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RESEARCH ARTICLE

Anthropometric measures of obesity as correlates of atherogenic index of plasma in young adult females

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ABSTRACT

Background: Cardiovascular diseases (CVDs) are the leading cause of death globally, accounting to one-third of all global deaths. The first step toward dealing with the epidemic of CVD is to come up with reliable and feasible screening methods, that when applied to the general population, can identify people with high CVD risk. Atherogenic index of plasma (AIP), defined as logarithm of the ratio of plasma concentration of serum triglycerides to high-density lipoprotein cholesterol, is a strong marker to predict the risk of atherosclerosis and a novel predictive indicator for CVD. We have undertaken the present study to find the correlation between the commonly used anthropometric measures of obesity and AIP. **Aims and Objectives:** The objective of the study was to evaluate the extent of correlation between anthropometric measures of obesity and AIP. **Materials and Methods:** This cross-sectional study was conducted on sixty apparently healthy young females. After recording the anthropometric measures of obesity in the subjects, lipid profile was evaluated and AIP was calculated. Correlation between anthropometric measures of obesity and AIP was tested by Pearson's correlation coefficient. **Results:** All anthropometric measures of obesity showed a significant correlation with AIP; however, waist circumference (WC) showed the strongest correlation (r = 0.369) followed by waist-to-hip ratio (WHR) (r = 0.298) and lastly body mass index (r = 0.277). **Conclusion:** Central measures of obesity such as WC and WHR are more accurate in predicting AIP, and hence, they can be used as handy screening tools to assess CVD risk in the general population.

KEY WORDS: Atherogenic Index of Plasma; Anthropometric Measures of Obesity; Body Mass Index; Waist Circumference; Waist-to-Hip Ratio

INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death globally, accounting for 31% of all global deaths in 2016.[1] Most CVDs can be prevented by addressing behavioral risk factors such as unhealthy diet, sedentary lifestyle, obesity, and substance abuse. This, however, necessitates the early and prompt screening for CVD risks in the general population so that effective preventive measures can be initiated in high-risk cases.

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Dyslipidemia is recognized as a prominent risk factor for CVDs and lipid abnormalities, including high levels of low-density lipoprotein cholesterol (LDL-C), elevated triglycerides (TGs) and low levels of high-density lipoprotein cholesterol (HDL-C), are associated with an increased risk of cardiovascular events. These lipid abnormalities have been recognized as the primary contributors to atherosclerosis and they tend to increase the risk of developing CVD.[2]

Atherogenic index of plasma (AIP) is a novel and reliable index composed of TGs and HDL-C. Defined as logarithm

(log) of the ratio of plasma concentration of TG to HDL-C, AIP is strongly correlated with CVD risks. It can act as an adjunct over the individual lipid profile parameters and can be used as a diagnostic indicator, especially in cases where the other atherogenic risk parameters appear to be normal.[3]

AIP has been used to quantify blood lipid levels and is generally considered as an optimal indicator of dyslipidemia and CVDs.[4]

The most effective way of dealing with the epidemic of CVDs is prompt screening and early detection of risk factors. As AIP is a strong marker to predict the risk of atherosclerosis and CVDs, we assessed the correlation between AIP and various anthropometric measures of obesity: The traditionally used body mass index (BMI) and measures of central obesity namely waist circumference (WC) and waist-to-hip ratio (WHR).

The present study was undertaken with the aim of detecting the anthropometric measure of obesity that best correlates with AIP.

MATERIALS AND METHODS

This cross-sectional study was undertaken in the Department of Physiology, Karnataka Institute of Medical Sciences, Hubli, with the assistance of the biochemistry laboratory. The study and its conduct were cleared by the Ethical Committee of the Institute.

Inclusion Criteria

The following criteria were included in the study:

1. Healthy young females with age ranging between 18 and 30 years.

Exclusion Criteria

The following criteria were excluded from the study:

1. Women on lipid-lowering drugs, oral contraceptives, or any medications which may influence lipid profile
2. Pregnant and lactating women.

Methods of Collection of Data

The procedure and nature of the study were explained in detail to all the participants and written informed consent was taken for the same. The collection of blood sample, which is an invasive procedure to be performed in the study, was explained to the subjects and consent was taken for venepuncture. Health status was assessed by a comprehensive questionnaire. The participants were advised to continue their normal daily diet and working routine.

Anthropometric Data

Measurements were taken while subjects were relaxed, standing erect with their arms at their sides and feet together.

- Body height was measured by wall-mounted stadiometer
- Body weight was recorded by clinical weighing machine, with subjects dressed in light clothes and no shoes
- WC and hip circumference were measured using a stretch-resistant measuring tape. The WC was measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest. Hip circumference was measured around the widest portion of the buttocks, with the tape parallel to the ground
- BMI was calculated as per formula: Weight (kg)/Height $(m)^2$
- AIP was calculated by the formula, AIP = $\log_{10}$ (Serum triglycerides/HDL-C).

Vital parameters such as pulse rate and BP were recorded. After selecting the subjects, appointment was scheduled in prior and they were requested to do an overnight fast before the day of the test to get fasting blood sample for lipid profile analysis. Between 7 am and 10 am, 2 ml of venous blood was collected in a plain bulb by venepuncture under aseptic precaution. Serum lipid profile was analyzed with clinical chemistry analyzer (Type Model: XL-300 ERBA).

Statistical Analysis

The correlation between anthropometric measurements and AIP was done using Pearson's correlation coefficient. All the analysis was done using SPSS-20 software. Statistically significant differences were reported at $P = 0.05$.

RESULTS

The present study was done on a total of sixty female participants, whose mean age was 24.27 ± 3.43 years (mean ± standard deviation [SD]) and BMI were 24.408 ± 3.078 (mean ± SD).

The mean serum TG levels were 130.4 ± 44.06 (mean ± SD), HDL levels were 32.87 ± 6.03 (mean ± SD), and AIP was 0.581 ± 0.148 (mean ± SD) [Table 1].

WC showed the strongest correlation with AIP ($r = 0.369$, $P = 0.0037$) followed by WHR ($r = 0.298$, $P = 0.02$) and lastly BMI ($r = 0.277$, $P = 0.032$) [Table 2 and Figures 1-3].

DISCUSSION

A notable finding of this study was the significant positive correlation between all measures of obesity and AIP. However, the measures of central obesity: WC and WHR showed a stronger correlation with AIP than the traditional BMI. WC showed the best correlation ($r = 0.369$) followed by WHR ($r = 0.298$) and BMI ($r = 0.277$).

The findings of the present study concur with a similar study done by Shen *et al*., who found a significantly higher AIP

Table 1: Mean anthropometric measurements and AIP of subjects

Parameter	Mean±standard deviation
Age (years)	24.27±3.43
Height (cm)	151.63±3.55
Weight (kg)	56.06±6.13
Body mass index (kg/m^2)	24.408±3.078
Waist circumference (cm)	79.359±4.65
Waist-to-hip ratio	0.85275±0.03
Serum triglycerides (mg/dl)	130.417±44.06
High-density lipoprotein (mg/dl)	32.87±6.03
AIP	0.581±0.148

AIP: Atherogenic index of plasma

Table 2: Correlation of various anthropometric measurements with atherogenic index of plasma

Variables	Body mass index	Waist circumference	Waist-hip ratio
r-value	0.277243	0.369506	0.298619
P-value	0.032	0.0037	0.02

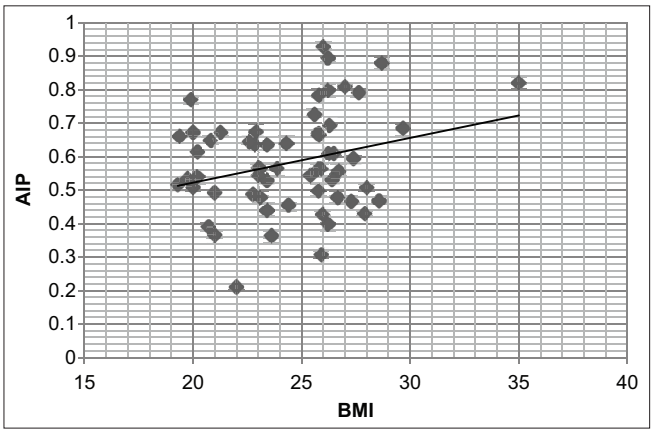

Figure 1: Correlation of body mass index with atherogenic index of plasma

in subjects with abdominal obesity than in those without abdominal obesity, and WC was found to be positively correlated with AIP.[5]

Zhang *et al*. found that in nomadic Kazakh adults, WHR was shown to have the best correlation with AIP.[6]

A study done by Savva *et al*. showed that WC and WHR are better predictors of CVD risk factors in children than BMI.[7]

However, a study was done by Furtado *et al*. in school children found that all anthropometric parameters were found to independently predict an altered lipid profile and were associated with dyslipidemia and increased CVD risk.[8]

One of the major risk factors of CVD is atherosclerosis, which is secondary to dyslipidemia and excess of LDL-C.

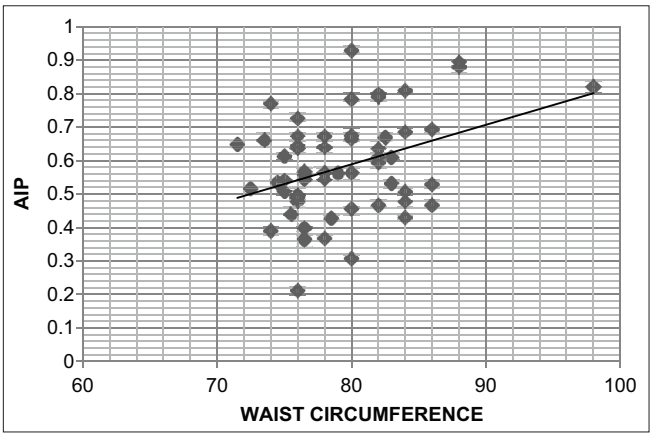

Figure 2: Correlation of waist circumference with atherogenic index of plasma

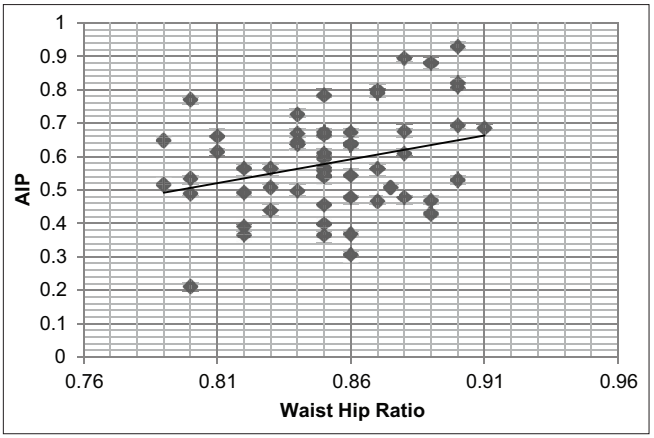

Figure 3: Correlation of waist-hip ratio with atherogenic index of plasma

Dyslipidemia is a metabolic abnormality characterized by a persistent increase in the levels of cholesterol and TGs in the blood. There are three types of dyslipidemia: Hypercholesterolemia, hypertriglyceridemia, and mixed hyperlipidemia.[9,10]

AIP is an index composed of TGs and HDL-C, which is used to quantify blood lipid levels and commonly used as optimal indicator of dyslipidemia and associated CVD. AIP, calculated as $\log_{10}$ (TG/HDL-C), was initially formulated as a biomarker of plasma atherosclerosis and has been proved to be significantly correlated with other important atherosclerosis indexes such as LDL-C.[11]

The reliability of AIP makes it an ideal candidate for identifying individuals at higher risk of CVD in the clinical practice.[12]

The aim of the study was to find a reliable anthropometric measurement that can be used as a handy tool in detecting AIP and thus help in early detection of CVD risks. Anthropometric measurements are a non-invasive and inexpensive method to assess the nutritional status of a person and can have wide clinical application in patients. Measuring abdominal, in

addition to general obesity, can enhance and improve the process of cardiometabolic risk assessment.[13]

The present study shows that measures of central obesity are superior to BMI, indicating that it is the pattern of fat distribution that plays a very important role in predicting atherogenicity. Recent evidence suggests that the distribution of fat during early adulthood is associated with increased metabolic disease risk in later adulthood. Some authors attribute this to generalized measures of obesity, while others have identified central measures of obesity. It has also been suggested that to some extent, the composition and size of lipoproteins are influenced by anthropometric characteristics of a person.[14]

Individuals with more visceral adiposity have a higher chance to get CVD complications. The reason being that visceral adipose tissue, which is mainly drained by the portal venous system into the liver, may cause insulin resistance. When compared to subcutaneous fat, the free fatty acid (FFA) mobilization is more rapid in visceral fat which increases the FFA levels in systemic circulation. Besides that, visceral fat shows the stronger lipolytic effect to catecholamines and a weaker antilipolytic effect to insulin hormone, and this may probably be due to decrease in insulin receptor affinity in that tissue. The excess FFAs may trigger lipid synthesis and gluconeogenesis, as well as lead to insulin resistance. This, in turn, may lead to hyperlipidemia, glucose intolerance, hypertension, and finally, atherosclerosis.[15]

The measure of obesity in nearly all cases has traditionally been BMI. However, given that the body fat increases and muscle mass decreases with age, changes in height, weight, and BMI may not correspond to proportional changes in body fat or muscle mass. The clinical utility of BMI could be questioned because it does not accurately reflect visceral fat accumulation-that visceral fat which is the main culprit that leads to most of the metabolic and clinical complications of obesity. Although BMI may be ideally suited for population-level studies, describing obesity by BMI can result in inaccurate assessment of adiposity.[16]

The pattern of fat distribution has been shown to have a large influence on cardiometabolic risk, and as a consequence, abdominal obesity seems to predict the development of CVDs better than overall obesity.[17]

The present study seems to concur with the vast amount of data available on the crucial effect of abdominal obesity on dyslipidemia and suggests that measures of central obesity should become a topmost priority in all screening processes related to CVD.

Limitations

The study was conducted with small sample size. Other population-based studies using larger samples could help in generalizing the results of our current work.

CONCLUSION

The present study concludes that measures of central obesity are more reliable for predicting AIP compared to traditionally used BMI in young adult females. The anatomical distribution of fat plays a major role in dyslipidemia, with central fat deposition being associated with an unfavorable lipid profile and increased risk of atherosclerosis and CVD. Efforts to recommend "optimal" weight or relying on BMI to predict atherogenecity and assess CVD risk may prove erroneous. Since central adiposity is the prime determinant of atherogenicity and dyslipidemia, employing WC and WHR will yield much better results and make the screening process for CVD more efficient.

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