

Original Research Article

Comparison of Heart Rate Response to Exercise and Heart Rate Recovery among Normal Weight and Overweight/Obese Adults

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Abstract: Overweight and obesity is a worldwide public health challenge. It is associated with abnormal function of autonomic nervous system. Function of autonomic nervous system can be easily measured by chronotropic response and heart rate recovery. Objective of our study was to compare heart rate response to exercise and heart rate recovery between normal weight and overweight/obese adults. Study was conducted at Ashok and Rita Patel Institute of Physiotherapy after getting approval from Institutional Research Board. 52 normal weight and 52 overweight and obese adults were included. Body mass index and waist hip ratios of each participant were calculated. All participants underwent Harvard step testing. Heart rate was measured using Polar Heart Rate monitor. At the end of test chronotropic response, heart rate recovery and harvard fatigue index was calculated. Mean body mass index of normal weight and overweight/obese group age was 19.92 ± 1.73 kg/m² and 27.12 ± 3.36 kg/m², respectively. Odds of having chronotropic incompetence and abnormal heart rate recovery were higher among overweight/obese group, compare to normal weight group. (Chronotropic incompetence, OR= 1.37, 95% CI, Heart Rate Recovery, OR= 4, 95% CI). In overweight group body mass index was found to be negatively correlated with peak heart rate ($r = -0.34, p = 0.05$) and chronotropic response ($r = -0.352, p = 0.04$). Between group analysis (for chronotropic response and heart rate recovery) revealed no statistical significant difference. Odds of having chronotropic incompetence and abnormal heart rate recovery were higher among participants of overweight/obese group. Chronotropic response and heart rate recovery are two easy measures of autonomic indices. If they are routinely incorporated into clinical practice they can easily categorize patients into high risk and low risk category.

Keywords: Overweight, Obesity, Chronotropic response, Heart rate recovery.

INTRODUCTION

Overweight and obesity are important risk factors for diabetes, cardiovascular diseases, cancer and premature death. Prevalence of overweight in Indian men and women is 10% and 11.7% respectively. Prevalence of obesity in Indian men and women is 1.8% and 4.4% respectively.

The high prevalence of overweight and obesity, combined with their concomitant health risks, makes it a particularly relevant public health challenge [1] Several body composition measures are available to discriminate normal weight individuals from overweight and obese individuals. Body mass

index appears to be the best indicator for obesity as it approximates adiposity and fat distribution in adults. Waist-hip ratio is an equally simple anthropometric index used as a marker of abdominal adiposity [2].

Along with acting as a risk factor for various non communicable diseases, overweight and obesity is also associated with the altered functioning of autonomic nervous system in adults [3, 4]. So overweight and obese adults may have some sign of altered activity of autonomic nervous system. Tests such as valsalva manoeuvre, isometric handgrip test, analysis of heart rate variability and thermoregulatory sweat test can measure function of

autonomic nervous system. These tests require specialized equipments. In contrast to it, chronotropic response and heart rate recovery are two easy to measure indices of autonomic nervous system [5-8].

To maintain heart rate at rest, during exercise and during recovery is a function of autonomic nervous system along with other factors such as age, physical conditioning, and baroreceptor reflex. The immediate response of the cardiovascular system to exercise is an increase in heart rate and with the cessation of exercise; Heart rate is expected to return to resting position [4]. An impaired heart rate response to exercise and abnormal heart rate recovery are identified as a powerful and independent predictor of cardiovascular and all-cause mortality in healthy adults [5-8].

There is paucity of the studies comparing the heart rate response to exercise and heart rate recovery in normal weight and overweight/obese adult population. Therefore aim of the present study was to compare heart rate response to exercise and heart rate recovery between normal weight and overweight/obese adults. Secondly we aimed at identifying the relationship between body composition measures and heart rate responses of exercise.

MATERIALS AND METHODS:

Study was conducted after getting approval from Institutional Review Board of Ashok & Rita Patel Institute of Physiotherapy, CHARUSAT.

Study Population:

This was a cross sectional study. Participants were screened for inclusion and exclusion criteria. Total 104 participants between age group of 18-25 years and of both genders were recruited for the study. Written informed consent of the participants was taken. They were divided into two groups, 52 participants in each group. Those who had body mass index between 18.25-22.5 kg/m² were considered into normal weight group. Those who had body mass index value 23-30 kg/m² were considered into overweight and obese group. Individuals with body mass index value more than 30 kg/m² were excluded from the study [9]. Individuals coming under “elevated risk” of ACSM fitness preparticipation screening questionnaire were excluded from the study. Also individuals who cannot perform the exercise test because of orthopedic, cardiovascular or neurological conditions were excluded. Baseline characteristics of each

participant (age, gender, resting heart rate, body mass index, and waist hip ratio) were recorded on the day of exercise testing.

Exercise testing:

Participants underwent symptom limited “Harvard step test”. For male participants 45 cm height step was used, for female participants 35 cm height step was used. Harvard step test is a 6 minute test, where participants were instructed to step up and down the step, on the beep of metronome. Stepping rate was kept at 30 steps/minute. Test was terminated on patient’s wish (due to exhaustion), or other signs of poor perfusion, shortness of breath, leg cramps. Patients were instructed to sit, as soon as test was ended [10, 11].

Heart rate was measured using polar heart rate monitor at rest (in sitting position), during each minute of testing, immediately after termination of test and during recovery period at 1, 2 and 3 minutes of recovery.

Outcomes:

The outcome variables were chronotropic response and heart rate recovery. Chronotropic response was calculated by formula, peak heart rate – resting heart rate/(age predicted maximal heart rate – resting heart rate) [12] Chronotropic Incompetence was considered as inability to achieve 80% of heart rate reserve. For the present study, heart rate recovery was calculated as “Maximal heart rate – heart rate at 2 minutes of recovery”. An abnormal heart rate recovery was considered a decrease of less than 22 beats after 2 minute of recovery [13, 14].

STATISTICAL ANALYSIS

IBM SPSS version 23 was used for the statistical analysis. Data was found to be not normally distributed. Descriptive statistics on baseline variables are presented as mean and SD. Odds ratio was calculated to find out the odds of having higher values of abnormal chronotropic response and heart rate recovery. For within group analysis, spearman correlation of coefficient was used to correlate body composition measures (BMI and WHR) with heart rate response (Chronotropic response and Heart Rate Recovery).

RESULT

A total 104 participants were recruited for the study. Baseline Characteristics and exercise test parameters of the participants are mentioned in table 1.

Table-1 Baseline Characteristics and Exercise test parameters of the participants

	Normal Weight	Overweight
n	52	52
Age (Years)	19.72± 2.07	20.1±2.16
BMI (Kg/M ²)	19.92±1.73	27.12±3.36
WHR	0.80±0.09	0.79±0.089
RHR(beats/minute)	86.33±11.63	86.48±12.39
Peak Heart Rate	172.02±17.14	173.31±15.07
Chronotropic Response	1.93±6.26	2.21±7.70
Heart Rate Recovery	47.70±14.38	50.24±19.79
Harvard Fatigue Index	16.43±7.83	14.50±7.88

Data are mean ± SD, BMI = Body Mass Index, WHR = Waist Hip Ratio, RHR= Resting Heart Rate, HRR= Heart Rate Recovery

In the normal weight group, 2 (4%) participants demonstrated abnormal value of heart rate recovery and 22 (42%) participants demonstrated chronotropic incompetence. In overweight/obese group, 7 (13.46%) demonstrated abnormal value of heart rate recovery and 26(52%) demonstrated chronotropic incompetence. Mean value of the harvard fatigue index, came under poor category of cardiopulmonary fitness for both normal weight and overweight/obese participants.

Among the participants of overweight/obese group, there was moderate negative correlation between body mass index and peak heart rate ($r = -0.343$, $p=0.007$), between body mass index and chronotropic response ($r = -0.352$, $p= 0.00$). Body mass index had poor correlation with heart rate recovery. There was negligible correlation between waist hip ratio and heart rate response (Chronotropic Response and Heart Rate Recovery) ($r = -0.12$, $p=0.004$ for chronotropic response, $r = -0.09$, $p= 0.002$ for heart rate recovery))

Between group comparisons

Odds of having abnormal chronotropic response were higher in overweight/obese group, in comparison of normal weight group. (OR= 1.37, 95% CI). Similarly Odds of having abnormal heart rate recovery were higher among overweight/obese group, compare to normal weight group. (OR= 4, 95% CI).

DISCUSSION

Influence of body weight on autonomic nervous system

Cardiovascular disease is more prevalent in obese individuals. One possible pathophysiological mechanism behind this association is altered cardiovascular autonomic regulation, including

reduced parasympathetic activity which is supported by previous studies, the most prominent finding being reduction in parasympathetic activity [3,12,15,16] Mechanism by which weight gain reduces parasympathetic tone has yet to be clarified. But one possible explanation is that obesity is associated with chronic inflammation of adipose tissue. Inflammatory adipokines secreted by white fat, such as tumor necrosis factor alpha and interleukin-6, affect the cardiac autonomic balance via the central nervous system, promoting sympathetic hyperactivity, especially in hypertensive obese individuals, counteracting increased parasympathetic activity and acetylcholine levels, which inhibit release of these inflammatory cytokines. It is through inflammatory states and autonomic nervous system dysfunction that obese patients have a higher risk of morbidity and mortality. Also its been proven that 10% reduction of initial body weight can result into increased parasympathetic activity, which shows influence of body weight on functioning of autonomic nervous system [3,16-19].

Chronotropic response and Heart Rate recovery as a measure of autonomic activity of heart

Influence of ANS on cardiac function is traditionally been measured by heart rate variability and baroreflex sensitivity. Neither of these measures has made it into routine clinical practice, as they require special equipment for measurement[20]. Increase in heart rate during exercise (Chronotropic Response) and decline in heart rate in recovery period (Heart rate recovery) are also regulated by autonomic nervous system. They are easy to measure in comparison to heart rate variability. Among them chronotropic incompetence is a stronger predictor of mortality than heart rate recovery, but risk can be more powerfully stratified by these two responses

together[8,22]. In the present cross sectional study, we have found 2 times higher percentage of chronotropic incompetence and 4 times higher abnormal heart rate recovery in overweight and obese participants, compare to normal weight group. This finding can be because of influence of excess body weight on autonomic nervous system.

Increased body weight and Chronotropic response

Chronoscopic incompetence has been proven as an independent predictor of mortality, after adjusting other cardiovascular risk factors [5, 8] Chronoscopic response is regulated by autonomic nervous system. During early exercise heart rate rise is because of central withdrawal of parasympathetic tone. Once heart rate exceeds about 100 bpm, further increase in heart rate is mediated by sympathetic stimulation[22]. In the present study BMI and WHR is taken as obesity indices. We have found moderate negative correlation between BMI and chronotropic response. This finding is in agreement with previous research conducted by Palin TY, Guilin F. They have found significant trend towards decrease in peak heart rate and chronotropic measures as BMI increases. WHR is an indicator of central obesity. According to Koenig J, Windham BG waist hip ratio is more strongly related to the function of autonomic nervous system than body mass index [21]. This argument supports our finding of negative correlation between WHR and chronotropic response value.

Influence of body weight and heart rate recovery

Once the cessation of high physical activity, heart rate decreases rapidly and more quickly than arterial blood pressure. Rapid heart rate decrease that occurs promptly when exercise ceases, is entirely due to increase in cardiac vagal activity and the subsequent slow exponential decay in heart rate results from algebraic summation of an increasing vagal inhibitory effect and a gradually subsiding excitatory sympatho- adrenal action. Thus heart rate recovery is regulated by autonomic nervous system [22]. In our study, we have found negative correlation between heart rate recovery and body composition measures (BMI and WHR). This finding can be because of the altered autonomic nervous system function, specifically reduced parasympathetic activity in overweight and obese individuals.

Similar results are found by TC Barbosa, Valente et al in their research to find out relationship between heart rate recovery and body mass index. Result of their study stated that impaired heart rate

recovery was associated with higher body mass index [23]. Another study by Hanifah RA, Mohamed MN *et al*, assesses the relationship between body composition measures (BMI, WC, WHR) and heart rate recovery in healthy adolescence. They have found inverse association between body composition measures and heart rate recovery in study population [24].

CONCLUSION

This study signifies that the odds of having chronoscopic incompetence and abnormal heart rate recovery were higher among individuals with higher body mass index. Also body composition is inversely associated with the chronotropic response and heart rate recovery. The simple application of these factors provides powerful risk stratification from the exercise test and should be routinely included in the test report.

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