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REVIEW

Risk Factors for Gestational Diabetes Mellitus in Mainland China: A Systematic Review and Meta-Analysis

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Objective: This study aimed to identify and evaluate risk factors associated with gestational diabetes mellitus (GDM) in mainland China.

Methods: Eight electronic databases were searched for literature published from January 2010 until December 2023. Heterogeneity was quantified using I^2. Data were pooled by fixed or random effects models and expressed as odds ratio and 95% confidence intervals.

Results: A total of 69 observational studies with an overall sample size of 2,138,032 Chinese women and 219,303 patients with GDM were included in the analysis. After adjusting confounders, older maternal age (OR = 1.12, 95% CI: 1.09–1.15), maternal age ≥35 years (OR = 1.96, 95% CI: 1.74–2.21), higher pre-pregnancy body mass index (OR = 1.24, 95% CI: 1.17–1.32), pre-pregnancy overweight (OR = 1.78, 95% CI: 1.64–1.92) or obesity (OR 2.52, 95% CI: 2.06–3.08), family history of diabetes (OR = 1.85, 95% CI: 1.58–2.17), history of GDM (OR = 4.09, 95% CI: 2.13–7.82), and elevated levels of fasting plasma glucose (OR = 2.54, 95% CI: 2.13–3.01), hemoglobin (OR = 1.47, 95% CI: 1.14–1.89) and serum triglycerides (OR = 1.69, 95% CI: 1.31–2.16) in early pregnancy were associated with an increased risk of GDM in mainland China. But gravidity ≥2 (OR = 1.06, 95% CI: 0.89–1.27), conception by assisted reproductive technology analyses (OR = 1.54, 95% CI: 0.95–2.51) were not associated with GDM, and parity ≥1 (OR = 0.88, 95% CI: 0.82–0.94) was related to lower risk of GDM. In available unadjusted studies, history of abortion (OR = 1.34, 95% CI: 1.31–1.37) increased risk of GDM, non-Han ethnicity (OR = 0.78, 95% CI: 0.59–1.03) and high school or lower education level (OR1.09, 95% CI: 0.94–1.26) showed no correlation with GDM.

Conclusion: The key risk factors for GDM in mainland China included older maternal age, maternal age ≥35 years, pre-pregnancy overweight or obesity, family history of diabetes, history of GDM, elevated levels of FPG, Hb, and serum TG in early pregnancy. Early identification and intervention for women at high risk should be performed to prevent the development of GDM.

Keywords: gestational diabetes mellitus, risk factors, mainland China, systematic review, meta-analysis

Introduction

Gestational diabetes mellitus (GDM) refers to diabetes being diagnosed in the second or third trimester of pregnancy without significant diabetes before pregnancy.[1] The incidence of GDM has been increasing in recent years. In 2021, the International Diabetes Federation reported that 16.7% of women aged 20–49 in the world had varying degrees of blood sugar elevation during pregnancy, of which 80.3% were caused by GDM.[2] In 2008, Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study indicated that mild hyperglycemia during pregnancy could increase the risk of adverse pregnancy outcomes such as, large for gestational age, cesarean delivery, neonatal hypoglycemia, preterm birth, shoulder dystocia and preeclampsia.[3] Based on these findings, in 2010, the International Association of Diabetes and Pregnancy Study Groups (IADPSG) recommended a new diagnostic criterion for GDM by performing a 75-gram 2-hour oral glucose tolerance (OGTT) at 24–28 weeks of gestation.[4] According to IADPSG criteria, when 1 or more glucose

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indexes met or exceeded the following cut-offs: fasting, 5.1 mmol/L; 1 hour, 10.0 mmol/L; 2 hours, 8.5 mmol/L, the pregnant women should be diagnosed with GDM.

Since then, many studies have shown that GDM is strongly associated with adverse maternal and infant outcomes.[5–7] In 2021, a systematic review about GDM and adverse pregnancy outcomes showed that the risks of cesarean section, preterm birth, macrosomia, and large for gestational age were 1.5 to 2 folds in women with GDM compared to those without GDM.[8] Additionally, women with GDM history had higher risk of suffering from diabetes and cardiovascular diseases after delivery.[9,10] Offsprings of mothers with GDM were at increased risk of becoming overweight or obese during childhood[11,12] and were more likely to develop abnormal glucose metabolism and hypertension.[13,14] It has been confirmed that early assessment of the risk of developing GDM among pregnant women and timely lifestyle intervention can reduce the occurrence of GDM.[9,15] GDM typically is diagnosed between 24 and 28 weeks of gestation. Therefore, the risk factors related to the onset of GDM and their significance should be clearly identified.

Pregnancy care in China has undergone significant transformation over the past decades.[16] Currently, more than 98% of births occur in hospitals, driven by government initiatives to reduce maternal and neonatal mortality rates. Home births, once common in rural areas, have become exceedingly rare due to improvements in healthcare infrastructure and the implementation of hospital-based birth policies.[17] In mainland China, the prevalence of GDM reached 14.8%,[18] indicating that this country might have the largest number of GDM patients worldwide. Globally, the prevalence of GDM varies significantly, influenced by differences in genetic predisposition, environmental exposures, lifestyle factors, and diagnostic criteria.[19] For example, the prevalence of GDM in Europe and North America typically ranges between 5% and 10%, whereas Asian populations, including Chinese women, tend to exhibit higher rates of GDM due to a combination of genetic and lifestyle factors.[20] These distinctions underline the importance of focusing on GDM risk factors in mainland China, where rapid economic development, urbanization, and dietary changes have further compounded the issue.[21,22] Understanding the unique risk profiles of Chinese women can provide critical insights for targeted prevention and intervention strategies. Thus, this study aims to identify key risk factors for GDM among pregnant women in mainland China through meta-analysis, with the goal of enhancing early identification and preventive strategies, ultimately reducing the incidence and adverse outcomes associated with GDM in this population.

Methods

This systematic review was reported according to and under the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement.[23] The protocol was registered in PROSPERO (CRD42024496696).

Search Strategy

The following databases including PubMed, Embase, Web of Science, Cochrane library, CBM, China National Knowledge Infrastructure (CNKI), Wang Fang Data and Chongqing VIP were systematically searched from January 2010 until December 2023. The references of included studies and relevant systematic review were manually searched to obtain additional literature. The search strategy combined with medical subject words and free text words related to risk factors of GDM. The detailed search strategies of PubMed and Embase were shown in Supplementary Table S1.

Eligibility Criteria

Studies were included if they meet the following criteria: (1) Case-control or cohort studies conducted in mainland China; (2) Participants: pregnant women aged 18 years or older; (3) Outcome measures: pregnant women in the studies should undergo an 75 g Oral Glucose Tolerance Test (OGTT) at 24–28 weeks of gestation; (4) Diagnosis of GDM: the diagnostic criteria established by IADPSG in 2010; (5) Studies reported one of the following risk factors: maternal age, ethnicity, educational level, pre-pregnancy body mass index (BMI), family history of diabetes, history of GDM, gravidity, parity, history of abortion, use of assisted reproductive technology (ART), early pregnancy fasting plasma glucose (FPG), hemoglobin (Hb) levels, serum triglycerides (TG) levels; (6) Studies reported risk ratios (RR) or odds ratios (OR) and their confidence interval (CI) for the risk factors, or provided sufficient data to calculate these metrics.

Studies were excluded if: (1) Studies included participants with pregestational diabetes; (2) Studies only focused on specific populations (such as, advanced maternal age pregnancy, multiple pregnancies, or individuals diagnosed with specific diseases); (3) Studies lacking a clear diagnostic standard for gestational diabetes; (4) Intervention studies, cross-sectional studies, systematic review, meta-analysis, conference abstracts, case reports, letters, guidelines, reviews and animal studies; (5) Total sample size less than 1000; (6) Duplicated data; (7) Studies published not in English or Chinese.

Data Extraction

Two researchers independently screened the literature, extracted the data, and cross-checked it. Any disagreement was resolved through discussion or consultation with a third review author. The extracted data included including author, publication year, year of recruitment, study design, region, sample size, number of women with GDM, risk factors, crude and adjusted OR and RR, and 95% CI. For studies adopting multivariate regression, we extracted adjusted ORs or RRs, which account for confounding variables such as maternal age, pre-pregnancy BMI, family history of diabetes, and other relevant factors reported by the original authors. Adjusted estimates were used for meta-analysis when available, and unadjusted estimates were analyzed separately to evaluate their consistency. For unadjusted studies, we calculated risk ratios and 95% confidence intervals based on the extracted data. The unadjusted and adjusted data were meta-analyzed separately.

Risk of Bias Assessment

Risk of bias assessment was independently evaluated by two reviewers using the Newcastle Ottawa Scale (NOS).[24] For each study, the item scores were collated and an overall risk of bias (low, moderate, and high) was determined. A lower risk of bias denotes higher quality. Scores above 5 indicate moderate-to-high quality study.

Statistical Analysis

A flow diagram illustrated the literature search and article selection process. The Cochran's Q test and I^2 was applied to detect heterogeneity between the studies. Subgroup analyses were performed for factors that could potentially affect GDM: study design, BMI classification standard and region. Next, we performed sensitivity analyses by omitting each study individually and recalculating the pooled effect size estimates for the remaining studies to assess the effect of individual studies on the pooled result. The publication bias was evaluated by using funnel plot and Egger's test (≥10 studies). All analyses were performed using Stata 14.0. $P < 0.05$ indicates statistical significance.

Results

Characteristics of Included Studies

Of the 4291 studies identified, 69 studies with a total of 2,138,032 women and 219,303 patients with GDM were included in the present study. The flow diagram of the search process is shown in Figure 1. Characteristics of the included study were summarized in Supplementary Table S2.

Quality Assessment

Among the 69 published papers, 15 were written in Chinese and 54 were written in English. The NOS results for 56 cohort studies and 13 case–control studies were summarized in Supplementary Table S3 and Table S4. Eight studies were judged as medium risk of bias, while 61 articles had a lower risk of bias and were assessed as high-quality study.

Risk Factors for GDM

Maternal Age

Data on maternal age (as a continuous variable) were provided by eight cohort studies[22,26–32] and seven case–control studies[33–39] with sample sizes ranging from 1136 to 12,870. In adjusted analysis, each one-unit increase in maternal age was associated with a slight increase in the odds of developing GDM (OR = 1.12,95% CI: 1.09–1.15, Supplementary Figure S1).

Twenty-two studies[22,28,31,40–58] reported the risk of GDM stratified by maternal age into specific age groups. The most commonly used strata were <25 years, 25–29 years, 30–34 years, 35–39 years, and ≥40 years, although some studies grouped ages more broadly, such as <35 years and ≥35 years, depending on their research objectives. The pooled estimate of GDM risk for mothers aged ≥35 years showed significantly increased odds for GDM in unadjusted analyses (OR = 2.30; 95% CI

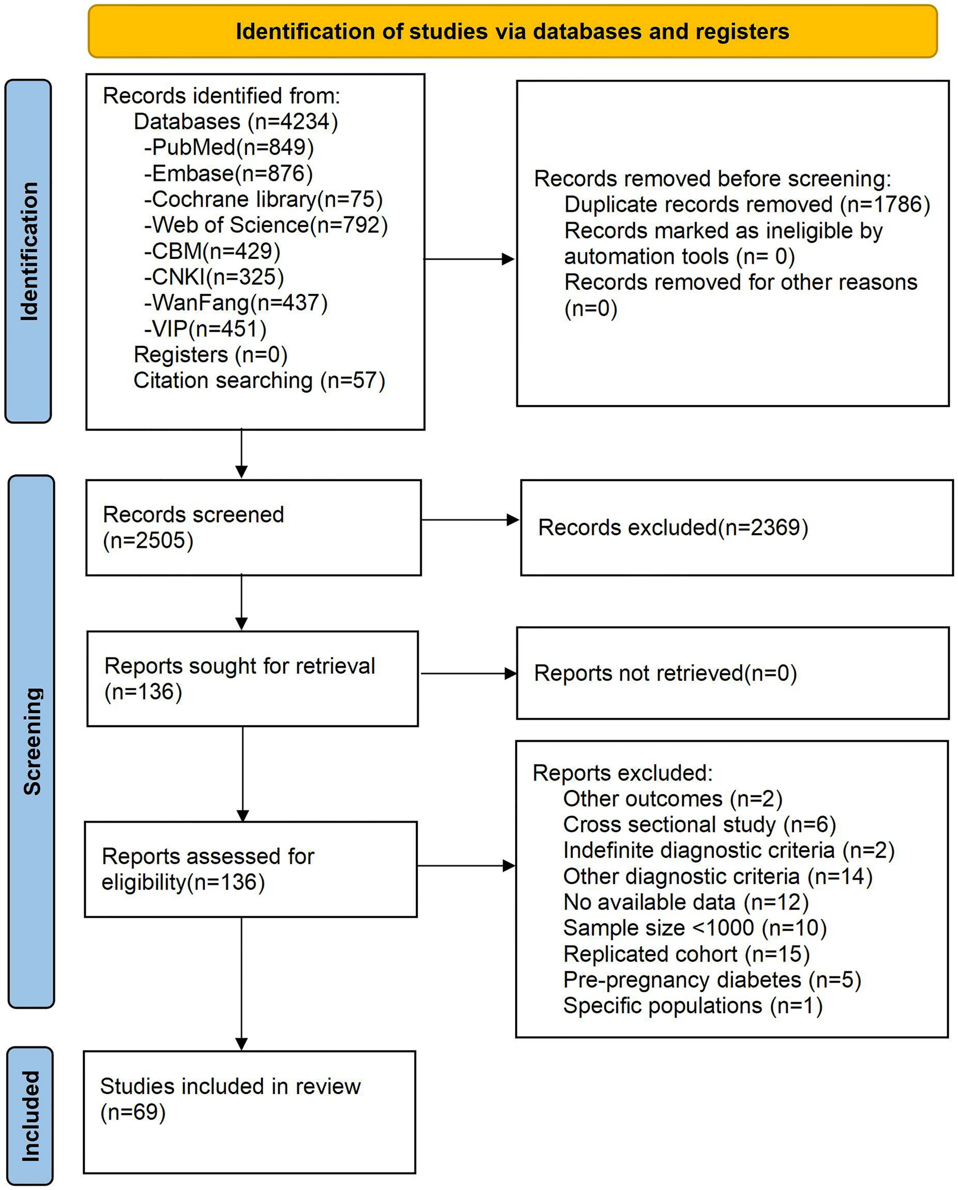

Figure 1 PRISMA flow diagram of study selection.

Notes: PRISMA figure adapted from Liberati A, Altman D, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of clinical epidemiology. 2009;62(10). Creative Commons.[25]

2.12–2.49, Figure 2) compared to mothers aged <35 years (reference group). The overall adjusted effects of maternal age categories on the risk of GDM are summarized in Table 1. Inspection of the forest plot for other maternal age groups suggested a consistent trend of increasing GDM risk with advancing maternal age (Supplementary Figure S2).

Ethnicity

Only three studies including 880 non-Han ethnic and 23064 han ethnicity women provided data on ethnicity.[22,42,59] There were no significant differences in risk of developing GDM between non-Han ethnic and Han nationality (OR = 0.78 95% CI: 0.59–1.03, Figure 3) in unadjusted analyses.

Education Level

Fourteen studies reported on education background and GDM.[22,26,41,43,46,49,50,53,54,60–64] Sample sizes ranged from 1360 to 114986. The pooled estimate of developing GDM had no statistical significance in women with high school or lower

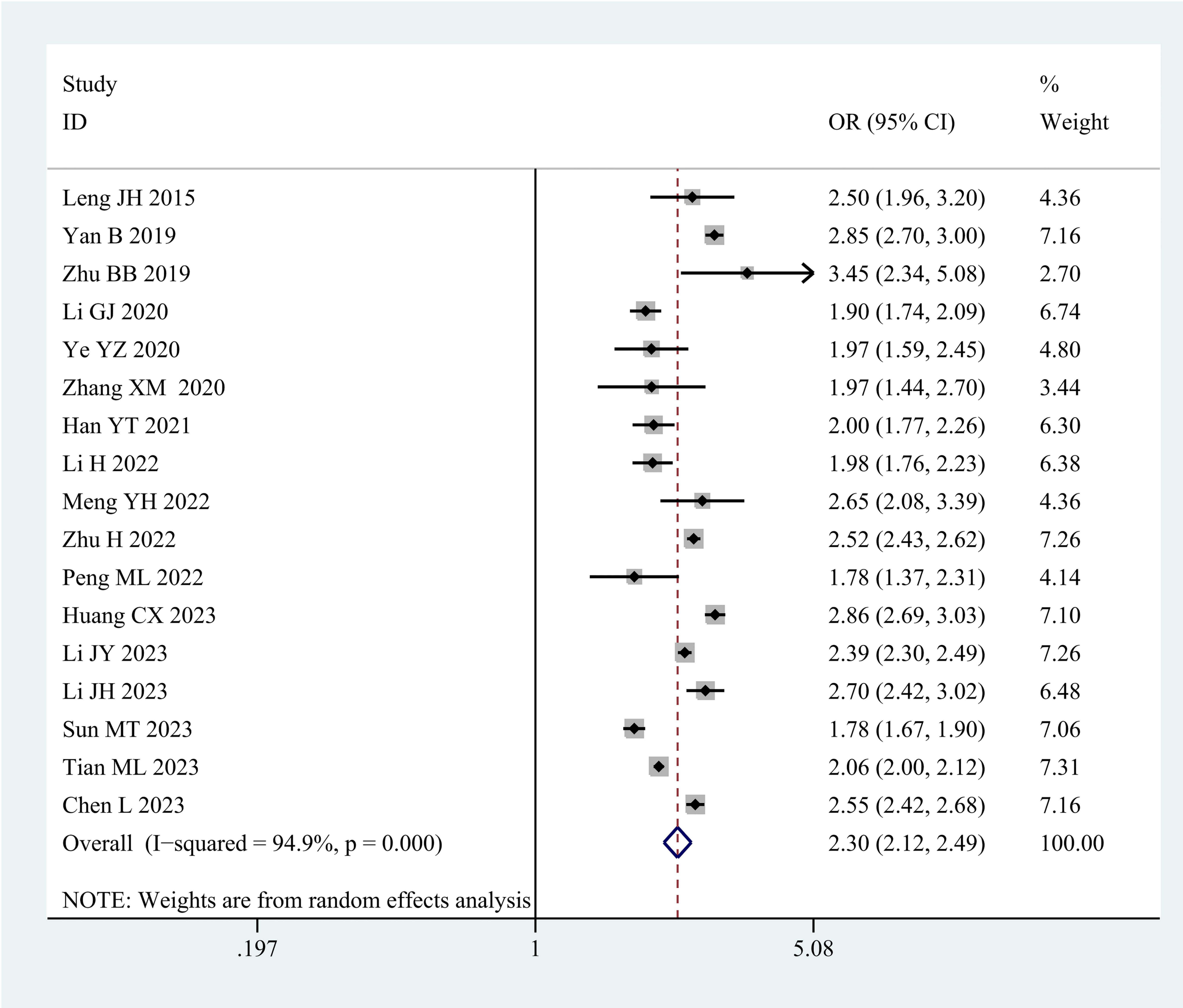

Figure 2 Forest plot of unadjusted association between maternal age≥35 years versus <35 years and gestational diabetes mellitus.

educational attainment when women with college or higher educational attainment as reference groups (OR = 1.09, 95% CI: 0.94–1.26, Figure 4) in unadjusted analyses.

Pre-Pregnancy BMI

Seven cohort studies[22,27–30,32,61] and six case–control studies[33,37–39,42,65] with continuous pre-pregnancy BMI (kg/m^2) were included in the meta-analyses. For every unit increase in BMI, there was a significant increase in odds for GDM in adjusted analysis (OR = 1.24, 95% CI: 1.17–1.32, Figure 5).

Three classification criteria were used to divide pre-pregnancy BMI into four groups: underweight, normal weight, overweight and obese populations in the included articles. Eight studies[28,41,43,48,54,66–68] reported BMI category according to the World Health Organization (WHO) cut-points (underweight: <18.5; normal weight: 18.5–24.9; overweight: 25.0–29.9; obese: ≥30.0). Twenty-four studies[22,26,29–31,40,44–46,51,53,61,63–65,69–77] defined BMI based on Chinese adult BMI classification criteria (underweight: <18.5; normalweight: 18.5–23.9; overweight: 24.0–27.9; obese: ≥28.0). One study[78] adopted definition from WHO BMI classification criteria for Asians (underweight: <18.5; normal weight: 18.5–22.9; overweight: 23.0–24.9; obese: ≥25.0). The pooled effect of GDM in the underweight, overweight, and obese pregnant women was 0.61, 1.94, and 2.99 in unadjusted analysis and 0.65, 1.78, and 2.52 after adjusting for confounders compared with women with normal weight (Table 2).

Table 1 The Adjusted Effect of Maternal Age Categories on the Risk of GDM

Maternal Age Group	Reference Group	Studies(n)	OR (95%)	I^2 (%)	P for Heterogeneity
25–29 years	<25 years	4	1.70(1.36–2.13)	77.8	0.004
30–34 years	<25 years	7	1.58(1.42–1.74)	69.6	0.003
≥35 years	<25 years	5	2.48(2.23–2.77)	47.8	0.105
35–39 years	<25 years	2	1.85(1.62–2.12)	88.8	0.003
30–34 years	<30 years	4	2.81(2.20–3.59)	80.2	0.002
35–39 years	<30 years	2	4.59(3.39–6.21)	81.5	0.02
≥40 years	<30 years	2	6.73(5.87–7.72)	0.5	0.316
≥35 years	<30 years	2	6.32(3.98–10.04)	0.00	0.822
≥35 years	<35 years	4	1.96(1.74–2.21)	81.9	<0.001
35–39 years	<35 years	2	1.59(1.13–2.23)	89.1	0.002
≥40 years	<35 years	2	2.09(1.72–2.53)	56.9	0.128

Forest plot of association between pre-pregnancy underweight, overweight and obese and GDM stratified by classification criteria could be seen in Supplemental Figures S3-S5.

Family History of Diabetes

Twenty-two studies reported data on the family history of diabetes[22,26–33,35,37,41,42,45,46,49,53,59,63,64,67,79] and demonstrated 1.85-fold increased odds for GDM in adjusted analyses (OR = 1.85, 95% CI: 1.58–2.17, Figure 6).

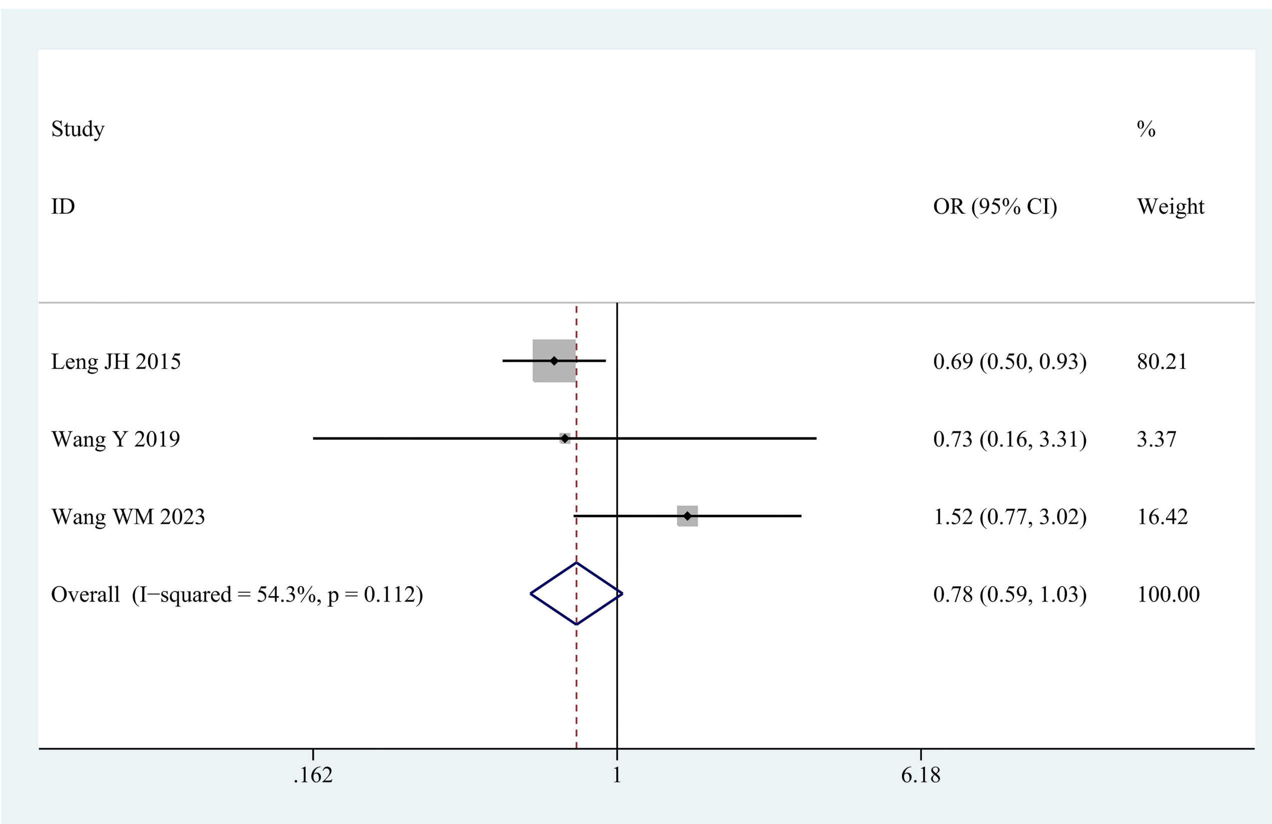

Figure 3 Forest plot of unadjusted association between other ethnic versus Han ethnicity and gestational diabetes mellitus.

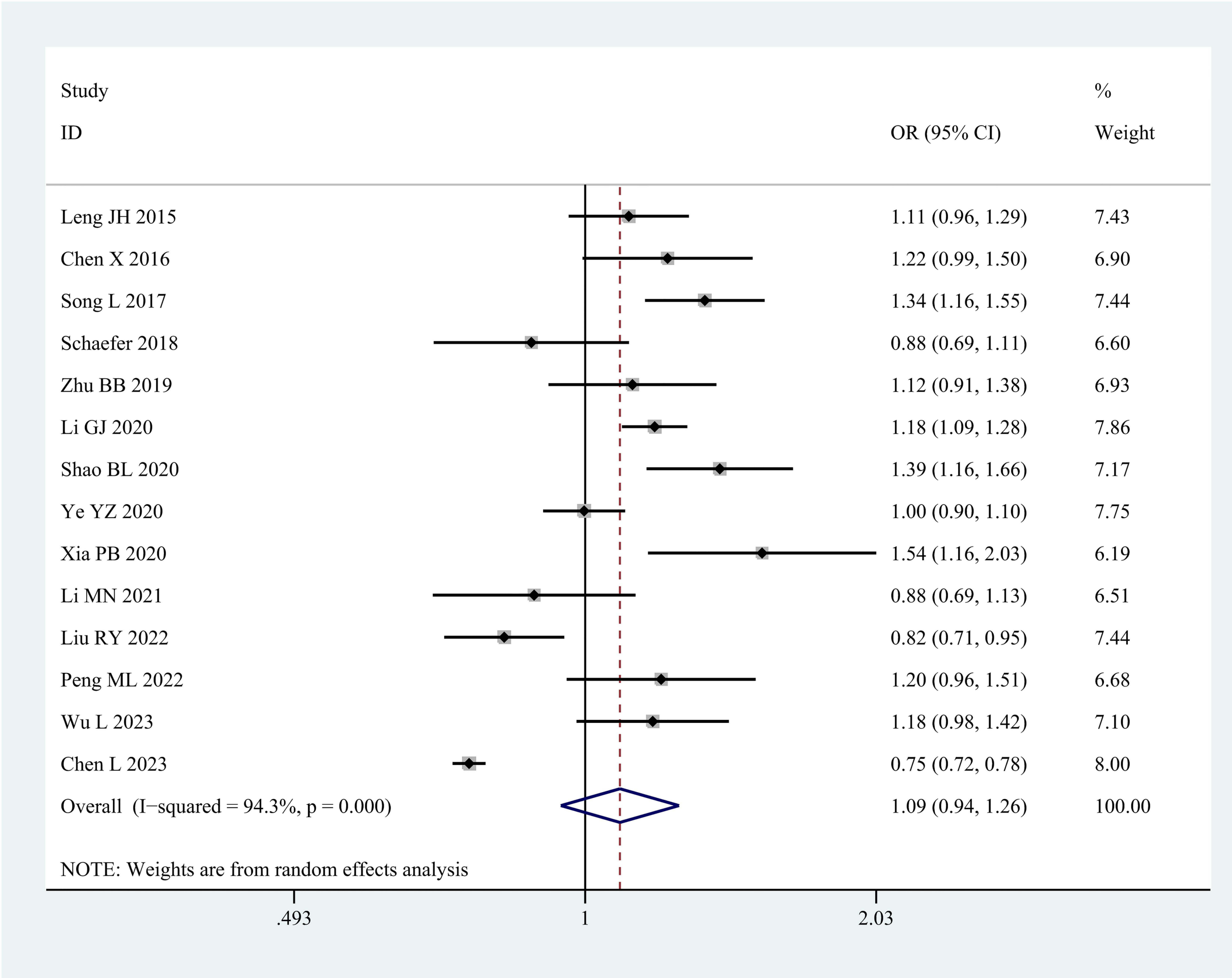

Figure 4 Forest plot of unadjusted association between education level and gestational diabetes mellitus.

History of GDM

The relationship between the history of GDM and GDM was studied in eleven papers.[26,30,31,37,41–43,49,63,64,79] The overall estimate of being diagnosed with the GDM was estimated at 4.09(95% CI 2.13–7.82, Figure 7) in adjusted analysis.

Gravidity

Seven papers reported an association between gravidity and GDM.[32,36,49,65,79–81] Compared with the reference group (gravidity = 1), gravidity ≥2 was associated with a higher risk of GDM in adjusted analysis (OR = 1.06, 95% CI: 0.89–1.27, Supplemental Figure S6), but was not statistically significant.

Parity

Additionally, twenty-four studies evaluated the relation between parity and GDM.[22,29,32,35–37,40,42–44,46,48–50,52,53,59–62,64,65,73,79] The pooled results showed that parity ≥1 was associated with lower risk of GDM in adjusted studies (OR 0.88,95% CI: 0.82–0.94, Supplemental Figure S7).

History of Abortion

The pooled OR based on result from three articles[50,82,83] addressed that there was high risk of GDM in women with history of abortion (OR1.34, 95% CI: 1.31–1.37, Supplemental Figure S8) by using crude OR.

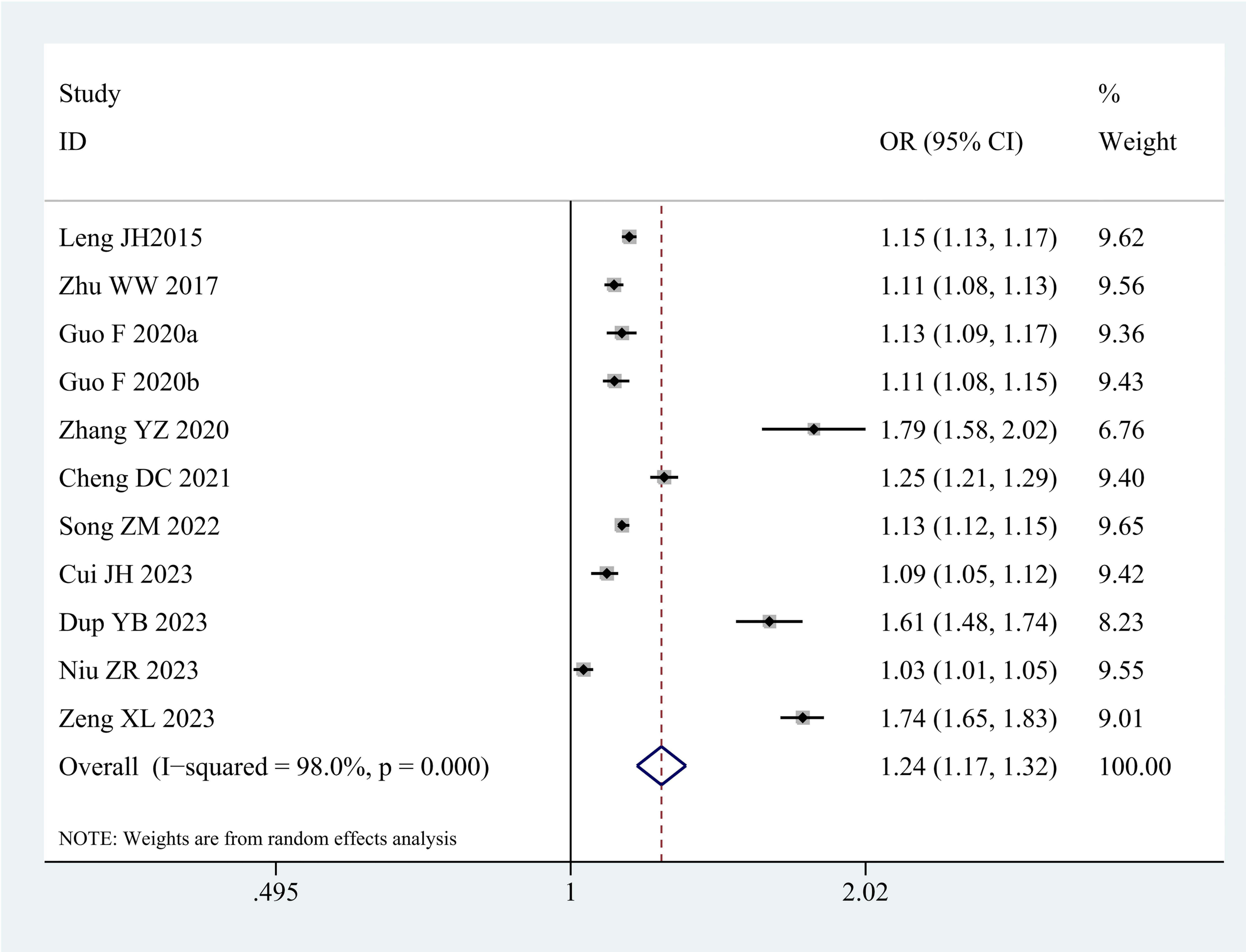

Figure 5 Forest plot of adjusted association between pre-pregnancy body mass index (as a continuous variable) and gestational diabetes mellitus.

Use of ART

Night papers provided data about ART.[31,37,39,42,43,73,84–86] Compared with spontaneous conception, using ART were related to higher GDM risk in adjusted analyses (OR 1.54, 95% CI: 0.95–2.51, Supplemental Figure S9), but there were no significant differences.

FPG in Early Pregnancy

Seven studies measured FPG in early pregnancy.[26,29,31,32,35,37,40] For every unit increase in FPG, there was an increase in odds for GDM (adjusted OR = 2.54, 95% CI: 2.13–3.01, Figure 8).

Hb Levels in Early Pregnancy

Seven studies were used in the meta-analysis[62,87–92] demonstrating an association between Hb in early pregnancy and GDM in adjusted analysis (OR = 1.47, 95% CI: 1.14–1.89, Figure 9).

Table 2 The Overall Effect of Pre-Pregnancy BMI Categories on the Risk of GDM

BMI Categories	Crude OR				Adjusted OR			
	Studies(n)	OR (95% CI)	I^2 (%)	p-value	Studies(n)	OR (95% CI)	I^2 (%)	p-value
Underweight	21	0.61(0.56–0.67)	78.1	<0.001	17	0.65(0.63–0.68)	8.3	0.357
Overweight	26	1.94(1.83–2.07)	74.6	<0.001	19	1.78(1.64–1.92)	73.4	<0.001
Obese	23	2.99(2.58–3.46)	84.1	<0.001	16	2.52(2.06–3.08)	76.9	<0.001

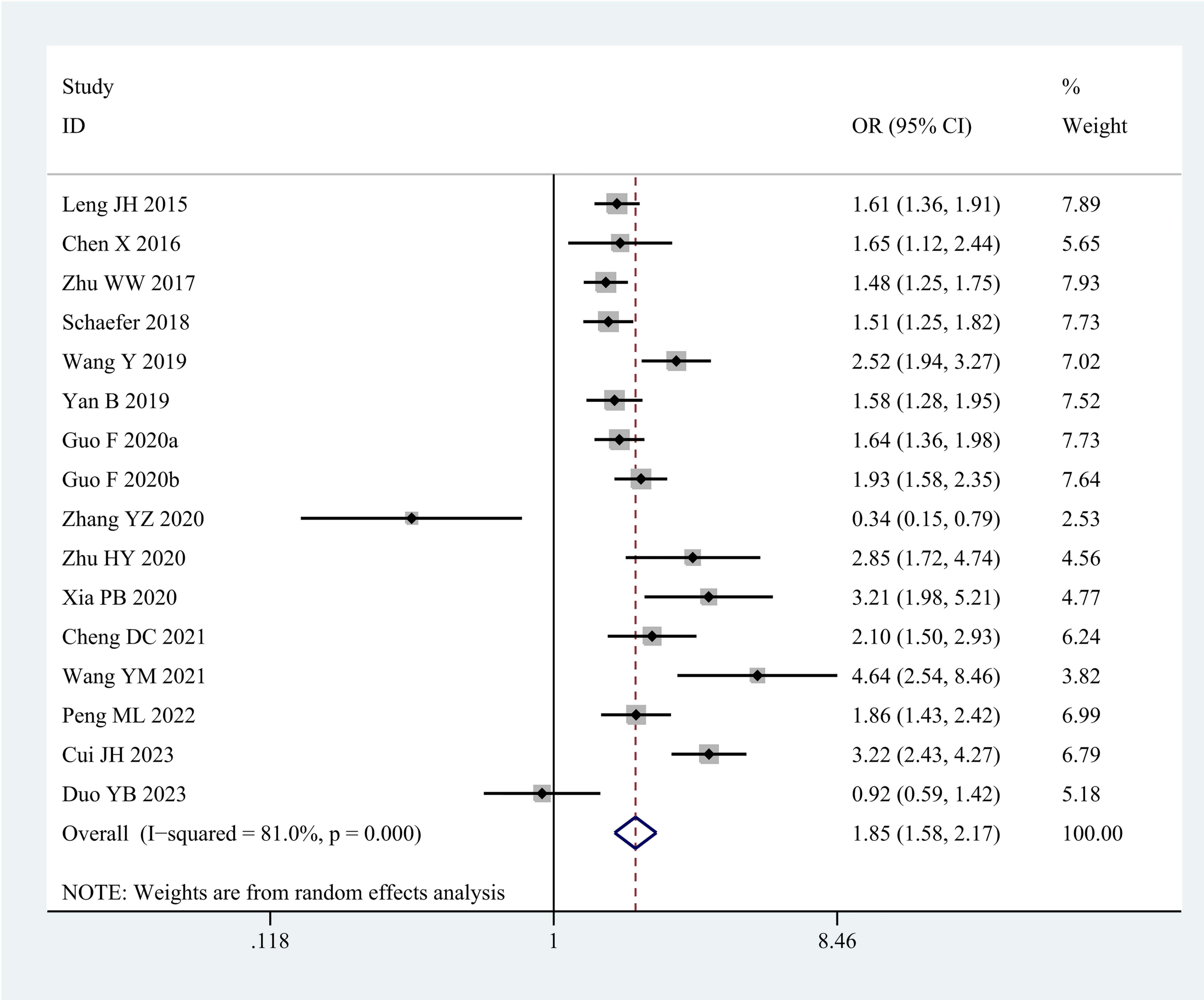

Figure 6 Forest plot of adjusted association between family history of diabetes and gestational diabetes mellitus.

TG Levels in Early Pregnancy

Four studies examined fasting TG in early pregnancy.[34,37,38,93] Increasing TG was associated with (OR = 1.69, 95% CI: 1.31–2.16, Figure 10) increased likelihood for GDM in adjusted analyses.

Subgroup and Sensitivity Analyses

Study design and BMI classification standard were not related to heterogeneity between studies. There were insufficient number of studies to perform subgroup analyses according to region. Sensitivity analyses were performed on adjusted analyses (Supplementary Item 1). Most pooled estimates were not significantly different when a study was omitted, suggesting that no one study had a large effect on the pooled estimate. Supplementary file showed the funnel plots of the included studies for GDM (≥10 studies).

Discussion

In this systematic review and meta-analysis, we identified several main risk factors for GDM among women in mainland China. Our findings highlighted that older maternal age, pre-pregnancy overweight or obesity, family history of diabetes, previous history of GDM, and elevated levels of FPG, Hb, and serum TG in early pregnancy were strongly associated with an increased risk of developing GDM. These associations remained robust in adjusted analyses.

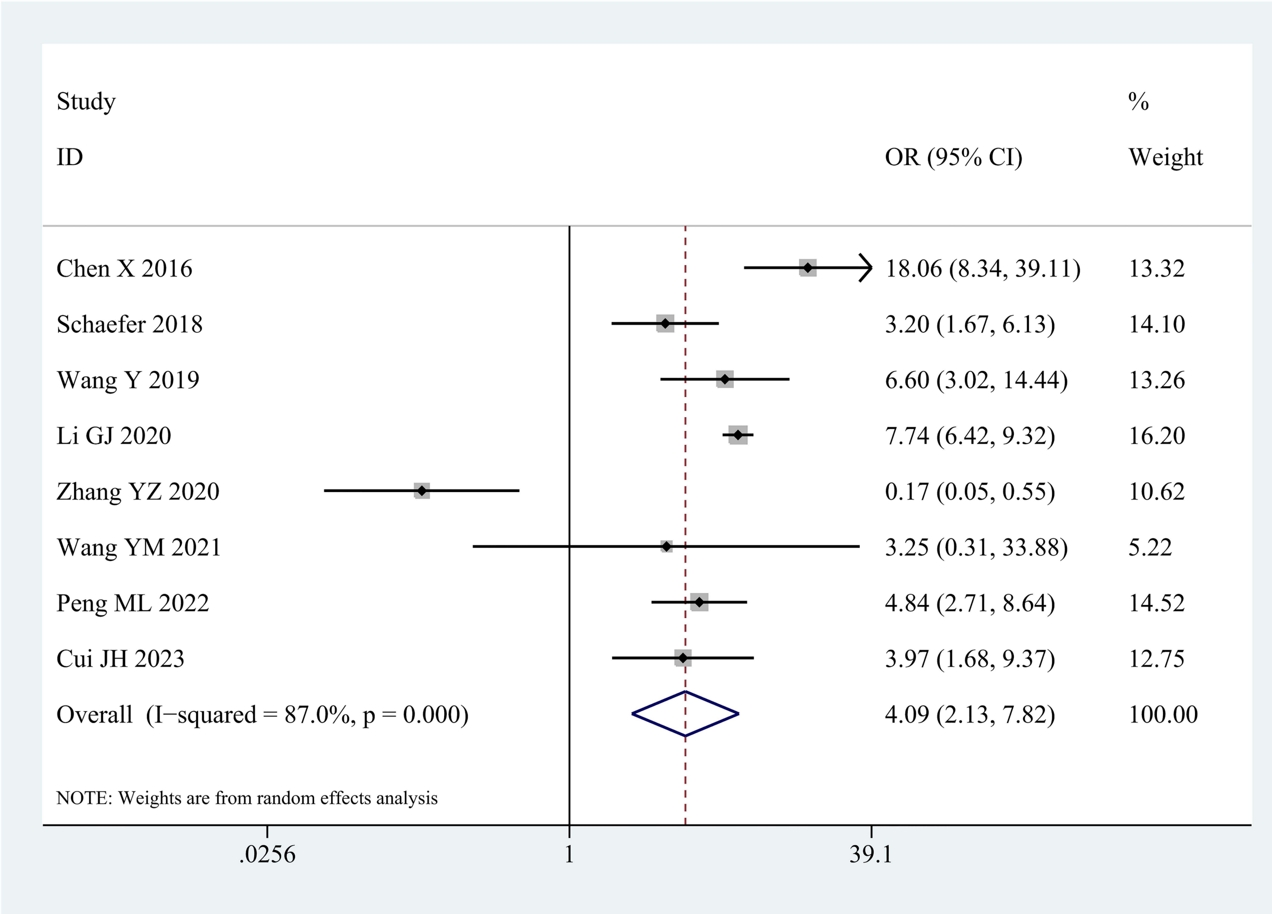

Figure 7 Forest plot of adjusted association between history of gestational diabetes mellitus (GDM) and GDM.

The present review first focused on populations from mainland China in evaluating multiple risk factors for GDM according to IADPSG criteria. A systematic review published in 2019 summarized the prevalence of GDM in mainland China but did not provide pooled estimates of risk factors related to GDM.[18] Another review focusing on Asian populations included a small subset of Chinese participants. However, the primary emphasis was on the broader Asian population,[94] which may not accurately reflect the unique risk profiles of women in mainland China.

Our findings are consistent with previous studies that advanced maternal age was a strong risk factor for GDM, and maternal age greater than 35 years was more prone to GDM.[95–97] However, other studies differed with this cutoff value of maternal age, women over 25 were identified as having a higher risk of GDM,[98] which was consistent with findings among Asian populations.[94] Conversely, reviews conducted in Europe and Middle East and North Africa typically indicated that the risk increased significantly for women over 30 years.[99,100] In mainland China, the shifting population policies (China's family planning) and the trend towards later marriage and childbirth are likely contributing factors to the observed age-related risk.

Similar to previous research, our study confirmed that pre-pregnancy overweight and obesity were independent risk factors for GDM.[96,100–104] In our analysis, we conducted subgroup analyses based on different BMI classification standards, and the results remained consistent, reinforcing the robustness of our findings. A higher BMI has been universally recognized as a risk factor, but the degree of risk associated with overweight and obesity could differ due to variations in genetic, lifestyle, and environmental factors among different populations.

Our unadjusted analyses demonstrated family history of diabetes were related with 2.13-fold increased odds for GDM, and even after adjusting for potential confounders, the odds remained significantly elevated at 1.85-fold.

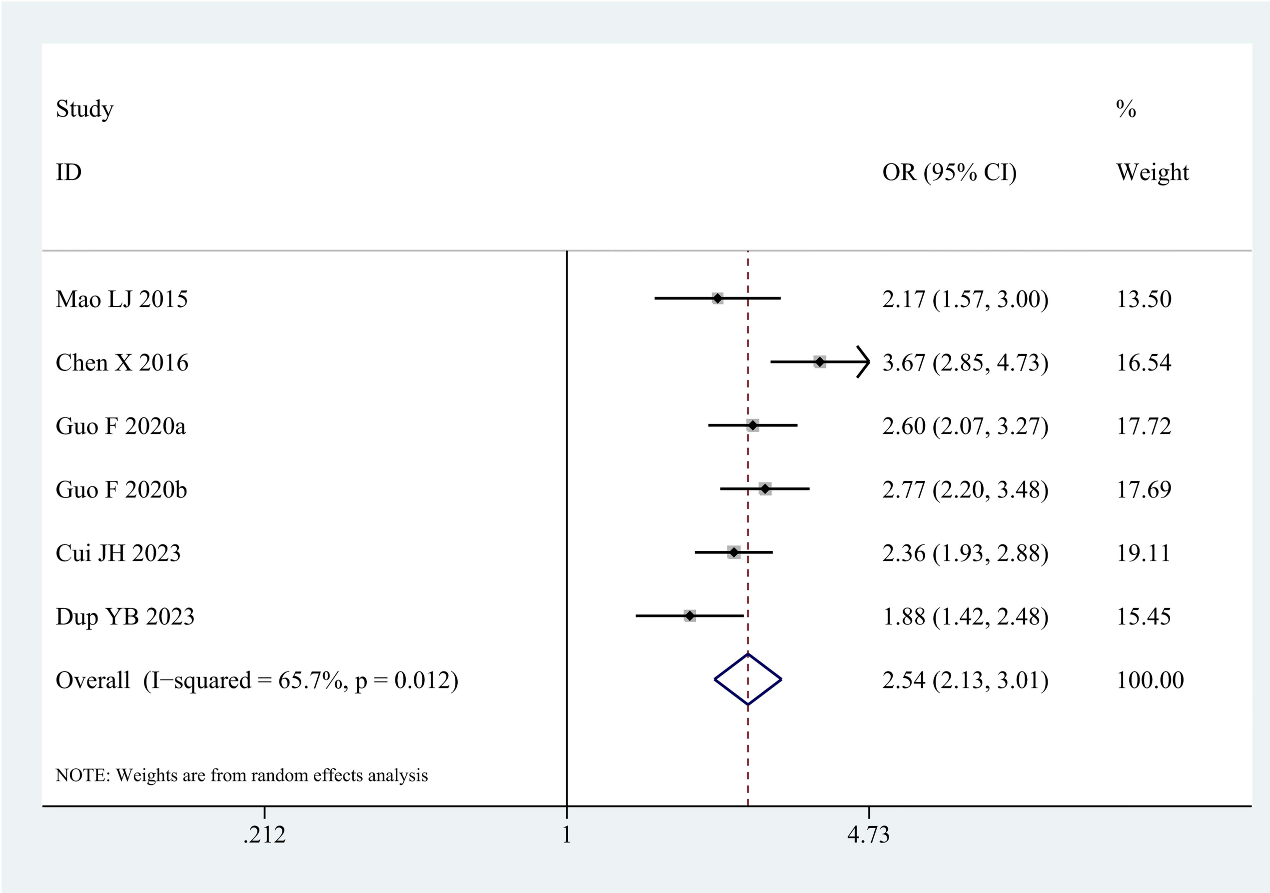

Figure 8 Forest plot of adjusted association between fasting plasma glucose and gestational diabetes mellitus.

A systematic review and meta-analysis suggested that women with family history of diabetes was estimated at 3.46-fold greater than those without.[105] Another study showed that the pooled odds of GDM was 2.326.[98]

Our study found that a history of GDM was a significant risk factor for the recurrence of GDM in subsequent pregnancies. Specifically, the overall OR of being diagnosed with GDM in women with history of GDM was 4.09 when adjusted for potential confounders. This finding aligned with numerous systematic reviews that had consistently identified a previous history of GDM as a prominent risk factor for GDM. A comprehensive review incorporating studies from various countries estimated the OR for history of GDM at 21.137, indicating a substantially higher risk of recurrence compared to women without a history of GDM. In the context of Asian populations, a meta-analysis demonstrated that the history of previous GDM was estimated with an OR of 8.42. Similarly, in sub-Saharan Africa, pooled analyses identified a history of GDM as one of the most important risk factors, with an RR of 5.9. In Ethiopia, the association was particularly strong, with women having a previous history of GDM showing an OR of 8.66. However, these studies did not provide information on whether the analyses were adjusted for confounding variables. The lower adjusted OR in our study compared to these studies might be due to adjustment of a wide range of confounding factors in primary studies.

Elevated FPG and serum TG levels in early pregnancy as predictors of GDM risk were supported by one review,[102] similar to our results. Also, we observed that elevated hemoglobin levels increased the risk of GDM, this finding aligned with the results of two systematic reviews that similarly identified elevated Hb levels as a significant risk factor for GDM.[106,107]

Interestingly, while gravidity ≥2 and conception via ART were associated with an increased incidence of GDM in univariable analysis, these associations were not significant after adjusting for potential confounders. Two other studies

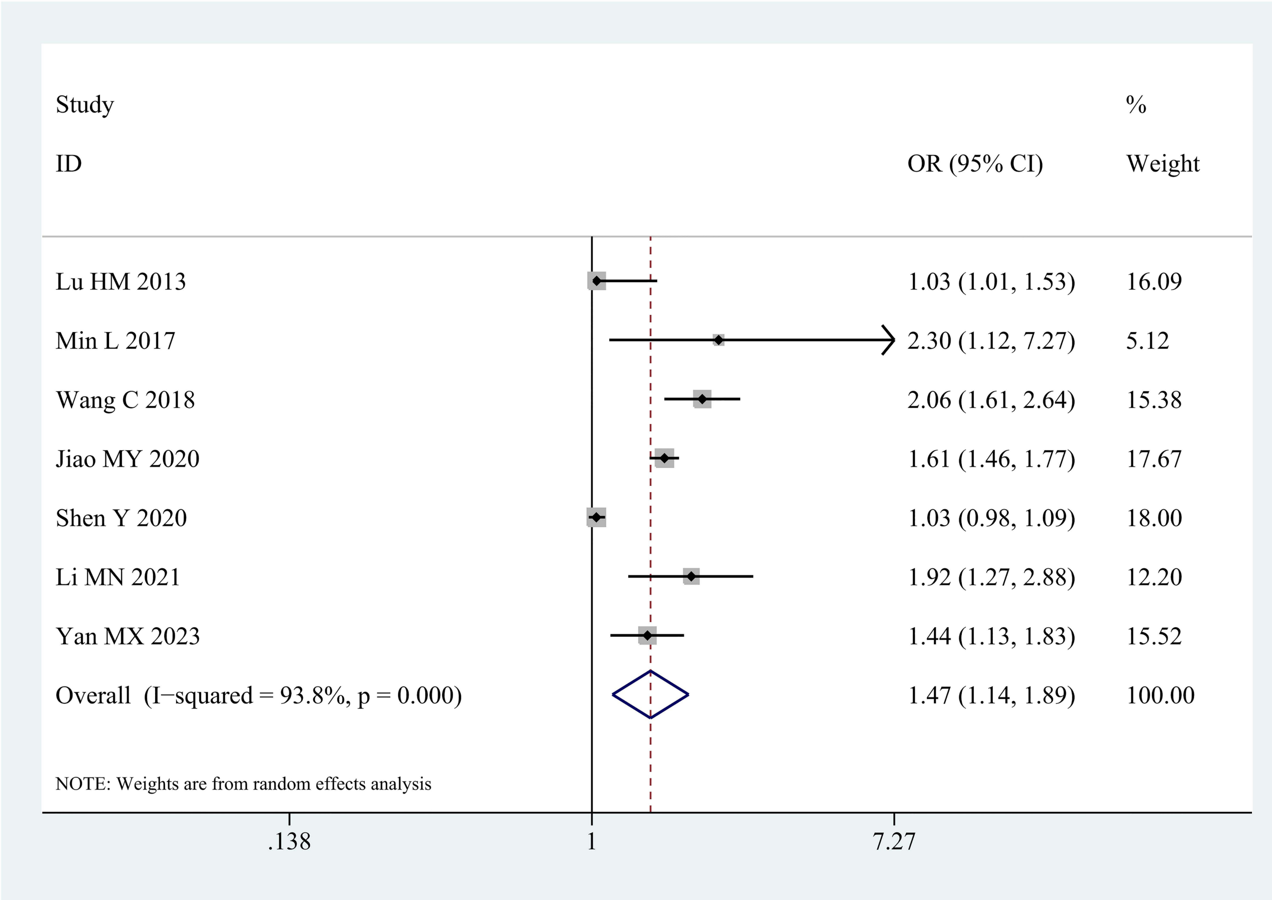

Figure 9 Forest plot of adjusted association between hemoglobin and gestational diabetes mellitus.

demonstrated that primigravida was associated with a lower risk of developing GDM.[94,98] It was reported that ART singleton pregnancies were associated with a higher risk of GDM compared with those of spontaneous conception by using crude OR.[108] The role of confounding factors could not be eliminated in these studies. This suggested that the observed associations in univariable analyses might be confounded by other factors.

Additionally, we observed that women with parity ≥1 had a higher likelihood of developing GDM based on crude odds ratios but appeared to reduce the risk of GDM after adjusting for confounders. This paradoxical finding might reflect the influence of parity-related physiological changes that are not fully accounted for by the confounders included in primary studies.

By summarizing unadjusted results, women with history of abortion were at higher risk of developing GDM, which was consistent with one study.[94] But it also was reported that history of abortion was not related to GDM.[98] Thus, the results about the relationship between the history of abortion and GDM were inconsistent. In this review, there was no significant difference in GDM between non-Han and Han ethnic groups. The small sample sizes in minority groups in our study might have limited the statistical power to detect any significant differences. Similarly, our analysis showed women with higher education (college or higher) did not have a different risk compared to those with lower education (high school or lower), these findings were different from some existing research. Those studies conducted in western countries had shown that low-educated women had an increased risk of GDM.[109,110]

One of the primary strengths of this study was its exclusive focus on populations from mainland China, providing a region-specific analysis of GDM risk factors. The inclusion of multiple risk factors and their assessment in both univariable and multivariable analyses provide a nuanced understanding of the independent and combined effects of these factors on GDM risk. However, several limitations should be noted. First, the possibility of residual confounding

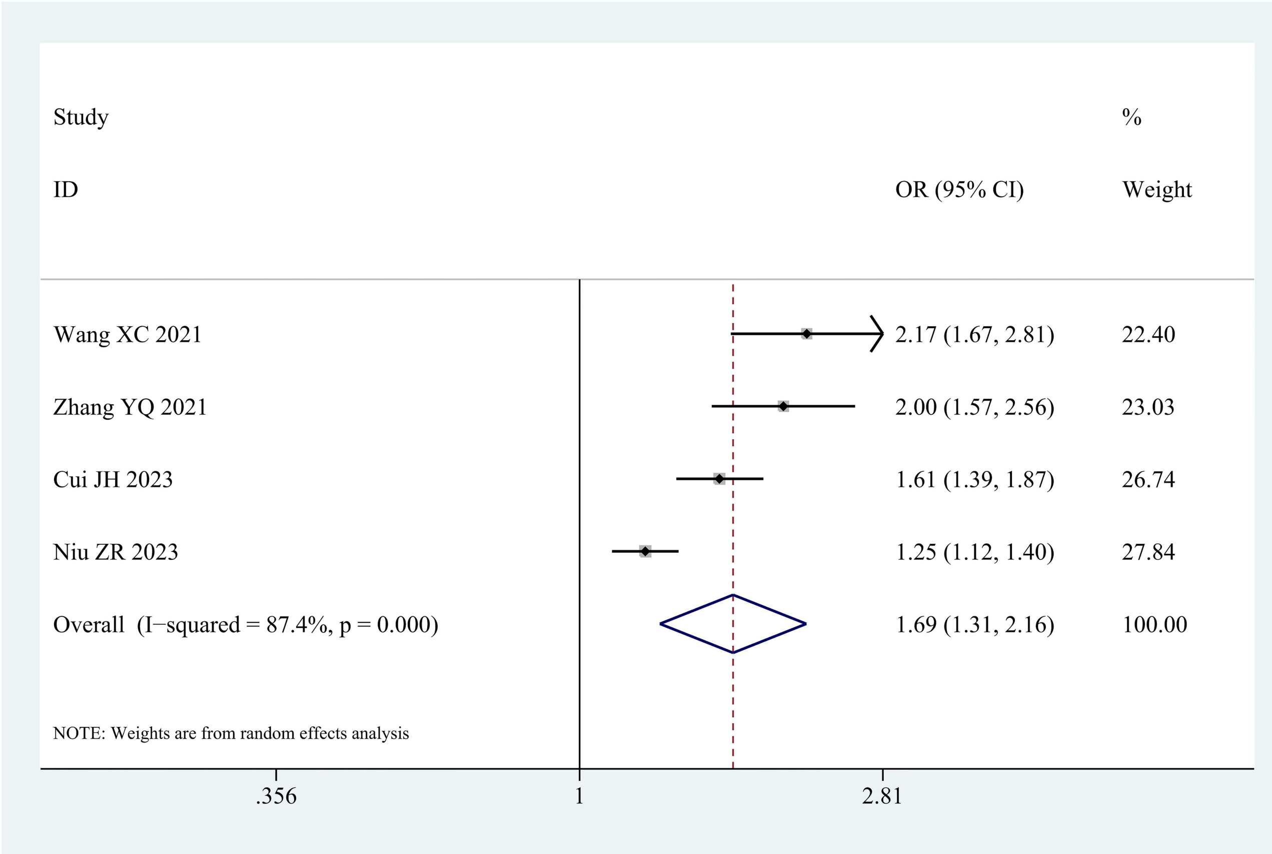

Figure 10 Forest plot of adjusted association between serum triglycerides and gestational diabetes mellitus.

cannot be entirely excluded. Additionally, while our focus on mainland China enhances the specificity of our results, it may limit the generalizability of these findings to other populations with different genetic, environmental, and lifestyle factors. Furthermore, as all data included in this meta-analysis were derived from published studies conducted in mainland China, comparisons with other countries or regions could not be made, which limits the ability to explore potential population-specific differences. Another important limitation is that our analysis primarily focused on the known maternal characteristics such as age, BMI and family history of diabetes. However, GDM risk was influenced by a multitude of factors, including lifestyle, diet, and physical activity, which were not comprehensively assessed in our review.

Conclusion

Overall, this meta-analysis identified key risk factors for GDM in mainland China, including advanced maternal age, pre-pregnancy obesity, family history of diabetes, and elevated early pregnancy biomarkers. The adjusted results were derived from multivariate regression models in the included studies, which accounted for confounders like age and BMI. However, variations in adjustment strategies across studies remain a limitation. Our findings emphasize the need for standardized methods and targeted interventions to reduce GDM risks in this population.

Data Sharing Statement

The data used and analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

No potential conflict of interest was reported by the authors.

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