

A Non Randomized Controlled Study to Evaluate the Effect of Isotonic Handgrip Exercise on Blood Pressure in Normal Weight and Preobese Healthy Adults

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Abstract

Background: The adverse health consequences of overweight and obesity in India leads to higher prevalence of diabetes mellitus and cardiovascular diseases. Also the compliance of people for routine form of exercise for BP control has not been very encouraging due to time, place etc constrains.

Aim: Therefore we conducted a nonrandomised clinical study to determine the short-term effects of isotonic handgrip exercise by using smiley balls on blood pressure in healthy normal weight and overweight adolescents with the objective to find a user friendly exercise which help in reducing blood pressure.

Method: A non randomized clinical study was conducted on 100 young normal-weight and pre-obese adults (50 Boys and 50 Girls) in the age group of 18–25 years. Isotonic handgrip exercise was performed at the rate 20 contractions/minute (2 sec contraction/1 sec relaxation) at maximal intensity for 10 minutes using **smiley ball**. Pulse rate and blood pressure parameters were tested at baseline and immediately after exercise in post-exercise recovery period.

Result: Statistically significant reduction was observed in systolic blood pressure(SBP) and mean arterial pressure (MAP) in both pre-obese boys and girls groups while pulse pressure & mean arterial pressure in normal weight girls after exercise regime.

Conclusion: We conclude that the exercise regime under consideration can produce some short-term beneficial effects with respect to blood pressure in especially pre-obese group of adults.

Keywords: *Isotonic Handgrip Exercise, Normal weight and pre-obese adults.*

Introduction

It is known that regular dynamic exercise reduces blood pressure (BP) and helps in the prevention of hypertension by various mechanisms such as decrease in sympathetic nerve traffic, potentiation of baroreceptor reflex, decrease in arterial stiffness, increase in total systemic arterial compliance, increase in the release of endothelium-derived nitric oxide, and increase in insulin sensitivity. It has also been reported that an acute bout of dynamic physical exercise involving large muscle mass also results in lowering of BP lasting for 12–16 hours in the postexercise period, known as postexercise hypotension (PEH).¹

The prevalence of overweight and obesity among children and adolescents has increased significantly in the developed countries during the past two decades and similar trends are being observed even in the developing world. Targeting adolescent age group for primary prevention can be justified for many reasons. The adverse health consequences of overweight and obesity in India leads to higher prevalence of type 2 diabetes and cardiovascular diseases.²

However, despite the strong evidences that recommend regular dynamic exercise involving large muscle mass (brisk walking and cycling) for lowering BP and prevention of hypertension, the compliance

of people toward such forms of exercise has not been encouraging owing to various possible reasons such as comorbid conditions (osteoarthritis and coronary artery disease) and other constraints (such as time, space, and economic constraints).³

It is, therefore, necessary to design an alternative feasible form of physical exercise involving a relatively lesser muscle mass, which can reduce BP and increase exercise compliance in the population.

Isotonic handgrip exercise is a simple, cheap, and feasible form of physical exercise involving relatively lesser muscle mass, which can be performed as per individual convenience with respect to time and place using simple equipment such as handgrip dynamometer, **smiley ball**. But, before we prescribe isotonic handgrip exercise to the population, it is essential to determine whether isotonic handgrip exercise decreases BP in post-exercise period as an acute short-term effect (PEH) and/or over a long term as a training effect. It is also essential to understand the mechanism underlying such BP-lowering effects of isotonic handgrip exercise. As scant literature is available, which illustrates the role of isotonic handgrip exercise in lowering blood pressure, We investigated a single bout of isotonic handgrip exercise for PEH.

Aim & Objectives of Study

- To evaluate the effect of isotonic handgrip exercise on blood pressure
- To compare the effect of exercise on normal and pre-obese healthy adults in both genders.

Material and Method

- **Study Design:** A Non randomized controlled study
- **Study Population:** Medical students of age group 18 to 25 years and both the genders
- **Sample size:** 100 students (50 girls and 50 boys including normal weight and pre-obese)
- **Inclusion criteria:**
 1. Age group 18 to 25 years boys and girls
 2. BMI -18.5 to 29.9 (normal weight-18.5-24.9; pre-obese -25 to 29.9 kg/m²)^{2,4}

Exclusion Criteria:

1. BMI less than 18.5 kg/m² and more than 30 kg/m²
2. Participants who were smokers, athletes and suffering from chronic illness

Method

Present study was conducted on 100 voluntary participants (50 Boys and 50 Girls) at SBKS Medical Institute and Research Center (SBKS MIRC) after taking approval from Human Research Review Panel (HRRP) of SBKS MI & RC and Institutional Ethics Committee (SVIEC) of our institute and consent from participants.

Those medical students who were in the age group of 18 to 25 years and had BMI in the range of 18.5 to 29.9 kg/m² were included in study. The body weight (Wt) was measured bare footed to the nearest 0.5 kg and the height was measured using meter scale without footwear to the nearest 0.5 cm. Body Mass Index (BMI) will be calculated as the weight (kg) divided by the square of height (m²).¹

The study participants were first tested for pre-exercise (baseline) pulse rate & blood pressure. This was followed by a bout of isotonic handgrip exercise for 10 minutes. After exercise, again pulse rate & blood pressure was taken.³

Method of Measurement of BP: The blood pressure was measured in the non-dominant arm in the sitting position with arm and back support. The blood pressure was recorded at the interval of 1 min till the difference between two consecutive blood pressure readings was <5 mmHg. The average of the two consecutive readings was used for statistical analysis. The systolic and diastolic blood pressure was measured by using digital sphygmomanometer¹. Pulse pressure (PP) was calculated by using formula: systolic blood pressure (SBP) – diastolic blood pressure (DBP). Mean arterial pressure (MAP) was calculated by formula (Diastolic Pressure + 1/3 Pulse pressure (PP)).¹

Method of Performing Single Bout of Isotonic Handgrip Exercise: The single bout of isotonic handgrip exercise was performed by the dominant hand of the participants using smiley ball for duration of 10 minutes continuously at an intensity of MVC. During the exercise the participant was asked to squeeze the ball for 2 seconds (Contraction phase) followed by release of the ball for 1 second (Relaxation phase) such that a compression cycle rate of 20/min (each cycle had 2 seconds contraction followed by 1 second of relaxation) is achieved. (1) Exercise was stopped if the heart rate rises above 85% MHR or Blood Pressure rises above 180/110 mmHg.^{1,3}

- Voluntary participation is in inclusion criteria.

- Sample size according to the time
- No ethical issues
- Data will collected rapidly, no complicated procedure involved

Ethical Issues

- Intervention was simple handgrip exercise in the study

Table 1: Subject Characteristics

Table 2: Short-term Effects of Single Bout of Isotonic Handgrip Exercise on Blood pressure in boys

Table 3: Short-term Effects of Single Bout of Isotonic Handgrip Exercise on Blood pressure in Girls

	Normal weight			Preobese		
	Baseline	Post-exe	p-Value	Baseline	Post-exe	p-Value
Pulse Rate	79.79±9.35	81.3±6.93	0.48	79.83±8.9	82.5±4.45	0.226
SBP	116±9.43	105.9±8.66	0.64	115±7.44	106.6±8.75	0.002*
DBP	71.6±6.4	71±5.76	0.709	74.7±6.99	75.3±7.11	0.784
PP	44±11	35±7.3	0.001*	40±9.7	31±10	0.005*
MAP	86.25±5.68	82.7±5.94	0.024*	106.6±8.75	85.7±5.98	0.045*
Values indicate Mean ± SD * Indicates significant difference between groups. P value < 0.05						

Table 1 shows subject characteristics age in yrs, weight (Kg), height (Cms) and BMI (Kg/M²) in both genders. As depicted in Table 2 and Table 3, in comparison to the pre-exercise baseline condition, systolic blood pressure (SBP), mean arterial pressure (MAP) in Preobese groups of both genders were found to be significantly different in the Post-Exercise period. Table 3 shows also significant reduction in pulse pressure (PP) and mean arterial pressure (MAP) in normal weight girls.

Discussions

The current study indicates that Isotonic Handgrip Exercise performed for 10 minutes at an intensity of MVC at a Compression cycle of 20 contractions per minute can produce post-exercise hypotension (PEH) in preobese adults as compared to normal weight adults specially in girls.

PEH has been well documented in humans with both borderline hypertension and hypertension. However, its occurrence in normotensive humans is inconsistent because of lesser magnitude than in hypertensive individuals and compensatory mechanisms such as the Baroreflex, which are activated in normotensive.⁵ JR Macdonald et al had found no difference in magnitude of hypotension following 30 min of cycle ergometry at 50% and 75% VO₂ peak in normotensive volunteers.⁵ In contrast Pescatello et al were unable to document PEH in a normotensive.⁶ These findings show that the effect of dynamic exercise on blood pressure in normotensive subjects is less clear. Our study has been conducted on healthy young normalweight adolescents aged 18-25 yrs and this could be possible reason for no significant results after a single exercise session.

Victor Ronald et al. found no significant difference in mean arterial pressure after rhythmic handgrip exercise at 10, 30 and 50 % of MVC and mild two-arm cycling at 0 to 20 watt, but at 40 and 60 watt intensity two arm cycling shows significant difference in arterial pressure response as compared to baseline values in recovery period.⁷ Present study shows significant difference in systolic blood pressure and mean arterial pressure in Preobese adults after a single bout of 10 minutes isotonic handgrip exercise at maximal intensity.

Nilesh Patel et al. study showed no significant difference in blood pressure due to normotensive adolescents and lower intensity isotonic handgrip exercise with more relaxation as compared to contractions.¹ Current study also has no significance result in normal

weight group but has significant difference in Preobese group due to higher intensity exercise with more contraction duration as compared to relaxation during exercise session.

A recent meta-analysis of 18 prospective cohort studies has shown elevated the risk of cardiovascular disease (CVD) by 1.55 (relative risk, RR), coronary heart disease (CHD) by 1.50, and stroke by 1.71 in pre-hypertension group compared to normotensive group. It is one of the most common modifiable risk factors in CVD. Mean reduction of 3.0 mmHg in SBP could reduce mortality from CHD by 6% and from stroke by 9%. Another subanalysis for healthy and hypertensive studies showed mean reduction of 4.03 mmHg in SBP and of 2.96 mmHg in DBP.⁸ The current study also reported significant reduction in SBP and MAP in Preobese groups in both genders.

Isotonic forearm exercise produces less of demand on heart than continuous isometric exercise. Marjorie et al. found that cardiovascular response produced by isotonic exercises is intensity dependant and exercise sessions which includes relaxation between contractions shows lower cardiovascular response.⁹ Many studies done as rhythmic handgrip exercises show significant rise in Muscle Sympathetic Nerve Activity (MSNA) and blood pressure during exercise sessions of different intensity but post-exercise response is less significant.⁷ In the present study, we have used protocol for isotonic handgrip exercise with less relaxation between contractions and which is probably responsible for the exercise to produce cardiovascular changes in post-exercise period specially in preobese adults.

Three mechanisms are thought to be responsible for the neural cardiovascular modulation during voluntary muscle contractions: an activation of higher brain centers ("central command") as well as reflex activity primarily involving inputs from chemo- and mechanoreceptor ("muscle metaboreflex") and baroreceptor afferents ("baroreflex"). The influence of each mechanism on the heart rate and blood pressure response to exercise depends on factors like recruited muscle mass, muscle fiber type, exercise intensity and the exercise mode.¹⁰

When oxygen delivery to active skeletal muscle is insufficient to meet the metabolic demands during dynamic exercise, metabolites (e.g., lactic acid, adenosine, potassium, diprotonated phosphate, and arachidonic acid products, among others) accumulate within the active muscle and stimulate group III and

IV afferent neurons. These sensory neurons project to the medulla oblongata and their activity elicits reflex increases in sympathetic nerve activity and systemic blood pressure in an effort to enhance blood flow to the ischemic muscle. Termed the muscle metaboreflex, this response is thought to provide important functional links between metabolism in active muscles and central hemodynamics during exercise. Our results show that increasing workload shifts the muscle metaboreflex threshold to higher blood flow levels and therefore reduces the change in blood flow necessary to elicit a reflex pressor response.¹¹

Conclusion

Present study reveals that a single bout of an isotonic handgrip exercise performed by dominant hand at an intensity of MVC using a **smiley ball** with contraction frequency of 20/minute for 10 minutes can produce post-exercise hypotension into the post-exercise period. However, further studies are required to determine if such exercise form can produce PEH in the hypertensive population and to study the long-term effects of training on blood pressure with such form of exercise in larger population.

Study limitations and Future Perspective: A major limitation of the study was that the participants were also normotensive individuals. Thus, it is essential to study the effect in Prehypertensive and hypertensive population. It is also required to determine if PEH can be produced by lowering the intensity, contraction cycle rate and duration of exercise. And finally, it is essential to study the effects of isotonic handgrip exercise training on blood pressure and cardiovascular autonomic functions in larger groups.

Ethical Clearance: Taken From Sumandeep Vidyapeeth Institutional Ethics Committee (SVIEC).

Source of Funding: Self

Conflict of Interest: Nil

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