

RELATIONSHIP BETWEEN CARDIOVASCULAR FUNCTION AND MARKERS OF ADIPOSITY IN YOUNG FEMALE SUBJECTS

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ABSTRACT

Background: Adiposity of a subject depends on pattern of distribution of body fat and is assessed by various anthropometric markers. Measurement of blood pressure and assessment of cardiorespiratory fitness are the two most important parameters to evaluate the cardiovascular functional status of a subject. Age, sex and genetics play vital role in development of adiposity and thus effect cardiovascular function of the subject from different ethnic back ground.

Aims & Objective: The current study was designed to evaluate various anthropometric markers of adiposity, blood pressure and cardiorespiratory fitness in young female subjects from both nontribal (Bengali) and tribal community of Tripura, a north-eastern state of India and to evaluate the relationship between the markers of adiposity and cardiovascular function of the subject.

Material and Methods: Seventy five nontribal (Bengali) and seventy five tribal female (18 -25 years of age) subjects were included in the study through random selection. The basal metabolic rate (BMI), the waist-hip ratio (WHR), the waist -height ratio (WHtR) and body fat (%) of the subjects were evaluated. The basal blood pressure of the subjects were recorded. The cardiorespiratory fitness of the subjects were evaluated by using Queen's College Step Test.

Results: There was no significant difference in the general characteristics of the subject from different ethnic background, except that the total body fat (%) was significantly less in tribal females. Both systolic and diastolic blood pressure correlated positively with BMI, WHR and WHtR of the females from both the communities. There was a negative correlation between adiposity markers and cardiorespiratory fitness of the subject.

Conclusion: The result of the present study suggests that obesity, especially central obesity, in young female subjects, reduces the cardiovascular fitness and increases the risk of prehypertension, irrespective of their ethnicity.

Key-Words: Body Mass Index; Waist-Hip Ratio; Waist-Height Ratio; Blood Pressure; Cardiorespiratory Fitness

Introduction

Cardiovascular disease is a primary cause of morbidity and mortality worldwide, including India.^[1] Obesity is the major risk factor for cardiac disease and metabolic disorder.^[2] In general, physical fitness levels of obese people at any age is much less than their leaner counterparts. A lower level of physical fitness during young age is an independent risk factor for future development of chronic disease, including cardiovascular disorders (CVDs).^[3]

Several studies have documented both basal metabolic rate (BMI) and central adiposity as independent risk for CVDs in different groups of population.^[4] Recent research, however, suggests that distribution of body fat, for which BMI does not account, is a more important indicator of cardiovascular risk.^[5] Anthropometric indicators of body fat distribution used in epidemiological studies include assessment of waist circumference (WC), waist-hip ratio (WHR) and waist-height ratio (wHtR).^[6]

Measurement of blood pressure and cardiorespiratory

fitness (VO₂ max) are the two most important parameters to assess cardiovascular functions of an individual.^[7] Low cardiorespiratory fitness seems to be a stronger predictor of both for all cause of mortality from cardiovascular disorders than any other established risk factors. Furthermore, cardiorespiratory fitness might play a protective role against the cardiovascular risk associated with obesity.^[8]

Obesity is a multifactorial condition that is often attributed to genetic back ground, nutritional habits and physical activity pattern. Moreover, pattern of distribution of body fat is age, sex and population specific.^[1] Environment also acts as a major trigger for obesity and thus play role in development of CVD.^[9] Reports suggests that there is a clear link between ethnicity of the subject and obesity and CVD.^[10] Current demographic shift and nutritional transition seen in India plays a major role in development of nutrition related disease, specially, CVD in different groups of Indian population.^[11]

Therefore, it is important to study the pattern of obesity and its associated adverse health effects in different groups

of people with diverse biological, ethnic and sociocultural back grounds. In view of this, in the present study we evaluated various obesity markers and its relationship with the cardiovascular function in young female subjects from both nontribal (Bengali) and tribal communities of Tripura, a North Easter state of India.

Materials and Methods

The study was carried out among 150 randomly selected female college and university students with in the age group of 18-25 years, 75 belonging to each Bengali and tribal population of the state. Exclusion criteria for the study included self-reported presence of hypertension or diabetes, and use of any form antihypertensive, antidiuretics, antihyperlipedemics or oral contraceptives. The purpose of the study and methodologies to be adopted were explained to each subject. Only subjects agreed to volunteer and signed a written consent were included for the study. The entire protocol was approved by the Institutional Ethical Committee.

Subjects height and weight were measured following the standard procedure mentioned earlier and body mass index were calculated.^[12] Waist and hip circumference and skin fold thickness at biceps, triceps and suprailiac region were measured according to the standard protocol.^[13] Waist-hip ratio and waist-height ratio were calculated. Skinfold thickness taken over different sites were used to calculate grand mean thickness and body density, which was then used in Siri's equation to calculate body fat percentage.^[14]

$$\% \text{ Body Fat} = (4.95 / D - 4.50) \times 100; D = \text{body density}$$

The baseline heart rate was recorded in sitting position after five minutes rest at carotid pulse. Blood pressure of the subject is recorded by using aneroid sphygmomanometer in sitting position. Cardiorespiratory endurance (VO₂ max) of the subject was evaluated by using Queen's College Step Test.^[15] Queens College Step Test provides an measure of cardiorespiratory fitness or endurance of the subject and is defined as the greatest rate at which oxygen can be consumed during exercise. The step test was performed on a stool of 16.25 inches (41.3 cm) height for a total duration of 3 minutes at the rate of 22 cycles per minute. After completion carotid pulse of the subject was recorded from 5 – 20 seconds, which was later converted for beats per minute, and following equation was used to calculate endurance of the subject.

$$VO_2 \text{ max (ml} \cdot \text{kg} \cdot \text{min)} = 111.33 - (0.42 \times \text{step test pulse rate})$$

Statistical analysis was done by using statistical software SPSS version 17.0. Means and standard deviation were calculated for all the variable. Intergroup analysis was done using 'one way' ANOVA. The level of significance was set at p<0.05. Pearson's correlation test was applied to correlation between the parameters.

Results

The general physical characteristics of the subject is presented in Table 1. There is no significant difference in general physical characteristics between tribal and nontribal (Bengali) female subjects of 18-25 years of age. The total body fat (%) was found to be significantly (P < 0.05) less in tribal female in comparison to Bengali subjects.

Table-1: General characteristics of the study subject

| Variables | Nontribal (Bengali) Participants (n= 75) | Tribal Participants (n = 75) |
|--------------------------------------|--|------------------------------|
| Height (cm) | 152.2 ± 5.16 | 149.0 ± 6.95 ^{NS} |
| Weight (kg) | 47.6 ± 7.52 | 49.3 ± 6.32 ^{NS} |
| Body mass index (kg/m ²) | 22.3 ± 3.26 | 22.9 ± 2.72 ^{NS} |
| Waist – Hip ratio | 0.69 ± 0.03 | 0.74 ± 0.07 ^{NS} |
| Waist – Height ratio | 0.46 ± 0.06 | 0.48 ± 0.05 ^{NS} |
| Body fat (%) | 17.4 ± 4.62 | 13.9 ± 5.29* |
| Systolic Blood Pressure (mmHg) | 110.7 ± 10.30 | 104.2 ± 9.37 ^{NS} |
| Diastolic Blood Pressure (mmHg) | 74.4 ± 8.80 | 70.8 ± 9.63 ^{NS} |
| VO ₂ max (ml/min/kg) | 35.47 ± 2.43 | 37.38 ± 2.66 ^{NS} |

Values are in Mean ± SD; NS – Not Significant; * P < 0.05

Table-2: Subjects in different categories of BMI and Blood pressure

| Variables | Nontribal (Bengali) Participants (n= 75) | Tribal Participants (n = 75) |
|-----------------------|--|------------------------------|
| Under weight (< 18.5) | NIL | NIL |
| BMI | Normal weight (≥ 18.5 - 24.9) | 53 / 75 (70.6%) |
| | Overweight (≥ 25 – 29.9) | 16 / 75 (21.3 %) |
| | Obese (≥ 30) | 06 / 75 (8.1%) |
| Blood Pressure | Normotensive (100 -120/60 -80 mmHg) | 56 / 75 (74.6%) |
| | Prehypertensive (120-139/80 – 89 mmHg) | 17 / 75 (22.6%) |
| | Hypertensive (≥ 140/ ≥ 90 mmHg) | 02 / 75 (02.8%) |

Table-3: Correlation between blood pressure and different adiposity markers of the subject

| Variables | Systolic Blood Pressure | | Diastolic Blood Pressure | |
|----------------------|-------------------------|---------------|--------------------------|---------------|
| | Nontribal Female | Tribal Female | Nontribal Female | Tribal Female |
| BMI | 0.29* | 0.34* | 0.33* | 0.31* |
| Waist – hip ratio | 0.44** | 0.40** | 0.37** | 0.42** |
| Waist – height ratio | 0.48** | 0.51** | 0.45** | 0.39** |
| Body fat (%) | 0.17 | 0.14 | 0.23 | 0.27 |

*p < 0.05; **p < 0.01

Table-4: Relationship between Cardiorespiratory Fitness and Different Adiposity markers of the Subject

| Variable | Nontribal Participants | | Tribal Participants | |
|----------------------|------------------------|-------|---------------------|--------|
| | r | p | r | p |
| BMI | -0.860 | 0.001 | -0.880 | 0.001 |
| Waist – Hip Ratio | -0.610 | 0.01 | -0.425 | 0.05 |
| Waist – Height Ratio | -0.403 | 0.05 | 0.01 | -0.580 |
| Body fat (%) | -0.140 | 0.14 | -0.180 | 0.12 |

Table 2 represents the number of subjects in different categories of BMI and blood pressure. Number of overweight subjects were more among Bengali females. Number of subjects with prehypertension were also found to be more among Bengali females. The linear correlation presented in Table 3 shows that there is a positive correlation between both systolic and diastolic blood pressure with the markers of adiposity like BMI, WHR and WHtR of the subject. The cardiorespiratory fitness of the subject correlated negatively with BMI, WHR and WHtR (Table 4). None of the parameters correlated with body fat (%) (Table 3 & 4).

Discussion

The present study aimed to examine relationship between various markers of adiposity and cardiovascular function status in young tribal and nontribal (Bengali) female subjects from Tripura. It is observed that there is no significant difference in general physical characteristics between tribal and nontribal female subjects of 18 – 25 years of age except for the total body fat (%), which was found to be significantly less in tribal female in comparison to Bengali subjects (Table 1). Such ethnic difference in the pattern of fat distribution is observed in Indian subjects by various workers.^[16] Leslie WD, et al., observed that mean trunk adiposity index was strongly related to the ethnicity in case of First Nations and white Canadian women.^[17] Both genetic and environmental factors may be responsible for ethnic difference in adiposity.^[16]

The basal blood pressure in nontribal Bengali female was marginally higher than the tribal female (Table 1). Number of subjects with prehypertension on the basis of both systolic and diastolic blood pressure was found to be more among the Bengali female (Table 2). Similar observation on ethnic difference in blood pressure among subjects from different ethnic groups of India was observed by Kapoor et al.^[18]

In our study, we have observed a positive correlation between blood pressure and BMI of the subject (Table 3). Such type of positive correlation between blood pressure and BMI is reported by several workers.^[19] Studies on relationship between adiposity and blood pressure in patients with symptomatic vascular disease also revealed that the relationship between general and abdominal adiposity persists after onset of symptomatic arterial disease in both men and women.^[20]

There are reports that suggest that a simple relationship between blood pressure and adiposity does not exist

below a critical level BMI. It is explained on the basis that the subjects having BMI below the critical level suffers from nutritional stress and that may alter BMI blood pressure relationship.^[21] However, none of our subjects is found to have BMI below the critical level and we observed a linear relationship of blood pressure with BMI of the subject.

Recent observations suggest that other indicators of obesity like waist circumference (WC), waist-hip ratio (WHR) and waist-height ratio (WHtR) are better determinants of hypertension than BMI as they indicate the central adiposity and visceral fat distribution.^[19] In our study, we have observed that WHtR was the best predictor of increased blood pressure in female subjects from both the population (Table 3). This is in agreement with the findings from different population of India.^[18] This findings highlight the point that anthropometric indicators most widely used in epidemiological studies may not reflect same risk in different population.^[19]

The relationship between various obesity indices and cardiorespiratory endurance of the subject revealed that cardiorespiratory endurance was low for obese subjects from both the groups (Table 4). Wi-Young So and Dai-Hyuk Choi observed similar relationship between cardiovascular endurance and obesity in Korean male subjects. Obesity overloads the heart through increase in triglycerides and low-density lipoprotein level and decrease in high density lipoprotein levels that might affect the endurance of heart adversely.^[22] Obesity may also effect the functioning of heart by increasing the rate of firing of sympathetic nerve and thus increasing the preload on heart.^[23]

A number of longitudinal studies have associated weight gain with low cardiorespiratory fitness at youth and clustering of cardiovascular risk factors in adulthood.^[24] Various long term prospective studies have also found both CRF and obesity to be strong predictors of CV mortality.^[25] However, recent findings indicate that different mechanism is involved with the protective effect of fitness as compared to carrying less fat. Reduced CRF is associated with decreased arterial compliance which lead to increased cardiac afterload and, in turn, left ventricular hypertrophy, reduced coronary perfusion and increased CV mortality.^[5]

Conclusion

In conclusion, the results of the present study suggest that obesity at youth in female subjects, irrespective of their ethnicity, reduces the cardiovascular endurance and

increases the risk of prehypertension. Central obesity in female at youth is the main factor that effects cardiovascular function and increases the risk of future development of cardiovascular disease.

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