



IMPACT OF ISOMETRIC HANDGRIP EXERCISE ON CARDIOVASCULAR AND RESPIRATORY PARAMETERS IN OBESE AND NON-OBESE HEALTHY YOUNG ADULTS: A CASE-CONTROL STUDY

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Abstract

Background: Isometric exercise produces sustained muscle contraction and significant cardiovascular responses. Obesity alters respiratory mechanics and autonomic regulation, potentially modifying responses to static exercise.

Objective: To evaluate cardiovascular and respiratory responses to isometric handgrip exercise in obese and non-obese healthy young adults.

Methods: A case-control study was conducted among 60 healthy participants aged 18–22 years. Thirty obese subjects (BMI ≥ 25 kg/m²) and thirty normal-weight controls (BMI 18.5–22.9 kg/m²) were included. Isometric exercise was performed using a handgrip dynamometer at 30% of maximum voluntary contraction (MVC). Cardiovascular parameters, including 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. Respiratory parameters, including Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV1), were measured using spirometry. Statistical analysis was performed using Student's t-test.

Results: The mean baseline 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 isometric exercise in both groups; however, intergroup differences immediately after exercise and during recovery were not statistically significant ($p > 0.05$). Baseline systolic and diastolic blood pressure values were comparable between groups, and post-exercise and recovery blood pressure responses showed no significant differences. Respiratory parameters, including FVC and FEV1, were comparatively reduced in obese individuals, indicating decreased pulmonary function.

Conclusion: Obese young adults demonstrate elevated baseline heart rate and reduced pulmonary function compared to normal-weight individuals, suggesting early autonomic and respiratory alterations. Although blood pressure responses to isometric exercise were comparable between groups, the observed physiological differences highlight the importance of early preventive strategies, including weight management and regular physical activity, to reduce future cardiovascular and respiratory risk.

Keywords: Isometric exercise; obesity; spirometry; handgrip dynamometer; cardiovascular response; pulmonary function

Introduction

Isometric exercise involves sustained muscular contraction without movement and produces significant cardiovascular responses characterized by increased peripheral resistance and blood pressure (1,2). Obesity is associated with structural and functional changes in the respiratory system, including reduced lung volumes and decreased chest wall compliance. These alterations contribute to impaired respiratory efficiency and increased cardiovascular workload (3,4). Spirometry is a widely used tool for evaluating pulmonary function, with Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEV1) serving as key indicators of ventilatory function (5).

Isometric handgrip exercise is commonly used to evaluate sympathetic activation and cardiovascular responses under controlled conditions (6,7).

Despite the increasing prevalence of obesity, limited studies have evaluated combined cardiovascular and respiratory responses to isometric exercise among young adults. Therefore, this study aimed to evaluate the effect of isometric handgrip exercise on cardiovascular and respiratory parameters in obese and normal-weight individuals.

Materials and Methods

This **case-control study** was conducted at **Index Medical College, Hospital & Research Centre, Indore**, which included 60 apparently healthy participants aged 18–22 years, comprising 30 obese and 30 normal-weight individuals. Participants were clinically screened prior to enrollment to exclude systemic, cardiovascular, or respiratory disorders.

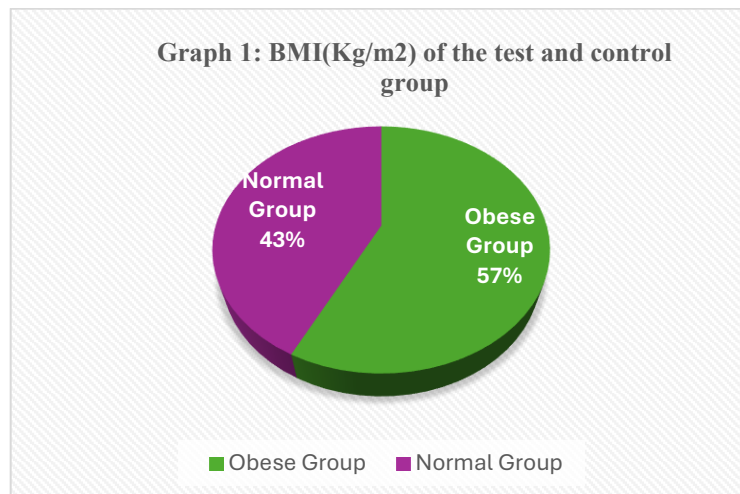
All experimental procedures were performed using standard instruments, including a handgrip dynamometer, electrocardiograph (ECG), mercury sphygmomanometer, and spirometer. Handgrip dynamometry is widely used as a reliable method for assessing isometric muscle strength and cardiovascular responses during static exercise (6).

Participants were allowed to rest for five minutes before baseline measurements of heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and spirometry parameters were recorded. Maximum voluntary contraction (MVC) was determined using three trials with a handgrip dynamometer, and the highest value was recorded. Subsequently, participants performed isometric handgrip exercise at 30% of MVC until fatigue, typically lasting approximately three minutes, to assess sympathetic responses to static exercise (7,8). Cardiovascular measurements were recorded immediately after exercise and again at five minutes during recovery.

All data were analyzed using SPSS software (Version 18). Results were expressed as mean $\pm$ standard deviation (SD), and comparisons between groups were performed using the Student's independent t-test, with $p < 0.05$ considered statistically significant.

Results

The mean body mass index (BMI) was significantly greater in the obese group ($27.32 \pm 4.3 \text{ kg/m}^2$) than in the normal group ($20.28 \pm 1.7 \text{ kg/m}^2$), confirming a clear anthropometric distinction between the obese and normal-weight participants. (Graph 1)



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 immediately after isometric exercise in both groups but showed no statistically significant difference between obese and normal participants ($p > 0.05$). Similarly, recovery heart rate values were comparable between groups ($p > 0.05$). (Table 1)

Table 1: Mean Heart Rate (bpm) Before and After Isometric Exercise			
Heart rate (bpm)	Obese Group (n=30) Mean $\pm$ SD	Normal Group (n=30) Mean $\pm$ SD	p-value
Pre-exercise	75.17 $\pm$ 7.3	72.87 $\pm$ 7.1	<0.001
Immediately after isometric exercise	82.96 $\pm$ 7.3	81.13 $\pm$ 7.9	>0.05
Recovery after isometric exercise	76.80 $\pm$ 5.6	75.27 $\pm$ 5.7	>0.05

Baseline systolic and diastolic blood pressure values were comparable between the obese and normal groups. Pulse pressure and mean arterial pressure also showed no statistically significant differences between groups ($p = 0.178$ and $p = 0.956$, respectively), indicating similar baseline hemodynamic status. (Table 2)

Table 2: Baseline Blood Pressure Parameters			
Blood Pressure Parameters (mmHg)	Obese Group (n=30)	Normal Group (n=30)	P-value
Systolic Blood Pressure (SBP)	109.73 $\pm$ 8.3	108.67 $\pm$ 7.3	<0.001
Diastolic Blood Pressure (DBP)	69.00 $\pm$ 6.21	69.53 $\pm$ 6.55	<0.001
Pulse Pressure (PP)	40.60 $\pm$ 5.3	38.83 $\pm$ 4.4	0.178
Mean Arterial Pressure (MAP)	82.03 $\pm$ 6.7	88.43 $\pm$ 7.2	0.956

Immediately after isometric exercise, systolic, diastolic, pulse pressure, and mean arterial pressure values were slightly higher in the obese group compared to the normal group; however, the differences were not statistically significant ($p > 0.05$), indicating similar immediate cardiovascular responses between groups. (Table 3)

Table 3: Blood Pressure Immediately after Isometric Exercise			
Blood Pressure Parameters (mmHg)	Obese Group (n=30)	Normal Group (n=30)	P-value

Systolic Blood Pressure (SBP)	113.73±7.5	111.0±8.1	>0.05
Diastolic Blood Pressure (DBP)	68.93±6.2	69.73±7.3	>0.05
Pulse Pressure (PP)	43.67±4.7	41.67±5.6	>0.05
Mean Arterial Pressure (MAP)	84.30±7.1	82.93±7.0	>0.05

During the recovery phase following isometric exercise, systolic, diastolic, pulse pressure, and mean arterial pressure values were comparable between obese and normal groups, with no statistically significant differences observed ($p > 0.05$), indicating similar cardiovascular recovery responses in both groups. (Table 4)

Table 4: Blood Pressure During Recovery (5 min) After Isometric Exercise			
Blood Pressure Parameters (mmHg)	Obese Group (n=30)	Normal Group (n=30)	P-value
Systolic Blood Pressure (SBP)	112.06±6.3	109.53±7.9	>0.05
Diastolic Blood Pressure (DBP)	68.60±5.7	68.53±6.5	>0.05
Pulse Pressure (PP)	43.26±4.7	41.0±5.3	>0.05
Mean Arterial Pressure (MAP)	82.86±5.4	82.23±6.5	>0.05

Discussion

The present study evaluated the cardiovascular responses to isometric handgrip exercise in obese and non-obese healthy young adults and examined associated respiratory function parameters. The findings demonstrated that obese individuals exhibited a significantly higher baseline heart rate compared to normal-weight participants, while blood pressure responses before and after isometric exercise remained comparable between groups. Additionally, respiratory function parameters were relatively reduced among obese individuals, suggesting impaired pulmonary efficiency.

In the present study, the **baseline heart rate** was significantly higher in obese participants compared to the normal group ($p < 0.001$). This observation suggests increased sympathetic activity and reduced parasympathetic tone among obese individuals, even at rest. Similar findings were reported by **Saito et al.**, who demonstrated enhanced sympathetic nerve activity during sustained muscle contraction in obese subjects, contributing to elevated resting heart rate and altered cardiovascular regulation (9). Increased resting heart rate in obesity has also been associated with elevated metabolic demand and increased cardiac workload required to maintain adequate tissue perfusion (1).

Following isometric exercise, heart rate increased in both obese and normal groups; however, the differences between groups immediately after exercise were not statistically significant. This pattern reflects the expected physiological response to isometric exercise, which is characterized by increased peripheral resistance and sympathetic activation. Comparable findings were reported by **Fisher and Nutter**, who observed similar increases in heart rate during isometric handgrip exercise across individuals with varying physiological characteristics (8). The absence of a statistically significant difference between groups in the immediate phase suggests that short-duration isometric exercise produces uniform cardiovascular activation across healthy individuals.

During the recovery phase, heart rate values showed a gradual return toward baseline levels in both groups. Although recovery values were comparable between obese and normal participants, the slightly elevated recovery heart rate observed in obese individuals suggests relatively slower autonomic recovery. **Lauer et al.** reported that delayed heart rate recovery following exercise is an indicator of impaired parasympathetic reactivation and may serve as an early marker of cardiovascular dysfunction (12). The present findings are consistent with these observations, indicating subtle autonomic alterations in obese individuals even in the absence of overt cardiovascular disease.

Baseline **systolic and diastolic blood pressure** values in the present study were within normal physiological limits in both groups and showed no statistically significant differences. This finding suggests that young obese individuals without established hypertension may initially exhibit

autonomic alterations rather than structural vascular changes. Similar results were reported by **Martin et al.**, who observed that resting blood pressure values remain within normal limits in young adults despite variations in body composition (6).

Immediately after isometric exercise, systolic blood pressure, diastolic blood pressure, pulse pressure, and mean arterial pressure showed slight increases in both groups; however, these changes were not statistically significant between obese and normal participants. This response is consistent with the known physiological effects of isometric exercise, which produces increased peripheral resistance due to sustained muscle contraction. **Schibye et al.** reported comparable increases in blood pressure parameters during static exercise, attributing these changes to sympathetic activation and increased vascular resistance (7).

During the recovery phase following isometric exercise, blood pressure parameters gradually returned toward baseline values in both groups. The absence of statistically significant differences in recovery blood pressure values suggests similar vascular recovery responses among obese and normal participants. These findings indicate that short-duration isometric exercise may not produce marked hemodynamic differences in young adults without established cardiovascular pathology.

In addition to cardiovascular responses, the present study observed relatively **reduced spirometry parameters**, including **Forced Vital Capacity (FVC)** and **Forced Expiratory Volume in one second (FEV1)**, among obese individuals compared to normal-weight controls. Reduced lung volumes in obese individuals have been widely reported and are primarily attributed to decreased chest wall compliance and increased intra-abdominal pressure. **Salome et al.** demonstrated that obesity significantly reduces lung volumes and impairs respiratory mechanics, leading to decreased ventilatory efficiency (10). Similarly, **Littleton** reported that increased adiposity alters respiratory mechanics and increases the work of breathing, thereby contributing to reduced pulmonary function (11).

Overall, the findings of the present study support the concept that obesity is associated with early physiological alterations in both cardiovascular and respiratory systems, even among young, apparently healthy individuals. The presence of elevated baseline heart rate and reduced pulmonary function suggests early autonomic and respiratory adaptations associated with increased body mass. These changes may precede the development of clinically significant cardiovascular or respiratory disease.

Conclusion

This study demonstrates that obese young adults exhibit higher baseline heart rate and relatively reduced pulmonary function compared to normal-weight individuals, indicating early autonomic and respiratory alterations. Although blood pressure responses to isometric exercise were comparable between groups, the observed physiological differences highlight the importance of early preventive strategies, including weight control and regular physical activity, to reduce long-term cardiovascular and respiratory risk.

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