

Effect of 5 Weeks of Isometric Handgrip Training on the Resting Blood Pressure in Young Healthy Individuals

Sumedha Shamsunder Audi¹, Isabelle Coelho Correia Afonso², Yogesh Parshuram Nerkar³

^{1,2,3} Department of Physiology, Goa Medical College, Goa, India.

ABSTRACT

BACKGROUND

Urbanization and modern lifestyle pattern have resulted in mechanization of life and rise in the diseases such as hypertension that are associated with sedentary lifestyle. Regular physical exercise has many health benefits and is an essential part of a healthy lifestyle. Our aim was to study the effect of 5 weeks of Isometric Handgrip Training (IHT) on the resting Blood Pressure (BP) in young healthy individuals.

METHODS

The study was conducted among 46 apparently healthy medical students of both genders, in the age group of 18 to 21 years. Resting BP was recorded before starting IHT and again on completion of IHT after 5 weeks. IHT was performed with the dominant hand, using handgrip spring dynamometer (Fig 1). Each IHT session, consisted of five sets of 2 minutes isometric contractions, at 30 % of the Maximum Voluntary Contraction (MVC) force with 3 minutes rest after each contraction. The exercise training sessions were conducted thrice a week for 5 weeks.

RESULTS

Data obtained from 46 healthy male and female students was analysed. Paired "T" test was used for comparison of mean values of Systolic BP (SBP), Diastolic BP (DBP) and Mean Arterial BP (MAP) before and after isometric handgrip training. P value of less than 0.05 was accepted as indicating significant difference between the compared values. We found that isometric handgrip training of 5 weeks produced significant decrease in the mean values of SBP, DBP and MAP in our subjects. (Table 1, Figure 2).

CONCLUSIONS

Our subjects performed 3 sessions per week of unilateral IHT at 30 % MVC consisting of five sets of 2 minutes contractions separated by 3 minutes rest. It was found that after 5 weeks of training, there was significant decrease in resting SBP, DBP and MAP in our subjects.

KEY WORDS

Isometric Handgrip Training, Handgrip Dynamometer, Resting Blood Pressure

Corresponding Author:

Dr. Sumedha Shamsunder Audi.

Department of Physiology,

Goa Medical College, Bambolim,

Goa, India.

E-mail: audisumedha@gmail.com

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BACKGROUND

Diseases such as hypertension can develop at a much younger age as a result of sedentarism, unhealthy diets, and increased mental stress. Arterial BP equal to or more than 140 / 90 mm Hg is defined as arterial hypertension.¹ Risk of cardiovascular complications increase logarithmically with rising levels of systolic blood pressure at or above 115 mm Hg and diastolic blood pressure at or above 75 mm Hg.¹ Incorporating health-promoting lifestyles, healthy diets and regular physical exercises in daily routine, may prevent development of hypertension later in life.² Either isotonic exercises or isometric exercises or combination of both types of exercises can be performed. In isotonic skeletal muscle exercises, the muscle length changes and the muscle tension remains constant.³ Isotonic exercises in form of aerobics have shown to have a favourable effect on blood pressure.² But due to time constraints, busy individuals very often refuse to take up these exercises and adherence to these exercises is poor. Isometric skeletal muscle exercises consist of sustained contraction of the skeletal muscle against an immovable load or resistance. Shortening of the skeletal muscle is prevented so the muscle remains at constant length despite increasing tension.³ Meta-analyses indicated that decrease in BP achieved with isometric handgrip exercise training may be similar or even greater than BP reductions obtained with dynamic aerobic and resistance type of exercises.^{4,5} Isometric handgrip exercise training may be also be helpful as an adjunct to drug therapy in hypertensives.^{5,6,7,8}

Very often the students pursuing higher studies in professional colleges are under constant stress due to busy academic schedules. They cannot make time for outdoor games or dynamic physical exercises such as walking, jogging, and swimming. Physical inactivity and stress are risk factors for hypertension. Regular physical exercises help in reducing BP and also decrease risk of cardiovascular diseases.² Young busy students in professional colleges need simple, short duration exercises that can be performed anywhere, anytime and even while studying. IHT can be performed in a sitting or standing position even whilst studying, with the help of a handy, portable, simple to use and affordable handgrip dynamometer. IHT are time saving exercises, well tolerated and no adverse effects have been reported.^{5,9} Hence there are more chances of greater compliance to these types of exercises.^{4,6} The aim of the present work was to study effect of 5 weeks of isometric handgrip training on the resting BP in young healthy individuals.

METHODS

This prospective pre-test post-test study was conducted among 46 healthy male and female medical students in the age group of 18 - 21 years. The subjects were randomly selected from 1st MBBS medical students of our college. After explaining the procedure of the isometric handgrip exercise training, informed consent was taken from the participants. The required sample size for this study was calculated as 46 using the formula.¹⁰

$$N = 2 \times (Z_{\alpha} + Z_{\beta})^2 \times \sigma_1^2 + \sigma_2^2 / (\mu_1 - \mu_2)^2$$

The assumptions were $\alpha = 5\%$ Therefore $Z_{\alpha} = 1.96$, $\beta = 80\%$ Therefore $Z_{\beta} = 0.84$, $\sigma_1 = 6.86$ and $\sigma_2 = 7.96$, $\mu_1 = 120.44$ and $\mu_2 = 114.29$. Confidence interval of 95%. The T test was two tailed and effect size was 0.6. Response variable approximates to a normal distribution. Mean (μ) standard deviation (σ) were taken from a similar study by Prashanth et al.¹¹

Inclusion and Exclusion Criteria

Subjects BP was recorded, and clinical examinations was done and the normotensive subjects with no history of cardiovascular disease or kidney disease were included in this study. The participants were non-smokers, non-alcoholics, were not on any medications and were not engaged in any regular exercise routine or walking, jogging, yoga, and pranayama. The subjects having a hand deformity, or any history of inflammatory joint disorder, fracture or any muscular or neurological disorder of upper limb were excluded from the present study.

Instruments

The isometric exercise training was performed with the help of a handgrip spring dynamometer (Inco, Ambala). It has two handles connected through a flexible metallic strip. It has graduated scale for estimation of compression force.



Figure 1. Handgrip Spring Dynamometer

BP was measured with help of a mercury sphygmomanometer and stethoscope.

BP Measurement

Resting BP of the subject was recorded before the start of isometric handgrip exercise training. Isometric handgrip training was given for 5 weeks and BP of the subject was recorded again after 5 weeks of IHT training

Measurement of Resting BP

The subjects were allowed to rest comfortably for 10 minutes before recording the resting BP. At the time of BP recording, the subjects were instructed to breathe normally and avoid breath holding to prevent the influence of Valsalva manoeuvre on BP. Three recordings of resting BP were taken with a gap of two minutes between each of the readings. Average values of 3 readings each of resting SBP and resting DBP were used for statistical analyses. After the resting BP was recorded, the subjects were asked to relax for 5 minutes before recording MVC.

Determination of Maximum Voluntary Contraction

The subjects were asked to press the handle of the handgrip dynamometer with the dominant hand briefly for about 2 - 3 seconds with maximum effort and the value of maximum voluntary contraction was noted. The subjects were given 3 attempts with a gap of 1 minutes between each attempt. The highest value of the 3 attempts obtained on the handgrip dynamometer was recorded as MVC. The subjects were asked to rest for 5 minutes before starting exercise training.

Isometric Handgrip Training

The subjects were instructed to perform isometric handgrip exercise training with the dominant hand for 5 weeks. Isometric handgrip training consisted of five sets of 2 minutes isometric contractions at 30 % MVC, with a rest of 3 minutes after each contraction. This supervised IHT protocol was conducted 3 times per week for a total period of five weeks.

Measurements of BP after Training

After completing 5 weeks of isometric exercise training, again three recordings of BP were taken with a gap of two minutes after each of the readings. Average values of 3 readings each of SBP and DBP obtained after IHT were used for statistical analysis. Pulse pressure (PP) and mean arterial pressure (MAP) was calculated using the formulas¹² $PP = SBP - DBP$ and $MAP = DBP + 1 / 3 (PP)$.

Statistical Analysis

Statistically analysis was done using SPSS Software Version 27. Data of 46 healthy male and female medical students was collected. The mean values of SBP, DBP, MAP obtained before and after 5 weeks of isometric handgrip training, were expressed as Mean + SD. Data was analysed using Paired "T" Test and 95 % confidence interval of difference and p value of < 0.05 was taken as statistically significant.

RESULTS

BP (mm Hg)	Mean ± SD	T Value	df	P Value
SBP before IHT	114.43 ± 5.89	12.04	45	< 0.001
SBP after IHT	106.39 ± 5.07			
DBP before IHT	73.83 ± 5.61	7.06	45	< 0.001
DBP after IHT	68.70 ± 5.12			
MAP before IHT	87.36 ± 4.73	9.58	45	< 0.001
MAP after IHT	81.78 ± 4.64			

Table 1. Showing the Effect of 5 Weeks of IHT on SBP, DBP, and MAP (mmHg) Expressed as Mean ± SD

After 5 weeks of supervised IHT, we found that there was a significant decrease in SBP, DBP, and MAP in our subjects. Resting mean ± SD SBP was 114.43 ± 5.89 mm Hg and after 5 weeks of IHT mean ± SD SBP was 106.39 ± 5.07 mm Hg (p < 0.001). Resting mean ± SD DBP was 73.83 ± 5.61 mm Hg and after 5 weeks of IHT mean DBP ± SD was 68.70 ± 5.12 mm Hg (p < 0.001). Before IHT mean ± SD MAP was 87.36 ± 4.73 mm Hg and after 5 weeks of IHT mean MAP ± SD was 81.78 ± 4.64 mm Hg (p < 0.001) (Table 1). The graph shows comparison of

mean SBP, mean DBP and mean MAP before and after IHT (Figure 2)

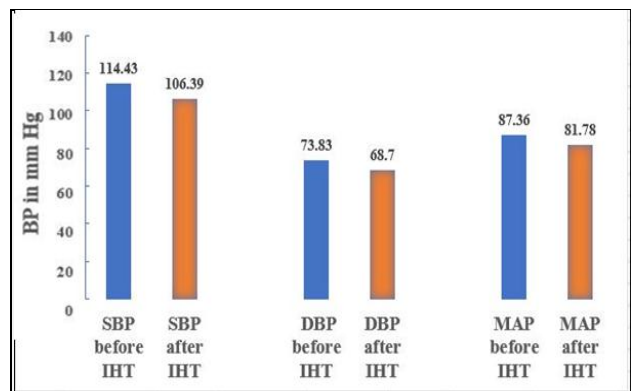


Figure 2. Comparison of Mean SBP, DBP, and MAP (mmHg) before and after 5 Weeks of IHT

DISCUSSION

We studied the effect of unilateral IHT conducted at 30 % MVC, thrice a week over a period of 5 weeks in 46 young healthy medical students. In our study we found a significant reduction in resting BP in the subjects after 5 weeks of isometric exercise training. The mean values of SBP, DBP and MAP showed significant decrease after 5 weeks of IHT. The results of our study were similar to that of Prashant P et al who found significant decrease in the resting BP in healthy normotensive medical students trained for 5 weeks compared to an untrained control group.¹¹ Our results are consistent with that of Garg et al who reported significant reductions in resting SBP and DBP in young healthy adults trained for 10 weeks.¹³ Various other studies also have reported that isometric exercise training was effective in lowering resting BP in their subjects.^{14,15,16,17,18,19}

Over the years various researchers have evaluated mechanisms that could be responsible for BP reduction in response to isometric handgrip exercise training, but the exact cause is not yet clear. Cardiac output and peripheral resistance are the determinants of arterial BP,¹² hence BP lowering effect of isometric handgrip training possibly involves multiple mechanisms.²⁰ Individuals who suffer from hypertension before age of 50 years usually have an increase in systolic as well as diastolic BP and the fault is vasoconstriction at the resistance vessels.¹ Nitric oxide synthase enzyme in the vascular endothelium synthesizes nitric oxide, a potent vasodilator and dilation of the resistance vessels decreases BP.²¹ This endothelium dependent, nitric oxide mediated vasodilation is often defective in the hypertensives.¹ Shear stress is a factor that increases bioavailability of nitric oxide by activating nitric oxide synthase enzyme.²¹ IHT increases shear stress as repeated isometric efforts with rest pauses during training repeatedly occludes vascular lumen, increases sympathetic activity and increases blood flow.²² Various studies have shown that handgrip exercise training has a favorable influence on the vascular endothelium and local, nitric oxide dependent vasodilation is better after training.^{16,17,23,24} But in one study on the normotensive subjects by McGowan CL et al, IHT lowered resting BP but it did not improve function of the systemic vascular

endothelium.¹⁹ Improved vascular endothelial function and more bioavailability of nitric oxide can also occur when the oxidative stress is reduced. Increased oxidative stress reduces bioavailability of nitric oxide because excess reactive oxygen species inactivates nitric oxide. Peters et al reported that exercise training increases antioxidant agents. Authors attributed BP reduction in their subjects to exercise training induced decrease in the oxidative stress.²⁵

Inder et al indicated that the mechanism for BP response to IHT may be mediated by the metabolites produced during training. The authors suggested that the metabolites formed during repeated hypoxia occurring due to repeated vessel occlusion during IHT, possibly might act as a stimulus for BP reduction.⁵ Another study reported that the training induced increased muscle blood flow and aerobic metabolism reduces the concentration of the metabolites in the muscle interstitial tissue. This results in less stimulation of muscle chemoreceptor afferent nerve endings and hence decreases metaboreceptors mediated rise in BP.²⁶ Researchers have also investigated if other mechanisms such as changes in autonomic functions,^{18,27,28,29,30} or increase in muscle blood flow³¹ could be the mediators of BP reduction occurring after exercise training.

We have not investigated the mechanisms responsible for lowering BP after isometric exercise training hence we cannot comment on the cause of the reduction in the resting BP in our subjects following 5 weeks IHT. Study of the mechanisms for BP lowering effect of IHT would have enriched our study.

CONCLUSIONS

5 weeks of IHT was effective in lowering resting BP in our young healthy subjects. There were significant reductions in resting SBP, DBP and MAP. IHT can be performed anywhere, be it at home, hostel, at the college during free time or even whilst reading or studying. Hence IHT is a very convenient type of exercise for busy students in professional colleges who very often fail to show compliance to dynamic aerobic or resistance exercises.

Data sharing statement provided by the authors is available with the full text of this article at jemds.com.

Financial or other competing interests: None.

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