Original Research Article

Effect of isometric hand grip exercise on cardiovascular responses in normal weight and overweight Indian young population

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Abstract

Background: For individuals with cardiovascular risk factors, even small reductions in systolic and diastolic blood pressure with maintenance of normal body weight can translate into significant reductions in morbidity and mortality. Isometric exercise training, and in particular isometric handgrip training, which is easily applicable (i.e. easy to use and can be performed anytime and anywhere), in expensive and hence accessible to the global population could offer a valuable new therapeutic adjunct in the overall approach for treating hypertension. **Aim and objective:** To evaluate the effect of isometric hand grip exercise on SBP, DBP, MAP and HR in normal weight and overweight population **Methodology:** A prospective study was carried out to evaluate the effect of isometric hand grip exercise on cardiovascular responses in Indian population aged 18-35 years according to their BMI. In this study, an intervention was done in the form of isometric exercise, where we studied the effect of Isometric handgrip exercise on cardiovascular responses in normal weight and overweight adults. Cardiovascular responses were measured in terms of SBP, DBP, MAP and HR upto 8 weeks after intervention. Data was analysed with appropriate statistical tests. **Results and discussion:** In our study we have observed that IHG training over 8 weeks in normal and overweight individual certainly have result in significant changes in cardiovascular responses. The results showed significant changes in the form of reduction in resting SBP, DBP, HR, and MAP pre and post IHG training over more than 4 weeks.

Key Word: isometric hand.

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INTRODUCTION

With the rising tide of an aging population, population growth, rapid urbanization and the globalization of unhealthy lifestyles, disease patterns have fundamentally changed and non-communicable diseases, like cardiovascular disease (CVD), are becoming more prevalent (Smith *et al.*, 2012). [1] Recently, the World Health Organization (WHO) has identified Cardio Vascular Disease as the leading cause of death globally (WHO, 2013).[2] Hypertension, or the chronic elevation in resting arterial blood pressure (BP), which is a significant risk factor for cardiovascular disease, the treatment goals comprises of lifestyle modifications (smoking cessation, weight loss, exercise training, healthy eating and reduced sodium intake) and if not solely effective, the addition of antihypertensive medications. [3,4] In particular, increased physical exercise and decreased sedentary are important strategies in the prevention and management of hypertension. It is undeniable that maintaining the blood pressure within normal range will significantly reduce the risk of cardiovascular as well as cerebrovascular morbidity and mortality. [3] The Indo-Asian countries like ours are also

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facing a unique dual challenge of growing overweight/obesity and a persistent burden of under nutrition. [5] Increase in body weight independently affects the cardiovascular health in all age group. Low physical fitness in overweight has adverse effect on vasculature thus predisposes to a greater cardiovascular reactivity. Body mass index (BMI) is a major tool to assess the body weight and acts as an independent risk factor for both cardiovascular morbidity and mortality. Studies also show the association of body mass with the alteration of cardiac autonomic activity which regulates cardiovascular system in rest and activity. Regular exercise has been shown to be effective in reducing risks of cardiac morbidity by reduction in blood pressure and normalization of body weight. Exercise is a form of self-induced stress, causes increase in metabolic demands which leads to circulatory and respiratory adjustments in the body and as a result of sympathetic and parasympathetic activity during exercise, it leads to changes in heart rate, stroke volume, systemic vascular resistance and mean arterial pressure. These changes depend on type of exercise undertaken, Isometric or Isotonic. Isometric or static exercise is defined as sustained muscle contraction (i.e. increase in intensity) with no change in muscle length of involved muscle group. However, in isotonic or dynamic exercise there is contraction of skeletal muscle which leads to change in muscle length. [6] In comparison to aerobic and dynamic resistance exercise training, meta-analytic evidence suggests that isometric exercise training may produce larger mean reductions in resting blood pressure. A form of isometric exercise - Handgrip exercise has been used in many research studies to see its response on cardiovascular system. This gave us an impetus to study the effect of Isometric handgrip exercise on cardiovascular responses in Indian population with varying BMI in order to early diagnose and provide further management to prevent progression of the cardiovascular diseases. Since in India, prevalence of hypertension, overweight and so the associated cardiovascular diseases are rising and hence there is a need to investigate the changes in hemodynamic responses to isometric handgrip exercise in individuals with different BMI. [7] This could be important for predicting and preventing the excessive cardiac load during static activities. The results of such study could be used as a reference for prescribing and practising the isometric exercise safely to the healthy as well as disease adults with different BMI. There exists increased cardiovascular mortality in overweight relative to normal weight category. So it was important to evaluate the cardiovascular responses to Isometric exercise in Indian population with varying BMI in order to early diagnose and provide further management to prevent progression of the cardiovascular diseases. Isometric exercise training, and in particular isometric handgrip training, which is easily applicable (i.e. easy to use and can be performed anytime and anywhere), in expensive and hence accessible to the global population, could offer a valuable new therapeutic adjunct in the overall approach for treating hypertension. For individuals with cardiovascular risk factors, even small reductions in systolic and diastolic BP with maintenance of normal body weight can translate into significant reductions in morbidity and mortality. [8] Deviation from normal blood pressure and body weight which are important risk factors for cardiovascular health with its deleterious effects on productive and healthy life in adults, its modifications after isometric exercise in the form of handgrip training has not been established in Indian population and hence studies designed to test the clinical efficacy of isometric exercise training on cardiovascular responses are a need of time. From this study we can justify that preventive measures are better than curative to curtail complications due to deviations from normal body weight and blood pressure by implementation of isometric exercise training, in particular isometric handgrip training as a valuable new therapeutic adjunct in the overall approach for treating hypertension and obesity.

MATERIAL AND METHODS

The study was conducted in the Department of Physiology, at the tertiary care institute of Greater Mumbai. The voluntary participants for the study have been recruited from the hospital.

Inclusion criteria: 1. Subjects between 18-35 years. 2. Subjects with BMI < 29.99 Kg/m2 and BMI > 18.5 Kg/m2 3. Subjects who don't have any acute illness (e.g. difficulty in breathing, pain in abdomen etc.)

Exclusion criteria: 1.Subjects with BMI > 29.99 Kg/m2 and BMI < 18.5 Kg/m2 2.Subjects with BP >140/90 mmHg 3. Subject having any physical deformity of upper limbs. 4. Subjects who were chronically ill. (e.g. Bronchial asthma, TB etc.) 5. Subjects who were taking any medication. (e.g. Bronchodilators, Sedatives etc) 6. Subjects who had undergone any recent surgery. 7. Subjects having history of cardio-respiratory illness like hypertension, myocardial infarction, valve diseases. Study was approved by ethical committee of the institute. A valid written consent was taken after explaining study to them. Detailed history, clinical examination to detect systemic involvement of any disease was done.

The standing heights of the subjects were recorded with the help of stadiometer to the nearest centimeter. Their weights were measured to the nearest to 0.1 kg by using a standardized weighing scale. Their Body Mass Index (BMI) were calculated by using the Quetlet's index [36]. Depending on their BMI, the subjects were classified into

two groups. The subjects with a BMI between18.5 to24.99 (kg/m2) were classified as the normal weight group which were served as the healthy controls and those who had a BMI of between 25 to 29.99 (kg/m2) were classified as overweight. There were 30 participants in each group of normal weight and overweight individuals. 15 males and 15 females had been taken in each normal and overweight group. Subjects were asked to avoid intake of caffeine, alcohol consumption 24 hours before the start of the study and each time the exercise protocol were performed after a light breakfast as per participant's convenience.

Before initiating the study, practical demonstration about how to perform isometric handgrip exercise was given. Subjects were asked to sit comfortably on chair and allow a rest for 10 minutes in a quiet room to avoid anxiety. The resting systolic blood pressure (SBP) and diastolic blood pressure (DBP) of all the subjects were taken with an appropriately sized cuff placed on the right upper arm parallel to the trunk, using the mercury sphygmomanometer and stethoscope. Heart rate (HR) was measured from the radial artery by palpatory method for one full minute. MAP was calculated by the following formula. The handgrip strength and endurance of the dominant hand were measured by using a handgrip dynamometer (Anand agency, Pune). The participants were advised to keep their hand on a table with the angle in the elbow being maintained at 90 degrees and they were asked to press the handle of the dynamometer with maximum strength. The maximal voluntary contraction was sustained for at least 3 seconds and it was recorded as the handgrip strength in kilograms (kg). Three readings were taken with a gap of 10 minutes and the maximum readings were taken for analysis.

Subject was then asked to perform Isometric contraction with 30% of Tmax for maximum 2minutes. Same procedure was asked to perform for 5 times with rest for 5 minutes between each attempt. The systolic blood pressure (SBP), diastolic blood pressure and heart rate were measured immediately and as well as after 5 minutes of the intervention. Participants were asked to perform this isometric handgrip exercise training protocol thrice in week for 8 weeks under our direct supervision. Resting and post exercise SBP, DBP, HR, MAP were recorded at end of 4th weeks and also at the end of 8th week and compared before and after the completion of 8 weeks of isometric handgrip exercise training. BMI were also calculated at the end of 4th and 8th week to ensure there was no shift of any subject within normal weight and overweight category. Study parameters were also compared in each group of normal weight and overweight individuals. Data was subjected to statistical analysis using Statistical package for social sciences (SPSS v 21.0, IBM).

RESULTS

The average BMI is 21.48 kg/m2 normal weight females, 26.38 kg/m2 in overweight females, 23.43 kg/m2 in normal weight males and 27.1 kg/m2 in overweight males. In our study, the resting SBP of Normal weight has reduced from 111.1± 4.8mmHg (0weeks) to107.4±5.3mmHg (4weeks) 103.8± 4.4mmhg (8weeks). The resting SBP of Overweight has reduced from 113.0± 5.6mmHg (0weeks) to109.5±5.6mmHg (4weeks) 103.8± 5.6mmhg (8weeks). P values in normal weight and overweight for SBP between 0-4 weeks and 0-8 weeks were statistically significant. (table 1) The resting DBP of normal weight has reduced from 77.4± 3.8mmHg (0weeks) to76.0±3.5 mmHg (4weeks) 74.0± 3.5mmHg (8weeks). The resting DBP of overweight has reduced from 77.3± 4.4mmHg (0weeks) to75.6±4.5mmHg (4weeks) 74.0± 4.2mmhg (8weeks). P values in normal weight and overweight for DBP between and 0-8 weeks were statistically significant. (table 2) The resting MAP of normal weight has reduced from 88.6± 3.5mmHg (0weeks) to86.5±3.5mmHg (4weeks) 83.9± 3.0mmhg (8weeks). The resting MAP of overweight has reduced from 89.2± 3.5mmHg (0weeks) to 86.9±3.5mmHg (4weeks) 84.6± 3.4mmhg (8weeks). This decrease was statistically significant in both groups after 4 weeks and 8 weeks of IHG training. (graph 1) The resting HR was observed to reduced in normal weight has from 76.4± 5.9bpm (0weeks) to73.5±6.0bpm (4weeks) 70.1± 6.3bpm (8weeks). In overweight from 77.5± 4.3bpm (0 weeks) to74.0±4.4bpm (4weeks) 69.8± 4.3bpm (8weeks). P values in overweight for HR between 0-4 weeks and 0-8 weeks were in normal weight for HR between 0-8 weeks were statistically significant. (graph 2)

Table1: Comparison of SBP in normal and overweight individuals after intervention

Weight of subjects	SBP R 0wk ± SD	SBP R 4wk ± SD	SBP R 8wk ± SD	p for SBP R (0-4 weeks)	p for SBP R (0-8 weeks)
Normal weight	111.13 ±4.805	107.47 ±5.355	103.80 ±4.468	0.0071**	0.0000***
Overweight	113.00 ±5.675	109.53 ±5.600	106.00 ±5.608	0.0205*	0.0000***

Table 2: Comparison of DBP in normal and overweight individuals after intervention

	DBP R 0wk ± SD	DBP R 4wk ± SD	DBP R 8wk ± SD	p for DBP R (0-4 weeks)	p for DBP R (0-8 weeks)
Normal weight	77.47 ±3.893	76.07 ±3.581	74.07 ±3.503	0.1526	0.0008***
Overweight	77.33 ±4.436	75.60 ±4.530	74.00 ±4.235	0.1397	0.0042**

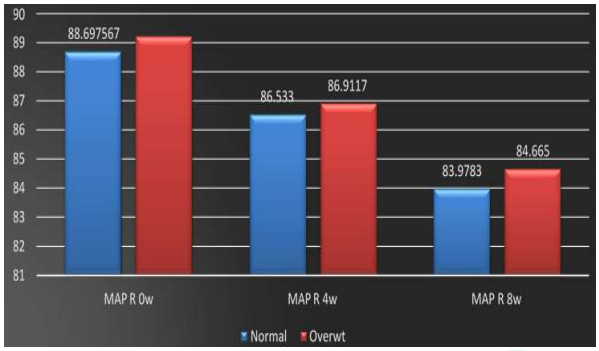

Figure 1

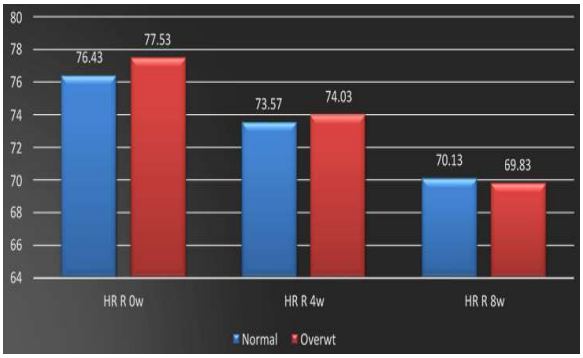

Figure 2

Figure 1: Comparison of MAP in normal and overweight individuals after intervention**; Figure 2:** Comparison of heart rate in normal and overweight individuals after intervention

DISCUSSION

In our study, the resting SBP of Normal weight has reduced from 111.1± 4.8mmHg (0weeks) to107.4±5.3mmHg (4weeks) 103.8± 4.4mmhg (8weeks). The resting SBP of Overweight has reduced from 113.0± 5.6mmHg (0weeks) to109.5±5.6mmHg (4weeks) 103.8± 5.6mmhg (8weeks). In both groups reduction was significant after 4 weeks as well as after 8 weeks of IHG training. The resting DBP of normal weight has reduced from 77.4± 3.8mmHg (0weeks) to76.0±3.5 mmHg (4weeks) 74.0± 3.5mmHg (8weeks). The resting DBP of overweight has reduced from 77.3± 4.4mmHg (0weeks) to75.6±4.5mmHg (4weeks) 74.0± 4.2mmhg (8weeks). The decrease of DBP was significant in Normal and Overweight after 8 weeks training. The reduction in DBP may be due to adaptations in the vascular system that leads to decrease in systemic vascular resistance. [9] These findings were similar to the study done by of Wiley *et al.*[13] who reported significant reduction in blood pressure after a isometric exercise training of 8 weeks. Also Millar *et al.* [10] had done study with similar IHG training protocol where he observed approximately 10 mmHg decrease in SBP and 3 mmHg in DBP.

The resting MAP of normal weight has reduced from 88.6± 3.5mmHg (0weeks) to86.5±3.5mmHg (4weeks) 83.9± 3.0mmhg (8weeks). The resting MAP of overweight has reduced from 89.2± 3.5mmHg (0weeks) to 86.9±3.5mmHg (4weeks) 84.6± 3.4mmhg (8weeks). Even this decrease was significant in both groups after 4 weeks and 8 weeks of IHG training. The resting HR was observed to reduced in normal weight has from 76.4± 5.9bpm (0weeks) to73.5±6.0bpm (4weeks) 70.1± 6.3bpm (8weeks). In overweight from 77.5± 4.3bpm (0weeks) to74.0±4.4bpm (4weeks) 69.8± 4.3bpm (8weeks). The drop in resting HR was observed to be around 8bpm in all subjects. Katz *et al.*. (1997) [11] and Hornig *et al.*. (1996) [12] investigated the effects of rhythmic handgrip training on endothelial where both of them observed that a localized improvement in endothelial-dependent vasodilation but not in endothelial-independent vasodilation. The fact that handgrip training causes improvement in endothelial-dependent vasodilation led McGowan and colleagues [9,13] to investigate whether these results may be responsible for the reduction in resting ABP with IHG training. [13,14] An increase in nitric oxide bioavailability due to shear stress, improved antioxidant activity can be a cause of local improvement in endothelial-dependent vasodilation. [9] Sinoway *et al.*. (1996) [15] and Somers *et al.*. (1992) [16] studies found that endurance forearm training significantly attenuated the increase in the sympathetic nerve response. These results made investigators to put hypothesis stating alterations in autonomic nervous system (ANS) activity can be a possible mechanism for the hypotensive effect following IHG training. Taylor and colleagues (2003) investigated this hypothesis and they observed changes in ANS activity, which may contribute to the hypotensive effect of IHG training. [17]

CONCLUSION

Irrespective of BMI, IHG training can help to reduce resting arterial pressure and heart rate. Thus this could be used as a reference for prescribing and practising the isometric exercise safely to the healthy as well as disease adults with different BMI.

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