J Renal Inj Prev. 2025: e38696.

https://journalrip.com doi: 10.34172/jrip.2025.38696

Journal of Renal Injury Prevention

A systematic review and meta-analysis on the association of triglyceride-glucose index levels with risk of gestational diabetes mellitus

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ARTICLE INFO

Article Type:
Meta-analysis

Article History:
Received: 14 Aug. 2025
Revised: 19 Oct. 2025
Accepted: 31 Oct. 2025
Published online: 4 Nov. 2025

Keywords:
Diabetes
Gestational age
Gestational diabetes mellitus
Pregnancy-induced diabetes
Triglyceride-glucose index

ABSTRACT

Introduction: Gestational diabetes mellitus (GDM) is a common metabolic disorder during pregnancy, and the triglyceride-glucose (TyG) index is among the indicators that can predict the occurrence of gestational diabetes. Accordingly, our goal was to examine the relationship between the TyG index and GDM.

Materials and Methods: Databases of Scopus, PubMed, Embase, Web of Science, Cochrane, and Google Scholar search engine were used for articles published until September 5, 2025. Data was analyzed using STATA 14. Tests with P values<0.05 were considered statistically significant.

Results: High TyG index in general (OR:1.77, 95% CI: 1.56, 2), in the second one-third (OR:1.90, 95% CI: 1.08, 3.36), third one-third (OR:3.94, 95% CI: 2.07, 7.50), second quartile (OR:1.24, 95% CI: 1.07, 1.44), third quartile (OR:1.58, 95% CI: 1.28, 1.94), fourth quartile (OR:2.42, 95% CI: 1.85, 3.17), second quantile (OR:1.23, 95% CI: 1.05, 1.43), third quantile (OR:1.44, 95% CI: 1.23, 1.68), fourth quantile (OR:2.15, 95% CI: 1.41, 3.28), fifth quantile (OR:2.92, 95% CI: 1.96, 4.37) increased the risk of GDM. Furthermore, high TyG index levels increased the risk of GDM in China (OR:1.84, 95% CI: 1.59, 2.13), Korea (OR:1.43, 95% CI: 1.08, 1.89), cohort studies (OR:1.82, 95% CI: 1.60, 2.07), women groups with mean ages ≥ 35 (OR:2.54, 95% CI: 1.84, 3.51), and women with BMIs ≥ 25 (OR:2.56, 95% CI: 2.06, 3.18).

Conclusion: High TyG index levels increased the risk of GDM by about 77%, and higher TyG index levels led to even higher possibilities of GDM occurrence. Additionally, obese and overweight women and those aged ≥ 35 were more exposed to this disease than other women.

Registration: This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD420251143086) and Research Registry (UIN: reviewregistry2046) websites.

Implication for health policy/practice/research/medical education:
High triglyceride-glucose (TyG) index levels increased the risk of gestational diabetes mellitus (GDM) occurrence by about 77% and higher TyG index levels were associated with increased risk of GDM. Additionally, obese and overweight women or those aged ≥ 35 were exposed to higher risks than other women. Consequently, it is recommended to conduct further studies in the future on vulnerable groups and those exposed to higher GDM risks.

Please cite this paper as: Farajisani M, Shamsghahfarokhi Sh, Hamidi Madani Z, Zamanpour Z, Rastad H, Ghaseminejad Kermani S, Safa K, Ashrafi L, Darabi F. A systematic review and meta-analysis on the association of triglyceride-glucose index levels with risk of gestational diabetes mellitus. J Renal Inj Prev. 2025; x(x): e38696. doi: 10.34172/jrip.2025.38696.

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Meta-analysis

Introduction

Gestational diabetes mellitus (GDM) is caused by disrupted glucose metabolism, which leads to an increase in blood glucose level during pregnancy (1,2). This condition is the most common complication during pregnancy, with a frequency ranging from 1 to 30 percent (3). As in 2021, approximately 21.1 million live births were affected by a type of diabetes mellitus, of which 80.3% of the cases were related to GDM (4). Various risk factors can cause GDM, including obesity, polycystic ovary syndrome, maternal ethnicity, and family history of diabetes (5,6). On the other hand, GDM is a risk factor for the health of the mother and fetus, accountable for the occurrence of macrosomia, perinatal mortality, and preeclampsia (7). Furthermore, women with GDM are more susceptible to type 2 diabetes mellitus, cardiovascular and cerebrovascular diseases (8,9).

Triglyceride-glucose index (TyG) is an indicator for the identification of insulin resistance and metabolic disorders (10,11). This index is a combination of fasting plasma glucose (FPG) and triglyceride (TG) (12), and provides the opportunity for early interventions and more accurate monitoring of pregnancies prone to metabolic complications (13). Various studies presented different results regarding the relationship between high TyG index levels and GDM. A study (14) demonstrated that in all quartiles, high TyG index levels increased the risk of GDM. However, another study (15) reported that there was no statistically significant association between TyG index levels and the risk of GDM in the second and third quartiles. Hence, the present research was conducted using systematic review and meta-analysis methods.

Materials and Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was conducted to design the present article (16), and its protocol was registered at the websites PROSPERO (International Prospective Register of Systematic Reviews) and Research Registry.

Search strategy

The databases Scopus, PubMed, Embase, Web of Science, Cochrane, and Google Scholar Search Engine were used to search for articles published by September 5, 2025, without any language or time restrictions. The Medical Subject Headings (MeSH) and their equivalents were used during the searching process. Operators (AND, OR) were used to combine the keywords. In the end, the process included a manual search. The search strategy in the PubMed database was as follows: ("Diabetes, Gestational"[Title/Abstract] OR Gestational Diabetes Mellitus[Title/Abstract] OR Pregnancy-Induced Diabetes[Title/Abstract]) AND (Triglyceride-Glucose Index[Title/Abstract]).

PECO components

- Population: Articles that aimed to investigate the association between TyG index and GDM.
- Exposure: High TyG index.
- Comparison: Women without GDM.
- Outcomes: Risk of GDM.

Inclusion criteria

Articles that aimed to investigate the association between TyG index and GDM.

Exclusion criteria

Non-observational studies, studies with low quality, duplicate studies, abstracts published in conferences, studies that did not have full text, and those that did not provide our required data were excluded.

Quality assessment

The quality of observational studies was assessed using the Newcastle-Ottawa Scale. This tool assigns a maximum of one star to each question, except for the comparative question. Therefore, a score of zero indicated the lowest quality, and a score of ten showed the highest quality. Then, studies with scores lower than five were considered low-quality (17).

Data extraction

Two researchers extracted data, including mean age, level of TyG index, sample size, type of study, country, year, duration of study, and the author's name. Then, the third researcher addressed the discrepancies.

Statistical analysis

The odds ratio (OR) or risk ratio (RR) logarithm were used for data analysis, and the studies were combined. The I^2 index was used to examine the heterogeneity between studies. A randomized effects model was used to combine the studies (I^2=94.9%). Data analysis was conducted using STATA 14 software. Tests with *P* values <0.05 were considered statistically significant.

Results

Overall, 191 articles were found during the search stage. Then, 93 duplicate studies were identified and removed. The abstracts were reviewed, and 11 studies without accessible full texts were removed. Out of the 87 remaining articles, 44 lacked the required data for analysis and were excluded. Among the 43 articles that entered the next step, 30 studies were removed due to other exclusion criteria, and 13 articles remained (Figure 1).

A total of 13 studies were examined in the following table, among which 11 were cohort, one was case-control, and one was cross-sectional (Table 1).

High TyG index levels increased the risk of GDM (OR:1.77, 95% CI: 1.56, 2). Furthermore, high TyG index

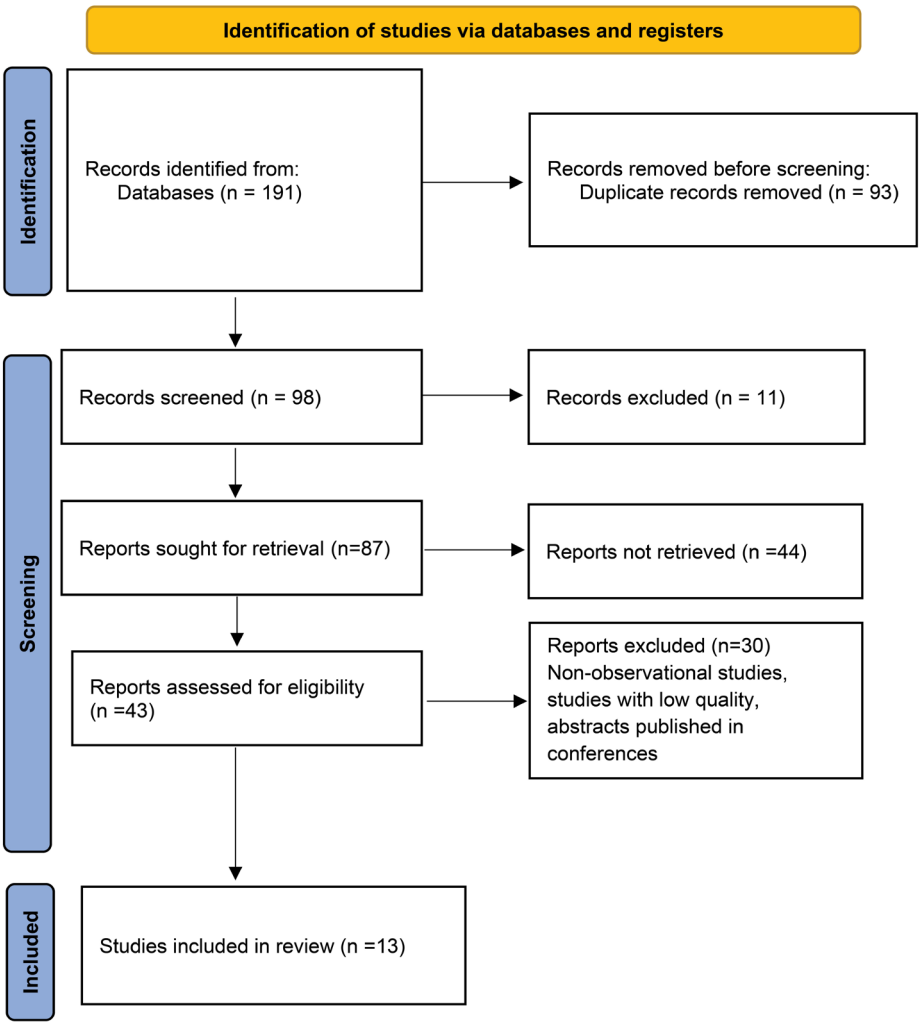

Figure 1. The PRISMA flow chart of study selection.

levels increased the risk of GDM in China (OR:1.84, 95% CI: 1.59, 2.13) and Korea (OR:1.43, 95% CI: 1.08, 1.89). However, in Mexico (OR:1.43, 95% CI: 0.80, 2.56) and the USA (OR:2.25, 95% CI: 0.98, 5.21), there was no statistically significant relationship between the TyG index and the risk of GDM (Figures 2 and 3).

High TyG index levels increased the risk of GDM in cohort studies (OR:1.82, 95% CI: 1.60, 2.07); however, in case-control (OR:1.28, 95% CI: 0.82, 2.01) and cross-sectional (OR:2.25, 95% CI: 0.98, 5.21) studies, there was no significant relationship between TyG index and the risk of GDM.

While investigating various TyG index levels we realized that the second one-third (OR:1.90, 95% CI: 1.08, 3.36), third one-third (OR:3.94, 95% CI: 2.07, 7.50), second quartile (OR:1.24, 95% CI: 1.07, 1.44), third quartile (OR:1.58, 95% CI: 1.28, 1.94), fourth quartile (OR:2.42, 95% CI: 1.85, 3.17), second quantile (OR:1.23, 95% CI: 1.05, 1.43), third quantile (OR:1.44, 95% CI: 1.23, 1.68), fourth quantile (OR:2.15, 95% CI: 1.41, 3.28), and fifth quantile (OR:2.92, 95% CI: 1.96, 4.37) increased the risk of GDM (Figures 4, and 5).

High TyG index levels in women aged ≥ 35 (OR:2.54, 95% CI: 1.84, 3.51) and women with BMIs ≥ 25 (OR:2.56, 95% CI: 2.06, 3.18) increased the risk of GDM (Figures 6 and 7).

Discussion

The present meta-analysis demonstrated that high TyG index levels in general (77%), in China (84%), Korea (43%), and cohort studies (82%) increased the risk of GDM. Furthermore, higher TyG index levels in women groups with mean ages ≥ 35 and those with BMIs ≥ 25 significantly increased the risk of GDM.

In a meta-analysis by Liu et al, the findings revealed a four-fold TyG index increase in patients with GDM compared with the control group (Mean difference: 0.22, 95% CI: 0.07, 0.36) (28). In a meta-analysis by Song et al on five studies, findings indicated that high TyG index levels compared with low levels increased the risk of GDM (OR: 2.52, 95% CI: 1.33, 4.67) (29). The previous meta-analysis was consistent with the present study; however,

Table 1. Summarized information of the studies

Name, year	Country	Type of study	Duration of study	Level of TyG index	OR/RR	Low limit	Up limit
Gurza G, 2025 (18)	Mexico	Cohort	from 2017 to 2019	Total	1.87	1.00	2.50
Zhang J, 2025 (19)	China	Cohort	between 2018 and 2022	Quartile2	1.68	0.75	3.75
				Quartile3	1.94	0.89	4.24
				Quartile4	2.67	1.17	6.07
Song S, 2025 (20)	China	Cohort	from May 2019 to Apr 2024	Quartile2	1.20	1.02	1.41
				Quartile3	1.44	1.23	1.70
				Quartile4	2.14	1.81	2.54
Zhang L, 2025 (14)	China	Cohort	from 2018 to 2022	Quartile2	1.40	1.27	1.54
				Quartile3	1.83	1.67	2.01
				Quartile4	2.77	2.52	3.04
Xu X, 2024 (15)	China	Case-control	from Jan 2021 to Jun 2023	Quartile2	0.88	0.63	1.22
				Quartile3	1.23	0.89	1.70
				Quartile4	1.95	1.39	2.73
Mo Z, 2024 (21)	Korea	Cohort	between Nov 2014 and Jul 2016	Tertile2	1.81	0.34	9.60
				Tertile3	5.61	1.19	26.43
Guo Y, 2024(13)	China	Cohort	between Aug 2021 and Apr 2023	Quintile 2	1.44	0.93	2.23
				Quintile3	1.67	1.07	2.61
				Quintile4	2.82	1.80	4.42
				Quintile5	3.87	2.34	6.38
Li L, 2024 (22)	China	Cohort	between Jan 2017 and Dec 2022	Quartile2	1.55	1.24	1.94
				Quartile3	2.16	1.75	2.65
				Quartile4	3.82	3.14	4.64
Zeng Y, 2023 (23)	USA	Cross-sectional	1999 to Mar 2020	Tertile2	1.62	0.69	3.80
				Tertile3	3.92	1.16	13.25
Li H, 2022 (24)	China	Cohort	between Jan 2019 and Sep 2020	Quintile 2	1.20	1.02	1.41
				Quintile 3	1.41	1.20	1.66
				Quintile 4	1.81	1.54	2.14
				Quintile 5	2.52	2.09	3.05
Kim JA, 2021 (25)	Korea	Cohort	between Jan 1, 2012 and Dec 31, 2015	Quartile2	1.1	1.04	1.15
				Quartile3	1.28	1.22	1.34
				Quartile4	1.80	1.72	1.89
Liu PJ, 2020 (26)	China	Cohort	2018	Tertile2	2.27	0.95	5.38
				Tertile3	3.53	1.48	8.42
Sanchez-Garcia A, 2020 (27)	Mexico	Cohort	From Nov 2017 to Oct 2019	Total	1.03	0.57	1.88

OR: Odds ratio, RR: Risk ratio.

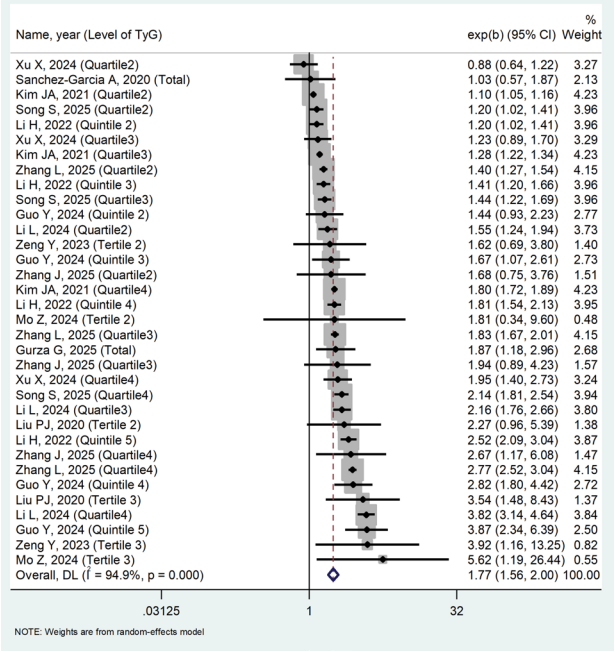

Figure 2. Forest plot showing the association between TyG index and risk of GDM.

the present meta-analysis included a larger sample and covered more studies, which increases the generalizability of the results.

Based on the results of a meta-analysis by Pranata et al, high TyG index levels were associated with increased frequency of type 2 diabetes mellitus occurrence (RR: 3.54, 95% CI: 2.75, 4.54) (30). In another meta-analysis, Da Silva et al demonstrated that high TyG index levels were risk factors for type 2 diabetes mellitus (HR: 2.44, 95% CI: 2.17, 2.76) (31). Yu et al conducted another research using meta-analysis methods and reported that the fourth quartile of the TyG index was associated with increased risk of diabetic retinopathy compared with the first quartile (OR: 1.91, 95% CI: 1.44 to 2.53) (32). Additionally, Zhou et al indicated in their meta-analysis that higher TyG index levels compared with low TyG-index levels increased the risk of diabetic retinopathy (OR: 2.34, 95% CI: 1.31, 4.19) (33). In a meta-analysis by Deng and Peng, findings indicated a direct and significant correlation between higher TyG index levels and increased risk of diabetic nephropathy in patients with type 2 diabetes mellitus (RR: 1.53, 95% CI: 1.37, 1.71) (34). The mentioned meta-analyses demonstrated that high TyG index levels compared with low levels were potential risk factors for the occurrence of type 2 diabetes mellitus, diabetic retinopathy, and diabetic nephropathy. Accordingly, their results were consistent with our findings and confirmed our results.

In a cohort study by Lin et al, findings indicated a significant increase in the risk of being large for gestational age (LGA) per each unit of increase in the TyG index (OR:

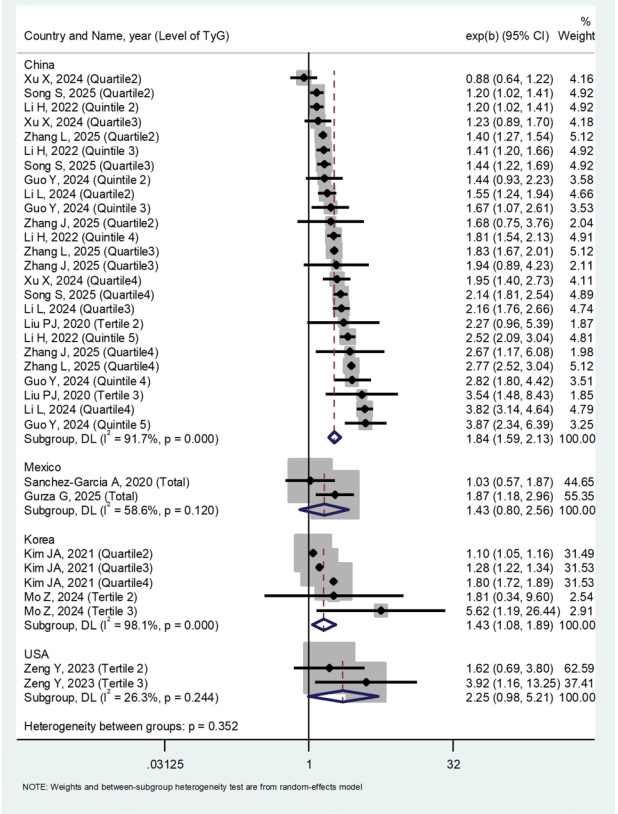

Figure 3. Forest plot showing the association between TyG index and risk of GDM by country.

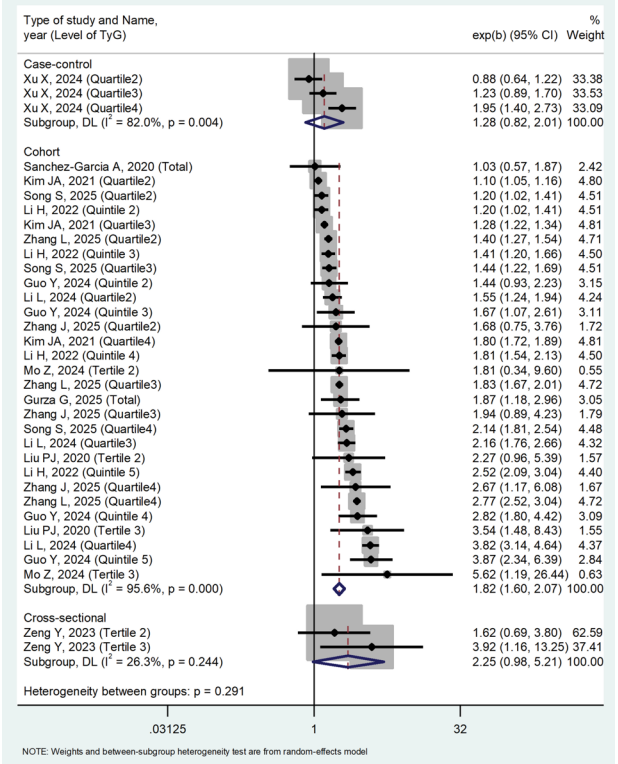

Figure 4. Forest plot showing the association between TyG index and risk of GDM by type of study.

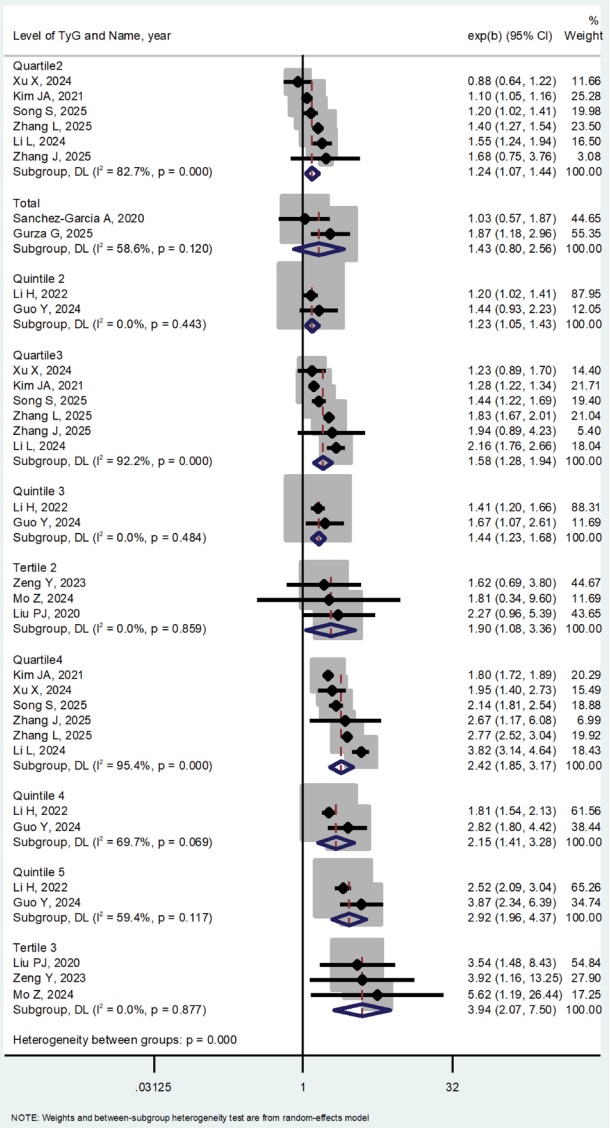

Figure 5. Forest plot showing the association between TyG index and risk of GDM by level of TyG index.

2.05, 95% CI: 1.64, 2.57) (35). Based on the results of a cohort study by Li et al, the fourth TyG index quartile increased the risk of preeclampsia (OR: 1.31, 95% CI: 1.11, 1.53) compared with the first quartile (36). Another cohort study by Zhao et al demonstrated that higher TyG index levels were risk factors for macrosomia occurrence (OR: 1.84, 95% CI: 1.02, 3.30) (37). In addition to the meta-analyses, cohort studies indicated that higher TyG index levels compared with lower levels were risk factors for the occurrence of complications in pregnant women, as they increased the risks of preeclampsia, macrosomia, and LGA. However, in the present research, we concluded through combining several cohort studies that higher TyG index levels increased the risk of GDM

Conclusion

High TyG index levels increased the risk of GDM occurrence by about 77% and higher TyG index levels were associated with increased risk of GDM. Additionally, obese and overweight women or those aged ≥ 35 were exposed to higher risks than other women. Consequently, it is recommended to conduct further studies in the future on vulnerable groups and those exposed to higher GDM risks.

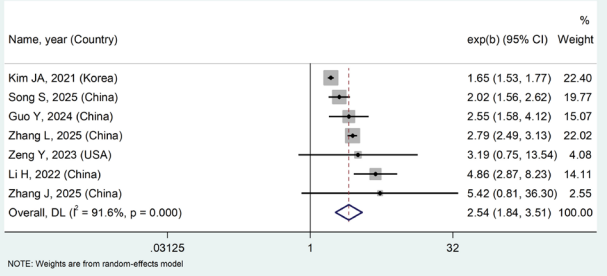

Figure 6. Forest plot showing the association between TyG index and risk of GDM in age group≥35 years.

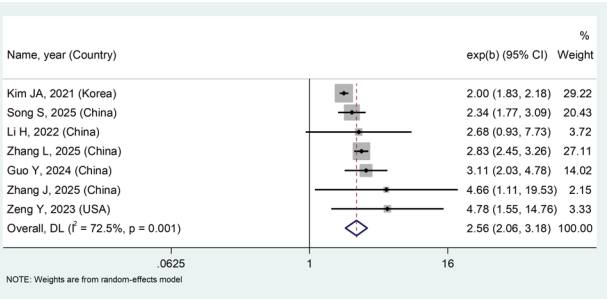

Figure 7. Forest plot showing the association between TyG index and risk of GDM in BMI ≥25 years.

Limitations of the study

A) Out of the 13 reviewed studies, only two were case-control and cross-sectional studies; accordingly, more case-control and cross-sectional studies are recommended in the future. B) The grouping of TyG index levels was not identical in all studies, and they had presented the data based on one-thirds, quartiles, and quantiles. C) Most studies were conducted in Asia, and there was a study gap in other continents.

Acknowledgments

The authors would like to thank Hosein Mardanparvar and Diana Sarokhani for guidance and editing of the manuscript registration on the PROSPERO and research registry websites.

Authors' contribution

Conceptualization: Maryam Farajisani, Sara Ghaseminejad Kermani, and Forouhar Darabi.

Data curation: Leila Ashrafi, Maryam Farajisani, and Kamran Safa.

Formal analysis: Shirin Shamsghahfarokhi and Zahra Hamidi Madani.
Investigation: Forouhar Darabi, Zeinab Zamanpour, and Hamid Rastad.
Methodology: Shirin Shamsghahfarokhi, Leila Ashrafi, and Zahra Hamidi Madani.
Project Management: Forouhar Darabi.
Supervision: All authors.
Validation: Zeinab Zamanpour and Sara Ghaseminejad Kermani.
Visualization: Hamid Rastad and Kamran Safa.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Conflicts of interest

There are no competing interests.

Ethical issues

This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO website (ID: CRD420251143086) and the Research Registry website with (Unique Identifying Number [UIN] reviewregistry2046). Besides, ethical issues (including plagiarism, data fabrication, and double publication) have been completely observed by the author.

Funding/Support

No funding.

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