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REVIEW

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Gestational diabetes mellitus and its associated factors in Ethiopia: a systematic review and meta-analysis

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Abstract

Background In Ethiopia, gestational diabetes mellitus (GDM) is a significant public health issue and a risk to maternal and child health. Understanding the prevalence and factors of GDM in Ethiopia may also help determine the best interventions. Therefore, we tried to review gestational diabetes and its factors in Ethiopia.

Methods The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) instrument was used to conduct the review. In order to report on the prevalence and contributing factors of gestational diabetes mellitus, the following databases were used: Google Scholar, PubMed, EMBASE, Scopus, Web of Sciences, and Grey literature. Pilo-tests were conducted using a standardized data gathering form in research using a random sample. All statistical analyses were performed using STATA version 16 software for Windows and the random-effects meta-analysis method. The results are presented using texts, tables, and forest plots, along with measure of effect and a 95% confidence interval.

Results Out of 1755 records, 10 studies with 6525 participants that fully satisfy the inclusion criteria were included for the meta-analysis. The pooled prevalence of gestational diabetes mellitus in Ethiopia was 12.04% [95% CI (8.17%, 15.90%)]. Inadequate dietary diversity, high body mass index, having a family history of DM, history of having macrosomic neonate, low physical activity, and previous history of GDM were statistically significant.

Conclusion The pooled prevalence of gestational diabetes mellitus is high in Ethiopia. Inadequate dietary diversity, high body mass index, having a family history of DM, history of having macrosomic neonate, low physical activity and previous history of GDM were statically significant variables. Emphasize on early screening, prenatal care and all women having risk factors and trying to get pregnant should get screens for diabetes to improve the maternal and child health at large.

Keywords Gestational, Diabetes mellitus, Systematic review, Meta-analysis, Ethiopia

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Introduction

Diabetes is a chronic condition that develops when either the pancreas does not create enough insulin or when the body does not utilize the insulin that is produced properly. It classified as Pre-gestational Diabetes Mellitus (Type I or Type II) and Gestational Diabetes Mellitus (GDM) [1]. One of the most prevalent endocrinopathies and medical consequences of pregnancy is gestational diabetes mellitus (GDM), which is purportedly brought on by pregnancy due to heightened physiological changes in glucose metabolism, placental synthesis diabetogenic substance, and maternal insulin resistance [2–8].

It is defined as the initial diagnosis or recognition of glucose intolerance during pregnancy and does not meet the criteria for overt diabetes outside of pregnancy [4, 9–12].

It is linked to serious short- and long-term morbidities for both the mother and the fetus (fetal morbidities include spontaneous abortion, preterm birth, malformations, altered fetal growth, unexplained fetal demise, respiratory distress syndrome, hydraminous, hypoglycemia and hypocalcaemia, hyperbilirubinemia, polycythemia, cardiomyopathy, and long-term cognitive development delay; and maternal morbidities includes Preeclampsia, Diabetic Nephropathy, Diabetic Retinopathy, Diabetic Neuropathy, Diabetic Ketoacidosis and infections [12–23].

The pooled global overall prevalence of GDM, irrespective of the screening threshold categories, was 4.4% [24]. And in Africa was 13.61% and 14.28% in the sub-Saharan African region [25].

Risk factors of GDM include excessive body weight, low level of physical activity, consanguineous marriage, previous history of GDM, glycated hemoglobin > 5.7%, history of cardiovascular disease, overweight and obese reproductive-age females soars, previous history of spontaneous abortion, age, parity, antenatal depression, family history of type 2 DM, having previous macrosomic baby, and a history of still birth [26–32].

The 2022 Standards of Care gives more emphasis on diabetes screening for women who are trying to get pregnant or are already pregnant. If they have risk factors, women who are trying to get pregnant should get screens for diabetes. Additionally, healthcare professionals should consider about screening all women who intend to get pregnant for diabetes who have not yet been diagnosed. Similar to this, screenings for pregnant women at risk should begin before week 15 of the pregnancy or in the initial prenatal appointment [33]. It is challenging to assess the prevalence of GDM between and within nations due to the lack of consistency in the diagnostic protocols, which vary not only between countries but also within countries. However, in 2013, taking into account the concerns raised by the International Association of Diabetes in Pregnancy Study Groups (IADPSG) recommendations, WHO changed its criteria for the diagnosis of GDM [34–36]. Ethiopia endorses the 2013 WHO screening and diagnosis standards and GDM may be diagnosed based on the fasting plasma glucose that is 92–125 mg/dL (5.1–6.9 mmol/L) and/after a 75 g oral glucose load, plasma glucose is 180 mg/dL (10.0 mmol/L) and/after a 75 g oral glucose load, plasma glucose is 153–199 mg/dL (8.5–11.0 mmol/L) at two hours [9].

There has not been a comprehensive study of the prevalence of GDM at the national level, only small-scale research at different regional and zonal levels. Therefore, the purpose of this meta-analysis is to estimate the prevalence of GDM and its contributing factors at the national level in a more comprehensive manner. The results of this study would emphasize the significance and urgency of expanding GDM screening and its care throughout Ethiopia. Understanding the prevalence and factors of GDM in Ethiopia may also help determine the best intervention to use in order to lessen the severity of the issue, enhance mother and child health, and end the burden of GDM in Ethiopia. As a result, we conducted a systematic review and meta-analysis to assess the prevalence and to determine GDM in Ethiopia.

Methods

Design and search strategy

This study followed a predetermined protocol and examined the data to determine the prevalence of gestational diabetes mellitus and its contributing factors in Ethiopia. We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria to review and present the findings of this systematic review and meta-analysis [37] in detail (Additional file 1).

For reporting the prevalence of gestational diabetes mellitus and its factors, a systematic and thorough literature search methodology was used without restriction from the beginning of the study until sending to the journal; via Google Scholar, PubMed, EMBASE, Scopus, Web of Sciences, and Grey literature databases. To find more pertinent articles, we manually looked for cross-references as well. The terms "prevalence of gestational diabetes mellitus," "gestational diabetes mellitus," "associated factors of gestational diabetes mellitus," "diabetes mellitus," "complication of gestational diabetes mellitus," screening and diagnosis of gestational diabetes mellitus, and "Ethiopia" have all been included in our search strategy.

Inclusion and exclusion criteria

Inclusion criteria

This review included all peer-reviewed, published, and repository research that addressed the prevalence of gestational diabetes mellitus, its risk variables, and reported accurate measures of relationship.

Exclusion criteria

Reviews, case studies, conference abstracts, letters, studies in which the proper measures of association were not presented, abstracts without additional details or without full-text articles and duplicate data were excluded.

Data collection and synthesis

Based on the inclusion and exclusion criteria, two independent authors (FYB and BGK) evaluated the eligibility of all retrieved papers by looking at the title and abstract. Additionally, three authors (FYB, GNM, and ADA) evaluated the studies' quality. We came to a rational consensus when there was a disagreement.

Data extraction

Pilo-tests were conducted using a standardized data gathering form in research using a random sample. First author, publication year, data collection year, study setting, study design, sample size, response rate, methods of diagnosis, statistically significant factors, adjusted Odds ratio (AOR), 95% confidence interval, prevalence, and covariance are all taken into account in the data collection. When results were published more than once, the data were only taken into account once. A logical agreement between the two authors was able to clear up any doubts that arose during the extraction procedure. We have excluded the research or the unavailable parameter in the event of incomplete data.

Study quality and risk of bias assessment

The quality and strength of each study are to be evaluated using the development of a critical assessment instrument for use in systematic reviews addressing problems of prevalence and incidence [38] in detail (Additional file 2). We evaluated based on the following assessment criteria: inclusion/exclusion criteria, sampling procedure, sample size, sample representativeness, data collection techniques, and adequate response rate (Table 1).

Data synthesis and statistical analysis

A meta-analysis was carried out to provide a comparative classification of the outcome and determinants of interest for the selected publications and to calculate the effect size for the prevalence of gestational diabetes mellitus in Ethiopia. The related factors of gestational diabetes mellitus were examined based on eligibility requirements. With regard to one linked factor of gestational diabetes mellitus, at least two studies were taken into consideration, together with their respective measures of effect and 95% confidence intervals (CI). Calculating the effect size and 95% confidence interval provided an approximation of the substantial relationship between gestational diabetes mellitus and its contributing components (CI). A DerSimonian–Laird method-based random effects model was taken into consideration in order to identify variations both within and between studies [39]. In addition, I^2 statistics and Cochran's Q test have been used to measure heterogeneity through studies. The percentage of the sample's overall variance that can be attributed to heterogeneity is thought to be measured by the I^2 statistics. I^2 values range from 0 to 100%, with $I^2 \geq 75\%$ signifying significant study heterogeneity [39]. We looked at publication bias qualitatively in the meta-analysis with funnel plot and used Begg's test and Egger's test (P 0.05) to determine statistical significance [41]. STATA version

Table 1 Characteristics of studies which are included in the systematic review and meta-analysis, 2022

References	Study year	Region	Study area	Study design	Sample size	Prevalence of gestational diabetes
Larebo et al. [42]	2020	SNNPR	Hadiya zone	Cross-sectional	470	26.2
Ewnetu et al. [48]	2016	Adiss Ababa	Adiss Ababa	Cross-sectional	162	29.6
Nigatu et al. [47]	2017	Adiss Ababa	Adiss Ababa	Cross-sectional	422	16.9
Seyoum et al. [50]	1999	Tigray	Tigray	Cross-sectional	890	3.7
Dedecha et al. [46]	2021	Oromia	Guji	Cross-sectional	190	7.4
Muche et al. [49]	2018	Amhara	Northwest Ethiopia	Cross-sectional	1110	12.8
Woticha et al. [44]	2017	SNNPR	Wolaita	Cross-sectional	564	4.2
Atlaw et al. [45]	2020	Oromia	Goba town	Prospective cohort	500	15.7
Wakwoya et al. [51]	2017	Harar	Harar and Dire Dawa	Case–control	1834	2.6
Boda et al. [43]	2019	SNNPR	Gamo zone	Cross-sectional	383	7.1

16 was used for the statistical analysis. The results are provided using texts, tables, and forest plots with measures of effect and 95% confidence interval.

Sensitivity and subgroup analysis

Using sensitivity analysis of the chosen studies, we investigate potential sources of heterogeneity. Sensitivity analysis was used to assess the impact of inappropriate studies. A subgroup analysis was also performed for prevalence by place of study, region, and sample size.

Operational definitions

Gestational diabetes: It is defined as the initial diagnosis or recognition of glucose intolerance during pregnancy. It was diagnosed using the one-step strategy by performing a 75-g oral glucose tolerance test (OGTT) protocol, with plasma glucose measurement taken when patient is fasting and at 1 and 2 h, at 24–28 weeks of gestation in women not previously diagnosed with overt diabetes. The OGTT was performed in the morning after an overnight fast of at least 8 h [2, 4, 9].

Results

A total of 1755 research were reviewed; of these, 426 studies were removed because the information in the title and abstract did not line up, and also 1189 papers were removed due to duplication. A thorough evaluation of the text led to the removal of another130 articles from the review due to duplication, incorrect statistical analysis, conflicting results publication, inconsistent research outcome, or irrelevant target participants. Finally, ten studies were taken into account for the pooled estimation of gestational diabetes mellitus and its factor analysis (Fig. 1). Among the included studies, nine of them were published articles while one of them was repository articles. Eight of the included studies were cross-sectional in design, the remaining two were cohort and case–control studies, and around 90% of the study setting of the included studies was institutional (Table 1).

Characteristics of the included studies

A total of 10 studies with 6525 participants were considered. Of those, three studies [42–44] were conducted in SNNPR, two [45, 46] in Oromia region, two [47, 48] in Addis Ababa city administration, and the rest three [49–51] in other regions (Amhara, Tigray, and Harari), respectively.

Prevalence of gestational diabetes mellitus

In Ethiopia, the pooled estimate of gestational diabetes mellitus using a random effects model was 12.04% (95% CI 8.17%, 15.90%) with significant heterogeneity between studies ($I^2 = 97.5$, $P = 0.000$) (Fig. 2).

According to the subgroup analysis by region, Addis Ababa has the highest rate of gestational diabetes mellitus [12.343% (95% CI 1.814, 22.873), $I^2 = 98\%$], and category of in other regions (Tigray, Amhara and Harari) region has the lowest rate [6.28 (95% CI 1.51, 11.04), $I^2 = 97.8\%$] (Fig. 3).

Checking for heterogeneity and publication bias

The overall meta-analysis result suggests that there was statistically substantial heterogeneity among studies ($I^2 = 97.5\%$), and we attempted to perform a subgroup analysis by region to reduce and modify heterogeneity (Fig. 3). Using the funnel plot and Egger's test to analyze the publication bias, it was determined that the included studies were distributed asymmetrically (Fig. 4). For the existence of publication bias, the Egger's test result was statistically significant ($P = 0.0001$). Additionally, we attempted to do the sensitivity analysis using the random-effects model and proposed that none of the studies had an impact on the total estimate (Fig. 5).

Factors associated with gestational diabetes mellitus (GDM)

The reviewed literature showed various significant factors associated with gestational diabetes mellitus in Ethiopia. Inadequate dietary intake were more risks to gestational diabetes mellitus than the counter parts which is adequate dietary intake with [OR: 1.51 (95% CI (1.25, 1.83), I^2: 0.0%] (Fig. 6). The heterogeneity test ($P = 0.453$) showed no evidence of variation across studies. The result of Egger's test showed no statistically significant publication bias ($P = 0.25$). The odds of developing GDM among pregnant women with BMI of ≥ 25 kg/m^2 were more likely than those with a BMI of < 25 kg/m^2 which is statistically significant [OR: 2.24 (2.07, 2.42), I^2: 0.0%] (Fig. 7). The heterogeneity test ($P = 0.916$)] showed that there is no significant variation across studies. The result of Egger's test showed that there is no statically significant evidence of publication bias ($P = 0.06$). Participants who had a family history of diabetes mellitus were a higher chance of developing gestational diabetes mellitus as compared to those who had no family history of diabetes mellitus which is statistically significant [OR: 3.60 (2.71, 4.77), I^2: 64.4%] (Fig. 8). The heterogeneity test ($P = 0.024$) showed that there is no significant variation across studies. The result of Egger's test showed no statistically significant evidence of publication bias ($P = 0.145$).

Pregnant mother who had macrocosmic baby (> 4 kg) was more likely to develop GDM as compared to pregnant mother who had no macrocosmic baby previously which is statistically significant [OR: 4.79 (1.79, 12.86), I^2: 96.0%] (Fig. 9). The heterogeneity test ($P = 0.001$) showed no significant variation across studies. The result of

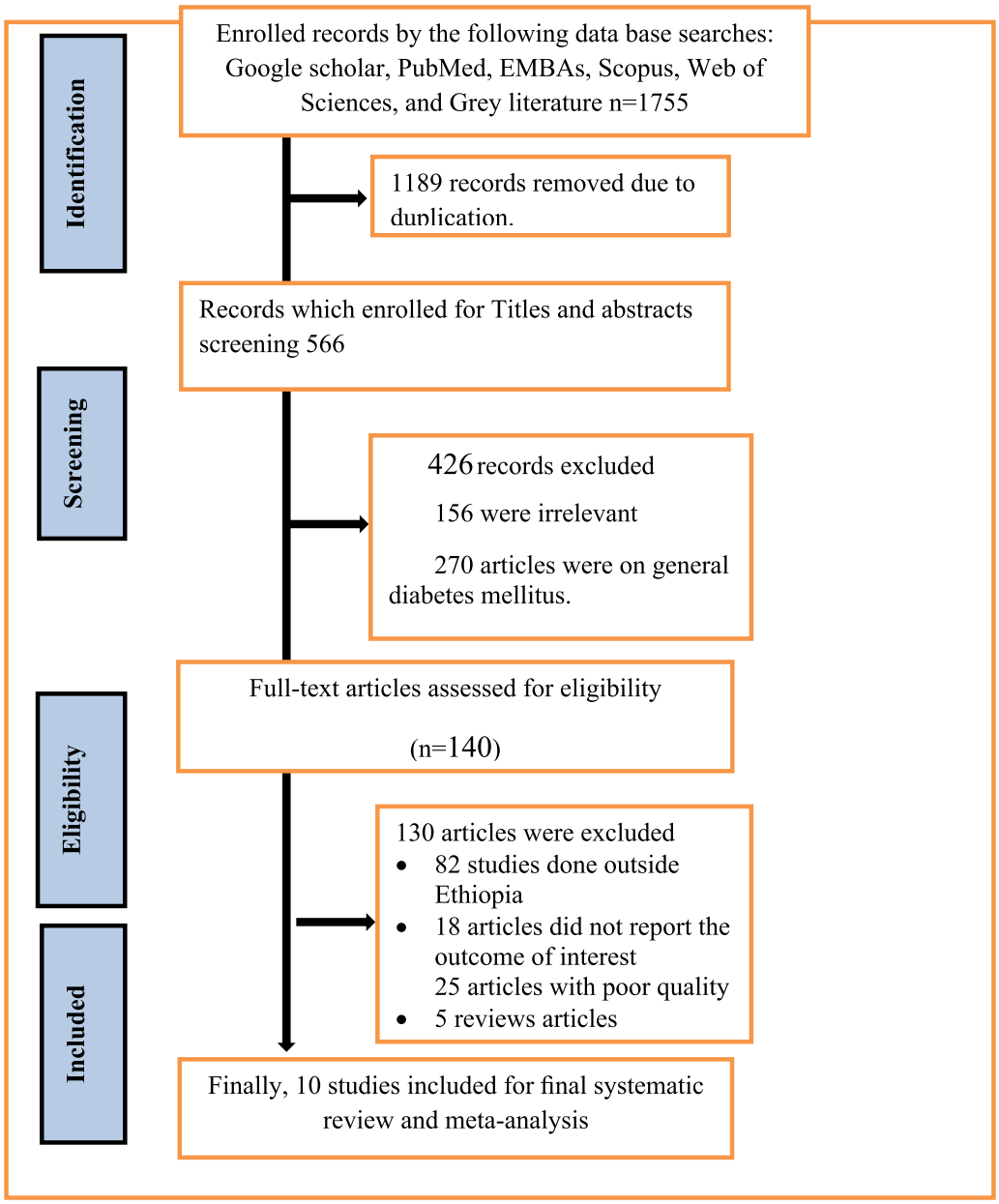

Fig. 1 PIRSMA flowchart diagram of the study selection

Egger's test showed no statistically significant evidence of publication bias ($P=0.431$).

Pregnant women with low physical activity were more at risk of GDM than those with high physical activity which is statistically significant [OR 18.08 (7.27, 44.99), I^2 97.7%] (Fig. 10). The heterogeneity test ($P=0.001$ showed no variation across studies. The result of Egger's test showed no statistically significant evidence of publication bias ($P=0.743$).

Women with a previous history of GDM had higher chance of developing GDM as compared to women without a history of GDM which is statistically significant [OR 8.66 (2.38, 31.59), I^2 99.9%] (Fig. 11). The heterogeneity test ($P=0.001$) showed no variation across studies. The result of Egger's test showed no statistically significant evidence of publication bias ($P=0.523$).

Discussion

The increased prevalence of gestational diabetes mellitus around the world has led to new findings about the link between blood sugar levels and the success of pregnancies [52].

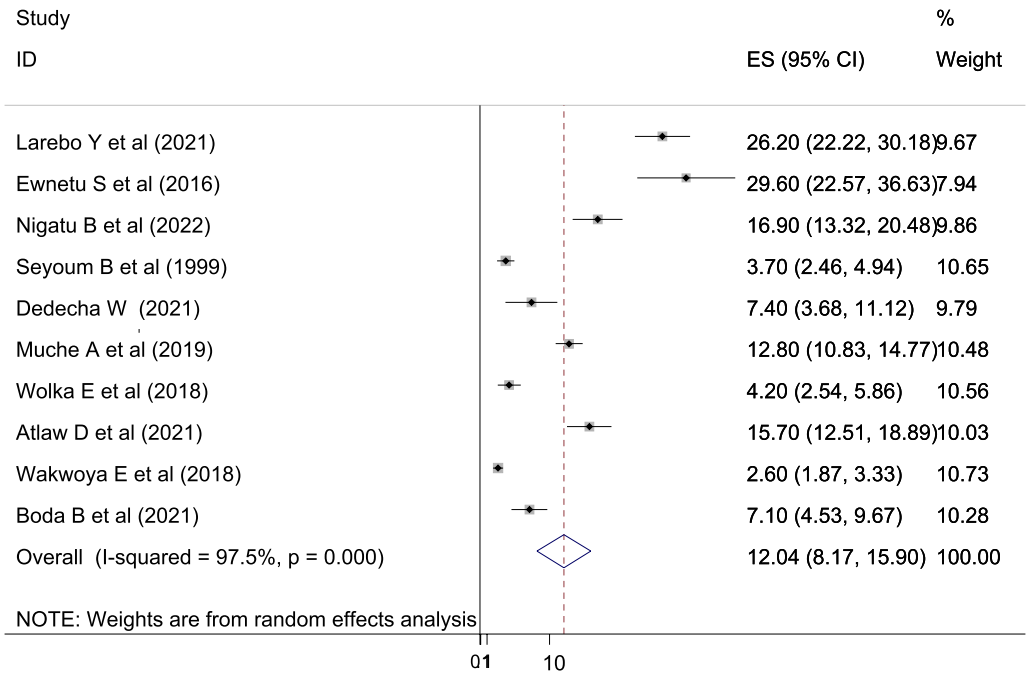

Fig. 2 Forest plot for pooled prevalence of gestational diabetes mellitus

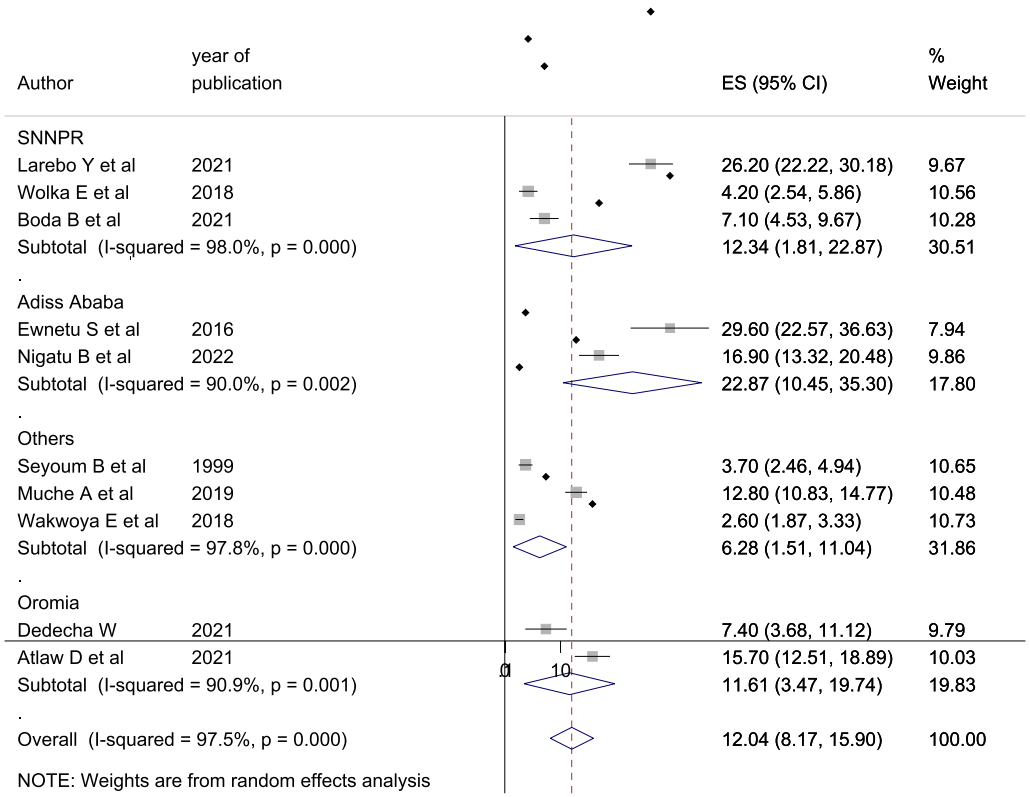

Fig. 3 Subgroup analysis by region on gestational diabetes mellitus

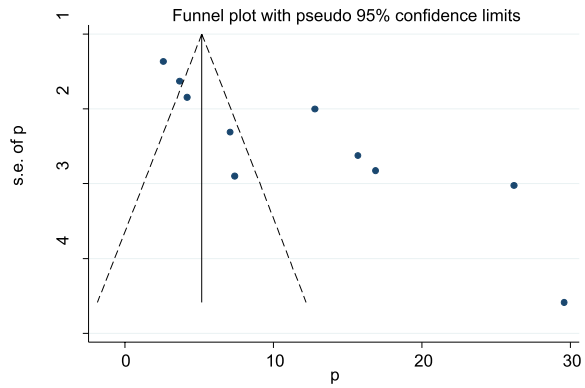

Fig. 4 Funnel plot to show the publication bias in 10 studies

This review showed that the pooled prevalence of gestational diabetes mellitus was 12.04% (95% CI 8.17%, 15.90%) in Ethiopia. This finding was in line with studies conducted in Africa: systematic review and meta-analysis (13.61%) [25], in Libreville (10.2%) [53], Itojo General Hospital, South Western Uganda (15.6%) [54], in Asia: a systematic review (11.5%) [55], eastern and southeastern Asia (10.1%) [56], Europe Systematic Review (10.9%) [57], and Kumasi, Ghana (8.5%) [58]. This might be due to using related screening approach and definitions.

However, the findings of this review were lower than the studies conducted in Bangladesh demographic finding (35%) [59], Lima, Peru (16%) [60], Punjab, North India (35%) [61], Dodoma region, Tanzania (27.5%) [62], Riyadh, Saudi Arabia (32.6%) [63], and in Limbe, Cameroon (20.5%) [64]. The variation might be due to variation in different diagnostic approach, operational definitions, study population, areas and methods used.

On the contrary, the pooled prevalence of gestational diabetes mellitus was higher than the studies conducted in sub-Saharan Africa: systematic review (2–6%) [65], Nigeria (2.98%) [66], western Kenya (2.9%) [67], Kigali City, Rwanda (8.3%) [68], Europe: a meta-analysis (5.4%) [69], in the National Health and Nutrition Examination Surveys in USA, 2007–2014 (7.6%) [70], southern Tanzania (4.3%) [71], Yemen (5.1%) [72], Turkey: systematic review (7.7%) [73], and Brazilian Public Health Care (5.4%) [74]. This might be due to study year variation, socio-demographic characteristics of the study participants, sample size, measurement tools used, and variation in diagnostic approach and variation in operational definitions.

The subgroup analysis by region showed that the highest level of GDM was in Addis Ababa which is 22.87% whereas the lowest was in other three regions (Tigray, Amhara, and Harar) which is 6.28%. This might be because women living at the federal level have more awareness about timing, benefit, and early screening of GDM than those living at the regional level.

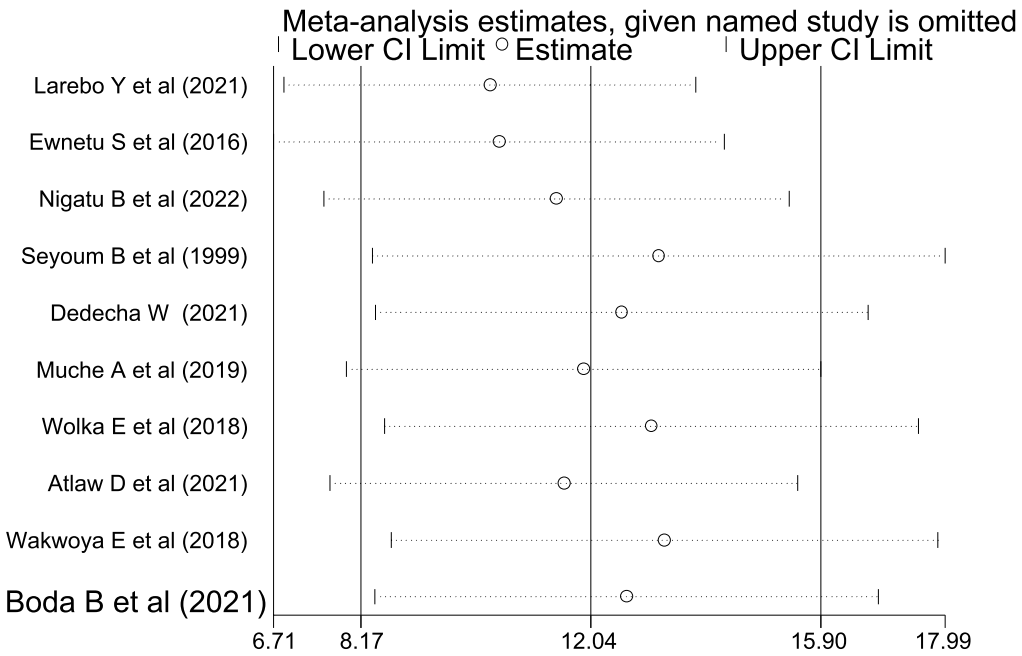

Fig. 5 Sensitivity analysis of the 10 studies

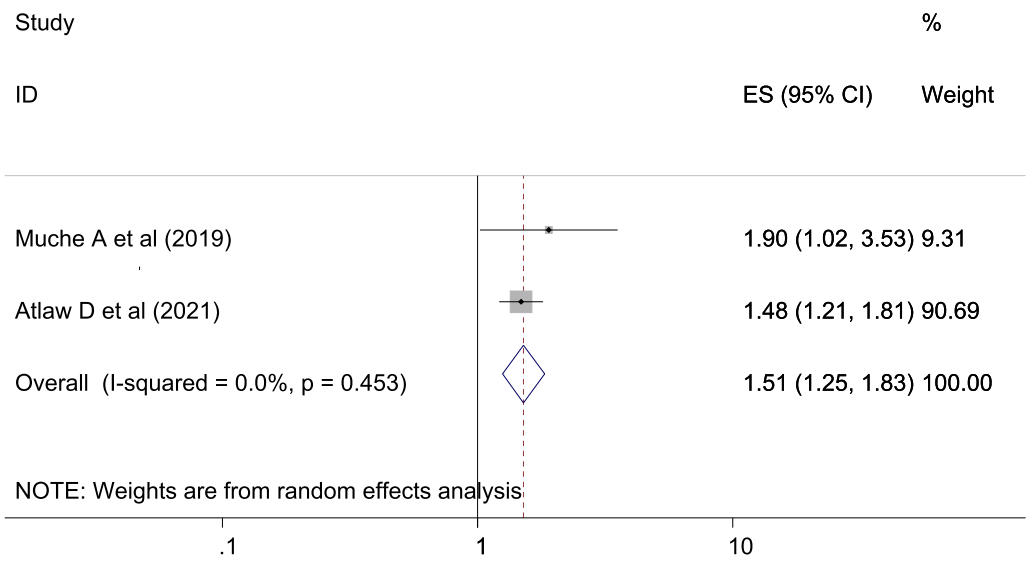

Fig. 6 Forest plot showing the association between gestational diabetes mellitus and inadequate dietary intake

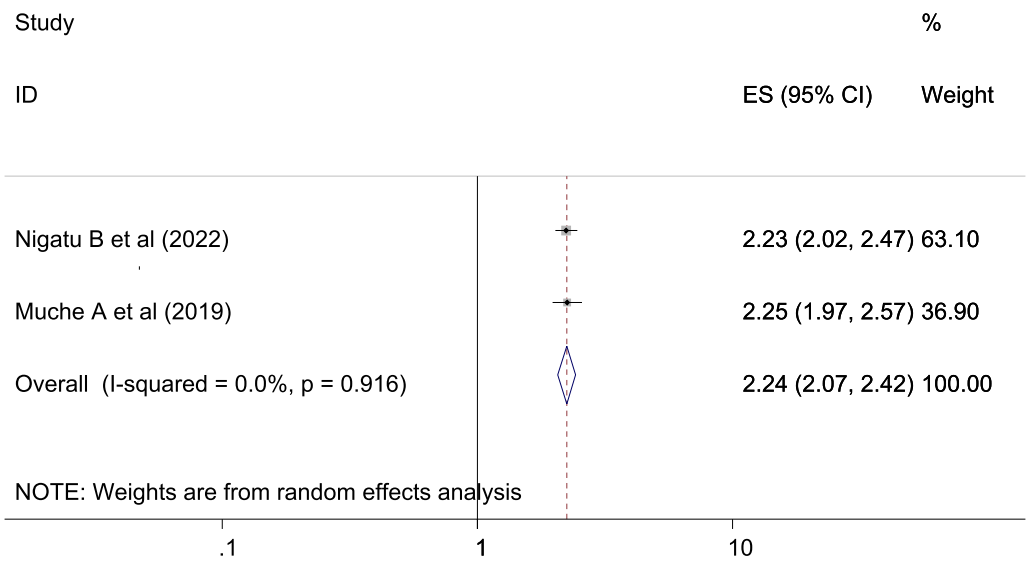

Fig. 7 Showing that the association of gestational diabetes mellitus and body mass index

According to our review and meta-analysis finding, inadequate dietary diversity, high body mass index, having family history of DM, history of having macrosomic neonate, low physical activity, and previous history of GDM were the statically significant variables.

Women who get inadequate dietary diversity were two times more exposed to GDM than the counters with OR: 1.51 [95% CI (1.25, 1.83)]. This finding is in agreement with the studies conducted in coastal Karnataka [75]. Inadequate dietary diversity may result in a reduced likelihood of obtaining various vitamins, minerals, nutrients, and phytochemicals that can help prevent nutrient deficiencies and chronic diseases. It may also increase stress, fatigue, and less capacity for work. Over time, it may also

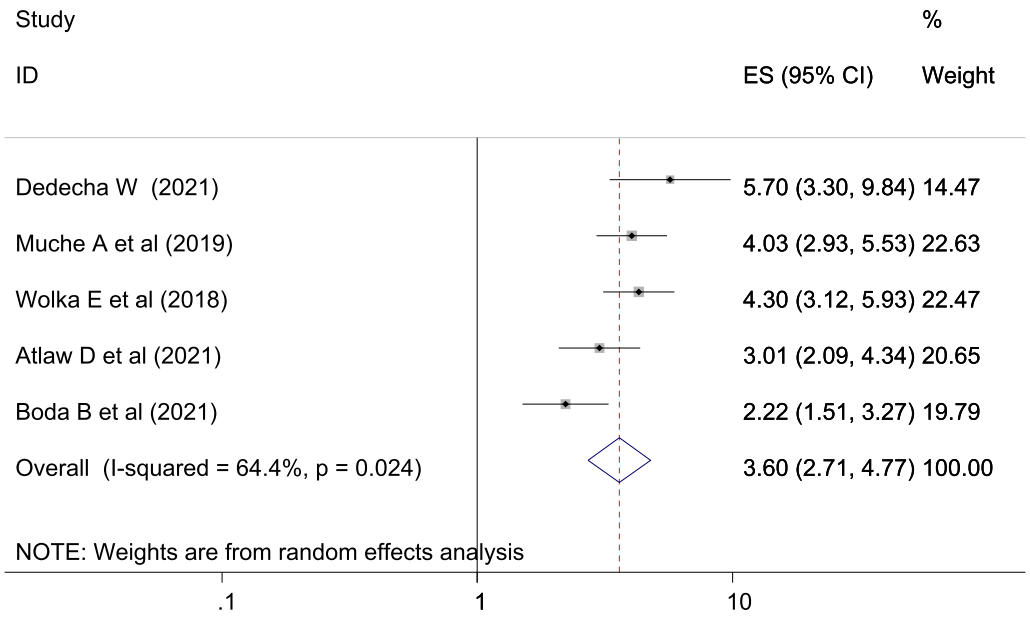

Fig. 8 Showing the association between gestational diabetes mellitus and family history of diabetes mellitus

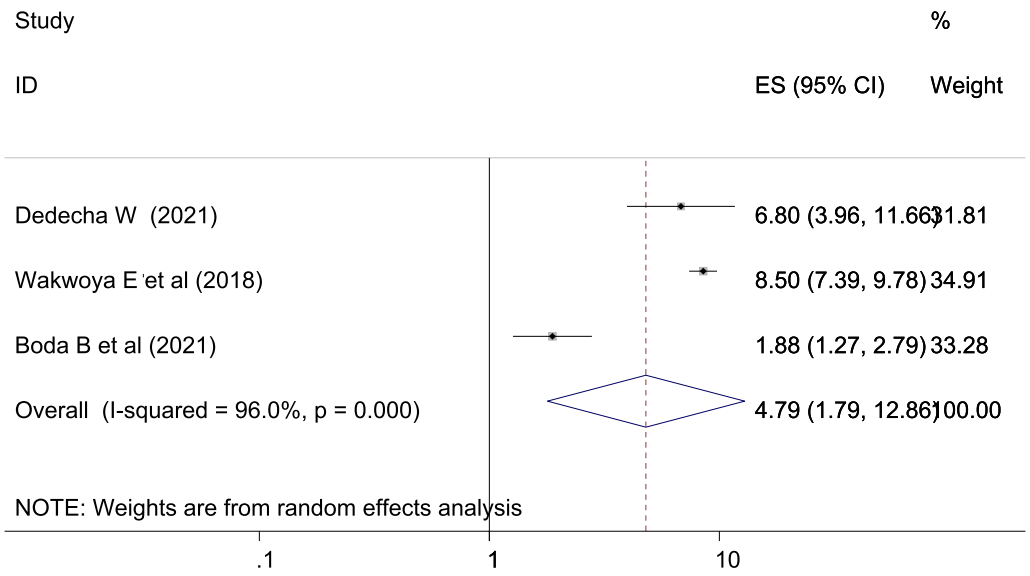

Fig. 9 Showing the relation between gestational diabetes mellitus and previous macrosomic baby

increase the risk of contracting certain diseases and other health issues, such as being overweight or obese and having an abnormal metabolism.

Participants with body mass index > 30 were high chance of getting GDM compared with normal level of body mass index with OR: 2.24 [95% CI (2.07, 2.42)]. This analysis is similar to the studies in Brazilian Public Health Care [74], southern Tanzania [71], in Riyadh, Saudi Arabia [63], in Limbe, Cameroon [64], Libreville [53], Punjab, North India [61], Lima, Peru [60], and in Asia: a systematic review [55]. Patients with higher BMI gain a higher fat mass accumulation, which could affect subsequent maternal insulin resistance [76]. This may be due to the fact that as a mother's BMI rises, she may engage

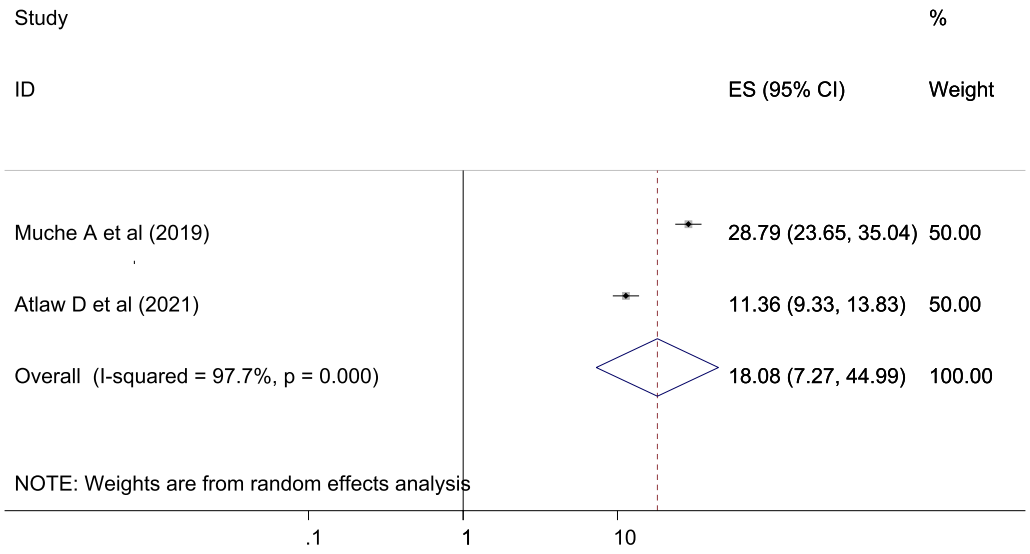

Fig. 10 Showing that the association of gestational diabetes mellitus and low physical activities

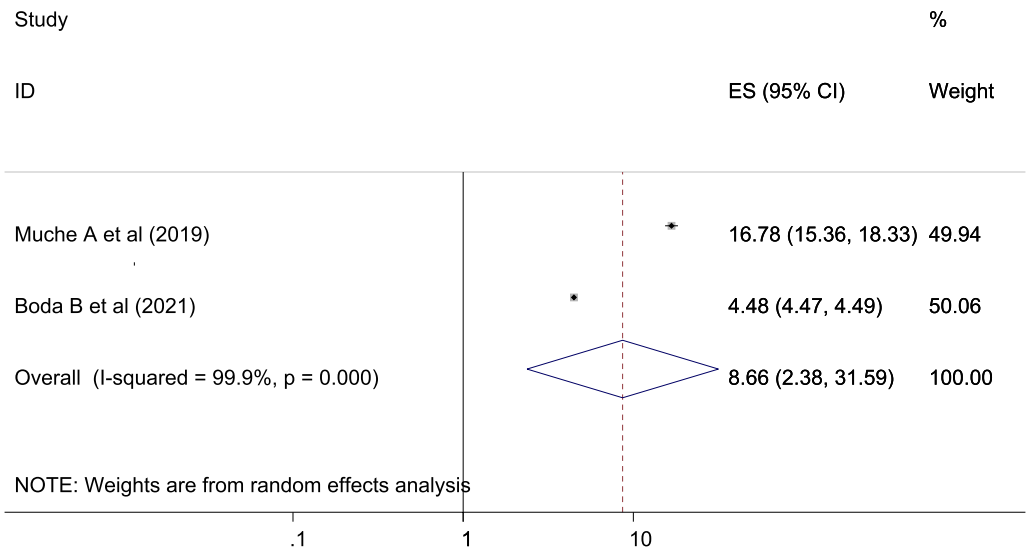

Fig. 11 Showing that the association of gestational diabetes mellitus and previous history of gestational diabetes

in less physical activity, experience stress, get weaker, and ultimately develop high fat stores, abnormal metabolism, and GDM.

Women having family history of DM were four times more develop GDM than no family history of DM with OR: 3.60 [95% CI (2.71, 4.77)]. This finding is in agreement with the studies conducted in Fujian province [77], Yemen [72], southern Tanzania [71], in Riyadh, Saudi Arabia [63], Dodoma region, Tanzania [62], Lima, Peru [60], Asia: a systematic review [55], and in coastal Karnataka [75]. This may be connected to pregnant women with a family history of diabetes and having a genetic predisposition that could lead to the development of GDM.

Women with a history of macrosomic neonate were more prevalent to GDM than the counter parts with OR: 4.79 [95% CI (1.79, 12.86)]. This is in agreement with the studies in southern Tanzania [71], in Riyadh, Saudi Arabia [63], in Limbe, Cameroon [64], and in Asia: a

systematic review [55]. Previous macrosomic neonates may have been caused by uncontrolled GDM or by hyperglycemia; this may have a substantial correlation with GDM emerging during a subsequent pregnancy.

Participants who had low physical exercise were more prone to GDM than those having high regular exercise with OR: 18.08 [95% CI (7.27, 44.99)]. This finding is in agreement with studies conducted in Dodoma region, Tanzania [71], and in coastal Karnataka [72]. Exercise is deemed to be an important component of lifestyle intervention for GDM [78]. Healthy pregnant women should engage at least 30 min of moderate-intensity exercise at least four times per week [79]. Exercise may be an effective strategy to help control blood sugar levels. If you do not exercise much or at all, your blood sugar levels may be abnormal, which can cause insulin resistance and aberrant metabolism, which can lead to GDM.

Women's having history of previous GDM were nine times more develop GDM than no history of GDM with 8.66 [95% CI (2.38, 31.59)]. This finding is in agreement with the studies conducted in Yemen [72], in Riyadh, Saudi Arabia [63], and Libreville [53], and in Asia: a systematic review [55]. Approximately, 50–73% of women with previous GDM developed GDM in a future pregnancy [80–82]. Different studies showed that there is a strong association between previous GDM and subsequent pregnancy developing GDM.

Limitations

We tried to examine only the influence of six factors because other major factors were not commonly investigated by the included studies. Due to the limitation of published systematic reviews and meta-analysis on gestational diabetes and its factor in national level, it creates difficulty to compare our results with other national evidence.

Conclusions and recommendations

The pooled prevalence of gestational diabetes mellitus is high in Ethiopia. Inadequate dietary diversity, high body mass index, having family history of DM, history of having macrosomic neonate, low physical activity, and previous history of GDM were statically significant variables. This might be very useful for healthcare policymakers (e.g. Federal Ministry of health, Hospital administrators and NGOs) to emphasize on early screening, prenatal care and all women having risk factors and trying to get pregnant should get screens for diabetes to improve the maternal and child health at large. Given the multifactorial nature of factors influencing gestational diabetes mellitus, further qualitative research is needed to identify additional factors, especially from participants' perspective, and explore context-specific strategies,

Abbreviations

CI	Confidence interval
DIP	Diabetes in pregnancy
DM	Diabetes mellitus
GDM	Gestational diabetes mellitus
OGTT	Oral glucose tolerance test
PRISMA	Preferred reporting items for systematic reviews and meta-analyses
WHO	World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40001-023-01088-5.

Additional file 1. PRISMA-P (preferred reporting items for systematic review and meta-analysis protocols) 2009 checklist: recommended items to address in a systematic review protocol.

Additional file 2. Quality assessment of included studies using the Joanna Briggs Institute criteria's for assessing quality of primary studies and JBI Critical Appraisal Checklist for Studies Reporting Prevalence Data, 2019.

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Author contributions

FYB and BGK developed the protocol and involved in the study selection, data extraction, statistical analysis, results interpretation, and developing the first draft of the manuscript. FYB, GNM, and ADA involved in data extraction, quality assessment, statistical analysis, revising subsequent drafts, and preparing the final draft of the manuscript. All authors read and approved the final draft of the manuscript.

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Availability of data and materials

All the data are available from the corresponding author upon a reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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