RELATIONSHIP OF RESTING HEART RATE WITH BODY COMPOSITION AND OBESITY AMONG YOUNG ADULTS IN INDIA – A CROSS SECTIONAL STUDY

Background: The autonomous dysfunction associated with obesity could lead to changes in resting heart rate (RHR), which has been linked with adverse cardiovascular outcomes. Scanty data is available on RHR among young adults of non-obese (NW) and obese (OB).

Aims & Objective: The present study was aimed at determining the effect of body composition and adiposity on RHR.

Materials and Methods: Study was conducted on medical students (n=132, age: 19-20 years) in Davangere, India. Anthropometric measures were obtained and BMI, WC, HC, WSR were measured. Body fat percentage (BF %), Fat mass (FM) were estimated and Fat Free Mass (FFM) was calculated. RHR was measured using a standard ECG after complete rest. Pearson's correlations (r) were computed obesity indices and RHR. ANOVA & Independent t test were used to compare RHR between non-obese (NW) and obese (OB).

Results: The obesity indices showed 40.1% students were generally obese (BMI ≥ 25.0 kg/m²). Central obesity (WC > 85 cm OR WSR > 50.0) was found in 34.1% (WC Mean = 86.1 ± 2.7; WSR Mean = 0.52 ± 0.02). Obese group presented with comparatively continuous faster RHR (Mean 80.21 ± 3.8 bpm) and was significantly positively correlated with obesity indices BMI, WC, WSR, FFM (r = 0.476, 0.678, 0.332, 0.617 respectively).

Conclusion: RHR had higher values and significantly positive correlation with obesity indices among obese group compared to non-obese individuals (p<0.05). A significantly higher RHR points towards an altered autonomic balance in obese young adults. This underscores the need to implement health education program to combat obesity among young adults.

Key Words: Resting Heart Rate; Obesity; Young Adults; Body Mass Index; Waist-Hip Ratio

INTRODUCTION

Over the last few decades obesity has reached epidemic proportions and has become one of the major public health targets worldwide. Obesity is associated with an increased risk of morbidity and mortality as well as reduced life expectancy. General obesity is usually described in terms of body mass index (BMI) by categorizing a person with BMI ≥ 25 as overweight/obese. Central or visceral obesity (abdominal obesity) can simply be assessed by measurement of waist circumference. Other measures including waist-to-hip ratio and waist to height ratio are used to assess central obesity. Many researches have indicated that obesity tracks from childhood to adulthood and constitutes a risk factor in the development of chronic diseases. Concern grows that the current dramatic rise of obesity among adolescents portends a future wave of increasing cardiovascular disease as these overweight youth reach the adult years.

Several studies in literature suggest that autonomic nervous system (ANS) of obese (OB) individuals is chronically altered. Since ANS is involved in energy metabolism and regulation of cardiovascular system, it is conceivable that one or more sub groups of obesity have an alteration in their autonomic nervous system that may promote obesity and account for several clinical consequences of obesity. It has been observed that individuals with low sympathetic nerve activity may be at risk for body weight gain resulting from a lower metabolic rate.

Obesity was found to be associated with decreased sympathetic activity in animal models. Several major prospective studies have found high heart rates in men at rest to be predictive of the future manifestation of coronary heart disease (CHD) or cardiovascular disease (CVD). The association between tachycardia and cardiovascular disease may be explained by the fact that tachycardia is associated with obesity, sympathetic activation, and hypertension. Obese people tend to have increased RHR as autonomic responsiveness has been shown to be diminished in these individuals.

In adults, the use of resting heart rate (RHR) as screening index for cardiovascular risk has been postulated and supported by studies that reported its relationship to mortality. The autonomous dysfunction associated with obesity could lead to changes in RHR and arterial blood pressure. Though the RHR is influenced by several constitutional and environmental factors, the most important determinants are parasympathetic and...
sympathetic influences.\textsuperscript{19} Quantifying RHR can give an index of the load imposed on the heart and the state of imbalance between sympathetic and parasympathetic activity.

Recently, Fernandes et al.\textsuperscript{20} identified that a higher RHR was associated with elevated blood pressure, in obese male children and adolescents, independent of age and ethnicity; however, it is not clear if RHR can also be applied as a screening for other risk factors, such as general and abdominal obesity.

Since there is dearth of literature for comprehensive studies which focus on the association between obesity, body composition and RHR among young adults in India, the present study was aimed to investigate the effect of body composition and adiposity on RHR in young individuals and finding correlation of RHR with indices of general obesity namely body mass index (BMI) and abdominal obesity viz waist circumference, waist-hip ratio and waist stature ratio (WC, WHR and WSR respectively).

**MATERIALS AND METHODS**

This cross sectional study was conducted during July 2012 to September 2012, at Medical College and Research Centre, Davangere, India, after obtaining the Ethical clearance from institutional review board. A total of 132, medical students (aged 19–20 years) studying first and second year of MBBS, took part in the study. After briefing about the objectives of the study, Students were asked to fill the data form including demographic details, daily exercise and time spent in sports. The time period for filling the details was utilized as period of physical rest. Written consent was obtained and the subjects were examined for their weight, height and waist circumference. Anthropometric measures were obtained in the physiology lab after a 30 minutes period of physical rest. Weight was measured in light clothing without shoes with a measuring tape. Body weight was measured to the nearest 0.5 kilogram (kg). Height was measured in centimeters (cm) bare foot against a wall with the help of a measuring tape to the nearest 0.2 cm. Measurement was done with heels close to the wall and feet close together so that weight was equally distributed, and the head in Frankfort’s plane.

Waist circumference (WC) was measured to the nearest centimeter with a plastic tape measure while the subjects were in the standing position at the end of gentle expiration using anatomical landmarks laterally midway b/w lowest portion of the rib cage and iliac crest and anterior midway between the xiphoid process of the sternum and the umbilicus as reference. WC was measured in standing position at the level midway between the lower rib margin and the iliac crest, rounded to the nearest 0.5 cm with the help of a measuring tape. The hip circumference (HC) was measured in standing position with a plastic tape at the largest horizontal circumference around the buttocks, in centimeters to the nearest 0.5 cm.

BMI was derived by Quetlet’s index. Waist – Hip Ratio (WHR) & Waist- Stature Ratio (WSR) were calculated. Body fat percentage (BF%), Fat mass (FM), Fat free mass (FFM) were calculated using the formulae mentioned in Table 1. It has been suggested that the reference cut-off points of BMI and WC for defining general obesity and abdominal obesity in Asians should be lowered. WHO Expert Consultation\textsuperscript{21}, after a meta-analysis of population data from more than 10 countries has agreed and suggested lower BMI action points of 23 and 27.5 kg/m\(^2\) for Asian population. Further research among Asian young adults\textsuperscript{22-24} supports the use of BMI ≥ 25.0 kg/m\(^2\) as a new cut-off point for obesity and BMI = 23.0–24.9 kg/m\(^2\) for overweight. We have used the cutoff point of 25 for BMI and 85 cm for WC in our study according to the recommendations.

Resting Heart Rate (RHR) was recorded using the ECG (CARDIART 108T/MK-IV, BPL) after fixing the standard bipolar limb leads. ECG was recorded in lead 2, which runs from the of the ECG paper in unit time. Since 25 mm/sec is the speed normally used, the RHR is counted with the calculation as mentioned in Table 1.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Formula</th>
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<tbody>
<tr>
<td>BMI</td>
<td>Quetlet’s index</td>
</tr>
<tr>
<td>BF%</td>
<td>(1.2 \times BM1 + (0.23 \times AGE) - (10.8 \times SEX) - 5.4) [where male=1 &amp; female=0]</td>
</tr>
<tr>
<td>FM (kg)</td>
<td>weight X BF%</td>
</tr>
<tr>
<td>FFM (kg)</td>
<td>Weight – FM.</td>
</tr>
<tr>
<td>RHR</td>
<td>(1500 / \text{Distance between two consecutive R-R waves in mm})</td>
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</table>

The SPSS version 18.0 was used to analyze the data. Simple frequency tables and descriptive statistics (means and standard deviations) were processed and analyzed. ANOVA & Independent t test as appropriate were used to compare RHR between non-obese (NW) and obese (OB) groups as defined by the cut off points. Correlation between RHR and different indices of obesity were tested.
using Pearson’s correlation coefficient (r). A p value <0.05 was considered statistically significant.

RESULTS

Figure 1 shows the descriptive statistics of the study population. The Mean BMI was 22.94 ±2.3 Kg/m² and 40.2% of the students had general obesity as defined by BMI of 25 or above. The number of students showing central obesity was 34.0 % as defined by either a WC greater than 85 cm or WSR of greater than 50 (Table-2). Using the WHO cut-off point (for Caucasians) of 94 cm for increased risk and 102 cm for substantially increased risk of complications the number of individuals falling into these categories of central obesity were 45 (34.0%) and 40 (30.3%). Central obesity defined on the basis of a WHR of greater than 0.85 was found in 27.2% of the individuals. BMI (general obesity) was positively correlated with various indices of abdominal adiposity, i.e., WC (0.400; p<0.01) and WSR (0.226; p=0.01). The WC was also well correlated with other indices of abdominal adiposity, i.e., WHR (0.403; p= 0.00) as well as WSR (0.555; p = 0.00).

Fat Free Mass (FFM): The Mean FFM in obese young adults was 53.26±8.41 and the mean FFM in Non-obese young adults was 47.70±7.93 there was statistically significant increase in FFM in obese subjects when compared to Non-obese. (p < 0.01)

Comparison of RHR: The Mean RHR in obese young adults was 77.21±3.38 and the mean RHR in Non-obese young adults was 69.97±2.75 there was statistically significant increase in RHR in obese subjects when compared to Non-obese (p = 0.00). The mean resting heart rate (RHR) was 74± 8.3 bpm (64–86 with a median of 65 bpm). Comparing the RHR between NW and OB groups (Table-3) defined on the basis of indices of obesity (i.e., BMI), the RHR in OB group were significantly higher than NW group. Comparing the RHR between NW and OB groups defined on the basis of indices of abdominal obesity, the Mean RHR was higher in OB group (77.21 ± 3.38) than NW group (69.97 ± 2.75), with a significant difference in mean of 6.94 ± 3.74 bpm (p=0.000) (Table 4).

Table 5 shows a highly significant positive correlation between RHR and index of general obesity (BMI) (r = + 0.476) and indices of abdominal obesity (WC, WHR and WSR) (r = +0.678, r = +0.145 and r = +0.332 respectively).

Table 2: Distribution of subjects into normal and obese groups based on the cut-off points of obesity indices used in this study

<table>
<thead>
<tr>
<th>Obesity Indices</th>
<th>Cut-off Values</th>
<th>Normal Weight (%)</th>
<th>Obese (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist circumference (WC) cm</td>
<td>85</td>
<td>87</td>
<td>65.9</td>
</tr>
<tr>
<td>Body Mass Index (BMI) kg/m²</td>
<td>25</td>
<td>79</td>
<td>59.8</td>
</tr>
<tr>
<td>Waist to Hip Ratio (WHR)</td>
<td>0.85</td>
<td>96</td>
<td>72.7</td>
</tr>
<tr>
<td>Waist to Stature Ratio (WSR)</td>
<td>0.50</td>
<td>92</td>
<td>69.6</td>
</tr>
</tbody>
</table>

Table 3: RHR in relation to obesity indices among obese and normal weight (non-obese) group

<table>
<thead>
<tr>
<th>Obesity Indices</th>
<th>Resting Heart Rate (Mean ± SD)</th>
<th>Normal Weight</th>
<th>Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist circumference (WC) cm</td>
<td>67.26 ± 2.1</td>
<td>79.96 ± 2.64</td>
<td></td>
</tr>
<tr>
<td>Body Mass Index (BMI) kg/m²</td>
<td>70.93 ± 3.7</td>
<td>80.21 ± 3.8</td>
<td></td>
</tr>
<tr>
<td>Waist to Hip Ratio (WHR)</td>
<td>72.57 ± 3.1</td>
<td>77.69 ± 4.66</td>
<td></td>
</tr>
<tr>
<td>Waist to Stature Ratio (WSR)</td>
<td>71.60 ± 4.1</td>
<td>78.19 ± 4.06</td>
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Table 4: Paired Samples t-test showing significant difference in RHR between obese and non-obese group

<table>
<thead>
<tr>
<th>RHR (Mean ± SD)</th>
<th>Paired Differences</th>
<th>t</th>
<th>df</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obese</td>
<td>69.97 ± 2.75</td>
<td>6.95</td>
<td>3.75</td>
<td>5.93-7.958</td>
</tr>
<tr>
<td>Non Obese</td>
<td>77.21 ± 3.38</td>
<td></td>
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</tbody>
</table>

Table 5: Correlation of RHR with BMI, WC, WHR, WSR, and FFM

<table>
<thead>
<tr>
<th>BMI</th>
<th>WHR</th>
<th>WSR</th>
<th>FFM</th>
<th>WSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>r</td>
<td>-0.48</td>
<td>0.587</td>
<td>0.001</td>
<td>0.000</td>
</tr>
<tr>
<td>p</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
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</table>

Figure 1: Descriptive statistics of the subjects (n=132)

Figure 2: Distribution of subjects into normal and obese groups based on the cut-off points of obesity indices used in this study
**DISCUSSION**

To our knowledge, there are very less studies investigating the relationship between indices of general and central obesity and RHR in Indian young adult group. To best of our knowledge this study might be the first to assess relationship of resting heart rate with body composition and obesity among young adults in India.

This study has shown that RHR is significantly greater in persons having general obesity or central obesity as compared to non-obese individuals. We observed a significant correlation of RHR with BMI, WC and WSR. The individuals with general obesity had RHR similar to those with abdominal obesity and higher than their respective NW groups. This observation is different from reports of Grassi who observed a greater cardiovascular effect in individuals with visceral obesity.[25] It is probably because in the present study, the index of general obesity was well correlated with indices of abdominal obesity. Another reason for this discrepancy could be that most of our subjects who belonged to OB group did not have marked abdominal obesity and only 7 out of 132 individuals (11%) showed a WC>100 cm.

**Cut off Values**

The body mass index has been used routinely to classify subjects as obese or non-obese. (WHO and International Obesity Task Force) Several studies have separately established that the BMI cutoff point for obesity for Asian populations is relatively lower (Pegged between 23 and 27 kg/m² for Asians) compared to European & American population. More studies[26-28] have shown that Asian populations have higher risks of cardiovascular disease and mortality from other causes at relatively lower BMI, which they postulated to be largely attributable to the higher proportion of body fat in Asian populations. Researches on cutoff value of the BMI based on the ROC curve among Indian population has shown that a BMI of 21.5 kg/m² for male subjects 19.0 kg/m² for female subjects displayed optimal sensitivity and specificity in identifying subjects with a high percentage of body fat and supports the view that a BMI of 23.0 kg/m² might be ideal for the Asian Indian population. The cutoff values derived for WC were 85 cm for men and 80 cm for women, and for WHR they were 0.85 for young adult men and 0.81 for women were also lower than those suggested in earlier studies. (Figure 2)

Our study has shown a significant higher RHR in both general and abdominal obesity young adults. In another study of the overweight children WSR was found to be more strongly associated with adverse risk-factor levels than BMI. Individuals with a similar BMI can vary considerably in their abdominal-fat mass. WC, WHR and WSR are good indicators of abdominal obesity. WSR takes into consideration both the height and WC and the WSR will change only when there is a change in WC in grown up adults. The mean values for RHR as obtained in the present study are comparable to RHR among 19 year individuals in Saudi Arabia[29] who had Mean RHR of 78±2, but that study had not included underweight and obese individuals. The study results of Salameh et al[30] also reported a mean RHR of 73 ± 9 in 15–20 years old males whereas, a RHR of 74.1 was observed in a large population study of 19 year old male University students in Belfast.[31]

This study emphasize the point that it is important to have local data for RHR in young individuals as ethnic differences can lead to significant variations in RHR. An elevated Heart Rate (HR) is a warning about an increased risk of cardiovascular dysfunction and an increase in heart rate by 10 beats per minute is said to be associated with an increase in the risk of cardiac death by at least 20%, which is similar to the risk observed with an increase in systolic blood pressure by 10 mm Hg.[32]

In the NHANES study[33], a heart rate higher than 84 beats/min implied a greater risk of cardiovascular mortality as well as all-cause mortality. Obesity and the cardiac autonomic nervous system are intrinsically related. A 10% increase in body weight is associated with a decline in parasympathetic tone, accompanied by a rise in Mean Heart Rate, and conversely, heart rate declines during weight reduction.[34] Shigetoh and Adachi et al[35] demonstrated that higher heart rate might predispose to the development of obesity and diabetes mellitus, implying the role of sympathetic system in the development of obesity.

Heart rate has been shown to have a positive relationship with other “conventional” risk factors like blood pressure readings, body weight, triglycerides, insulin and glucose metabolism.[35] It is not sure if the relationship between resting heart rate and the body composition and obesity among young adults is linear. In the present study attempt has been made to determine any such relationship and it is observed there was a greater change in RHR in obese group compared to normal weight group. This could be explained on the basis of a relatively higher sympathetic tone in the obese group than NW or the
parasympathetic tone was comparatively less in the obese compared to the NW.

The heart rate is an integrated index of autonomic cardiovascular function and elevated heart rate values indicate adrenergic overdrive, leading to/or worsening ischemia with risk of acute coronary syndromes (ACS), fatal or non-fatal arrhythmias or heart failure. Secondly, the elevated heart rate exerts mechanical effects on the cardiac vasculature leading to increased shear stress, impaired arterial compliance and favours the development of atherosclerotic vascular lesions.[36,37]

**BENEFITS & LIMITATIONS**

The autonomous disturbances appear to be reversible with weight reduction, improvement obtained from weight loss should be beneficial for the health of individuals with obesity. One major benefit of this study could be that the young students may be advised to alter their eating habits and lifestyle by demonstrating to them an immediate observable effect of obesity on RHR. This is particularly useful at this stage of life when the subjects are in the adolescent years because the weight gain after 18 years of age increases cardio-vascular risk even in patients with normal body mass index. The sample size for the present study may have been too small and a large scale study and long term follow-up is required for further assessments in this regard.

**CONCLUSION**

There is a significant positive correlation between obesity indices and RHR with the obese group exhibiting a significantly faster RHR compared to NW group. This continuous faster RHR in these young individuals exhibiting either abdominal obesity or general obesity could contribute to various cardiovascular problems later in life. During a transitional period between adolescence and young adulthood, the proportion of adolescents becoming and remaining obese into adulthood is very high. Thus a healthy lifestyle, including dietary and physical activity modification, especially in early adolescence may play an essential part in the battle against atherosclerosis, obesity and metabolic syndrome. Our findings strengthen the previously reported usefulness of RHR in providing an early sign of cardiovascular risks in young adults. It further stresses the need to prevent obesity early in life to avoid life-threatening consequences in advancing age.

**REFERENCES**

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