RESEARCH ARTICLE

Heart rate recovery at 1st min after graded exercise an indicator of parasympathetic function in healthy obese young adults

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ABSTRACT

Background: Heart rate recovery at 1st min (HRR 1 min) after graded treadmill exercise (GTX) is a predictor of parasympathetic function. Impaired HRR 1 min and obesity are strong predictors of metabolic syndrome and cardiovascular disorders. This study is done to assess HRR 1 min on apparently healthy obese young adults with body mass index (BMI) ≥30, without any other metabolic syndrome components. Aims and Objectives: The objective of this study was to assess the parasympathetic function by estimating HRR 1 min after exercise in apparently healthy obese young adults of 18–30 years of age without any metabolic syndrome components and is compared with age- and gender-matched controls with normal BMI. Materials and Methods: Fifty obese young adults with BMI ≥30 without any other metabolic syndrome component and 50 age- and gender-matched controls with BMI ≤24.9 were selected and subjected to GTX according to modified Bruce protocol. Maximum heart rate reached during exercise (HRmax) and heart rate at 1st min of recovery phase (HR1min) were recorded. HRR 1 min was calculated as HRmax-HR1min and was analyzed. Results: This study showed significantly attenuated HRR 1 min in obese young adults compared to age- and gender-matched controls (mean 24.02 ± 8.87 vs. 42.42 ± 5.3, \(P < 0.001\)). Conclusion: HRR 1 min was significantly decreased in obese young adults, indicating attenuated parasympathetic function, who are at higher risk of developing chronic cardiovascular and other metabolic disorders.

KEY WORDS: Heart Rate Recovery at 1st Min; Parasympathetic Function; Obese Young Adults; Graded Exercise

INTRODUCTION

The prevalence of obesity among young adults is rapidly increasing worldwide, becoming a global health problem. Obesity is proved to be the risk factor of metabolic and cardiovascular disorders. Studies indicate that autonomic dysfunction is associated with obesity.\(^1\) Autonomic dysfunction becomes evident when subjected to stress like exercise.\(^2\) The rise in heart rate during exercise is considered to be due to combination of parasympathetic withdrawal and sympathetic activation.\(^3\) After cessation of exercise, heart rate recovers to the resting level by parasympathetic reactivation and sympathetic withdrawal.\(^1\) Heart rate recovery at 1st min (HRR 1 min) post-exercise is more reflective of parasympathetic nervous system function.\(^1\) Therefore, HRR 1 min after exercise has been proposed to be an indicator of parasympathetic activity (PSA) and an abnormally slower HRR 1 min after exercise would indicate impaired parasympathetic function (vagal activity).\(^1,4\)

Delayed HRR 1 min after graded treadmill exercise (GTX) was found to be associated with metabolic syndrome and its components (hyperglycemia/insulin resistance, visceral obesity, atherogenic dyslipidemia, and hypertension),
Type 2 diabetes mellitus, carotid atherosclerosis, adverse cardiovascular events, arrhythmias, and sudden death. It is a strong predictor of mortality in patients undergoing stress test, independent of ischemia. Some studies have shown that significant drop in HRR 1 min in obese group in comparison with age- and gender-matched controls should be considered as impaired parasympathetic function.

Obesity is a known risk factor for various metabolic and cardiovascular disorders.

CARDIA study done on participants aged between 18 and 30 years, of similar age group as that of this study, it showed slower HRR does not proceed to the development of metabolic syndrome, but appeared in whom the syndrome components were already present. In another study done on 75 year old subjects with and without metabolic syndrome components, the HRR was significantly attenuated among those with metabolic syndrome components compared to those without metabolic syndrome. There are few studies relating HRR 1 min (parasympathetic function) and apparently healthy obese young adults without any other components of metabolic disorders. Most of the studies are relating attenuated HRR 1 min after exercise with manifested metabolic and cardiovascular disorders in various age groups. This study is done to evaluate HRR 1 min after GTX in apparently healthy obese young adults of 18–30 years of age, without any other metabolic syndrome component and is compared with normal body mass index (BMI), age- and gender-matched healthy young adults as controls.

Weight loss-induced exercise training has improved the HRR after exercise and the responsiveness of the autonomic nervous system in obese men with metabolic syndrome. Parasympathetic tone is good in physically fit individuals. HRR improved with weight loss and increased physical activity in obese subjects. HRR is increased in exercise trained subjects compared to non-exercising controls. Attenuated HRR 1 min after exercise in obese is a modifiable risk factor of metabolic and cardiovascular disorders. This study may create awareness about the importance of exercise and lifestyle modification to maintain normal BMI and good parasympathetic function in young adults.

Objectives of the Study

The objectives of the study are as follows:
1. To assess the HRR 1 min after graded exercise in obese and normal BMI healthy young adults
2. To compare HRR 1 min after graded exercise in obese and normal BMI age- and gender-matched young adults.

MATERIALS AND METHODS

The Institutional ethical committee approval and prior informed written consent of all the subjects were obtained to from perform the study. All required patient details and information were obtained before starting the study. The subjects were selected among medical students and staff of Medical College and Hospital. 18–30 years aged 50 obese (O) healthy young adults with BMI ≥30 were included in the obese group. Fifty age- and gender-matched healthy young adults with normal BMI ≤24.9 were considered as controls (C). Subjects with history of Type 2 diabetes mellitus, hypertension, dyslipidemia, heart diseases, other metabolic disorders, smokers, alcoholics, and those with family history of premature cardiac deaths among first degree relatives were excluded from the study. Those with abnormal ECG at rest, on drugs altering autonomic functions like beta-blockers, or those who developed cardio vascular symptoms during exercise were excluded from the study. Females during menstrual cycles, pregnancy, or lactation were not included in the study.

Individuals satisfying inclusion and exclusion criteria were made to rest for 10 min and resting heart rate (HR rest), BP, and ECG were recorded. Height (using stadiometer) and weight (using digital scale) of subjects were recorded and BMI (kg/m²) was calculated using the Quetelet index.

Those included in study were subjected to symptom limited GTX according to modified Bruce protocol, using standardized Treadmill of research grade, T 2100 GE medical systems. Maximum achievable heart rate is age dependent and is calculated using formula: achievable maximum heart rate (HRmax) = 205.8 – (0.685 × age). They were made to exercise till they attained at least 85% of achievable HRmax with continuous vigilance of symptoms of ischemia and ECG display on monitor. HRmax is maximum heart rate reached by the subject during exercise. Once targeted heart rate was reached, subjects were asked to cool down by exercising at the speed of 1.5 mph and 0% inclination. The HR was recorded exactly at 1st min of recovery phase (HR1min). HRR 1 min was calculated (HRR 1 min = HRmax – HR1min). After exercise subjects were observed at rest for 15 min in the laboratory.

Statistical analysis

The data of the obese and control groups were analyzed and compared using statistical program SPSS. The Chi-square test was used and variables are presented as Mean ± SD. P ≤ 0.05 was considered to be statistically significant.

RESULTS

In the present study, total of 104 subjects satisfied exclusion and inclusion criteria and performed the procedure, of which four obese were excluded as they could not complete the procedure. Fifty apparently healthy obese subjects with BMI ≥30 were included in the obese group (O) and 50 age- and
gender-matched healthy individuals with BMI <24.9 as controls (C).

The subject’s age, sample size, anthropometric recordings, and BMI differences of both the groups are depicted in Table 1 and their heart rate parameters and comparison of means HRR 1 min after graded exercise, of obese (O) and controls (C) are presented in Table 2.

There was no significant difference in the age of control and obese group. The mean weight in Kilograms was found to be 55.82 ± 7.03, and 84.20 ± 10.26, respectively, and mean BMI was 21.32 ± 2.02 and 33.04 ± 2.01, respectively, in controls and obese groups and they showed statistically significant difference (P < 0.001).

Mean HRR 1 min of obese is 24.02 ± 8.872 and is found to be significantly attenuated when compared to controls 42.42 ± 5.326 with being P < 0.001.

**DISCUSSION**

This study was done on 18–30-year-old healthy obese young adults with significantly raised weight and BMI when compared with age- and gender-matched normal BMI young adult controls were subjected to GTX and HRR 1 min was estimated. The study showed significant attenuation of HRR 1 min after graded exercise (P < 0.001) in obese young adults (24.02 ± 8.872 beats) when compared to age and gender matched controls (42.42 ± 5.326). Although few large-scale studies have considered HRR 1 min <12 beats and few studies have considered. HRR 1 min ≤18 beats to be the cut off value predicting all-cause mortality, attenuation in HRR 1 min in our study is more than 12–18 beats in both obese and control group. Some studies have shown that significant drop in HRR 1 min in Obese group in comparison with age and gender matched controls should be considered as impaired parasympathetic function.[4,6,17,18] Considering this, obese young adults may be considered to have impaired parasympathetic function and are at increased risk of chronic metabolic disorders and cardiovascular morbidity and mortality.[19] This difference in our study groups could be due to age related better physical work capacity and absence of any other metabolic syndrome components.

Brinkworth et al. study on obese subjects with BMI >27 kg/m² showed mean HRR 1 min after exercise as 33 ± 1.4 beats which was similar to that observed in the present study and attenuated HRR 1 min was directly associated with increase in BMI.[20] CARDIA study done on similar age group as that of the present study, 18–30 years apparently healthy young adults showed that subjects with higher BMI had lower HRR and had higher fasting insulin though were euglycemic. On follow-up of these individuals was at 3–4 fold greater risk of developing Type 2 diabetes. This study has suggested that impaired parasympathetic function precedes development of overt diabetes mellitus.[7] In Singh et al. study, on apparently healthy obese children of mean age 12 years HRR 1 min was higher in boys and correlated inversely with age-adjusted BMI in both boys and girls indicating no gender difference in obese children and HRR 1 min after exercise was attenuated with age in children.[19] Another recent study by Anand et al. on 18–30 year old obese young adults have shown no significant correlation between HRR and various obesity indices. However, they have not mentioned that HRR is considered at what point of recovery phase and they mention the limitation of their study being small sample size.[20]

The mechanisms by which weight gain reduces parasympathetic tone is yet to be fully clarified. One possible explanation is that obesity is associated with chronic inflammation of adipose tissue.[3,4,19] Inflammatory adipokines secreted by white fat, such as tumor necrosis factor alpha and interleukin,[19] affects the cardiac autonomic balance through the central nervous system, promoting sympathetic hyperactivity, especially in hypertensive obese individuals, decreasing the PSA and acetylcholine levels, which inhibit release of these inflammatory cytokines.[5,6,12] It is through increased inflammatory action and autonomic dysfunction that obese patients have a higher risk of morbidity and mortality.[7,9]

Attenuated HRR 1 min is a significant predictor of decreased parasympathetic function which is found to be associated with metabolic disorders and cardiovascular morbidity and mortality. The decreased HRR 1 min after exercise among

<p>| Table 1: Age and anthropometric values of controls and obese subjects |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th><strong>Subjects</strong></th>
<th><strong>Sample size</strong></th>
<th><strong>Age (years)</strong></th>
<th><strong>Height (cm)</strong></th>
<th><strong>Weight (Kg)</strong></th>
<th><strong>Body mass index (kg/m²)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (C)</td>
<td>50</td>
<td>24.20±3.65</td>
<td>161.78±8.23</td>
<td>55.82±7.03</td>
<td>21.32±2.02</td>
</tr>
<tr>
<td>Obese (O)</td>
<td>50</td>
<td>26.08±3.58</td>
<td>159.56±9.21</td>
<td>84.20±10.26</td>
<td>33.04±2.01</td>
</tr>
</tbody>
</table>

Values are expressed in mean±SD
obese young adults is an alarming predictor of underlying subclinical chronic metabolic disorders, which is a reversible risk factor. It is of great importance and may create awareness among young adult population regarding body weight and lifestyle modification.

Limitations of our study is that it is a single center experience. Most of our obese subjects were working class people with increased physical activity compared to sedentary subjects; Further continued study in sedentary group and multicenter study would further strengthen relation of HRR and prognosis in raised BMI individuals. Further follow-up study on healthy obese young adults would confirm that attenuated HRR 1 min after exercise is an early marker of metabolic disorders and cardiovascular morbidity and mortality.

CONCLUSION

HRR 1 min after GTX, an indicator of parasympathetic function is significantly decreased in healthy obese young adults in comparison with age and gender matched normal BMI controls. HRR 1 min after GTX may be considered as a significant prognostic marker along with other investigations which is an early predictor of metabolic disorders and cardiovascular morbidity and mortality in obese young adults. This study also emphasizes that exercise and life style modifications can help in reducing BMI and restore good parasympathetic functioning. Further follow-up studies are required to confirm this.

REFERENCES


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