Lipid Accumulation Product: An Effective Obesity Index to Predict Metabolic Syndrome

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Abstract:

Background: Obesity is a significant risk factor in the development of metabolic syndrome (MetS). Lipid Accumulation Product (LAP) is an obesity index and has been proposed to be a predictor of metabolic syndrome. The present study aims to see the effectiveness of Lipid Accumulation Product as an obesity index to predict metabolic syndrome in a Bangladeshi population.

Methods: This cross-sectional study was conducted in Department of Biochemistry and Molecular Biology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, between March 2016 and February 2017. A total of 200 apparently healthy subjects (127 men and 73 women) were selected for the study, attending out-patient-departments of the same institution. Anthropometric measurements were recorded, which included their height, weight, waist circumference (WC) and body mass index (BMI). Overnight fasting blood samples were collected to estimate fasting serum glucose and lipid profile. Then LAP was calculated and evaluated as a tool in prediction of MetS in the study subjects. Receiver operating characteristic (ROC) curves were plotted to assess the performance of LAP in MetS prediction by gender. The power of MetS prediction was quantified by the area under the curve (AUC) with 95% confidence intervals.

Results: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NVP) of LAP in predicting MetS were 70.45%, 78.57%, 72.09% and 77.19% in male study subjects and 20.45%, 96.43%, 81.82% and 60.67% in female subjects respectively. ROC curve analysis showed that the optimal cutoff value of LAP in male study subjects was 40.72, while area under the curve was 0.92; in female study subjects, the values were 51.69 and 0.91 respectively (P<0.001).

Conclusion: Lipid Accumulation Product was found simple, accessible and effective obesity index to predict metabolic syndrome in apparently healthy adults.

Key words: Metabolic Syndrome, Obesity, Obesity Index, Lipid Accumulation Product.

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Introduction:

Metabolic syndrome (MetS) is a major and escalating public health as well as clinical challenge worldwide[1]. To define metabolic syndrome, ATP III identified 6 components[2]: i) Abdominal obesity; ii) Atherogenic dyslipidemia; iii) Raised blood pressure; iv) Insulin resistance ± glucose intolerance; v) Proinflammatory state; and vi) Prothrombotic state. 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; it turns to an underlying risk factor in the development of metabolic syndrome[2-4]. To date, body mass index (BMI) is the most commonly used tool to classify overweight and obesity; however, the BMI can neither distinguish between fat and lean tissues nor identify the anatomic location or function of distinct fat depots[5]. To overcome this barrier, Lipid Accumulation Product (LAP) has been proven to be a measure of adipose tissue distribution and function i.e. visceral adiposity[5,6]. Hence, LAP has been proposed as a useful tool for early detection of metabolic obesity in individuals with normal BMI. LAP takes regional body fat distribution into consideration, as visceral fat is more metabolically deleterious than subcutaneous fat[6]. The subcutaneous fat depot appears to act as a protective metabolic sink, storing dietary fat to limit their deposition in undesired sites such as liver, heart, skeletal muscle, and pancreatic beta cells[6]. For some individuals with more visceral fat and less subcutaneous fat, available lipids exceed the subcutaneous adipose tissues' capacity for buffering and storage and the excess of lipids tends to reorient towards non-adipose tissues[8]. However, through its complexity of metabolism and mobilization,

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the ectopic lipid deposits ultimately lead to a state called 'lipotoxicity' that may incur insulin resistance as well as metabolic syndrome in adults[9]. Nevertheless, obesity seems remarkably a heterogeneous disorder, as evidence showed occurrence of a subset of obese people who are insulin sensitive, while another subset of normal-weight people who are insulin resistant[10]. With this heterogeneity, measuring an indicator of visceral fat such as LAP is of clinical benefit[11].

The Lipid Accumulation Product (LAP), a novel index of central lipid accumulation, is a mathematical model based on the product of waist circumference and serum triglyceride level of an individual. Emerging evidence suggests lipid accumulation product to be a new indicator of visceral adiposity[5,6,8]. It can identify insulin resistance as well and has been proposed as a good predictor of metabolic syndrome (MetS)[2,5]. Since LAP incorporates triglyceride along with waist circumference (WC), which is another indicator of adiposity, it might be a superior marker of insulin resistance compared to the conventional biomarkers[5,7,9]. Lipid accumulation product is gender-specific and based on simple parameters and it did not originate from theoretical assumptions rather from practical observations in a healthy, normal/overweight population[4]. Taking all those assumptions and evidences into consideration, the present study was designed to see the effectiveness of 'Lipid Accumulation Product' as an obesity index to predict metabolic syndrome among Bangladeshi adult population. The results of the present study can help clinicians to detect MetS in a simple way, counsel their patients to consider lifestyle interventions, and thereby prevent a significant amount of morbidity and mortality.

Materials and Methods:

This cross-sectional study was conducted in Department of Biochemistry and Molecular Biology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh. A total of 200 apparently healthy subjects participated in the study, who attended the out-patient-departments of Bangabandhu Sheikh Mujib Medical University (BSMMU) Hospital, Dhaka, Bangladesh, between March 2016 and February 2017. 127 male and 73 female subjects aged between 19 and 45 years were enrolled through purposive and convenient sampling method (after exclusion of subjects who were pregnant, diabetic, or having history of kidney, liver, endocrine or malignant disease or any type of infection). The purpose and procedures were explained to them in details and written informed consent was taken. They were evaluated by history, clinical examinations and laboratory investigations as per data collection sheet. Anthropometric measurements were recorded, which included their height, weight and waist circumference (WC). Then BMI was calculated – weight in kilograms divided by the square of height in meters (Kg/m^2), for each of them. In sitting position, systolic and diastolic blood pressure were recorded. Overnight fasting blood samples were collected from them to estimate fasting serum glucose and lipid profile. Fasting serum glucose was estimated by using hexokinase method (in AU680 Clinical Chemistry Analyzer – Beckman Coulter, Inc., made in USA). Serum total cholesterol (TC), triglycerides (TG) and High-Density Lipoprotein cholesterol (HDL-C) were estimated by using by enzymatic method (in ARCHITECT c4000 Clinical Chemistry Analyzer – Abbott Diagnostics Inc., made in USA). Low-Density Lipoprotein cholesterol (LDL-C) was calculated using the 'Friedewald formula'. Individuals were considered to have metabolic syndrome having at least three or more of the criteria (as determined by the American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement)[12], and were categorized.

Lipid Accumulation Product (LAP) was calculated by the following formula:

[WC (cm) – 65] × [TG (mmol/l)] for men, and [WC (cm) – 58] × [TG (mmol/l)] for women (according to Kahn)[5]. Then LAP was evaluated as a tool to predict metabolic syndrome in the study subjects. Receiver operating characteristic (ROC) curves were plotted to assess the performance of Lipid Accumulation Product (LAP) in MetS prediction by gender. The power of MetS prediction was quantified by the area under the curve (AUC) with 95% confidence intervals, i.e. a larger AUC reflecting better predictive accuracy.

All statistical analyses were conducted using SPSS version 22.0. for Windows (SPSS, Chicago, IL, USA). The difference was considered statistically significant at P value <0.001 based on a 2-sided probability. This study was approved by the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

Results:

In the present study, 200 study participants were enrolled. Among 127 men, 67 had metabolic syndrome, while among 73 women, 17 had metabolic syndrome (Table-I), as determined by the anthropometric and biochemical parameters, based on the criteria of the American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement[11]. Then study subjects were further evaluated by Lipid

Accumulation Product (LAP) tool. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NVP) of LAP in detection of MetS in male study subjects were 70.45%, 78.57%, 72.09% and 77.19% respectively (Table-II). Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NVP) of LAP in female study subjects were 20.45%, 96.43%, 81.82% and 60.67% respectively (Table-II). Receiver operating characteristic (ROC) curve analysis showed that the optimal cutoff value of LAP in male study subjects was 40.72, and area under the curve (AUC) value was 0.92; those indicated that LAP is a good predictor of metabolic syndrome in adult males. (Table-III, Figure 1). Similarly, in female study subjects, the optimal cutoff value was 51.69, and area under the curve (AUC) value was 0.91; those also indicated that LAP is a good tool for prediction of metabolic syndrome in adult females (Table-III, Figure 2).

Table-I

Incidence of metabolic syndrome among the study subjects (n = 200)

Sex	Metabolic Syndrome		
	Yes (%)	No (%)	Total
Male	67 (33.50 %)	60 (30.00 %)	127
Female	17 (8.50 %)	56 (28.00 %)	73
Total	84 (42.00 %)	116 (58.00 %)	200

Table-II

Effectiveness of lipid accumulation product (LAP) as an obesity index in diagnosing metabolic syndrome

Variables	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
LAP (Male)	70.45%	78.57%	72.09%	77.19%
LAP(Female)	20.45%	96.43%	81.82%	60.67%

Table-III

Analysis of Receiver Operating Characteristic (ROC) curve of lipid accumulation product (LAP) in male and female study subjects

Variable	Area under the curve (AUC)	P Value	Optimal Cutoff Point
LAP (Male)	0.924	0.000	40.7288
LAP (Female)	0.919	0.000	51.6949

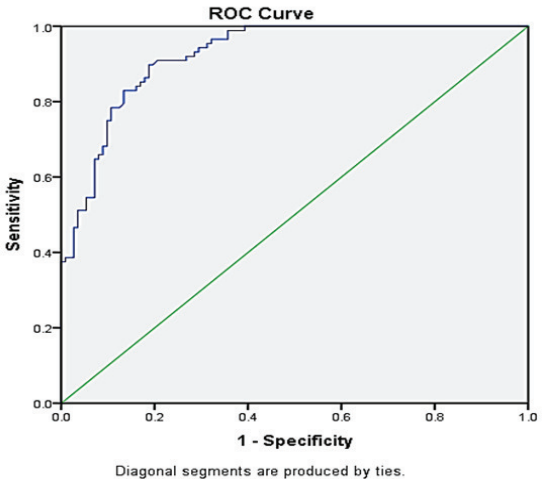

Fig.-1: *Receiver Operating Characteristic (ROC) Curve for Lipid Accumulation Product (LAP) in Male*

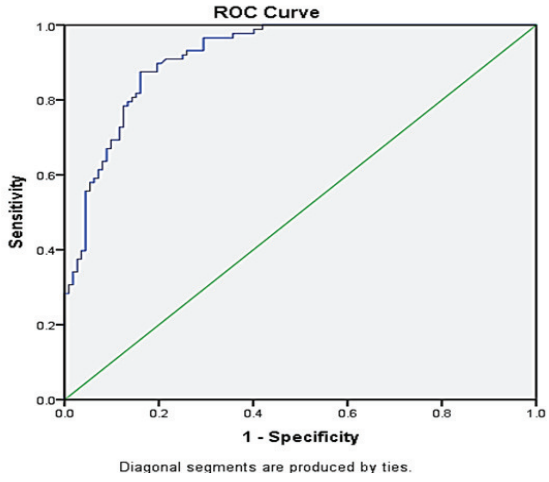

Fig.-2: *Receiver Operating Characteristic (ROC) Curve for Lipid Accumulation Product (LAP) in Female Study Subjects*

Discussion:

To our knowledge, this is the first report to date to find that LAP has a high rate of accuracy for prediction of metabolic syndrome in Bangladeshi healthy men and women. Tellechea et al.[13] studied on 552 men in Argentina and reported that the cutoff value of LAP was 53.63 and showed the highest diagnostic accuracy for metabolic syndrome (sensitivity 83%, specificity 83%, PPV 62%, and PNV 93%) and receiver operating characteristic curves showed area under the curve (AUC) for metabolic syndrome was 0.91, among all risk markers. Taverna et al.[14] studied on 768 Spanish adults and LAP showed area under the curve 0.91 and 0.90 among males and females respectively. Among males and females, different LAP cut-off values exhibited high sensitivity (78-85%) and specificity (78-85%). They concluded that LAP has a strong and reliable diagnostic accuracy for MetS. Motamed et al.[15] found similar results while studying on 5797 Iranians where optimal cutoff points determined for LAP were 39.89 for men (sensitivity = 86%, specificity = 79.6%) and 49.71 for women (sensitivity = 85.2%, specificity = 82.3%). Er et al.[16] studied on 511 Taiwanese individuals and found the area under the curve for LAP 0.761. Omuse et al.[17] studied on 528 Kenyan people, living in urban areas, and they found LAP as the best predictor of MetS, with cutoff value of 42.895 in male and 30.56 in male (as AUC 0.949 and 0.822 in male and female respectively). The sensitivity and specificity were 84.3% and 74.9% in male, while 77.5% and 72.8% in female. Nascimento-Ferreira et al.[18] studied on 201 Brazilians aged 20-79 years and the cut-off point of 34.2 for LAP showed the highest accuracy for MS (sensitivity 90%, specificity 61%), among all the predictors. The result of our study was compared and found more or less in agreement with that of previous studies. However, we found only few studies to support our results as because very limited number of studies have been conducted around the globe to date. Apart from this, no previous studies were found in Bangladeshi people to compare with our findings.

Evidence showed that adipose tissue with high levels of lipolysis is an early and critical abnormality in the development of cardiovascular disease, type 2 diabetes, and metabolic syndrome[3,11]. Hence, we assume that the superior diagnostic performance of LAP could be associated with the detection of highly lipolytic adipose tissue.

Limitations:

The limitations of the present study were its small sample size, due to time constraint and limited budget, selection of the study subjects purposively and conveniently and being a single-centre study in an urban area. Therefore, drawing conclusion for a general population from the study results would be challenging. Moreover, the study design (cross-sectional) limits observation on the mechanism of visceral adiposity in metabolic syndrome or assessment of the outcomes, which could be obtained from a prospective cohort study.

Conclusion:

Our study revealed that there is a significant prevalence of metabolic syndrome in Bangladeshi people especially among adult males and Lipid Accumulation Product (LAP) could be used as simple, accessible and effective tool to predict metabolic syndrome in adults. The reliability and potential utility of LAP in early detection of metabolic syndrome indicate that further multi-centre research should be undertaken in the same ethnic population using larger sample size and prospective study design.

Conflict of interest: None to disclose.

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