miss*, ratios varied from 32.2 and 44.4/1,000 LB, as severe/extremely severe maternal morbidity, and the ratios varied from 36.7/1,000 women in patients55 to 52.9/1,000 deliveries.[56] Nakamura-Pereira *et al*.[58] evaluated the information quality of the *Sistema de Informações Hospitalares do Sistema Único de Saúde* (SIH-SUS) (Hospital Information System of the Public Health Service) for the study on severe maternal morbidity and estimated low sensitivity (18.5%) with high specificity (94.3%).

In this group of studies, the worse primary care assistance, as well as the history of stillbirth children and ages between 35-49 years old were the variables associated to the poverty markers outcome.

Discussion

This review identified 48 studies on severe maternal morbidity/maternal *near miss* in Brazil. Unlike other themes in women and childhood health, there was a high number of studies in the Northeast region was observed.

In 2005, the first Brazilian article was published using the term maternal *near miss*.[9] The criteria used were from Waterstone, Mantel and Geller.[31-33] Hypertensive diseases and hemorrhages shared as the main causes, according to the criterion. Both conditions remain as the main causes associated to maternal morbidity.

Three approaches were adopted by the studies as regard to the data sources:[8] hospital based predominance, with local or national primary or secondary data; the use of the information systems, *Sistemas de Informações Hospitalares do Sistema Ùnico de Saúde, Sistemas de Informação sobre Mortalidade* (SIH-SUS, SIM) (Hospital Information System of the Public Health Service, Information System on Mortality), and also the local or national population surveys. Each one showed advantages and fragilities.

In the case of hospital based studies, the main problem concern management criteria of the WHO classification. Depending on the infrastructure, the existence of protocols and the quality of the team, the indications and applications of some procedures can vary widely among institutions. The ICU indication, alone, is already considered as a *near miss* criterion and is very dependent on the factors above.

Limitations for the WHO *near miss* criteria in case of using the SIH-SUS as a data source: difficulty in correlating these criteria with diagnoses of ICD-10 and with procedures codes adopted by SIH-SUS[56] and low sensitivity.[59] However, Magalhães *et al*.[57] used the SIH as a source and WHO criteria in their study, and evaluated the results found as satisfactory. Silva *et al.*[56] supports the use of Waterstone's criteria for studies with SIH to increase sensitivity.

In relation to the national surveys, such as DHS, the information is self-referred and there are no forms to prove the diagnoses. Souza *et al.*[49] comment on the limitations of the questionnaires used in this type of survey. When referring to their morbidities, women remember more of the interventions than the clinical complications; they rarely report eclampsia, for example.

The heterogeneity of the terminology was observed: Severe Maternal Morbidity, Extremely Severe Maternal Morbidity and Maternal *Near Miss*. In some cases, the authors use the terms indiscriminately and sometimes they use Severe Maternal Morbidity (SMM) as the synonym of Life Threatening Conditions. This heterogeneity implies the difficulty to compare results within the studies, but notice that the term maternal *near miss* prevailed. There was also heterogeneity in relation to the indicator that expresses the relative frequency of MNM. The MNM ratio was calculated when the denominator consisted on the number of live births and the incidence was calculated when the denominator referred to the number of childbirths or hospitalized women.

The study on maternal *near miss* showed the potential of indicators proposed by WHO as predic-

tors of maternal death: women that presented three or more criteria were more likely to die than those that presented only one criterion.[35]

There was also a similarity between the causes of MNM and those of maternal death in Brazil. Direct obstetric causes still prevail, but indirect ones are increasing. This pattern, allied to the increase of cesarean sections confirm that the Country presents itself in an obstetric transition movement.[59]

The most frequently associated factors in this study with MNM/SMM/ESMM were: age ≥ 35 years old, low schooling, current or previous cesarean section, hemorrhage, previous hypertension and prior abortion.

Inequalities inmaternal health were evidenced as regarding maternal morbidity. Considering the MNM/MD as an indicator to assess the quality of obstetric care after women's admission, the values observed were three times lower in regions with the lowest HDI in the Country[39] In Pfitscher *et al.*,[43] study considering that the H1N1 pandemic and its effect on maternal *near miss*, it was observed that non-white women progressed more frequently for more severe conditions, including death. Pacagnella *et al*.[46] analyzed any presence of delays in pregnant women care and showed that non-white color adolescence with low schooling were strongly associated. In relation to the age group, Oliveira Jr. *et al.*[36] found the lowest MNMR in women aged 10 to 19 years old, however this age group had the most delays in care. The inequities in relation to these variables add to of other maternal and child health outcomes, such as prenatal access.[60]

On the other hand, a protective effect was observed in relation to MNM for the beneficiary families of Bolsa Família Program[55] (a Government program for extreme low income family to receive like an allowance) and the protective association of prenatal care regarding MNM was well evidenced.[18,24,28,46] It ratifies that complementing both politics and income as a basic care can reverse inequalities. However, it is necessary to improve prenatal care adequacy in SUS, considering that some studies showed worse performance compared to private prenatal care.

Brazil is known worldwide for the high incidence of cesarean sections.[61] In several studies, previous or current cesarean section was associated to MNM/ESMM/SMM.[21, 22, 24, 25, 27, 29, 34, 52] Only one study showed cesarean section as a protective factor.[17] The maternal *near miss* rate for cesarean section was 91 cases/1,000 deliveries whereas the incidence rate on vaginal delivery was 16 /1,000 deliveries.[32] Although it is not possible to evidence a direct association, in virtue of an adequate procedure for several gestational risk situations, even though the cesarean section rate was high and the association to postpartum hemorrhage, identified in some studies, does not justify for the prior indication but could be attributed to the procedure. Adopting Robson's classification to monitor and compare cesarean indications should be a national recommendation.

As for abortion, about 2% of the women (more than 450) interviewed in the "Born in Brazil" research reported the tentative to interrupt their current gestation.[60] Souza *et al.*[9] and Galvão *et al.*[22] studies found an association between previous abortion and maternal *near miss*, and Santana *et al*.[37] and Camargo *et al.*[51] studies reported a higher risk of *near miss* in women submitted to abortion.

An evaluation of national base studies is required. "Born in Brazil" research was a hospital based study covering all the Brazilian regions, including only hospitals with more than 500 childbirths per year and excluding cases of abortion and hospitalization during pregnancy which was not the main goal of this study.[5] As most births in Brazil occur in a hospital environment, this study could be considered as a population study approach, except for the above limitations. Their results, consistent with those studies at the local level have a great relevance for guiding health policies.

This study showed an association between cesarean section and maternal *near miss*, even after the adjustments on obstetric complications and two groups of women were identified: the first, white skin, high schooling, adequate prenatal care, no history of pilgrimage for delivery and a high frequency of elective cesarean section; and the second one, mixed or black skin, low schooling, younger, with absence of prenatal care and a higher frequency of vaginal delivery.

Domingues *et al.*[34] concluded that indiscriminate use of cesarean section may approximate the occurrence of MNM between the two groups. However, if the interpretation of the hierarchical model was used, preserving distal factors without adjustment, there was a positive association between age ≥ 35 years old, low schooling, primiparity and previous cesarean section (considering the OR obtained in model 1, without adjusting for intermediate and distal variables). This analysis reinforces inequality in *near miss* occurrence and the importance of previous cesarean section.

Studies derived from the Multicenter Surveillance Network for Severe Maternal Morbidity explored for the first time MNM

subgroups according to different conditions and increasing the knowledge on maternal morbidity. Maternity hospitals were select from five Brazilian regions, with a greater representation in the Southeast, mainly São Paulo State. As a limitation, the maternities included were predominantly tertiary/reference and were not representative of the morbidity population profile. This is confirmed by the MMR found in the study of 170/100,000 live births. However, they managed to capture in these locations a large number of patients with severe maternal morbidity, increasing statistical power of the results.

Another limitation was the absence of comparison with the control group (women without complications in the maternity hospitals), which does not allow to identify the population risk factors. In contrast, it was possible to evaluate the severity gradient in the subgroups in the same clinical condition, observing the relationship between PLTC, MNM and MD. The highest mortality rate was found for respiratory diseases (32.2%), with emphasis on H1N1 (51.8%), followed by infections (26.3%), heart diseases (24%), eclampsia (19%), postpartum hemorrhage (15%), hypertensive disease (10.7%), and antepartum hemorrhage (9%). Although the mortality rate for hemorrhagic conditions is not so high, the frequency of placental abruption is high, contributing for *near miss*. When the data was collected for this study, there was a H1N1 pandemic underway (2009) and the severity of this infection in pregnant women revealed high morbidity and mortality.

When comparing these two studies, a very similar MNM ratio was observed, but the MMR was much higher in the Multicenter Network study. In addition to the reasons explained above, "Born in Brazil" study did not directly estimate maternal deaths, but used a proxy, which may have contributed to the difference found. Regardless to the differences between the studies, several results are similar and corroborate the need to increase and qualify care for women.

There is a predominance of publications in international journals in the English language, which may hampered the dissemination of the *near miss* concept among health professionals in our Country. In international journals, the area of Reproductive Health was predominant, while in national journals, public health showed to be more productive and there were only three articles in the journals of the Gynecology-Obstetrics specialty.

As the limitations of this review, we point out the bibliographic search, which unpublished studies were not included. We only used well-known keywords used by WHO: *near miss* and severe maternal morbidity. However, we believe that we have made our search more specific, considering that many national studies have already incorporated the WHO terminology. We would like to suggest the incorporation of the terms to the health descriptors.

Regarding possible information bias, the reading and extraction of the data by more than one researcher, independently, contributed to its attenuation.

There are no other systematic national reviews on the subject, and the most recent review included a few Brazilian studies.[6] And besides that, this study goes back to prior studies conducted before the WHO definition for *near miss*. Therefore, comparison is limited. Nevertheless, we highlight the heterogeneity of the *near miss* criteria, the prevalence of hospital based studies and the presence of social inequalities.

The study on maternal morbidity has been relevant in Brazil in pointing out fragile points in the health services. Although the results vary, the frequency of women with potential life-threatening complications is high in Brazil, which reinforces the need to universalize more complex interventions as well as coverage of primary care.[62]

We conclude that the evaluation of maternal *near miss* should be implanted as a routine in the maternity hospitals, using the WHO criteria of greater specificity and adding other criteria according to the capacity of each unit, in increasing sensitivity. It is important to emphasize that it should not only be an aid for the study on maternal mortality, but also for the conditions of maternal morbidity in pregnancy, childbirth and the puerperium.

In the research field, the theme is not exhausted; other studies evaluating more than one criterion and using longitudinal outlines are necessary to deepen the understanding of maternal morbidity and mortality in Brazil.

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