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RESEARCH ARTICLE

Association of anthropometric variables with dyslipidemia in obesity

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ABSTRACT

Background: Obesity leads to dyslipidemia and predisposes to risk of atherosclerosis and premature death. Anthropometric variables when correlated with lipid profile help to screen at risk individuals who are more susceptible for developing obesity-related morbidities. **Aim and Objective:** This study aims to determine the association of dyslipidemia of obesity with body mass index (BMI) and anthropometric indices. **Materials and Methods:** A cross-sectional observational study was done in the Department of Physiology, National Institute of Medical Science and Research, Jaipur. Lipid profile parameters were measured and compared between the groups and their association with BMI and other anthropometric indices was observed. SPSS software version 22.0 was used for statistical analysis. Mean and standard deviation was calculated for quantitative variables. The statistical difference in mean value was tested using unpaired *t*-test and one-way ANOVA. Pearson's correlation was determined between BMI, waist circumference (WC), hip circumference (HC), waist hip ratio (WHR) and lipid profile parameters. $P < 0.05$ was taken as statistically significant. **Results:** The anthropometric parameters such as weight, BMI, and WHR were found highest in the obese Class II; also, the intergroup difference was significant. The intergroup difference in the mean level of total cholesterol (TC), serum triglycerides (TGs), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C) was statistically highly significant ($P < 0.001$). BMI, WC, HC, and WHR had positive correlation with TC, serum TGs, and LDL-C and negative correlation with HDL in both obese groups. WHR was the best anthropometric variable to predict for dyslipidemia as it had the highest correlation coefficient compared to others. **Conclusion:** This study shows that there was positive correlation between dyslipidemia and anthropometric variables in obesity. Hence, simple anthropometric measurements can be used as clinical tools to target the vulnerable within the obese population to prevent various cardiometabolic complications.

KEY WORDS: Obesity; Body Mass Index; Lipid Profile; Anthropometric indices

INTRODUCTION

Obesity and overweight are defined as abnormal and excessive fat accumulation in adipose tissue to the extent of impairing normal health.[1] Body mass index (BMI) provides the most useful population level measure of obesity. Its classification allows for meaningful comparison of weight status and level of adiposity within population and identifies the at risk group. With the whole world now in the risk zone of obesity, this has become a big menace of public health in our country with the increasing modernization and imbibing of a low physical activity lifestyle.

Obesity is defined by (BMI) calculated as kilograms per square meters. Overweight according to the WHO is BMI

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≥25.00, pre-obese: BMI is 25.00–29.99, Class I obese: BMI is 30.00–34.99, Class II obese: BMI is 35.00–39.99, and Class III obese when BMI ≥40.00.[2] The Asian cutoff value for overweight and obese is BMI ≥23.0 and ≥25.0, respectively.[3] BMI fails to differentiate weight associated with muscle or fat; so, the fat content varies with body built and proportions across different ethnic populations.[4]

Obesity occurs due to complex interaction between faulty dietary habits, sedentary lifestyle, and lack of physical exercise and is aggravated by genetic predisposition in some subsets of population. The WHO states that in 2016, more than 1.9 billion adults (39%) and above were overweight and of these over 650 million (13%) were obese.[5] In India, over the past one decade, men and women who were overweight and obese (BMI ≥25.00 kg/m^2) increased from 9.3–18.6% to 12.6–20.7%, respectively.[6] Obesity itself leads to enhanced risk of development of type 2 diabetes (44%), hypertension, 23% of ischemic heart disease, gallbladder disease, 7–41% of some cancers, and degenerative bone diseases.[7]

Abdominal fat is very variable for a narrow range of BMI. High waist–hip ratio >1 in men and >0.85 in women indicates abdominal fat accumulation.[8] Recent evidences indicate that detrimental effect on cardiovascular and metabolic health is more correlated by waist circumference (WC).[9,10]

Dyslipidemia is common in obesity leading to atherosclerosis. Total cholesterol (TC) to high-density lipoprotein cholesterol (HDL-C) ratio is strongly related to risk of coronary heart disease (CHD).[11] Obese is more likely to have high cholesterol levels, which increases their risk of atherosclerosis. Higher percentage of fat accumulation in truncal area and abdomen is seen in asian Indians which makes them prone for development of insulin resistant syndrome and early atherosclerosis.[12]

The National Cholesterol Education Programme Adult Treatment Panel -III states that TC <200 mg/dl is taken as normal and levels more than 240 mg/dl are considered as risk factor for CHD. Furthermore, low-density lipoprotein cholesterol (LDL-C) more than 100 mg/dl and HDL-C <60 mg/dl are considered abnormal.[13]

Some studies done in the past suggest that both BMI and WC can predict the risk of cardiovascular disease (CVD) in an individual.[14] WC and WHR are considered better significant predictors of CVD risk when controlled for BMI as in the simplified general CVD risk score model.[15] A study done for association between cholesterol and risk of ischemic heart disease shows the positive association between them.[16] There are other meta-analysis which show us the association of serum TGs with risk of CVD, independent of cholesterol levels.[17,18]

Aims and Objectives

Primary objective

The objective of the study was to determine the anthropometric indices and lipid profile of obese and compare with normal controls.

Secondary objective

The objective of the study was to assess the association of anthropometric indices with lipid profile parameters in the above groups.

MATERIALS AND METHODS

The present study was conducted in the Physiology Department of National Institute of Medical Sciences and Research, Jaipur, after obtaining ethical clearance from the Institute's Ethics Committee. Duration of study was from June 2015 to March 2016.

A total of 60 overweight and obese subjects and 30 age- and BMI-matched normal healthy males and females aged 20–60 years were selected. They were classified as normal, overweight, and obese according to the WHO guidelines of BMI. All subjects with a history of CVD, diabetes mellitus, osteoarthritis, hypertension, asthma, and chronic obstructive pulmonary disease were excluded from the study.

Subjects reported at 9 am empty stomach for the measurement of anthropometric parameters and for giving blood sample for lipid profile. The following parameters were assessed at the time of entry (pre-test). Weight recorded to nearest 0.5 kg using a standard scale. Height was measured to nearest 0.1 cm without footwear by stadiometer in Frankfurt position. For BMI, Quetelet's index was used weight in kg overheight in m^2. WC was measured with minimal adequate clothing by the tailor's measuring tape in a plane perpendicular to the long axis body at the level of umbilicus without compression of skin during inspiration. Hip circumference (HC) measured with minimal adequate clothing across the greater trochanter with legs and feet together by a measuring tape without compressing the skin fold. Waist–hip ratio (WHR) is the ratio of WC and HC in cm and is the measure of central pattern of fat distribution.

Assessment of lipid profile was done by semi autoanalyzer. TC was reported by enzymatic end point cholesterol-oxidase/peroxidase method, triacylglycerol (triglyceride [TG]) by enzymatic glycerol phosphate oxidase/peroxidase method, and HDL-C by direct enzymatic end point method.

Statistical Analysis

Statistical analysis was done using Statistical Package for the Social Sciences version 22.0 (SPSS) software. Unpaired *t*-test and one-way ANOVA (one-way analysis of variance) were applied for the obtained data and $P < 0.05$ was taken as statistically significant. Pearson's correlation was used for obtaining the relation between BMI, anthropometric indices, and the lipid parameters.

RESULTS

Table 1 shows distribution of the study population according to BMI. Table 2 shows that the demographic parameters such as weight, BMI, and WHR were found highest in the obese Class II group as compared to obese Class I and control group, and this difference between the groups was statistically highly significant (<0.001). Table 3 shows comparative lipid profile parameters among control group, obese Class I, and obese Class II. All the lipid profile parameters except HDL were found highest in obese Class II as compared to obese Class I and control group, and this difference between the groups was statistically highly significant (<0.001). In this group, BMI had significant positive association with TC and LDL-C. WC had positive significant association with LDL-C. HC had positive significant association with serum TGs. WHR had highly significant, positive correlation with all lipid parameters [Table 4]. In this group, BMI, WC, HC, and WHR had positive association with TC, serum TGs, LDL-C, and negative association with HDL-C. HC and WHR had highly significant positive correlation with serum TGs [Table 5].

Table 1: Distribution of the study population according to BMI (*n*=90)

BMI	WHO BMI cutoffs	*n* (number of subjects)
Normal weight (controls)	≤25.00	30
Obese Class I	Between 30.00 and 34.99	30
Obese Class II	Between 35.00 and 39.99	30

BMI: Body mass index

DISCUSSION

Mean age of controls, obese Class I, and obese Class II was 40.3 ± 9.07 years, 38.7 ± 9.15 years, and 38.26 ± 8.10 years, respectively. Mean body weight of controls, obese Class I, and obese Class II was 59.43 ± 6.52 kg, 82.73 ± 5.05 kg, and 92.16 ± 6.06 kg, respectively. Mean height of controls, obese Class I, and obese Class II was 166.4 ± 5.56 cm, 161.3 ± 4.49 cm, and 157.8 ± 5.45 cm, respectively. Mean BMI of controls, obese Class I, and obese Class II was 21.23 ± 1.79 kg/m^2, 31.75 ± 1.12 kg/m^2, and 36.94 ± 1.21 kg/m^2, respectively. Mean WHR of controls, obese Class I, and obese Class II was 0.826 ± 0.046 cm, 0.96 ± 0.059 cm, and 0.958 ± 0.056 cm, respectively. All the anthropometric variables were found highest in the obese Class II as compared to obese Class I and control, and this difference between the groups was statistically highly significant [Table 2]. TC, serum TGs, and LDL-C were very much elevated in obese Class II and the intergroup difference was also highly significant [Table 3]. BMI was positively correlated with TC (significant in obese Class I, r = 0.406, $P = 0.026$ and r = 0.135 for obese II), serum TGs (r = 0.059 for obese I and 0.317 for obese II) and LDL-C (highly significant in obese Class I, r = 0.565, $P = 0.001$ and r = 0.195 for obese II) and negatively correlated with HDL-C (r = −0.043 in obese I and −0.145 in obese II) in our study [Tables 4 and 5]. WC was positively correlated with TC (r = 0.338 and 0.073), serum TGs (r= 0.053 and 0.037), and LDL-C (r = 0.365 and 0.122) and negatively correlated

Table 2: Baseline characteristics of obese Class I, obese Class II, and control group

Parameter	Control group, *n*=30	Obese Class I, *n*=30	Obese Class II, *n*=30	*P*-value
Age (years)	40.3±9.07	38.7±9.15	38.26±8.10	0.64
Weight (kg)	59.43±6.52	82.73±5.05	92.16±6.06	<0.001
Height (cm)	166.4±5.56	161.3±4.49	157.8±5.45	<0.001
BMI (kg/m^2)	21.23±1.79	31.75±1.12	36.94±1.21	<0.001
WHR	0.826±0.046	0.96±0.059	0.958±0.056	<0.001
WC (cm)	85.67±5.115	102.57±6.781	115.63±6.250	<0.001
HC (cm)	103.27±6.125	106.73±8.060	120.33±5.241	<0.001

Data presented as Mean±SD, BMI: Body mass index, WHR: Weight–hip ratio, WC: Waist circumference, HC: Hip circumference. SD: Standard deviation

Table 3: Comparative lipid profile parameters among controls, obese Class 1, and obese Class 2

Parameter	Controls, *n*=30	Obese Class I, *n*=30	Obese Class II, *n*=30	*P*-value
Total cholesterol	188.76±7.32	203.4±25.69	246.36±28.76	<0.001
Serum triglycerides	112.16±14.82	142.5±24.28	163.96±21.8	<0.001
HDL	55.93±4.41	44.06±5.56	42.76±3.27	<0.001
LDL	110.05±6.83	130.8±19.28	170.8±24.65	<0.001

Data presented as Mean±SD; HDL: High-density lipoprotein, LDL: Low-density lipoprotein. SD: Standard deviation

Table 4: Pearson's correlation between BMI, WC, HC, and WHR with lipid profile parameters in obese Class 1

Variables	T. cholesterol	Serum triglyceride	HDL	LDL
BMI				
R	0.406*	0.059	−0.043	0.565**
p	0.026	0.756	0.821	0.001
WC (cm)				
r	0.338	0.053	−0.238	0.365*
p	0.068	0.782	0.205	0.047
HC (cm)				
r	0.356	0.449*	−0.270	0.285
p	0.054	0.013	0.150	0.128
WHR				
r	0.774**	0.606**	−0.548**	0.719**
p	0.000	0.000	0.000	0.000

*Correlation is significant at the 0.05 level (two tailed); **Correlation is significant at the 0.01 level (two tailed); r: Pearson correlation coefficient; p: Significance. BMI: Body mass index, WC: Waist circumference, HC: Hip circumference, HCL: High-density lipoprotein, LDL: Low-density lipoprotein

Table 5: Pearson's correlation between BMI, WC, HC, and WHR with lipid profile parameters in obese Class 2

Variables	T. cholesterol	Serum triglyceride	HDL	LDL
BMI				
r	0.135	0.317	−0.145	0.195
p	0.476	0.088	0.446	0.303
WC (cm)				
r	0.073	0.037	−0.231	0.122
p	0.703	0.844	0.219	0.521
HC (cm)				
r	0.335	0.617**	−0.284	0.244
p	0.070	0.000	0.128	0.194
WHR				
r	0.310	0.409*	−0.012	0.290
p	0.096	0.025	0.951	0.119

*Correlation is significant at the 0.05 level (two tailed); **Correlation is significant at the 0.01 level (two tailed); r: Pearson correlation coefficient; p: Significance. BMI: Body mass index, WC: Waist circumference, HC: Hip circumference, HCL: High-density lipoprotein, LDL: Low-density lipoprotein

with HDL-C (r = −0.238 and −0.231), respectively, in the obese I and obese II groups [Tables 4 and 5]. HC was positively correlated with TC (r = 0.356 and 0.335), serum TGs (significant in both obese classes; r = 0.449 and 0.617), and LDL-C (r = 0.285 and 0.244) and negatively correlated with HDL-C (r = −0.270 and −0.284), respectively, in both the obese groups [Table 4 and 5]. WHR was positively correlated with TC (r = 0.774 and 0.310), serum TGs (r = 0.606 and 0.409), and LDL-C (r =0.719 and 0.290) and negatively correlated with HDL-C (r = −0.548 and −0.012), respectively, in obese I and II groups (this correlation was highly significant with all lipid parameters in obese Class I and significant with serum TGs in obese Class II) [Table 4 and 5]. Anthropometric parameters have been used in various studies for predicting the cardiometabolic risk associated with obesity in different studies. One of the consequences of obesity is development of metabolic syndrome.[19] Other most recognized complications of obesity include coronary artery disease, high blood pressure (BP), stroke, type 2 diabetes, cancer, sleep apnea, gallstones, osteoarthritis, and hyperlipidemia.[20] BMI has its own limitations in predicting adiposity since it cannot say about the regional distribution of fat, especially the abdominal fat which is said to be the main contributor toward development of diabetes, dyslipidemia, high BP, etc.[21] Many studies have documented that WC is a better indicator of abdominal adiposity and metabolic risk.[22] According to the National Institutes of Health, a WC ≥ 88 cm in women and a WC ≥102 cm in men who are overweight and have BMI ≥25 kg/m^2 should be screened for ill effects of obesity.[23]

A significant increase in three lipid profile parameters – TC, serum TG, and LDL-C and decrease in HDL-C in obese compared to controls were observed in this study. Similar results as ours were found in other studies.[24-26] Similar findings were also seen in a study done in children where the lipid profile parameters were significantly higher in obese children compared to normal weight children.[27] In a study done by Pisharody and Prasad in obese young adults also, similar results were obtained.[28] The finding that was different from ours in this study was with HDL levels, which was not significant in obese and non-obese groups (intergroup difference in HDL is significant in our study).

Coming to the correlations of the anthropometric indices with lipid profile parameters, we found positive correlation of BMI, WC, HC, and WHR with TC, serum TGs, and LDL-C and negative correlation with HDL levels. Similar results as ours were found in other studies.[25,29,30] Furthermore, from this study, we found that BMI definitely has a positive significant correlation with TC and LDL-C, but WHR had highly significant, stronger positive correlation with all lipid parameters than BMI on comparison [Tables 4 and 5]. Hence, WHR was best predictive of dyslipidemia than HC, BMI, or WC in this study. Similar findings with WHR were found in other studies.[31,32]

The strength of this study is that WHR was found to be a very strong predictor for dyslipidemia as it significantly correlated with serum TGs which are the component responsible for the development of cardiovascular disorders. Similar results were deciphered from the study of lipid profile done in young adults in Canada.[33] Similar result where central obesity predicted more with atherogenic index than BMI was found in another study.[34] Hence, we can conclude from this study that WHR is the most important anthropometric index for obese subjects for risk screening rather than BMI as it had higher coefficient correlation value. Therefore, this study reiterates the fact that anthropometric indices are very powerful simple clinical, non-invasive screening tools for dyslipidemia in overweight and obese population. The limitation was that the sample size was very small- and large-scale community surveys in different regions of India should be done. Furthermore, due to small sample size, ethnocultural and sex-wise analysis were not done which have a great bearing on the association between the measures of adiposity and dyslipidemia.

CONCLUSION

In the present times when highly sophisticated instruments for accurate measurement of body fat distribution and body composition analysis are available, we can accurately pin point the at risk group. However, most of the centers do not have access to them and it is here the simple anthropometric measurements of body and lipid profile analysis can be used as an alternative. Obesity strongly correlates with dyslipidemia and altered lipid profile status. Furthermore, from this study, we can say that WHR is the most specific parameter that can be used in the clinical setup to identify within obese subjects those who are more predisposed for developing CVD and treated appropriately.

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