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Undiagnosed Gestational Diabetes Mellitus and Its Impact on Maternal and Perinatal Outcomes: A Systematic Review

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ABSTRACT

Gestational diabetes mellitus (GDM) was a common metabolic disorder during pregnancy associated with significant maternal and neonatal morbidity. Although outcomes of diagnosed and treated GDM had been well established, some cases remained unrecognized because of variations in screening implementation and diagnostic thresholds. This study aimed to evaluate the association between undiagnosed GDM and adverse maternal and perinatal outcomes. A systematic review was conducted in accordance with PRISMA guidelines. PubMed, ScienceDirect, and Google Scholar were searched for eligible observational studies. Undiagnosed GDM was categorized into four subtypes: diagnostic misclassification, mild untreated hyperglycemia with one abnormal oral glucose tolerance test value, late-diagnosed GDM, and postpartum reclassified diabetes. Methodological quality was assessed using the Newcastle–Ottawa Scale. Where comparable adjusted effect estimates were available, a random-effects meta-analysis was performed; otherwise, findings were synthesized narratively. Fourteen observational studies were included. Undiagnosed GDM was consistently associated with increased risks of hypertensive disorders, cesarean delivery, large-for-gestational-age infants, neonatal morbidity, and perinatal mortality in some cohorts. A meta-analysis of four studies showed a significantly increased risk of large-for-gestational-age infants among undiagnosed cases (pooled odds ratio = 1.77; 95% confidence interval: 1.41–2.23), with substantial heterogeneity. In several analyses, outcomes among undiagnosed cases were comparable to or more severe than those in diagnosed and treated GDM. Undiagnosed gestational dysglycemia was associated with elevated maternal and perinatal morbidity. Improving antenatal screening, diagnostic harmonization, and timely identification of hyperglycemia during pregnancy were important to reduce preventable complications.

1. INTRODUCTION

Gestational Diabetes Mellitus (GDM) is one of the most common metabolic disorders encountered during pregnancy and is defined as glucose intolerance with onset or first recognition during gestation. The global prevalence of GDM has increased markedly over the past two decades in parallel with rising rates of obesity, delayed maternal age, and sedentary lifestyles (Lavery et al., 2017; Zhu et al., 2019). Current estimates indicate that hyperglycemia in pregnancy affects approximately 16.2% of live births worldwide, with GDM representing 75-90% of these cases (Magliano DJ, 2021). The burden is particularly significant in a low to middle income

countries, where rapid urbanization and dietary transitions coexist with limited access to comprehensive antenatal screening programs (Sweeting et al., 2024). In Southeast Asia, several population-based studies have reported a steady increase in GDM prevalence, with pooled estimates of 10.1%(Nguyen et al., 2018), reflecting demographic shifts as well as improved clinical awareness. Nevertheless, variations in screening practices and health system capacity result in many cases remaining unrecognized during pregnancy (Amarra et al., 2021; Muche et al., 2019).

The pathophysiology of GDM involves an interaction between pregnancy-related insulin resistance and inadequate pancreatic beta cell compensation (Mittal et al., 2025). Insulin resistance intensifies during the second and third trimesters as placental hormones including human placental lactogen, progesterone, and cortisol counteract insulin action. In women with limited beta cell reserve, this adaptive response fails, leading to maternal hyperglycemia. Sustained hyperglycemia has well-established consequences, including increased transplacental glucose transfer, fetal hyperinsulinemia, and alterations in placental function. These mechanisms explain many of the adverse maternal and neonatal outcomes associated with GDM, such as hypertensive disorders of pregnancy, operative delivery, excessive fetal growth, and metabolic disturbances in the newborn.

Although the effects of diagnosed GDM have been widely investigated, less attention has been given to cases that remain undetected during pregnancy. Undiagnosed GDM may arise from the absence of universal screening, late initiation of antenatal care, limited laboratory resources, or inconsistent application of diagnostic criteria (Gupta et al., 2015; Reddi Rani & Begum, 2016). In these circumstances, women do not receive glucose monitoring, dietary counseling, or pharmacologic therapy, and maternal hyperglycemia persists without treatment throughout gestation. Failure to establish the diagnosis therefore represents a missed opportunity for intervention and may expose both mother and fetus to prolonged metabolic stress. Emerging evidence indicates that undiagnosed GDM may be associated with risks that are comparable to, or in certain contexts greater than, those observed in diagnosed and treated cases, yet the available findings remain dispersed across diverse study designs and populations.

Maternal complications potentially linked to unrecognized GDM include preeclampsia, gestational hypertension, cesarean delivery, and postpartum complications, all of which contribute to increased healthcare utilization and long-term cardiovascular risk. On the fetal and neonatal side, chronic exposure to intrauterine hyperglycemia may result in macrosomia, shoulder dystocia, birth trauma, neonatal hypoglycemia, respiratory morbidity, and admission to neonatal intensive care units (Jarmuzek et al., 2015). Furthermore, growing evidence suggests that metabolic programming associated with maternal hyperglycemia may predispose offspring to obesity, impaired glucose tolerance, and cardiometabolic disease later in life. These intergenerational effects underscore the importance of identifying not only overt GDM but also cases that remain clinically silent during pregnancy (Mittal et al., 2025).

Despite its clinical relevance, research on undiagnosed GDM remains fragmented. Studies differ in how cases are defined, with some identifying women retrospectively through postpartum glucose testing and others inferring undiagnosed

hyperglycemia from intrapartum glucose levels or neonatal outcomes. Differences in screening policies, diagnostic thresholds, and population characteristics further limit comparability across settings. Consequently, clinicians and policymakers lack a consolidated understanding of the magnitude of risk specifically attributable to undiagnosed GDM and how it contrasts with pregnancies unaffected by dysglycemia (Behboudi-Gandevani et al., 2019).

Given the increasing global burden of hyperglycemia in pregnancy and ongoing gaps in screening coverage, a comprehensive synthesis of the available evidence is necessary. This systematic review aims to evaluate the impact of undiagnosed GDM on maternal and perinatal outcomes by integrating findings from observational studies conducted in diverse healthcare contexts. By clarifying the spectrum and magnitude of associated risks, this review seeks to inform clinical practice, support effective screening strategies, and contribute to improved maternal and child health outcomes.

2. METHOD

This This systematic review was conducted to synthesize evidence on the impact of undiagnosed Gestational Diabetes Mellitus on maternal and perinatal outcomes. The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) statement developed by Page et al. (2021). The objective of this review was to determine whether pregnancies complicated by undiagnosed GDM are associated with an increased risk of adverse maternal and neonatal outcomes compared with pregnancies without GDM or with diagnosed and managed GDM. The research question was structured using the PICO framework as summarized in Table 1.

Table 1. PICO Logical Framework

Population	Intervention	Comparison	Outcome
Pergnant women.	Undiagnosed gestational diabetes mellitus.	Women without GDM or with diagnosed GDM.	Maternal and perinatal outcomes.

The primary comparator was normoglycemic pregnancies. A secondary comparative analysis was conducted where available, comparing undiagnosed GDM with diagnosed and treated GDM to evaluate whether timely recognition and management mitigated adverse outcomes.

Operational definition of undiagnosed GDM

To address clinical heterogeneity, undiagnosed gestational diabetes mellitus (GDM) was categorized into four predefined subtypes:

1) Diagnostic misclassification due to differing criteria, referring to women who met alternative diagnostic thresholds (e.g., IADPSG or Carpenter–Coustan) but were not diagnosed under other criteria (e.g., NDDG or two-step approaches).

2) Mild untreated hyperglycemia, defined as one abnormal oral glucose tolerance test (OGTT) value not meeting formal GDM diagnostic criteria and therefore not treated.
3) Late-diagnosed GDM, referring to cases diagnosed after an initially negative screening or in late gestation.
4) Postpartum-reclassified diabetes, where diabetes was identified after delivery but likely present during pregnancy and not recognized antenatally.

These subcategories were analyzed separately where data permitted.

Search Strategy

A comprehensive literature search was conducted in January across electronic databases included PubMed, Science Direct, and Google Scholar. The search included studies published from database inception to the final search date and was limited to articles published in English. The search strategy combined controlled vocabulary and free text terms related to undiagnosed gestational diabetes and pregnancy outcomes. Key search terms included "undiagnosed gestational diabetes," "missed gestational diabetes," "hyperglycemia in pregnancy," "maternal outcomes," "neonatal outcomes," and "perinatal outcomes." The search syntax was tailored to the indexing structure of each database. In addition, the reference lists of all included articles were manually reviewed to identify additional relevant studies.

All records retrieved from the database searches were imported into the reference management software Mendeley, and duplicate entries were removed. Two reviewers independently screened the titles and abstracts to identify potentially eligible studies. The full text of selected articles was then assessed according to the predefined eligibility criteria. Any disagreements between reviewers were resolved through discussion and, when necessary, consultation with a third reviewer. The study selection process was documented using a PRISMA flow diagram, as presented in Figure 1.

Data extraction

Data extraction was performed independently by two reviewers using a standardized data collection form developed in a spreadsheet format. The extracted variables comprised the first author, year of publication, country, study design, sample size, operational definition of undiagnosed or misclassified GDM, comparator group, reported maternal and perinatal outcomes, and effect estimates (adjusted estimates where available). Discrepancies in data extraction were resolved through discussion until consensus was achieved.

In addition to extracting study characteristics and outcome measures, author keywords from all included studies were systematically collected for bibliometric analysis. All eligible articles were first imported into Mendeley reference management software, where keywords were manually reviewed one by one to ensure relevance and consistency with the study focus. Variations and synonymous terms were carefully examined and harmonized to minimize redundancy and conceptual fragmentation. After verification and standardization, the curated dataset was exported in RIS format and subsequently processed using VOSviewer software to perform keyword co-occurrence analysis and generate bibliometric visualizations.

This stepwise approach was undertaken to enhance accuracy and reduce bias related to inconsistent indexing across studies.

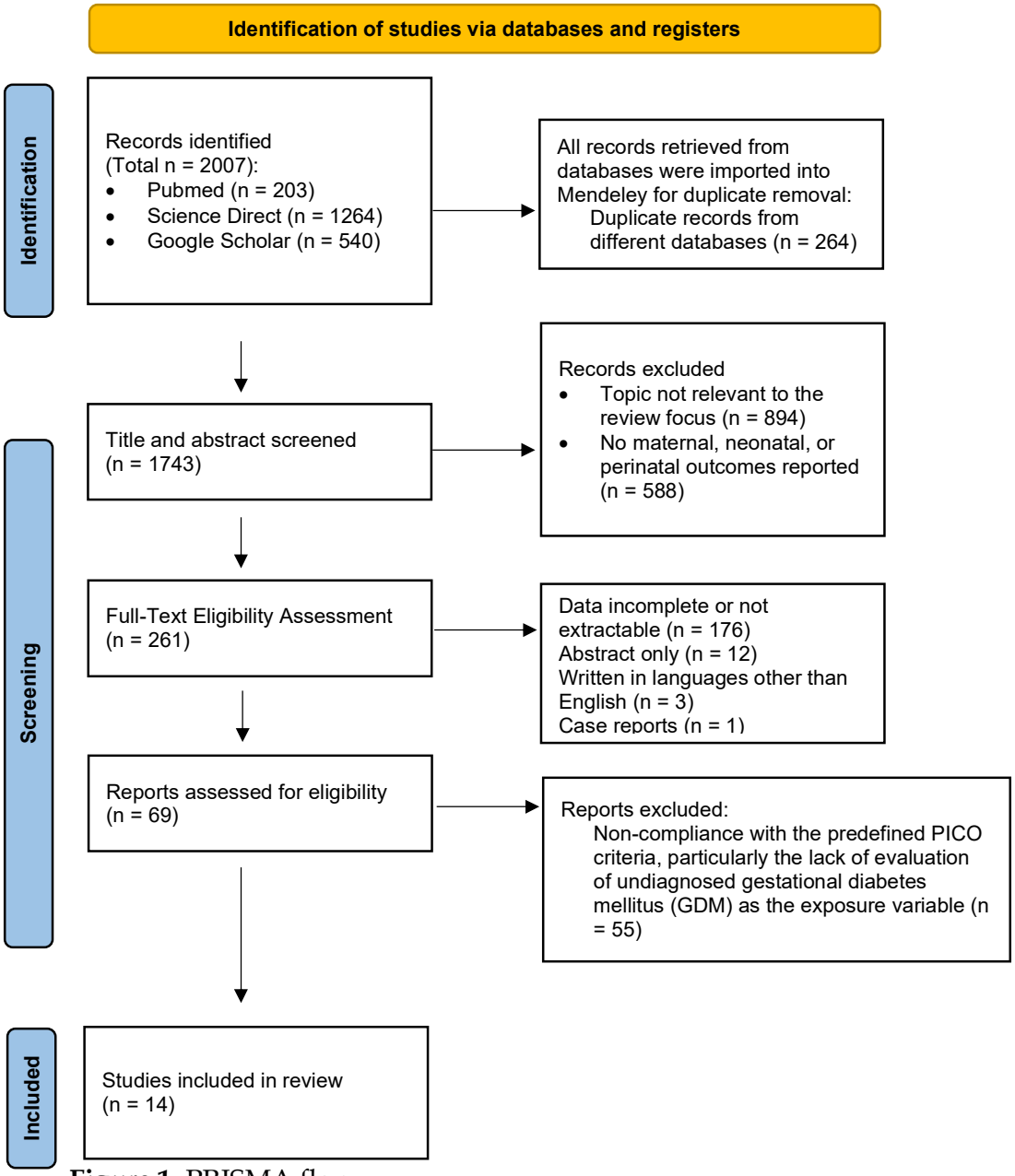

Figure 1. PRISMA flow

Quality Assessment

The methodological quality of the included cohort and case–control studies were evaluated using the Newcastle–Ottawa Scale (NOS), a tool designed to assess the risk of bias in observational research. The NOS examines three key domains: the selection of study groups, the comparability of groups based on adjustment for potential confounders, and the ascertainment of exposure and/or

outcomes, including the adequacy of follow-up where applicable. Each study received a total score ranging from 0 to 9 points. Studies scoring 7–9 points were classified as high methodological quality, those scoring 5–6 as moderate quality, and those scoring 4 or fewer as low quality. Two reviewers independently performed the quality assessment, and any discrepancies were resolved through discussion and consensus to ensure methodological consistency and transparency.

Data Analysis

Given the clinical and methodological heterogeneity across included studies, a full meta-analysis encompassing all reported outcomes was not feasible. Variability in exposure definitions, diagnostic thresholds, comparator groups, and outcome measurement limited direct comparability for several endpoints. Therefore, quantitative synthesis was restricted to outcomes reported with sufficiently comparable adjusted effect estimates and confidence intervals. For outcomes meeting these criteria, pooled estimates were calculated using a random-effects model. For other outcomes characterized by substantial heterogeneity or insufficient reporting of adjusted effect measures, findings were synthesized narratively. Extracted data were organized into thematic categories representing maternal and perinatal outcomes, and patterns of association between undiagnosed gestational diabetes mellitus and adverse health events were examined according to recurring outcome domains.

In addition to the qualitative and quantitative syntheses, a bibliometric network analysis was conducted using VOSviewer software to map the intellectual structure of research on undiagnosed gestational diabetes mellitus. A keyword co-occurrence analysis was performed based on author-provided keywords from the included studies. The minimum occurrence threshold was set at one term due to the limited number of eligible studies. VOSviewer generated three complementary visualizations, including network visualization to identify clusters of related research themes, overlay visualization to assess temporal evolution based on average publication year, and density visualization to determine areas of thematic concentration. Node size reflected keyword frequency, link strength represented co-occurrence relationships, and color coding indicated cluster membership. This bibliometric approach was used to contextualize the thematic synthesis and to identify dominant and emerging research domains within the literature on undiagnosed GDM.

3. RESULTS AND DISCUSSION

Result

A total of 2,007 records were identified through systematic database searches, including 203 from PubMed, 1,264 from ScienceDirect, and 540 from Google Scholar. After removal of 264 duplicate records using reference management software, 1,743 unique records remained for title and abstract screening. During this stage, 894 articles were excluded due to irrelevance to the research question and 588 were excluded because they did not report maternal or perinatal outcomes. Consequently, 261 full-text articles were retrieved for detailed eligibility assessment.

Of these, 191 articles were excluded for the following reasons: non-extractable or incomplete data (n = 176), conference abstracts without full reports (n = 12), case reports (n = 1), and non-English publications (n = 3). Sixty-nine articles underwent

further detailed review. Subsequently, 55 studies were excluded due to non-compliance with the predefined PICO criteria, primarily because they did not clearly define undiagnosed gestational diabetes mellitus (GDM) as the exposure of interest, failed to distinguish undiagnosed GDM from diagnosed or treated GDM, or did not provide quantitative maternal or perinatal outcome measures. Ultimately, 14 observational studies met all eligibility criteria and were included in the final synthesis.

Study Characteristics and Exposure Classification

The chracteristics of included studies are presented in table 2. All included studies involved pregnant populations and evaluated undiagnosed or unrecognized gestational dysglycemia as the primary exposure. To address clinical heterogeneity, undiagnosed GDM was classified into four operational subtypes. Diagnostic misclassification due to differing criteria was examined in studies comparing alternative diagnostic thresholds, including Carpenter–Coustan versus NDDG criteria and IADPSG versus two-step strategies (González-González et al., 2023; Luengmettakul et al., 2015). Mild untreated hyperglycemia defined by one abnormal OGTT value was reported in cohort analyses evaluating untreated borderline glucose intolerance (Martínez-Cruz et al., 2019; Scifres et al., 2024). Late-diagnosed GDM following an initially negative screening test was examined in retrospective and registry-based studies (Regnault et al., 2024; Shub et al., 2018; Sohn et al., 2020). Postpartum-reclassified diabetes, likely reflecting previously unrecognized pre-existing or overt dysglycemia during pregnancy, was investigated in large population-based cohorts and timing-based classifications of hyperglycemia (Lee et al., 2020; Regnault et al., 2024).

The primary comparator across studies was normoglycemic pregnancies. Where data permitted, secondary comparisons were conducted between undiagnosed GDM and diagnosed and treated GDM to evaluate the potential protective effect of timely recognition and management (Lauring et al., 2018; Luengmettakul et al., 2015; Scifres et al., 2024; Stacey et al., 2019). Study designs were predominantly retrospective or population-based cohort studies, with sample sizes ranging from small institutional cohorts of fewer than 100 participants (Olszak & Kalinka, 2024), to nationwide registry datasets exceeding 900,000 deliveries (Lee et al., 2020; Regnault et al., 2024).

Table 2. Extracted data from the included study

Author (Year)	Study Design	Country	Sample Size	Exposure Definition (Undiagnosed / Misclassified GDM)	Comparator	Maternal Outcomes	Perinatal Outcomes	Adjusted Effect Estimates
Luengmettakul et al. (2015)	Retrospective cohort	Thailand	832	Met Carpenter–Coustan (CC) but not NDDG; untreated	Normal OGTT; Treated CC-only GDM	Preeclampsia; Cesarean section	LGA; Neonatal hypoglycemia; Hyperbilirubinemia	LGA aOR 1.3 (0.8–1.9); Neonatal hypoglycemia OR 12.3
Scifres et al. (2024)	Secondary RCT analysis (IPTW)	United States	827	One abnormal OGTT value; untreated	Normal glucose tolerance; Treated GDM	Maternal composite morbidity	LGA; Macrosomia; NICU	Maternal composite OR 2.03 (1.57–2.62); NICU OR 1.39 (1.03–1.87); LGA OR 3.42 (1.39–8.41)
Shah & Sharifi (2020)	Population registry	Canada	90,140	Met IADPSG but not diagnosed under two-step approach	No GDM; Two-step GDM	Hypertensive disorders	LGA; Shoulder dystocia; NICU	Hypertensive disorders RR 1.27; LGA RR 1.37; NICU RR 1.12
Olszak & Kalinka	Retrospective cohort	Poland	80	Abnormal OGTT	Diagnosed & treated	Hypertensive disorders	LGA; Hyperbilirubine	LGA 15% vs 0%

(2024)				identified during hospitalization; untreated	GDM	mia	(p=0.039)
Lee et al. (2020)	Population-based cohort	Canada	995,990	GDM during pregnancy + diabetes diagnosis within 1 year postpartum	GDM alone; Pre-existing DM; No DM	Preeclampsia/ GH	Perinatal mortality; LGA; NICU; Hypoglycemia	Perinatal mortality aOR 3.37 (2.28–4.98); LGA aOR 1.98 (1.76–2.23); NICU aOR 1.86 (1.66–2.08)
Lauring et al. (2017)	Retrospective cohort	United States	3,699 total deliveries (Meeting CC non-GDM n=25)	Met Carpenter–Coustan (CC) but not NDDG; untreated	GDM by CC; GDM by NDDG; Non-GDM	Preeclampsia; Hypertensive disorders	NICU admission; Preterm birth	Preeclampsia OR 11.11 (2.7–50.0); NICU OR 6.47 (2.6–14.8)
Pavic et al. (2021)	Retrospective cohort	Croatia	2,405	Normoglycemic under WHO-1999 but GDM under IADPSG	Non-GDM	Cesarean; Preeclampsia	Macrosomia; LGA	Increased LGA and macrosomia (no adjusted OR)
Shalev et al.	Retrospecti	Israel	19,703	Previous	No GDM	Preeclampsia;	LGA;	Macrosomia

(2025)	ve cohort			GDM but no GDM diagnosis in subsequent pregnancy	both pregnancies	Cesarean	Macrosomia	OR 1.40 (1.01–1.92); LGA OR 1.60 (1.20–2.00); Composite aOR 1.30 (1.01–1.67)
Martinez et al. (2019)	Retrospective cohort	Mexico	282 vs 282	One abnormal OGTT value; untreated	Matched non-GDM	Preeclampsia; Cesarean	Birthweight; LGA	Higher mean birthweight (p=0.003)
Jeenah Sohn (2020)	Retrospective cohort	South Korea	169	Late-diagnosed GDM after prior negative screening	Non-GDM	Earlier delivery; Higher CS rate	LGA-related outcomes	Primarily unadjusted comparisons
Shub (2018)	Retrospective cohort	Australia	888	Late GDM after earlier negative test	Early vs Late vs No GDM	Obstetric composite	Neonatal composite; Hypoglycemia	Early vs No GDM OR 1.8 (1.15–2.92)
Regnault (2024)	Nationwide cohort	France	695,912	Timing-based classification of hyperglycemia	GDM 22–30 weeks reference	Cesarean; Preeclampsia; Hemorrhage	LGA; Preterm; Hypoglycemia; Perinatal death	Overt DM vs GDM22–30: LGA PR 2.00; Preterm PR 1.84
Stacey et al. (2019)	Prospective case–control	United Kingdom	1,024	At-risk not screened; Raised FPG	Screened; Normal FPG	—	Late stillbirth	Undiagnosed raised FPG aOR

				undiagnosed				4.22 (1.04–17.02)
González-González et al. (2023)	Multicenter cohort	Spain	2,983	Reclassified early-GDM under IADPSG	Non-GDM	↑ Hypertension; ↑ CS; ↑ Preeclampsia	↑ Prematurity; ↑ NICU; ↑ Composite outcomes	Significant increases ($p<0.05$)

Risk of Bias Assessments

All included studies were observational in design, and considerable variability was observed in exposure definitions, diagnostic thresholds, screening strategies, timing of diagnosis, and comparator groups. Such heterogeneity may introduce selection bias, residual confounding, and exposure misclassification, which can influence effect estimates and reduce comparability across studies. For this reason, careful appraisal of methodological quality was considered essential to contextualize both the narrative synthesis and the quantitative findings. A structured risk of bias assessment was therefore undertaken to evaluate the internal validity and overall robustness of the included evidence.

Risk of bias was assessed using the Newcastle–Ottawa Scale (NOS), as specified in the revised methodology. The assessment focused on potential bias related to selection of study populations, comparability between groups, and outcome or exposure ascertainment. A summary of the quality evaluation across included studies is presented below.

Table 3. Risk of Bias Assessment

Study	Selection (max 4)	Comparability (max 2)	Outcome (max 3)	Total (9)	Quality
Lee et al. (2020)	✓✓✓✓	✓✓	✓✓✓	9	High
Regnault et al. (2024)	✓✓✓✓	✓✓	✓✓✓	9	High
Shah & Sharifi (2020)	✓✓✓✓	✓✓	✓✓✓	9	High
Stacey et al. (2019)	✓✓✓✓	✓✓	✓✓✓	9	High
Shalev-Rosenthal et al. (2025)	✓✓✓✓	✓✓	✓✓✓	9	High
Scifres et al. (2024)	✓✓✓	✓✓	✓✓✓	8	High
González-González et al. (2023)	✓✓✓	✓✓	✓✓✓	8	High
Sohn et al. (2020)	✓✓✓	✓✓	✓✓	7	High
Shub et al. (2018)	✓✓✓	✓✓	✓✓	7	High
Luengmettakul et al. (2015)	✓✓✓	✓	✓✓	6	Moderate
Lauring et al. (2018)	✓✓✓	✓	✓✓	6	Moderate
Martínez-Cruz et al. (2019)	✓✓✓	✓	✓✓	6	Moderate
Olszak & Kalinka (2024)	✓✓	✓	✓✓	5	Moderate
Pavic et al. (2021)	✓✓	✓	✓✓	5	Moderate

As presented in Table 3, nine of the fourteen included studies were classified as high methodological quality (7–9 points), primarily reflecting strong selection frameworks, adequate adjustment for confounding variables, and reliable outcome ascertainment. Large population-based and nationwide registry studies achieved the

maximum score due to comprehensive sampling strategies, robust data sources, and multivariable adjustment, thereby minimizing the likelihood of substantial selection or comparability bias. Four retrospective cohort studies and one smaller institutional cohort were rated as moderate quality (5–6 points). These studies generally demonstrated acceptable outcome assessment but were limited by narrower recruitment settings or less comprehensive adjustment for confounding factors. In particular, smaller single-center cohorts showed reduced representativeness and therefore lower scores in the selection domain.

Overall, no study was categorized as low quality. Although variability in exposure definitions and comparator classification was observed across studies, the NOS assessment suggests that the overall risk of bias was low to moderate, with the strongest evidence derived from large population-based cohorts. These findings support the internal validity of the qualitative synthesis while acknowledging residual heterogeneity inherent to observational research designs.

Maternal Outcomes

Across exposure subtypes, undiagnosed GDM was generally associated with increased maternal morbidity, although the magnitude of risk varied according to the operational definition. Studies examining diagnostic misclassification demonstrated higher risks of hypertensive disorders and operative delivery when alternative diagnostic thresholds were retrospectively applied. Women meeting Carpenter–Coustan criteria but not NDDG criteria had higher rates of preeclampsia and neonatal complications (Lauring et al., 2018; Luengmettakul et al., 2015). Similarly, women meeting IADPSG criteria but not treated under two-step strategies exhibited increased risks of hypertensive disorders and cesarean delivery (Shah et al., 2023). Late-diagnosed GDM was associated with increased cesarean delivery rates in institutional cohorts (Sohn et al., 2020).

In nationwide analyses, timing-based classifications of hyperglycemia demonstrated higher risks of preeclampsia and adverse composite maternal outcomes depending on gestational age at diagnosis (Regnault et al., 2024). Postpartum-reclassified diabetes demonstrated particularly elevated risks of perinatal mortality and severe maternal–neonatal morbidity in large population-based cohorts, suggesting prolonged or more severe dysglycemia (Lee et al., 2020). In contrast, smaller cohorts evaluating mild untreated hyperglycemia reported more modest or inconsistent maternal associations after adjustment for confounders (Martínez-Cruz et al., 2019; Scifres et al., 2024). Importantly, studies directly comparing untreated hyperglycemia with treated GDM frequently observed lower complication rates among treated cases, reinforcing the clinical benefit of early diagnosis and management (Luengmettakul et al., 2015; Scifres et al., 2024; Stacey et al., 2019).

Perinatal Outcomes

Perinatal complications were consistently reported across studies, most commonly large for gestational age infants, macrosomia, neonatal hypoglycemia, NICU admission, prematurity, and perinatal mortality. Large population-based registry studies demonstrated significantly elevated adjusted risks of LGA, NICU

admission, and perinatal mortality among women with previously unrecognized hyperglycemia compared with normoglycemic pregnancies (Lee et al., 2020; Regnault et al., 2024; Shah & Sharifi, 2020). The strongest associations were observed in postpartum reclassified diabetes, where risks of perinatal mortality and neonatal morbidity approached or exceeded those seen in overt diabetes (Lee et al., 2020; Regnault et al., 2024). These findings suggest potentially severe underlying metabolic disturbance in cases that remain unrecognized during pregnancy.

Studies focused on diagnostic threshold misclassification similarly showed increased rates of fetal overgrowth and neonatal complications when stricter criteria were retrospectively applied (Lauring et al., 2018; Luengmettakul et al., 2015; Martínez-Cruz et al., 2019). Although some smaller institutional cohorts did not demonstrate statistically significant differences in composite outcomes (Martínez-Cruz et al., 2019; Olszak & Kalinka, 2024; Sohn et al., 2020), directional trends toward higher birthweight, increased cesarean delivery, and greater neonatal complications were frequently observed among undiagnosed groups.

Quantitative Synthesis for Large-for-Gestational-Age (LGA)

A partial quantitative synthesis was performed for large-for-gestational-age (LGA) using a random-effects model (DerSimonian–Laird method). Four observational studies reporting adjusted odds ratios (aOR) with complete 95% confidence intervals were eligible for pooling. The included studies represented heterogeneous exposure definitions, including diagnostic misclassification across criteria, mild untreated hyperglycemia, postpartum-reclassified diabetes, and prior gestational diabetes without recurrence. Effect estimates were pooled on the logarithmic scale and back-transformed to odds ratios for interpretation. The combined random-effects estimate demonstrated that undiagnosed or misclassified gestational dysglycemia was associated with a significantly increased risk of LGA (pooled OR 1.77, 95% CI 1.41–2.23). Between-study heterogeneity was substantial (I^2 = 73%; Q = 11.1, p = 0.01; τ^2 = 0.027), reflecting variability in exposure definitions and comparator groups. Despite heterogeneity, the direction of association was consistent across all studies, with point estimates indicating elevated LGA risk among undiagnosed cases.

Sensitivity Analysis

A sensitivity analysis excluding the study comparing untreated mild hyperglycemia with treated GDM resulted in a reduction in heterogeneity while preserving the direction and statistical significance of the association (Scifres et al., 2024). This suggests that comparator differences contributed partially to between-study variability, but the overall association between undiagnosed dysglycemia and LGA remained robust.

Table 4. Random-Effects Meta-analysis of Adjusted Odds Ratios for Large-for-Gestational-Age (LGA)

Study	Adjusted OR	95% CI
Lee 2020	1.98	1.76–2.23
Luengmettakul 2015	1.30	0.80–1.90
Shalev 2025	1.60	1.20–2.00
Scifres 2024	3.42	1.39–8.41

Pooled (Random-effects)	1.77	1.41–2.23

Adjusted odds ratios pooled using the DerSimonian–Laird random-effects model. I^2 = 73%, τ^2 = 0.027.

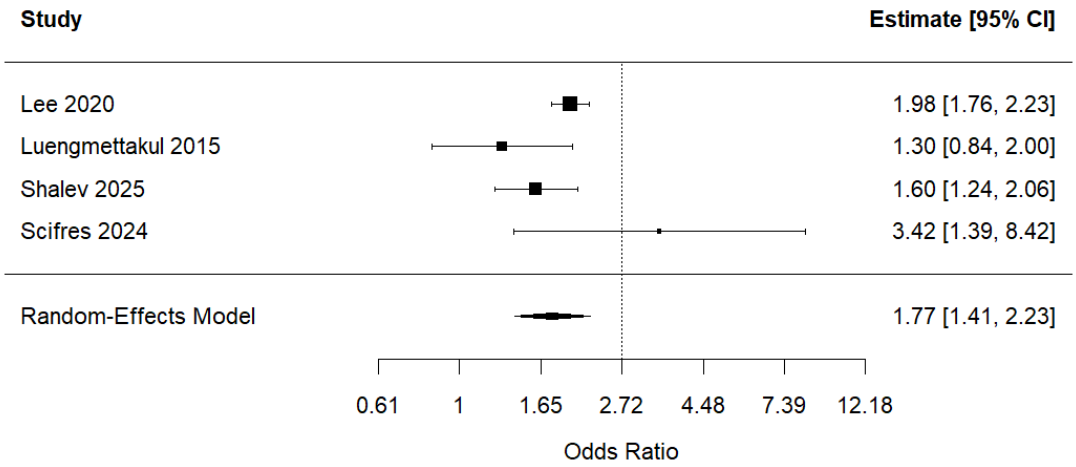

Figure 2. Forest plot of adjusted odds ratios for large-for-gestational-age (LGA) among women with undiagnosed or misclassified gestational dysglycemia. Effect estimates were pooled using a DerSimonian–Laird random-effects model. Horizontal lines represent 95% c onfidence intervals. The pooled estimate is shown as a diamond. I^2 = 73%

Overall, the cumulative evidence indicates that undiagnosed gestational diabetes mellitus GDM, across varying operational subtypes, is consistently associated with an increased risk of adverse maternal and neonatal outcomes when compared with normoglycemic pregnancies. Importantly, several studies demonstrated that the magnitude of risk among undiagnosed cases was comparable to or, in some instances, higher than that observed in diagnosed and treated GDM. These findings underscore the potential clinical consequences of delayed recognition and untreated dysglycemia during pregnancy. However, these results should be interpreted with caution.

Subgroup Analysis by Study Setting and Sample Size

When studies were examined according to national setting and sample size, distinct patterns were observed. Large population based and nationwide cohort studies conducted in high income countries, including Canada, France, the United Kingdom, and Israel, consistently demonstrated statistically significant associations between undiagnosed or misclassified gestational dysglycemia and adverse maternal or perinatal outcomes. For example, the population-based study by Lee et al. (2020) involving 995,990 deliveries in Canada reported significantly increased risks of perinatal mortality, large for gestational age, and neonatal intensive care unit admission among women with previously unrecognized diabetes. Similarly, the nationwide French cohort by Regnault et al. (2024) including 695,912 deliveries showed higher adjusted risks of large for gestational age and preterm birth among women with overt or early hyperglycemia compared with reference groups.

In contrast, smaller single center retrospective cohorts conducted in middle income settings, such as those by Olszak & Kalinka (2024) and Martínez-Cruz et al. (2019), reported more variable findings, with some outcomes reaching statistical significance while others did not. Studies with sample sizes below 300 participants demonstrated wider confidence intervals and less stable effect estimates compared with registry-based studies exceeding 90,000 participants. Overall, while the direction of association was generally consistent across settings, statistical precision and magnitude of effect appeared more robust in large population level datasets than in smaller institutional cohorts.

Bibliometric Network Analysis results

Figure 3 presents the network visualization of keyword co-occurrence, revealing 41 terms grouped into seven thematic clusters. The map demonstrates that gestational diabetes mellitus and pregnancy are the most central and highly connected nodes, followed by gestational diabetes, indicating their structural prominence within the literature. Strong link strengths between gestational diabetes mellitus and adverse outcomes such as large for gestational age, macrosomia, and preeclampsia confirm that the dominant research focus centers on maternal–neonatal complications. Additional clusters represent interrelated domains including diagnostic criteria, perinatal outcomes, metabolic disturbances, and healthcare delivery, suggesting that the field integrates clinical, epidemiological, and policy-oriented dimensions rather than addressing them in isolation.

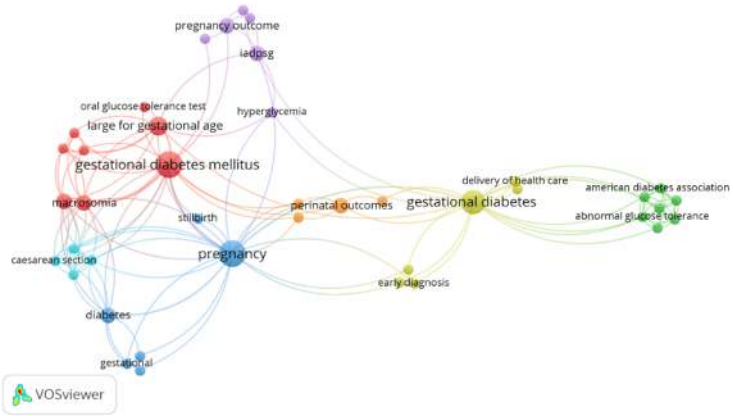

Figure 3. Author keywords co-occurrence maps

Moreover, as illustrated in Figure 4, the overlay visualization highlights the temporal evolution of research themes between 2018 and 2025. Earlier publications (2018–2020) were more strongly associated with healthcare delivery, early diagnosis, and general pregnancy outcomes. From 2021 onward, core clinical constructs such as gestational diabetes mellitus, pregnancy, and large for gestational age became increasingly prominent. More recent studies (2023–2025) show a growing emphasis on updated diagnostic classifications (e.g., ADA, IADPSG, NDDG), screening at the first prenatal visit, and severe maternal–neonatal outcomes including macrosomia, preeclampsia, perinatal death, and insulin resistance. This temporal pattern indicates a shift from service-oriented and descriptive discussions toward more refined diagnostic debates and high-risk outcome analyses.

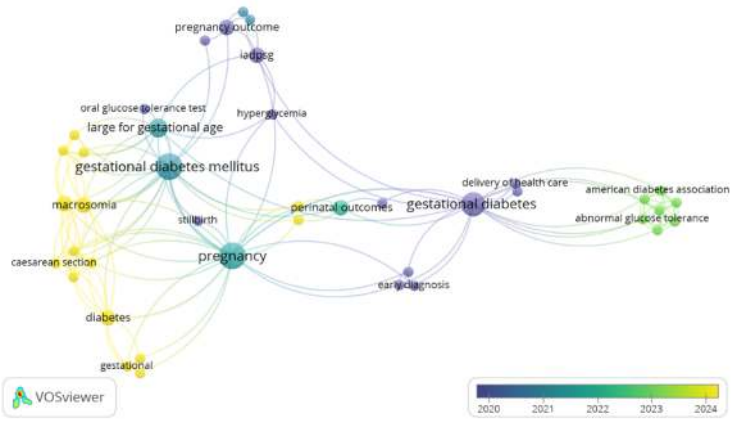

Figure 4. Overlay visualization of keyword co-occurrence based on average publication year

The density visualization in Figure 5 further confirms these patterns by demonstrating the highest concentration of research activity around gestational diabetes mellitus, pregnancy, gestational diabetes, large for gestational age, and macrosomia. These high-density regions reflect the sustained empirical priority given to fetal overgrowth and adverse pregnancy outcomes. Areas of moderate density, including perinatal outcomes, diagnostic criteria, and early diagnosis, indicate ongoing but comparatively more focused lines of inquiry. Taken together, the three visualizations suggest that while outcome-based research remains foundational, the field is progressively advancing toward nuanced evaluation of diagnostic standards and deeper exploration of severe maternal–neonatal complications, signaling a maturation of the scientific discourse.

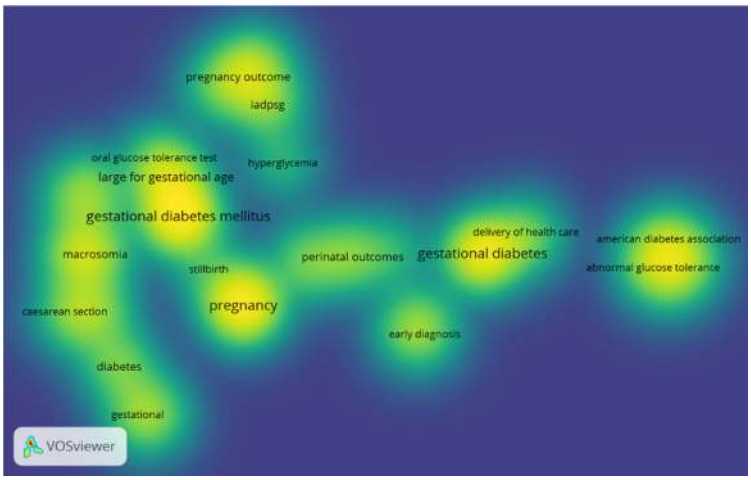

Figure 5. Density visualization of keyword co-occurrence in the gestational diabetes literatureKlik atau ketuk di sini untuk memasukkan teks..

Discussion

This systematic review synthesizes evidence from fourteen observational studies examining the maternal and perinatal consequences of undiagnosed gestational diabetes mellitus across diverse healthcare settings. The findings demonstrate a consistent pattern of undiagnosed or misclassified gestational dysglycemia that is associated with increased risks of hypertensive disorders, cesarean delivery, fetal overgrowth, neonatal morbidity, and, in severe forms such as postpartum reclassified diabetes, perinatal mortality (Lee et al., 2020; Shah & Sharifi, 2020). Importantly, the magnitude of risk in several cohorts was comparable to or greater than that observed in diagnosed and treated GDM, highlighting the clinical significance of missed or delayed recognition (Scifres et al., 2024).

The stratification of undiagnosed GDM into four operational subtypes provides important insight into the observed heterogeneity. Diagnostic misclassification resulting from differing thresholds, particularly when stricter criteria were retrospectively applied, consistently revealed elevated risks of large for gestational age infants and hypertensive complications (Lauring et al., 2018; Luengmettakul et al., 2015; Shah & Sharifi, 2020). Mild untreated hyperglycemia defined by a single abnormal OGTT value showed more variable associations, suggesting that metabolic severity may influence outcome magnitude. In contrast, late diagnosed GDM and postpartum reclassified diabetes were associated with stronger and more consistent adverse outcomes (Sohn et al., 2020), likely reflecting prolonged intrauterine exposure to untreated hyperglycemia. These findings support the hypothesis that both the duration and severity of dysglycemia are key determinants of maternal and fetal risk.

The partial meta-analysis focusing on large for gestational age further strengthens this interpretation. The pooled random effects estimate demonstrated 77% increased odds of LGA among women with undiagnosed or misclassified dysglycemia. Although between study heterogeneity was substantial, the direction of association was uniform across all included studies. Sensitivity analysis suggested that comparator differences contributed to variability but did not alter the overall conclusion. The persistence of effect despite heterogeneity indicates that fetal overgrowth represents a robust and biologically plausible consequence of untreated maternal hyperglycemia (Lee et al., 2020; Scifres et al., 2024; Sohn et al., 2020).

From a pathophysiological perspective, these findings are coherent with established mechanisms of maternal glucose transfer and fetal hyperinsulinemia. Sustained maternal hyperglycemia promotes excessive fetal growth through anabolic stimulation, increases placental nutrient transport, and contributes to metabolic dysregulation in the neonate (Jarmuzek et al., 2015; Mittal et al., 2025). When hyperglycemia remains unrecognized, opportunities for dietary counseling, glucose monitoring, and pharmacologic treatment are lost. The observed similarity between outcomes in undiagnosed and overt diabetes subgroups further suggests that some undetected cases may represent previously unrecognized pre-existing metabolic dysfunction rather than isolated gestational impairment.

The methodological quality assessment supports the credibility of these conclusions. The majority of included studies were classified as high quality according to the Newcastle Ottawa Scale, particularly large population-based cohorts with robust adjustment for confounders. Although moderate heterogeneity was

observed in exposure classification and comparator selection, no study demonstrated critical risk of bias. Therefore, the overall direction of association appears unlikely to be solely attributable to systematic methodological flaws. Nevertheless, residual confounding, especially related to obesity, socioeconomic status, and access to care, cannot be fully excluded (Scifres et al., 2024).

The bibliometric network analysis complements these findings by illustrating the evolution of research emphasis within the field. Earlier literature focused primarily on screening implementation and healthcare delivery, whereas more recent studies increasingly examine diagnostic thresholds, timing of diagnosis, and severe maternal and neonatal outcomes. The high centrality of terms such as large for gestational age, macrosomia, and preeclampsia in the co-occurrence maps underscores that adverse-outcomes remain the dominant research priority. The temporal shift toward diagnostic debate reflects ongoing uncertainty regarding optimal screening strategies and threshold definitions (Behboudi-Gandevani et al., 2019; Gupta et al., 2015).

Clinical Implication

The present findings have important implications for screening policy and diagnostic strategy in pregnancy. First, universal screening is more beneficial than selective risk-based screening alone because undetected dysglycemia is consistently linked to poor maternal and perinatal outcomes (Gupta et al., 2015; Sweeting et al., 2024). Several included studies demonstrated that women with clinically meaningful hyperglycemia would not have been identified using selective approaches, yet experienced elevated risks of fetal overgrowth and hypertensive complications. These data suggest that universal screening may improve detection of metabolically vulnerable pregnancies and reduce preventable morbidity.

Second, the observed risks among women who narrowly missed diagnostic thresholds or who had mild untreated hyperglycemia raise important questions regarding the adequacy of current diagnostic cutoffs. While lowering thresholds may increase healthcare utilization and the number of women labeled with GDM, the findings indicate that some individuals classified as normoglycemic under existing criteria still carry measurable risk. This does not necessarily imply that current thresholds are uniformly too high, but it underscores the need for continued evaluation of whether diagnostic criteria optimally balance sensitivity, specificity, and clinical benefit (Behboudi-Gandevani et al., 2019).

Third, the implications are particularly relevant for low- and middle-income countries, where screening implementation that may inconsistent and access to diagnostic testing limited. In such settings, missed or delayed diagnosis may disproportionately contribute to adverse outcomes due to reduced opportunities for glycemic monitoring and intervention. Strengthening antenatal screening infrastructure, ensuring availability of oral glucose tolerance testing, and integrating early glucose assessment into routine prenatal care may represent cost effective strategies to mitigate maternal and neonatal complications. Finally, the elevated risks observed in postpartum reclassified diabetes highlight the importance of early pregnancy screening and structured postpartum follow up. Failure to detect pre-existing or early onset dysglycemia may result in prolonged intrauterine exposure to

hyperglycemia, increasing the hazards to the mother's and child's long-term and immediate health (Behboudi-Gandevani et al., 2019).

Future Research Directions

Future research should prioritize prospective cohort studies employing standardized definitions of undiagnosed GDM to enhance comparability across settings. Harmonization of outcome reporting, particularly for LGA, preeclampsia, NICU admission, and perinatal mortality, would facilitate more comprehensive meta-analytic synthesis. In addition, cost effectiveness analyses comparing universal versus selective screening strategies are needed to inform policy decisions, especially in resource constrained environments. Further meta-analyses incorporating harmonized datasets could clarify whether specific exposure subtypes, such as mild untreated hyperglycemia versus late diagnosis, carry differential prognostic implications. Finally, long term follow-up studies examining intergenerational metabolic consequences of undiagnosed dysglycemia would provide valuable insight into the broader public health impact.

Strengths and Limitations

This review has several strengths, including predefined exposure stratification, application of a validated risk of bias tool, integration of quantitative and narrative synthesis, and incorporation of bibliometric mapping to contextualize thematic evolution. However, limitations must be acknowledged. All included studies were observational, and exposure definitions were not uniform. The meta-analysis was limited to four studies for LGA due to reporting constraints, and heterogeneity remained substantial. Publication bias could not be formally assessed given the small number of pooled studies. Therefore, while the direction of association is consistent, effect magnitude should be interpreted cautiously.

4. CONCLUSION AND RECOMMENDATION

Conclusion

Undiagnosed or misclassified gestational diabetes mellitus was consistently associated with increased risks of adverse maternal and perinatal outcomes, particularly large-for-gestational-age infants, hypertensive disorders, cesarean delivery, and neonatal morbidity. The findings indicated that untreated maternal dysglycemia remained clinically significant despite variations in diagnostic thresholds and exposure definitions across studies. These results suggested that healthcare providers and policymakers should strengthen antenatal screening programs, improve the standardization of diagnostic criteria, and ensure earlier identification and management of hyperglycemia during pregnancy. Enhanced screening implementation in both high-income and resource-limited settings may help reduce preventable maternal and neonatal complications associated with undiagnosed gestational dysglycemia.

Recomendation

Based on the findings of this systematic review, it is recommended that healthcare systems strengthen universal antenatal screening programs and improve the standardization of gestational diabetes mellitus diagnostic criteria to ensure earlier detection and management of maternal hyperglycemia. Increased access to timely glucose testing, particularly in low- and middle-income settings, may help

reduce preventable maternal and neonatal complications associated with undiagnosed gestational diabetes mellitus.

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