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Prevalence and determinants of maternal near miss in Ethiopia: a systematic review and meta-analysis, 2023

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Abstract

Background Ethiopia's progress in maternal health is commendable, but the persistence of life-threatening complications during pregnancy and childbirth highlights the need for further research and action. While individual studies on maternal near-misses (MNM) exist, a comprehensive understanding of their prevalence and underlying factors remains elusive. This systematic review and meta-analysis aimed to bridge that gap by consolidating available evidence, paving the way for targeted interventions to improve maternal health outcomes.

Methods A search for relevant studies was performed using the databases of PubMed, Scopus, the Cochrane Library, and Google Scholar, from years November 26 to 30, 2023, encompassed studies conducted in Ethiopia and published in English that reported the prevalence of maternal near miss and/or identified at least one determinant. Duplicate studies were removed using Endnote X8, resulting in a total of 13 studies included for analysis. The methodological quality of the included studies was assessed using the Joanna Briggs Institute's (JBI) quality appraisal checklist. The data synthesis and statistical analysis were performed using STATA Version 17 software. The pooled prevalence was presented using forest plots based on the random effects model.

Result The nationwide combined prevalence of maternal near misses (MNM) in Ethiopia was an adjusted odds ratio (AOR) of 12.9 and a 95% confidence interval (CI) of 6.30 to 19.49. Several factors were identified as determinants of maternal near-misses based on the pooled estimate. These factors included the absence of formal education (AOR = 2.48, 95% CI: 1.59–3.36), pre-existing chronic conditions (AOR = 4.70, 95% CI: 2.97–6.42), lack of antenatal care (AOR = 3.09, 95% CI: 2.12, 4.05), previous cesarean section (AOR = 4.40, 95% CI: 3.51, 5.28), and a history of referral (AOR = 2.67, 95% CI: 1.36–3.98); thus, factors were found to contribute significantly.

Conclusion Maternal near-misses are prevalent in Ethiopia, with determinates including chronic conditions, lack of education, referral history, inadequate antenatal care, and previous cesarean sections. Addressing this requires improving women's education access, enhancing antenatal care services for early complication management, and proactive chronic condition care during pregnancy. Promoting safe delivery practices, reducing unnecessary cesarean sections, and enhancing referral systems are crucial steps. Effective implementation necessitates collaboration among healthcare providers, policymakers, the Ethiopian Ministry of Health, and hospitals to reduce maternal near-misses in Ethiopia. The cross-sectional design hinders drawing causal conclusions, and the relevance

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of the findings may be limited to countries with specific socio-economic and cultural contexts, considering that the research was conducted exclusively in Ethiopia.

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Background

Maternal near miss refers to a critical condition wherein a woman comes close to death due to pregnancy or childbirth complications within 42 days after the termination of pregnancy, regardless of the place or length of the pregnancy, but survives either due to the care provided or by chance. When assessing obstetric care, maternal near miss (MNM) is a more valuable metric than maternal mortality as it provides a more insightful measurement [1]. The occurrence of maternal near miss is more frequent compared to maternal mortality. Several studies indicate that maternal near misses are 15 times more prevalent than maternal deaths [2]. Another study conducted in low-resource countries demonstrated that the prevalence of maternal near-misses was 26 times higher than that of maternal deaths [1].

Globally, approximately 140 million births occur annually. The impact of pregnancy-related complications on women's lives remains substantial, particularly in developing countries worldwide [3]. More than 99% of maternal deaths transpire in low- and middle-income nations, primarily due to severe poverty, which hinders women's access to adequate healthcare and education [4]. Due to substantial endeavors made during the Millennium Development Goals (MDG) era to combat maternal mortality, the maternal mortality ratio has witnessed a decline of 44% [5].

Despite the progress made, the persistently high levels of maternal mortality and morbidity remain concerning, particularly considering that 99% of maternal deaths occur in developing countries. In impoverished nations, the likelihood of maternal death is 1 in 41 live births, while in developed nations, it is 1 in 3300 live births. Additionally, for every woman who dies, approximately 20 more women suffer from acute and chronic complications related to pregnancy and childbirth [1, 2]. Ethiopia is among the sub-Saharan African nations facing a significant maternal mortality challenge. According to the Ethiopian Demographic and Health Survey (EDHS, 2016), the maternal mortality rate (MMR) in Ethiopia stands at 412 per 100,000 live births. Disturbingly, for every maternal death, 10–15% of women encounter pregnancy-related complications [6]. Ethiopia is among a group of five nations that contribute to 50% of maternal fatalities on a global scale [7]. Every year, approximately 20,000 women lose their lives due to complications arising from pregnancy and childbirth [8].

In recent decades, there has been global advancement in reducing maternal and infant mortality rates. Since 1990, there has been a notable decrease in maternal and infant deaths. Nevertheless, the reduction in maternal mortality has been comparatively slower, and despite the significant decline, it falls short of the 1990 Millennium Development Goals (MDGs) target of 75% [4, 9]. The World Health Organization (WHO) report indicates that the current global rate of maternal mortality ratio is 216 deaths per 100,000 live births [10]. The main factors associated with this high MNM were: history of chronic medical disorder [11–14], rural residency [11–13, 15], no antenatal care attendance [11–15], age of respondent [14, 15], not having formal education or having low educational levels [13, 15], source of referral [12–16], having a history of chronic hypertension and anemia [17, 18] and, having a previous caesarian section and/or abortion were significantly associated with MNM [19].

Furthermore, exploring the underlying factors behind severe maternal morbidity (MNM) offers valuable insights for healthcare practitioners in delivering high-quality maternity care by improving facility preparedness. Moreover, investigating MNM incidents, as opposed to maternal deaths, presents several advantages. MNM cases are more prevalent than maternal mortality cases, allowing for a larger pool of tangible evidence to understand the pathways leading to severe maternal morbidity. Since the women involved in these cases have survived, examining the care they received is less emotionally distressing for healthcare providers. Additionally, the women themselves can provide valuable firsthand accounts, serving as witnesses to help us learn from their experiences. Lastly, every near-miss case offers a valuable opportunity to learn and enhance maternity care without any cost, providing a platform for continuous improvement [15].

Several primary studies have been conducted [12, 14, 20–24] on the prevalence of near-miss cases, and determining factors were conducted in Ethiopia at the time this study was initiated, but the inconsistent nature of the reports presents challenges for healthcare programs and clinical decision-making. Thus, it was deemed vital to conduct this research to verify this finding and provide

strong evidence for clinical decision-making or health programs.

Considering the diversity in demographic, obstetric, and medical attributes of women, as well as factors like educational background and history of antenatal care (ANC) follow-up, these variables play a significant role in the provision of care during pregnancy and childbirth. Analyzing cases of maternal near-misses enables the evaluation of effective interventions and identification of shortcomings in the healthcare system and offers alternative approaches to decrease maternal mortality [25]. While there is ample evidence available in this field, the outcomes of studies display variability, making it prudent to consolidate the evidence through synthesis. Consequently, the objective of this systematic review and meta-analysis is to assess the overall prevalence of MNM and identify the factors that contribute to them among women in Ethiopia. The results of this study will provide valuable guidance for policymakers and other stakeholders in developing and executing strategies to reduce occurrences of maternal near-misses.

Methods

Study design and protocol

To examine the prevalence of maternal near-miss cases in Ethiopia, a systematic review and meta-analysis were carried out. The study strictly followed the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines. These guidelines include checklists that offer guidance on conducting and reporting systematic reviews and meta-analyses in a standardized manner (S1 File). This study was registered with the Prospective International Register of Systematic Reviews (PROSPERO, number CRD42023485844. Ethiopia, a low-income nation situated in the Horn of Africa, is anticipated to have a population of 123.4 million in 2022, 133.5 million in 2032, and 171.8 million in 2050. Administratively, Ethiopia is divided into 11 regions and two city administrations. The regions are further segmented into zones, and zones are then subdivided into districts.

Study selection

The identified studies were imported into reference management software, specifically Endnote version 8, to eliminate duplicate studies. Two researchers independently assessed the selected studies based on their titles and abstracts to determine their relevance. Full-text papers were retrieved for further evaluation, following predefined inclusion criteria. Any disagreements that arose during the screening process were resolved through a consensus meeting involving other reviewers, MW and MB.

Eligibility criteria

Inclusion and exclusion criteria

This review included observational studies, including cross-sectional, case–control, and cohort studies. The inclusion criteria encompassed studies conducted in Ethiopia and published in English that reported the prevalence of MNM and/or identified at least one determinant. Unpublished works on MNM were also taken into consideration. Citations lacking an abstract and/or full text, anonymous reports, editorials, and qualitative studies were excluded from the analysis. Additionally, studies that did not report the outcomes relevant to our research objectives were also excluded. Our focus was specifically on identifying observational studies, including case–control and cross-sectional designs, that examined the prevalence or proportion of failed induction and its related factors. The study period considered for inclusion ranged from January 1, 2016, to September 23, 2023 (Fig. 1).

Searching strategy data source

The databases of PubMed, Scopus, the Cochrane Library, and Google Scholar were searched for relevant studies. We utilized MeSH terms, keywords, and combinations thereof to refine the search. Additionally, we employed snowball searching techniques by examining the reference lists of retrieved papers to identify any additional relevant articles. To ensure a comprehensive search, unpublished studies were also sourced from official websites of international and local organizations, as well as university repositories. The search strategy involved the use of keywords and medical subject heading (MeSH) terms, with combinations of "OR" and "AND" operators. Key search terms included "maternal," "near miss," "obstetric complications," "pregnancy," "maternal death," "respiratory infection," "causes," "risk factors," "determinants," "associated factors," "predictors," and "Ethiopia." Various Boolean operators were employed to develop the search strategies. Notably, for the PubMed database, the following search strategy was utilized: prevalence OR magnitude OR epidemiology; AND (causes OR determinants OR associated factors OR predictors OR risk factors; AND maternal near miss [MeSH Terms] OR childbirth OR child OR childhood) AND Ethiopia. Additionally, we screened the reference lists of selected papers to identify any further relevant studies for inclusion in this review.

Identification and study selection

All the identified studies were imported into the Endnote X8 reference manager software, and any duplicate articles were removed. The screening process involved evaluating the titles and abstracts of the studies. Three authors

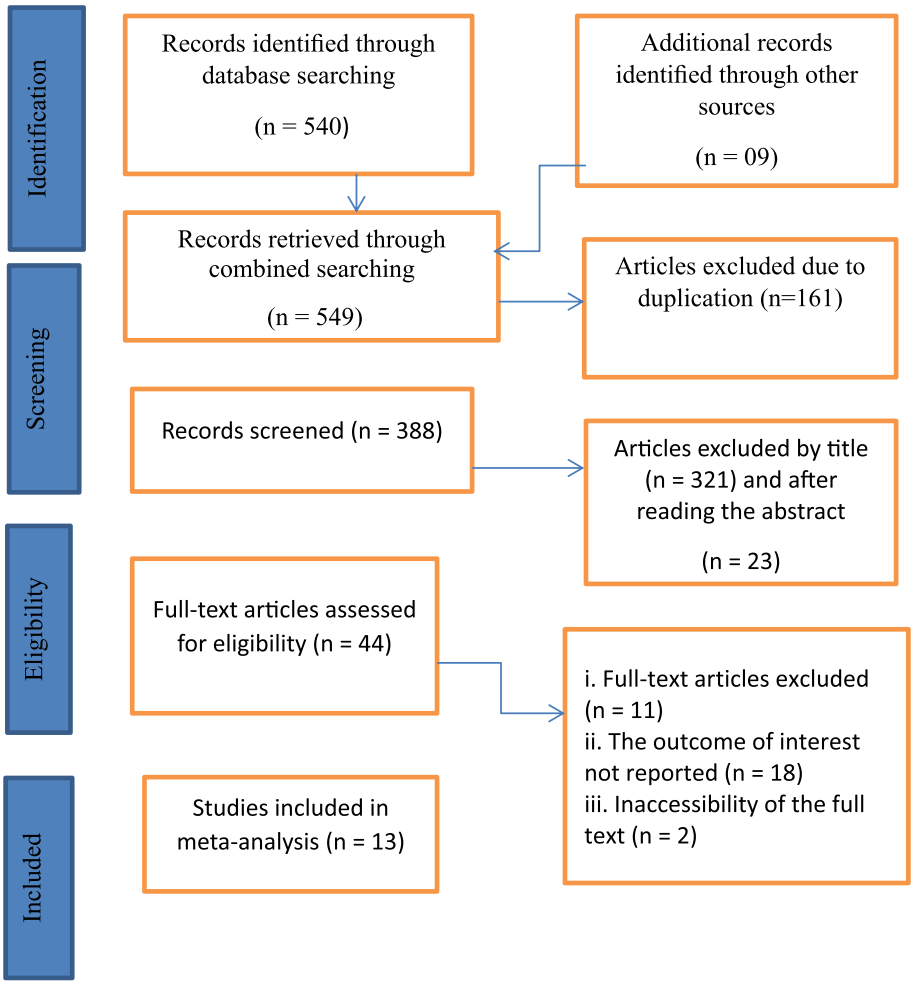

Fig. 1 PRISMA flow diagram showing searching strategies, screening, reasons for exclusion and number of included research articles in this systematic review and meta-analysis, 2023

together screened and assessed the articles. The full text of the selected studies was then evaluated based on their objectives, methodology, participants/population, and key findings related to maternal near miss. In case of any disagreements during the screening process, a consensus meeting was held involving other senior reviewers to resolve them.

Data extraction

An Excel sheet was developed by the authors to create a data extraction form, which consisted of fields such as author name, year of publication, region, study design, sample size, prevalence of MNM, and reported determinant factors. To ensure the effectiveness of the data extraction form, a pilot test was conducted using four randomly selected papers. Following the pilot phase, adjustments were made to the extraction form template. Subsequently, two authors collaborated to extract the data using the revised extraction form. The third and fourth authors independently verified the accuracy of the extracted data. In cases where there were discrepancies between the reviewers, discussions took place involving a third and fourth reviewer to reach a consensus. To minimize errors in data entry, cross-checking with the included papers was performed to rectify any mistyping or inaccuracies.

Quality assessment

The evaluation of article quality was carried out using the Joanna Briggs Institute's (JBI) quality appraisal checklist. The Joanna Briggs Institute's (JBI) quality appraisal checklist score is 1 for "yes," 0 for "no," and U for "unclear." The final Scores for each study were summed and transformed into a percentage. Finally, the ranking was given as follows: ≤ 49% = high risk of bias, 50–69% = moderate risk of bias, and above 70% = low

risk of bias. Only studies that scored ≥ 50% were considered in this systemic review and meta-analysis. In the case of ongoing disputes between reviewers, the average ratings of the reviewers were computed. The quality of the primary study results was recorded in a separate column in the data extraction form. This meticulous process ensured that the quality assessment was conducted rigorously and comprehensively, incorporating diverse perspectives and the expertise of the author team. Four independent authors were assigned to assess the quality of the studies, each responsible for evaluating them individually. The assessment encompassed various aspects such as methodological quality, sample selection, sample size, comparability, outcome assessment, and statistical analysis of the study. To ensure thoroughness and comprehensiveness, the appraisal process involved multiple rounds where authors exchanged assessments with each other. Consequently, each paper was appraised by two authors. In the event of disagreements, discussions took place, and a senior author was consulted for resolution. This meticulous process guaranteed that the quality assessment was conducted with rigor and a comprehensive approach, taking into account diverse perspectives and the expertise of the author team (Supplementary Table 1).

Outcome of measurement

The primary focus of this systematic review and meta-analysis was to examine maternal near-miss as the primary outcome. MNM refers to the condition of a critically ill pregnant or recently delivered woman who experienced a severe complication during pregnancy, childbirth, or within 42 days after the termination of pregnancy but managed to survive [26, 27]. The second outcome of this study aimed to identify the determinate of MNM. The goal was to examine the factors that may contribute to the occurrence of MNM. The systematic review and meta-analysis sought to analyze and summarize the available evidence on these determinate factors to provide a comprehensive understanding of their influence on MNM.

Statistical analysis

Once the data was extracted in Microsoft Excel format, it was imported into STATA version 14.0 statistical software for further analysis. The standard error for each study was calculated using the binomial distribution formula. To determine the overall estimates of the magnitude of MNM (maternal near miss), a random effect meta-analysis was conducted by pooling the data. The pooled prevalence of MNM, along with a 95% confidence interval (CI), was presented using forest plots. Similarly, forest plots were used to present the odds ratio (OR) with a 95% CI to illustrate the determinants of MNM. To assess the heterogeneity among the studies, Cochrane's Q statistics (chi-square), inverse variance (I^2), and p-values were employed. In this study, an I^2 value of zero indicated true homogeneity, while values of 25, 50, and 75% denoted low, moderate, and high heterogeneity, respectively. For data identified as heterogeneous, a random-effects model analysis was utilized. Additionally, subgroup analysis was performed based on the study region and design. Sensitivity analysis was conducted to evaluate the impact of individual studies on the overall estimation. Publication bias was assessed through the funnel plot and, more objectively, using Egger's regression test.

Subgroup analyses

To investigate potential variations in the prevalence of (MNM) within Ethiopia, subgroup analyses were conducted based on the study region and study design. The purpose of these analyses was to assess whether the prevalence estimates differed significantly across different geographical areas and the study design employed.

Publication bias and heterogeneity

Comprehensive and thorough searches, including electronic/database searches and manual searches, were conducted to minimize bias risks. The authors' collaborative efforts played a crucial role in reducing bias by adhering to clear objectives and eligibility criteria, evaluating the quality of studies, and extracting and compiling the data. Publication bias was assessed through a visual inspection of the funnel plot graph, providing a qualitative evaluation. Additionally, Egger's correlation tests were conducted at a significance level of 5% to further assess the presence of publication bias. Another aspect considered was the sensitivity analysis, which aimed to evaluate the stability and robustness of the pooled estimates in the presence of outliers and the potential influence of individual studies on the overall results. This analysis involved systematically excluding one study at a time and re-analyzing the data to understand the impact of specific studies on the pooled estimates and overall conclusions of the systematic review and meta-analysis. By performing sensitivity analysis, a more comprehensive understanding of the potential effects of individual studies on the pooled estimates and the overall findings of the study could be obtained.

Results

Literature search findings

The first database search discovered 540 articles. After removing duplicates, there were 388 distinct articles. Following the screening of titles and abstracts, 321 articles

were excluded based on titles and 23 based on abstracts. The remaining articles were subject to a detailed full-text evaluation to determine their eligibility for inclusion. 6 studies were excluded due to differing outcome estimates, 18 because the outcome of interest was not reported, and an additional 2 papers were excluded due to the inaccessibility of the full text. As a result, a total of 13 studies were included in the final analysis (Fig. 1).

Characteristics of included studies

Supplementary Table 2 summarizes the characteristics of the *1*3 included studies in the systematic review and meta-analysis, of which [13, 21] studies were from the Amhara region [14, 15, 22], from the Oromia region [3, 12, 23], studies were from the SNNP region [24, 25], studies from the Harar region [28], study from the Tigray region [11, 17], studies from Addis Abeba city. Four studies were cross-sectional, eight studies were case–control, and the other wasa cohort study. The studies included participants ranging from 183 [22] to 29,697 [17] (Supplementary Table 2).

Prevalence of MNM in Ethiopia

Some of the studies ($n=6$) reported the prevalence of MNM [3, 15, 17, 20, 22, 29]. The prevalence of MNM ranged from 0.8% [17] up to 28.7% [15]. The random-effects model analysis from those studies revealed that the pooled prevalence of MNM in Ethiopia was found to be 12.9% (95% CI; 6.30–19.49; $I^2=98.3\%$; $p<0.001$) (Fig. 2).

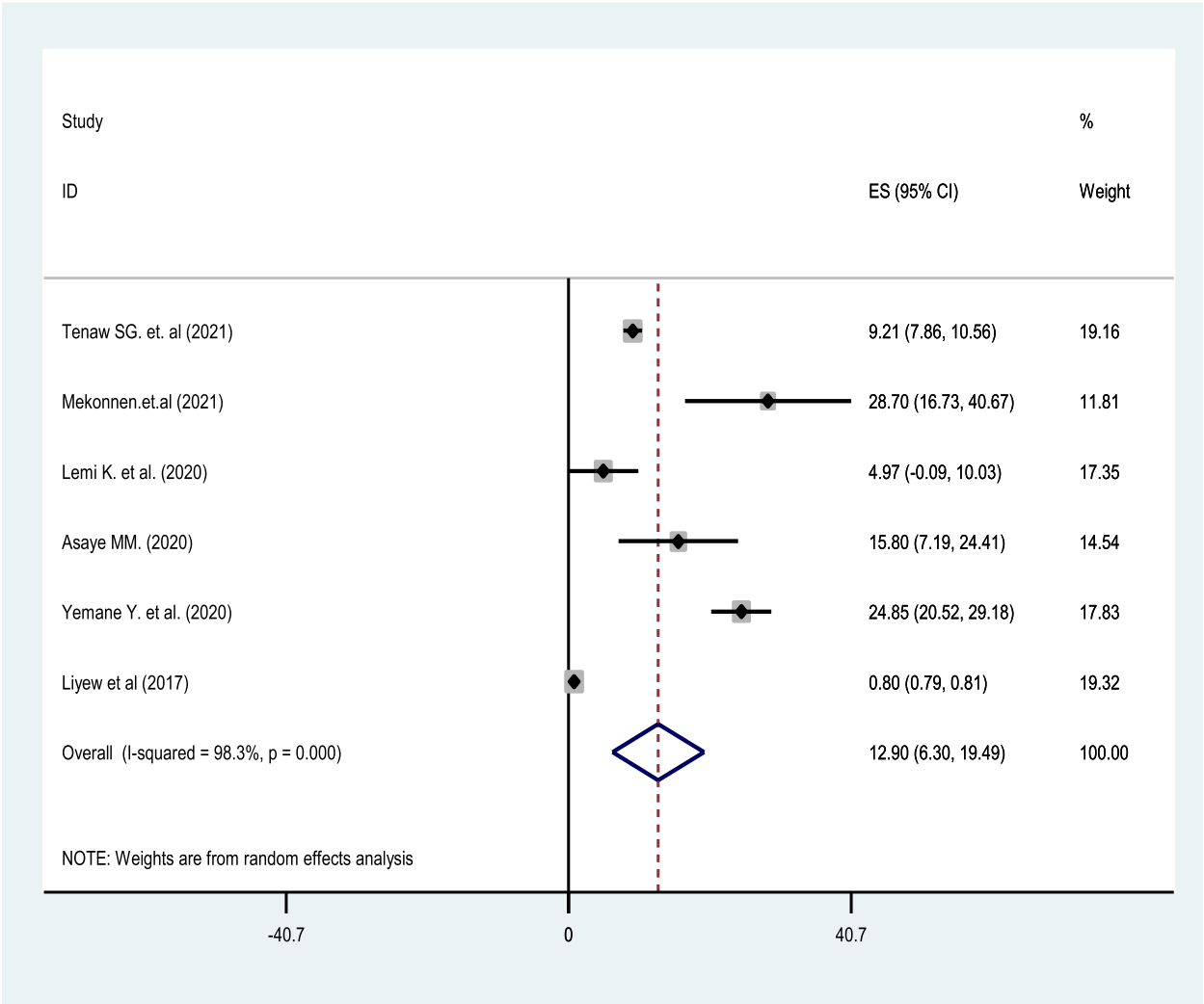

Fig. 2 Forest plot showing the pooled prevalence of maternal near miss in Ethiopia,2023

Publication bias

A funnel plot showed asymmetrical distribution. Egger's regression test *p*-value was 0.036, which indicated the presence of publication bias (Fig. 3).

Subgroup analysis of the MNM in Ethiopia

The prevalence of MNM was examined through subgroup analysis, stratifying by study region and study design. The findings revealed a prevalence of 24.85 in SNNPR, 16.19 in Oromia, 15.8 in Amhara, 9.21 in Harar, and 0.8 in Addis Ababa (Fig. 4). Additionally, based on the study design, the prevalence of MNM was determined as 17.17 in cross-sectional studies, 9.21 in cohort studies, and 4.49 in case–control studies (Fig. 5). In order to identify potential sources of heterogeneity in the analysis of MNM prevalence in Ethiopia, a leave-one-out sensitivity analysis was conducted. The results indicated that the findings were not reliant on a single study, ensuring the robustness of the overall conclusions. To assess publication bias, a funnel plot was examined, demonstrating a symmetrical distribution. Furthermore, the *p*-value from Egger's regression test was 0.63, indicating the absence of publication bias (Supplementary Fig. 1).

Factors associated with MNM

History of cesarean section

Out of the six studies analyzed, a notable correlation was observed between a history of cesarean sections and maternal near miss (MNM). Among these studies, the highest risk-adjusted odds ratio (AOR) was 7.68 (95% confidence interval: 5.69, 9.67) [12], and the lowest risk factor, AOR = 3.53 (2.22, 4.48), Dessalegn FN et al. [14] as compared to those who had no history of cesarean section. In terms of testing for heterogeneity, the Galbraith plot indicated homogeneity. Combining the results from six studies, the forest plot displayed an overall estimated adjusted odds ratio (AOR) of 4.40 (95% confidence interval: 3.51, 5.28; $I^2 = 64.4\%$; $P = 0.0013$), indicating moderate heterogeneity (Fig. 6). The *I*-squared (I^2) value and *p*-value also supported the presence of homogeneity. When assessing publication bias, the funnel plot exhibited a symmetrical distribution. However, during Egger's regression test, the *p*-value was 0.049, suggesting the presence of publication bias (Supplementary Fig. 2). To identify potential sources of heterogeneity in the pooled estimate analysis regarding the association of a history of cesarean section as a risk factor for MNM in Ethiopia, a leave-one-out sensitivity analysis was conducted. The results of this analysis demonstrated that the findings were not reliant on a single study. The pooled estimate of having a history of cesarean section ranged from 3.99 (95% CI: 3.47–4.52) to 4.51 (95% CI: 3.42–5.60).

Lack of antenatal visit

Among the nine studies examined, a significant association was identified between a lack of antenatal care (ANC) visits and maternal near-misses. The highest risk factor was reported by Lemi K et al., with an adjusted

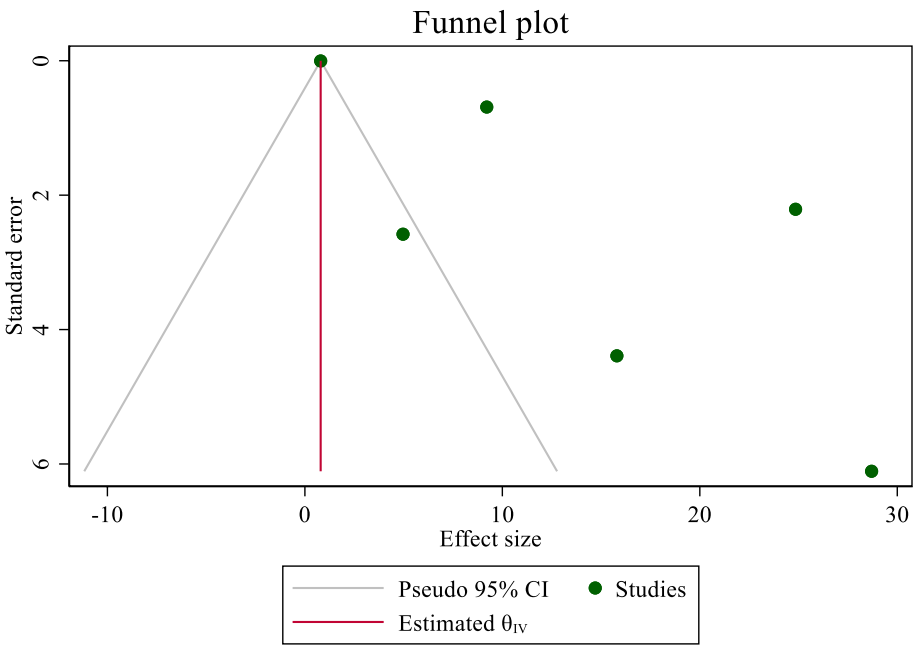

Fig. 3 Publication bias for the pooled estimate of prevalence of maternal near miss in Ethiopia, 2023

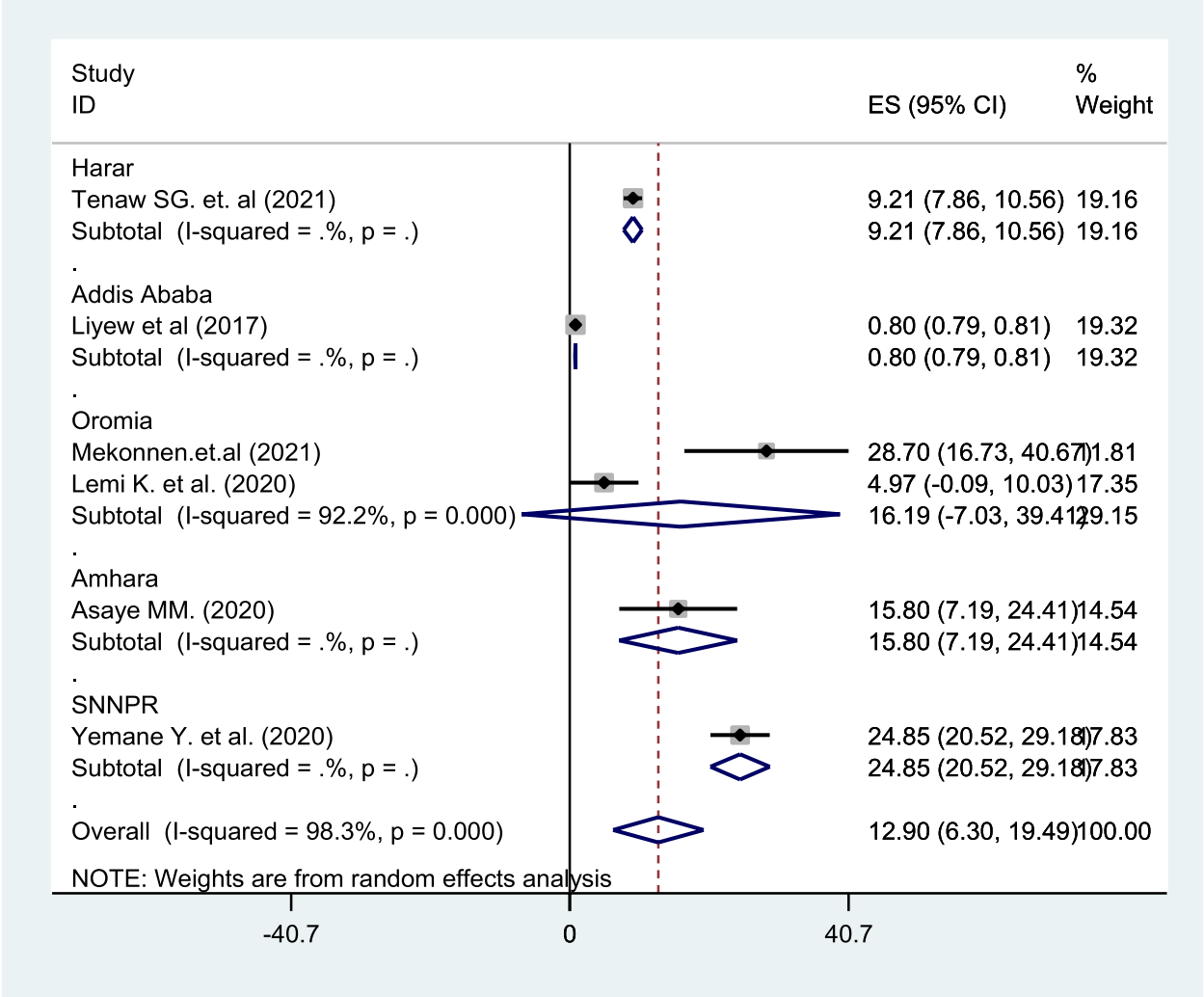

Fig. 4 Forest plot of subgroup analysis by study region of maternal near miss in Ethiopia,2023

odds ratio (AOR) of 6.02 (95% confidence interval: 3.69, 8.35) [22]. On the other hand, the lowest risk factor was found with an AOR of 0.76 (95% confidence interval: 0.16, 1.36) Kasahun AW, Wako WG [12]. The forest plot displayed an overall estimated adjusted odds ratio (AOR) of 3.09 (95% confidence interval: 2.12–4.05; $I^2 = 86.6\%$; $P = 0.00$) for the association between a lack of antenatal care (ANC) visits and maternal near-misses. The *I*-squared (I^2) value and *p*-value also indicated homogeneity among the studies (Fig. 7). In terms of publication bias, the funnel plot exhibited an asymmetrical distribution. The *p*-value from Egger's regression test was 0.002, suggesting the presence of publication bias. To identify potential sources of heterogeneity in the pooled estimate analysis regarding the lack of ANC visits as a risk factor for maternal near-misses in Ethiopia, a leave-one-out sensitivity analysis was conducted (Supplementary Fig. 3).

Having chronic comorbidity

Out of the seven studies included in the study, a significant association was observed between having chronic comorbidity and MNMs. Among these studies, the highest risk-adjusted odds ratio (AOR) was 12.10 (95% confidence interval: 8.61, 15.59). Teshome HN et al. [13] and the lowest risk factor had an AOR of 2.04 (1.22, 2.86) Dessalegn FN et al. [14] in comparison to individuals without chronic comorbidity, individuals with chronic comorbidity were found to have a significant association with MNMs. The Galbraith plot indicated homogeneity, and when combining the results of seven studies, the forest plot displayed an overall estimated adjusted odds ratio (AOR) of 4.70 (95% confidence interval: 2.97–6.42; $I^2 = 93.2\%$; $P = 0.00$), indicating substantial heterogeneity (Fig. 8). The *I*-squared (I^2) value and *p*-value also supported the presence of heterogeneity. When examining publication bias, the funnel plot demonstrated

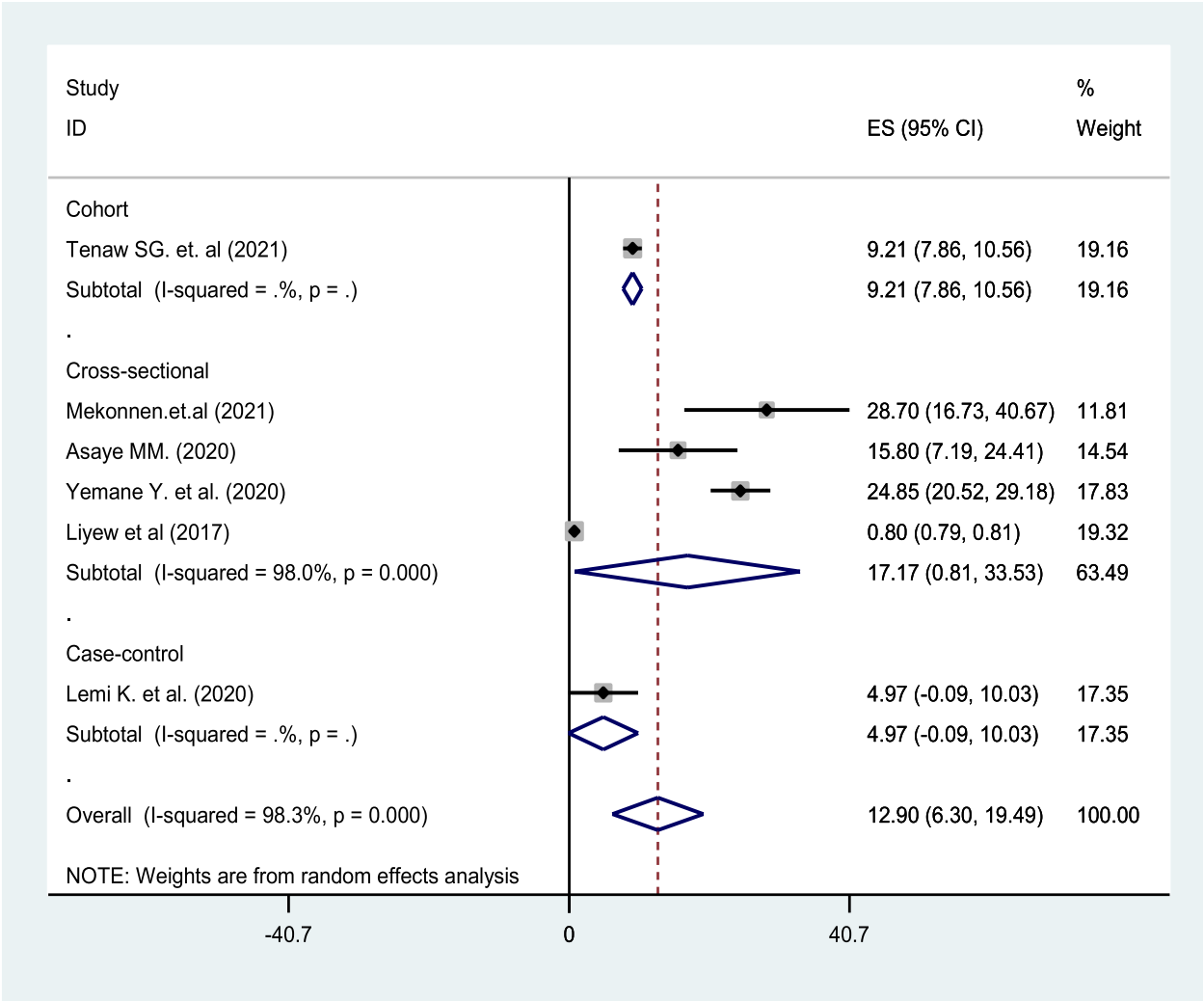

Fig. 5 Forest plot of subgroup analysis by study design of maternal near miss in Ethiopia,2023

a symmetrical distribution. However, during Egger's regression test, the *p*-value was 0.001, suggesting the presence of publication bias (Supplementary Fig. 4). To identify potential sources of heterogeneity in the pooled estimate analysis regarding chronic comorbidity as a risk factor for maternal near-misses in Ethiopia, a leave-one-out sensitivity analysis was conducted. The results of this study indicated that the findings were not reliant on a single study. The pooled estimate of chronic comorbidity ranged from 3.42 (95% CI: 2.22–4.62) to 5.28 (95% CI: 3.18–7.39) when no studies were excluded (Supplementary Fig. 5).

Rular residence

Eleven studies found a significant association between ruler residency and MNMs. Among these studies, the highest risk-adjusted odds ratio (AOR) was = 13.00 (10.96, 15.04) in Liyew et al. [11] and the lowest is AOR = 0.01 (−0.86, 0.88) in Asaye MM [20]. In terms of testing for heterogeneity, the Galbraith plot indicated homogeneity. Combining the results from seven studies, the forest plot displayed an overall estimated adjusted odds ratio (AOR) of 1.71 (95% confidence interval: 0.93–2.49; $I^2 = 94.2\%$; $P = 0.00$) for the association between rural residency and MNMs. The *I*-squared (I^2) value confirmed the presence of substantial heterogeneity (Fig. 9). When assessing publication bias, the funnel plot exhibited a symmetrical distribution. However, during Egger's regression test, the *p*-value was 0.008, suggesting the presence of publication bias (Supplementary Fig. 6). To identify potential sources of heterogeneity in the pooled estimate analysis regarding rural residency as a risk factor for MNMs in Ethiopia, a leave-one-out sensitivity analysis was conducted. The results of this analysis indicated

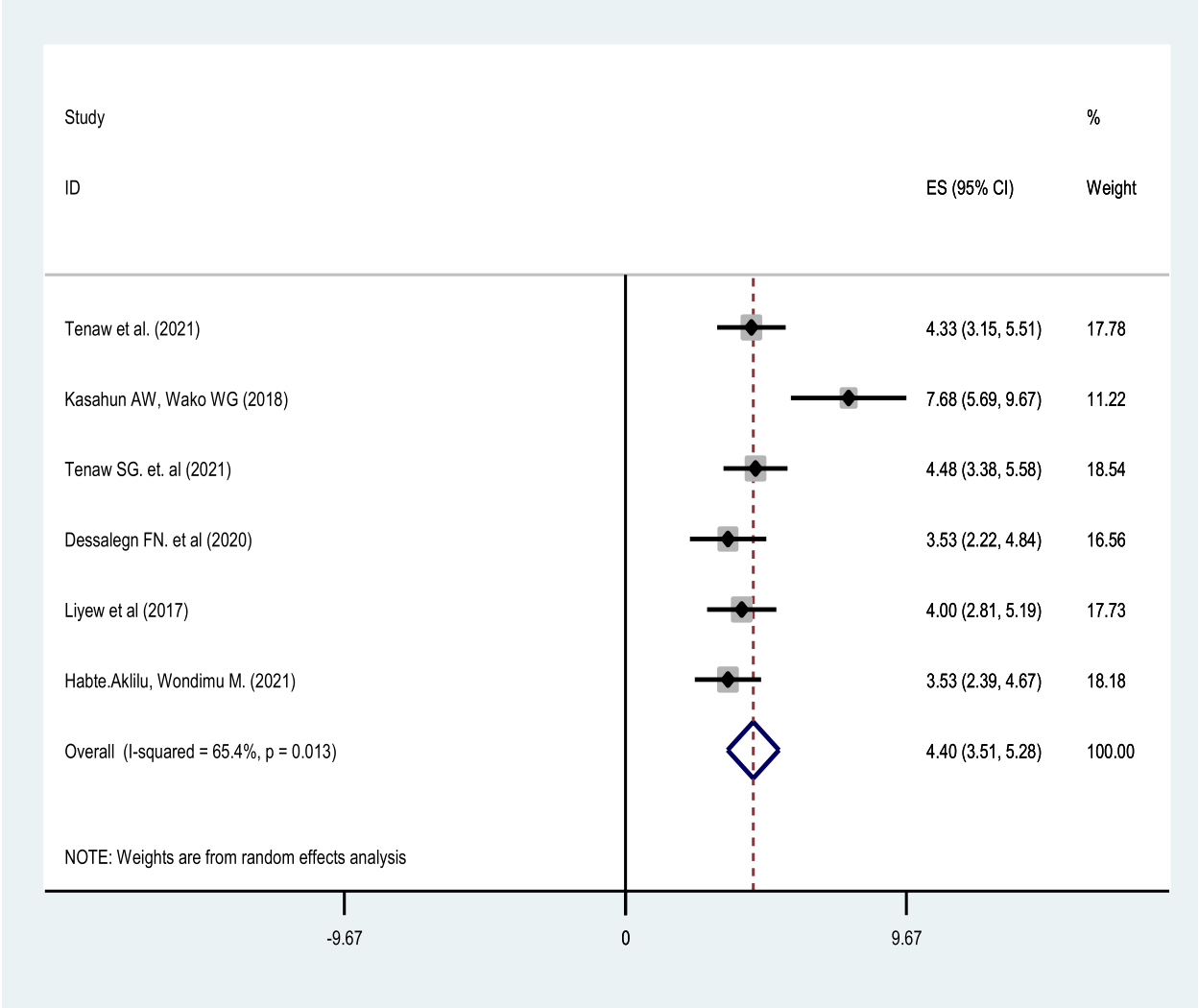

Fig. 6 The pooled estimate of AOR of having a history of cesarean section and MNM in Ethiopia

that the findings were not reliant on a single study (Supplementary Fig. 7).

Mode of admission

Six studies found a significant association between referred from other health facilities and MNMs. Among these studies, the highest risk-adjusted odds ratio (AOR) was 7.47 (5.11, 9.83) Kasahun AW, Wako WG [12], and the lowest risk factor has an AOR of 0.41 (0.07, 0.75 Mekonnen et al. [15] as compared to those who were not referred from other health facilities. In terms of testing for heterogeneity, the Galbraith plot indicated homogeneity. Combining the results from seven studies, the forest plot displayed an overall estimated adjusted odds ratio (AOR) of 2.67 (95% confidence interval: 1.36–3.98; $I^2 = 93.1\%$; $P = 0.00$) for the association between being referred from other health facilities and MNMs. The *I*-squared (I^2) value confirmed the presence of substantial heterogeneity (Fig. 10). When assessing publication bias, the funnel plot exhibited a symmetrical distribution. However, during Egger's regression test, the *p*-value was 0.00, suggesting the presence of publication bias (Supplementary Fig. 8). To identify potential sources of heterogeneity in the pooled estimate analysis regarding being referred from other health facilities as a risk factor for MNMs in Ethiopia, a leave-one-out sensitivity analysis was conducted. The results of this study indicated that the findings were not reliant on a single study. The pooled estimate of being referred from other health facilities ranged from 1.96 (95% CI: 0.84–3.08) to 3.17 (95% CI: 1.79–4.45) when no studies were excluded (Supplementary Fig. 9).

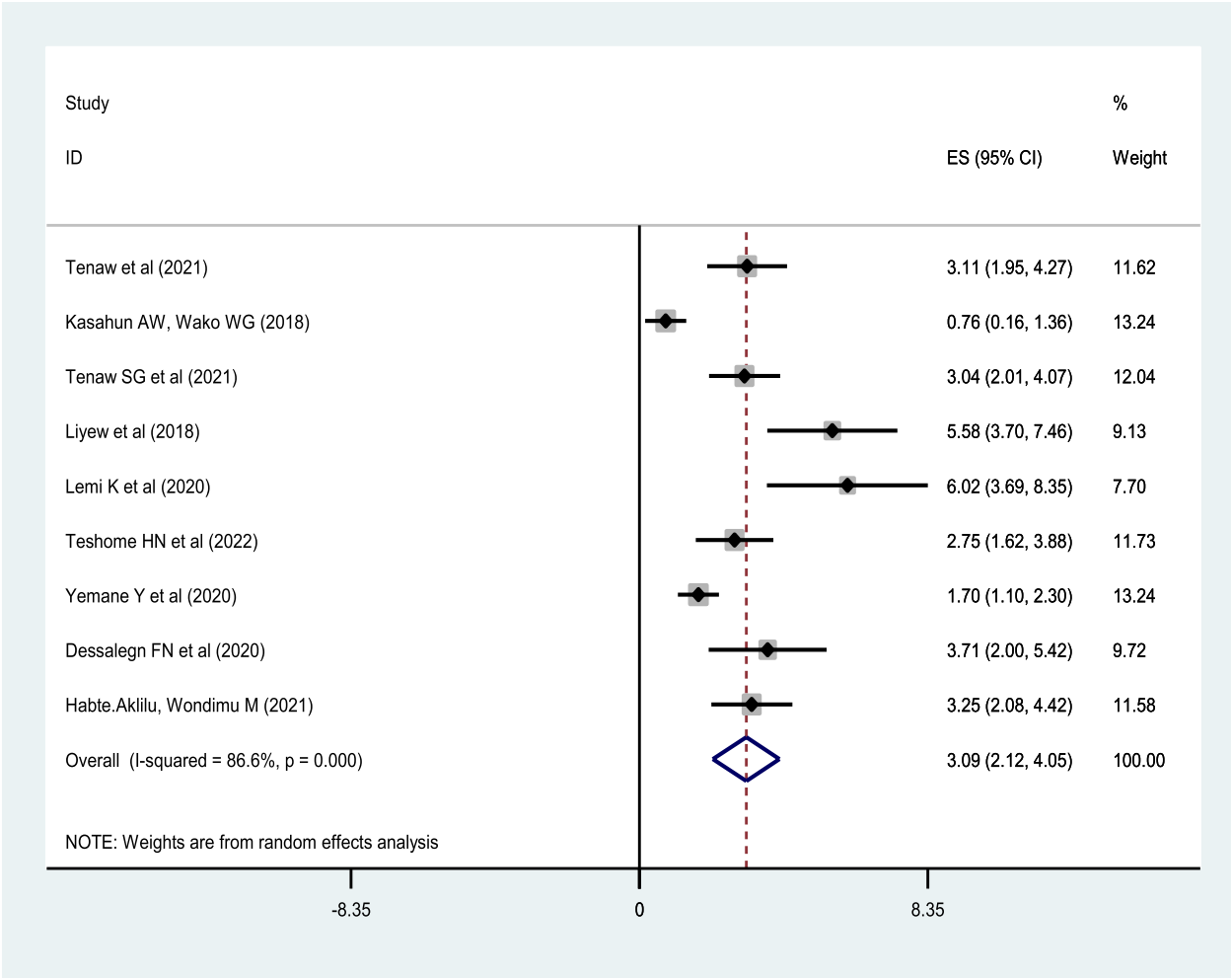

Fig. 7 The pooled estimate of AOR of Lack of antenatal care visit on MNM in Ethiopia,2023

Educational statues

Four studies found a significant association between being unable to read and write and MNMs. Among these studies, the highest risk-adjusted odds ratio (AOR) was 3.28 (2.28, 4.28) Liyew et al. [11] and the lowest risk factor AOR = 1.14 (0.51, 2.31) Mekango DE et al. [23] as compared to their educational status (college and above). Concerning the heterogeneity test, the Galbraith plot revealed homogeneity. Combining the results from four studies, the forest plot displayed an overall estimated adjusted odds ratio (AOR) of 2.48 (95% confidence interval: 1.59–3.36; $I^2 = 67.5\%$; $P = 0.026$) for the association between being unable to read and write and MNMs. The I-squared (I^2) value and p-value also indicated the presence of heterogeneity (Fig. 11). In terms of publication bias, the Egger's regression test yielded a p-value of 0.348, indicating the absence of publication bias (Supplementary Fig. 10). The pooled estimate of being unable to read and write ranged from 2.18 (95% CI: 1.25–3.12) to 2.83 (95% CI: 2.12–3.53) without the exclusion of any individual study (Supplementary Fig. 11).

Discussion

This review aimed to investigate the prevalence and factors influencing MNMs in Ethiopia. The results revealed that MNMs pose a substantial public health concern in the country, highlighting the need for policymakers to develop strategies to enhance obstetric and maternal care in order to reduce these occurrences. The pooled prevalence of MNMs in this study was 12.9%, which was higher than the reported prevalence in Malaysia. Additionally, the MNM incidence ratio in Ethiopia was found to be 2.2 [30], in India from 7.6 to 15.6 [31], in Indonesia at 4.2%, in Brazil at 9.6 [32], incidence of MNM of 4.0% [1] in low-income countries, the weighted pooled prevalence of MNMs was higher compared to developed countries. This disparity could be attributed to the higher socioeconomic status of developed countries, which enables

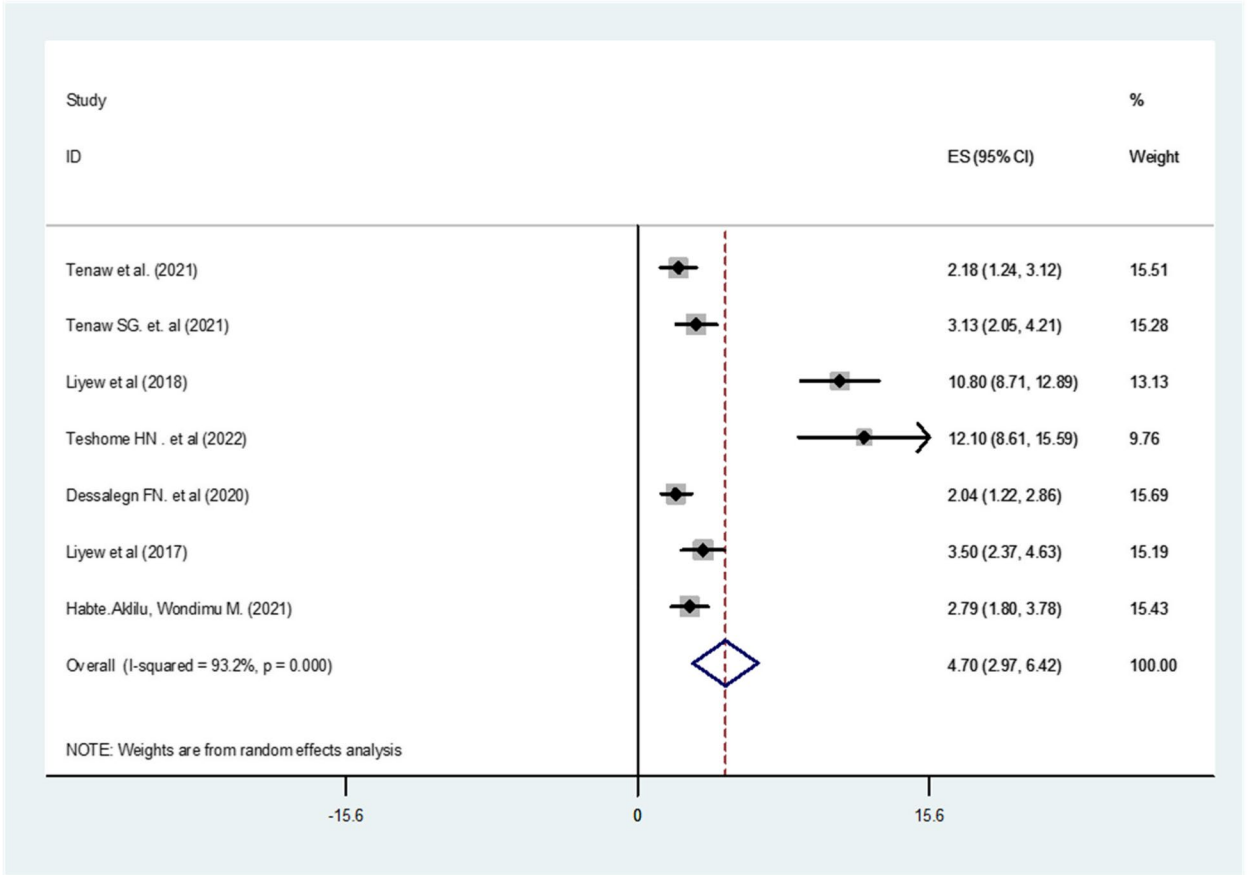

Fig. 8 The pooled estimate of AOR of having chronic comorbidity on MNM in Ethiopia,2023

them to have access to better facilities and resources for providing high-quality obstetric and maternal care. This approach is directly associated with how a country addresses the issue of MNMs. Furthermore, variations in study settings, study designs, and sample sizes could also contribute to the observed differences. However lower than in Tanzania the MNM incidence ratio was 23.6 [33] and in Uganda (22.7%) [34], This could be attributed to the difficulty of diagnosing MNMs in many sub-Saharan African settings using the laboratory-based criteria recommended by the World Health Organization (WHO), especially in low-income settings. This challenge arises from factors such as inadequate infrastructure, limitations in making accurate diagnoses, and other related factors.

In this review, mothers who had a history of referral from other health facilities showed higher odds of 2.67 (95% CI: 1.36–3.98) of developing a MNM; this finding was supported by another study [12, 13, 20, 35]. One possible explanation is that the increase in the number of complex cases referred contributes to MNM events. Factors such as lack of transportation, long distances that hinder timely access to referral facilities (second delay), delayed referrals, and failure to identify potentially life-threatening complications early can all play a role. Another factor could be the association between a history of referrals and MNMs, as delays in receiving appropriate services have been linked to an elevated risk of experiencing a MNM event. This association suggests that the Regional Health Bureau and the Ministry of Health should consider integrating maternal intensive care units into each hospital to reduce the need for referrals.

This review identified a strong correlation between a previous cesarean section and (MNM). The overall adjusted odds ratio (AOR) for a history of cesarean section was 4.40 (95% confidence interval: 3.51, 5.28), indicating a significantly higher risk of MNM compared to those without a history of cesarean section. It is worth noting that the global incidence of cesarean sections has been steadily rising and has reached a rate of 29.55% [36] in Ethiopia. The occurrence of cesarean section during the current pregnancy was found to be prevalent among pregnant women with maternal near-misses MNM, and

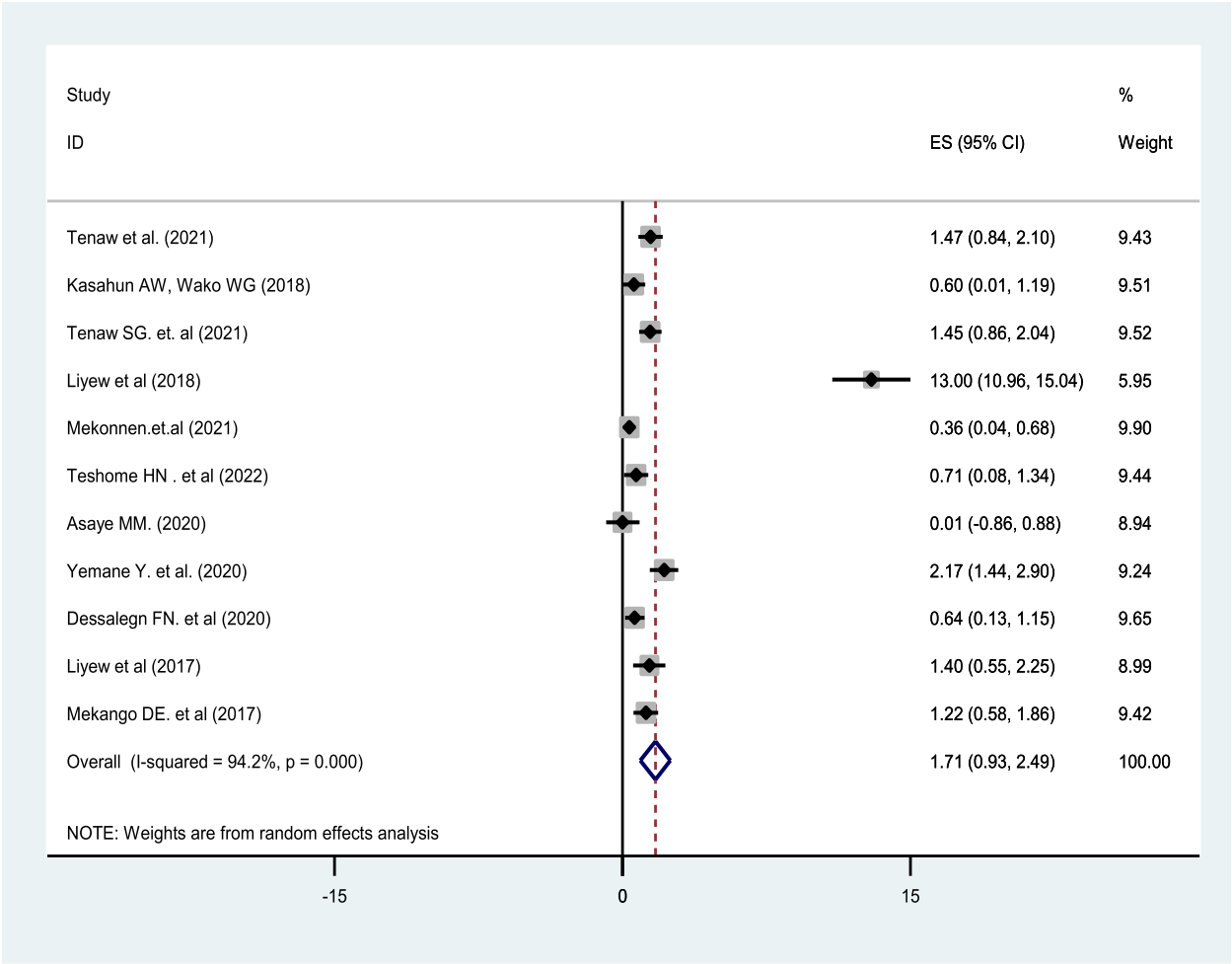

Fig. 9 The pooled estimate of AOR of rural residence on MNM in Ethiopia,2023

it was significantly associated with a fourfold increase in the risk of MNMs. This finding aligns with the results of previous studies, providing further support for the relationship between cesarean section and the occurrence of MNMs. [37–39]. This may be CS increased risk of thromboembolism, puerperal infection, hemorrhages, and anesthetic complications, as well as the inherent risks associated with cesarean sections such as blood loss, anesthetic risks, and postoperative complications, which may contribute to this phenomenon. Cesarean sections are recognized to carry potential health risks for women, and when compared to vaginal delivery, they may serve as a modifiable risk factor for maternal mortality. While a previous cesarean surgery can be life-saving for both the mother and the baby, it also raises the likelihood of complications such as hemorrhage, recurrence, placenta accretion in scar tissue, thrombosis, uterine rupture during subsequent vaginal attempts, and other factors that can increase the risk of MNMs. Therefore, it appears that cesarean section acts as an additional risk factor that heightens the likelihood of maternal near-misses.

Furthermore, among women with pre-existing chronic conditions and MNMs, the overall adjusted odds ratio (AOR) for MNM was estimated to be 4.70 (95% confidence interval: 2.97–6.42). This finding aligns with previous studies conducted in the USA, Brazil, the Netherlands, and other locations, indicating a consistent association between pre-existing chronic conditions and the occurrence of maternal near-misses [40–43]. This could be attributed to the presence of comorbidities that significantly elevate the risk of complications such as superimposed pre-eclampsia, placental abruption, intrauterine growth retardation, and preterm delivery. Chronic hypertension, diabetes mellitus, and cardiovascular disease are indicators for referral to higher-level healthcare facilities. Promoting screening programs for non-communicable diseases would be a beneficial approach to reducing maternal near-misses.

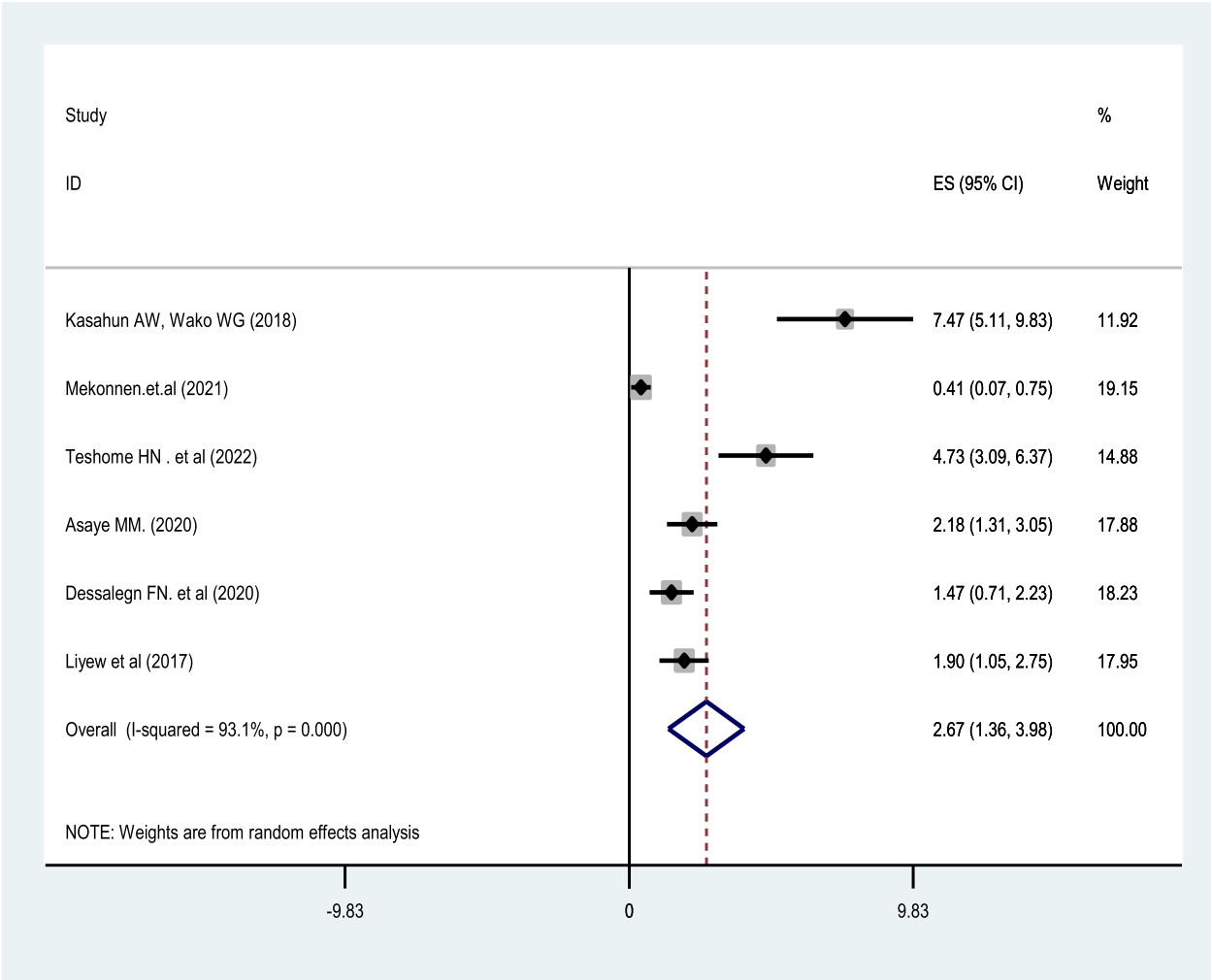

Fig. 10 The pooled estimate of AOR of mode of admission on MNM in Ethiopia, 2023

This review identified a notable correlation between the absence of formal education and MNMs, in comparison to individuals with a college education or higher. The overall adjusted odds ratio (AOR) for MNMs among those without formal education was estimated to be 2.48 (95% confidence interval: 1.59–3.36). Educational status emerges as another influential factor impacting the occurrence of MNMs. The pooled estimate suggests that individuals without formal education were 2.48 times more likely to experience MNMs compared to the educated group, aligning with findings from other studies [23, 44, 45]. This could be attributed to the fact that women with lower levels of education may have less access to information, resulting in limited awareness of their health and the signs of potential pregnancy complications. Consequently, they may be less likely to utilize maternity healthcare services. Conversely, individuals with higher levels of education tend to have easier access to information, which is associated with a better understanding of their health, obstetric complications, and enhanced decision-making abilities.

The review also revealed a significant association between antenatal care follow-up and MNMs. Women who did not receive antenatal care follow-up during their pregnancy had 3.09 times higher odds of experiencing near-miss events compared to those who received regular antenatal care. This finding aligns with similar studies conducted in Ethiopia, Nigeria, Pakistan, Bangladesh, and Bolivia [43, 44, 46, 47]. This could be attributed to the lack of antenatal checkups, which can result in a lack of knowledge regarding the timing and signs of labor, optimal birthing locations, and when to seek professional assistance rather than managing things independently.

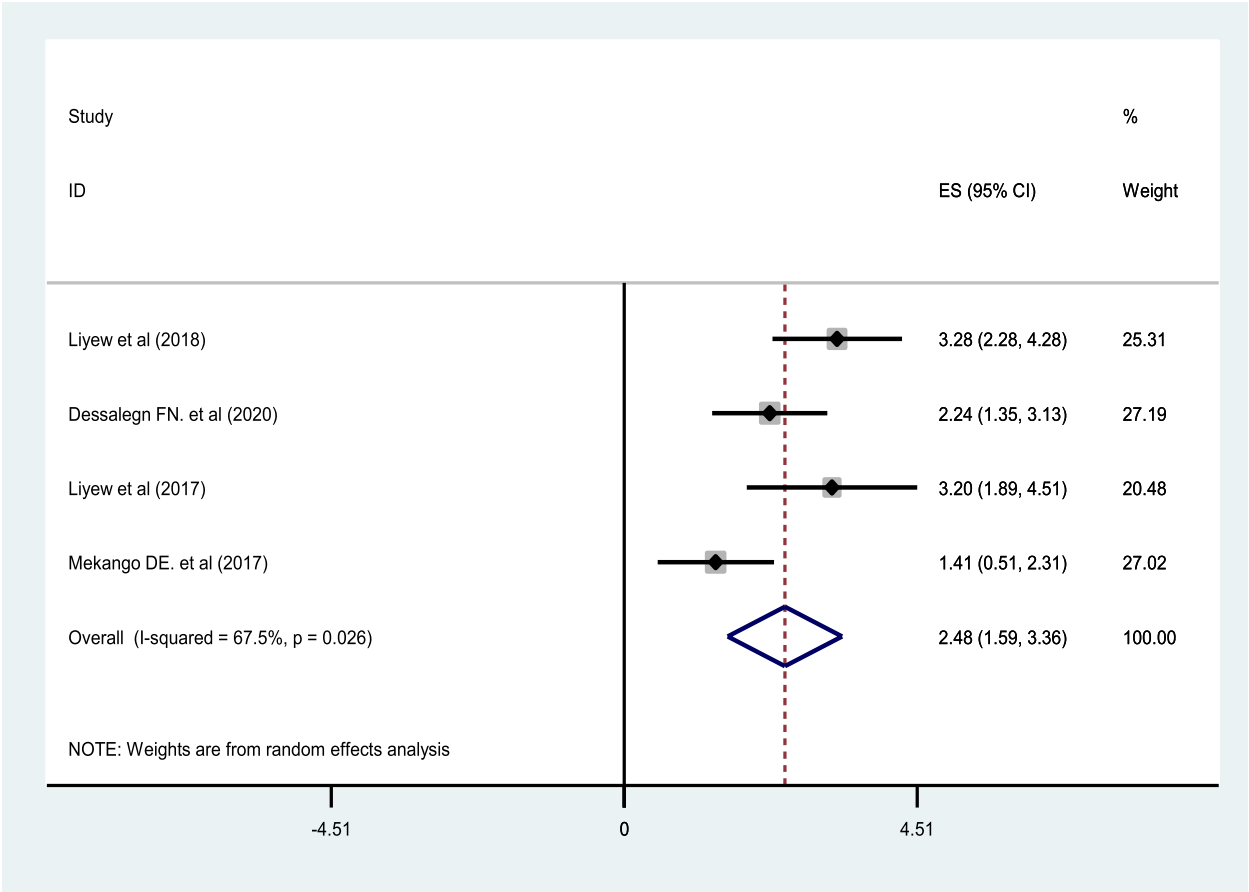

Fig. 11 The pooled estimate of AOR of educational statues on MNM in Ethiopia,2023

Conclusion and recommendation

Maternal near-misses continue to be prevalent in Ethiopia, and several factors were identified as predictors of these events, including preexisting chronic conditions, lack of formal education, history of referral, lack of antenatal care, and history of cesarean section. To address this issue, it is crucial to focus on including strategies to increase access to education for women, especially in rural areas, to empower them with knowledge about maternal health. Strengthening antenatal care services, focusing on early detection and management of complications, is crucial. Additionally, proactive management of pre-existing chronic conditions during pregnancy, promoting safe delivery practices to reduce unnecessary cesarean sections, and improving the quality of referral systems are essential steps. Collaboration between healthcare providers, policymakers, Ethiopian Ministry of Health, and hospital is vital to implement these recommendations effectively and reduce the prevalence of maternal near-misses in Ethiopia.

Strengths and limitations of the study

To ensure the rigor of this review, we adhered to a predetermined search strategy and employed established methods for evaluating the quality of individual studies. Sensitivity and subgroup analyses were conducted based on the study region and design. Additionally, the authors employed trim-fill analysis to mitigate the potential influence of publication bias. Nevertheless, it is crucial to recognize that the selective incorporation of literature could potentially bias this study. Primarily, due to the cross-sectional design, the observed results cannot be interpreted as causal. The possibility of publication bias exists due to the exclusion of certain grey literature sources, alongside language biases arising from the restriction to English-language publications. Furthermore, the generalizability of the findings may be limited to countries with distinct socio-economic and cultural landscapes, given that the included studies were exclusively conducted in Ethiopia.

Abbreviations

ANC	Antenatal care
AOR	Adjusted odds ratio
CI	Confidence interval

DHS	Demographic and Health Surveys
EDHS	Ethiopian Demographic and Health Survey
MNM	Maternal near miss
MMR	Maternal mortality rate
MDGs	Millennium Development Goals
SMM	Severe maternal mortality
OR	Odds ratio
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13643-025-02770-x.

Supplementary Material 1: S1 File. PRISMA checklist

Supplementary Material 2: Fig. 1 Publication bias for the Subgroup analysis of the prevalence of maternal near miss based on region and study design in Ethiopia. Fig. 2 Publication bias for the pooled estimate of AOR of having a history of cesarean section and MNM in Ethiopia. Fig. 3 Sensitivity for the pooled estimate of AOR of lack of ANC visit and MNM in Ethiopia. Fig. 4 Publication bias pooled estimate of AOR of having chronic comorbidity on MNM in Ethiopia. Fig. 5 Sensitivity pooled estimate of AOR of having chronic comorbidity on MNM in Ethiopia. Fig. 6Publication bias pooled estimate of AOR of rural residence on MNM in Ethiopia. Fig. 7 Sensitivity pooled estimate of AOR of rural residence on MNM in Ethiopia. Fig. 8 Trim and fill the pooled estimate of AOR of mode of admission on MNM in Ethiopia. Fig. 9 Sensitivity the pooled estimate of AOR of mode of admission on MNM in Ethiopia. Fig. 10 publication bias pooled estimate of AOR of educational statues on MNM in Ethiopia. Fig. 11 Sensitivity pooled estimate of AOR of educational statues on MNM in Ethiopia

Supplementary Material 3: Supplementary Table 1: JBI Quality Assessment Scale for cross sectional studies to assess determinants of maternal near miss, 2023. Supplementary Table 2: Characteristics of research articles included in this systematic review and meta-analysis, 2023

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Authors' contributions
Befkad Derese is a principal investigator. BD, MA, GK, AW, BB, AB, and GY: developed the study design and protocol, literature review, selection of studies, quality assessment, data extraction, statistical analysis, interpretation of the data, and developing the initial drafts of the manuscript and prepared the final draft of the manuscript. All authors read and approved the final manuscript.

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Data availability
Additional data can be available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
The study was carried out following relevant guidelines and regulations of the Helsinki Declaration of Medical Research Ethics, as it included only ethically approved articles. Ethical approval for each individual article included in this systematic review and meta-analysis.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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