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EFFECT OF GENDER ON THE ASSOCIATION OF ADIPOSITY WITH CARDIOVASCULAR REACTIVITY IN GUJARATI INDIAN ADOLESCENTS

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Abstract : Studies have reported that both gender and adiposity influence cardiovascular reactivity amongst adolescents. However, not much is known about the effect of gender on the association of adiposity with cardiovascular reactivity. The current study was conducted to learn how gender affects the association of adiposity with cardiovascular reactivity in the Gujarati Indian adolescents so as to develop preventive strategies for the local population. A cross-sectional study was conducted on 428 (Girls-173, Boys-255) Gujarati Indian adolescents of age group 16-19 years. Adiposity was assessed in terms of Body Mass Index (BMI), Body Fat Percentage (BF %), Fat Mass (FM), Fat Mass Index (FMI) and Waist Circumference (WC). Percentage Rise in Pulse Rate (%RPR) and Percentage Rise in Diastolic Blood Pressure (%RDBP) during Isometric Handgrip Test were used to assess the cardiovascular reactivity to acute sympathetic stress. Pearson's correlation coefficient was determined to find the association of adiposity with cardiovascular reactivity. Boys were found to have a significantly larger WC, higher physical fitness and greater %RDBP in comparison to girls while girls had a significantly higher BF% and FMI in comparison to boys. In both boys and girls, BMI, BF%, FMI and WC showed significant positive association with %RDBP with stronger correlationship found in girls. Girls also showed a significant negative correlationship between physical fitness and vascular reactivity. It could thus be concluded that gender affected the association of adiposity with vascular reactivity in Gujarati Indian adolescent such that girls tend to have a larger correlationship between adiposity and vascular reactivity than boys which is most likely due to lower physical fitness.

Key words : gender; total adiposity; visceral adiposity; cardiovascular reactivity; physical fitness; Gujarati Indian adolescents

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INTRODUCTION

Pathophysiological imbalances in cardiovascular autonomic activity, cardiovascular reactivity to physical and mental stress, insulin sensitivity, leptin sensitivity, plasma lipid profile, vascular endothelial function and functioning of Renin-Angiotensin System (RAS) have been implicated in the obesity associated rise in blood pressure (1, 2). Central (Visceral) adiposity is shown to have a larger influence on the cardiovascular risk factors for hypertension as compared to peripheral adiposity across all the age groups (3, 4). However, studies have also reported that differences exist in the etiopathogenesis of hypertension across varied ethnic populations, age groups and gender (5, 6, 7, 8, 9). A study conducted by us on the Gujarati Indian adolescents showed that adiposity had significant positive correlationship with pulse pressure amongst boys while an insignificant correlationship in girls suggesting that gender differences exist in the risk of obesity associated rise in blood pressure amongst the Gujarati Indian adolescents (10). Since exaggerated cardiovascular reactivity is associated with obesity and is considered as a risk factor for hypertension (1, 11), it is essential to understand how gender influences the effect of adiposity on cardiovascular reactivity in Gujarati Indian adolescents and to know which of the adiposity indices has a predominant effect on the cardiovascular reactivity according to gender so as to help in framing guidelines for preventive measures.

MATERIALS AND METHOD

A cross-sectional study was conducted from January 2007 to March 2008 after the approval from the human research ethical committee of the institute and obtaining informed consent from the participants or their parent/guardian. Adolescents of age group 16-19 years, both boys and girls, studying in school and colleges in the local population, and who had attained a tanner stage of at least 4 by self-reporting were recruited for the study irrespective of their socioeconomic class (12). A total of 428 subjects (Girls-173, Boys-255) were recruited into the study by multistage sampling.

Assessment of adiposity

Adiposity was assessed in a standardized state of clothing. The body weight (Wt) was recorded bare footed to the nearest 0.5 kg. The height was measured using meter scale without footwear to the nearest 5 cm. Body Mass Index (BMI) was calculated as the weight (kg) divided by the square of height (m^2). Body Fat Percentage (BF %) and Total Body Fat Mass (FM) were assessed by bioelectrical impedance technique using Omron Body Fat Monitor HBF -302. Fat Mass Index (FMI) was calculated as the Fat Mass (kg) divided by the square of height (m^2). BMI, BF%, FM and FMI were used as indices of peripheral adiposity. Waist circumference, a known index of central (visceral) adiposity was measured at the midpoint between the lower costal margin and the highest point on the iliac crest to the nearest 0.5 cm at the end of normal expiration (10, 13).

Assessment of physical activity status and physical fitness

The participants were also assessed for their physical activity status and physical fitness which also tends to affect the cardiovascular autonomic reactivity. Participants reported their physical activity status on a scale of 0 to 7 using the NASA/Johnson Space Centre Physical Activity Rating scale (14). The NASA/Johnson Space Center Physical Activity Rating (PA-R) scale has been developed to provide an assessment score of 0-7 on a person's level of regular physical activity. There are a series of eight statements about routine physical activity. Participants are to select only one response that best describes their physical activity level. Physical Fitness was measured in terms of Predicted VO_2max based on the gender, age, physical activity status as on NASA/Johnson Space Center Physical Activity Scale and body fat percentage as calculated by the formula shown below :

Female, PVO2 max = 50.513 + 1.589 (PA-R) – 0.289 (age) – 0.552 (% body fat)

Male, PVO2 max = 56.376 + 1.589 (PA-R) – 0.289 (age) – 0.552 (% body fat)

Cardiovascular reactivity

The cardiovascular reactivity was assessed by measuring the changes in pulse rate and blood pressure during an Isometric Hand Grip Test. The participants were asked to do maximum voluntary contraction using the handgrip dynamometer with the dominant hand. Three attempts were made at intervals of 1 minute and the highest reading amongst the attempts was considered as the maximum voluntary contraction (MVC) for the participant. Pulse rate and blood pressure were measured prior to exercise at the brachial artery from the arm not involved in exercise (non-exercising arm) using the Omron T8 Automatic Blood Pressure instrument. The participants were than asked to perform isometric handgrip exercise at an intensity of 30% MVC for 1 minute in the sitting posture. Pulse rate and Blood Pressure were measured at 1 minute from the non-exercising arm. The Percentage Rise in Pulse rate(%RPR), Systolic Blood Pressure (%RSBP) and Diastolic Blood Pressure (%RDBP) due to isometric exercise were calculated from the pre-exercise and 1-minute exercise values. %RPR and %RDBP were considered as the indicator of vascular reactivity to sympathetic stress (15).

Statistical analysis

Mean and Standard Deviation were calculated for the independent and dependent variables. Pearson's correlation coefficient was determined to assess the relationship of various indices of adiposity with %RPR and %RDBP.

RESULTS

Table I and II show that boys had a significantly greater weight, larger WC, higher physical fitness and larger %RDBP

TABLE I : Subject characteristics.

Variables	*Girls (173)*	*Boys (255)*
Age, yrs	16.5±1	16.7±1
PA-R	1.8±0.9	3.1±1.3**
Weight, kg	47±9.6	52.5±11.4**
BMI, kg/m²	19.4±3.5	18.8±3.2
BF%	24.11±6.8	16.4±5.5**
FM, kg	11.9±5.7	9±4**
FMI, kg/m²	4.9±2.2	3.2±1.6**
WC, cm	64±6.9	67±7.8**
PVO2max, ml/kg/min	35.7±4.5	47.7±4**

Figures in bracket indicate number of participant subjects. Values indicate Mean±SD.
*P<0.05, **P<0.01.

as compared to girls while girls had a significantly greater BF% and FMI. Table III and IV shows that in both girls and boys, BMI, BF%, FMI and WC showed significant correlationship with %RDBP, with girls showing a stronger correlationship than boys.

TABLE II : Cardiovascular study variables characteristics in Gujarati Indian adolescents.

Variables	*Girls (173)*	*Boys (255)*
PR, Pulse/min	88±12	80±11**
%RPR	18.2±12	19.4±11
SBP, mmHg	111±9.4	115±10.3**
DBP, mmHg	75.7±7.8	73.4±7.6*
%RDBP, mmHg	15.6±10.3	20.6±12.9**

Figures in bracket indicate number of participant subjects. Values indicate Mean±SD. *P<0.05, **P<0.01, %RPR: Percentage Rise in Pulse Rate at 1 minute of Isometric Handgrip exercise %RDBP: Percentage Rise in Diastolic Blood Pressure at 1 minute of Isometric Handgrip exercise.

TABLE III : Correlationship of adiposity indices and physical fitness with cardiovascular reactivity in Gujarati Indian adolescent girls (n=173).

Explanatory variable	*%RPR*	*%RDBP*
Weight, kg	–0.04	0.18*
BMI, kg/m^2	0.01	0.57**
BF%	–0.007	0.27**
FM, kg	–0.04	0.31**
FMI, kg/m^2	–0.03	0.83**
WC, cm	0.06	0.26**
PVO_2max	0.003	–0.27**

Values indicate Pearson's correlation coefficient (r). *P<0.05, **P<0.01, %RPR : Percentage Rise in Pulse Rate at 1 minute of Isometric Handgrip exercise, %RDBP : Percentage Rise in Diastolic Blood Pressure at 1 minute of Isometric Handgrip exercise, PVO_2max : Predicted VO_2max.

TABLE IV : Correlationship of adiposity indices and physical fitness with cardiovascular reactivity in Gujarati Indian adolescent boys (n=255).

Explanatory variable	*%RPR*	*%RDBP*
Weight, kg	–0.08	0.12*
BMI, kg/m^2	–0.04	0.28**
BF%	0.17	0.09
FM, kg	0.01	0.22**
FMI, kg/m^2	0.3	0.47**
WC, cm	–0.06	0.17**
PVO_2max	–0.11	–0.07

Values indicate Pearson's correlation coefficient (r). *P<0.05, **P<0.01, %RPR – Percentage Rise in Pulse Rate at 1 minute of Isometric Handgrip exercise, %RDBP – Percentage Rise in Diastolic Blood Pressure at 1 minute of Isometric Handgrip exercise, PVO_2max – Predicted VO_2max.

DISCUSSION

The findings of our study show that girls have a stronger correlationship between adiposity and vascular reactivity as compared to boys despite having a lower cardiovascular reactivity in comparison to boys. This finding may be explained by the fact that girls have a significantly lower physical fitness in comparison to boys and since physical fitness shows a significant negative correlationship with vascular reactivity amongst girls, it is possible that the low physical fitness in girls predisposes them to a greater vascular reactivity to acute sympathetic stress. This view is supported by the observations that, fit individuals show significantly attenuated heart rate and systolic blood pressure reactivity and a trend towards attenuated diastolic blood pressure reactivity (16, 17).

The finding that boys show a significantly larger vascular reactivity in comparison to girls may be explained by the fact that since the age group under consideration is post-pubertal, it may happen that the male and female sex hormone may be influencing the vascular responsivess to stress. This view is supported by various studies which have reported a decreased incidence of cardiovascular disease (CVD) in premenopausal compared with postmenopausal women and the female sex hormone Estrogen is believed to have protective effects in the cardiovascular system. Experiments conducted in adult female animals have shown that estrogen induces endothelium-dependent vascular relaxation via the nitric oxide (NO), prostacyclin, and hyperpolarization pathways. Also, surface membrane estrogen receptors (ERs) decrease intracellular free Ca2+ concentration and perhaps protein kinase C-dependent vascular smooth muscle contraction (18).

A study conducted to determine the effects of sex hormone levels on aortic reactivity in female rats with metabolic syndrome (MS) found that vasoconstriction was larger in intact MS and ovariectomized MS + testosterone aortas than in intact Control and ovariectomized Control + testosterone, respectively. Vasodilation was reduced in intact MS and ovariectomized MS + testosterone compared with intact control, ovariectomized control + testosterone, ovariectomized MS, and ovariectomized MS + estradiol. The results suggest endothelial dysfunction in intact MS and ovariectomized MS + testosterone, but protection by ovariectomy + estradiol in MS due to hormone (19).

Our findings also suggest that visceral adiposity as indicated by waist circumference though has a lower correlationship with vascular reactivity in comparison to total adiposity it seems to be more influential in increasing vascular responsiveness to sympathetic stress than the total fat mass. This view is supported by the observation that despite having a significantly lower BF% and FMI than girls, boys show a significantly higher %RDBP than girls. This is probably because boys have a significantly larger waist circumference in comparison to girls.

Similar findings have also been reported by other studies which were conducted to learn the pathogenesis of high blood pressure associated with an increase in adiposity. A study conducted on 46 White and 49 Black normotensive adolescents with family histories of essential hypertension found that after controlling for peripheral (that is, triceps skinfold) and overall (that is, BMI) adiposity, the group with higher Waist to Hip Ratio exhibited greater SBP (that is, peak response minus mean pre-stressor level) to all three stressors and greater DBP reactivity to postural change and cold pressor (all $P<0.05$). The study concluded that Central adiposity appears to adversely influence hemodynamic functioning during adolescence (3).

Another study examined the association between central adiposity, measured by waist circumference, and cardiovascular reactivity to stress among 106 White and 105 Black adolescents, approximately 50% of whom were girls. Participants engaged in 4 laboratory tasks while cardiovascular reactivity measures were taken. Independent of body mass index, race, and gender, participants with a greater waist circumference exhibited greater systolic blood pressure reactivity and diastolic blood pressure reactivity (boys only). Results from the study suggested that central adiposity is associated with blood pressure reactivity early in life, especially in adolescent boys (20).

Conclusion

It can thus be concluded from our study that though boys tend to have a higher vascular reactivity to acute sympathetic stress than girls, girls tend to show a greater correlationship between adiposity and vascular reactivity due to low physical fitness and therefore low physical fitness predisposes girls to the adverse effects of adiposity on the vasculature. It is also concluded from the study that visceral adiposity seems to be the type of adiposity which influences vascular reactivity to greater extent than total adiposity amongst Gujarati Indian adolescents.

Limitations and future perspectives

A major limitation in the current study is that it is a cross-sectional study which is a useful but a weak tool in assessing the relationship between two variables. Another major limitation is the lack of the study of sex hormones and their influence on the study variables. Further study may be conducted to search for further evidence in this line by studying the influence of sex hormones on the relationship and studying the relationship during the two phases of menstrual cycle.

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