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The Role of Triglyceride/Glucose Index in patients with Polycystic Ovary Syndrome

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ABSTRACT

OBJECTIVE: Our study aimed to examine the function of triglyceride/glucose (TyG) index, TyG-BMI, HOMA-IR, and conventional lipid ratios in determining IR in women with PCOS and to evaluate whether the TyG index is a clinical marker for IR.

STUDY DESIGN: A total of 171 individuals with PCOS and 93 control patients who were admitted to our gynecology clinic between January 2018 and January 2024 were evaluated in this case-control study retrospectively. BMI, FBG, QUICKI, HOMA-β, HOMA-IR, FSH, LH, TyG-BMI, TyG, LDL-C, HDL-C, TG, TC, and fasting insulin levels of all patients were retrieved from the hospital database and evaluated retrospectively.

RESULTS: The TyG index was significantly higher (8.35±0.44) in the PCOS group compared to the control group (8.23±0.36) (p=0.04). The PCOS group had a significantly higher TyG-BMI index (217.93±46.2) than the control group (199.16±42.4) (p=0.026). The PCOS group had a substantially higher TC/HDL-C ratio (4.52±1.36) than the control group (3.94±1.62) (p=0.016). The PCOS group had a significantly higher TG/HDL-C ratio (2.75±1.18) than the control group (2.15±1.12) (p=0.008).

CONCLUSION: According to our research, the TyG index and TyG-BMI demonstrated a strong predictive power in identifying impaired insulin sensitivity in female PCOS patients. The TyG index can serve as a potential surrogate marker for calculating IR in female PCOS patients, as TG and glucose tests are both commonly performed and cost-effective. Further large-scale prospective and epidemiological studies are needed to validate these findings.

Keywords: Insulin resistance; Polycystic ovary syndrome; Triglyceride/glucose index

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Introduction

The most prevalent endocrine and metabolic condition affecting females of reproductive age is polycystic ovarian syndrome (PCOS), which is also a major contributor to infertility (1,2). Ovulatory dysfunction, hyperandrogenism, and polycystic ovarian morphology (PCOM) on ultrasound imaging are characteristics of PCOS (3). Insulin resistance (IR) and hyperandrogenism (HA) are thought to be the main endocrine characteristics and etiologies of the condition (4). Metabolic syndrome (MetS) and PCOS have similar characteristics; regardless of body mass index (BMI), the majority of female PCOS patients (44-85%) have compensatory hyperinsulinemia and IR (5). IR and secondary hyperinsulinemia are considered to be the most crucial components in understanding

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the various PCOS phenotypic traits (6,7). Hepatic steatosis, type 2 diabetes, dyslipidemia, and MetS are among the comorbidities linked to PCOS (8). Assessing IR in female PCOS patients is crucial. On the other hand, opinions about the best way to assess IR are divided (9). The hyperinsulinemic-euglycemic clamp (HIEC), the gold standard for measuring insulin resistance, is currently only appropriate for scientific studies and is challenging to implement broadly in clinical practice because of its costly and time-consuming nature (10). Thus, surrogate indicators including the fasting glucose/insulin ratio (FG-IR), the quantitative insulin sensitivity check index, and the homeostasis model assessment for insulin resistance (HOMA-IR) have emerged to present estimation regarding IR (11). Clearance of triglyceride (TG) rich lipoproteins from plasma is delayed in IR states, resulting in hypertriglyceridemia. According to reports, there is a substantial correlation between Total cholesterol (TC)/high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and conventional lipid ratios of TG and IR (determined using HOMA-IR) in PCOS patients (12). Prior research indicated a strong correlation between IR and the triglyceride/high-density lipoprotein cholesterol (TG/HDL-C) ratio and the fasting triglyceride/glucose (TyG) index. Furthermore, some research has linked the TC/HDL-C ratio to the risk of IR and cardiovascular disease (13,14). When determining IR in non-diabetic people, TyG-BMI, which incorporates BMI, may be a straightforward and useful substitute (15). There are few studies examining the relationship between the TyG index and PCOS. Our study aimed to examine the function of the TyG index, TyG-BMI, HOMA-IR, and conventional lipid ratios in determining IR in women with PCOS and to evaluate whether the TyG index is a clinical marker for IR.

Material and Method

The present study had a retrospective observational case-control design. The investigation was designed in line with the Declaration of Helsinki Principles. The patients were asked to sign informed consent papers. This study began once our hospital's ethics committee gave its approval (Date: 27/11/2024, Number: 2024/354). The study included 171 patients who were admitted to our gynecology clinic between January 2018 and January 2024 and diagnosed as having PCOS and 93 control patients. All patients' PCOS were newly diagnosed, and no treatment had been given for PCOS. The 2003 Rotterdam criteria, which needed at least 2 of the following three factors-polycystic ovaries, clinical and/or biochemical evidence of hyperandrogenism, and oligo-ovulation and/or anovulation-were used to diagnose the patients. After ruling out alternative causes of hyperandrogenemia or ovulatory dysfunction, including Cushing syndrome, hyperprolactinemia, thyroid illness, androgen-secreting tumors, congenital adrenal hyperplasia, and 21-hydroxylase deficiency, PCOS was confirmed (16). Participants of the control group were required to have regular menstrual cycles and normal ovarian morphology on transvaginal ultrasound examination and not to have clinical signs of hyperandrogenemia, including seborrhea, alopecia, acne, or hirsutism.

The exclusion criteria were patients taking antilipidemic drugs, antihypertensive drugs, weight loss, and hormonal drugs, those with hypertension, endocrine disorders or cardiovascular disease, and pregnant females. BMI, LDL-C, HDL-C, TC, TG, TyG, TyG-BMI, luteinizing hormone (LH), follicle-stimulating hormone (FSH), HOMA-IR, homeostasis model assessment for β-cell function (HOMA-β), QUICKI, fasting blood glucose (FBG) and fasting insulin levels of all participants were retrospectively evaluated in the hospital database. HOMA-IR was determined as glucose value (mg/dL) ×insulin value (μU/mL)/405. HOMA-β was found as [20×fasting insulin (mIU/L)]/[fasting glucose (mmol/L)-3.5]. IR was defined as HOMA-IR value ≥ 2.5 (17). QUICKI was determined as 1/(log [insulin value (μU/mL)] +log [glucose value (mg/dL)]) (17). TyG index was determined using the following formula: fasting triglyceride [mg/dL] ×fasting glucose level [mg/dL]/2. TyG-BMI was calculated by the TyG index × BMI method. FG-IR was found with fasting glucose (mg/dL)/fasting insulin (μU/mL). TG/HDL-C was determined using TG (mg/dL)/HDL-C (mg/dL), and TC/ HDL-C indices were determined using TC (mg/dL)/ HDL-C (mg/dL) calculations.

Statistical analysis

The statistical program SPSS version 26.0 (IBM Inc., Chicago, IL, USA) was utilized for the statistical analysis. The Kolmogorov-Smirnov test was used to assess the distribution's normality. The mean±standard deviation was utilized to represent normal variables. All patient quantitative data is displayed as median (minimum-maximum). The Mann-Whitney U test or the student t-test was chosen to compare group differences. The Mann-Whitney U test was used for the assessment of parameters that were not regularly distributed. A 95% confidence interval (CI) was chosen for the result analysis. A p-value of less than 0.05 was deemed statistically significant.

Results

The BMI value was significantly higher in the PCOS group in comparison with the control group (p=0.039). The gravidity value was significantly lower in the PCOS group in comparison with the control group (p=0.022). The parity value was significantly lower in the PCOS group compared with the control group (p=0.026) (Table I).

The LH value was significantly higher (9.16±7.24 mIU/mL) in the PCOS group in comparison with the control group (5.72±1.96 mIU/mL) (p<0.001). The TC value was significantly higher (198.3±42.64 mg/dL) in the PCOS group in comparison with the control group (184.45±34.6 mg/dL) (p= 0.039). The TG value was significantly higher (121.44±61.36 mg/dL) in the PCOS group in comparison with the control

Table I: *Comparison of demographic and obstetric data according to the presence of PCOS*

	PCOS (n=171)	Control (n=93)	p
	median (min-max)		
Age (years)	31 (19 - 40)	31 (18 - 42)	0.48
BMI (kg/m^2)	26.1 (19.1 - 36.7)	24.2 (18.6 - 34.2)	0.039
Smoking, n (%)	18 (10.5%)	11 (11.8%)	0.31
Alcohol, n (%)	10 (5.8%)	6 (6.4%)	0.37
Gravidity	1.4 (1 - 3)	1.9 (1 - 4)	0.022
Parity	1.2 (1 - 3)	1.7 (1 - 4)	0.026

PCOS: Polycystic ovary syndrome, BMI: Body mass index

group (99.44±46.74) (p=0.034). The TC/HDL-C ratio was significantly higher (4.52±1.36) in the PCOS group in comparison with the control group (3.94±1.62) (p=0.016). The TG/HDL-C ratio was significantly higher (2.75±1.18) in the PCOS group in comparison with the control group (2.15±1.12) (p=0.008). The LDL-C value was significantly higher (129.22±24.4 mg/dL) in the PCOS group in comparison with the control group (117.72±21.72 mg/dL) (p=0.002). The LDL-C/HDL-C ratio was significantly higher (2.93±1.19) in the PCOS group in comparison with the control group (2.54±1.13) (p=0.012). The TyG index was significantly higher (8.35±0.44) in the PCOS group in comparison with the control group (8.23±0.36) (p=0.04). The TyG-BMI index was significantly higher (217.93±46.2) in the PCOS group in comparison with the control group (199.16±42.4) (p=0.026) (Table II).

The FBG value was significantly higher (92.2±14.16 mg/dL) in the PCOS group in comparison with the control group (90.1±12.64 mg/dL) (p=0.042). The fasting insulin value was significantly higher (11.1±8.64 mIU/L) in the PCOS group in comparison with the control group (8.35±6.74 mIU/L) (p<0.001). The FG-IR ratio was significantly lower (8.36±3.28) in the PCOS group in comparison with the control group (10.78±4.12) (p<0.001). The HOMA-IR value was significantly higher (2.52±1.12) in the PCOS group in comparison with the control group (1.85±1.02) (p<0.001). The QUICKI value was significantly lower (0.332±0.016) in the PCOS group in comparison with the control group (0.347±0.018) (p<0.001). The HOMA-β value was significantly higher (137.8±22.6) in the PCOS group in comparison with the control group (112.1±10.4) (p=0.022) (Table III).

Table II: *Comparison of lipid parameters according to the presence of PCOS*

	PCOS (n=171)	Control (n=93)	p
	mean ± SD		
FSH (mIU/mL)	6.68 ± 2.19	6.54 ± 2.06	0.58
LH (mIU/mL)	9.16 ± 7.24	5.72 ± 1.96	<0.001
TC (mg/dL)	198.3 ± 42.64	184.45 ± 34.6	0.039
TG (mg/dL)	121.44 ± 61.36	99.44 ± 46.74	0.034
TC/HDL-C	4.52 ± 1.36	3.94 ± 1.62	0.016
TG/HDL-C	2.75 ± 1.18	2.15 ± 1.12	0.008
HDL-C (mg/dL)	44.54 ± 16.8	46.84 ± 16.88	0.38
LDL-C (mg/dL)	129.22 ± 24.4	117.72 ± 21.72	0.002
LDL-C/HDL-C	2.93 ± 1.19	2.54 ± 1.13	0.012
TyG	8.35 ± 0.44	8.23 ± 0.36	0.04
TyG-BMI	217.93 ± 46.2	199.16 ± 42.4	0.026

PCOS: Polycystic ovary syndrome, FSH: Follicle stimulating hormone, LH: Luteinizing hormone, TC: Total cholesterol, TG: Triglyceride, HDL: High-density lipoprotein, LDL: Low-density lipoprotein, TyG: Triglyceride glucose, TyG-BMI: Triglyceride glucose-body mass index

Table III: *Comparison of glucose parameters according to the presence of PCOS*

	PCOS (n=171)	Control (n=93)	p
	mean ± SD		
FBG (mg/dL)	92.2 ± 14.16	90.1 ± 12.64	0.042
Fasting insulin (mIU/L)	11.1 ± 8.64	8.35 ± 6.74	<0.001
FG-IR	8.36 ± 3.28	10.78 ± 4.12	<0.001
HOMA-IR	2.52 ± 1.12	1.85 ± 1.02	<0.001
QUICKI	0.332 ± 0.016	0.347 ± 0.018	<0.001
HOMA-β	137.8 ± 22.6	112.1 ± 10.4	0.022

PCOS: Polycystic ovary syndrome, FBG: Fasting blood glucose, FG-IR: Fasting glucose-to-insulin ratio, HOMA-IR: Homeostatic model assessment, QUICKI: Quantitative insulin sensitivity check index, HOMA-β: β-cell function

Discussion

Despite the numerous investigations in the literature on PCOS, uncertainty about its pathophysiology remains. IR has a major part in the pathophysiology and complications of PCOS, causing hyperandrogenism and reproductive disorders due to compensatory hyperinsulinemia (18). IR may be a significant risk element for PCOS and is an important element in the management of disease (19). In our study, the traditional markers and new and potential biomarkers used to evaluate IR in females in the PCOS group were significantly higher compared to the control group. When participants having PCOS were compared with the control group, TC, TyG-BMI, TyG, LDL-C/HDL-C, LDL-C, TG/HDL-C, TC/HDL-C, TG, HOMA-β, HOMA-IR levels were higher, and FG-IR and QUICKI scores were lower.

When evaluating IR, the HIEC test is regarded as the gold standard. Nevertheless, the test has limited use in research settings and is considered a complex and time-consuming method (20). However, there are different approaches to IR assessment, using markers obtained from faster and less costly biochemical measurements (21). Indirect and direct techniques for IR assessment (HOMA-IR, FG-IR, and QUICKI) are generally complex methods and have the disadvantages of being expensive and unsuitable for epidemiological studies (18). Various IR biomarkers, including QUICKI, TGC/HDL, and HOMA-IR have been used with varying characteristics and sensitivities (22,23). IR is essential to the pathophysiology of MetS; however, it is not a key element in the diagnosis (24).

According to some research, the prevalence of dyslipidemia in individuals with PCOS has been revealed as 41.3-53.1% (25-27). The American Diabetes Association does not recommend screening the general public or high-risk groups for IR (28). Criteria have been developed to define MetS, a diagnostic phrase that encompasses conditions including dyslipidemia, fasting hyperglycemia, hypertension, and obesity that are closely linked to IR (29). There is an increasing demand for other methods to assess IR in females with PCOS.

In the current research, we evaluated the applicability of the TyG index and associated lipid parameters as a surrogate marker to determine insulin sensitivity/resistance in females having PCOS. According to studies in literature, serum lipoprotein ratios (TG/HDL-C, TC/HDL-C, and LDL-C/HDL-C) may be regarded as a straightforward and trustworthy indication in identifying IR and have a substantial positive link with IR in patients with type 2 diabetes (30). The HOMA-IR of PCOS patients was shown to be considerably higher than that of age-matched healthy females in the research by Xiang et al., indicating that IR is a key element in the pathophysiology of PCOS (18). TG/HDL-C, TC/HDL-C, and LDL-C/HDL-C levels in PCOS patients were considerably greater than in healthy females in the same age group, according to research by Xiang et al. (18). These values also showed a strong positive connection with HOMA-IR.

Few research has looked at the TyG index's predictive capacity for IR in females with PCOS, even though several studies in the literature have demonstrated the index's viability in predicting IR (31,32). According to the Yang et al. study, the TyG index, which highlighted the critical role of IR in the development of MetS in females having PCOS, may be a novel method of identifying metabolic problems early (33). In addition, in the study by Kheirollahi et al., when HOMA-IR was taken as a reference, it was revealed that the AUC levels of the TyG index were higher than those of lipid ratios like TG/HDL-C (34).

The literature has little information about the application of TyG and TyG-BMI markers for PCOS diagnosis (10). Current findings in the literature emphasize the potential benefit of biochemical parameters associated with serum TG levels, including TyG and TyG-BMI, in forecasting IR in females having PCOS (35). TyG-BMI and TyG indices, which are biomarkers associated with elevated serum TG, are associated with IR in many studies in the literature (36,37). Zheng et al. demonstrated that the TyG index was significantly associated with HOMA-IR and QUICKI in Chinese females with PCOS (32). Du et al.'s extensive cross-sectional study of Chinese individuals likewise revealed that the TyG index was the most effective indication for determining the risk of IR and that the TG/HDL-C ratio and the TyG index were both helpful indicators for predicting IR (38). In the study conducted by Yılmaz Ergani et al., it was revealed that a high TyG index detected in the first trimester can predict GDM and a high TG/HDL-C ratio in the first trimester can also predict GDM (39). In females with PCOS, Bilginer et al. discovered a significant positive connection between the TyG index and HOMA-IR (40). In our study, consistent with the literature, TyG, and TyG-BMI parameters were found to be significantly higher in participants having PCOS than in the control group.

This current research has some limitations. The retrospective design and small sample size of our research may have led to difficulties in obtaining the optimum sample size, which may affect the representativeness of the participants. The comparison of all hormonal and metabolic parameters, the presentation of comprehensive data on what the possible markers in PCOS screening may be and to what extent these markers can be decisive, and the provision of a broad perspective can be shown as the strengths of the study.

Conclusion

IR has an important role in the pathogenesis of PCOS. In addition, dyslipidemia is a common metabolic disorder among females with PCOS. Our study showed that the TyG index and TyG-BMI exhibited strong predictive ability in determining

abnormal insulin sensitivity in females with PCOS. These indexes are valuable indicators for estimating IR, partly because they are easily accessible analytically and financially in all clinical laboratories. The TyG index can be employed as a potential surrogate measure for calculating IR in female PCOS patients because blood TG and glucose tests are both frequently conducted and reasonably priced. To validate these findings, further extensive prospective and epidemiologic research is required.

Declarations

Ethics approval and consent to participate: The study received ethical approval from the hospital's Ethics Committee (Approval number: 2024/354, Approval date: 27/11/24). The informed consent of all patients was documented and signed before participants were included in the study. The study was conducted in compliance with the guidelines outlined in the Declaration of Helsinki.

Availability of data and materials: The data supporting this study is available through the corresponding author upon reasonable request.

Conflict of interest: The authors declare that they have no competing interests.

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Authors' contributions: UA, OY, and HAA: Raised the presented idea. SE, TBB, HAA, and UA: Designed the study. OY, ACO, and BE: Conducted the analysis. UA, OY, CA, HAA, and TBB: Developed the first draft of the manuscript. UA, TBB, OY, and CA: Participated in data collection and result interpretation. UA, SE, HAA, CA, and OY: Assisted with data collection and analysis. SE, FA, and UA: Critically revised the manuscript. All authors contributed to the writing of the article and read and approved the final version of the article.

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