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The association between triglyceride-glucose index and contrast-induced nephropathy; a systematic review and meta-analysis

Maede Safari[1], Akram Kadhim Kareem[2], Khorshid Rigi[3,4], Akbar Abbasi[5], Bahman Mokhtarinia[6], Paniz Pourpashang[7,8], Elham Ahmadipour[9], Batool Heydarisadegh[10], Halime Aali[11*]

[1]Urology Department, School of Medicine, Isfahan University of Medical Science, Isfahan, Iran
[2]College of Nursing, Al-Qadisiyah University, Iraq
[3]Tropical and Communicable Diseases Research Centre, Iranshahr University of Medical Sciences, Iranshahr, Iran
[4]Midwifery Department, Chabahar University of Medical Science, Chabahar, Iran
[5]Department of Nursing, Naghadeh School of Nursing, Urmia University of Medical Sciences, Urmia, Iran
[6]School of Paramedical, Yasuj University of Medical Sciences, Yasuj, Iran
[7]Pediatric Chronic Kidney Disease Research Center, Gene, Cell and Tissue Research Institute, Tehran University of Medical Sciences, Tehran, Iran
[8]Department of Pediatric Nephrology, Bahrami Hospital, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
[9]Independent Researcher, Pezeshkan st, Alvand Building, 3th floor, Shiraz, Iran
[10]Department of Emergency Medicine, School of Medicine, Zabol University of Medical Sciences, Zabol, Iran
[11]Department of Internal Medicine, School of Medicine, Amir Al-Momenin Hospital Zabol University of Medical Sciences, Zabol, Iran

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ABSTRACT

Introduction: The triglyceride-glucose index (TyG) is an indicator of insulin resistance, which can cause chronic dysfunction in renal performance. Accordingly, the present study aimed to examine the association between high TyG index levels and the risk of contrast-induced nephropathy (CIN) using systematic review and meta-analysis methods.

Materials and Methods: Searches were conducted across several databases, including Web of Science, Cochrane Library, ProQuest, PubMed, Embase, and Google Scholar. Data was analyzed using STATA 14 software, and tests with $P<0.05$ were considered statistically significant.

Results: High TyG index levels in total population (odds ratio [OR]: 2.24, 95% CI: 1.85, 2.71), in China (OR: 2.16, 95% CI: 1.76, 2.66), Turkey (OR: 2.77, 95% CI: 1.66, 4.6), cohort studies (OR: 2.13, 95% CI: 1.64, 2.78), case-control studies (OR: 2.59, 95% CI: 1.92, 3.51), and cross-sectional studies (OR: 2.17, 95% CI: 1.21, 3.89) increased the risk of CIN. On the other hand, the relationship between high TyG index levels among women (OR: 1.22, 95% CI: 0.84, 1.77) and CIN was insignificant. Furthermore, the association between high age (OR: 1.03, 95% CI: 1, 1.05), low-density lipoprotein (LDL) cholesterol (OR: 1.08, 95% CI: 1.03, 1.14), and eGFR (OR: 0.98, 95% CI: 0.96, 0.99) and the risk of CIN was statistically significant, but there was no significant relationship between blood hypertension (OR: 1.46, 95% CI: 0.95, 2.24), systolic blood pressure (SBP) (OR: 1.01, 95% CI: 0.99, 1.02), diastolic blood pressure (DBP) (OR: 1, 95% CI: 0.98, 1.03), diabetes mellitus (DM) (OR: 1.36, 95% CI: 0.58, 3.18), fasting blood glucose (FBG) (OR: 1.06, 95% CI: 0.97, 1.16), and hemoglobin (OR: 0.97, 95% CI: 0.94, 1.01) and the risk of CIN.

Conclusion: High TyG index levels, high age, and LDL cholesterol levels increased the risk of CIN, indicating that the TyG index can be a strong predictor for the occurrence of CIN.

Registration: This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (ID: CRD420250651085)and Research Registry (UIN: reviewregistry1951) websites.

Implication for health policy/practice/research/medical education:
High triglyceride-glucose index (TyG) index levels, high age, and low-density lipoprotein (LDL) cholesterol levels increase the risk of contrast-induced nephropathy (CIN). Accordingly, examination of the TyG index in those with high levels of TyG can help identify individuals exposed to CIN occurrence, and through preventive measures, the risk of CIN occurrence and consequences, in addition to the healthcare costs can be reduced.

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***Corresponding author**: Halime Aali, Email: Aalihalime@gmail.com

Meta-analysis

Introduction

Contrast-induced nephropathy (CIN), determined by the rapid reduction in kidney function following the administration of iodinated contrast media, is the most common complication following percutaneous coronary intervention (PCI) (1-4). Although PCI is the current primary treatment for patients with acute coronary syndrome, 15% to 35% of the patients suffer contrast-induced acute kidney injury (CI-AKI) after PCI (5). On the other hand, CI-AKI is the third primary cause of hospital-acquired acute renal failure after surgery and administration of nephrotoxic agents (6).

The CIN risk factors include chronic kidney disease, diabetes mellitus (DM), hypotension, anemia, congestive heart failure, high age, type of contrast media, and female gender (7). Furthermore, CIN is associated with long-term hospitalization, high mortality rates, increased healthcare costs, and higher cardiovascular incidents (8-12).

Recent studies suggested triglyceride-glucose index (TyG) as a cost-effect and simple indicator for insulin resistance (13). Higher TyG index levels can trigger inflammation, oxidative stress, and vascular dysfunction (14-16). On the other hand, insulin resistance is closely related to the prevalence of chronic kidney disease (17), DM, and metabolic complications (18,19). Accordingly, the present study aimed to investigate the association between high TyG index levels and the risk of CIN on a global scale using systematic review and meta-analysis methods.

Materials and Methods

Study design

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines were followed to prepare this study (20), and the protocol was registered with PROSPERO (International Prospective Register of Systematic Reviews) and Research Registry.

Search strategy

Databases Web of Science, Cochrane, ProQuest, PubMed, Embase, and Google Scholar were used to access sources published by February 3, 2025. Medical Subject Headings (MeSH) and their equivalents were used to conduct the searches, and keywords were combined using the operators 'AND, OR.' The research included a separate manual search. The search strategy in the database Web of Science was as follows: Triglyceride-glucose index OR TyG index (All Fields) AND Contrast-induced nephropathy OR Contrast-induced Acute Kidney Injury (All Fields)

PECO (Population, Exposure, Comparison, Outcomes)

Study population included observational studies on the relationship between TyG index and CIN. High TyG index was the exposure. The comparison group included healthy individuals, and the investigation on the association between TyG index and CIN was the primary outcome.

Inclusion criteria

Observational studies that examined the association among the TyG index and CIN.

Exclusion criteria

Non-observational studies, low-quality studies, duplicate studies, those without accessible full-texts, studies without the required data for analysis, and abstracts published in conferences.

Quality assessment

Two researchers examined the quality of the studies using the Newcastle-Ottawa Scale. In this method, each question received a maximum of one star (except for the comparison question, which could receive two stars). Accordingly, the scores ranged between 0 and 10, indicating the minimum and maximum quality, respectively. Studies that achieve scores higher than six entered the current meta-analysis (21).

Data extraction

Two researchers extracted information including the author's name, age, association amid TyG index and CIN, country of origin, year, number of samples, the association between hypertension, age, hemoglobin, DM, systolic blood pressure (SBP), diastolic blood pressure (DBP), fasting blood glucose (FBG), low-density lipoprotein (LDL) cholesterol, and eGFR (estimated glomerular filtration rate) and the risk of CIN, in addition to their 95% confidence interval.

Statistical analysis

Odds ratio (OR) logarithm was used to analyze the data, and studies were combined. The I^2 index was used to examine the heterogeneity between the studies. The present research used a random effects model. Data was analyzed using STATA 14 software, and tests with $P < 0.05$ were considered statistically significant.

Results

A total of 91 articles were found in the search stage, among which 41 were duplicates and were excluded. The abstracts were reviewed and 4 articles without accessible full-texts were removed. Among the remaining 46 studies, 27 lacked the required data for analysis, and were removed in addition to another 11 studies due to other exclusion criteria, and eight studies remained (Figure 1).

In Table 1, a total of 8 observational studies were reviewed, including 4 cohort studies, 3 case-control studies, and 1 cross-sectional study.

According to Figure 2, high TyG index levels increased the risk of CIN (OR: 2.24, 95% CI: 1.85, 2.71).

High TyG index levels increased the risk of CIN (Figure 3) in China (OR: 2.16, 95% CI: 1.76, 2.66) and Turkey (OR: 2.77, 95% CI: 1.66, 4.62). As shown by Figure 4, subgroup analysis demonstrated that a high TyG index was a risk

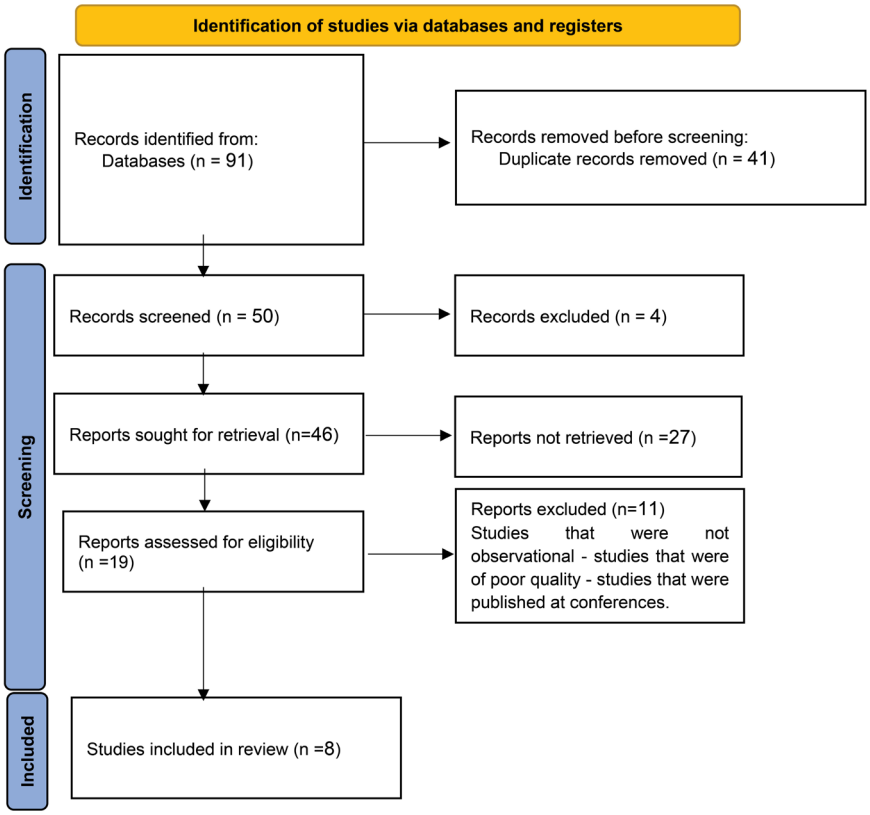

Figure 1. The PRISMA flow chart of study selection.

factor for CIN in the cohort (OR: 2.13, 95% CI: 1.64, 2.78), case-control (OR: 2.59, 95% CI: 1.92, 3.51), and cross-sectional (OR: 2.17, 95% CI: 1.21, 3.89) studies.

However, there was no statistically significant relationship between high TyG index levels and CIN among women (OR: 1.22, 95% CI: 0.84, 1.77) (Figure 5).

Table 2 demonstrated that the association between high age (OR: 1.03, 95% CI: 1, 1.05), LDL cholesterol (OR: 1.08, 95% CI: 1.03, 1.14), and eGFR (OR: 0.98, 95% CI: 0.96, 0.99) and the risk of CIN was statistically significant. On the other hand, the relationship between hypertension (OR: 1.46, 95% CI: 0.95, 2.24), SBP (OR: 1.01, 95% CI:

Table 1. Characteristics of studies

Author, year	Location	Design	Duration of study	Statistical population	Mean of TyG index	Index
Soner S, 2025 (22)	Turkey	Cross-sectional	between Feb 2010 and Apr 2012	PCI	≥8.65	OR
Zhiming ZH, 2024 (23)	China	Case-control	from Jan 2017 to May 2022	PCI	NR	OR
Zhu Y, 2023 (24)	China	Cohort	between Feb 2019 and Dec 2022	PCI	9.39	OR
Gursoy E, 2023 (25)	Turkey	Case-control	between Jan 2014 and Jan 2018	PCI	≥8.65	OR
Aktas H, 2023 (26)	Turkey	Cohort	between Mar 2022 and Aug 2022	underwent coronary angiology	NR	OR
Hu Y, 2022 (15)	China	Case-control	from Aug 2018 to Dec 2021	PCI	8.556-8.98 8.99-9.39 ≥9.40	OR
Li M, 2022 (27)	China	Cohort	from May 2017 to May 2019	drug-eluting stents	NR	OR
Qin Y, 2021 (28)	China	Cohort	between October 2017 and October 2019	underwent coronary angiology	8.62-9.03 9.04-9.44 >9.45	OR

NR; Not reported, OR; Odds ratio, PCI; Percutaneous coronary intervention.

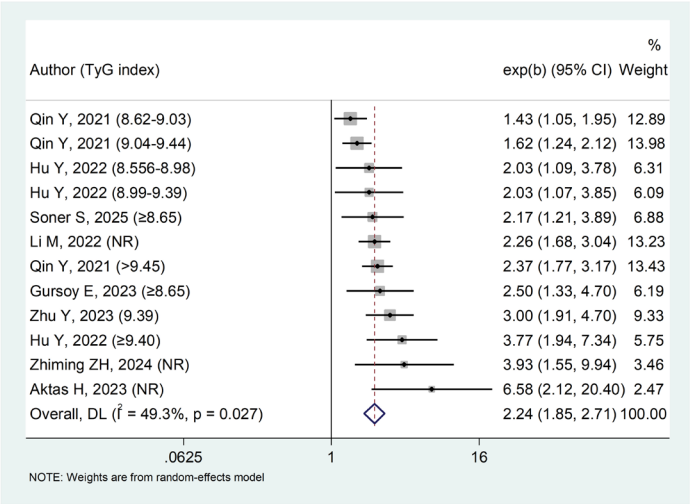

Figure 2. Forest plot showing the association between TyG index and CIN.

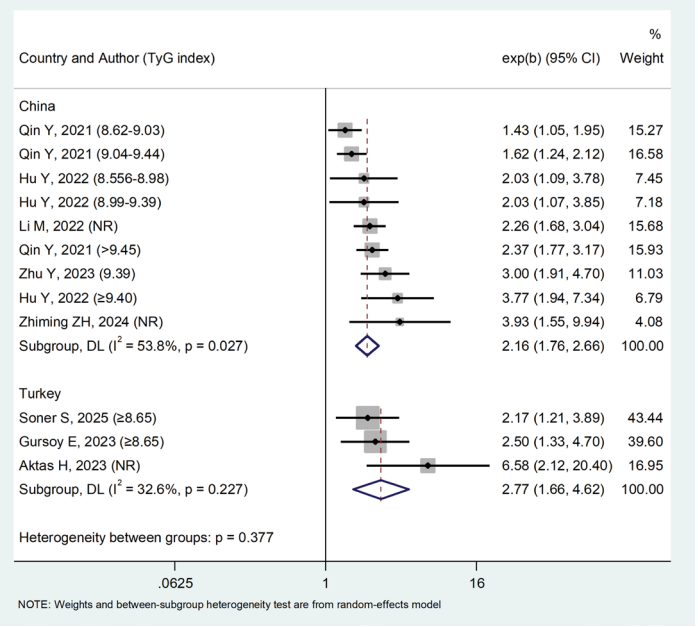

Figure 3. Forest plot showing the association between TyG index and CIN by location.

0.99, 1.02), DBP (OR: 1, 95% CI: 0.98, 1.03), DM (OR: 1.36, 95% CI: 0.58, 3.18), FBG (OR: 1.06, 95% CI: 0.97, 1.16), and hemoglobin (OR: 0.97, 95% CI: 0.94, 1.01) was statistically insignificant.

Discussion

The present study indicated that high TyG index levels, age, and LDL cholesterol levels increased the risk of CIN. Furthermore, the results of an umbrella review by Nayak et al revealed a significant connection between the TyG index and different healthcare outcomes. High TyG index levels were significantly associated with strengthened risk of CIN (OR: 2.24, 95% CI: 1.82, 2.77) and CKD (RR: 1.46, 95% CI: 1.32, 1.63) (29). Yin et al showed in their umbrella review that high TyG index levels strengthened the risk of CIN (RR: 2.25, 95% CI: 1.82, 2.77) (30). The results of the mentioned studies were consistent with our findings, indicating that a high TyG index is a predictor for CIN occurrence. The only difference was that our research was a meta-analysis, and the mentioned studies were umbrella reviews.

Soner et al examined patients under PCI in cross-sectional research and concluded that increased TyG index (OR: 2.17, 95% CI: 1.21, 3.89) enhanced the risk of CIN occurrence (22). According to a cohort study by Aktas et al on non-diabetic non-ST elevation myocardial infarction (NSTEMI) patients, high TyG index levels significantly increased the risk of CIN (OR: 6.58; 95% CI: 2.12, 20.40) (26). Case-control research by Gursoy et al revealed that high TyG index (OR: 2.5 CI: 1.3, 4.6) and

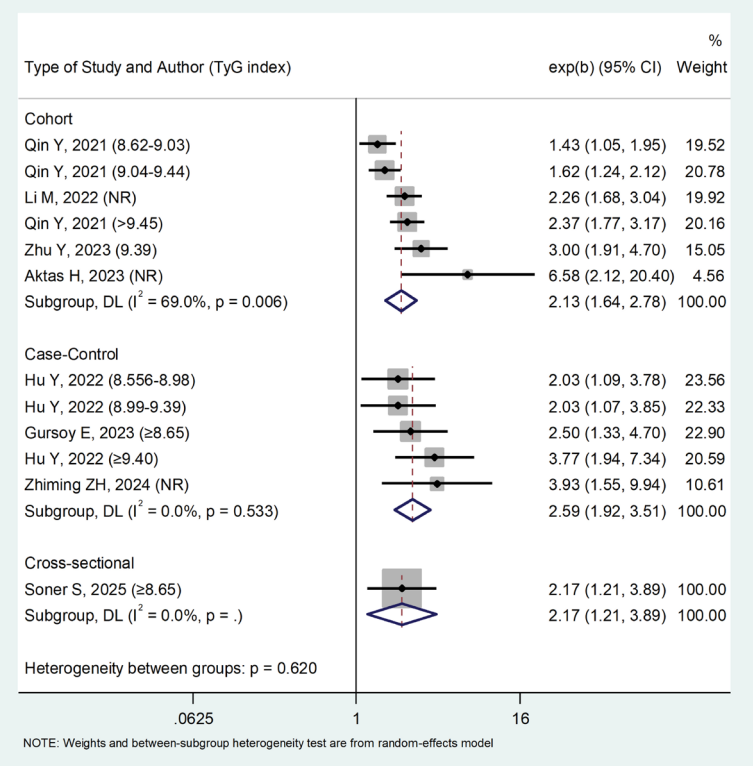

Figure 4. Forest plot showing the association between TyG index and CIN by design.

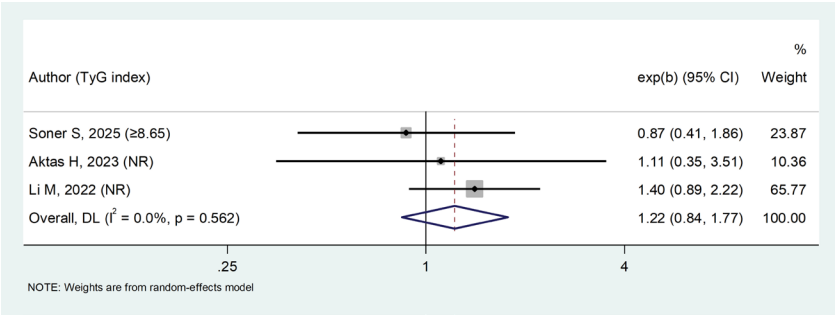

Figure 5. Forest plot showing the association between TyG index and CIN in females.

high age (OR: 1.0 CI: 1.0, 1.1) increased the risk of CIN in non-diabetic patients with NSTEMI (25). Findings of a cohort study by Li et al showed that high TyG index levels were associated with CIN occurrence (OR: 2.25, 95% CI: 1.67, 3.03) (27). In another cohort study by Qin et al on diabetic patients who underwent coronary angiography, results indicated that high TyG levels increased the risk of CI-AKI (OR: 2.37 95% CI: 1.88, 3.36) (28). Subgroup analysis in the current research showed that high TyG index levels in cohort, case-control, and cross-sectional studies were a serious risk factor for CIN incidence.

According to the findings of a meta-analysis by Chang et al on patients under PCI treatment, high TyG index levels were related to the enlarged risk of CIN (OR: 2.25, 95% CI: 1.82, 2.77) (31), which was consistent with our results. However, the current research is a more recent study with a larger sample size and a greater number of examined studies than the previous meta-analysis. Accordingly, the results of the current study have greater generalizability.

Results of a meta-analysis by Ren et al indicated a significant relationship between high TyG index levels and increased risk of CKD (RR: 1.47, 95% CI: 1.32, 1.63) (32), which along with the current study showed that a high TyG index is a risk factor for kidney diseases.

Study limitations: The groupings of TyG index levels in the reviewed studies did not provide us the opportunity to conduct a subgroup analysis based on the TyG index levels. Although the searches were not limited to a particular geographical location, the published studies were only originated from Turkey and China. The examined studies did not report the association between the TyG index and risk of CIN among men.

Table 2. The association between other variables and risk of contrast-induced nephropathy

Variables	OR	Low limit	Up limit	*P* value	I^2 (%)
Age	1.03	1	1.05	0.001	74.4
Hypertension	1.46	0.95	2.24	0.008	67.9
SBP	1.01	0.99	1.02	0.051	66.3
DBP	1	0.98	1.03	<0.001	89.3
DM	1.36	0.58	3.18	0.006	80.7
FBG	1.06	0.97	1.16	0.001	81.1
Hemoglobin	0.97	0.94	1.01	0.017	70.5
LDL cholesterol	1.08	1.03	1.14	<0.001	93.5
eGFR	0.98	0.96	0.99	<0.001	82.5

SBP; Systolic blood pressure, DBP; Diastolic blood pressure, eGFR; Estimated glomerular filtration rate, FBG; Fast blood glucose, OR; Odds ratio.

Conclusion

High TyG index levels, high age, and LDL cholesterol levels increase the risk of CIN. Accordingly, examination of TyG index in those with high levels of TyG can help identify individuals exposed to CIN occurrence, and through preventive measures, the risk of CIN occurrence and consequences, in addition to the healthcare costs can be reduced.

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Authors' contribution

Conceptualization: Maede Safari and Halime Aali.
Data curation: Maede Safari, Akbar Abbasi, and Batool Heydarisadegh.
Formal analysis: Akram Kadhim Kareem and Paniz Pourpashang.
Investigation: Halime Aali and Bahman Mokhtarinia.
Methodology: Akram Kadhim Kareem and Khorshid Rigi.
Project management: Halime Aali.
Supervision: Maede Safari.
Validation: Khorshid Rigi and Paniz Pourpashang.
Visualization: Akbar Abbasi and Elham Ahmadipour.
Writing–original draft: All authors.
Writing–review and editing: All authors.

Ethical issues

This investigation has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (International Prospective Register of Systematic Reviews) with (ID: CRD420250651085) and Research Registry website with (Unique Identifying Number (UIN) reviewregistry1957) websites. Besides, the authors have observed ethical issues (including plagiarism, data fabrication, and double publication).

Conflicts of interest

Authors declare that there are no competing interests.

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