

Comparative Evaluation of Cardiovascular Responses to Isotonic Exercise in Obese and Non-Obese Young Adults: A Case-Control Study

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Abstract

Background: Obesity is associated with altered autonomic regulation and increased cardiovascular risk. Exercise-induced cardiovascular responses provide an important assessment of cardiovascular fitness and autonomic balance. The objective is to evaluate cardiovascular responses to isotonic exercise in obese and non-obese healthy young adults. **Material and Methods:** A case-control study was conducted among 60 healthy subjects aged 18–22 years. Thirty obese subjects (BMI ≥ 25 kg/m²) were compared with thirty normal-weight controls (BMI 18.5–22.9 kg/m²). Participants performed isotonic exercise using a bicycle ergometer for five minutes. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse pressure (PP), and mean arterial pressure (MAP) were recorded at baseline, immediately after exercise, and during recovery. Statistical analysis was performed using Student's t-test with significance set at $p < 0.05$. **Results:** Baseline HR was higher in obese subjects (75.17 ± 7.3 bpm) compared to controls (72.87 ± 7.1 bpm). Following isotonic exercise, HR increased significantly in both groups. Recovery HR remained elevated longer in obese subjects, indicating delayed autonomic recovery. **Conclusion:** Obese young adults demonstrate exaggerated cardiovascular responses and delayed recovery following isotonic exercise, suggesting impaired autonomic regulation.

Keywords: Isotonic exercise; obesity; cardiovascular response; autonomic function; heart rate recovery.

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INTRODUCTION

Exercise is a coordinated physiological activity involving cardiovascular, respiratory, and metabolic adjustments necessary to meet the increased energy demands of skeletal muscles.^[1] Isotonic exercise, characterized by rhythmic contraction and relaxation of muscles, results in increased cardiac output, oxygen consumption, and systolic blood pressure.^[2,3]

Obesity is recognized as a major risk factor for cardiovascular morbidity and mortality. Excess adipose tissue increases cardiac workload and contributes to autonomic imbalance, particularly increased sympathetic activity and reduced parasympathetic tone.^[4,5]

Heart rate recovery following exercise is considered an important indicator of autonomic function. Delayed recovery has been associated with increased cardiovascular risk and reduced functional capacity.^[6,7]

Although several studies have investigated cardiovascular responses to exercise, limited data are available comparing isotonic exercise responses among obese and non-obese young adults. Therefore, this study aimed to evaluate cardiovascular responses to isotonic exercise in obese and normal-weight healthy individuals.

MATERIALS AND METHODS

This case-control study was conducted at Index Medical College, Hospital & Research Centre, Indore, among first-

year medical students aged 18–22 years. Participants were initially screened based on age and relevant medical history, including history of hypertension, cardiovascular or pulmonary disease, smoking habits, and alcohol consumption. A detailed clinical examination was performed for all participants to exclude underlying systemic disorders. The study protocol was approved by the Institutional Ethics Committee, and participant recruitment was undertaken following ethical clearance.

Standardized inclusion and exclusion criteria were established to ensure uniform participant selection. Eligible participants aged 18–22 years were categorized into two groups based on body mass index (BMI): an obese group (BMI ≥ 25 kg/m²) and a control group (BMI 18.5–22.9 kg/m²). Only individuals who were normotensive, non-smokers, non-alcohol consumers, and non-tobacco users were included in the study. Participants were excluded if they had BMI values outside the specified ranges, age below 18 years or above 22 years, hypertension, a history of substance use, or any acute or chronic systemic illness.

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Study Population, Exercise Protocol, and Statistical Analysis: A total of 60 participants were included in the study, comprising 30 obese and 30 non-obese (control) subjects aged 18–22 years. All participants were screened prior to enrollment to exclude systemic illness and cardiovascular disorders through detailed medical history and clinical evaluation.

All experimental procedures were performed under standardized conditions. Participants were instructed to rest for 5 minutes prior to baseline measurements. Following the rest period, baseline cardiovascular parameters, including heart rate (HR) and blood pressure (BP), were recorded. Subsequently, participants performed isotonic exercise using a bicycle ergometer for a duration of 5 minutes at a standardized workload. Cardiovascular measurements were recorded immediately after completion of exercise and again at 5 minutes post-exercise to assess recovery responses. Cycle ergometry is widely recognized as a reliable and reproducible method for evaluating cardiovascular responses to dynamic exercise.^[8]

All collected data were compiled and analyzed using appropriate statistical methods. Continuous variables were

expressed as mean ± standard deviation (SD). Comparisons between the obese and control groups were performed using the Student’s t-test, and a p-value <0.05 was considered statistically significant. The student’s t-test is commonly employed to compare mean differences between two independent groups in physiological and clinical studies.^[9]

RESULTS

A total of 60 participants were included, consisting of 30 obese and 30 normal-weight individuals. The mean age of the obese and normal groups was 19.4 ± 1.3 years and 19.9 ± 1.7 years, respectively. The mean height was 163.7 ± 6.4 cm in the obese group and 161.8 ± 7.2 cm in the normal group. The mean body weight was higher in the obese group (73.53 ± 13.1 kg) compared to the normal group (53.03 ± 6.0 kg). Similarly, the mean BMI was significantly higher in the obese group (27.32 ± 4.3 kg/m²) than in the normal group (20.28 ± 1.7 kg/m²).

The mean age and height were comparable between the obese and normal groups, with no statistically significant difference (p > 0.05). However, the mean body weight and body mass index (BMI) were significantly higher in the obese group compared to the normal group (p < 0.001). [Table 1]

Table 1: Baseline Characteristics of Study Participants

Parameter	Obese Group (n=30) Mean±SD	Normal Group (n=30) Mean±SD	p-value
Age (yrs)	19.4±1.3	19.9±1.7	>0.05
Height (cm)	163.7±6.4	161.8±7.2	>0.05
Weight (kg)	73.53±13.1	53.03±6.0	<0.001
Body Mass Index (kg/m ²)	27.32±4.3	20.28±1.7	<0.001

Table 2: Comparison of Mean Heart Rate (bpm) Between Obese and Normal Groups Before and After Exercise

Heart rate (bpm)	Obese Group (n=30) Mean±SD	Normal Group (n=30) Mean±SD	p-value
Pre-exercise	75.17±7.3	72.87±7.1	<0.001
Immediately after isotonic exercise	128.9±34.0	120.93±16.2	>0.05
Immediately after isometric exercise	82.96±7.3	81.13±7.9	>0.05
Recover after isotonic exercise	85.30±9.8	83.03±9.3	>0.05
Recovery after isometric exercise	76.80±5.6	75.27±5.7	>0.05

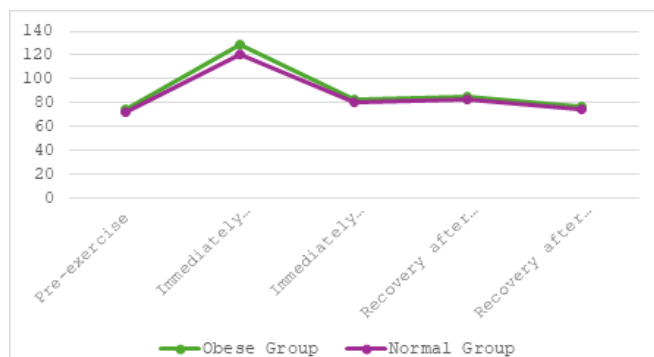


Figure 1: Comparison of Mean Heart Rate (bpm) Between Obese and Normal Groups at Different Phases of Exercise

The pre-exercise heart rate was significantly higher in the obese group (75.17 ± 7.3 bpm) compared to the normal group (72.87 ± 7.1 bpm) (p < 0.001). Heart rate increased following both isotonic and isometric exercise in both groups; however, intergroup differences immediately after exercise and during recovery were not statistically significant (p > 0.05). [Table 2]

The mean pre-exercise heart rate was significantly higher in the obese group (75.17 ± 7.3 bpm) compared to the normal group (72.87 ± 7.1 bpm) (p < 0.001). Heart rate increased following both isotonic and isometric exercise in both groups; however, the differences between obese and normal groups immediately after exercise and during recovery phases were not statistically significant (p > 0.05). [Figure 1]

Table 3: Comparison of Baseline Blood Pressure Parameters Between Obese and Normal Groups

Blood Pressure Parameters	Obese Group (n=30)	Normal Group (n=30)	P-value
Systolic Blood Pressure (SBP)	109.73± 8.3	108.67± 7.3	<0.001
Diastolic Blood Pressure (DBP)	69.00± 6.21	69.53± 6.55	<0.001
Pulse Pressure (PP)	40.60± 5.3	38.83± 4.4	0.178
Mean Arterial Pressure (MAP)	82.03± 6.7	88.43± 7.2	0.956

The baseline systolic blood pressure (SBP) and diastolic blood pressure (DBP) values were comparable between the obese

and normal groups. Pulse pressure (PP) and mean arterial pressure (MAP) also showed no statistically significant differences between the groups at baseline ($p > 0.05$), as shown in [Table 3].

DISCUSSION

The present study evaluated cardiovascular responses to isotonic exercise among obese and non-obese young adults. The findings demonstrated that baseline heart rate was significantly higher in obese individuals compared to normal-weight controls, while baseline blood pressure parameters were comparable between the two groups. Additionally, heart rate increased following exercise in both groups, with relatively slower recovery observed in obese participants.

In the present study, the baseline heart rate was significantly higher in the obese group compared to the normal group ($p < 0.001$). This observation suggests increased sympathetic activity and reduced parasympathetic tone among obese individuals. Similar findings were reported by Myers et al., who demonstrated that elevated resting heart rate in obese individuals reflects impaired autonomic regulation and increased cardiovascular risk.^[4] Increased resting heart rate among obese subjects has also been attributed to higher metabolic demand and increased cardiac workload required to perfuse excess adipose tissue.^[10]

Although baseline systolic and diastolic blood pressure values were slightly higher in the obese group, the differences between groups were not statistically significant. This finding indicates that, in young adults without established hypertension, obesity may initially influence autonomic control before causing overt blood pressure alterations. Similar observations were reported by Selvamurthy et al., who noted that early physiological changes associated with obesity involve autonomic imbalance rather than immediate hypertension.^[5]

Following isotonic exercise, heart rate increased significantly in both obese and normal groups, reflecting the expected physiological response to dynamic exercise. Isotonic exercise is known to increase cardiac output through elevation of heart rate and stroke volume, thereby enhancing oxygen delivery to working muscles.^[2,12] In the present study, although heart rate values were higher in obese subjects immediately after exercise, the intergroup difference was not statistically significant. This finding is consistent with the work of Convertino et al., who reported similar exercise-induced cardiovascular responses between individuals with varying body compositions during short-duration dynamic exercise.^[11]

An important observation in the present study was the delayed recovery of heart rate among obese individuals compared to the normal group. Although recovery differences were not statistically significant, the trend toward slower normalization of heart rate suggests impaired parasympathetic reactivation. Heart rate recovery is considered a sensitive indicator of autonomic function, particularly vagal tone. Lauer et al. reported that delayed heart rate recovery following exercise is associated with

reduced parasympathetic activity and increased cardiovascular mortality risk.^[6] Similarly, Kleiger et al. emphasized the role of heart rate variability and recovery patterns as markers of autonomic dysfunction.^[13]

The comparable baseline values of pulse pressure (PP) and mean arterial pressure (MAP) between obese and normal groups observed in the present study suggest preserved vascular compliance among young obese individuals. This finding supports the concept that early-stage obesity primarily affects autonomic regulation before structural vascular changes become evident. Comparable findings were reported in previous physiological studies, indicating that significant vascular alterations usually develop later in the progression of obesity-related cardiovascular disease.^[10]

The increased heart rate response observed following isotonic exercise in both groups reflects normal physiological adaptation to dynamic muscular activity. During isotonic exercise, vasodilation of skeletal muscles reduces peripheral resistance while increasing cardiac output to maintain adequate tissue perfusion.^[12] The exaggerated heart rate response observed in obese individuals may be attributed to reduced cardiovascular efficiency and increased sympathetic drive, as previously described in exercise physiology studies.^[8]

Overall, the findings of the present study support the hypothesis that obesity is associated with altered autonomic regulation even in young, apparently healthy individuals. Although major blood pressure differences were not observed, the presence of elevated baseline heart rate and slower recovery patterns indicates early physiological adaptation to increased body mass. These findings highlight the importance of early screening and preventive interventions among obese individuals to reduce long-term cardiovascular risk.

CONCLUSION

The present study demonstrated that obese young adults exhibit altered cardiovascular responses to isotonic exercise compared to normal-weight individuals. A significantly higher baseline heart rate observed in the obese group suggests increased sympathetic activity and early autonomic imbalance. Although both obese and normal groups showed an expected rise in heart rate following isotonic exercise, the trend toward delayed recovery among obese participants indicates reduced parasympathetic reactivation and decreased cardiovascular efficiency.

Baseline systolic and diastolic blood pressure values were comparable between obese and normal groups, suggesting that overt blood pressure alterations may not yet be evident in young obese individuals. However, the observed differences in heart rate dynamics highlight the presence of early physiological changes associated with increased body mass.

Overall, the findings of this study indicate that obesity in young adults is associated with subtle but measurable alterations in cardiovascular regulation, even in the absence of clinically significant hypertension. These results emphasize the importance of early identification of cardiovascular risk factors and implementation of lifestyle modifications, including regular physical activity and weight management, to prevent the progression of obesity-related cardiovascular complications.

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Conflicts of interest

There are no conflicts of interest.

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