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## Systematic Review

# Prevalence and risk factors of maternal near miss in India: A systematic review and meta-analysis

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***Background and objectives***: Maternal near miss (MNM) is a marker of severe maternal complications and reflects the quality of obstetric care systems. The present systematic review and meta-analysis aimed to estimate the prevalence of MNM and identify common risk factors among pregnant women in India.

***Methods***: In accordance with PRISMA 2020 guidelines, "MEDLINE, Scopus, Embase, and Web of Science" database search was carried out until November 21, 2024. Observational studies from India that detailed the risk factors and prevalence of MNM were included. The Newcastle Ottawa Scale (NOS) and the JBI checklist were used to evaluate quality. Prevalence and heterogeneity were determined through meta-analysis using a random-effects model.

***Results***: There were 6,606 MNM cases in 39 studies with 242,015 pregnant women. The pooled prevalence of MNM was 3.9% (95% CI: 1.6%–7.2%) with substantial heterogeneity ($I^2$=99.4%). The prevalence of MNM varied between the states, with Rajasthan reporting as low as <1% to West Bengal reporting 38%. Anemia, sepsis, haemorrhage, and hypertensive disorders were the most frequently mentioned risk factors.

***Interpretation and conclusions***: The prevalence of MNM varies greatly throughout India. The study emphasizes the necessity of integrating MNM surveillance into national health systems.

**Keywords** India; Maternal near miss; Meta-analysis; Risk factors; Severe maternal morbidity

An estimated 260,000 maternal deaths occurred worldwide in 2023, a 40% decrease from 2000. Despite these advancements, there are still significant differences; 70% of maternal deaths worldwide occur in Sub-Saharan Africa, while 17% occur in Southern Asia.[1,2] The World Health Organization (WHO) defines a maternal near miss (MNM) as 'a woman who nearly died but survived a life-threatening complication during pregnancy, childbirth, or within 42 days of termination of pregnancy'.[3,4] The fact that MNM cases are 20–30 times more common than maternal deaths provides important information about the standard of obstetric care and the efficacy of emergency measures.[5] Studies have demonstrated a strong correlation between the occurrence of adverse perinatal outcomes, such as stillbirth, and preterm birth, among others and the MNM events.[6] Although India has achieved notable progress in reducing maternal mortality through policies like LAQSHYA, '*Janani Suraksha Yojana* (JSY)', maternal morbidity—especially MNM—continues to be underreported and insufficiently recognized.[7-9] In India, MNM rates vary across states and settings, ranging from 8 to 39 per 1,000 live births in hospital-based studies.[10-12] Common determinants include anaemia, prior caesarean delivery, lack of antenatal care (ANC), hypertensive disorders, and delays in

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seeking or receiving care.[13] Common medical causes include severe bleeding and hypertension, but the cases are worsened by poor antenatal care, delay in receiving care, and lack of critical resources like blood or trained staff. Social issues such as limited awareness, transport challenges, and financial hardship also play a major role.[14]

There are few attempts to examine severe maternal morbidity in order to find the determinants that can be prevented and scope to enhance the maternity care that hospitals and health systems provide.[15] Currently, India lacks pooling of data on MNM and a national surveillance is crucial for guiding policy and improving maternal health outcomes.[14] This systematic review and meta-analysis (SRMA) aims to generate pooled estimates of maternal near miss and its associated factors in Indian context.

## Methods

'Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA)' 2020 guidelines were adhered to for this SRMA (**Supplementary Table I**). Study was registered with PROSPERO. The primary research question was: 'What is the prevalence of maternal near miss among pregnant women in India?' While secondary research question was: 'What are the underlying risk factors and causes for maternal near miss among pregnant women in India?' Detailed eligibility criteria as per PECO is enumerated in **Supplementary Table II**.

*Search strategy*: Search was done on "MEDLINE (PubMed), Scopus and Web of Science" databases till November 21, 2024. The initial search strategy was developed by one of the reviewers (APG), which was peer reviewed by two other reviewers (PR and PD). Database specific search strings are given in **Supplementary Table III**. Reference lists of the included studies were manually examined to identify any additional relevant studies.

*Study selection process*: The study selection was done in two stages- title/abstract and full text screening. Two reviewers (PR, SVK, PA and PS) independently carried out the screening at title/abstract and full text screening stages (KD, AY, SS, CG). The articles found relevant were advanced for full text review, where they were again assessed by both the reviewers according to the predefined eligibility criteria. The reviewers arrived at the consensus after discussion with the third reviewer APG and disagreements if any, were resolved

*Data extraction*: Data of the studies included after consensus was extracted. Two reviewers (PR, SVK, PA and PS) independently extracted the data in a preformed Microsoft Excel sheet which included study location, study period/publication year, study design, diagnostic criteria, incidence of MNM and/or its risk/causes. A final consensus sheet was then used for analysis and review purpose.

*Quality assessment*: Two reviewers (KD, AY, SS, CG) independently assessed the quality of the included studies. JBI checklist was used for cross-sectional studies and New Castle Ottawa scale was used for analytical observational studies. Consensus was met after discussion with third reviewer (AGP)

*Statistical analysis*: A random-effects model employing maximum likelihood estimators was utilized to derive pooled outcome estimates (proportions). Inter-study heterogeneity was assessed using the $I^2$ statistic. Freeman–Tukey double-arcsine (PFT) transformation (sm = "PFT" in the R meta package) was applied to stabilize variances when pooling proportions. The pooled results were back-transformed to the proportion scale to simplify interpretation. To evaluate publication bias, Doi plots and the LFK index were applied. Leave-one-out analysis was undertaken to determine the sensitivity of pooled estimate. Meta-regression and bubble plot were made to explore the heterogeneity. All statistical analyses were performed in R Studio.

## Results

*Study selection*: A systematic search yielded 498 studies and after removing the duplicates (n=235), 232 unique articles were received from 4 databases [Embase(n=218), Scopus (n=123), PubMed (n=66) and Web of Science (n=91)]. Following two stage screening, 39 studies were found eligible, **(Fig. 1)** from which 20 studies were included in meta-analysis. The most common reasons for exclusion at full text review were that they reported outcomes other than maternal near miss (n=66), including populations that did not fit our criteria (n=69), or used study designs that were not eligible for this review.

*Study characteristics*: The demographics of individual studies are mentioned in **Table.**[16-33,35-48,51-53,55-58]

Out of 242015 pregnant females reported across the selected studies, 6606 were MNM. Data were collected from either face-to-face interviews or hospital records. The study periods ranged from 2009 to 2023.The included studies represented diverse geographical

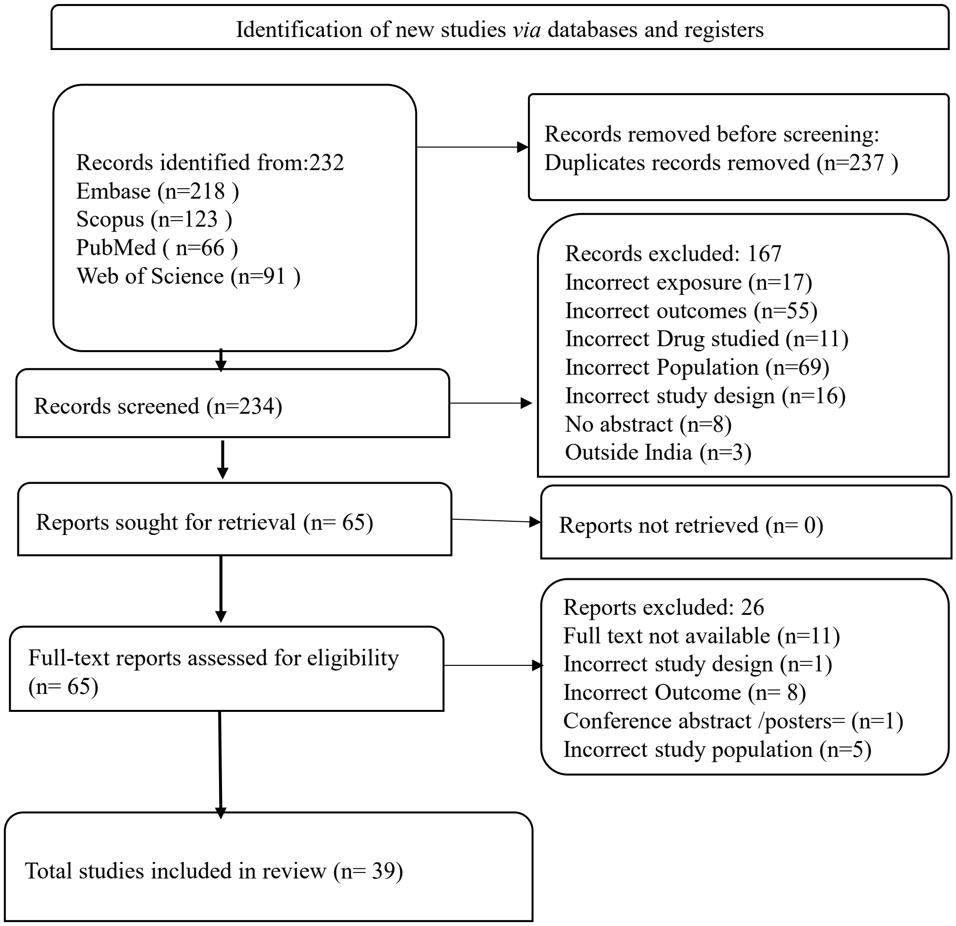


**Fig. 1.** PRISMA flowchart for identification of studies.

regions of India- from the North,[16-25] South,[26-31] West,[32-44] and East/Central regions.[14,45,46]

The prevalence and incidence of MNM per 1000 live births and mortality ratio were given by various studies.[18,19,21-24,26,33,35,36,43,47-53] Maternal near miss incidence ratio of 45.2 per 1000 was reported by Yasmin *et al.*[18] MNM IR of 24.2/1000 live births and a mortality ratio of 2.4:1 was reported by Grover *et al*[17]. The prevalence of MNM varied between the states, with Rajasthan reporting as low as <1% to West Bengal reporting 38%.[38,39]

Neonatal mortality was reported at 21.5 per 1,000 live births, while the maternal mortality ratio was 832.8 per 100,000 live births. The most common determinant of maternal near-miss (MNM) events was severe pregnancy-induced hypertension (PIH), which had a relatively low mortality index of 5.8 per.[44] Another study reported an MNM ratio of 23.8 per 1,000 live births and an MNM rate of 20.6 per 1,000 pregnant women admitted.[36] A hospital-based analysis of 220 MNM cases found that 58.18% of women underwent caesarean delivery, while 40% delivered vaginally.[32] Hypertensive disorders of pregnancy were identified as the leading cause of near-miss events (53.2%), followed by anaemia (19.09%), heart disease (9.09%), and abruptio placentae (6.36%) (Doshi *et al*,[32]). Approximately 52% of the women exhibited vascular and haematological dysfunction.[32]

A study identified haemorrhage as the leading cause for maternal mortality.[26] In another study 36,366 deliveries were reviewed, and 315 cases of MNM were identified.[33] Hypertensive disorders were the most common cause, accounting for 133 cases (42.22%). This was followed by obstetric haemorrhage (97 cases, 30.79%), severe anaemia (36 cases, 11.42%), and sepsis (30 cases, 9.52%).

*Prevalence of maternal near miss*: A meta-analysis of 20 studies assessing maternity near miss events showed a pooled prevalence of 0.04 (95% CI: 0.02; 0.07%).[16,26-28,31,37-42,45,46,48,54,55] High heterogeneity was observed

**Table. Characteristics of the included studies**

| No. | Authors, yr | Location | Study period | Study design | MNM | Sample size |
|---|---|---|---|---|---|---|
| 1 | Chhabra *et al*[16] , 2019 | Delhi | January 2013 to June 2015 | Case-control | 261 | 38111 |
| 2 | Grover *et al*[17], 2022 | Punjab | March 2015 to July 2016 | Observational study | 53 | 413 |
| 3 | Yasmin *et al*[18], 2016 | Uttar Pradesh | July 2015 to July 2016 | Prospective Observational study | 122 | - |
| 4 | Madan *et al*[19], 2021 | Punjab | Duration - 20 months | Retrospective | 63 | - |
| 5 | Nath *et al*[20], 2020 | Delhi | October 2015 to December 2016 | Cross sectional observational study | 249 | |
| 6 | Pandit *et al*[21], 2019 | Chandigarh | July 2015 to February 2016 | Prospective observational study | 174 | - |
| 7 | Nanda *et al*[22], 2016 | Haryana | September 2012 to February 2014 | prospective observational study | 184 | 15170 |
| 8 | Sangeeta *et al*[23], 2014 | North India | January 2012 to March 2013 | Prospective observational study | - | - |
| 9 | Bakshi *et al*[24], 2015 | Uttarakhand | 12 months | Cross sectional epidemiological study | 51 | |
| 10 | Pandey *et al*[25], 2014 | Uttar Pradesh | May 2011 to April 2012 | Retrospective case record study | 633 | - |
| 11 | Vandana *et al*[26], 2021 | Karnataka | October 2016 to June2018 | Prospective observational | 31 | 300 |
| 12 | Reena *et al*[27], 2018 | Kerala | January 2016 to December 2016 | cross-sectional | 32 | 3451 |
| 13 | Roopa PS *et al*[28], 2013 | Karnataka | Jan 2011 to Dec 2012 | Observational study | 131 | 7330 |
| 14 | Shiva *et al*[29], 2023 | Karnataka | September 2018 and August 2019 | prospective observational study | 218 | 16016 |
| 15 | Sunanda *et al*[30], 2023 | Karnataka | October 2021 to September 2022 | retrospective analysis | 164 | 8791 |
| 16 | Padmavathi *et al*[31], 2023 | Andhra Pradesh | January 2022 to September 2023 | prospective study | 109 | 4536 |
| 17 | Doshi *et al*[32], 2023 | Maharashtra | September 2017 to August 2019 | Prospective observational | 220 | - |
| 18 | Ingole *et al*[33], 2021 | Not reported | January 2010 to September | retrospective observational study | 315 | - |
| 19 | Rathod *et al*[35], 2016 | Maharastra | January 2011 to December 2013 | Retrospective cohort study | 161 | - |
| 20 | Parmar *et al*[36], 2016 | Gujarat | May 2012 to September 2012 | Cross sectional observational study | 46 | - |
| 21 | Maity *et al*[37], 2022 | West Bengal | April 2018 to December 2020 | Descriptive observational | 249 | 26332 |
| 22 | Kumar *et al*[38], 2018 | West Bengal | May–June 2016 | Prospective observational | 126 | 332 |
| 23 | Kalra *et al*[39], 2015 | Rajasthan | May 2011 to October 2012 | Cross-sectional observational study | 112 | 26734 |
| 24 | Bhattacharjee *et al*[40], 2024 | Gujarat | January 2014 to December 2021 | retrospective observational | 280 | 9133 |
| 25 | Bhadra *et al*[41], 2024 | West Bengal | June 2023 to June 2024 | Observational, record-based cross-sectional | 234 | 6582 |
| 26 | Thakur *et al*[42], 2023 | Madhya Pradesh | January 2015 to June 2015 | hospital based cross sectional study | 63 | 6198 |
| 27 | Sayyed *et al*[43] , 2023 | Rajasthan | January2020 to December 2020 | prospective observational study | 170 | 12127 |
| 28 | Desai *et al*[44], 2013 | Gujarat | April 2011 to October 2011 | Retrospective case record study | - | - |

*contd..,*

| No. | Authors, yr | Location | Study period | Study design | MNM) | Sample size |
|---|---|---|---|---|---|---|
| 29 | Meravi *et al*[45], 2024 | Madhya Pradesh | August 2019 to August 2020 | Observational | 262 | 2481 |
| 30 | Thakur *et al*[46], 2023 | Chandigarh | November 2018 to 31st October 2019 | prospective study | 258 | 5994 |
| 31 | Chaudhary *et al*[47], 2018 | West Bengal | April 2013 to October 2014 | Prospective observational study | 177 | 4200 |
| 32 | Abha *et al*[48], 2016 | Chattisgarh | September 2013 to August 2015 | Prospective observational study | 211 | - |
| 33 | Khan *et al*[51], 2017 | Delhi | September 2009 to August 2011 | retrospective cross-sectional study | 302 | - |
| 34 | Singh *et al*[52], 2023 | Jharkhand | April 2018 toSeptember 2019. | Observational study | 200 | - |
| 35 | Kulkarni *et al*[53], 2023 | Maharashtra | July 26, 2018 to November 25, 2020 | Prospective observational | 228 | 26091 |
| 36 | Balachandran *et al*[55], 2022 | Puducherry | May 2018 to April 2021 | Prospective observational | 323\|280 | 37590 |
| 37 | Bavdekar *et al*[56], 2023 | Maharashtra | 18 months | Retroprospective observational study | 120 | 3488 |
| 38 | Keepanasseril *et al*[57], 2024 | Puducherry | May 2018 and September2021 | Prospective observational study | 323 | 1833 |
| 39 | Nanda *et al*[58], 2016 | Haryana | September 2012 to February 2014 | Prospective observational study | - | - |

PIH, pregnancy induced hypertension; HTN, hypertension; BPL, below poverty line; CVD, cardiovascular disorders; MNM, maternal near miss

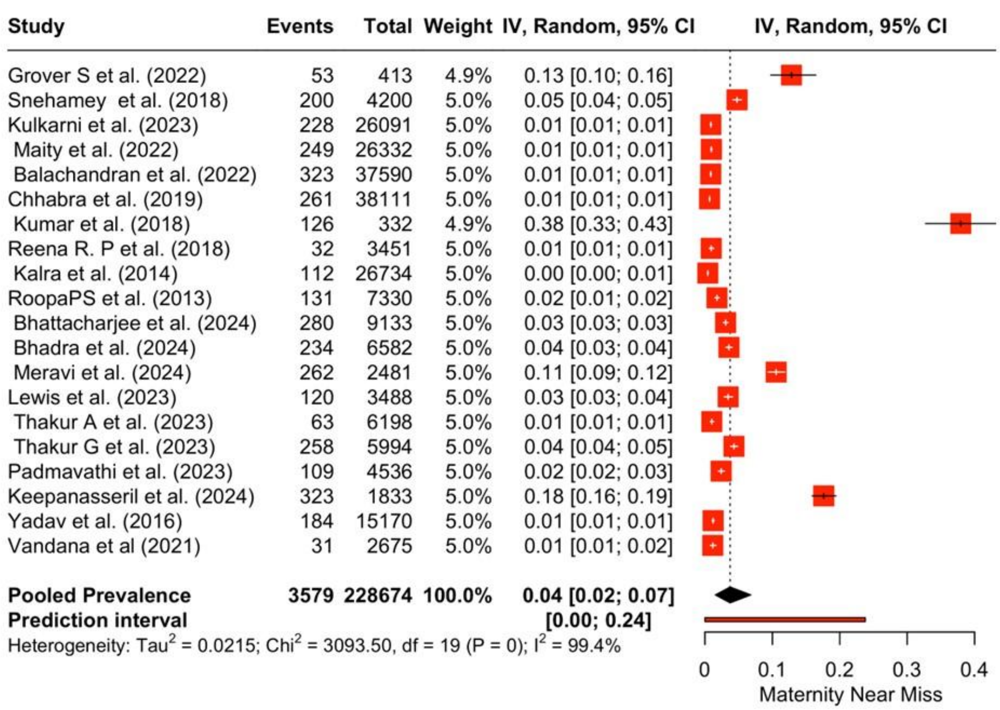


**Fig. 2.** Prevalence of maternal near miss.

across the studies ($I^2$=99.4%, *P*< 0.001). The prediction interval (0.00–0.25) is also suggestive of variability **(Fig. 2)**. The sensitivity analysis revealed that omitting any single study did not substantially affect the findings. The pooled prevalence of MNM was found to be 3.9% (95% CI: 1.6%–7.2%) (**Supplementary Fig. 1**). In

DOI plot, the LFK index was 4.53, thus indicating major asymmetry and substantial publication bias (**Supplementary Fig. 2**).

*Risk factors of maternal near miss*: Hypertensive disorders of pregnancy were reported among MNM cases in a total of 38 studies, with specific mention on eclampsia in 12, pre-eclampsia in 12, and PIH in 6 studies. Anaemia was cited among MNM cases in 16 studies and other haematological conditions including coagulation disorders, sickle cell disease, and HELLP syndrome in 7 studies. Cardiac conditions and hepatic diseases (including hepatitis and hepatic coma) complicating pregnancy among MNM women were reported in 13 studies each. Renal problems, respiratory diseases, and neurological conditions were noted among MNM cases in 6, 9, and 3 studies, respectively. Multi-organ failure among MNM was seen in 6 studies. Sepsis or infection was identified in 26 studies, of which malaria, chorioamnionitis, and endometritis were reported in onestudy each. Complications of pregnancy mentioned in MNM were any type of haemorrhage (31 studies), abortion and related complications (6 studies), ectopic pregnancy (9), placental abruption (10), rupture of uterus/ dystocia (8), obstructed labour (2), and caesarean/ previous C-section (3). Type II diabetes mellitus was mentioned in 1 study and other endocrine disorders in another. Socio-demographic variables such as parity, rural residence, and below poverty line (BPL) status were mentioned as frequent occurrences in MNM in a single study and gravida, and age in 2 studies. A meta-regression was performed, and it demonstrated no significant association between maternal age and the prevalence of maternal near miss ($\beta = 0.0141$, $P= 0.69$) (**Supplementary Fig. 3**).

*Quality assessment*: Out of the 39 included studies, 29 were observational cohort, 1 was a case-control, and 9 cross-sectional studies. Among the cohort studies, 6 were rated as poor quality,[18,19,26,28,33] 7 as fair,[23,31,41-43,45] and the remaining were graded as good quality.[21,29,35,37,38,40,47,49,50,55,55-60]. The JBI critical appraisal tool was used for the cross-sectional studies. Of the 9 cross-sectional studies, 4 were assessed as having low risk of bias,[18,27,39,51] while 5 were found to be of moderate quality[20,24,36,50,52]. The case-control study was assessed to be of high quality.

## Discussion

This systematic review revealed high variability in MNM prevalence across studies, (4%). A global meta-analysis of MNM on 2011 to 2018 on 60 studies showed a lower pooled prevalence of 1.4%.[61] The studies included in the current meta-analysis showed that MNM ranged from 0.1% to 10.6% with an exception of one study that showed a high prevalence of 37.9% from West Bengal.[38] A similar range of MNM (0.58% to 12%) was also reported from the 11 studies based on WHO MNM criteria included from India in the previous meta-analysis and the highest 12% was from a study in Uttar Pradesh.[61] Only two to three studies were available from other central and southern Asian countries for the global review in 2018, and they showed high variations, Afghanistan (0.12%,), Iran (0.5%-2.5%), Nepal (0.3%-1.5%), Pakistan (0.7-5.2%), Sri Lanka (0.4%) and Thailand (0.5%).[61] Notably, even currently, Uttar Pradesh and West Bengal have the third and sixth leading MMR among Indian states with values above the national average.[62] Variation were observed in the reported maternal near miss ratios (MNMR) across these regions. Studies conducted in relatively resource-limited or geographically difficult areas, such as rural Madhya Pradesh, and parts of Uttar Pradesh, generally reported higher MNMRs, likely reflecting barriers to timely access and limited availability of comprehensive emergency obstetric care.[14,16] In contrast, studies from urban tertiary centers such as Delhi and West Bengal tended to report comparatively lower MNMRs, suggesting better access to specialized maternal health services.[20,38] A national survey from Brazil showed an MNM of 1%.[63] In the current study a very high heterogeneity was observed ($I^2$=99.4%).This might be explained by the existing inequities in healthcare services in India. Apart from the determinants of healthcare received, variability might be also be explained by the different criteria and approaches used to diagnose MNM.[3,64]

Overall, the most commonly reported risk factors for maternal near miss were hypertensive disorders, followed by haemorrhage, sepsis/infection, and anaemia. Jena *et al*[65] had reported that hypertensive disorders followed by haemorrhage were common in MNM and anaemia increased the risk of MNM pre-existing medical problems. Among the 16 studies of MNM reporting anaemia to be frequently occurring, 14 had haemorrhagic conditions including abruptio placenta and this can be explained by the established relation of anaemia with obstetric haemorrhage.[66,67] Among the 13 studies where hepatitis was reported in MNM, Sahijwani *et al*[50], specifically mentioned Hepatitis E as a risk factor for MNM, but notably the study period coincided with an epidemic of the same.[68] None of the included studies reported about the level of antenatal care or the availability of services in determining MNM. A survey from Brazil listed that ANC visits and search for health care services were strongly associated with MNM.[63]

In addition to the obstetric determinants, social factors also have a significant influence on MNM. Social determinants such as poverty, rural residence, low literacy, and limited awareness of maternal danger signs play a critical role in maternal near miss events.[69] Barriers like inadequate transport, financial constraints, and gender-related inequities often delay timely access to skilled obstetric care, thereby worsening outcomes even when medical causes are otherwise manageable.

This meta-analysis revealed a considerable variation between studies (design, quality and geography) which limits the comparability and interpretability of pooled estimates and so the strength of conclusions drawn from the same. Differences in how MNM was defined, diagnosed, and reported across various settings may have introduced misclassification bias. Inconsistent reporting on antenatal care and health service availability or systemic delays made it harder to analyze risk factors in a meaningful way. Owing to the hospital setting of the included studies, the community level MNM may be underestimated. The analysis showed major asymmetry in the DOI plot and a high LFK index, suggesting possible publication bias. The major limitation stems from the indicator itself, as the diagnosis of MNM can be based either on clinical criteria or the level of intervention, making it difficult to achieve uniformity. Future research and health systems should prioritise the standardized use of WHO-defined criteria to improve consistency and comparability across studies.[64,70]

The study emphasises the need for standardized MNM diagnostic criteria and their uniform application across institutions. Routine MNM monitoring should be integrated into national health surveys, with regular case audits. Strengthening antenatal and emergency obstetric care, improving referral systems, and implementing targeted interventions for haemorrhage and hypertensive disorders are crucial to reduce MNM and enhance maternal outcomes.

***Authors contributions***: PR: Design, methodology, data acquisition, manuscript writing; SK: Design, methodology, data acquisition, manuscript writing; KD: Methodology, data acquisition, analysis, manuscript writing; PD: Conception or design of the work, data curation, manuscript writing; PA: Methodology, data acquisition, manuscript writing; PS: Methodology, data acquisition, manuscript writing; AY: Methodology, data acquisition, manuscript writing; SS: Methodology, data acquisition, manuscript writing; CG: Methodology, data acquisition, manuscript writing; APG: Conception or design of the work, methodology, supervision, data curation, manuscript writing. All authors have read and approve the final edited version of the manuscript.

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