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Insulin Resistance Indices (Tyg Index And Tg/Hdl-C Ratio) In Different Obesity Phenotypes Of Non-Diabetic Adult Of Bsmmu

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ABSTRACT
Background: *Obesity is a global problem and it antedates the insulin resistance (IR). Traditionally HOMA-IR is usually used for prediction of insulin resistance. As HOMA-IR is an expensive method, most of the primary healthcare centers cannot afford this. Therefore, TyG index & TG/HDL-C ratio can be used as alternative method of HOMA-IR for detection of IR. Assessment of insulin resistance indices (TyG index & TG/HDL-C ratio) can help in prediction of severity of obesity induced health risks.*
Materials and Methods: *A cross sectional analytical study was conducted in the Department of Biochemistry and Molecular Biology, Bangabandhu Sheikh Mujib Medical University (BSMMU) with 512 samples. Fasting blood sample and another blood sample at 2 hours after 75gm glucose were collected. BMI was calculated. Obese individuals were classified into three phenotypes named as phenotype A (obese BMI, non-obese WC), phenotype B (non-obese BMI, obese WC) and phenotype C (obese BMI,obese WC). Then insulin resistance indices (IRI) were calculated and compared among different obesity phenotypes.*
Results: *All IRI were significantly higher in obese in obese individuals compared to non obese individuals. TyG index was significantly higher in phenotype C compared to A & B but A & B found to be identical with respect to TyG index. TG/HDL-C ratio was statistically identical between phenotype B and C but lowest in phenotype A.*
Conclusion: *Phenotype A found to show lowest risk of IR with respect to insulin resistance indices (TyG index and TG/HDL-C ratio). Between phenotype B & C, phenotype C found to show higher risk of IR with respect to TG/HDL-C ratio. Therefore, phenotype C seems to be at highest risk of IR and phenotype A seems to be at lowest risk of IR. IR in phenotype B appears to be in between phenotype A and C.*
Keywords: *Insulin resistance indices, obesity phenotypes, non-diabetic adult, Insulin resistance, Metabolic syndrome.*

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I. Introduction

Obesity is a global problem now a days. It is becoming a threat to the public health worldwide. The prevalence of obesity is now found to be more than double worldwide over last few decades.[1] Obesity is a complex disease consisting of an excess or abnormal distribution or both of fat containing adipose tissue which give rise to metabolic and endocrine alterations and changes in the immune system and ultimately results in increased morbidity and lower life expectancy.[2] Obesity is closely related to various metabolic diseases, like type 2 diabetes mellitus, hypertension, dyslipidaemia and certain forms of cancer; All of these conditions ultimately results in higher mortality and morbidity. Obesity antedates the insulin resistance (IR) which ultimately increases the risk of T2DM as well as various cardiovascular outcome.[3,4] IR is featured by normal or high insulin levels but insulin fails to generate a sufficient biological response. More than 80% cases of obese individuals develop insulin resistance at certain points in their lifetime.[5] The most used method for prediction of IR is homeostasis model assessment of insulin resistance (HOMA-IR). HOMA-IR is calculated from fasting insulin (U/mL) and fasting glucose (mmol/L).[6] HOMA-IR is expensive method and many primary health care centers may not afford this.[7] Triglyceride (TG) and HDL-C are routine test and less expensive compared to insulin. In individuals with insulin resistance, TG level usually increases and HDL-C level decreases.[8] The cut-off values for IR in the overall population is 2.4 for the TG/HDL-C ratio.[9] For this reason the TG/HDL-C ratio can be useful in identifying individuals at higher risk of insulin resistance. The triglyceride/glucose index (TyG index), a formula formed by fasting triglyceride (TG) and glucose, is used now-a-days as an alternative tool to

estimate IR in comparison with the HOMA-IR. The cut-off values for IR in the overall population is 8.8 for the TyG index.[9] The advantage of the use of the TyG index is to minimize the costs of screening, expanding its coverage. Body mass index (BMI) and waist circumference (WC) have been widely used to define obesity. According to WHO criteria for Asia-Pacific region (WHO, 2000) individuals with BMI ≥25.0kg/m2 are considered as generally obese and WC ≥90 cm (men) and ≥80cm (women) are considered as centrally obese. Recent studies show that BMI may vary in different obesity phenotypes.[10,11] Several researchers showed that WC, coupled with BMI, predicts health risk better than BMI alone.[12] Therefore it will be wise to classify different obesity phenotypes considering both BMI and WC. Obesity phenotypes may be classified as phenotype A (obese BMI, non-obese WC), phenotype B (non-obese BMI, obese WC) and phenotype C (obese BMI, obese WC).Individuals with different obesity phenotypes are at different metabolic risk. Metabolic consequences of obesity seem to be more dangerous among individuals with insulin resistance. Assessment of IR indices in different phenotypes of obesity is essential for assessment of health risk in different obese individuals. This study is to evaluate insulin resistance indices (TyG index and TG/HDL-C ratio index) for assessment of insulin resistance risk in different phenotypes of obesity.

II. Material and Methods

After getting approval from Institutional Review Board (IRB), BSMMU, A cross sectional analytical study was conducted in the Department of Biochemistry and Molecular Biology, BSMMU from March, 2022 to February, 2023 among 512 participants. Participants included for the study were nondiabetic, either sex (25-65 years) having BMI ≥18.5 kg/m^2. Individuals who had chronic diseases, cardiovascular diseases, malignancy, history of taking lipid lowering drugs, NSAID, steroids and pregnant women were excluded from the study groups. Subjects (non-obese and obese individuals) from the outpatient department of BSMMU, who match the inclusion and exclusion criteria were enrolled in the study by non-probability sampling technique. The participants were divided into non-obese (reference) and obese group on the basis of body mass index (BMI) and waist circumference (WC). Individuals with both non-obese BMI and non-obese WC were included into non-obese (reference) group. On the other hand, individuals with either obese BMI or obese WC or both were included into obese group. A written informed consent was taken from all who agreed to participate in the study. All relevant information were collected and recorded in a data collection sheet.

After giving proper instruction fasting blood sample and another blood sample at 2 hours after 75gm glucose were collected for estimation of fasting lipid profile, fasting plasma glucose, serum creatinine, SGPT and post load blood glucose. Serum creatinine, SGPT were done to exclude chronic diseases. BMI was calculated. Obese individuals were classified into three phenotypes which were determined as phenotype A (obese BMI, non-obese WC), phenotype B (non-obese BMI, obese WC) and phenotype C (obese BMI, obese WC) considering BMI ≥25.0 kg/m2 as obese and waist circumference (WC) ≥90 cm as obese in men and ≥80 cm as obese in women. Then insulin resistance indices (TyG index and TG/HDL-C ratio) were calculated. Finally insulin resistance indices were compared among different obesity phenotypes.

Data were cleaned, entered and analyzed by Statistical Package for the Social Sciences (SPSS) software version 26.0. Unpaired t test, Mann-Whitney U-test, one way ANOVA test, Kruskal-Wallis test were performed. According to data as needed to achieve level of significance. P-value ≤ 0.05 was considered statistically significant.

III. Results

Table 1: Distribution of subjects with respect to obesity

Total subjects	Non-obese group (reference group)	Obese Group			Total Obese
		Phenotype A	Phenotype B	Phenotype C	
512	149	49	92	222	363 (71%)

Table 2: Comparison of Triglyceride glucose (TyG) index between non-obese (reference) and obese group

Parameter	Non-obese (n= 149) [mean ± SD]	Obese (n = 363) [mean ± SD]	p-value
TyG	8.5 ± 0.4	9.1 ± 0.6	**0.035**

 # Unpaired t-test was applied

TyG index was significantly elevated in obese group , in comparison to non-obese (reference) group.

Table 3: Comparison of Triglyceride glucose (TyG) index between different obesity phenotypes

Parameter	Obesity Phenotypes (N = 363)			p- value
	A (n = 49) [mean ± SD]	B (n = 92) [mean ± SD]	C (n = 222) [mean ± SD]	
TyG	8.8 ± 0.4	8.9 ± 0.4	9.2 ± 0.6	**0.000**

#One-way ANOVA test was applied

TyG index was significantly elevated in phenotype C. Phenotype A and phenotype B found statistically identical with respect to TyG index.

Table 4: Comparison of TG/HDL-C ratio between non-obese (reference) and obese group

Parameter	Non-obese(n = 149) [Median (IQR)]	Obese (n = 363) [Median (IQR)]	p-value
TG/HDL-C	3.8 (2.3-5.8)	4.1 (2.9- 6.4)	**0.003**

 # Mann Whitney U test was applied

TG/HDL-C ratio was significantly elevated in obese group, in comparison to non-obese (reference) group.

Table 5: Comparison of TG/HDL-C ratio between different obesity phenotypes

Obesity phenotypes	Mean Rank	p-value
Phenotype A (n= 49)	124.0	**0.000**
Phenotype B (n= 92)	180.2	
Phenotype C (n= 222)	195.5	

#Kruskal-Wallis test was applied followed by Dunn-Bonferroni pairwise comparison test

TG/HDL-C ratio was significantly elevated in phenotype B and phenotype C, compared to phenotype A. Phenotype B and phenotype C found statistically identical with respect to TG/HDL-C ratio.

IV. Discussion

Body mass index (BMI) and waist circumference (WC) have been widely used to define obesity. In our study, we categorized different obesity phenotypes according to WHO (2000) criteria for Asia-Pacific region on the basis of BMI and WC. Individuals with different obesity phenotypes are at different metabolic risk. Certain phenotypes are at higher risk than other phenotypes because of variation in insulin sensitivity/ resistance. The main purpose of this study was to determine the status of insulin resistance indices (TyG and TG/HDL-C ratio) in different obesity phenotypes.

Among 512 total study subjects 363 (71%) were obese possessing an obese BMI or an obese WC or both together. This indicates a very high proportion of obese individuals among our study subjects. This might be due to enrollment of subjects from hospital outpatient department (not from general population) where people with obesity related medical problems frequently attend. In this study, the obese individuals (363) were further classified into three obesity phenotypes. Among them, obesity phenotype C (obese BMI and obese WC) showed the highest prevalence, followed by obesity phenotype B (non-obese BMI and obese WC). Obesity phenotype A (obese BMI and non-obese WC) showed the lowest frequency. So, we have got higher proportion of central obesity (obese WC) in comparison to general obesity (obese BMI). Excessive intake of high calorie food and sedentary life style may be responsible for the increasing prevalence of both general and central obesity altogether regardless of gender.[13]

Insulin resistance indices (TyG and TG/HDL-C ratio) found to be significantly higher in obese individuals compaired to non-obese. Obesity may lead to increased hepatic triacylglycerol production and decreased HDL cholesterol.[14] Visceral fat has higher lipolysis rates and increases the supply of non free fatty acids to the liver through the portal vein causing changes in glucose and lipid metabolism. On other hand, expansion of adipose tissue causes an increase in tissue hypoxia, infiltration of inflammatory cells and changes in the cytokine profile, which is also concerned to IR.[15] IR causes elevated triglyceride (TG) hydrolysis and free fatty acid release from adipose tissue. Elevated TG leads to increased exchange of cholesterolesters (CE) from HDL to VLDL and LDL in exchange of TG by cholesterylester-transfer-protein (CETP) which ultimately causes decreased HDL-C concentration. So, the elevated TG level and lower HDL-C level as well as altered glucose metabolism with hyperglycemia due to insulin resistance may raise TyG significantly in obese group compared to non-obese group. These results are also supported by Fritz et al. who suggested TyG index and

BMI showed a positive linear association.[8] The TG/HDL-C ratio may predict insulin resistance mediated organ damage.

Among all the obesity phenotypes in this study, subjects in phenotype C (obese BMI and obese WC) showed higher risk profile with respect to TyG index. TyG index was highest in phenotype C and lowest in phenotype A. TyG index was found to be statistically identical between phenotype A and phenotype B .Subcutaneous adipose tissue in contrast to visceral adipose tissue shows saturation of adipose tissue expansion. Beyond the saturation point, subcutaneous adipose tissue cannot expand anymore and spillover fat to be deposited in undesirable non adipose tissue ectopic sites (eg: liver, pancreas etc). This ectopic fat depots are associated with adverse metabolic profile and IR.[16] Individual of obesity phenotype A probably have ectopic fat depots because of which TyG index of phenotype A did not differ from that of obesity phenotype B. Individuals in phenotype B possess higher amount of visceral fat with little subcutaneous fat. Visceral fat increases lipolysis and efflux of FFA, increases hepatic gluconeogenesis and glycogenolysis and increases pancreatic insulin secretion resulting in hyperglycemia and hepatic TG production which increases TyG index in phenotype B. TyG index was found significantly more in phenotype C than phenotype B and A. TyG index was highest phenotype C in comparison to other phenotypes because of combined elevation of general and visceral adiposity.

Again, in this study, we observed TG/HDL-C ratio was significantly elevated in phenotype B and phenotype C, compared to phenotype A. Phenotype B and phenotype C found statistically identical with respect to TG/HDL-C ratio. Individuals of phenotype B contain high amount of visceral fat which indicates higher rate of lipolysis, increased FFA, increased hepatic production of TGs and VLDL as well as reduced clearance of serum triacylglycerol via peripheral lipolysis of triacylglycerol-rich lipoproteins.[17] This ultimately increases the probability of lipid exchange via the action of cholesterol ester transfer protein. The cholesterol ester transfer protein pathway decreases cholesterol esters in HDL with simultaneous elevation of cholesterol ester in triacylglycerol-rich lipoprotein remnants. As a result TG/HDL-C ratio increased with higher proportion of visceral adiposity. Tikkanen et al. proposed that high percentage of slow twitch muscle fibers is associated with high serum HDL-C.[18] Obese individuals with high BMI usually have high lean body mass and skeletal muscle mass. Therefore, this group of people might have high serum HDL-C. In obesity phenotype C, since the individuals are obese with respect to WC as well as BMI; these people are expected to have high lean body mass as well as muscle mass with high serum HDL-C. Probably this is the possible explanation of TG/HDL-C ratio to be identical between phenotype B and C.

V. Conclusion

Phenotype A found to show lowest risk of IR with respect to insulin resistance indices (TyG index and TG/HDL-C ratio). Between phenotype B & C, phenotype C found to show higher risk of IR with respect to TG/HDL-C ratio. Therefore, phenotype C seems to be at highest risk of IR and phenotype A seems to be at lowest risk of IR. IR in phenotype B appears to be in between phenotype A and C.

References

[1]. Gomez-Abarca L, Abdeen Za, Hamid Za, Abu-Rmeileh Nm, Acosta-Cazares B, Et Al., (2017) Worldwide Trends In Body-Mass Index, Underweight, Overweight, And Obesity From 1975 To 2016: A Pooled Analysis Of 2416 Population-Based Measurement Studies In 128 · 9 Million Children, Adolescents, And Adults. Lancet , 390: 2627–42.

[2]. Haslam D, James W. Obesity,(2005), Lancet,366(9492):1197–209.

[3]. World Health Organization. Obesity And Overweight—Fact Sheet, Https://Www.Who.Int/Mediacentre/Factsheets/Fs311/En/ (2017)

[4]. Després Jp, (2012), Body Fat Distribution And Risk Of Cardiovascular Disease: An Update. Circulation, 126(10):1301–1313. Doi:10.1161/ Circulationaha.111.067264

[5]. Viner R.M, Et Al., (2005), Prevalence Of The Insulin Resistance Syndrome In Obesity, Arch. Dis. Child. 90 (1) 10–14.

[6]. Matthews Dr, Hosker Jp, Rudenski As, Naylor Ba, Treacher Df, Turner Rc.(1985) Homeostasis Model Assessment: Insulin Resistance And Beta Cell Function From Fasting Plasma Glucose And Insulin Concentrations In Man. Diabetologia.; 28: 412–419. Https://Doi.Org/10.1007/Bf00280883 Pmid: 3899825

[7]. Wallace Tm, Levy Jc, Matthews Dr,(2004), Use And Abuse Of Homa Modeling. Diabetes Care;27:1487–95

[8]. Mclaughlin, T. Et Al., (2003), Use Of Metabolic Markers To Identify Overweight Individuals Who Are Insulin Resistant. Ann Intern Med. 139, 802–809.

[9]. Unger Gisela, Silvia Fabiana Benozzi , Fernando Perruzza , Graciela Laura Pennacchiotti (2014), Triglycerides And Glucose Index: A Useful Indicator Of Insulin Resistance; Endonu-621; No. Of Pages 8; Http://Dx.Doi.Org/10.1016/J.Endonu.2014.06.009

[10]. Meigs, J.B., Wilson, P.W., Fox, C.S. Et Al.,(2006), Body Mass Index, Metabolic Syndrome, And Risk Of Type 2 Diabetes Or Cardiovascular Disease. The Journal Of Clinical Endocrinology And Metabolism, 91, 2906–2912.

[11]. Karelis, A.D., St-Pierre, D.H., Conus, F. Et Al., (2004), Metabolic And Body Composition Factors In Subgroups Of Obesity: What Do We Know? The Journal Of Clinical Endocrinology And Metabolism, 89, 2569–2575

[12]. Ardern, C.I., Katzmarzyk, P.T., Janssen,I. And Ross,R, (2003), Discrimination Of Health Risk By Combined Body Mass Index And Waist Circumference. Obesity Research, 11(1), 135-142. Https://Doi.Org/10.1038/Oby.2003.22.

[13]. Zaman, M. M., Rahman, M. M., Rahman, M. R., Bhuiyan, M. R., Karim, M. N., And Chowdhury, M. A. (2016). Prevalence Of Risk Factors For Non-Communicable Diseases In Bangladesh: Results From Steps Survey 2010. Indian Journal Of Public Health, 60(1), 17–25. Https://Doi.Org/10.4103/0019-557x.177290

[14]. Kang B, Yang Y, Lee Ey, Yang Hk, Kim Hs, Et Al.(2017), Triglycerides/ Glucose Index Is A Useful Surrogate Marker Of Insulin Resistance Among Adolescents. Int J Obes ,41:789–92.
[15]. Brito, A. D. M., Hermsdorff, H. H. M., Filgueiras, M. S., Vieira-Ribeiro, S. A., Franceschini, S. D. C. C., And Novaes, J. F. (2021). Tag-Glucose (Tyg) Index In Childhood: An Estimate Of Cut-Off Points And The Relation To Cardiometabolic Risk In 4- To 9-Year-Old Children. Public Health Nutrition, 24(9), 2603–2610. Https://Doi.Org/10.1017/S1368980020000944
[16]. Gyllenhammer, L. E., Alderete, T. L., Toledo-Corral, C. M., Weigensberg, M., And Goran, M. I. (2016). Saturation Of Subcutaneous Adipose Tissue Expansion And Accumulation Of Ectopic Fat Associated With Metabolic Dysfunction During Late And Post-Pubertal Growth. International Journal Of Obesity (2005), 40(4), 601–606. Https://Doi.Org/10.1038/Ijo.2015.207
[17]. Grundy, S. M., Mok, H. Y., Zech, L., Steinberg, D., And Berman, M. (1979). Transport Of Very Low Density Lipoprotein Triglycerides In Varying Degrees Of Obesity And Hypertriglyceridemia. The Journal Of Clinical Investigation, 63(6), 1274–1283. Https://Doi.Org/10.1172/Jci109422
[18]. Tikkanen, H. O., Härkönen, M., Näveri, H., Hämäläinen, E., Elovainio, R., Sarna, S. Et Al., Aa (1991). Relationship Of Skeletal Muscle Fiber Type To Serum High Density Lipoprotein Cholesterol And Apolipoprotein A-I Levels. Atherosclerosis, 90(1), 49–57. Https://Doi.Org/10.1016/0021-9150(91)90243-V.