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Correlation of Combined Lipid Indices and Triglyceride-Glucose Index as Predictor of Insulin Resistance among Male Police Officers in East Java, Indonesia: A Cross-Sectional Study

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ABSTRACT

Police officers represent a special group with high occupational stress and elevated cardiovascular risk factors. Triglyceride-Glucose Index (TyG) is a marker associated with the resistance of insulin which demonstrated better diagnostic accuracy compared to other indicators. However, there has been limited study investigating the associations combine lipid indices and cardiovascular risk factors related to TyG in a large population of male police officers. From January to June 2024, In East Java Regional Police headquarters, a health screening test was performed on a large population of male police officers. The survey included a total of 2927 male police officers. Laboratory and clinical parameters were measured. The values of combine lipid indices: LCI (Lipoprotein Combine Index), Atherogenic Index/AI (Ratio NonHDL to HDL), Castelli Risk Index I/CRI I (ratio Total cholesterol to HDL), Castelli Risk Index II/CRI II (ratio LDL to HDL), conventional risk factors, lipid profiles, and blood inflammatory parameters were analyzed with TyG using SPSS Software. All participants (100%) of male police officers demonstrated elevated level of TyG as predictor of insulin resistance. There were significant correlations between Castelli Risk Index II (CRI II), Lipoprotein Combined Index (LCI). age, triglyceride, Fasting Glucose, and LDL with TyG. This study found significant associations between various clinical and laboratory parameters, including several combine lipid indices to TyG. New parameters included in this study should be considered as predictors of insulin resistance. Those parameters may also relate to other cardiovascular diseases (CVD).

KEYWORDS: Triglyceride-Glucose Index, TyG, Combine Lipid Indices, Male Police Officer

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INTRODUCTION

Police officers is an occupational group which frequently exposed to high levels of mental and physical stress and substantially impacts their health. The unpredictable nature of police duties, which frequently entail working at odd hours, facing dangerous situations, and experiencing substantial mental strain, may lead to a heightened prevalence of heart disease risk factors within these groups [1]. Worldwide, cardiovascular diseases are a significant reason for sickness and mortality, and recognizing the unique risk characteristics of various job sectors is essential for successful prevention and treatment plans [2].

Police officers are prone to several conventional risk factors for cardiovascular disease, such as DM, dyslipidemia, obesity, and HTN. Lifestyle habits that are more prevalent in high-stress employment, such as smoking, drinking alcohol, eating poorly, and not exercising exacerbate these risk factors [3]. To lessen the burden of CVDs in this population, recognizing and controlling these risk factors is essential [4].

Recent studies have emphasized the importance of novel biomarkers in anticipating cardiovascular risk. Fasting triglyceride and glucose measurements are used to compute the TyG index, which has been validated as an accurate measure of insulin resistance, the principal mechanism implicated in the pathogenesis of atherosclerosis [5–8]. Furthermore, the TyG index is linked to increased risk of calcified coronary arteries and CVDs [9].

Despite the recognized importance of these biomarkers, there is a lack of research exploring their associations with traditional cardiovascular risk factors in specific occupational groups, such as police officers. To fill this gap, we aim to explore the association between established cardiovascular risk factors and novel markers, such as the TyG index in large sample of male East Javan police officers.

RESEARCH METHOD

Study Design

A cross-sectional observational study was conducted to assess the association between conventional and novel cardiovascular risk factors in male law enforcement personnel from East Java, Indonesia.

Setting

Between January and April 2024, data were collected from male police officers stationed at the East Java Regional Police Headquarters who participated in this study.

Participants

Initially, the total population of 8770 male police officers was considered, A total of 2927 officers was selected due to completed of all parameters. The study's inclusion criteria were willingness to participate and active-duty status. The Faculty of Medicine's Ethical Review Board at Universitas Airlangga, Indonesia, authorized this study in submission with the ethical principles outlined in the Declaration of Helsinki. All participants were given a thorough description of the study's goals, procedures, and the voluntary nature of their involvement before giving their informed consent. Every participant was made aware of their freedom to leave the examination at any time without incurring any implications.

Variables

Standardized clinical measurement procedures were followed throughout the study. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2), obtained using a calibrated digital scale and stadiometer. Waist circumference (WC) was measured at the midpoint between the lowest rib and the iliac crest; values greater than 102 cm were considered abnormal. Blood pressure was measured twice with an automatic sphygmomanometer after a five-minute rest, and the mean of the two readings was used. Uncontrolled hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg. Without considering treatment history, normal blood pressure included both non-hypertensive and controlled hypertensive individuals.

Data Sources/Measurement

Information was gathered via organized interviews, medical checkups, and scientific examinations. Trained medical personnel conducted the physical examinations and collected the blood samples. The interviews were designed to gather demographic information and personal health histories. Several clinical parameters were measured following standardized protocols to ensure accuracy and consistency. The participants' body mass index (BMI) was determined from their height and weight, obtained using a stadiometer and digital scale, respectively. Waist circumference (WC) was measured with a non-stretchable tape placed midway between the inferior border of the last palpable rib and the superior aspect of the iliac crest. A waist circumference of more than 102 cm is deemed abnormal. An automatic sphygmomanometer was used to take the participant's blood pressure after they had been sitting still for at least five minutes. Analysis was done using the means of the two readings of blood pressure that were obtained. Uncontrolled hypertension was defined in this study as possessing a blood pressure reading of 90 or higher at the diastolic and 140 or higher at the systolic. Since the participants past medical history was not taken into account, normal blood pressure was regarded as either controlled hypertension or non-hypertension.

Blood samples were collected the next morning after fasting for at least eight hours. Fasting blood glucose was measured using the hexokinase method, recognized as the gold standard for its accuracy and precision. Total platelet count, platelet-to-lymphocyte ratio (PLR), neutrophil-to-lymphocyte ratio (NLR), and lymphocyte-to-platelet ratio (LPR) were calculated accordingly. Lipid profiles, including total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides, were analyzed using enzymatic colorimetric assays. These analytical methods were selected for their reliability and consistency in clinical diagnostics.

The TyG (Triglyceride-Glucose) index was established by applying the formula:

TyG=ln(triglycerides[mg/dL] ×fasting glucose[mg/dL]/2)

Combined lipid indices were calculated in this study was AI, LCI, Castelli risk index-I (CRI-I), and Castelli risk index-II (CRI-II)

Atherogenic Index (AI), was expressed in mmol/L calculated using the formula:
AI = non-HDL-C / HDL-C

Lipoprotein Combined Index (LCI) was calculated using the formula:
(Total Cholesterol × Triglycerides × LDL-C) / HDL-C

Castelli risk index-I (CRI-I) was calculated using the formula:
Castelli Risk Index-I = Total Cholesterol / HDL-C

Castelli risk index-II (CRI-II) was calculated by the following formula:
Castelli Risk Index-II = LDL-C / HDL-C

Bias
To minimize selection bias, we included all eligible active-duty male police officers during the study period. Standardized protocols were used for physical examinations and laboratory procedures, and trained personnel conducted all measurements to reduce information bias. Moreover, the use of objective laboratory markers, such as fasting glucose, lipid profiles, and inflammatory indices, helped to ensure data reliability and mitigate reporting bias.

Study Size
The original group was made up of 8,770 men working as police officers at the East Java Regional Police Headquarters. Out of these, 2,927 officers were selected for the final study because they met all the necessary criteria in terms of clinical, anthropometric (BMI, WC), blood pressure, and laboratory parameters. No formal sample size calculation was conducted prior to the study, as the sampling relied on a census-like approach involving all eligible officers available during the study period (January to April 2024) who met the inclusion criteria and provided complete data. This approach ensured adequate power for subgroup analyses and improved the generalizability of the findings within the target population.

Quantitative Variables
Quantitative variables in this study included anthropometric measures (e.g., BMI, waist circumference), hemodynamic parameters (e.g., systolic and diastolic blood pressure), laboratory parameters (e.g., fasting glucose, total cholesterol, LDL, HDL, triglycerides, platelet counts), and calculated indices (e.g., TyG index, Atherogenic Index [AI], Lipoprotein Combined Index [LCI], Castelli Risk Index-I and II, as well as inflammatory ratios such as PLR, NLR, and LPR).
Normality testing for all continuous variables was performed using the Kolmogorov–Smirnov test. Variables following a normal distribution were summarized as mean ± standard deviation (SD), while categorical variables were presented in terms of frequency and percentage.
For descriptive and interpretative clarity, some continuous variables were also categorized based on established clinical thresholds. For instance:
a. Waist circumference >102 cm was classified as abnormal.
b. Blood pressure was categorized as uncontrolled hypertension if systolic ≥140 mmHg and/or diastolic ≥90 mmHg.
No arbitrary or data-driven cut-off points were used; all groupings followed international clinical guidelines to support relevance and comparability across studies.

Statistical Methods
Data management was performed in Microsoft Excel, and analyses were conducted using SPSS version 26.0. Descriptive statistics were used to summarize participant characteristics: categorical variables as frequencies and percentages, and continuous variables as mean ± SD. The Kolmogorov–Smirnov test assessed the normality of continuous data. Pearson's correlation coefficient was applied to assessed blood inflammatory parameters (total platelet, the ratio of lymphocyte-to-platelet, the ratio of platelet-to-lymphocyte, the ratio of neutrophil-to-lymphocyte, the combined lipid indices (AI, LCI, Castelli risk index-I and Castelli risk index-II), the TyG index, and traditional risk factors of cardiovascular (age, waist circumference, BMI, fasting glucose, LDL, HDL, and triglycerides). A significance criterion of $p<0.05$ was established.

RESULTS AND DISCUSSION
Participants
Initially, the total population of 8770 male police officers was considered, A total of 2927 officers was selected due to completed of all parameters. The study's inclusion criteria were willingness to participate and active-duty status.

Descriptive Data
There were 2927 participants of male police officers were obtained. The participants had the majority being between 36 and 65 years old (mean age 51.71 ± 10.97). Overweight or obese individuals made up nearly 65% of the participants. Among participants who had normal BMI, 85% had elevated LDL and 56% had high TG level. Half of the subjects had uncontrolled hypertension, 70% of them had normal fasting glucose level. More than 85% population had high LDL, nearly 57% participants have elevated Triglyceride level, and 60% had elevated total cholesterol. All the participants in this study had high TyG index with score 9.05 ± 0.65 which is suggestive to insulin resistance. Moreover, there were 60% people with TyG index more than 8.81 which is predictive to have

metabolic syndrome.

Outcome Data

Among the 2,927 male police officers included, all participants exhibited TyG index values above the standard threshold for insulin resistance, with a mean score of 9.05 ± 0.65, indicating a universally high prevalence of metabolic risk. Furthermore, 60% of participants had a TyG index exceeding 8.81, a threshold commonly associated with the presence of metabolic syndrome in previous literature. In addition to TyG-based outcomes, 65% of participants were classified as overweight or obese. Among those with normal BMI, 85% had elevated LDL and 56% had high triglyceride levels highlighting metabolic risk even in non-obese individuals. More than 85% of the total sample had elevated LDL cholesterol. A total of 57% of the subjects had high triglyceride levels, 60% had elevated total cholesterol. Moreover, 50% of participants had uncontrolled hypertension. Despite these risk factors, 70% of participants had normal fasting glucose levels.

Nonetheless, most patients had normal HDL and waist circumference. Table 1 displays the participants' overall characteristics. Likewise, Table 2 showed the mean of the composite lipid indices, other lipid parameters (non-HDL), and blood inflammatory biomarkers included in this investigation.

Table 1: Characteristics of Subjects and Correlation with TyG

Variable	Groups	n (%)	p value (correlated to TyG)
Sex	Men	2927 (100.00%)	N/A
Age (years)	26-35	217 (7.41%)	0.006
	36-45	767 (26.20%)	
	46-55	781 (26.70 %)	
	55-65	750 (25.62%)	
	>65	412 (14.07%)	
Waist Circumference	Normal	1886 (64.43%)	0.130
	Abnormal	1041 (35.57%)	
Blood Pressure	No/Controlled HT	1438 (49.12%)	0.348
	Uncontrolled HT	1489 (50.88%)	
BMI	Normal	1004 (34.30%)	0.773
	Overweight	995 (33.98%)	
	Obese	928 (31.72%)	
Triglycerides	<150	1272(43.46%)	0.000
	>=150	1655(56.54%)	
LDL	<100	460 (15.72%)	0.000
	>=100	2467 (84.28%)	
HDL	Normal (>=40)	2538 (86.70%)	0.051
	Low (<40)	389 (13.30%)	
Cholesterol Total	<200	1154 (39.43%)	0.51
	>=200	1773 (60.57%)	
Fasting Blood Glucose	<100	2011 (68.71%)	0.000
	>=100	916 (31.29%)	

Table 2: Correlation of Lipid Indices and Blood Inflammatory Markers with TyG

Variable	Mean +- SD	p value (correlated to TyG)
Non-HDL Cholesterol	177.44 ± 56.467	0.401
Total Platelets	256000 ± 68000	0.261
Platelet to Lymphocyte Ratio	7.94 ± 2.63	0.225
Lymphocyte to Platelet Ratio	0.14 ± 0.13	0.224
Neutrophil to Lymphocyte Ratio	1.90 ± 0.58	0.604
Total Cholesterol / HDL (CRI-I)	4.58 ± 1.19	0.524
LDL / HDL (CRI-II)	2.74 ± 0.80	0.000
non-HDL / HDL (AI)	3.77 ± 1.41	0.920
Lipoprotein Combine Index	92233.72 ± 9223.37	0.000

A significant correlation was identified between the TyG index and both LDL/HDL and the Lipoprotein Combine Index (LCI). In contrast, no significant relationships were found with total platelet count, neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-platelet ratio (LPR), or platelet-to-lymphocyte ratio (PLR).

Main Results

Analyses using Pearson's correlation coefficients were performed to examine associations between cardiovascular risk factors, composite lipid indices, and inflammatory biomarkers. All results were evaluated at a significance level of $p < 0.05$.

The TyG index (mean: 9.05 ± 0.65) showed a positive correlation with the LDL/HDL ratio and the Lipoprotein Combined Index (LCI), suggesting a consistent association between insulin resistance and atherogenic lipid profiles. However, there was no notable connection discovered between TyG and inflammatory markers like total platelet count, neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-platelet ratio (LPR), or platelet-to-lymphocyte ratio (PLR).

Although continuous variables were primarily analyzed in their original form to preserve statistical power, certain variables were also categorized using established clinical cutoffs:

a. Waist circumference >102 cm was classified as elevated.
b. Uncontrolled hypertension was defined as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg.
c. A TyG index >8.81 was considered predictive of metabolic syndrome, based on previous literature.

Confounder-adjusted analyses were not performed in this cross-sectional study, as the main aim was to explore associations rather than establish causality. Estimates of absolute risk or longitudinal outcomes were not provided, as this study employed a cross-sectional design and no follow-up data were available.

Other Analyses

Additional analyses were conducted to explore the relationships between composite lipid indices and blood inflammatory markers, stratified by traditional cardiovascular risk factors. Pearson's correlation tests were employed to examine these associations within subgroups, including participants with normal versus elevated BMI and those with TyG index above versus below the threshold of 8.81 (predictive of metabolic syndrome).

No formal interaction or subgroup analysis was pre-specified. However, exploratory comparisons indicated that the TyG index had a stronger correlation with LDL/HDL ratio and LCI in individuals with higher BMI and elevated fasting glucose.

These additional findings help strengthen the understanding of how composite lipid indices relate to metabolic risk.

Discussion

Key Results

The essential outcomes of this investigation are that in this population of male police officers: Combined lipid indices (LCI, and CRI-II) were correlated to TyG; Risk factors (older age, high levels of Triglycerides and LDL, high fasting blood glucose) significantly correlated to TyG; Other parameters (total platelets, ratio of lymphocyte-to-platelet, ratio of platelet-to-lymphocyte, ratio of neutrophil-to-lympocyte) were not correlated with TyG.

TyG, an index that consists of fasting glucose and TG, is a powerful predictor of resistance of insulin and used as a substitute screening method if the findings of other atherogenic parameters are considered normal, or there was limitation to measure other laboratory values with higher expenses [7,8,10]. The HOMA-IR index was employed as the standard test to evaluate the TyG index's diagnostic performance. The cutoff levels were reported in 5 (4.55–4.78), with sensitivity varied from 73% to 90% and specificity levels that varied from 45% to 99%. Low HDL and elevated TG levels are strongly associated with heart disease, according to multiple studies. Numerous functions of triglyceride-rich lipoproteins (TRL) in atherogenesis have been demonstrated [8,11].

The TyG index is a reliable and can be easy to be found metric for assessing Insulin Resistance (IR) in hazardous population, according to comprehensive clinical investigations. Diabetes mellitus (DM) and reduced glucose tolerance are both significantly influenced by insulin resistance (IR). Remarkably, several investigations have shown that the TyG index predicts the beginning of atherosclerosis and its negative effects more accurately than the HOMA-IR index [8,12]. Adverse outcome which included consequently is the higher incidence of carotid atherosclerosis and the progression of Coronary Artery Calcium (CAC) as measured by the CAC score. Lee et al. [13] conducted a follow-up study of 5,354 non-diabetic, middle-aged Koreans and found that individuals in the highest TyG quartile had over a fourfold greater risk of developing diabetes compared to those in the lowest quartile (RR = 4.095; 95% CI: 2.701–6.207), indicating the TyG index as a valuable marker of diabetes risk. This study also showed that, the predictive ability for IR evaluation, the TyG index performed higher to the HOMA-IR index. But the absence of useful comparisons for DM diagnosis restricted their findings about how well the TyG index predicts the existence of DM [13]. According to David et al. [14], the TyG index outperformed both triglyceride and fasting blood glucose levels in predicting diabetes mellitus among 4,820 individuals. These findings suggest that the TyG index may effectively identify individuals at elevated risk of diabetes, allowing for earlier intervention and preventive management [14].

In contrast to the direct measurement of blood insulin levels, which is lavish and inaccessible in most places in developing nations, prior research showed that the TyG index, a different test generated from fasting TG and FBG, is more generally available and less expensive. Additionally, exogenous insulin may affect the HOMA-IR index result because of the requirement for quantification. Therefore, diabetic patients receiving insulin treatment might not be able to use the current HOMA-IR index estimation of IR. The

TyG index may be broadly pertinent to all diabetes patients receiving insulin treatment because it is a formula made up of fasting TG and FG and does necessitate the measurement of insulin. In conclusion, TyG is thought to be a trustworthy and accessible IR index [12,15].

Nevertheless, several observations demonstrated debatable of noteworthy correlations between CVD and the TyG index in several circumstances. First, the use of the TyG index initially stemmed from the association between insulin resistance and elevated levels of triglycerides and glucose. As a result, conditions like diabetes and hyperlipidemia can influence how the TyG index is interpreted in people with cardiovascular disease. Proper management of hypertriglyceridemia and glucose metabolism disorders is necessary to ensure the effectiveness of the TyG index as a diagnostic tool. However, because a number of patients with excessively high TGs or FBG were included in earlier clinical investigations, the TyG index application in CVD patients was unable to examine reverse causality. For example, in their study, Laura and colleagues did not identify any link between the TyG index and cardiovascular disease in patients with diabetes or hypertension. They suggested that the results could be attributed to the fact that individuals with a background of high blood pressure or diabetes may have been undergoing treatment or making lifestyle improvements, suggesting that their analytical parameters were under control. Finally, many clinical trials lacked other crucial data, such as exercise, alcohol use, and a medical history in the family [16,17].

In a study included 22 nations on five continents, they discovered that the Cardiovascular mortality and acute CVD (such stroke and myocardial infarction) were significantly linked with the TyG index. The results of a large prospective cohort study demonstrate that resistance of insulin is a risk factor for cardiovascular and metabolic diseases and imply that people in middle- and low-income countries may be more vulnerable to this metabolic condition [12].

Uncontrolled hypertension and elevated TyG levels did not significantly correlate in this investigation. Prior research revealed a favourable link between insulin resistance and blood pressure. The renin-angiotensin-aldosterone system and the sympathetic nervous system, and renal salt excretion are all known to be impacted by the overproduction of insulin in reaction to insulin resistance, and the sympathetic nervous system. Hence, Elevated blood pressure may be a result of these harmful insulin resistance's outcomes on the blood vessels [18]. However, this study was not classified as subjects with previous history of hypertension and medication had been consumed, as it may interfere with the results.

However, several other studies demonstrated associations of TyG with hypertension only in particular subgroups. The risk of DM and HTN, as assessed by the basis of TyG index, was only significant in the fourth quintiles of the TyG index in all patients, according to a study that included 4434 male and female participants who were followed up for seven years. In particular, after controlling for confounding variables, it was more significant in females. Contrast to people with lower TyG index values, patients with higher TyG index levels who were older (≥65), obese (BMI≥28 kg/m²), or had normal eGFR (≥90 mL / (min·1.73 m²)) tend to have an elevated risk of DM and HTN, per the additional stratified analyses [19].

This study showed a substantial correlation between greater TyG levels and older age. Considering the findings of this particular research project, the incidence of diabetes was seven times higher in individuals between the ages of 55 and 64 than in people in the 25–34 age range. A meta-analysis conducted in Afghanistan revealed that compared to the 25–34 age group, the age-specific prevalence was more than twice as high in the 55 and older age group [20]. As stated by meta-analysis conducted by According to Akhtar et al., the risk of developing diabetes was more than ten times higher for those aged 60 and beyond than for those in their 20s and 29s [21]. The prevalence of diabetes is influenced by changes in the body that occur with age. Reduced secretory cap2024; 16:29creatic beta cell loss or dysfunction, and resistance of insulin in skeletal muscles caused by increases in obesity and sedentary lifestyles all contribute to a higher chance of developing diabetes [20].

Most of the subjects in this study were classified as overweight and obese. However, there was no significant correlation to TyG as predictor of insulin resistance. Obesity is common and strongly linked to several health hazards, including insulin resistance, metabolic diseases, and impaired glucose tolerance. Previous studies demonstrated the correlation between visceral obesity and TyG level [22]. Evidence indicates a pronounced sex specificity in regional adipose tissue distributions, with males exhibiting greater accumulation in the abdominal (visceral) region. Because visceral fat growth increased gluconeogenesis, which was strongly linked to insulin resistance, and decreased peripheral insulin sensitivity, it significantly impacted blood glucose control as compared to subcutaneous fat and general obesity [23,24]. Nonetheless, others obesity-related parameters (body fat percentage, fat-free mass, and waist-to-hip ratio) were not evaluated in this study and most of participants have normal waist circumference. Therefore, Although BMI can provide a health information, it is insufficient to capture the complexity of resistance of insulin. The distribution of body fat, muscle mass, the existence of metabolic syndrome, and individual differences are all important factors in predicting insulin resistance risk [25]. The TyG score is usable as an alternative to BMI, which is unable to assess fat distribution, to screen metabolic health in high-risk patients [26].

Our current study revealed significant correlations of trygliceride, LDL, and fasting blood glucose with TyG levels. Following population stratification, previous study revelaed TG and insulin resistance were found to be positively connected by multiple linear regression analysis. The investigation revealed markedly compromised early-phase and activity of islet beta cells in the late phase, elevated TG levels, and more severe resistance of insulin. Hence, dysglycemia may develop along with worsening insulin resistance and insulin secretion deficit as TG levels rise [27]. Changes in lipid profiles and elevated cholesterol production are linked to insulin resistance. People who have insulin resistance have greater levels of LDL cholesterol (LDL-C). Obesity, diabetes, and other metabolic syndrome characteristics are frequently associated with this dyslipidemia. A large study by Dannecker et al. states a strong positive correlation between C-peptide-based measures of insulin secretion and LDL cholesterol [28].

LDL to HDL Ratio and LCI have significant correlation to TyG while additional lipid indicators (ratios of total cholesterol to HDL and non-HDL to HDL) were not. This particular correlation may emphasize the importance of LDL level in correlation to TyG as the first two indices included LDL and the last two indices were not [29].

Several recent studies have demonstrated a significant relationship between composite lipid indices, such as the Atherogenic Index of Plasma (AIP), and insulin resistance-related metabolic disturbances. The AIP, derived from the logarithmic ratio of triglycerides to HDL cholesterol, has been shown to independently predict metabolic-associated fatty liver disease (MAFLD) in patients diagnosed with type 2 diabetes mellitus (T2DM). In a study by Samimi et al. (2022), AIP was significantly higher in T2DM patients with MAFLD than in those without, and each unit increase in AIP was associated with a fivefold increase in the odds of MAFLD, independent of other confounders. This supports the use of AIP as a practical and inexpensive marker that parallels the role of TyG index, especially in metabolic risk screening for individuals with T2DM [30].

Similarly, Zhang and Tan [31] highlighted the predictive value of TyG and several modified TyG-derived indices (such as TyG-BMI and TyG-WHtR) for cardiovascular disease (CVD) across various glycemic states. Their findings showed that TyG-WHtR, LAP, and VAI all had strong correlations with TyG and were significantly associated with increased risks of heart disease and stroke, particularly in non-diabetic populations. These indices, along with AIP, reflect the pathophysiological continuum involving dyslipidemia and insulin resistance that underlies both metabolic and cardiovascular diseases. Notably, although TyG alone had a lower predictive capacity in diabetic individuals, its modified versions performed better, emphasizing the value of integrated indices in risk stratification [31].

A large cohort study demonstrated non-HDL to HDL ratio has been substantially correlated with insulin resistance. This ratio represents the balance of cholesterol transport by reflecting the amounts of cholesterol in both atherosclerotic and anti-atherosclerotic lipoproteins. Hyperglycemia, which disrupts several metabolic pathways, can result from pancreatic cell dysfunction brought on by increased cholesterol transfer to peripheral cells. This stimulates the protein kinase C (PKC) pathway, lipid glycation, and the production of advanced glycation end products [22].

This study has several strengths. First, the participants are in particular population which is male police officer. Second, the study has a large sample size with population across East Java province and robust data. Nevertheless, there are certain restrictions: The study is cross-sectional, to start. Secondly, there was no exclusion whether the subjects consume antihypertension or cholesterol-lowering-drug. However, the significant variation in cutoff values and IR definitions among research limits its application. To create new treatments and preventative measures for IR-related diseases such as obesity and DM, which are quite common, it is essential to identify individuals with IR.

Future research will need to examine how the distributional differences between men and women affect the cutoff value for IR-related illness prediction. The earlier published TyG cutoff levels will offer trustworthy values for use in clinical settings and will be beneficial for evaluating illness development in the future if the gender distribution difference has no effect on the TyG index cutoff value.

Limitations

Although the study involved a large sample of male police officers from East Java, the findings may not be generalizable to the general population, especially to women or individuals in different occupational or socioeconomic groups. The study did not include subgroup or interaction analyses by relevant stratifies such as age, BMI categories, or comorbidity status, which could have revealed differential associations or effect modification.

Although there are some restrictions, the research offers valuable perspectives on how the TyG index and composite lipid indices are related in a high-risk working population. It emphasizes the possibility of using TyG as a useful screening method for insulin resistance and cardiometabolic risk.

Interpretation

This study investigated the association between the Triglyceride-Glucose (TyG) index and metabolic and inflammatory parameters in male police officers in East Java, Indonesia. The TyG index showed significant correlations with cardiovascular risk factors such as triglycerides, LDL cholesterol, fasting glucose, and age, but not with inflammatory markers or blood pressure. The results indicate that the TyG index could serve as a useful indicator for both insulin resistance and cardiometabolic risk, especially in environments with limited resources.

Consistent with prior studies, TyG appears to be a strong, cost-effective predictor of insulin resistance, potentially outperforming HOMA-IR. Its predictive value for diabetes, atherosclerosis, and metabolic syndrome has been validated in various populations. However, due to the cross-sectional design and possible use of medications, causal interpretations are limited, especially regarding blood pressure.

The homogeneity of the study population (all male police officers) may limit generalizability, and the lack of stratified analysis by BMI, age, or medication use restricts insights into effect modifiers. The absence of a TyG-blood pressure association contrasts with earlier findings, possibly due to unmeasured confounders or subgroup differences not assessed here. TyG correlated with lipid-based indices like the LDL/HDL ratio and LCI, emphasizing LDL’s role in insulin resistance. Meanwhile, BMI was not significantly linked to TyG, suggesting its limitations in reflecting visceral fat. Future research should consider TyG-derived indices such as TyG-

BMI or TyG-WHtR for improved risk prediction in broader populations.

Generalisability

This study, conducted among a large, uniform group of male police officers in East Java, offers insight into the relationship between the TyG index and metabolic parameters in high-risk, working-age men. However, the findings may not be generalizable to women, older adults, or those with different occupations or lifestyles. The study did not account for sex-specific factors such as hormonal differences and fat distribution, which may affect TyG's association with insulin resistance. Although most participants were overweight or obese, BMI was not significantly associated with TyG, limiting applicability to populations with different body compositions. Despite these limitations, the results align with international evidence supporting the TyG index as a predictor of metabolic syndrome, diabetes, and cardiovascular disease. The findings are particularly relevant in middle-income settings where insulin testing is less accessible. Future studies should include more diverse populations and stratified analyses by sex, age, BMI, and medication use. Incorporating modified TyG indices, like TyG-BMI or TyG-WHtR, may also improve predictive value and clinical relevance.

CONCLUSION

Police officers is a specific risk profile occupational group which frequently exposed to high levels of mental and physical stress and substantially impacts their health. This study demonstrated cardiovascular risk factors and four lipid indices and correlates to TyG. Additional lipid indicators, including the ratio of non-HDL to HDL and total cholesterol to HDL, did not significantly correlate with TyG, however LDL to HDL ratio and LCI did. However, the significant variation in cutoff values and IR definitions among research limits its application. To create new treatments and preventative measures for IR-related diseases like obesity and DM, which are quite common, it is essential to identify individuals with IR.

Existing knowledge on this topic indicates that insulin resistance is a common underlying mechanism occurring in various metabolic disorders, and this condition can emerge even in individuals with normal body mass index (BMI) and fasting glucose levels. The TyG index has been confirmed as an effective and straightforward alternative indicator for identifying insulin resistance. This study adds the important finding that there is a high prevalence of elevated TyG index values indicating insulin resistance in male police officers, despite their having normal BMI and fasting glucose levels. These results highlight the limitations of using conventional markers such as BMI and fasting glucose in assessing metabolic health. Furthermore, the findings of this research support the use of the TyG index as a cost-effective and easily accessible tool for early identification of cardiometabolic risk, particularly in worker groups with high stress levels.

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