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BLOOD PRESSURE RESPONSES TO ISOMETRIC HANDGRIP TRAINING IN NORMAL HEALTHY FEMALE STUDENTS

MAHFOODHA AL KITANI
Department of Physical Education, College of Education, Sultan Qaboos University, OMAN.
Email: *mkitani@squ.edu.om*

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ABSTRACT

The objective of the study was to determining the effect of isometric handgrip training program on blood pressure in sedentary young female students and to compare and find the differences between the control group and the experimental group. Thirty-nine untrained female students participated in this study (Age 18.47±0.51). After taking resting measures, the experimental group were required to perform an isometric hand grip strength contraction with one hand for 45 seconds at 30% of maximal voluntary contraction. Four repeated isometric contraction was required (two per hand) with total of 3 minutes of exercise per session. Measurements of HR and BP were taken immediately before the first 45 seconds contraction, and immediately after the 4th contraction and after 3 minutes of sitting period. There were no significant differences between the groups in terms of age, body mass, height, resting heart rate, systolic blood pressure and diastolic blood pressure. However, there were significant differences between the groups for the maximal voluntary contraction between pre and post intervention. Isometric handgrip training may reduce resting heart rate and blood pressure in Omani female adults.

Keywords: *Isometric exercise, blood pressure, female, hypertension.*

1. INTRODUCTION

Blood pressure (BP) is defined as the hydrostatic pressure of the blood exerted on the walls of blood vessels, which ranges levels between the maximum (systolic) 140 mm/Hg and the minimum (diastolic) 40 mm/Hg or more between each heartbeat (Booth,1977). Hypertension was defined as a systolic blood pressure of 140 mm Hg or higher and a diastolic blood pressure of 90 mm Hg or higher (or taking medication to control the condition) (Burt, Whelton, Edward, Roccella,

Correspondence: Mahfoodha Al Kitani, (Ph.D.), Assistant Professor, Exercise physiology, College of Education, Physical Education Department, Sultan Qaboos University, OMAN, Tel: 00968 92662660, Email: mkitani@squ.edu.om.

Brown, Cutler, Higgins, Horan, & Labarthe, 1995; Wolz, Cutler, Roccella, Rohde, Thom, & Burt, 2000). Recent studies indicate that cardiovascular diseases and diabetes were a major causes of death in countries of the Gulf Cooperation Council (Oman, Saudi Arabia, Qatar, Bahrain, Kuwait and United Arab of Emirates) (Al Bahlani & Mabry, 2014). The very high prevalence of diabetes, obesity and hypertension in these countries were strongly linked to the socioeconomic development which was associated with sedentary life style, stress, consumption of tobacco and unhealthy diet.

According to the Oman World Health Survey (2008) the prevalence of hypertension was about (40%) among Omanis (Al Riyami, Elaty, Morsi, Al Kharusi, Al Shukaily, & Jaju, 2012). It is well established that hypertension is a major risk factor for stroke, heart failure, coronary artery disease, peripheral disease and chronic kidney disease. At the level of the world, the proportion of people who suffer high blood pressure were more than 30% (Mackay & Menash, 2004; Chobanian, Bakris, Black, Cushman, Green, Izzo, ….. & NHBPEPCC, 2003). However, studies showed that deaths from strokes can be reduced by 14% and deaths from coronary heart disease can be reduced by 9% when reducing systolic blood pressure by 5 mmHg, (Havas, Roccella, & Lenfant, 2004).

Along with healthy diet, regular physical activity was recommended to improve cardiovascular health and lower blood pressure among both the general population and patients with hypertension. Regular exercise was found to be effective on preventing and treating hypertension (Chobanian *et al*., 2003). The American Heart Association and the American College of Sports Medicine both have recommended the inclusion of resistance training as an integral component of an exercise program for preventing cardiovascular disease (Pescatello, Franklin, Fagard, Farquhar, Kelley, & Ray, 2004; Williams, Haskell, Ades, Amesterdam, Bittner, Franklin, …., & Stewart, 2007). Resistance exercise was recommended for the prevention, treatment, and control of hypertension. According to this recommendation the practice of aerobic exercises such as walking, light running, swimming and special muscle resistance training may contribute to the decrease in blood pressure.

Regular physical activity was recommended to improve cardiovascular health and lower blood pressure among both the general population and patients with hypertension. Studies showed that deaths from strokes can be reduced by 14% by reducing systolic blood pressure by 5 mmHg, also deaths from coronary heart disease can be decreased by 9% (Stamler,1991). Regular exercise is key to preventing and treating hypertension (Chobanian *et al.*, 2003).

Studies reported that dynamic exercise play a positive role in reducing blood pressure through changing people sedentary life style to involve more physical activity patterns such as walking, swimming and cycling. On the other

hand, short-term studies in normotensive and hypertensive subjects suggested that short periods (10 min or so) of isometric exercise (muscle contraction with the generation of a force, but without movement) undertaken three to four times a week can lower systolic and diastolic blood pressure (Mancia, Fagard, Narkiewicz, Redon, Zanchetti, & Bohm, 2014; Buck & Donner, 1985). Therefore, the purpose of this study was to determine the effect of isometric handgrip training program on blood pressure in sedentary young female students and to compare and find the differences between the control group and the experimental group.

2. METHODS AND MATERIALS

2.1 Subjects

Thirty-nine untrained female students were participated in this study. All the participants were undergraduate female students from Sultan Qaboos University (SQU). Participation were voluntary, and written informed consent was obtained from each participant prior to the experiment. Before testing, all participants received a verbal description of the experiment. Participants were excluded from the study if they were under any medication for hypertension, anti-depression medication, any metabolic disease. The study was performed in the female sport complex. Pre- testing took place on Thursday morning between 8 am to 2 pm. One participants were dropped from the study due to failure to present at the experiment time.

Age, height, weight and waist to hip circumference were recorded for all participants at the beginning. Maximum voluntary contraction (MVC) was measured by asking the participants to maximally squeeze the hand held dynamometer. Resting blood pressure (BP) and resting heart rate (HR) was also measured after the participants had been sitting quietly for ten minutes. Table 1 show the participant baseline characteristics.

2.2 Experimental Protocol

A maximal voluntary contraction test was performed using each hand (handgrip dynamometer T.K.K 5401, Japan). The value obtained from this test was used to determine the appropriate magnitude of contraction (set 30% maximal voluntary contraction) required during the intervention. The intervention was performed on five consecutive days of the week (Sunday to Thursday), each session was 15-20 minutes. For both groups. After taking resting measures, the experimental group were then required to perform an isometric hand grip strength contraction with

one hand for 45 seconds at 30% of maximal voluntary contraction. One minute rest was given following this contraction. The left hand contraction was then performed for 45 seconds at 30% of maximal voluntary contraction. A one minutes resting period was also giving following the contraction. Four repeated isometric contraction was required (two per hand) with total of 3 minutes of exercise per session. Performing this exercise for 5 days elicited a duration of 15 minutes for the entire study. Measurements of HR and BP were taken immediately before the first 45 seconds contraction, and immediately after the 4th contraction and after 3 minutes of sitting period. Measurements of resting HR and BP were performed for the control group after 5 minutes rest while they sit quietly and not performing any isometric contraction.

2.3 Statistical analysis

Data was analyzed using a group *x* time repeated measure ANOVA and *t*-tests. Statistical significance was set at $p<0.05$. Data are expressed as mean ± standard error.

3. RESULTS

Table 1: Baseline participant characteristics (mean ± SE) and p-value for experimental and control groups

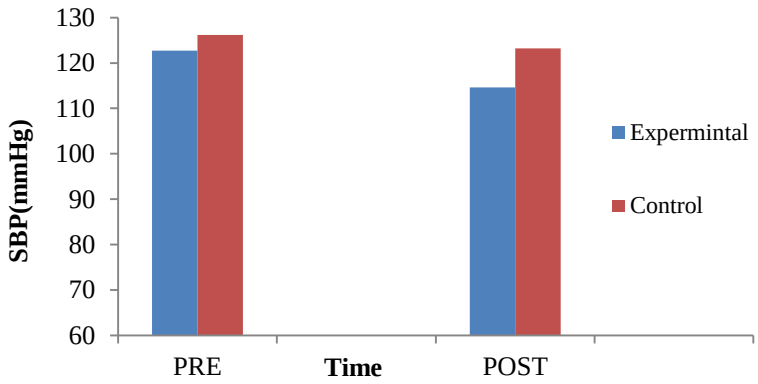
Variable	Experimental (n=19)	Control (n=19)	p-value
Age	18.47±0.51	18.89±0.99	0.11
Body mass	58.26±10.64	54.26±4.42	0.14
Height	164.0±4.04	162.2±2.60	0.11
BMI%	21.59±4.13	21.13±2.12	0.66
WHR	0.78±0.05	0.81±0.04	0.08
Resting HR	*93.7±13.63*	84.6±12.96	0.12
SBP: pre	122.7±12.70	126.2±9.27	0.33
DBP: pre	82.0±11.71	84.31±7.57	0.47
MVC (right) pre	27.07±4.19	22.27±5.37	0.00*
MVC (left) pre	25.91±3.31	20.97±4.66	0.00*
MVC (right) post	28.97±4.05	23.16±6.50	0.00*
MVC (left) post	28.50±3.90	21.03±5.06	0.00*

*Significant difference

There were no significant differences between the groups in terms of age, body mass, height, BMI, WHR, resting HR, SBP and DBP. However, there were

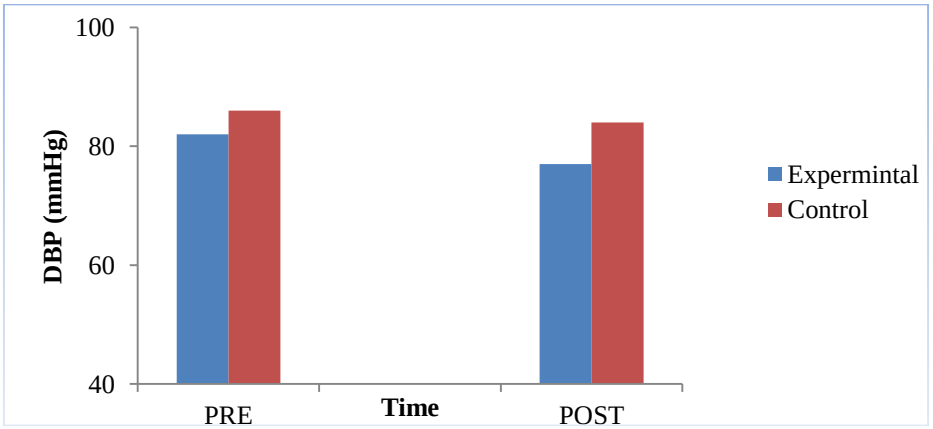
significant differences between the groups for the maximal voluntary contraction between pre and post intervention.

Figure 1: Systolic blood pressure (mean±SE) before and after the exercise intervention



For SBP, there was no significant interaction effect between the experimental and control groups (p=0.33), however there was a significant time effect (p=0.000), with SBP being lower post-intervention. The experimental group showed a reduction from 122.7 ± 12.7 to 117.6 ± 10.4 mmHg, while the control group showed a reduction from 126.2 ± 9.2 to 123.2 ± 8.7 mmHg (Fig. 1). There was, however, no significant difference in the percentage change in SBP between the two groups (p = 0.26).

Figure 1: Diastolic blood pressure (mean±SE) before and after the exercise intervention



For DBP, there was no interaction effect between the experimental and control groups (p=0.47), however there was a very significant time effect (p=0.000) with DBP being lower post intervention. The experimental group showed a reduction from 82 ± 11.7 to 76.6 ± 7.0 mmHg, while the control group showed a reduction from 84.3 ± 7.5 to 81.5 ± 6.5 mmHg. However, no significant difference in the percentage change in DBP between the two groups (p=0.31).

4. DISCUSSION

This study is one of few studies that explore the effect of short term isometric exercise training in younger adults including a control group. Our study showed that there is a decrease in resting blood pressure in response to five days of isometric handgrip training in normal young healthy female volunteers for both groups. Results of the present study were similar to that of (Mortimer & Mckune, 2011) who reported significant decrease in blood pressure after isometric exercise training for 5 consecutive days in older people. Numerous studies have used isometric exercise training to induce reductions in resting blood pressure in both healthy participants and hypertensive patients (Howden, Lightfoot, Brown, & Swaine, 2002; Taylor, McCartney, Kamath, & Wiley, 2003; McGowan, Levy, McCartney, & MacDonald, 2007; Millar, Bray, McGowan, MacDonald, & McCartney, 2007; Stiller-Moldovan, Kenno, & McGowan, 2012).

Studies suggested that the significant reduction observed in SBP after isometric exercise training was due to the reduction in sympathetic nerve activity (Pescatello *et al*., 2004). While reduction in DBP was related to the adaptation in vascular system that leads to decrease in systemic vascular resistance (Millar *et al.*, 2008). The decrease in DBP may be related to reduction in plasma norepinephrine levels or decrease in vascular sensitivity to norepinephrine (McGowan *et al*., 2007). These mechanisms may contribute to the reduction in SBP and DBP found in this study.

Studies also documented that 2mmHg decrease in diastolic arterial pressure would lead to a 17% decrease in hypertension, 15% decrease in stroke and 6% decrease in coronary heart disease (Cook, Cohen, Hebert, Taylor, & Hennekens, 1995). Thus there is a beneficial health effect of a small decrease in diastolic arterial pressure. In addition, several studies documented the effect of relaxation techniques on lowering blood pressure. Finding of this study also support the hypothesis that sitting quietly for 15-20 minutes a day for five consecutive days, whether performing isometric handgrip training or not, had a lowering effect on resting blood pressure. Some studies also reported that a single session of mental relaxation or slow breathing can result in a temporary fall in blood pressure (Kaushik, Kaushik, Mahajan, & Rajesh, 2006). A study in china

found that qigong (a series of relaxation, breathing, gentle movement, and walking exercises) also resulted in the reduction of both systolic and diastolic BP (Cheung, Lo, Fong, Chan, Wong, Wong, ….. & Karlberg, 2003). A study done by (Patel, Kathrotia, Pathak, & Thakkar, 2012) reported that muscle relaxation technique may reduce systolic blood pressure. Possible mechanism contributed to this results explained by the effect of relaxation on reduces the arousability of cerebral cortex, thereby decreasing the impulse from various centres to the hypothalamus, decreasing the sympathetic tone leading to a decrease in blood pressure (Dickinson, Campbell, Beyer, Nicolson, Cook, Ford, & Mason, 2008; Agras, Horne, Taylor, 19982).

Based on the present study results, more studies on the long-term effect of isometric exercise training is needed. It is recommended that future studies should include larger sample size and control group to allow for more significant results.

5. CONCLUSIONS

Studies in the effect of isometric exercise training are interestingly increasing. It appears that isometric exercise may be useful, time-saving, safe technique and effective training modality to reduce BP for normotensive and hypertensive individuals. The results of this study show that isometric handgrip training may reduce resting heart rate and arterial blood pressure in healthy females.

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