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Triglyceride-glucose index: a surrogate marker of homeostasis model assessment of insulin resistance to predict diabetic nephropathy

Chander Khatri [1], Kiran Kumari [2], Fnu Reeha [3] , FNU Reea [4] , Ravi Raja [5] , Aroon Kumar[6]

[1] MBBS, MD, Chandka Medical College, Larkana, Sindh, Pakistan, Chanderkp1@gmail.com
[2] MBBS, MD, LUMHS, Jamshoro, Sindh, Pakistan, drkiranfulwani28@gmail.com

[3] MBBS, GMMC Sukkur, Sindh, Pakistan, pari37498@gmail.com

[4] MBBS, MD, Chandka medical College, Larkana, Sindh, Pakistan, doctor.reea@gmail.com

[5] General Practitioner, NMC Specialty Hospital, Alain, Abu Dhabi, UAE, drravifulwani@gmail.com (corresponding author)
[6] MBBS, Chandka Medical College, Larkana, Sindh, Pakistan, aroonkp37@gmail.com

ABSTRACT

Background: Diabetes mellitus (DM) is like a cluster of metabolic disorders characterized by high blood sugar levels, disruptions in carbohydrate, protein, and fat metabolism, progressive damage, dysfunction, and failure of various critical organs including the kidneys, eyes, nerves, heart, and blood vessels. Diabetes is expected to impact approximately 537 million people worldwide by 2021, with a global incidence of 10.5%. Because type 2 diabetes (T2DM) progresses slowly, patients should be evaluated for diabetic nephropathy (DN) at the time of diagnosis and every year thereafter.

Objective: To investigate the link between the TyG index and HOMA-IR in T2DM patients, as well as the TyG index and UACR in predicting diabetic nephropathy.

Study design: A cross-sectional study

Place and Duration This study was conducted in Chandka Medical College, Larkana, Sindh, Pakistan, February 2022 to February 2023.

Methodology: Participants had been diagnosed with T2DM within the last 1-5 years and had fasting plasma glucose (FPG) ≥ 126 mg/dl. Demographic and clinical information included age, gender, waist circumference (WC), diabetes duration, weight, height, body mass index (BMI), blood pressure (BP) were documented. After a 10-12 hour overnight fast, 5 cc of venous blood was drawn and stored at -20°C. . Fasting plasma glucose and insulin levels were assessed for the HOMA-IR test. A spot urine sample was taken to assess UACR, which was calculated by dividing the albumin content (mg) by the creatinine concentration

Results: There were a total of 250 individuals who were a part of this study as a participant. The males were 160 (64%) and females were 90 (36%). The average age calculated was 49.8 years. There were 117 (46.8%) overweight patients, 93 (37.2%) had normal weight and 40 (16%) were obese. The study found that the TyG index had a greater linear connection with atherogenic dyslipidemia, BMI, HbA1c, and IR than other indicators such as fasting triglycerides, HOMA-IR, and HDL-C.

Conclusion: The TyG index had a favorable link with HOMA-IR and surpassed it in predicting diabetic nephropathy in people with T2DM.

Keywords: T2DM, TyG index, HOMA-IR, diabetic nephropathy

INTRODUCTION

Diabetes mellitus is like a cluster of metabolic disorders characterized by high blood sugar levels, disruptions in carbohydrate, protein, and fat metabolism, progressive damage, dysfunction, and

failure of various critical organs including the kidneys, eyes, nerves, heart, and blood vessels [1, 2]. Diabetes is expected to impact approximately 537 million people worldwide by 2021, with a global incidence of 10.5% [3]. This amount is expected to rise to 643 million by 2030 [4]. According to the most recent data from the International Diabetes Federation (2022), the adult diabetes incidence in Pakistan has increased to 26.7% (around 33 million cases) [5].

The World Health Organization (WHO) reported almost 1.5 million diabetes-related fatalities in 2019, with Pakistan severely affected due to its high prevalence in low- and middle-income countries [6]. Genetics, sugary processed food consumption, and sedentary lifestyles are all major risk factors for becoming obese [7]. In Pakistan, 57.9% of the population is obese overall, with central obesity at 73.1% [8]. Diabetic nephropathy (DN) is the major cause of end-stage renal disease (ESRD) among diabetics, accounting for 40% globally [8]. In Pakistan, 31% of DN cases are associated with chronic renal impairment, as evidenced by albuminuria or a reduced glomerular filtration rate (GFR) [9].

Because type 2 diabetes (T2DM) progresses slowly, patients should be evaluated for diabetic nephropathy (DN) at the time of diagnosis and every year thereafter [10]. The glomerular filtration rate (eGFR) and urine albumin-to-creatinine ratio (UACR) are both estimated during screening. Microalbuminuria (30-300 mg/g) and macro-albuminuria (>300 mg/g) suggest renal problems, while a normal ACR is <30 mg/g [11]. Albuminuria indicates diabetic kidney disease, with insulin resistance causing hyper filtration and disease development. Early intervention can reverse microalbuminuria, which is associated with endothelial dysfunction [12].

Relevant data has been lacking in Pakistan. There is a need for innovative, accessible, inexpensive, and dependable markers to predict early-stage DN in the Pakistani population. The current study

was to examine the link between the TyG index and HOMA-IR in T2DM patients, as well as the link between the TyG index and UACR in terms of DN prediction.

METHODOLOGY

This study was approved by the Ethical review committee. The sample was acquired from Diabetic Clinic patients using a non-probability consecutive sampling technique. Participants had been diagnosed with T2DM within the last 1-5 years and had fasting plasma glucose (FPG) ≥ 126 mg/dl.

Exclusion criteria: Patients with type 1 diabetes (T1DM), pregnancy, smokers, chronic or systemic disorders, and those on dialysis were not a part of this research.

Data was acquired with full consent of the participants. Demographic and clinical information included age, gender, waist circumference (WC), diabetes duration, height, weight, body mass index (BMI), blood pressure (BP) were documented. After a 10-12 hour overnight fast, 5 cc of venous blood was drawn and stored at -20°C. Fasting plasma glucose (FPG) and insulin levels were assessed for the HOMA-IR test. A spot urine sample was taken to assess UACR, which was calculated by dividing the albumin content (mg) by the creatinine concentration. Participants were classified into four quartiles based on their TyG index scores:

- Q1=4.5-5
- Q2=5.1-5.5
- Q3=5.6-6
- Q4=>6

Data was analyzed with SPSS version 26. Pearson correlation investigated the correlations between the TyG index, UACR, HOMA-IR, anthropometric indices, eGFR, and biochemical markers.

RESULTS

There were a total of 250 individuals who were a part of this study as a participant. The males were 160 (64%) and females were 90 (36%). The average age calculated was 49.8 years. There were 117 (46.8%) overweight patients, 93 (37.2%) had normal weight and 40 (16%) were obese. Table number 1 shows the demographics of the participants of this study according to the TyG index quartiles.

Table No. 1: demographics of the participants of this study according to the TyG index quartiles.

Demographics	Q1	Q2	Q3	Q4
Age (years)	51.5	46.6	49.5	51.6
BMI	26.2	26.2	26.3	26.7
Systolic blood pressure (mmHg)	129.3	125.2	126.5	125.1
Duration of T2DM (years)	3.8	3.5	3.7	4.1
Waist circumference (inches)	30.9	30.7	30.0	30.8
Diastolic blood pressure (mmHg)	86.2	85.2	84.2	90.1

Table number 2 shows the biochemical parameters according to TyG index quartiles.

Table No. 2: biochemical parameters according to TyG index quartiles

Biochemical Parameters	Q1	Q2	Q3	Q4
TyG Index	4.92	5.33	5.43	6.10
Urinary creatinine (mg/dL)	90.1	89.5	94.2	90.6
Urinary albumin (mg/dL)	4.85	6.26	5.38	7.24
HDL-C (mg/dL)	43.20	37.17	36.72	33.12
HOMA-IR	1.44	1.85	1.82	2.34
UACR (mg/g)	58.09	73.10	56.40	78.10
Fasting plasma glucose (mg/dL)	156.40	215.20	255.20	373.50
Serum creatinine (mg/dL)	0.90	1.03	0.98	1.00
LDL-C (mg/dL)	125.5	135.5	140.3	177.3

Table number 3 shows the correlation of biochemical parameters with HOMA-IR, UACR, and TyG index.

Table No. 3: correlation of biochemical parameters with HOMA-IR, UACR, and TyG index.

Parameters	UACR	TyG Index	HOMA-IR
	r-value	r-value	r-value
TyG Index	0.28	1	0.32
Total Cholesterol	0.08	0.39	0.11
LDL-C (mg/dL)	0.16	0.55	0.34
HDL-C (mg/dL)	0.11	-0.35	-0.22
Glycated Haemoglobin	0.15	0.35	0.05
Fasting plasma glucose (mg/dL)	0.10	0.76	0.48

DISCUSSION

The current study investigated the connection between the TyG index and HOMA-IR in patients with type 2 diabetes (T2DM) [13]. It also identified the link between the TyG index and UACR in predicting diabetic nephropathy (DN). The TyG index has been extensively studied as a marker for diabetes, metabolic disorders, and cardiovascular diseases, but it is not as well-known as other measures for detecting insulin resistance [14, 15].

Lipid levels have been investigated as a critical element in calculating insulin action in order to assess insulin resistance (IR), which is defined by diminished tissue sensitivity to insulin and increases the risk of hyperglycemia, hypertension, and dyslipidemia. Overweight and obese people with higher triglyceride levels have more IR and lipoprotein metabolic abnormalities, such as

heightened levels of triglyceride-rich lipoprotein remnants, remnant-like particle cholesterol, and Apo lipoprotein B. Insulin sensitivity and triglyceride levels have a reciprocal relationship: lower insulin sensitivity is associated with greater triglyceride levels, and vice versa. Muscles with high triglyceride levels have been found to have poor glucose metabolism. This study found that fasting plasma glucose (FPG) and triglycerides were independently linked with diabetic nephropathy (DN).

A 2018 study conducted in Pakistan looked at the relationship between the TyG index, insulin resistance (IR), and diabetic nephropathy (DN) [16]. The study found that the TyG index had a greater linear connection with atherogenic dyslipidemia, BMI, HbA1c, and IR than other indicators such as fasting triglycerides, HOMA-IR, and HDL-C. The study indicated that the TyG index was a more reliable indicator of metabolic syndrome (MSm), although there was no evidence associating it to DN.

Previous studies have also found a link between diabetic nephropathy (DN) and HOMA-IR [17, 18, 19, 20]. The current investigation supports previous findings, demonstrating that DN patients frequently have increased HOMA-IR readings. The study discovered that the TyG index had a greater area under the curve (AUC) with a sensitivity of 67% and a specificity of 85%, indicating a stronger connection with DN than HOMA-IR, which had a sensitivity of 59% and a specificity of 65%. This implies that the TyG score is a more reliable predictor of albuminuria and type 2 DN than HOMA-IR.

CONCLUSION

The TyG index had a favorable link with HOMA-IR and surpassed it in predicting diabetic nephropathy (DN) in people with T2DM. It successfully diagnosed microalbuminuria and early-stage DN in these patients.

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Conflict in the interest

The authors had no conflict related to the interest in the execution of this study.

Permission

Prior to initiating the study, approval from the ethical committee was obtained to ensure adherence to ethical standards and guidelines.

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