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Research Article

Which Triglycerid-Glucose Indexs can be Applied in the Diagnosis of Insulin Resistance in Vietnamese Metabolic Syndrome Patients with or without Hypertension?

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Abstract

Objective: To evaluate the triglycerid-glucose indexs (TyG, TyG-BMI and TyG-WC) in measurement insulin resistance and the correlation between the triglycerid-glucose indexs with conventional HOMA-IR index in Vietnamese metabolic syndrome patients with or without hypertension.

Subjects and methods: A cross-sectional study of 69 patients with mean age $64,96 \pm 14,01$ with metabolic syndrome in Heart Center, Hue Central hospital and were diagnosed of MS according to NCEP-ATP III 2009 included in the study.

Results: The percentage of insulin resistance of metabolic syndrome patients was 44,9%. The mean value of the index TyG, Tyg-BMI and TyG-WC respectively were $4,56 \pm 0,52$, $102,21 \pm 18,59$ and $399,29 \pm 52,85$. There was no difference in TyG, TyG-BMI and TyG-WC among metabolic syndrome patient with and without hypertension ($p > 0,05$). There was the positive correlation between TyG index with HOMA-IR index in patient with metabolic syndrome ($r = 0,488$, $p < 0,001$), insulin resistance ($r = 0,482$, $p < 0,05$), non-insulin resistance ($r = 0,407$, $p < 0,05$). TyG-WC had the association with HOMA-IR in patient with metabolic syndrome ($r = 0,327$, $p < 0,05$), non-insulin resistance ($r = 0,482$, $p < 0,05$). TyG was significantly a independent prediction insulin resistance with OR = 3,362 (KTC95% 1,211 - 9,303). The TyG index was significantly different between insulin resistance and non-insulin resistance patient ($p < 0,05$).

Conclusion: The study showed that there was a difference in the TyG index between Vietnamese metabolic syndrome patients with and without insulin resistance. There was a moderate correlation between the TyG index and the HOMA-IR index. TyG is a independent predictor but it need the further studies to define whether TyG index can be used to evaluating the insulin resistance in metabolic syndrome.

Keywords: Arterial hypertension; Metabolic syndrome; Triglyceride-Glucose index, TyG-BMI and TyG-WC index

Introduction

Insulin resistance is a decrease in the sensitivity of insulin to muscle and adipose tissue, reducing the liver's ability to metabolize glucose [1]. Otherwise, Insulin resistance is considered a factor to increase the risk of developing type 2 diabetes and cardiovascular disease, increasing the mortality [2]. For that reason,

insulin resistance should be detected and diagnosed early before progressing to more serious illnesses later. Metabolic syndrome (MS) is a compound of important risk factors, among which the background was insulin resistance [3]. Insulin resistance is the cornerstone of increased risk in patients with MS. Based on the effects of triglycerid metabolism products and changes in fasting blood glucose that affect insulin sensitivity Triglycerid/Glucose Indexs (TryG index) has been shown by many studies to be strongly associated with the Homeostatic model assessment HOMA-IR

index in the diagnosis of insulin resistance [4,5]. Furthermore, this index has high sensitivity and specificity, which can be considered as an alternative to hyperglycemia clamp test [6,7,8]. Therefore, we conducted the study: " Triglycerid-Glucose Index in the diagnosis of insulin resistance in patients with metabolic syndrome with or without hypertension" with two objectives: 1) Evaluation of insulin resistance by Triglycerid - Glucose indexs (TyG, TyG-BMI, TyG-WC) in patients with metabolic syndrome. 2) Definition the correlation of these index (TyG, TyG-BMI, TyG-WC) with HOMA-IR index in patients with metabolic syndrome with or without hypertension.

Subjects and Methods

Inclusion Criteria

All patients ≥ 18 years of age, patients who admitted at the Heart center, Hue Central Hospital from June 2017 to June 2018 were eligible for diagnosis of MS according to NCEP-ATP III 2009 included in the study.

Exclusion Criteria

patients <18 years of age who are diagnosed with diabetes with blood glucose >10 mmol/L and disagree with the study.

Study Design

It was a cross-sectional description. All the patients were undergone the clinical examination, exploiting personal history such as Hypertension (HTN), diabetes, alcoholism, drug use. Metabolic syndrome was diagnosed when the patient has any of 5 criteria as follow: WC > 40 inches (M), >35 inches (F), fasting glucose ≥ 100 mg/dl or treated, TG ≥ 150 mg/dl or treated, HDL-C < 40 mg/dl (M), < 50 mg/dl (F) or treated, SBP > 130 mmHg or DBP > 85 mmHg or treated.

The clinical variables were age, gender, Waist Circumference (WC), hypertension, Body Mass Index (BMI) and the subclinical variables were fasting blood glucose, blood insulin, hs-CRP, lipid profile. The Triglycerid/Glucose indexs were calculated as follow: $TyG = Ln [TG (mg/dL) \times Go (mg/dL)/2]$, $TyG\text{-}BMI = TyG \times BMI$ and $TyG\text{-}WC = TyG \times WC$. [9,10,7]. The insulin resistance index was calculating by $HOMA\text{-}IR = Glucose \times Insulin/22,5$ [11,12]. The ratio of atherosclerosis was the TC/HDL-C, TC/HDL-C and LDL-C / HDL-C. the study protocol was in compliance with the Ethical Committee of Hue Central Hospital and University of Medicine and Pharmacy, Hue University. Written informed consents were signed from all participants included in the study.

Processing and Analyzing Data

Use SPSS 20 software to process data. Consider the correlation between standardized continuous variables by Pearson function and non-standard distribution by Spearman. Use the logistic regression equation to evaluate the insulin resistance prediction ability of TyG indexs. Concretly, we use a linear regression function to examine the correlation between factors and indices with HOMA-IR insulin resistance index, calculate R^2 coefficient and linear regression equation. This correlation will be analyzed in patients with insulin resistance, insulin resistance and general metabolic syndrome group. Logistic regression to calculate OR, Cl 95% and consider the ability to predict insulin resistance according to HOMA-IR index of TyG, TyG-BMI and TyG-WC.Our study included Hs-CRP inflammation, lipid bilan, atherosclerosis ratio and TyG index in correlation with HOMA-IR. Then compare the correlation of the factors and HOMA-IR index.

Results

General Characteristics of the Study Objects

There were 69 patients participating in the study who met the criteria for selection (Table 1).

		HTN (a) (n = 35)		Without HTN(b)(n = 34)		Total(n = 69)		p (a),(b)
		n	%	n	%	n	%	
Gender	Male	12	17,4	23	33,3	35	50,7	> 0,05
	Female	23	33,3	11	15,9	34	49,3	
Age group	≤ 60	8	22,9	14	41,2	22	31,9	> 0,05
	> 60	27	77,1	20	58,8	47	68,1	
BMI (kg/m²)	< 23	20	57,1	20	58,8	40	58,0	> 0,05
	≥ 23	15	42,9	14	41,2	29	42,0	

Waist circumference (cm)	Normal	9	13	5	7,2	14	20,3	> 0,05
	Abdomen obesity	26	37,7	29	42	55	79,7	
Age (years)	Total	68,51 ± 10,45		61,29 ± 16,28		64,96 ± 14,01		< 0,05
	Male	66,58 ± 14,42		59,26 ± 17,23		61,77 ± 16,49		> 0,05
	Female	69,52 ± 7,84		65,55 ± 13,86		68,24 ± 10,14		> 0,05
Waist circumference (cm)		86,43 ± 9,03		89,26 ± 7,17		87,83 ± 8,234		> 0,05
BMI (kg/m^2)		22,998 ± 4,44		22,015 ± 2,60		22,513 ± 3,66		> 0,05
SBP (mmHg)		135,14 ± 7,21		115,29 ± 12,37		125,36 ± 17,95		< 0,001
DBP (mmHg)		78,57 ± 9,44		69,41 ± 8,86		74,06 ± 10,19		< 0,001
Total Cholesterol (mmol/L)		5,19 ± 1,55		4,96 ± 1,64		5,07 ± 1,59		> 0,05
Tryglicerid (mmol/L)		2,47 ± 1,79		2,07 ± 0,82		2,27 ± 1,40		> 0,05
LDL-Cholesterol (mmol/L)		3,04 ± 1,15		3,07 ± 1,46		3,05 ± 1,30		> 0,05
HDL-Cholesterol (mmol/L)		1,15 ± 0,34		0,96 ± 0,19		1,06 ± 0,29		< 0,05
NonHDL-Cholesterol (mmol/L)		4,04 ± 1,46		3,99 ± 1,57		4,02 ± 1,50		> 0,05
Glucose (mmol/L)		6,47 ± 1,71		6,20 ± 1,34		6,34 ± 1,53		> 0,05
Insulin (μU/mL)		18,82 ± 16,18		8,78 ± 4,06		13,87 ± 12,82		< 0,05
hs-CRP (mg/L)		6,12 ± 9,19		3,92 ± 3,07		5,04 ± 6,93		> 0,05
HOMA-IR		5,33 ± 4,43		2,34 ± 1,14		3,86 ± 3,56		< 0,05

The proportion of men and women in the research group is nearly the same. The median age of the study group was 64.96 ± 14.01 years old. The highest was 88 years old and the youngest was 21 years old. People over 60 account for 68.1%. The proportion of overweight and obese patients with BMI ≥ 23 kg/m^2 accounted for 42% and the abdominal circumference accounted for 79.7%. Mean serum HDL-C and insulin were different between the two groups of patients with and without hypertension (p <0.05). Average HOMA-IR study group was 3.86 ± 3.56.

Table 1: General characteristics of the study subjects.

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	With HTN (a) (n = 35)		Without HTN(b) (n = 34)		Total (n = 69)		p (a),(b)
	n	%	n	%	n	%	
With Insulin resistance (HOMA-IR $\geq 2,6$)	20	57,1	11	32,4	31	44,9	< 0,05
Without Insulin resistance (HOMA-IR $< 2,6$)	15	42,9	23	67,6	38	55,1	

Table 2: Rate of insulin resistance in metabolic syndrome patients

The Insulin Resistance (IR) rate of the study patients was 44.9%. This ratio was significant difference between two groups of patients with and without hypertension ($p < 0.05$) (Table 3).

Clinical data	With IR (n = 31) (HOMA-IR $\geq 2,6$)	Without IR (n = 38) (HOMA-IR $< 2,6$)	p
Age (years)	$68,13 \pm 11,92$	$62,37 \pm 15,18$	> 0,05
Waist circumference (cm)	$87,84 \pm 8,47$	$87,82 \pm 8,15$	> 0,05
BMI (kg/m^2)	$22,847 \pm 4,267$	$22,24 \pm 3,12$	> 0,05
SBP (mmHg)	$128,71 \pm 20,61$	$122,63 \pm 15,19$	> 0,05
DBP (mmHg)	$75,48 \pm 10,595$	$72,89 \pm 9,84$	> 0,05
Total Cholesterol (mmol/L)	$5,259 \pm 1,71$	$4,926 \pm 1,486$	> 0,05
TriGlycerid (mmol/L)	$2,703 \pm 1,89$	$1,92 \pm 0,673$	< 0,05
LDL-Cholesterol (mmol/L)	$3,097 \pm 1,28$	$3,021 \pm 1,34$	> 0,05
HDL-Cholesterol (mmol/L)	$1,089 \pm 0,358$	$1,033 \pm 0,216$	> 0,05
NonHDL-Cholesterol (mmol/L)	$4,17 \pm 1,57$	$3,89 \pm 1,43$	> 0,05
Glucose (mmol/L)	$6,66 \pm 1,372$	$6,074 \pm 1,619$	> 0,05
Insulin (µU/mL)	$23,13 \pm 14,25$	$6,32 \pm 2,668$	< 0,001
hs-CRP (mg/L)	$5,92 \pm 9,13$	$4,32 \pm 4,42$	> 0,05
TC/HDL-C ratio	$5,06 \pm 1,677$	$4,875 \pm 1,52$	> 0,05
TG/HDL-C ratio	$2,76 \pm 2,16$	$1,92 \pm 0,726$	< 0,05
LDL-C/HDL-C ratio	$2,95 \pm 1,104$	$2,99 \pm 1,408$	> 0,05

Table 3: Clinical characteristics distributed by insulin resistance group.

There was a significant difference between mean TG, blood insulin and TG / HDL-C ratio between the two groups with and without insulin resistance ($p < 0.05$) (Table 4).

Indexes	With IR (n = 31)(a) (HOMA-IR ≥ 2,6)	Without IR (n = 38)(b) (HOMA-IR < 2,6)	Total (n = 69)	p(a),(b)
TyG	4,73 ± 0,6	4,42 ± 0,42	4,56 ± 0,52	< 0,05
TyG-BMI	107,43 ± 21,80	97,95 ± 14,44	102,21 ± 18,59	> 0,05
TyG-WC	413,41 ± 54,20	387,78 ± 49,48	399,29 ± 52,85	> 0,05

Table 4: Value of Triglycerid/ Glucose Indexs (TyG, TyG-BMI and TyG-WC).

The average TyG index of the study group was 4.56 ± 0.52 and there was the difference between the two groups with and without insulin resistance (p <0.05) (Table 5).

	Hypertension (n = 35)	Without HTN (n = 34)	p
TyG index			
HOMA-IR ≥ 2,6 (n = 31)	4,82 ± 0,66	4,56 ± 0,421	> 0,05
HOMA-IR < 2,6(n = 38)	4,31 ± 0,42	4,49 ± 0,41	> 0,05
TyG - BMI index			
HOMA-IR ≥ 2,6 (n = 31)	111,13 ± 24,62	100,71 ± 14,05	> 0,05
HOMA-IR < 2,6(n = 38)	97,23 ± 16,23	98,42 ± 13,51	> 0,05
TyG - WC index			
HOMA-IR ≥ 2,6 (n = 31)	415,12 ± 59,79	410,31 ± 44,78	> 0,05
HOMA-IR < 2,6(n = 38)	370,94 ± 50,28	398,75 ± 46,79	> 0,05

Table 5: Characteristics of TyG, TyG-BMI, TyG-WCindex according to hypertension (HTN).

There were no significant differences in the values of TyG, TyG-BMI and TyG-WC between patients with and without hypertension (Table 6).

	With IR (n = 31) (HOMA-IR ≥ 2,6)	Without IR (n = 36) (HOMA-IR < 2,6)	p
TyG Index			
Male (n = 35)	4,57 ± 0,596	4,48 ± 0,439	> 0,05
Female (n = 34)	4,872 ± 0,579	4,35 ± 0,39	< 0,05
TyG - BMI Index			
Male (n = 35)	104,94 ± 21,15	100,83 ± 13,50	> 0,05
Female (n = 34)	109,77 ± 22,82	94,76 ± 15,16	> 0,05
TyG - WC Index			
Male (n = 35)	411,04 ± 65,58	405,29 ± 41,53	> 0,05
Female (n = 34)	415,64 ± 43,02	368,32 ± 51,38	> 0,05

Table 6: Value of Triglycerid Glucose index (TyG, TyG, TyG-WC) by gender.

There was only a difference between TyG index in women between group with and without insulin resistance (p <0.05) (Table 7).

	With IR (n = 31) (HOMA-IR ≥ 2,6)	Without IR (n = 36) (HOMA-IR < 2,6)	p
TyG Index			
≤ 60 years old (n = 22)	4,84 ± 0,70	4,49 ± 0,48	> 0,05
> 60 years old (n = 47)	4,69 ± 0,57	4,37 ± 0,37	< 0,05

TyG - BMI index			
≤ 60 years old (n = 22)	96,53 ± 18,21	96,53 ± 18,21	> 0,05
> 60 years old (n = 47)	109,73 ± 23,53	98,88 ± 11,73	> 0,05
TyG - WC index			
≤ 60 years old (n = 22)	412,89 ± 50,06	389,86 ± 62,08	> 0,05
> 60 years old (n = 47)	413,56 ± 56,38	386,42 ± 40,75	> 0,05

Table 7: Value of Triglycerid Glucose Index (TyG, TyG, TyG-WC) index by age group.

There was a difference between TyG index in patients> 60 years old between group with and without insulin resistance ($p <0.05$). There was no statistically significant difference between TyG-BMI and TyG-WC between the group with and without insulin resistance (Table 8).

Patients\Index	MS with IR (n = 31) r (p)	MS without IR (n = 38) r (p)	MSr (p)
Hs-CRP	0,016 (> 0,05)	-0,082 (> 0,05)	-0,064 (> 0,05)
Lipid profile			
Cholesterol	0,36 (< 0,05)	-0,004 (> 0,05)	0,253 (< 0,05)
Triglycerid	0,272 (> 0,05)	0,327 (< 0,05)	0,254 (< 0,05)
HDL-C	0,231 (> 0,05)	-0,204 (> 0,05)	0,189 (> 0,05)
LDL-C	0,177 (> 0,05)	-0,071 (> 0,05)	0,096 (> 0,05)
Non-HDL-C	0,339 (> 0,05)	0,043 (> 0,05)	0,231 (> 0,05)
Atherosclerosis index			
TC/HDL-C	0,2 (> 0,05)	0,140 (> 0,05)	0,146 (> 0,05)
TG/HDL-C	0,147 (> 0,05)	0,406 (< 0,05)	0,209 (> 0,05)
LDL-C/HDL-C	0,03 (> 0,05)	0,019 (> 0,05)	-0,002 (> 0,05)
TyG Index			
TyG	0,482 (< 0,05)	0,407 (< 0,05)	0,488 (< 0,001)
TyG - BMI	0,136 (> 0,05)	0,231 (> 0,05)	0,222 (> 0,05)
TyG - WC	0,251 (> 0,05)	0,482 (< 0,05)	0,327 (< 0,05)

Table 8: Correlation between HOMA-IR index and other factors.

TyG index was positively correlated with HOMA-IR index in patients with metabolic syndrome, the group of patients with insulin resistance and without insulin resistance ($p <0.05$) (Figures 1-3).
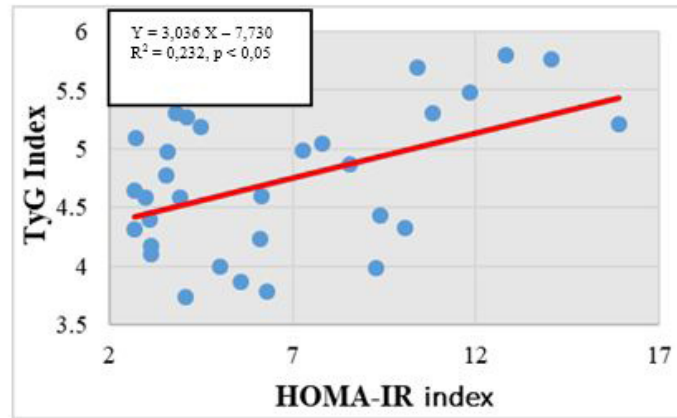
Figure 1: Spearman correlation between TyG index and HOMA index in group of metabolic syndromes with insulin resistence.
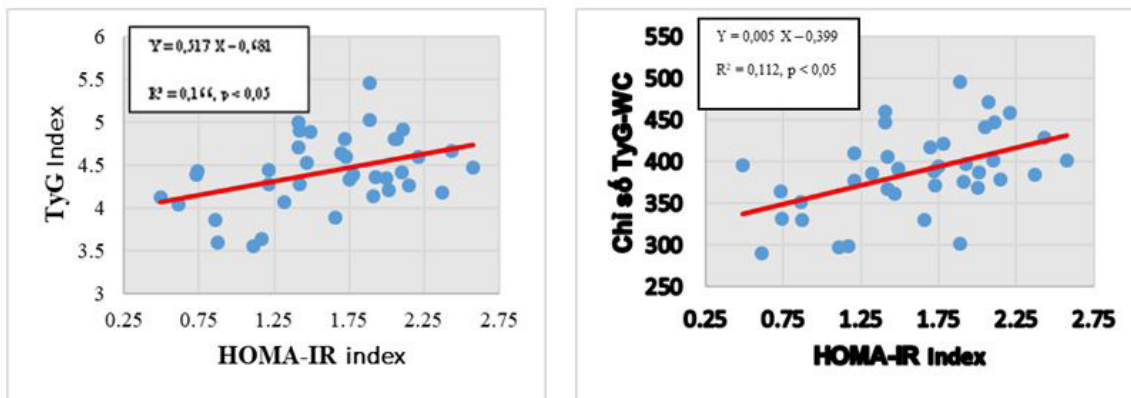

Figure 2: Spearman correlation of TyG, TyG-WC index with HOMA index in the group of metabolic syndrome without insulin resistance.
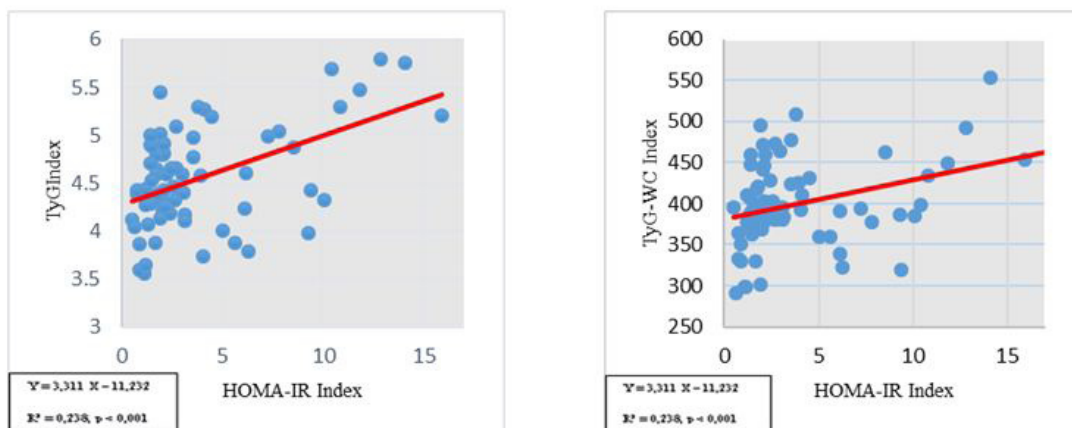

Figure 3: Spearmen correlation of TyG indicators with HOMA-Index in the group of Metabolic syndromes.

The TyG-WC index was positively correlated with the HOMA-IR index in the group of patients with MS and group of MS without insulin resistance (p <0.05) (Table 9).

	OR	Cl 95%	p
Hs-CRP	1,035	0,963 - 1,113	> 0,05
Lipid profile			
Cholesterol	1,144	0,844 - 1,551	> 0,05
Triglycerid	1,593	1,029 - 2,467	< 0,05
HDL-C	1,975	0,368 - 10,606	> 0,05
LDL-C	1,046	0,725 - 1,509	> 0,05
NonHDL-C	1,133	0,822 - 1,562	> 0,05
Atherosclerosis index			
TC/HDL-C	1,077	0,796 - 1,457	> 0,05
TG/HDL-C	1,483	1,010 - 2,179	< 0,05
LDL-C/HDL-C	0,969	0,665 - 1,413	> 0,05
TyG index			
TyG	3,362	1,211 - 9,303	< 0,05
TyG - BMI	1,031	1,001 - 1,061	< 0,05
TyG - WC	1,010	1,000 - 1,020	> 0,05
TyG and TyG-BMI indices had independent prognostic significance for insulin resistance in patients with metabolic syndrome (p <0.05).			

Table 9: Logistic regression between insulin resistance and indicators.

Discussion

Insulin Resistance and Characteristics of TyG, TyG-BMI and TyG-WC index in Patients with Metabolic Syndrome with or without Hypertension

HOMA-IR Index and Insulin Resistance Rate

Our study on 69 subjects' metabolic syndrome showed that HOMA-IR was 3.86 ± 3.56. This result is lower than that of Luis conducted on 241 subjects with 4.4 ± 1.6 [5]. The HOMA-IR index in the hypertension group was higher than the non-hypertensive group with the value of 5.33 ± 4.43 compared to 2.34 ± 1.14, this difference was significant and statistically significant with p <0.05. The average value of HOMA-IR in patients without insulin resistance was 1.604 ± 0.53, which is close to the results of Leay-Kiaw Er et al. $1.58 \pm (1.24-1.98)$ [6].

According to the recommendations of the World Health Organization and the European Insulin Resistance Research Group (EGIR): the highest quartile of HOMA-IR certificate group as the cutoff point, which is greater than this value, is considered as insulin resistance. So, we selected the reference value according to a reliable international study by Ascaso Juan F. in which the HOMA-IR ≥ 2.6 was considered as insulin resistance [11]. In our study, the rate of insulin resistance in the research group according to HOMA-IR was 44.9%, our study is slightly higher than that of our previous study [13], the same results as other study on Asian Americans despite lower BMI [14]. Otherwise, the proportion of hypertensive patients with insulin resistance is much higher than that of patients without hypertension, it was 57,1%, this difference is statistically significant with p<0.05. The reason can be justified because hyperinsulinemia with insulin resistance was a new risk factor for Vietnamese hypertensive patients [1,2,13].

Tyg, Tyg-BMI and Tyg-WC Index on Patients with Metabolic Syndrome

In 2014, a cross-sectional study directly to measure the amount of insulin resistance was concluded that the TyG index was most effectively assessed for early identification of insulin resistance. Along with, BMI and WC are two simple, inexpensive and non-invasive anthropometric parameters that are useful in diagnosing obesity as well as assessing metabolic risk [15]. TyG-

BMI, TyG-BMI and TyG-WC have been shown by many studies to be a scale for estimating and replacing HOMA-IR. These TyG indicators are more significant than the HOMA-IR index in the diagnosis of insulin resistance [6,16]. In our study, the TyG index was calculated based on fasting triglycerides and fasting blood glucose after an 8-hour fasted patient showed a result of 4,55 ± 0,52. Our results are close to that of Juan Salazar et al. Done in 2004, subjects ≥ 18 years old in Venezuelan in 2017 was 4.6 ± 0.3 [8]. A study in Mexico, analysis of multiple subjects showed TyG results was 3.7 ± (3.5 -3.9) in healthy subjects, 5.3 ± (4.9 - 5.6) in obese people, 5.5 ± (5.0 - 5.7) in pre-diabetes [9].

Differences in our study subject's selection and other studies affect TyG results but the difference is not significant. Comparing TyG index between men and women, there is no statistically significant difference. Although the value of TyG in our study in the both sexes is similar to that of Luis E. Simental-Mendía et al. it may be because the sample is not large enough to make a significant difference between men and women [5]. TyG index was distributed by age group in patients with and without hypertension and no statistically significant differences. For patients with and without hypertension, we compared the average value of the TyG index between patients with and without insulin resistance, and there was no significant difference between patients with or without insulin resistance and with or without hypertension (p> 0.05). The TyG index in our study was higher in the group with insulin resistance than the group without insulin resistance. In men and women, the group with insulin resistance in women is higher than in men, this difference is significant with p <0.05. When compared by age group, patients > 60 years with HOMA-IR ≥ 2.6 had a higher value of TyG than those of HOMA-IR < 2.6 and had a significant difference (p <0, 05), TyG values were 4.69 ± 0.58 and 4.37 ± 0.37 respectively. When compared to other studies such as B Kang (2017) done in adolescence, Leay-Klaw Er (2016) performed in patients without diabetes all gave the same conclusion when comparing between the two HOMA-IR group [6,10].

In our study, the value of TyG-BMI is 102,218 ± 18,618 and TyG-WC is 399,31 ± 52,91. There was no significant difference between the hypertensive group and the nonhypertensive group with p> 0.05, the difference between patients with or without insulin resistance was not significant when the patient had hypertension (p> 0, 05). In terms of gender between the two research groups with and without insulin resistance, TyG-BMI and TyG-WC were not significantly different. Comparing by age group, both research groups have low TyG-BMI and TyG-WC in ≤ 40. However, the differences by 3 age groups are not statistically significant. In general, the values of TyG-BMI and TyG-WC were higher in the insulin-resistant group (HOMA-IR ≥ 2.6). Perhaps the sample of our study is not large enough, so it could not make a statistically significant difference between the two groups with and without insulin resistance.

Correlation Between TyG, TyG-BMI and TyG-WC and HOMA-IR Index in Patients with Metabolic Syndrome with or without Hypertension

In patients with insulin resistance, blood cholesterol and TyG index were positively correlated with HOMA-IR. In particular, TyG index has the strongest correlation with HOMA-IR with r = 0.483, p <0.05, next is blood cholesterol concentration with r = 0.36, p <0.05.

For patients without insulin resistance, triglycerides and the TyG index remained correlated with HOMA-IR. In addition, TyG-WC was also correlated with r = 0.482, p <0.05, TG / HDL-C ratio was also correlated with r = 0.406, p <0.05. In patients with metabolic syndrome (with or without hypertension), TyG was significantly correlated with the largest HOMA-IR index (r = 0.488, p <0.001). This is a strong correlation between the TyG index and the insulin resistance index. Our results were similar to those of Fernando Guerrero-Romero and colleagues in 99 patients after considering the pearson correlation between TyG and HOMA-IR. But our study has a stronger correlation, Fernando giving R = 0.391 (p = 0.01) [9]. The 2008 Luis study also demonstrated a correlation between TyG and HOMA-IR with r = 0.32 [5]. In 2017, B Kang's work published the results of TyG index which is a very useful insulin resistance diagnostic marker with r = 0.41, p <0.001 [10].

Logistic regression of TyG indices and insulin resistance showed that TyG was able to predict independently of insulin resistance according to HOMA-IR's diagnostic threshold ≥ 2.6 with p <0.05, OR = 3,362 (Cl 95%: 1,211 - 9,303). With OR = 4.11 (Cl 95%: 2.51 - 14.80) and p <0.001 Leay-Klaw Er also have similar conclusions about the independent relationship between TyG and insulin resistance [6]. Regardless of the research group's correlation, the results show that the TyG index is positively correlated with the HOMA-IR index. Our results are consistent with many foreign studies of prestigious authors in Mexico, Korea and Italy [9,10].

For TyG-WC, our study also showed a correlation with HOMA-IR insulin resistance index in patients with metabolic syndrome with or without hypertension and patients with metabolic syndrome which has insulin resistance with r = 0.332 respectively, p <0.05 and r = 0.482, p <0.05. There is no agreement on the insulin diagnosis value of TyG-WC between the studies. Leay-Kiaw Er's study also found no strong association between TyG-WC and HOMA-IR insulin resistance index [7]. However, some authors have found the opposite result that TyG-WC is more diagnostic than TyG-BMI can be explained by the reason of the waist including subcutaneous fat and visceral adipose tissue. Visceral adipose tissue plays a major role in insulin resistance, the waist circumference cannot adequately represent visceral adipose tissue, so the ability to assess insulin resistance is insufficiently convincing [6].

Conclusion

The rate of insulin resistance in Vietnamese patients with metabolic syndrome is 44.9% and metabolic syndrome with hypertension was 57,1%. The average value of TyG, TyG-BMI and TyG-WC was respectively 4.56 ± 0.52, 102.21 ± 18.59 and 399.29 ± 52.85. The TyG index had a significant difference between the group of MS with and without insulin resistance. Only TyG index showed the strongest positive correlation with HOMA-IR index ($p <0.05$) and TyG index had an independent prognostic significance with OR = 3,362 (CI 95%: 1,211 - 9,303). This is our initial study, although the encouraging results and it need have the further studies to define whether TyG index can be used to evaluating the insulin resistance in metabolic syndrome.

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