Section: Physiology

Original Research Article

EFFECT OF HANDGRIP EXERCISE TRAINING ON RATE PRESSURE PRODUCT AMONGST FIRST YEAR MBBS STUDENTS

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ABSTRACT

Background: Regular physical activity has proven benefits in prevention of non-communicable diseases. Most youngsters are adopting a sedentary lifestyle with a lot of junk foods, leading them to a state of pre hypertension. Isometric handgrip exercise (IHG) training, one of the static exercises, using a handgrip dynamometer was used for 8 weeks, among medical students. Rate Pressure Product (RPP), a valuable marker of cardiac function was calculated as product of heart rate (HR) and systolic blood pressure (SBP) divided by thousand. RPP up to 12 at rest and up to 22 under stress are normal. If this static exercise training reduces RPP, this could be adopted by young population in their daily life to prevent progression of prehypertension and related sequelae.

Objective: To study the effect of IHG exercise training on RPP among first year MBBS students of Govt. TDMC Alappuzha.

Materials and Methods: An interventional study was conducted among 23 medical students of age group 18 to 20 years. Name, age, sex and medical history were documented in proforma. Blood pressure was recorded on the right arm in the sitting posture using a mercury and digital sphygmomanometer, before and after 8 weeks of IHG training. HR was measured using pulse oximeter. RPP was calculated as HR x SBP/1000. In the 8-week training program, student had to pull the handle of dynamometer using dominant hand with maximum strength, 3times with a rest period of 5 minutes in between. This had to be repeated three times per week.

Data was analyzed using SPSS version 20. Some variables did not assume normality, so non-parametric tests were used to analyze the dat.

Results: There was statistically significant decrease in RPP values recorded both manually and digitally and SBP values recorded digitally.

Conclusion: IHG exercise training is beneficial to reduce SBP and RPP. Hence IHG exercise training protocols can be adopted by youngsters for preventing progression of prehypertension.

Keywords: Isometric Exercise training, Heart Rate, Rate Pressure Product, Systolic Blood Pressure.

INTRODUCTION

Disease patterns have undergone a fundamental change as sequelae to population growth, rapid urbanization and globalization of unhealthy lifestyles. Non communicable diseases now form the major health burden rather than infectious diseases.[1] Of these a leading problem is cardiovascular disease (CVD). The WHO declared elevated blood pressure; HT as a worldwide health problem in 2013 and foresaw an impending epidemic.[2] Systolic and diastolic blood pressure, which represent different parts of the cardiac cycle, make up the dichotomous measure known as arterial blood pressure. SBP is the highest pressure recorded during cardiac systole.[3] According to Harrison's Manual of Medicine, average adult resting systolic / diastolic blood pressure should be 120 / 80 mmHg. People having a resting SBP of 120 to 129 mmHg and/or a diastolic blood pressure of less than 80-89 mmHg are

considered to have prehypertension.[4]Pre-hypertension increases the risk of CVD since it can cause the development of HT and its deleterious effects.

HT is defined as a resting SBP of >140 mmHg or diastolic blood pressure of >90 mm Hg or both.[5]

The American Heart Association (AHA) has recently recommended guidelines endorsing the use of IHG exercise as a strategy for managing HT.[6] In particular, using a hand dynamometer , 2 minutes of sustained contractions done at 30% of maximal voluntary strength (maximal voluntary contraction, MVC) for a total of 12–15 minutes every session, throughout an 8–12 week period.[7] There is data to suggest that acute IHG exercise regimens lower blood pressure in younger, normotensive patients by 11–12 mmHg.[8] Impact of acute IHG exercises on resting blood pressure, is seen as post-exercise hypotension and the processes underlying the reactions have not been thoroughly investigated. As a result, the related mechanisms are still mysterious. In addition to role of demographic characteristics, the hypotensive adaptations involved include modulation of the ANS, endothelium-dependent vasodilation and/or decrease in oxidative stress.

In this study the initial SBP readings were compared to those obtained after 8 weeks of IHG exercise training. In the 8-week training program, student had to pull the handle of dynamometer using dominant hand with maximum strength, 3times with a rest period of 5 minutes in between, for three times per week. Pulse oximeter readings provided the heart rate.

Determination of RPP is the best non-invasive and time sparing method of assessing the functional status of heart. It is controlled by autonomic nervous system (ANS) through HR and SBP. RPP (also called double product) calculated as product of HR and SBP, divided by thousand (HR x SBP/1000), provides a convenient estimate of myocardial workload over a range of exercise intensities. Any total value of RPP more than 10 is a clear indicator of increased risk for heart disease. Lower value of RPP thus indicates good cardiac function and less risk of cardiovascular disease.

Objectives

- To find the effect of IHG exercise training of 8 weeks on RPP among medical students of between the age group of 18-20 years..

MATERIALS AND METHODS

Study design: Interventional study

Study duration: 18 months after getting Ethics Committee approval

Study setting: Department of Physiology, Govt. T.D.M.C Alappuzha.

Sampling method: Subjects fulfilling the inclusion criteria, Non probability sampling – consecutive

Sample size: 175 students of first year M.B.B.S, T.D. Medical college Alappuzha

Sample size calculation

Sample size was calculated based on the main reference study "Effect of Isometric Handgrip Exercise Training on Resting Blood Pressure in Normal Healthy Adults"- by Garg R et al.[9] using the formula:-

$$n = \frac{2Sp^2[1-\beta Z1-\alpha/2 + Z]^2}{\mu^2 d}$$

$Sp^2 = S1^2 + S_2^2 / 2$

Where,

$S1^2$ =Standard deviation in the first group

$S2^2$ =Standard deviation in the second group

$\mu^2 d$ = Mean difference between samples

α = Significance level

1-β= Power

According to this calculation the minimum sample size required was 18. Since the first M.B.B.S. students of 2021 batch was 175, all consenting students formed the study sample.

Study population: First year MBBS students of Government TDMC Alappuzha,2021 batch, who gave informed consent.

Inclusion criteria:

First year M.B.B.S students of Govt. T.D.M.C Alappuzha 2021 batch having normal blood pressure, not suffering from any acute or chronic illness, not taking any medication and non-smokers were included.

Exclusion criteria:

Students with hypertension, on any medication or having any acute or chronic illness or smokers were excluded.

Study variables

The study variables includes age (years), sex, systolic blood pressure(mmHg), heart rate in beats per minute and Rate Pressure Product (Systolic blood pressure x Heart rate/1000)

Data collection tools

This includes proforma, mercury sphygmomanometer (Life-Line Alpha Portable), digital sphygmomanometer (type: ACMNP-1, Electronic Blood Pressure Monitor, Arm Type, suitable arm circumference 23 cm 33 cm), and Hand-held dynamometer (qingfeng hand dynamometer)

Data collection procedure

After obtaining Institutional Research Committee (Protocol No: P02/2021) and Institutional Ethics Committee (No: EC 12/2021) approval, the study was conducted in Govt. T.D Medical College Alappuzha among consenting first year MBBS students of 2021 batch.

Details like name, age, sex and medical history taken and blood pressure recorded in sitting posture on right upper arm manually and also compared immediately using digital sphygmomanometer. RPP was then calculated by multiplying SBP and HR, divided by thousand.

Static exercise protocol: The exercise protocol was repeated 3 times/week for 8weeks. Prior to the IHG

exercise training, each subject was given verbal instruction and demonstration of the test. In the 8-week training program, student had to pull the handle of dynamometer using dominant hand with maximum strength, 3times with a rest period of 5 minutes in between, repeated three times per week.
The initial blood pressure recording was compared with the blood pressure values obtained after exercise training of 8weeks. Only after a rest period of 5 minutes, SBP (manual and digital), and HR were recorded and RPP calculated.

Data analysis

Data was entered into Microsoft Excel office 2010 and analysed using SPSS statistical software version 20. Shapiro wilkis test was used to check the normality of data which showed skewing, so non parametric tests were planned for analysis.
Qualitative data like age, sex were expressed as percentage and quantitative data like SBP were expressed using median and inter quartile range. Comparison of paired study variables before and after exercise training were done using Wilcoxon signed rank test. Comparison between independent/unpaired quantitative variables were done using Mann-Whitney test. A p value <0.05 was considered to be statistically significant.

Ethical considerations

Students who voluntarily signed the informed written consent were included as participants. Permission to conduct the study was obtained from institutional research committee and institutional Ethical committee Govt. TDMC, Alappuzha.

RESULTS

The present study included 23 participants, of whom 10 were males (43.5%) and 13 were females (56.5%). (Fig 1).

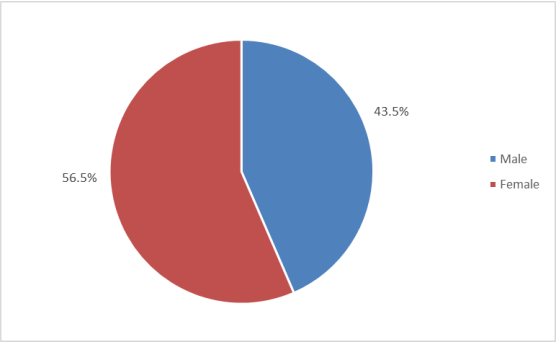

Fig 1: Percentage of gender distribution

Comparison of cardiovascular parameters before and after IHG exercise demonstrated meaningful changes. Systolic blood pressure measured digitally showed a statistically significant reduction after IHG exercise (p = 0.015), indicating that IHG training effectively lowered systolic blood pressure. Although manual SBP also showed a reduction, it did not reach statistical significance (p = 0.127), suggesting a trend toward improvement. Heart rate remained unchanged before and after exercise (p = 0.125), indicating that IHG exercise did not significantly affect resting heart rate. (Table 1).

Table 1: Comparison of variables before and after IHG exercise

	Before Median (IQR)	After Median (IQR)	p value
SBP manual	118 (12)	116 (18)	0.127
SBP digital	117 (22)	112 (12)	**0.015***
HR	80 (17)	80 (14)	0.125
RPP Manual	9.86 (3.08)	9.19 (2.58)	**0.035***
RPP Digital	9.72 (2.97)	9.03 (2.46)	**0.018***

* Indicates statistical significance at 5% level

Fig 2 illustrates the comparison of heart rate (HR) before and after IHG exercise training. The graph shows almost overlapping median values, indicating that there was no appreciable change in heart rate following the intervention. This visual observation is consistent with the statistical analysis (p = 0.125), confirming that IHG exercise did not significantly influence resting heart rate.

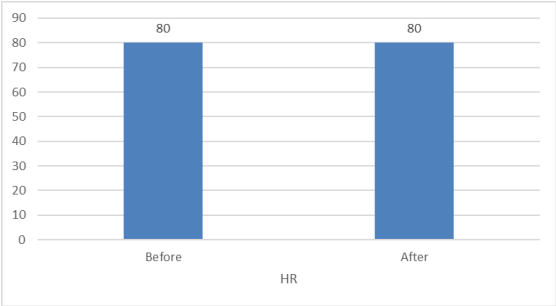

Figure 2: Graph - HR of participants before and after IHG exercise

Fig 3 depicts the Rate Pressure Product (RPP) calculated from both manual and digital measurements before and after IHG exercise. The graph clearly demonstrates a downward shift in

median RPP values following the intervention. This visible decline aligns with the statistically significant reduction observed in both manual and digital RPP measurements. Since RPP reflects myocardial oxygen consumption and overall cardiac workload, the reduction seen in the graph indicates improved cardiac efficiency and decreased myocardial demand after IHG training.

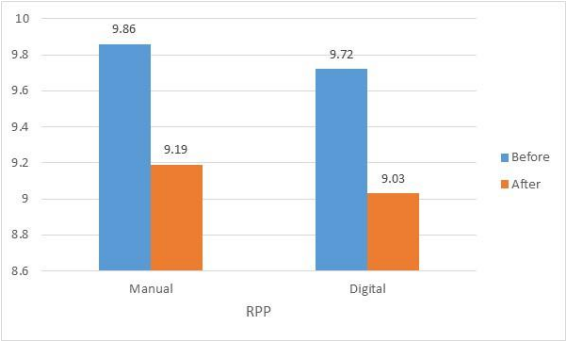

Fig 3: Graph –RPP calculated from both digital and manual values before and after IHG

According to Mann-Whitney test, there is no statistically significant difference between before exercise values of SBP and RPP obtained by manual and digital methods; taking $p<0.05$ as statistically significant. (Table 3)

Table 3: Comparison of before IHG exercise values SBP and RPP both manual and digital

	Median (IQR)	Median (IQR)	p value
SBP (B) manual & digital	118 (12)	117 (22)	0.817
RPP (B) manual & digital	9.86 (3.08)	9.72 (2.97)	0.947

There is no statistically significant difference between after exercise values of SBP and RPP obtained by manual and digital methods. (Table 4)

Table 4: Comparison of after IHG exercise values of SBP and RPP both manual and digital

	Median (IQR)	Median (IQR)	p value
SBP (A) manual & digital	116 (18)	112 (12)	0.314
RPP (A) manual & digital	9.19 (2.58)	9.03 (2.46)	0.684

DISCUSSION

Physical fitness reflects a state of overall health and well-being, and its importance has increased in the context of rising lifestyle-related disorders such as diabetes, hypertension, and coronary artery disease. Sedentary habits and poor dietary practices significantly contribute to cardiovascular morbidity.[10] Hand Grip Strength (HGS), an isometric contraction test, has been widely used as a simple indicator of physical fitness and nutritional status. Evidence suggests that impaired HGS is associated with cardiovascular risk factors, particularly hypertension. Recent meta-analyses of randomized controlled trials have demonstrated that isometric resistance exercises, including handgrip training, can reduce systolic blood pressure (SBP) by approximately 3–4 mmHg.[11,12]

The present study included 23 medical students (13 females and 10 males) and evaluated the effect of 8 weeks of isometric handgrip (IHG) training on systolic blood pressure, heart rate (HR), and rate pressure product (RPP). A statistically significant reduction in SBP measured by the digital method was observed after training ($p = 0.015$). This reduction suggests improved vascular function following IHG exercise. The mechanism underlying post-exercise hypotension is believed to involve sustained reduction in total peripheral resistance due to nitric oxide–mediated vasodilatation in skeletal muscle. Exercise training also enhances renal sodium excretion, contributing to reduced plasma volume and blood pressure.

These findings are consistent with Ogbutor GU et al.[13] who demonstrated that IHG exercise combined with lifestyle modifications effectively lowered blood pressure in prehypertensive individuals. Similarly, Kowshik V et al.[14] reported significant reductions in SBP following isometric resistance training performed at 30% of maximum voluntary contraction, supporting the blood pressure–lowering effect of moderate-intensity IHG training. Although acute intense isometric exercise can transiently elevate SBP due to sustained vasoconstriction, chronic training appears to induce beneficial vascular adaptations.

In the present study, RPP showed a statistically significant reduction after IHG training (manual $p = 0.035$; digital $p = 0.018$). RPP, calculated as HR × SBP, is a reliable indicator of myocardial oxygen consumption and cardiac workload. The observed decline indicates improved cardiac efficiency and reduced myocardial demand following training. This finding aligns with Sembulingam P et al.[15] who emphasized RPP as a valuable index for assessing exercise intensity and cardiovascular fitness.

Heart rate did not show a statistically significant change following IHG training in our study. This

suggests that the primary cardiovascular adaptation was vascular rather than chronotropic. Inder JD et al.[16] have reported that chronic exercise training can reduce resting HR due to improved autonomic balance, whereas acute exercise increases HR, cardiac output, and blood pressure. The absence of significant HR reduction in our study may be attributed to the relatively short training duration or the already healthy baseline status of participants.

Similar improvements have been documented by Verma NK et al.[17] who conducted a randomized controlled study on 72 healthy young adults undergoing 3 months of IHG training. They observed significant reductions in blood pressure ($p < 0.001$) and HR ($p = 0.014$), supporting the role of IHG exercise in cardiovascular regulation. Interestingly, in female participants, diastolic BP decreased significantly, while changes in SBP and HR were not significant, indicating possible gender-related physiological variations.

Shorter-duration interventions have also demonstrated beneficial effects. Aathira TV et al.[18] reported that 4 weeks of IHG training resulted in significant reductions in resting SBP and DBP, with no significant differences across age groups or genders. This suggests that IHG exercise is effective across diverse demographic categories.

Conversely, Karthikkeyan K et al.[19] observed a significant acute rise in SBP and DBP during isometric handgrip testing, highlighting the difference between acute exercise response and chronic training adaptations. Acute isometric contraction increases sympathetic activity and peripheral resistance, whereas long-term training induces vascular remodeling and improved endothelial function.

The association between physical fitness and handgrip strength has also been supported by Orozco-Sánchez CC et al.[20], who demonstrated adequate cardiorespiratory capacity and handgrip strength among university students, potentially lowering future risk of non-communicable diseases.

Furthermore, Keshari KK et al.[21] reported that obese individuals had higher resting HR and BP compared to non-obese individuals, and that acute IHG exercise produced greater BP increases in non-obese participants. These findings suggest that body composition influences cardiovascular response to isometric exercise.

The present study align with existing literature demonstrating that chronic isometric handgrip training can reduce systolic blood pressure and myocardial workload, as reflected by decreased RPP. While heart rate remained unchanged, the reduction in SBP and RPP indicates improved cardiovascular efficiency. These results support the utility of IHG exercise as a simple, cost-effective, and non-pharmacological intervention for cardiovascular health promotion and hypertension prevention.

CONCLUSION

After 8 weeks of IHG exercise training, a statistically significant reduction was observed in systolic blood pressure measured digitally and in RPP values obtained by both manual and digital methods, as determined by the Wilcoxon signed rank test. These findings indicate that IHG exercise effectively reduces myocardial workload. Therefore, IHG training may serve as a simple, cost-effective, non-pharmacological intervention to improve cardiac efficiency, particularly among young individuals with sedentary lifestyles.

Limitations and Future Scope of Study

This study was limited to a narrow age group of 18-20years and so age-related changes in muscle quality and its impact on hand grip strength were not investigated. Hence, future studies need to be done with focus on a wider age group and more anthropometric parameters. Also the number of dropouts were unexpectedly more.

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