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IMPACT OF TYG RELATED PARAMETERS (TYG INDEX, TYG-BMI, TYG-WC) AND ADIPOSITY INDICATORS (VAI, LAP, BAI) ON ADULT POPULATION

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ABSTRACT

Background: Since the measurement of fasting insulin is cumbersome with no standard assay available, an insulin-free equation for estimating insulin resistance was sought and developed. In 2010, the product of the fasting levels of triglycerides and glucose (TyG), the so-called triglycerides and glucose index (TyG index), was suggested as a useful surrogate measure for insulin resistance in healthy adults. **Objective:** To calculate TyG related parameters (TyG index, TyG-BMI, TyG-WC) and adiposity indicators (VAI, LAP, BAI) of study subjects. **Method:** Cross sectional analytical study. **Result:** Our study recommended TyG-WC, TyG-BMI and TyG index as better predictors of IR in adult individuals.

KEYWORDS: TyG index, TyG-BMI, TyG-WC, VAI, LAP, BAI.

INTRODUCTION

Insulin resistance (IR) is a clinical condition marked by a loss of peripheral tissue physiological response to insulin intervention, culminating in metabolic and hemodynamic disruptions known as metabolic syndrome. The main characteristics of this syndrome include dyslipidemia (high triglyceride and low HDL cholesterol levels), hypertension, sugar sensitivity or type 2 diabetes, hyperuricemia or gout, abdominalobesity, fibrinolytic process hypercoagulability and abnormalities, hyperandrogenism, fatty liver, and an increased incidence of heart disease.[1] The triglyceride-glucose index (TyG index), the sum of triglyceride and glucose fasting rates, was proposed as a quick and cost-effective IR indicator.[2] It has indeed associated with HOMA-I and the gold standard IR diagnostic process, recognized as hyperinsulinemic euglycemic clam.[3,4] TyG index has been tested in Iranian and Korean population with promising results.[4]

A cross-sectional analysis directly compared the lipid ratios, VAI, LAP, and TyG index to test their IR detection performance, and the TyG index was found to be the most active marker for early IR detection.[2] When evidence progressively shows that obesity is closely related to IR, a combination of obesity measures (BMI and WC) and TyG in the form of TyG-BMI & TyG-WC that better identify IR than other proxy markers.

Homeostasis template insulin resistance assessment (HOMA-IR), derived from the insulin and glucose fasting rate drug, is a reliable instrument used as an insulin resistance proxy test. Since the calculation of fasting insulin is tedious without standard testing, a sulin-free formula was found and established to estimate insulin resistance. Triglycerides and glucose (TyG), the so-called triglycerides and glucose level (TyG index), are proposed as a valuable proxy test of insulin resistance in healthy adults in 2010.

MATERIALS AND METHODS

Type of study: Cross sectional analytical study.
Place of study: Department of Biochemistry & Molecular Biology, BSMMU, Shahbagh, Dhaka, Bangladesh.
Period of study: March 2017-February 2018.
Study subjects: Apparently non-diabetic healthy adult (patient and attendant) who attends the outpatient department of BSMMU.

Grouping of study subjects:
• Group- A (No insulin resistance)
• Group- B (Insulin resistance)

Research instrument: For the purpose of the study, the data collection sheet will be planned, which will include all relevant variables.
Sampling method: Non-probability sampling
Sample size: 1250 (Twelve hundred fifty)

It will measure all main variables such as HOMA1-IR, TG / HDL ratio, TyG-related parameters (TyG chart, TyG-BMI, TyG-WC) & Adiposity indices (VAI, LAP, BAI). Calculation of all primary variables such as HOMA1-IR, TG / HDL, TyG-related parameters (TyG measure, TyG-BMI, TyG-WC) & Adiposity (VAI, LAP, BAI) markers.

Overnight fasting (at least 12 hours) of blood samples was obtained from study subjects to measure serum glucose, leptin, TG, and HDL-C. With all aseptic care, 5 ml of venous blood was extracted from the anti-cubital vein in a reusable syringe and instantly transferred to a dry clean test tube, which was kept in a standing position until the forming of a clot.

After centrifuging, serum was extracted for 5 minutes at 3000 rpm and deposited in eppendorf, properly labelled. At the Department of Biochemistry & Molecular Biology, BSMMU, Dhaka, the whole biochemical experiment was carried out.

RESULTS

It was a study of cross-sectional analysis. The outpatient department (OPD) of the Bangabandhu Sheik Mujib Medical University (BSMMU) has selected 1,250 adult individuals. Initially we recruited 1250 adults attending BSMMU OPD. From them (N=1250), we finally enrolled 1203 adults in our study because 47 individual insulin resistance was not calculated (HOMA calculator IR index can be calculated when the insulin level is between 2.9 -57.6 µU / mL and the glucose level is between 3 and 25 mmol / L).

All participants were adequately informed on the analysis and their anthropometric measures & blood pressure (BP) were registered after obtaining written consent. Fasting blood specimens were collected with complete aseptic security from each subject. Fasting serum glucose, insulin and lipid profile were assessed in the Biochemistry & Molecular Biology Department, BSMMU. Both variables such as HOMA1-IR, TG to HDL Ratio, VAI, LAP, BAI, TyG index and its associated parameters are determined to evaluate insulin resistance predictors in adults.

Table 1: Distribution of study subjects by IR chart (N=1203).

IR Index	Number of subjects	Percentage
Group A: < 2.5 (No insulin resistance)	539	44.80
Group B: ≥ 2.5 (Insulin resistance)	664	55.20
Total	1203	100.0

Group A: IR < 2.5 (No insulin resistance) 539(44.80%) and Group B: ≥ IR 2.5 (Insulin resistance) 664(55.20%) of the 1203 subjects tested.

Table 2: Gender correlation of two different groups (N=1203).

Age (years)	Group A (n=539) No. (%)	Group B (n=664) No. (%)	p value
20-25	70(13.00%)	49(7.40%)	
26-30	121(22.40%)	91(13.70%)	
31-35	84(15.60%)	124(18.70%)	
36-40	82(15.20%)	104(15.70%)	
41-45	51(9.50%)	75(11.30%)	
46-50	55(10.20%)	82(12.30%)	
51-55	44(8.20%)	67(10.10%)	
56-60	32(5.90%)	72(10.80%)	
Total	539(100.00%)	664(100.00%)	
Mean±SD	37.26±10.68	40.59±10.80	<0.001[s]

Group A: IR index < 2.5 (No insulin resistance)
Group B: IR index ≥ 2.5 (Insulin resistance)
The age range between Group A and Group B was shown. The mean age of Group B was significantly higher relative to Group A. Unpaired Student t-testing was conducted to equate two classes, the relevant P value < 0.001.

Table 3: Study patient sex distribution between two groups (N=1203).

Sex	Group A (n=539) No. (%)	Group B (n=664) No. (%)	p value
Male	312(57.90)	343(51.70)	0.031
Female	227(42.10)	321(48.30)	
Total	539(100.00)	664(100.00)	

Data were expressed frequency and percentage
Group A: IR index < 2.5 (No insulin resistance)
Group B: IR index ≥ 2.5 (Insulin resistance)
Table-3: Out of 1203 subjects 664 (55.20%) were found insulin resistance of them 51.70% male and 48.30% female, Chi-square test was done between group A and group B which is significant (P= 0.031).

Table 4: Zone under the ROC curves for different insulin resistance predictors in adults.

Test Result Variable(s)	AUC	Std. Error	P value	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
TG/HDL ratio	0.645	0.016	<0.001	0.614	0.677
TYG Index	0.745	0.014	<0.001	0.717	0.772
TYG BMI	0.753	0.014	<0.001	0.725	0.780
TyG- WC	0.763	0.014	<0.001	0.736	0.790
VAI	0.602	0.016	<0.001	0.570	0.634
LAP	0.625	0.016	<0.001	0.593	0.657
BAI	0.634	0.016	<0.001	0.602	0.665

TG/HDL Ratio= Triglyceride High density Lipoprotein ratio, TyG index=Triglyceride glucose index, TyG-BMI=Triglyceride glucose-BMI index, TyG-WC=Triglyceride glucose-waist circumference index, VAI=Visceral adiposity index, LAP=Lipid accumulation product, BAI=Body adiposity index.

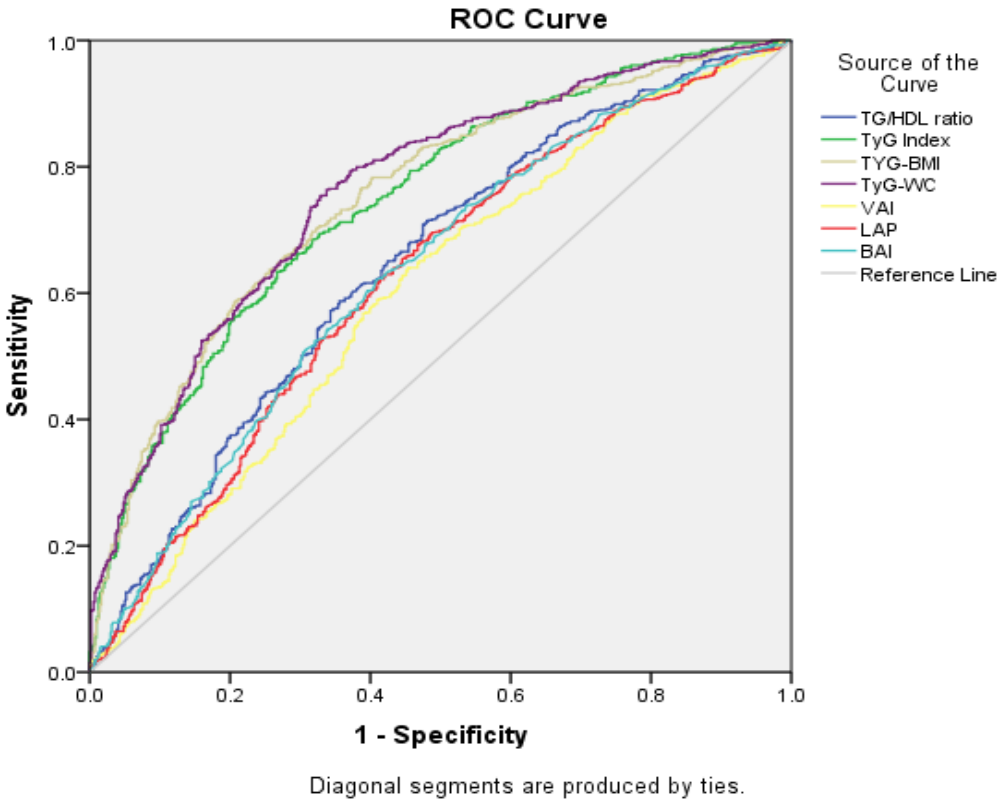

Figure 1: ROC Curves analysis on the basis of TG/HDL ratio, TyG index, TyG- BMI, TyG- WC, VAI, LAP, BAI.

Table 5: Area under the ROC curves (AUC) of different predictors of insulin resistance in adult individuals with optimal cutoff point (N=1203).

Predictors	Area Under Curves (AUC)	P Value	Optimal cutoff point (Determined by Youden Index)
TyG- WC	**0.763**	<0.001	805.98
TyG-BMI	**0.753**	<0.001	233.42
TyG Index	**0.745**	<0.001	8.83
TG/HDL ratio	0.645	<0.001	3.18
BAI	0.634	<0.001	32.72
LAP	0.625	<0.001	45.52
VAI	0.602	<0.001	123.43

Table 6: Performance of different predictors of insulin resistance in adult individuals according to optimal cutoff point determined by Youden index (N=1203).

Predictors	Sensitivity	Specificity	PPV	NPV
TG/HDL ratio	**71.4%**	51.9%%	64.67%	59.57%
TYG Index	68.52%	**68.27%**	**72.55%**	63.45%
TYG BMI	69.73%	**68.27%**	**72.91%**	64.61%
TyG- WC	**76.35%**	66.23%	**73.57%**	**68.77%**
VAI	63.86%	54.73%	63.47%	55.14%
LAP	67.62%	53.25%	64.05%	57.17%
BAI	62.05%	59.18%	65.19%	55.87%

DISCUSSION

The purpose of this cross-sectional empirical analysis was to establish surrogate markers for insulin resistance: check for clear and true markers in the adult population attending the outpatient department (OPD) of the Bangabandhu Sheikh Mujib Medical University (BSMMU).

To this purpose, we originally recruited 1250 adults attending BSMMU OPD. From them (N=1250), we eventually enrolled 1203 adults in our sample because there was no estimate of 47 person insulin resistance. In our study, the frequency of insulin resistance (IR) was found to be (55.20%) in all adult individuals (N=1203).[2] Conducted a cross sectional study on 7629 Chinese adults and found that the frequency of IR in 36.70%. Another cross sectional study was done by Er, et al. (2016) on 511 Taiwanese adults and found frequency of IR in adults 20.70%.

TyG index was recently recommended as a simple and inexpensive index to test IR, according to Guerrero-Romero et al. 2010[6] and Simental-Mendia et al. 2008.[7] TyG index has been recently recommended as a simple and inexpensive index to evaluate IR. Because of the variability of TG levels according to ethnicity, it is necessary to assess the utility of TyG in predicting IR in a Chinese population. Moreover their study extends previous studies by directly comparing the utility of TyG with visceral adiposity indicators and other lipid parameters in assessing IR risk. In this study TyG index was found 68.52% sensitivity and 68.27% specificity with cutoff value 8.83 and AUC 0.745 which is statistically significant. Our study support the study of Du et al. 2014.

In our study we found TyG- BMI 69.73% sensitivity and 68.27% specificity with cutoff value 233.42 and AUC 0.753. According to Er et al. 2016, TyG-BMI, Leptin and adiponectin ratio (LAR) had the largest AUC (0.801). The TyG-BMI AUC in detecting IR was significantly higher than that of TyG, TG/ HDL-C, and leptin (P = 0.004, 0.004 and < 0.001, respectively). Their data showed that TyG-BMI is a simple and clinically useful surrogate marker for IR in nondiabetic individuals. In addition, the ROC curve investigation affirmed that TyG-BMI is the most favorable surrogate marker of IR. Our result support with this study.

In our Study TyG-WC showed 76.40% sensitivity (highest) and 66.20% specificity with optimal cut off point 805.98 and AUC 0.763. Zheng, et al. (2016) conducted a cross sectional and prospective cohort study on first degree relatives (FDRs) of T2DM patients (635 men and 909 women). Logistic regression analysis and receiver operating characteristic (ROC) curve were used to compare and identify the associations of the six parameters (BMI, WC, VAI, TyG, TyG-BMI and TyG-WC) with the prevalence of prediabetes and diabetes. Subsequently, 452 of them were followed-up for an average of 5 years. Among the indices, TyG-WC was more strongly associated with the prevalence of prediabetes and diabetes. They proposed TyG-WC as a novel and clinically effective marker for early identifying the risks of prediabetes and diabetes in FDRs of T2DM patients. Our findings also support TyG-WC in this regard.

To find out the predictors associated with insulin resistance, bivariate logistic regression analysis was done in adult individuals. All predictors of IR found statistically significant though their unadjusted odds ratio

(OR) found close to 1.0 but exceptTyG index, it was 2.022 which is top of the list. Others like, TG/HDL ratio (1.171), BAI (1.085), TyG-BMI (1.024), TyG- WC (1.010) and VAI (1.002) were topping the list. These findings were nearly consistent to the findings of Er, et al. (2016). They conducted a cross sectional study on 511 Taiwanese adults and found all visceral adiposity indicators, TyG related parameters, adipokines to be strongly associated with IR (P<0.001). Of them, LAR & TyG-BMI were topping the list of OR. Du, et al. (2014) also found association of TyG index, VAI, LAP with insulin resistance.

We calculated optimal cutoff point (OCP) of different predictors for detection of IR in adult individuals on the basis of Youden Index. We found OCP for TG/HDL ratio – 3.18, TyG index─8.83, TyG-BMI─233.42, TyG-WC─805.98, LAP─45.52, BAI─37.72, VAI─123.43. Lee, et al. (2016) evaluated the OCP of TyG index─8.8 for identifying the development of diabetes in first degree relatives of T2DM which was in agreement with our study.

In this regard, our study showed high sensitivity with TyG- WC (76.35), TG/HDL ratio (71.40%), TyG-BMI (69.73%), TyG index (68.52%), LAP (67.62%), VAI (63.86%) and BAI (62.05%). All of them could be used as an alternative test for screening IR in adult individuals. Regarding the specificity and NPV; TyG-WC found to be on the top to be used as a diagnostic test for confirming IR in adult individuals. From the view point of sensitivity and PPV; TyG-WC and TyG-BMI found to be satisfactory predictors to be used both for screening and confirmation of IR. Er, et al. (2016) conducted a study on non-diabetic adult individuals and concluded that TyG- BMI is a simple powerful and clinically useful surrogate marker for identification of IR.

Finally our study recommended TyG-WC, TyG-BMI and TyG index as better predictors of IR in adult individuals.

CONCLUSION

Different predictors of IR, TG/HDL ratio, TyG Index, TyG- BMI, TyG- WC, VAI, BAI, LAP were calculated. Among the predictors AUC for TyG-WC is 0.763 which is highest then followed by TyG-BMI, TyG index, TG/HDL ratio, BAI, LAP and VAI were 0.753, 0.745, 0.645, 0.634, 0.625 and 0.602 respectively. Among them TyG-WC showed highest sensitivity 76.35%, followed by TG/HDL ratio, TyG- BMI, TyG index, LAP, VAI and BAI were 71.40%, 69.73%, 68.52%, 67.62%, 63.86% and 62.05% respectively. TyG-WC having higher NPV 68.77%. TyG- BMI and TyG index showed highest specificity 68.27% followed by TyG-WC 66.23%, BAI 59.18%, VAI 54.73%, LAP 53.25%, TG/HDL ratio 51.90%. TyG-BMI and TyG index having higher PPV 72.91% and 72.55% respectively. All results were expressed in tables and ROC curves and most of them found statistically significant. Therefore based on simplicity and low-cost, we recommend TyG related parameters are clinically useful predictors of IR in adult individuals of Bangladesh attending tertiary level hospital.

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