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EVALUATION OF CARDIOVASCULAR RESPONSES TO ISOMETRIC EXERCISE IN TRAINED FEMALE BASKET BALL AND VOLLEY BALL PLAYERS

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ABSTRACT

Background: Physical inactivity is recognized as a risk factor for coronary artery diseases. The aim of present study was to observe changes induced by isometric hand grip exercise on cardiovascular responses in young healthy trained female Volleyball and Basketball players. **Methods**: This study was carried out at Department of Physiology, J.S.S. Medical College and Hospital. Hundred and eighty (180) female participants were included and were divided into trained Volleyball & Basketball players and healthy adult controls of 60 each. Estimation of SBP, DBP, MAP and HR were carried out before, after and during various duration of exercise by adopting standard procedures **Results:** The mean SBP, DBP, MAP and HR at various durations for female subjects playing basketball, Volleyball and Control groups shows a significant increase ($p<0.0001$) in all the parameters at rest, during isometric HG exercise and at post exercise in untrained Controls compared with trained subjects. No significant difference was observed in the above said parameters at rest, during isometric HG exercise and at post exercise between Subjects and between volleyball and basketball players.

Conclusions: Exercise leads to significant decrease in cardiovascular stress in trained individuals.

Keywords: Sphygmomanometer, ECG leads, Isometric hand grip exercise, cardiovascular response.

INTRODUCTION

Health is the absence of conditions that would preclude participation in regular physical activity that can reduce the risk for certain chronic degenerative diseases and improve metabolic fitness, VO2 max, and daily functioning.

In recent decades, research has validated the effectiveness of regular exercise as a way to reduce and/or prevent age-related functional decline and reduce the risks of a sedentary lifestyle. Most medical groups recommend regular physical activity. People over age 65 carry the highest load of chronic disease, disability, and healthcare utilization (King AC et.al., 1998). Though many of these problems are preventable, physicians rarely provide their patients with an appropriate exercise recommendation that includes an individualized motivational message, a preparticipation evaluation to ensure a safe exercise program, and a tailored exercise prescription (Will PM et.al., 1996).

Isometric or Static exercise involves the contraction of skeletal muscle without a change in muscle length. Static exercise produces a cardiovascular response that differs significantly from that observed during dynamic exercise. Numerous factors may influence the sympathetic and pressure response to physical exercise, age, sex, type of activity carried on and training. Training, in particular is considered to reduce both adrenergic and pressure response to exercise. Previous studies on young trained athletes have shown a lower sympathetic and hemodynamic response to the isometric exercise and this is accompanied by improved cardiac performance (Nami R et.al., 1988). Physical inactivity is recognized as a risk factor for coronary artery disease. Regular aerobic physical activity increases exercise capacity and plays a role in both primary and secondary prevention of cardiovascular disease (Crosby CA et.al., 1994). Exercise training increases cardiovascular functional capacity and decreases myocardial oxygen demand at any level of physical activity in healthy persons as well as in subjects with cardiovascular disease. Regular physical activity is required to maintain these training effects. The potential risk of physical activity can be reduced by medical evaluation (Lippold, 1952).

Also there is a need to know the effect of exercise training of the above said degree on cardiovascular system so that similar benefits if any could also be obtained to same extent in similar age group if they practice physical training regularly. Cardiovascular responses to isometric handgrip exercises have been studied in different sportsmen of different categories. It has shown that regular exercise training reduces both adrenergic and pressure response to isometric exercises. The same data is lacking in adult female Basket ball and Volley ball players. Hence the present study was under taken to investigate the cardiovascular responses to isometric handgrip exercises in trained adult female Basket ball and Volley ball players.

MATERIALS AND METHODS

The present study consists of B.P.Ed and M.P.Ed students who were pursuing their studies at University of Mysore, Mysore. The study group consisted of 60 trained Basket ball players and 60 trained Volley ball players in the age group of 22-26 years. The control group consisted of 60 age and sex matched untrained adults who were studying in final year M.B.B.S / Interns / Tutors and Post graduates from J.S.S. Medical College and Hospital.

The Study group was divided into 3 groups. Group I comprised of 60 healthy female trained Basket ball players, Group II comprised of 60 healthy female trained Volley ball players and Group III comprised of 60 healthy female Untrained Controls who were studying in final M.B.B.S / Interns / Tutors and Post graduates from J.S.S. Medical college and Hospital. Informed and written consent was obtained from all the subjects recruited for the study. The study was conducted after the approval of the Ethical committee of J.S.S. Medical College, Mysore. All the Subjects selected for the study were healthy and normotensive and were without history of hypertension, cardiovascular, renal, musculoskeletal, neurological disorders. Subjects with acute illness and or on any medication were excluded from the study. The study was performed in the morning between 09.30am and 12.30pm after having their light breakfast (Martin EC et.al., 1974).

PROCEDURE OF STUDY

The exercise was performed in the normal room temperature with bright light (Kyuichi N and Yoshimi M, 1999). Subjects were examined for hemodynamic changes before, and after the end of isometric hand exercise (Haneda T et al., 1980). Hemodynamic changes like BP, HR, and MVC at rest and at the end of 20% and 40% MVC and post exercise were recorded. BP was recorded by Mercury Sphygmomanometer and Stethoscope (Kyuichi N and Yoshimi M, 1999). HR was recorded by using ECG machine. Isometric exercise was performed by hand grip dynamometer (HGD) (Chrysant SG,1978). The duration of the static exercise is of 3 min timed by stopwatch or performed till fatigue (Hultman E et.al, 1982 and Karlson J et al, 1975).The subjects were instructed not to hold their breath during the handgrip to avoid performing the Valsalva manoeuvre (Martin EC, 1974). These tests were performed in 4 sets.

Recording of 1st set of Hemodynamic parameters- BP & HR at rest

After settling down in supine posture, the BP cuff of the standard size was tied to the non exercising upper arm of the subject. The radial pulse was palpated by middle three fingers to detect the rate. As the cuff was inflated, the diaphragm of the stethoscope was lightly placed on the brachial artery just below the cubital fossa medial to biceps tendon and blood pressure was measured by Auscultatory method with mercury Sphygmomanometer.In supine posture, at the same time, 4 Limb leads of ECG -RA, RF, LA, and LF were connected to all the 4 limbs ignoring the chest leads. HR is calculated by recording the R-R interval in Lead II. Before fixing the Limb leads to wrists and ankles, Cardiac jelly was applied in sufficient amount to the respective areas to have a good contact between the electrodes and the skin surface so that better electric signals are conducted from beating heart. The other end of the 4 Limb leads is connected to the ECG machine. After the setup was ready, resting Electrocardiogram of lead II was recorded, Thus from R-R interval, resting HR was calculated by the formula, H.R = 1500 / R-R interval.

Recording of Maximum Voluntary Contraction (MVC)

The study groups were asked to produce a maximum effort by their dominant hand squeezing the bars of HGD as hard as possible and maintaining the maximal effort for 2-3 sec and MVC was recorded. Three trials were allowed with a brief pause of 10sec between each trial to avoid excessive fatigue (Clausen JP, 1973). MVC is defined as the maximum force generated by the subject during the three attempts using the HGD. The grip strength of the small muscle group of the hand was tested (Wiley R,. 1992).

Recording of 2nd set of Hemodynamic parameters- BP & HR at 20% MVC

A 2nd set of hemodynamic parameters were measured as the subjects performed the sustained isometric contraction at 20% MVC. The subjects were instructed to sustain the handgrip with dominant hand at 20% of the predetermined MVC for a maximum of 3 minutes or till fatigue, which ever sets in early. The duration of contraction was accurately timed by stopwatch. The subjects were encouraged to continue the handgrip exertion till failure (Haneda T, 1980).

Failure is defined as the subjective impression by a subject that further maintenance of the exercise was no longer possible because of perceived muscle fatigue (Hietanen E, 1984). When they were no longer able to hold the exertion, they were instructed to inform. At that moment, the BP cuff, which was already tied to the non-exercising hand, was inflated through the pneumatic bulb and with the help of mercury sphygmomanometer and stethoscope, BP (SBP & DBP) was recorded to the nearest 2 mm Hg just at the verge of release of the sustained grip by the subject. At the same time, with the aid of pre-attached limb leads, ECG was recorded before they release the sustained grip at 3min or before the onset of fatigue and from limb lead II R-R interval was measured, thereby calculating the heart rate.

Recording of 3rd set of hemodynamic parameters- BP & HR at 40% MVC

After 20% MVC recording and 5 min rest, the subjects BP and HR return to the resting state BP and HR. 3rd set of hemodynamic parameters were measured as the subjects performed the sustained isometric contraction at 40% MVC. The subjects were instructed to sustain the handgrip with dominant hand at 40% of the predetermined MVC for a maximum of 3 minutes or till fatigue, which ever sets in early. The duration of contraction was accurately timed by stopwatch. The subjects were encouraged to continue the handgrip exertion till failure. The SBP & DBP was recorded to the nearest 2 mm of Hg as explained above. Similarly, HR was also recorded by ECG limb leads (measuring the R-R interval), just moments before the subject released HGD at 3 min or at the onset of fatigue.

Recording the 4th set - Post Exercise hemodynamic parameters - BP & HR

After a rest period of 5 min, the last set of measurements was recorded. As in the previous recordings, post exercise BP and HR were measured with the help of mercury sphygmomanometer, stethoscope and ECG limb leads and Hand Grip Dynamometer. The recordings of MVC, B.P and H.R. were performed on both the Study and Control groups.

Statistical Analysis

All the data's were expressed as Mean $\pm$ Standard deviation. The data's were analyzed for their significant variation among the different groups between different parameters by ANOVA, which was performed using SPSS for Windows Version 14.0 (SPSS, 2005. SPSS Inc, New York). $P<0.05$ was considered the level of significance.

RESULTS

In this study, the cardiovascular responses to isometric handgrip exercises in trained adult female Basket ball and Volley ball players were documented and analyzed.
The results of mean SBP at various durations for female subjects playing basketball, Volleyball and Control groups (Table-1) shows that, there was a significant increase (p<0.0001) in SBP at rest, during isometric HG exercise and at post exercise in untrained Controls compared with trained Subjects. There was a nonsignificant decline in SBP at rest, during isometric HG exercise and at post exercise in Female Basketball players compared to Female Volleyball players. No significant difference was observed in SBP at rest, during isometric HG exercise and at post exercise between Subjects.

Table-1: Mean SBP at various durations for female subjects playing basketball, Volleyball and Control groups. n=60 in each group.

Category	Mean SBP at			
	REST	20% MVC	40% MVC	Post Exercise
	Mean± S.D	Mean±S.D	Mean±S.D	Mean±S.D
Group-I	107.3333±8.1762	111.9333±8.145	116.6±8.1053	107.4±8.4225
Group-II	108.9333±7.6606	112.7333±7.2299	116.8±6.9798	108.7333±7.51
Group-III	111.4667±6.3231	115.9333±6.3785	120.8±6.5306	111±5.8191

P<0.0001 between all the groups. Group I = Feale trained Basket ball players, Group II = Female trained Volley ball players and Group III = Female Untrained healthy Controls.

The results of mean DBP at various durations for female subjects playing basketball, Volleyball and Control groups (Table-2) shows that, there was a significant increase (p<0.0001) in DBP at rest, during isometric HG exercise and at post exercise in untrained Controls compared to trained Subject. There was a nonsignificant decline in DBP at rest, during isometric HG exercise and at post exercise in female Basketball players compared to female Volleyball players. No significant difference was observed in DBP at rest, during isometric HG exercise and at post exercise between Subjects.

Table- 2: Mean DBP at various durations for female subjects playing basketball, Volleyball and Control groups. n=60 in each group.

Category	Mean DBP at			
	REST	20% MVC	40% MVC	Post Exercise
	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D
Group-I	66.20±5.57	68.73±6.07	72.73±6.09	66.40±6.71
Group-II	66.93±4.83	69.73±4.60	73.07±4.42	68.40±4.50
Group-III	70.27±5.87	72.80±5.82	77.33±6.24	68.53±13.25

P<0.0001 between all the groups. Group I = Female trained Basket ball players, Group II = FEmale trained Volley ball players and Group III = Female Untrained healthy Controls.

The results of HR at various durations for female subjects playing basketball, Volleyball and Control groups (Table-3) shows that, there was a significant increase (p<0.0001) in HR at rest, during isometric HG exercise and at post exercise in untrained Controls compared to trained Subject. There was a nonsignificant decline in HR during isometric HG exercise in female Basketball players compared to female Volleyball players. No significant difference was observed in HR at rest, during isometric HG exercise and at post exercise between Subjects.

Table-3: Mean HR at various durations for female subjects playing basketball, Volleyball and Control groups. n=60 in each group.

Category	Mean HR at			
	REST	20% MVC	40% MVC	Post Exercise
	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D
Group-I	68.87±5.95	74.90±6.30	82.40±6.07	69.43±5.98
Group-II	70.73±6.53	76.33±6.52	82.17±6.92	71.30±6.70
Group-III	76.93±3.37	86.90±3.36	98.63±5.71	76.87±3.69

P<0.0001 between all the groups. Group I = Female trained Basket ball players, Group II = Female trained Volley ball players and Group III = Female Untrained healthy Controls.

Table-4: Mean MAP at various durations for female subjects playing basketball, Volleyball and Control groups. n=60 in each group.

Category	Mean MAP at			
	REST	20% MVC	40% MVC	Post Exercise
	Mean±S.D	Mean±S.D	Mean±S.D	Mean±S.D
Group-I	79.91±6.20	83.13±6.47	87.36±6.41	80.07±7.01
Group-II	80.93±5.41	84.07±5.08	87.64±4.85	81.84±5.04
Group-III	84.00±5.85	87.18±5.83	91.82±6.00	82.69±9.80

P<0.0001 between all the groups. Group I = Female trained Basket ball players, Group II = Female trained Volley ball players and Group III =Female Untrained healthy Controls.

The results of mean arterial pressure (MAP) at various durations for female subjects playing basketball, Volleyball and Control groups (Table-4) shows that, there was a significant increase (p<0.0001) in MAP at rest, during isometric HG exercise and at post exercise in untrained Controls compared to trained Subject. There was a nonsignificant decrease in MAP during isometric HG exercise in female Basketball players compared to Male Volleyball players. No significant difference was observed in MAP at rest, during isometric HG exercise and at post exercise between Subjects.

DISCUSSION

Preventive services are an important component of the national health agenda. Physicians have the opportunity and responsibility to promote regular physical activity as well as the reduction of high blood pressure, weight control, management of abnormal blood lipids, and prevention and cessation of smoking. In addition to the physical benefits of exercise, both short-term exercise and long-term aerobic exercise training are associated with improvements in various indexes of psychological functioning. Cross-sectional studies reveal that, compared with sedentary individuals, active persons are more likely to be better adjusted (Lippold,1952), to perform better on tests of cognitive functioning (Martin EC,1974) to exhibit reduced cardiovascular responses to stress (Kyuichi N and Yoshimi M,1999) and to report fewer symptoms of anxiety and depression (Haneda T,1980).
This study has showed that there is a rise in Blood pressure and Heart rate responses to sustained isometric handgrip exercise performed by the trained subjects and controls. At both the intensities of isometric exercise, namely 20% MVC and 40% MVC there was rise in hemodynamic parameters, but more increase was seen during 40% MVC. Trained Subjects had a significant lower hemodynamic response to the isometric handgrip exercise compared to age and sex matched Untrained Controls.

This study showed an attenuated response in HR, SBP and DBP to isometric handgrip contractions by the Study groups i.e. trained Basket ball and Volley ball players compared to untrained Control groups. This study confirmed the previous report which showed that young trained athletes have a lower sympathetic and hemodynamic response to the isometric exercise compared to nontrained youths.

A change in autonomic regulation after physical training in sedentary individuals has also been demonstrated by a study (Schibye B et.al., 1981) which explored the relationship between physical training and HRV in 11 subjects with mild hypertension. Subjects underwent a 6-month training program that consisted of jogging for 20 min at least 5 days a week in addition to a daily routine of calisthenics. They reported that the training intervention produced a training bradycardia, a decrease in the LF component and an increase in the HF component.

It was suggested previously that changes in sympathetic neural influences on total vascular resistance might act as a sufficient stimulus to produce a decline in blood pressure after isometric training (Tallarida G et.al., 1981). While the present study does not reveal the precise mechanisms responsible for these changes the data suggest that the attenuated blood pressure response was at least in part mediated by alterations in autonomic nervous system activity. Previous investigators have proposed alternative mechanisms such as decreased muscle sympathetic nerve activity (Ryszard Gruczal et.al., 1991) increased muscle blood flow (Chester A et.al. 2000) and baroreceptors resetting (Schibye B et.al., 1981).

In this study we investigated the relationship between physical training and subsequent changes in autonomic modulation of heart rate and blood pressure. We observed that trained Subjects have attenuated response in HR, SBP and DBP to isometric handgrip contractions when compared to untrained Controls and were associated with a corresponding change in sympathovagal balance. Thus we conclude that physical training at a modest intensity could be a useful adjunct to the pharmacological treatment of hypertension.

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