



# SHORT-TERM EFFECTS OF ISOTONIC HANDGRIP EXERCISE ON CARDIOVASCULAR AUTONOMIC REACTIVITY IN HEALTHY YOUNG ADOLESCENTS

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## ABSTRACT

**Background:** Objective of the study was to determine the short-term effects of isotonic handgrip exercise on cardiovascular autonomic reactivity in healthy adolescents and to find a user friendly exercise which help in reducing blood pressure.

**Method and Materials:** Present study was conducted on 50 young healthy adolescents in the age group of 17-19 years. Isotonic handgrip exercise was performed for 20 minutes at the rate 12 contractions per minute (2 sec contraction/3 sec relaxation) at an intensity of 30%MVC using Ball-Squeeze Dynamometer. Vascular sympathetic reactivity and cardiac parasympathetic reactivity were tested at baseline and during recovery period (Immediate- post-exercise and 1 hour-post-exercise).

**Result:** There were no changes in the parameters (Expiration: Inspiration ratio and Valsalva Ratio) measuring parasympathetic reactivity. Sympathetic reactivity as evaluated by diastolic blood pressure responses to isometric handgrip test (HGT) and cold pressor test (CPT) showed no significant decreases. No significant difference was observed in cardiovascular autonomic reactivity during immediate and 1 hr post-exercise recovery in both boys and girls.

**Conclusion:** It can be concluded that the exercise regime under consideration could not produce any short-term beneficial effects with respect to cardiovascular autonomic reactivity.

**Key Words:** Isotonic Handgrip Exercise Regime, Cardiovascular Autonomic Reactivity, Normotensive, Adolescents

## INTRODUCTION

Exercise is a potent stimulus for sympathetic nervous system activation. <sup>1</sup> Autonomic reactivity refers to cardiovascular responses to potential stimuli, which are essentially reflexive in nature.<sup>2</sup> Recent evidences also suggest that acute dynamic exercise result in transient changes in physiological variables that lead to reduction in blood pressure for 12 to 16 hours following the exercise act.<sup>3</sup>

However, the compliance of people towards routine forms of exercise has not been very encouraging for healthcare professionals due to a number of reasons like time, space and economic constraints. It is therefore necessary to provide an exercise therapy which is feasible for people.<sup>4</sup>

Cardio-respiratory response to physical exercise varies depending upon the type of exercise, duration of exercise, intensity of exercise, exercise

training, subject characteristics etc. According to Brian A. Batman et al. (1994) study the sympathetic nervous system can be activated in a more graded fashion by observing progressive increases in muscle sympathetic nerve activity (MSNA) from a baseline value by rhythmic forearm exercise.<sup>1</sup>

Isotonic handgrip exercise is a simple, cheap and feasible form of physical exercise which can be performed at the person's convenience at any time or place using simple equipment like handgrip in the form of Bulb-Squeeze Dynamometer or Smiley balls. However, scant literature is available so far which indicates the effect of isotonic handgrip exercise on cardiovascular autonomic functions. Therefore the current study was designed to study the short-term effects of isotonic handgrip exercise on cardiovascular autonomic functions in healthy young adolescents.

## METHOD

Our study was conducted on 50 voluntary participants (25 Boys and 25 Girls) at Department of Physiology, Pramukhswami Medical College (PSMC), Karamsad between 5:00 pm to 8:00 pm after taking approval from Human Research Ethics Committee of our institute and consent from participants. The study included those adolescents who were in the age group of 17 to 19 years and had a BMI in the range of 15<sup>th</sup> -85<sup>th</sup> percentile. The study excluded participants who were smokers, athletes and who were suffering from any chronic illness or on any medical therapy. 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) was calculated as the weight (kg) divided by the square of height (m<sup>2</sup>).<sup>5</sup>

The study participants had to visit the Physiology department at 5:30 pm on the exercise day where participants were first tested for baseline cardiovascular autonomic reactivity. This was followed by a bout of isotonic handgrip exercise for 20 minutes. Following the exercise bout, the study participants were again tested for cardiovascular autonomic reactivity during the Immediate -Post exercise period (PE- i R) and at one hour into the post-exercise period (PE-1hr R).

**Method for Assessment of Cardiovascular Autonomic Function:** Ewing's battery of tests were conducted to determine the sympathetic and par-

asympathetic cardiovascular reactivity which include Deep Breathing Test (DBT), Valsalva Manoeuvre, Isometric Handgrip Test (HGT) and Cold Pressor Test (CPT).<sup>2,5</sup>

**Deep breathing test (DBT):** After 30 second baseline ECG recording, the subject was asked to take slow and deep inspiration for 5 seconds followed by slow and deep expiration for 5 seconds for one minute (total 6 breathing cycles / minute). The changes in the heart rate between inspiration and expiration were averaged over 6 cycles and Expiration: Inspiration Ratio (E:I Ratio) has been calculated.

**Valsalva Manoeuvre:** After baseline ECG in sitting position, the subject was instructed to blow into a mouth piece attached to sphygmomanometer and hold the expiratory pressure at 40 mmHg for 15 seconds. At the end of 15 seconds the subject was asked to release the pressure. Valsalva Ratio (VR) was calculated from the longest RR interval during phase IV (After releasing pressure) and shortest RR interval during phase II (During pressure).

**Isometric Handgrip test (HGT):** The baseline blood pressure and pulse rate was recorded. The subject was asked to perform a maximum voluntary contraction using handgrip dynamometer. The subject was asked to hold a handgrip dynamometer at 30% of maximum voluntary contraction (MVC) for 1 minute. The blood pressure was recorded at the end of 1 minute and one minute after contraction. The change in the diastolic blood pressure (C DBP HGT) from the baseline was noted.

**Cold Pressor Test (CPT):** The baseline blood pressure was recorded. The subject was instructed to immerse the dominant hand in the cold water (10 degree Celsius) for 1 minute up to the wrist. The blood pressure was measured at the end of one minute. The change in the diastolic blood pressure (C DBP CPT) from baseline was noted.

**Method of Isotonic Handgrip Exercise:** Isotonic handgrip exercise was performed using Ball-squeeze Dynamometer with the dominant hand for 20 minutes. The participants were first asked to make three attempts for MVC at 1 minute interval. The highest value amongst the three readings was considered as the MVC for the participant. Participant then performed isotonic handgrip exercise by squeezing the ball-squeeze dynamometer at 30% MVC for duration of 20 minutes at a compression cycle rate of 12/ min (2 seconds contraction followed by 3 seconds of relaxation).

Heart rate and blood pressure was monitored at intervals of every 5 minutes and exercise was stopped if the heart rate rises above 85% MHR or Blood Pressure rises above 180/ 110 mmHg.<sup>1</sup>

**Statistical Analysis:** Mean and Standard Deviation of the dependent and independent variables were calculated. Paired t-test was used to study if any significant differences in dependent variables were observed between the baseline and recovery period. P value < 0.05 was considered as significant.

**RESULTS**

Table 1 shows body composition of participants (25 Boys and 25 Girls). Boys and Girls had been shown no significant difference in age, height, weight and Body Mass Index (BMI). As depicted in Table 2 and Table 3, there were no changes in the parameters (Expiration: Inspiration ratio and

Valsalva Ratio) measuring parasympathetic reactivity. Sympathetic reactivity as evaluated by diastolic blood pressure responses to isometric handgrip test (HGT) and cold pressor test (CPT) showed no significant decreases. cardiovascular autonomic reactivity (sympathetic and parasympathetic) were not found to change significantly in the post-exercise period (immediate recovery and 1 hr recovery) after isotonic handgrip exercise in both girls and boys.

**Table 1: Body Composition of Participants**

Variables	Girls (25)	Boys (25)
Age ( Years)	17.84 ± 0.48	17.9 ± 0.65
Height (Cm)	155.72 ± 7.65	169.91 ± 6.37
Weight (Kg)	47.35 ± 5.96	57.47 ± 9.43
BMI (Kg/M <sup>2</sup> )	19.59 ± 2.88	19.89 ± 2.86

Values indicate Mean ± SD

**Table 2: Short-term Effects of Isotonic Handgrip Exercise on Cardiovascular Autonomic Reactivity in Girls**

Variable	Baseline	PE -i R	PE - 1hr R	P value (Baseline Vs PE -i R)	P value (Baseline Vs PE - 1hr R)
E:I R	1.47 ± 0.14	1.49 ± 0.13	1.47 ± 0.11	0.467021	0.84900
VR	1.6 ± 0.3	1.61 ± 0.35	1.61 ± 0.3	0.996956	0.94799
C DBP HGT	16.23 ± 9.22	17.7 ± 10.23	18.13 ± 7.8	0.996849	0.943584
C DBP CPT	15.53 ± 10.80	15.26 ± 8.23	15.83 ± 8.67	0.959296	0.927225

Values indicate Mean ± SD. Paired t-test, \*P value < 0.05 indicates significance. E:I R -Expiration: Inspiration Ratio, VR- Valsalva Ratio , C DBP HGT - Change in Diastolic Blood pressure in Isometric Handgrip Test, C DBP CPT - Change in Diastolic Blood pressure in Cold Pressor Test.

**Table 3: Short-term Effects of Isotonic Handgrip Exercise on Cardiovascular Autonomic Reactivity in boys**

Variable	Baseline	PE -i R	PE- 1 Hr R	P value (Baseline Vs PE -i R)	P value (Baseline Vs PE - 1hr R)
E:I R	1.43 ± 0.12	1.46 ± 0.14	1.44 ± 0.13	0.3883	0.7546
VR	1.68 ± 0.46	1.63 ± 0.42	1.68 ± 0.41	0.6522	0.9791
C DBP HGT	17.76 ± 8.90	15.8 ± 9.55	17.53 ± 8.27	0.4129	0.9166
C DBP CPT	15.66 ± 10.02	14.06 ± 10.75	14.4 ± 8.61	0.3663	0.8333

Values indicate Mean ± SD. Paired t-test, \*P value < 0.05 indicates significance. E:I R -Expiration: Inspiration Ratio; VR- Valsalva Ratio ; C DBP HGT - Change in Diastolic Blood pressure in Isometric Handgrip Test; C DBP CPT - Change in Diastolic Blood pressure in Cold Pressor Test

**DISCUSSION**

Our study found that Isotonic Handgrip Exercise showed no change after a single bout of isotonic handgrip exercise on cardiovascular autonomic reactivity (sympathetic and parasympathetic) during the post-exercise period. Isolated aerobic exercise sessions produce immediate decrease in

blood pressure which can persist for 12 hrs after exercise especially in high pre-exercise blood pressure people.<sup>6</sup> 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.<sup>7</sup>

The autonomic profile of the individual changes during the exercise as well as recovery phase and is also dependent on the intensity of the exercise.<sup>2</sup> 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.<sup>9</sup> Many studies done as rhythmic handgrip exercises shows significant rise in Muscle Sympathetic Nerve Activity (MSNA) and blood pressure during exercise sessions of different intensity but post exercise response is less significant.<sup>1,8</sup> In present study we have used almost similar protocol as Brian A. Batman et al. study for isotonic handgrip exercise and done for 20 minutes with more relaxation between contractions shows no difference in cardiovascular response after isotonic handgrip exercise.

It has been a well established fact now that regular physical training causes a decrease in sympathetic tone and an increase in parasympathetic tone.<sup>2</sup> Though we did not find any study showing effect of isotonic handgrip exercise on cardiovascular autonomic status. Rajesh Sharma et al. study concluded that even 15 days of physical training using cycle ergometry is not enough to alter autonomic activity and parasympathetic reactivity but can result in changes in sympathetic reactivity.<sup>2</sup> In present study, we did not find any significant difference in both Parasympathetic and Sympathetic reactivity after single bout of isotonic handgrip exercise. This could probably be due to lower intensity or lower contraction rate in healthy volunteers or because the study population was less and normotensive.

According to Brian A. Batman et al, during prolonged rhythmic handgrip exercise group III mechanically sensitive afferents which becomes sensitized to metabolic products especially prostaglandin products produced in exercising forearm and led to progressive rise in muscle sympathetic nerve activity.<sup>1</sup>

A major limitation of the study was that the participants were less and all are normotensive individuals. Therefore, it is essential to study the effect in pre-hypertensive and hypertensive adolescents and for higher intensity with higher sample

size and longer duration of regular isotonic handgrip exercise on cardiovascular autonomic functions.

## CONCLUSION

Present study concludes that an isotonic handgrip exercise performed by dominant hand at an intensity of 30% of MVC with contraction frequency of 12/minute for 20 minutes is not able to change cardiovascular autonomic reactivity for upto one hour into the post-exercise period. Various possible explanations include involvement of normotensive adolescents, small sample size or lower intensity, frequency or duration of exercise etc.

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