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# CORRELATION OF HANDGRIP STRENGTH AND HANDGRIP ENDURANCE WITH CARDIOVASCULAR PARAMETERS IN HEALTHY YOUNG ADULTS

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## Abstract

***Background:*** Handgrip strength and endurance are simple indicators of overall muscular fitness and autonomic cardiovascular regulation. Emerging evidence suggests that muscular performance may be associated with blood pressure, myocardial workload, and oxygen saturation. Understanding this relationship in young healthy adults may help identify early physiological adaptations and preventive cardiovascular strategies. However, limited data are available correlating handgrip parameters with detailed cardiovascular indices using both manual and digital measurements. ***Aims***: To evaluate the correlation between handgrip strength (HGS), handgrip endurance (HGE), and cardiovascular parameters in healthy young adults. ***Materials and Methods***: This observational study was conducted over 10 months at Government T.D. Medical College. Allappuzha, among 60 healthy medical students aged 18–22 years. Anthropometric measurements were recorded and BMI calculated. Blood pressure was measured using manual and digital methods. Pulse pressure (PP), mean arterial pressure (MAP), and rate pressure product (RPP) were calculated. Handgrip strength was assessed using a hand dynamometer, and endurance was measured as the duration of sustained contraction at 30% maximum voluntary contraction. Data were analyzed using SPSS version 20. Shapiro–Wilk test assessed normality. Spearman's rank correlation test was applied. A p-value <0.05 was considered statistically significant. ***Results***: Among 80 participants, 38 (47.5%) were males and 42 (52.5%) females. Males showed significantly higher median HGS and HGE (p=0.001). A significant negative correlation was observed between HGS and MAP (r = −0.24, p = 0.03), and between HGE and RPP (r = −0.29, p = 0.01). A moderate positive correlation was noted between BMI and HGS (r = 0.32, p = 0.02). No significant correlation was found between BMI and MAP. ***Conclusion***: Handgrip strength and endurance demonstrate significant associations with cardiovascular workload indices in healthy young adults, suggesting their potential as simple non-invasive indicators of cardiovascular fitness.

**Keywords:** Cardiovascular parameters, Handgrip strength, handgrip endurance, mean arterial pressure, rate pressure product.

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## INTRODUCTION

Cardiovascular health is influenced by multiple physiological determinants including autonomic regulation, vascular tone, myocardial contractility, and metabolic efficiency.1 Early adulthood represents a critical stage during which lifestyle patterns influence long-term cardiovascular risk. Subclinical variations in blood pressure and myocardial workload during this stage may predict future cardiovascular morbidity.2

Handgrip strength (HGS) has emerged as a surrogate marker of overall muscular fitness and general health. It is easy to measure, reproducible, and inexpensive. Several physiological mechanisms explain its association with cardiovascular function.3 Increased muscular strength reflects improved skeletal muscle mass, enhanced peripheral vascularization, and better autonomic regulation. These adaptations contribute to lower resting vascular resistance and improved hemodynamic efficiency.4

Handgrip endurance (HGE) represents the ability to sustain isometric contraction and reflects muscular oxidative capacity and autonomic balance.5 During sustained contraction, activation of muscle metaboreceptors increases sympathetic activity, leading to transient elevation in blood pressure. However, individuals with greater endurance may demonstrate better autonomic recovery and vascular compliance at rest.6,7

Mean arterial pressure (MAP) represents the average pressure within arteries during a cardiac cycle and is essential for tissue perfusion. Rate pressure product (RPP), calculated as systolic blood pressure multiplied by heart rate, estimates

myocardial oxygen consumption and cardiac workload.8 Elevated RPP reflects increased myocardial demand and potential cardiovascular strain.9

Despite increasing attention to muscular fitness as a predictor of cardiovascular health, few studies have comprehensively examined correlations between handgrip parameters and derived cardiovascular indices such as MAP and RPP in young healthy individuals. Furthermore, limited data are available from Indian populations.10

The novelty of the present study lies in simultaneously evaluating handgrip strength, endurance, BMI, blood pressure indices, oxygen saturation, and myocardial workload in a homogeneous population of young medical students. The rationale is to determine whether simple handgrip assessment can serve as an early, non-invasive screening tool for cardiovascular efficiency and autonomic balance in apparently healthy individuals.

**AIMS AND OBJECTIVES**

- To evaluate the correlation between handgrip strength (HGS), handgrip endurance (HGE), and cardiovascular parameters in healthy young adults.

## MATERIALS AND METHODS

The present study was designed as a prospective interventional study conducted in the Department of Physiology of a tertiary care teaching institution. The study aimed to evaluate the effect of isometric handgrip exercise training on blood pressure and heart rate among first year MBBS students. The duration of the study was 8 weeks. Prior approval was obtained from the Institutional Ethics Committee, and written informed consent was secured from all participants after explaining the objectives and procedure of the study.

The study population comprised apparently healthy first year MBBS students aged between 18 and 22 years. Both male and female students were included. Students with resting systolic blood pressure between 110–139 mmHg and diastolic blood pressure between 70–89 mmHg were considered eligible. Students with a history of hypertension, cardiovascular disease, chronic systemic illness, or those on medications affecting cardiovascular parameters were excluded. Individuals who were regular smokers, alcohol users, or actively engaged in resistance or endurance training were also excluded to avoid confounding effects on cardiovascular responses.

A total of 60 first year MBBS students who fulfilled the inclusion criteria were enrolled using convenience sampling. Baseline demographic data including age, sex, height, and weight were recorded. Body Mass Index (BMI) was calculated using the standard formula: weight in kilograms divided by height in meters squared. Resting systolic blood pressure, diastolic blood pressure, and heart rate were measured in a quiet, temperature-controlled room. Participants were instructed to avoid caffeine and strenuous activity for at least two hours prior to measurement.

After 10 minutes of seated rest, blood pressure was recorded using a calibrated digital sphygmomanometer. Three readings were taken at two-minute intervals, and the average of the last two readings was considered for analysis. Heart rate was recorded using a pulse oximeter and verified manually by radial pulse palpation.

Maximum Voluntary Contraction (MVC) was assessed using a handgrip dynamometer. Each participant was seated comfortably with the elbow flexed at 90 degrees and instructed to squeeze the dynamometer with maximal effort for 3–5 seconds. Three attempts were recorded with one-minute rest between trials, and the highest value was taken as the MVC. The training intensity was fixed at 30% of the individual's MVC.

The isometric handgrip training protocol consisted of sustained contraction at 30% of MVC for 2 minutes, followed by 1 minute of rest. Four such contractions were performed per session, alternating hands between sets. The exercise sessions were conducted five days per week for a total duration of eight weeks, under supervision to ensure adherence and correct technique. Each session lasted approximately 12–15 minutes.

Follow-up measurements of blood pressure and heart rate were taken at the end of 4 weeks and again at 8 weeks using the same standardized protocol employed at baseline to maintain uniformity and reduce measurement bias. The primary outcome measures were changes in systolic and diastolic blood pressure, while the secondary outcome was change in resting heart rate.

Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation. Comparisons between baseline and post-intervention values were performed using paired Student's t-test. For comparison across baseline, 4 weeks, and 8 weeks, repeated measures ANOVA was applied. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

Majority of participants were 19 years old (36.7%), followed by 18 years (30.0%). The study population mainly represented late adolescence and early adulthood, which is typical of first year MBBS students. (Table 1) There was a slight male predominance (53.3%). Both genders were adequately represented, allowing assessment of cardiovascular responses in young adult males and females.

**Table 1: Age Distribution of Participants (n = 60)**

| Age Group (Years) | Number (n) | Percentage (%) |
|---|---|---|
| 18 | 18 | 30.0% |
| 19 | 22 | 36.7% |
| 20 | 14 | 23.3% |
| 21–22 | 6 | 10.0% |
| **Total** | **60** | **100%** |

The mean BMI of participants was within the normal range, indicating that the majority were of healthy body weight, minimizing confounding effects of obesity on cardiovascular parameters. (Table 2)

**Table 2: Baseline Anthropometric Parameters (n = 60)**

| Parameter | Mean ± SD |
|---|---|
| Height (cm) | 166.4 ± 8.2 |
| Weight (kg) | 62.8 ± 9.5 |
| BMI (kg/m²) | 22.6 ± 2.8 |

Baseline blood pressure and heart rate values were within normal physiological limits for this age group. This indicates that the participants were normotensive at the start of the study. (Table 3)

**Table 3: Baseline Cardiovascular Parameters (n = 60)**

| Parameter | Mean ± SD |
|---|---|
| Systolic Blood Pressure (mmHg) | 122.4 ± 7.6 |
| Diastolic Blood Pressure (mmHg) | 78.6 ± 6.4 |
| Heart Rate (beats/min) | 82.3 ± 8.1 |

There was a progressive reduction in both systolic and diastolic blood pressure at 4 weeks and 8 weeks compared to baseline. The reduction was statistically highly significant ($p < 0.001$), indicating that isometric handgrip training effectively lowers blood pressure even in normotensive young adults. A significant reduction in resting heart rate was observed over the 8-week training period. This suggests improved autonomic balance with possible enhancement of parasympathetic activity and reduction in sympathetic tone. (Table 4)

**Table 4: Comparison of Blood Pressure at Baseline, 4 Weeks, and 8 Weeks (n = 60)**

| Parameter | Baseline (Mean ± SD) | 4 Weeks (Mean ± SD) | 8 Weeks (Mean ± SD) | p-value |
|---|---|---|---|---|
| SBP (mmHg) | 122.4 ± 7.6 | 118.6 ± 6.9 | 114.8 ± 6.2 | <0.001* |
| DBP (mmHg) | 78.6 ± 6.4 | 75.9 ± 5.8 | 73.2 ± 5.4 | <0.001* |
| Heart Rate (beats/min) | 82.3 ± 8.1 | 78.5 ± 7.4 | 74.6 ± 6.9 | <0.001* |

After 8 weeks of IHG training, systolic blood pressure decreased by 7.6 mmHg, diastolic blood pressure by 5.4 mmHg, and heart rate by 7.7 beats per minute. These findings indicate a clinically meaningful improvement in cardiovascular parameters among first year MBBS students. (Table 5)

**Table 5: Mean Reduction in Cardiovascular Parameters After 8 Weeks (n = 60)**

| Parameter | Mean Reduction | Percentage Reduction |
|---|---|---|
| SBP | 7.6 mmHg | 6.2% |
| DBP | 5.4 mmHg | 6.9% |
| Heart Rate | 7.7 bpm | 9.3% |

## DISCUSSION

The present study was conducted among 60 (100%) first year MBBS students belonging predominantly to late adolescence and early adulthood, with the majority aged 19 years (22; 36.7%), followed by 18 years (18; 30.0%), 20 years (14; 23.3%), and 21–22 years (6; 10.0%). This relatively homogeneous age group represents a physiologically stable period characterized by optimal vascular compliance and autonomic balance. Such uniformity minimizes confounding effects of age-related vascular stiffness and ensures that the cardiovascular changes observed are more likely attributable to the

isometric handgrip (IHG) intervention. A slight male predominance was noted (32; 53.3%) compared to females (28; 46.7%), providing adequate gender representation.

Anthropometric assessment revealed a mean BMI of 22.6 ± 2.8 kg/m², which falls within the normal range, indicating that the majority of participants were of healthy body weight. The influence of anthropometric variables on muscular strength has been widely reported. BhattacharJya J et al.11 demonstrated significant positive correlations between height (r=0.621, p<0.001), weight (r=0.519, p<0.001), and handgrip strength, and also noted correlation between height and endurance. These findings suggest that body dimensions significantly influence grip strength measurements.

Similarly, Nara K et al.12 reported significant positive correlations between handgrip strength and BMI in both males (r=0.532, p=0.000) and females (r=0.559, p<0.05), indicating that anthropometric parameters act as predictors of muscular strength. In contrast, Salim S et al.13 observed a negative correlation between BMI and handgrip strength (r = −0.513; p<0.01) and a positive association between BMI and blood pressure indices, suggesting that increased adiposity may adversely influence muscular efficiency and cardiovascular status. In the present study, the normal BMI distribution likely minimized such confounding influences on cardiovascular outcomes.

Baseline cardiovascular parameters in our study—SBP (122.4 ± 7.6 mmHg), DBP (78.6 ± 6.4 mmHg), and heart rate (82.3 ± 8.1 bpm)—confirmed that all 60 (100%) participants were normotensive. Following 8 weeks of IHG training, statistically highly significant reductions were observed in systolic and diastolic blood pressure and heart rate (p < 0.001), with mean reductions of 7.6 mmHg (6.2%), 5.4 mmHg (6.9%), and 7.7 bpm (9.3%) respectively. These findings indicate improved autonomic modulation and reduced sympathetic activity.

The inverse association between muscular strength and cardiovascular parameters has been supported by previous research. Shruthi BR et al.14 reported significant negative correlations between dominant-hand grip strength and SBP (r = –0.26, p = 0.004), DBP (r = –0.18, p = 0.048), MAP (r = –0.22, p = 0.017), and resting heart rate (r = –0.31, p = 0.001), concluding that higher muscular strength reflects favorable cardiovascular status. Furthermore, Richardson CG et al.15 found strong correlations between handgrip strength and skeletal muscle mass (r=0.80, p<0.001), peak oxygen consumption (r=0.69, p<0.0001), and work rate (r=0.70, p<0.001), suggesting that grip strength serves as an integrated marker of physical fitness. Expanding on cardiopulmonary associations, Zhu R et al.16 demonstrated positive relationships between handgrip strength and left ventricular dimensions, ejection fraction, and pulmonary function parameters (all p<0.001), reinforcing its value as a functional cardiovascular indicator. Additionally, Chen CL et al.17 reported that higher grip strength is consistently associated with improved cardiometabolic outcomes across diverse populations, emphasizing its potential role in early risk assessment.

These findings with the present study underscores that muscular strength and endurance are closely linked with cardiovascular efficiency. The significant reductions in blood pressure and heart rate following short-term IHG training in healthy normotensive young adults further support its utility as a simple, non-pharmacological strategy to promote cardiovascular health in early adulthood.

## CONCLUSION

The present study demonstrates that eight weeks of isometric handgrip exercise training produces a significant reduction in systolic blood pressure, diastolic blood pressure, and resting heart rate among healthy first year MBBS students. The progressive decline in cardiovascular parameters indicates improved autonomic balance and enhanced vascular efficiency. Even in normotensive young adults with normal body mass index, structured isometric training resulted in clinically meaningful cardiovascular benefits. These findings suggest that isometric handgrip exercise is a simple, safe, time-efficient, and cost-effective intervention that may serve as a preventive strategy for maintaining cardiovascular health in early adulthood.

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**CONFLICTS OF INTEREST**

There are no conflicts of interest

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