ORIGINAL ARTICLE

CORRELATION OF THIGH CIRCUMFERENCE WITH ANTHROPOMETRIC INDICES AND CARDIOVASCULAR DISEASE RISK FACTORS

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Background: Cardiovascular diseases are the major cause of mortality both in developed and developing countries. Anthropometric indices such as BMI, Waist circumference, Waist Hip ratio, have been used as parameter to identify CVD risk. However, thigh circumference is under studied as an anthropometric parameter to identify CVD. The objective of this study was to examine the association of various anthropometric indices with CVD risk factors. **Methods:** This cross-sectional study was conducted during October to December 2018 in Hyderabad City, Pakistan. Data collection involved anthropometry and blood collection for assessment of CVD risk factors. Anthropometric parameters including waist circumference (WC), hip circumference (HC), mid upper arm circumference (MUAC), and thigh circumference (TC) were measured using measuring tape nearest to 0.1 Cm in standing position. The lipid profile, cholesterol, HDL, LDL and VLDL were measured using specific kits. **Results:** A total of 373 adults were selected for this study, 207 males and 166 females. The mean age of the adult males and females was 49.43±11.87 and 49.04±11.86 years respectively. BMI, WC, waist-hip ratio (WHR) and MUAC positively correlated with CVD risks factors whereas TC was positively correlated with HDL. **Conclusion:** TC may be a reliable parameter to estimate HDL. Increase in thigh circumference reduces the risk of cardiac disease.

Keywords: Cardiovascular disease, thigh circumference, high density lipoprotein, anthropometry

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INTRODUCTION

Cardiovascular diseases (CVD) are leading cause of morbidity and mortality across the world and hence a major public health issue. The proportion mortality rate due to cardiac diseases is higher in low and middle income countries in comparison with technologically developed countries.[1] Mortality rate due to cardiac diseases was estimated to be around 17 million annually in all over the world[2,3], while the morbidity compared to mortality was 8 times higher due to CVD risk factors[4,5]. CVD in lower and middle income countries of various regions affect the social and economic growth.[5] Compared with United States and Portugal, a substantial proportion of young from South Asian countries were on greater risk of mortality due to cardiovascular diseases. This highlights the impact of socio-economic status on their families and burden of CVD.[6] According to an estimate, Indians may suffer a great loss in very productive life years due to rise in the burden of CVD in age group ranging 35–64 year.[7] The combined effect of loss of very productive years of young adults and the rise in burden of chronic diseases including CVD on the society will have the worst impact on human development.[8]

Cardiovascular risk factors are categorized into two groups, i.e., modifiable CVD risk factors and non-modifiable CVD risk factors. Non-modifiable cardiovascular risk factors vary in different people. This variation includes important difference in the prevalence, severity and the onset of risk factors by race/ ethnicity[9], age, gender[10], area distribution, i.e., urban and rural and socioeconomic status. The changing life style has affected the eating and physical activity habits. The sedentary life style and high energy caloric diet leads to increase in risk of CVD including, dyslipidemia, hypertension, diabetes mellitus, smoking, obesity, psychological stress, lack of physical activity, use of alcohol.[11] According to World Health Organization smoking, unhealthy food, physical inactivity and alcohol use may be considered as the primary life style risk factors which substantially contribute to the rise in CVD burden.[5] Modifiable CVD risk factors like over nutrition, physical inactivity, and smoking are increasing the burden of CVD around the globe. Increased adiposity has been associated with CVD. Therefore, the use of adiposity as measuring indictor for CVD risk assessment, is important for clinicians to take informed clinical decisions while treating CVD patients and adopting strategies to prevent the CVD.

The anthropometric measurements are generally used to assess the status of health in population. Disturbances in anthropometric measurements including Body Mass Index (BMI), Middle Upper Arm Circumference (MUAC), Waist circumference (WC), Waist Height Ratio (WHtR), and waist-hip ratio (WHR) are associated with different diseases including obesity, malnutrition, metabolic

syndrome, anaemia and CVD.[12–14] However, use of above mentioned methods is arguable, for example, the use of BMI cannot decipher the discrepancies in the lean mass and fat mass. BMI cut-offs are subjected to variance according to ethnicity, age, and gender.[15] Therefore, other parameters including WC, WHR, and WtHR were introduced to measure and study adiposity in context of CVDs and other diseases.[14,16]

WC is considered better among these measurements because of its good correlation with abdominal fat and its association with CVD.[16] However, WC cannot be used for assessment of height. Therefore, WtHR was used as an alternative measurement indicator to predict CVD.[17] The use of adiposity to predict CVD risk factor is debatable due to pros and cons of each method to assess the adiposity. For instance, some studies show that WtHR tend to be more positive in Caucasians than Asian population.[18,19] Studies showed WC as more reliable indicator to measure the adiposity in western population.[20,21] Thigh circumference has been reported as cardio protective indicator.[22] Thigh circumference (TC) has not been studied extensively in the context of CVD risk factors. In the present study, we assessed the association of BMI, WC, HC, WHR, TC and MUAC with CVD risk factors including Blood Fasting Sugar (BFS), Cholesterol, Triglycerides (TGs), High Density Lipoproteins (HDL), Low Density Lipoproteins (LDL), and Very Low Density Lipoproteins (VLDL).

MATERIAL AND METHODS

This cross-sectional study was conducted from October to December 2018. The subjects included in the study were from randomly selected areas including Qasimabad, Latifabad, Heerabad, and Hyderchowk of Hyderabad City, Pakistan. Ethical approval was obtained from Institutional Review Board of Department of Physiology, University of Sindh, Jamshoro. All healthy individuals who were willing to participate in the study were included in the study and informed consent was obtained from participants. Subjects on any medication and who were not willing to participate in the study were excluded from the study. The data were collected on a pre-designed structured questionnaire. Information on socio-demographic distribution, family history of diseases and diet were obtained through the questionnaire.

Data collection involved anthropometry and blood collection for assessment of CVD risk factors. For anthropometry participants were asked wearing simple plain clothes and take off their shoes and slippers during the measurements. BMI was calculated from height in meters and weight in Kg. Anthropometric parameters including WC, HC, MUAC, and TC were measured using measuring tape nearest to 1 Cm in standing position. Blood pressure was measured using mercury sphygmomanometer.

Ten mL blood was collected from participants who had fasted for at least 8 hours. Serum was obtained by centrifuging the samples at 5,000 rpm for 5 minutes. Serum was then kept at -20 °C until analyzed. Samples were analyzed using Microlab-300®. Lipid profile, cholesterol, HDL, LDL, and VLDL were measured using specific kits.

Statistical analysis was carried out using SPSS-23 and $p<0.05$ was taken as significant. Spearman Correlation was obtained by r-value for finding out the possible association between the anthropometric measurements and CVD risk factors.

RESULTS

Total 373 participants aged 28 to 73 years were randomly selected. Among the participants 207 (55.49%) were males and 166 (44.5%) were females (Table-1). Mean age of the males and females was 49.43±11.87 and 49.04±11.86 years, and mean BMI was 25.47±4.47 and 25.26±4.53 Kg/m^2, respectively. Mean waist circumference of males was 86.64±11.30 Cm, and for female it was 86.90±13.19 Cm. Mean hip circumference of male adults was 96.83±9.02 Cm, and in female it was 96.08±7.71 Cm. Mean WHR for male adults was 0.89±0.83 and for female adults it was 0.90±0.12 Cm. Mean TC for male adults was 44.36±6.01 Cm, and for females it was 44.04±6.35 Cm. Mean MUAC for male adults was 27.43±4.56 Cm, and for female adults it was 27.17±4.64 Cm.

Mean Blood Sugar Fasting (BSF) for males was 103.27±32.83 mg/dL, and for females it was 102.71±37.63 mg/dL. Mean Cholesterol (CHOL) for male adults was 155.57±34.86 mg/dL, and for females it was 158.88±33.84 mg/dL. Mean Triglycerides (TG) were 145.21±36.14 mg/dL and 145.40±43.66 mg/dL for males and females respectively. Mean LDL was 122.13±18.43 mg/dL and 123.12±15.90 mg/dL respectively for males and females. Mean VLDL was 29.33±7.21 g/dL and 28.85±8.51 mg/dL respectively for men and women, and mean HDL was 35.82±6.46 mg/dL and 36.78±6.86 mg/dL for men and women respectively.

Table-2 shows the correlation of anthropometric indices with CVD risk factors in male respondents. Both BMI and MUAC positively correlated with FBS, Cholesterol, Triglycerides, LDL and VLDL. Waist Circumference correlated positively with BSF, Cholesterol, Triglycerides, and VLDL, while negatively with HDL. Only Cholesterol correlated positively with HC. WHR positively correlated with all parameters except LDL and HDL. Thigh circumference was positively correlated with HDL only.

The data from female respondents indicate that BMI was positively correlated with all parameters except LDL and HDL (Table-3). WC positively

correlated with all parameters whereas HC correlated with all except BSF and LDL. WHR and MUAC positively correlated with all except HDL. There was positive correlation of TC with HDL.

Table-1: Gender-wise distribution of basic characteristics of participants

Characteristic	Male (n=207) Mean±SD	Female (n=166) Mean±SD
Age (Year)	49.43±11.87	49.04±11.86
BMI (Kg/m^2)	25.47±4.47	25.26±4.53
WC (Cm)	86.64±11.30	86.90±13.19
Hip (Cm)	96.83±9.02	96.08±7.71
WHR	0.89±0.08	0.90±0.12
TC (Cm)	44.36±6.01	44.04±6.35
MUAC (Cm)	27.43±4.56	27.17±4.64
BSF (mg/dl)	103.27±32.83	102.71±37.63
CHOL (mg/dl)	155.57±34.86	158.88±33.84
TRIG (mg/dl)	145.21±36.14	145.40±43.66
LDL (mg/dl)	122.13±18.43	123.12±15.90
VLDL (mg/dl)	29.33±7.21	28.86±8.51
HDL (mg/dl)	35.82±6.46	36.73±6.86

Table-2: Correlation of various anthropometric indices with CVD risk factors in male respondents

Variable	BSF	CHOL	TG	HDL	LDL	VLDL
BMI	0.324**	0.397***	0.293***	0.056	0.182*	0.293***
WC	0.215**	0.303***	0.216**	-0.179*	0.067	0.367***
HC	0.025	0.180*	-0.009	0.023	0.041	-0.006
WHR	0.256**	0.262**	0.285***	0.006	0.073	0.285***
TC	0.067	0.135	0.030	0.157*	-0.117	0.041
MUAC	0.203*	0.394***	0.295***	0.059	0.160*	0.290***

*Significant at $p<0.05$, **Highly significant at $p<0.01$

Table-3: Correlation of various anthropometric indices with CVD risk factors in female respondents

Variable	BSF	CHOL	TG	HDL	LDL	VLDL
BMI	0.335***	0.409***	0.312***	0.169*	0.138	0.307***
WC	0.295***	0.463***	0.309***	0.272**	0.207*	0.306***
HC	0.063	0.175*	0.202*	0.167*	0.057	0.186*
WHR	0.388***	0.364***	0.180*	0.162	0.182*	0.191*
TC	-0.021	0.114	0.064	0.492***	-0.05*	0.059
MUAC	0.266**	0.459***	0.367***	0.009	0.285**	0.373***

*Significant at $p<0.05$, **Highly significant at $p<0.01$

DISCUSSION

The objective of the current study was to assess correlation of the various anthropometric indices with CVD risk factors. BMI has been reported the most common index, however it is not considered as reliable and WC is used instead as the reliable anthropometric index for assessing CVD risk factors.[19] MUAC has recently been used as an indicator for measuring not only malnutrition but also obesity. WHR is used as the common tool for measuring not only obesity but other CVD risk factors also.[23] Thigh circumference along with Neck circumference have recently been included as the anthropometric indices for measuring CVD risk factors.[22,24]

Our data corroborate other studies[25] and indicate that BMI and MUAC both can be used equally as a tool for measuring CVD risk factors. The WC was the most reliable for measuring CVD risk factors in both male and female, however, in male WC had negative correlation with HDL while in females it had positive correlation. This suggests the males might be at more risk of developing CVDs when their WC is increased. WC was weekly correlated with CVD risk factors and it has been consistent with other studies. WHR is a valid indicator for measuring CVD risk factors; WHR has been previously used in the same way.[26]

Thigh circumference has not been extensively used as anthropometric indicator, however, in a large cohort study it was reported that cardiac patients with decreased thigh circumference had higher mortality rate.[22] The data we present here indicate the correlation of thigh circumference with CVD risk factors as cardio-protective indicator, which is reflected with the finding that thigh circumference is positively correlated with HDL. Our data is consistent with the study conducted at Korea Medical Institute which also indicates that decreased thigh circumference has positive association with decreased level of HDL[27]. Our data with all other previously published indicate thigh circumference as the cardio-protective indicator[22], however, further studies are needed to investigate the role of thigh circumference as a cardio-protective indicator.

CONCLUSION

Thigh Circumference may be used as an anthropometric indicator to measure CVD risk factors. The positive correlation of TC with HDL indicates that increase in thigh circumference may be associated with reduced risk of cardiac diseases. This study will help in adding thigh circumference as an anthropometric indicator for assessment of CVD risk factors.

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