RESEARCH ARTICLE

Correlation of anthropometric indices with lipid profile in adult females

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ABSTRACT

Background: The prevalence of dyslipidemia has increased manifold in the industrialized, developed, and the developing countries to the extent that it is becoming an escalating epidemic. Obesity, an important risk factor of dyslipidemia, places individuals at risk of various chronic diseases such as diabetes mellitus, hypertension, and cardiovascular diseases. Screening obese individuals by anthropometry and correlating it with the lipid profile helps to identify individuals at risk of developing obesity-related complications. **Aims and Objectives:** The current study was done to correlate anthropometric indices with lipid profile of individuals and determine the best anthropometric index which predicts dyslipidemia. **Materials and Methods:** This was a hospital-based cross-sectional study. A total of 306 adult females who attended Kannur Medical College Hospital for executive checkup were included in the study. Demographic data were collected, the thorough general physical examination was done, and anthropometric measurements were taken according to the standard protocol. Blood samples were taken, and lipid profile was done with the help of automatic analyzer. **Results:** It was observed that the mean age of the subjects was 47 years (standard deviation 10.92), the mean waist circumference (WC) was 85.09 cm ± 10.53, body mass index (BMI) was 23.35 ± 4.09 kg/m^2, and the mean waist hip ratio (WHR) was 0.87 ± 0.05. Although all anthropometric indicators had a significant positive correlation with lipid parameters, WHR had the highest correlation coefficient when compared to BMI and WC. **Conclusion:** It was concluded that WHR is a better predictor of dyslipidemia and its associated complications than BMI and WC.

KEY WORDS: Anthropometry; Body Mass Index; Waist Circumference; Waist Hip Ratio; Dyslipidemia; Obesity

INTRODUCTION

Dyslipidemia is an abnormal amount of lipids in the blood. In developed countries, most dyslipidemias are hyperlipidemias. It may be manifested as an elevation of total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglyceride (TG) concentration and a decrease in high-density lipoprotein cholesterol. This is most often due to changes in diet and lifestyle. Overweight and obesity are the two major modifiable risk factors in the causation of dyslipidemia. Serum lipid level as a cardiometabolic risk factor has been well known. Abnormal visceral fat produces physiological changes that alter lipid profile, leading to dyslipidemia and hyperlipidemia, which in turn increases the risk of cardiovascular events. This is particularly true of alterations in LDL-C, an independent causal factor in atherosclerosis.[1]

Obesity is a major public health problem, the prevalence of which has increased worldwide and it significantly increases morbidity and mortality of any given population. Indians have a considerably higher prevalence of premature coronary artery disease compared with Europeans, Chinese, and Malaysians.[2] Within the Indian subcontinent, a dramatic increase in the prevalence of coronary artery disease has been predicted in the next 20 years due to rapid changes

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in lifestyle consequent to economic development. Obesity is an excessive accumulation of body fat and in its gross manifestation possesses a real threat to health.[3] Alterations in body fat distribution are associated with changes in lipids and lipoproteins and associated with increased coronary heart disease.[4]

Obese individuals differ not only in the amount of excess fat they store but also in the regional distribution of fat within the body. It is useful therefore to be able to distinguish between those at increased risk as a result of “abdominal fat distribution” or “android obesity” from those with the less serious “gynoid” fat distribution, in which fat is more evenly and peripherally distributed around the body.[1]

Different methods are used for the measurement of obesity - they include simple anthropometric measurements such as body mass index (BMI), waist circumference (WC), waist hip ratio (WHR), skinfold thickness, and body density. It is unclear which anthropometric measure is the most important predictor of risk of cardiovascular disease in adults. BMI has traditionally been the chosen indicator by which to measure body size and composition and to diagnose underweight and overweight. BMI does not account for factors such as body fat distribution, specifically abdominal obesity, and cannot distinguish between lean and fat body mass.[5] WC reflects abdominal fat, which contains a higher amount of visceral fat. Therefore, measures that reflect abdominal adiposity and which have an influence on blood lipid profile such as WC, WHR, and WHR are considered superior to BMI in predicting cardiovascular disease risk. Anthropometric indices are simpler and non-invasive tests. It can be applied to predict lipid profile abnormality and at-risk population for future cardiovascular and other endocrine events. Hence, this study aims to correlate and understand the association between measures of adiposity such as WC, WHR, and BMI with serum lipid levels and to determine the best predictor of deranged serum lipid profile among them.

MATERIALS AND METHODS

The study was a hospital-based cross-sectional, descriptive study. The participants of the study were adult females attending Kannur Medical College, Anjarakandy, for executive checkup. The study was done on 306 female subjects. The inclusion criteria were individuals willing to enroll in the study, individuals undergoing executive checkup, and individuals with no known previous history of hypertension, hyperlipidemia, diabetes mellitus, liver diseases, and endocrine diseases. The exclusion criteria were individuals with the previous history of hypertension, diabetes mellitus, liver disease, and endocrine diseases, individuals on lipid-lowering drugs, anti-tubercular drugs, and herbal medications and pregnant and lactating women. The Institutional ethical committee approval was obtained, written informed consent was taken from all subjects, thorough history was taken from all subjects, and all the participants underwent complete general physical examination for the presence of pallor, icterus, clubbing, cyanosis, lymphadenopathy, and edema. Vital parameters such as pulse rate, blood pressure, and temperature were checked. Systemic examination including respiratory, cardiovascular, abdominal, and central nervous system examination was done thoroughly in all subjects. Routine blood investigations such as hemoglobin and random blood sugar were done. Patients who were on medications for tuberculosis, herbal medications, and lipid-lowering drugs and who were on thyroid medications were excluded based on history. Blood investigations done were LDL-C, high-density lipoprotein cholesterol (HDL-C), TC, TGs, very LDL-C, LDL/HDL, and TC/HDL. The anthropometric measurements done were height, weight, BMI, WC, hip circumference, and WHR. Lipid profile tests were done in fully automated analyzer.

BMI

Body weight was measured in kg by a mechanical scale to the nearest kg. Height was measured to the nearest 1 cm. BMI was calculated using Quetelet’s index-BMI = weight in kg/height (m^2).

WC and WHR

WC was measured midway between the lowest rib and the iliac crest and hip circumference at the level of the greater trochanters with legs close together, using a non-stretchable measuring tape by an average of three measurements nearest to 0.5 cm. The WHR equals WC divided by hip circumference.[6]

Statistical Analysis

Data were entered into Microsoft Excel after coding the data and were analyzed using SPSS 17 version software. Data are presented in the form of frequencies and proportions. Bar diagrams are used to show the graphical representation of data. Pearson correlation was done to calculate the correlation coefficient for quantitative variables. Scatter plots are used to demonstrate correlation. Association between qualitative data was done by Chi-square test, and for quantitative data, analysis of variance (ANOVA) was used. A $P < 0.05$ was considered as statistically significant.

RESULTS

A total of 306 subjects were included in the study. According to Table 1, the mean age of the subjects was 47 years (standard deviation 10.92), the mean WC was 85.09 cm ± 10.53 cm, BMI was 23.35 ± 4.09 kg/m^2, and the mean WHR was 0.87 ± 0.05. The mean values for lipid profile parameters were as follows: TC - 194.61 ± 40.11 mg/dl, LDL - 125.67 ± 36.04 mg/dl, HDL - 46.75 ± 2.57 mg/dl, 23.53 ± 9.88 mg/dl, TGs - 116.58 ± 48.32 mg/dl, LDL/HDL - 2.67 ± 0.81, and that of TC/HDL - 4.16 ± 0.9.

Majority of the subjects were in the age group of 40–59 years [Table 2]. In summary of the results, it was seen that there was significant positive correlation between BMI and TC, LDL, LDL/HDL, and TC/HDL ratio [Table 3], there was a significant positive correlation between WC and TC, LDL, TGs, LDL/HDL, and TC/HDL ratio [Table 4], there was a significant positive correlation between WHR and TC, LDL, VLDL, TGs, LDL/HDL ratio, and TC/HDL ratio [Table 5], there was no significant positive correlation observed with BMI, WC and WHR and HDL-C. WHR correlated best with lipid profile parameters.

DISCUSSION

Dyslipidemia is one of the most important known and modifiable risk factors for the development of coronary artery disease and other complications. Obesity, being one of the important reversible causes of dyslipidemia, is simply a condition of excess body fat. This study was done to correlate simple anthropometric measurements with lipid profile parameters and hence to signify the importance of implementing anthropometry in routine screening procedures.

Table 1: Mean values of quantitative variables among the subjects

Parameters	Mean (*n*=306)	SD	SEM
Age (years)	47.28	10.92	0.62
Height (cm)	163.8	9.42	0.71
Weight (kg)	62.79	12.78	0.73
Waist circumference (cm)	85.09	10.53	0.60
Hip circumference (cm)	97.01	923	0.52
BMI (kg/m^2)	23.35	4.09	0.23
WHR	0.87	0.05	0.01
Total cholesterol (mg/dl)	194.61	40.11	2.29
LDL (mg/dl)	125.67	36.04	2.06
HDL (mg/dl)	46.75	2.57	0.14
VLDL (mg/dl)	23.53	9.88	0.56
Triglycerides (mg/dl)	116.58	48.32	2.76
LDL/HDL	2.67	0.81	0.04
TC/HDL	4.16	0.90	0.05

SD: Standard deviation, BMI: Body mass index, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, VLDL: Very low-density lipoprotein, TC: Total cholesterol, SEM: Standard error mean, WHR: Waist hip ratio

Table 2: Age distribution of the subjects

Age (years)	Frequency (%)
20–29	13 (42)
30–39	70 (22.9)
40–49	85 (27.8)
50–59	84 (27.5)
60–69	54 (17.6)
Total	306 (100.0)

However, due to the difficulty in obtaining accurate measures of body fatness in the population, measures of height and weight have been widely used to identify overweight and obesity. Obesity is currently defined using BMI. BMI does not, however, measure the proportion of weight which is related to increased muscle or the uneven distribution of abnormal excess fat within the body, which seriously affect the health risks associated with overweight and obesity. It is a good but not a perfect surrogate for body fatness. For the above-mentioned reason, a measure of obesity and overweight that takes into account increased incidence of obesity-related morbidity because of accumulation of abdominal and visceral fat is more desirable. WHR and WC are simple measures and give a better measure of abdominal and visceral fat. In this study, it was observed that there was a significant positive correlation between BMI, TC, LDL, LDL/HDL ratio, and TC/HDL ratio. It was also observed that there was a significant positive correlation between WC, TC, LDL, TGs, LDL/HDL ratio, and TC/HDL ratio and a significant positive correlation between WHR, TC, LDL, VLDL, TGs, LDL/HDL ratio, and TC/HDL. Pearson's correlations (*r*) between lipid profile and anthropometric measurements were done. It was also observed that, on quantitative analysis using ANOVA, there was a significant association between anthropometric indices (BMI, WC, and WHR) with lipid profile parameters which were similar to the findings seen with Pearson's correlation. BMI, WC, and WHR, all the three parameters correlated well with the parameters of lipid profile. However, WHR best correlated with lipid profile parameters and hence was the better indicator of deranged lipid profile, abdominal obesity, and its adverse effects. The finding of the study was in accordance to so many other studies.

In a study done by Zhang *et al*., "Anthropometric predictors of coronary heart disease in Chinese women," it was concluded that WHR was positively associated with the risk of coronary artery disease in both younger and older women, while other anthropometric indices, including BMI, were related to cardiovascular disease risk primarily among younger women.[7]

In another study done by Parvin *et al*., it was concluded that WHR, as compared to BMI, WC, and WHR, may be a better indicator of cardiovascular risk factors.[8]

In this study, BMI, WC, and WHR and lipid parameters were high in subjects in the age group of 40–59 years, which shows that menopause has great effect of body fat and lipid profile. WHR which measures central and abdominal obesity is thus a

Table 3: Correlation between BMI (kg/m^2) and lipid parameters (mg/dl)

Parameters	TC	LDL	HDL	VLDL	TGs	LDL/HDL	TC/HDL
BMI (kg/m^2)							
Pearson correlation	0.258	0.231	0.049	0.045	0.072	0.217	0.235
P	<0.001	<0.001	0.390	0.436	0.208	<0.001	<0.001

BMI: Body mass index, TC: Total cholesterol, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, VLDL: Very low-density lipoprotein, TGs: Triglycerides

Table 4: Correlation between WC (cm) and lipid parameters (mg/dl)

Parameters	TC	LDL	HDL	VLDL	TGs	LDL/HDL	TC/HDL
WC (cm)							
Pearson correlation	0.457	0.431	0.061	0.092	0.128	0.405	0.424
P	<0.001	<0.001	0.291	0.109	0.025	<0.001	<0.001

WC: Waist circumference, TC: Total cholesterol, LDL: Low-density lipoprotein,
HDL: High-density lipoprotein, VLDL: Very low-density lipoprotein, TGs: Triglycerides

Table 5: Correlation between WHR and lipid parameters (mg/dl)

Parameters	TC	LDL	HDL	VLDL	TGs	LDL/HDL	TC/HDL
WHR							
Pearson correlation	0.587	0.560	0.092	0.137	0.178	0.508	0.538
P	<0.001	<0.001	0.106	0.017	0.002	<0.001	<0.001

TC: Total cholesterol, LDL: Low-density lipoprotein, HDL: High-density lipoprotein, VLDL: Very low-density lipoprotein, TGs: Triglycerides, WHR: Waist hip ratio

better predictor of dyslipidemia and its observed consequences. In a study done by Lee *et al*., it was concluded that measures of centralized obesity proved superior over BMI for detecting cardiovascular risk factors in both men and women.[9] In another study done by Dixon *et al*., it was said that smaller hip and larger WC are associated with dyslipidemia and the metabolic syndrome in obese women.[10] In a study done by Chu *et al.,* on premenopausal Taiwanese women, it was concluded that WHR had the best performance in predicting hypertension and diabetes mellitus.[11] Liu *et al*., in a study "utility of obesity indices in screening Chinese post-menopausal women for metabolic syndrome," concluded that WHR and waist height ratio are the best indicators of metabolic syndrome development. It was also said in that study that a WHR of 0.85 or higher should be incorporated into the identification of metabolic syndrome risk in Chinese post-menopausal women.[12]

The utility of WHR as an effective screening measure of obesity has been observed in a study done by Hadaegh *et al.* in which it was revealed that a high WHR and general obesity are the important predictors of type-2 diabetes mellitus.[13]

A similar finding was observed in a study done by Kaur *et al*., in which it was concluded that WHR was the best predictor of type-2 diabetes mellitus and that it should be used as a routine measurement along with BMI for screening.[14]

WHR is a more reliable tool than WC when ethnic differences are taken into account. In such a situation, WHR proves superior. In a study done by Herrera *et al*., it was concluded that WHR was the most accurate anthropometric indicator to screen for high-risk coronary artery disease in the presence of interethnic differences. It was also seen that BMI was almost uninformative and WC was less reliable.[15]

In a study done by Farrag *et al.*, it was demonstrated that WHR had the best association with coronary artery disease severity.[16]

Several factors may account for the discrepancy in findings. First, the predictive power of WC is population dependent,[17] and second, it also varies from race to race. A study done by Lear *et al*.[18] also reported that ethnic descent modifies the relationship between WC and metabolic risk factors. Although most studies showed that WC may be a better reflection of the accumulation of visceral fat than WHR, it should be noted that WHR has been introduced as an appropriate index for the evaluation of chronic disease risk and it has been suggested that an increased WHR may reflect both relative abundance of abdominal fat (increased WC) and a relative lack of gluteal muscle (decreased hip circumference).[19] WHR not only shows body fat distribution but also reflects most of the lifestyle-related factors of a person. It is also independently associated with cardiovascular risk factors. Therefore, using WHR as a screening measure could definitely provide much more useful information to identify subjects with cardiovascular risk factors.

The principal limitation of this study is that it was done on a smaller population and also the fact that the causes for dyslipidemia are multifactorial. Hence, besides anthropometric measures, other factors such as heredity and lifestyle changes should also be considered.

A small amount of error can be attributed to the measurements of WC and WHR done on extremely obese subjects, in whom the exact site of waist and hip circumference becomes difficult to measure. However, the problem with the measurement of WC and WHR is restricted to the very obese population, for whom further investigation of dyslipidemia and other cardiovascular disease risk factors is done as a routine in any case. Therefore, considering that the measurement of obesity in the clinical setting is usually conducted primarily to inform further investigations, these measurements (WC and WHR) can be easily used to screen people for dyslipidemia and obesity-related complications.

CONCLUSION

Obesity and dyslipidemia are key independent modifiable risk factors for many non-communicable chronic diseases. Both obesity and dyslipidemia appear to develop from an interaction of genotype and the environment. Using simple anthropometric methods, diagnosing obesity as a possible predictor of dyslipidemia is expected to be helpful in efforts to prevent and diagnose both morbidities. This study was done to correlate anthropometric indicators of obesity such as WC, WHR, and BMI with lipid profile parameters and to identify the best indicator in predicting individuals at risk of future complications of obesity and overweight. On analyzing and comparing the data collected, I have come to the conclusion that WHR was a better indicator of dyslipidemia when compared to WC and BMI. WHR had the highest correlation signifying the importance of measuring abdominal and visceral fat in predicting dyslipidemia and associated complications. It can be used as an effective screening tool to predict dyslipidemia and the grave complications which it can lead to. Finally, it can be said that obesity is a health epidemic across the world and we have a responsibility as a society to do all we can to promote good nutrition, healthy eating, and physical activity so that we can stop the rising trend.

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