

Adiposity indicators lipid accumulation product and triglyceride–glucose index as alternate criteria for the diagnosis of metabolic obesity in adult

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Article Info

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Received: 4 May 2018

Accepted: 22 May 2018

Available Online: 28 May 2018

ISSN: 2224-7750 (Online)
2074-2908 (Print)

DOI: 10.3329/bsmmuj.v11i2.36629

Keywords: Adiposity; Glucose; Lipid; Metabolic obesity; Trygliceride

Cite this article:

Tabassum M, Rahman MM, Mozaffor M. Adiposity indicators lipid accumulation product and triglyceride-glucose index as alternate criteria for the diagnosis of metabolic obesity in adult. *Bangabandhu Sheikh Mujib Med Univ J*. 2018; 11: 118-121.

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A Journal of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

Abstract

Metabolic obesity refers to the state of having metabolic syndrome irrespective of one's body mass index. This study was aimed to elucidate the lipid accumulation product and triglyceride-glucose index as simple and alternate criteria for detecting metabolic obesity in adult. The study was conducted in 200 adult (age range: 19-45 years). According to lipid accumulation product and triglyceride-glucose index, the prevalence of metabolic obesity was 54.0% and 53.5% respectively. With a cutoff value of 45.5, the lipid accumulation product was found good to evaluate the metabolic obesity having area under receiver operating characteristic curve 0.9 ($p=0.000$), with sensitivity 90.9%, specificity 75.0%, positive predictive value 74.1%, and negative predictive value 91.3%. With a cutoff value of 8.7, the triglyceride-glucose index was found good to evaluate the metabolic obesity having area under receiver operating characteristic curve 0.9 ($p=0.000$), with sensitivity 95.5%, specificity 79.5%, positive predictive value 78.5%, and negative predictive value 95.7%. In conclusion, lipid accumulation product and triglyceride-glucose index are good as alternate criteria for diagnosing the metabolic obesity in adults.

Introduction

Obesity is a medical condition in which excess body fat has been accumulated to such an extent that it can cause a negative impact on health (World Health Organization, 2014).¹ The body mass index (BMI) is most commonly used to classify overweight and obesity. BMI is calculated by dividing a person's weight in kilogram with the square of his/her height in meter (kg/m^2).

Recently, the concept of metabolic health status, apart from obesity, has gained much significance.² A number of studies have been identified that some subpopulations show metabolic profiles that portray gross deviations from the so far established relationship between BMI and metabolic disturbances.^{3,4} The theory that some non-obese adults have multiple risk factors for the metabolic disorders like obese adults, was first proposed almost 20 years back.⁵ These non-obese adults are characterized by higher levels of adiposity, increased insulin resistance and are more prone to suffer from type 2 diabetes mellitus and cardiovascular disease.⁶

Obesity and overweight, according to BMI, do not always lead to metabolic disorders. In fact, some obese and overweight individuals are metabolically healthy, having normal insulin sensitivity, normal blood pressure, a favorable

lipid profile and a lower proportion of visceral fat.⁶

A number of studies have brought out the metabolically healthy and unhealthy obesity phenotypes in different BMI groups, considering the presence or absence of metabolic syndrome among the study subjects.^{3,4} Individuals are considered to have metabolic syndrome when they have at least three or more of the metabolic syndrome criteria.⁷

Emerging evidence suggests lipid accumulation product to be a new indicator of visceral adiposity.⁸ It is a mathematical model based on the product of serum triglyceride level and waist circumference of an individual. It can identify insulin resistance as well. Since lipid accumulation product incorporates triglyceride along with waist circumference, which is another indicator of adiposity, it might be a superior marker of insulin resistance compared to the conventional biomarkers.⁸ Lipid accumulation product is gender-specific and based on simple parameters. It did not originate from theoretical assumptions but from observations in a healthy, normal/overweight population.⁸

Lipid accumulation product takes visceral fat distribution into count. Visceral fat is more metabolically dangerous than the subcutaneous fat.⁹ The subcutaneous fat depot functions as a



strong metabolic defense by storing excess dietary fats and thereby reduces their deposition in undesired sites such as the liver, heart, kidneys etc.¹⁰ However, if there is more visceral fat and less subcutaneous fat, the subcutaneous adipose tissues cannot neutralize the effects of this excess fat. The excess fat will then get deposited in non-adipose tissues.¹¹ These ectopic fat deposits lead to cellular dysfunction and abnormalities resulting in insulin resistance. Hence, obesity is a heterogeneous disorder as evidenced by a subgroup of obese people who are insulin sensitive and a subgroup of normal weight people who are insulin resistant.¹² Keeping this heterogeneity in mind, using the visceral adiposity indicator lipid accumulation product, as an alternate criterion for detecting the metabolic obesity can be of maximum clinical benefit.¹³

Triglyceride-glucose index is the product of serum triglyceride level and fasting serum glucose. It is a simple marker that is found to be proportional to the level of insulin resistance (highly sensitive for detecting insulin resistance). This was revealed in hyperinsulinemic-euglycemic clamp studies.¹⁴ In previous studies, the metabolically obese status has been termed as the co-existence of metabolic syndrome with insulin resistance (insulin resistance must fall under the highest quartile or in the specific range of homeostasis model assessment), excess visceral or body fat and cardiovascular risk factors.¹⁵ From these definitions it becomes obvious that the main component of metabolic obesity is the insulin resistance. Triglyceride-glucose index has been shown to correlate well with other biomarkers of insulin sensitivity.

This study has been designed to propose adiposity indicator lipid accumulation product and triglyceride-glucose index as alternate diagnostic criteria of metabolic obesity among Bangladeshi adults, which might become effective indistinguishable subjects with a higher susceptibility of non-communicable diseases.

Materials and Methods

This study was conducted in the patients attending the various outpatient departments under the Faculty of Medicine, Bangabandhu Sheikh Mujib Medical University from March 2016 to February

2017. A total of 200 subjects aged 19-45 years were enrolled through purposive and convenient sampling. Subjects who were pregnant, diabetic, kidney, liver or endocrine disease and any known malignancy were excluded.

Purpose and procedure of the study were explained in details and informed written consent was taken from all the study subjects. Anthropometric measurements of all the subjects were recorded, which included their height, weight and waist circumference. Then their BMI were calculated.

Then with all aseptic precautions, overnight fasting (8-10 hours) blood samples were collected from them to estimate the serum glucose and triglyceride levels. With full aseptic precautions, 5 mL of venous blood was collected in a disposable plastic syringe from each subject. Then it was immediately delivered into a clean and dry test tube. The test tube was kept in upright position till the formation of clot. The serum was separated after centrifuging at 3,000 rpm for 5 min and was collected in an eppendorf tube and labeled properly. The serum was then stored in an ultra-freezer at -20°C, until analytical measurement of glucose and triglyceride. Fasting serum glucose was measured by hexokinase method using the dimension clinical chemistry system.¹⁶ Fasting serum triglyceride was measured by enzymatic method using the dimension clinical chemistry system.¹⁷

Lipid accumulation product was calculated by using the following formula:¹⁸

In males: $[WC (cm) - 65] \times [TG (mmol/L)];$

In females: $[WC (cm) - 58] \times [TG (mmol/L)].$

Where, WC is the waist circumference and TG is the triglyceride

Triglyceride glucose index was calculated the formula:^{15,18}

$\text{Serum triglyceride (mg/dL)} \times \text{Fasting serum glucose (mg/dL)} / 2$

Statistical analysis

Data were tabulated and then analyzed using the Software Statistical Package for Social Sciences version 24.0. Receiver operating characteristic curve analysis was done to find the optimal cutoff values of lipid accumulation product and triglyceride-glucose index.

Results

The prevalence of metabolic obesity in total study subjects based on adiposity indicators lipid accumulation product and triglyceride index was 54.0 and 53.5% (Table I). According to lipid accumulation product 76% male and 34% female had

Table I

Prevalence of metabolic obesity based on adiposity indicator and triglyceride-glucose index

Variables	Metabolic obesity	
	Present	Absent
Lipid accumulation product (n)	108	92
Triglyceride-glucose index (n)	107	93

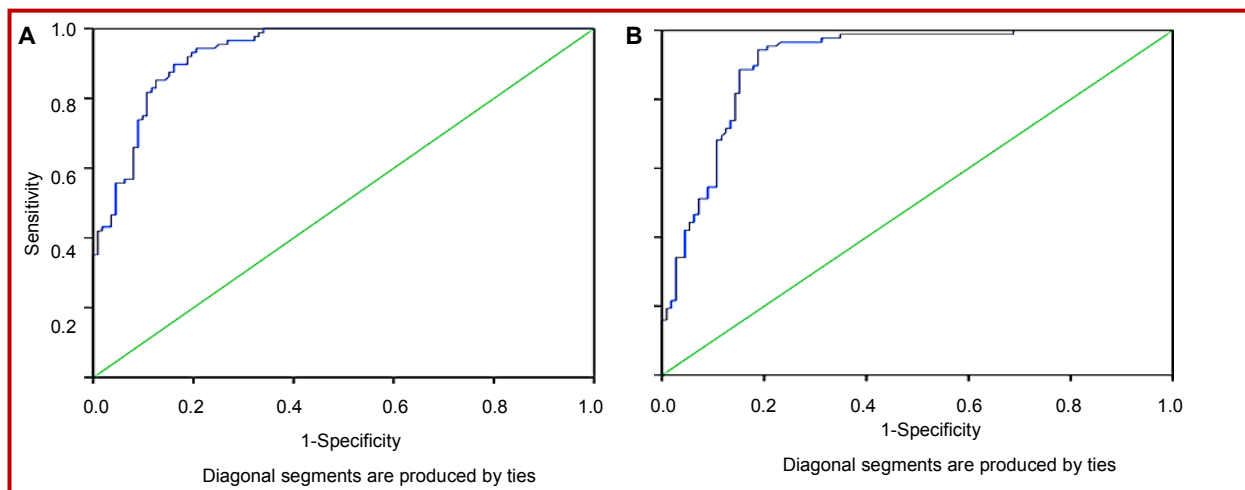


Figure 1: Receiver operating characteristic curve for lipid accumulation product (A) and triglyceride-glucose index (B) in total study

metabolic obesity and according to triglyceride-glucose index, 70% male and 35% female had metabolic obesity.

The receiver operating characteristic curve for lipid accumulation product of metabolic obesity in total study subjects showed area under the curve 0.9 ($p=0.000$) with sensitivity 90.9%, specificity 75.0%, positive predictive value 74.1%, and negative pre-dictive value 91.3% (Figure 1).

The receiver operating characteristic curve for triglyceride-glucose index of metabolic obesity in total study subjects showed area under the curve 0.9 (p value = 0.000) with sensitivity 95.5%, specificity 79.5%, positive predictive value 78.5%, and negative predictive value 95.7% (Figure 1).

Discussion

In this study, firstly, the distribution of the total subjects was based on the presence or absence of metabolic syndrome. The majority of the males had metabolic syndrome indicates that males are metabolically obese. On the other hand, females do not have any metabolic syndrome indicating that majority of the females study are metabolically healthy.

The receiver operating characteristic curve analysis was done to find the cutoff value of lipid accumulation product. The optimal cutoff value of lipid accumulation product in total study subjects was 45.5. Area under the curve value of lipid accumulation product in total study subjects was 0.9 ($p=0.000$), which indicates that lipid accumulation product is a good criterion for diagnosis of metabolic obesity in adults.

Similarly, the receiver operating characteristic curve analysis was done to find the cutoff value of

triglyceride-glucose index. The optimal cutoff value of triglyceride-glucose index in total study subjects was 8.7. Area under the curve value of triglyceride-glucose index in total study subjects was 0.9 ($p=0.000$), which indicates that triglyceride-glucose index is a good criterion for diagnosis of metabolic obesity in adults.

This study assessed the performance of adiposity indicator and triglyceride-glucose index as diagnostic criteria for metabolic obesity in total study subjects in terms of their sensitivity, specificity, positive predictive values and negative predictive values. Sensitivity of lipid accumulation product and triglyceride-glucose index were 90.9 and 95.5% respectively. This indicates that both lipid accumulation product and triglyceride-glucose index are highly sensitive for diagnosing metabolic obesity. Specificity of lipid accumulation product and triglyceride-glucose index were 75.0 and 79.5% respectively. This indicates that both lipid accumulation product and triglyceride-glucose index are highly specific for diagnosing metabolic obesity in adults. Rui et al. showed in a study 2018 showed that lipid accumulation product is better surrogate marker for predicting metabolic syndrome in middle aged and elderly Chinese people.¹⁹

This study is supported by Kahn (2005). He conducted a study among Taiwanese people and found lipid accumulation product to be an accurate method for assessing the risk of metabolic obesity in adult Taiwanese population.⁸

A study on adult Korean population showed triglyceride-glucose index to be a better indicator of metabolic obesity and insulin resistance. This is also in favor of the results of our study.²⁰ Er et al. (2016) found triglyceride-glucose index is simple and clinically useful surrogate marker for insulin resistance in non diabetic individuals.²¹

The prevalence of metabolic obesity in total study

subjects based on adiposity indicator and triglyceride-glucose index were 54.0 and 53.5% respectively. Thus, this study provides the evidence that lipid accumulation product and triglyceride-glucose index are good and appropriate as alternate criteria for diagnosis of metabolic obesity in adults.

Conclusion

Lipid accumulation product and triglyceride-glucose index are appropriate as alternate criteria for diagnosis of metabolic obesity in adults.

Ethical Issue

The ethical clearance was taken from the Institutional Review Board of Bangabandhu Sheikh Mujib Medical University.

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