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COMPARATIVE STUDY OF CARDIOVASCULAR RESPONSE IN TRAINED AND UNTRAINED VOLLEYBALL AND BASKETBALL PLAYERS

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ABSTRACT: Background: Exercise training increases cardiovascular functional capacity and decreases myocardial oxygen demand at any level of physical activity. The aim of present study was to observe and compare the changes induced by isometric hand grip exercise on cardiovascular responses in young healthy male and female trained Volleyball and Basketball players with age and sex matched untrained controls. **Methods**: This study was carried out at Department of Physiology, J.S.S. Medical College and Hospital. Two hundred and forty (240) participants were included and were divided into trained Volleyball & Basketball players and healthy adult controls of both sex with 40 members in each category. 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 male 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 Control subjects.

Conclusions: Exercise training increases cardiovascular functional capacity.
Keywords: SBP, DBP, HR, MAP, Isometric hand grip exercise, stress.

INTRODUCTION

Toned and shaped muscles are a statement of good health and personality. For that, one needs to follow a stringent workout regime involving special exercises to strengthen the different muscles and joints in the body. Isometric Exercise is typically preformed as an anaerobic exercise, because it is done only for a few seconds that involves static contraction of muscles. That is, in this exercise, the muscle length remains the same even if it is been tensed by pressing against a static body such as a wall, building or an opposing pair of muscles. The advantage of this type of exercise is that one can do it without the aid of any equipment and anybody can do it as the whole procedure does not include even a single complex step.

During such exercises heart rate increases steadily. Stroke volume increases slightly due to sympathetic stimulation and increased contractility of the myocardium. Cardiac output being the product of heart rate and stroke volume increases about six times at peak exercise. Blood flow to the exercising muscles increases markedly, to supply the increased nutritional demand and oxygen as well as to wash out the waste products of metabolism. The oxygen extraction from blood also increases with exercise upto three times the basal value. Thus total oxygen consumption can increase upto 18 times with peak exercise. Unlike the other organs, the heart extracts oxygen to the maximum possible extent even at rest so that coronary sinus has the least oxygen saturation. Isometric exercises can help create endurance in the muscles to handle everyday activities. Isometric exercises activate more muscle fibre which will help our muscles get stronger and faster.

In addition, aerobic exercise adds an independent blood pressure–lowering effect in normotensive and hypertensive groups with a decrease of 8 to 10 mm Hg in both systolic and diastolic blood pressure measurements[1, 2]. 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, risk stratification, supervision, and education[3].

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. But, there is a limitation in the comparative study of cardiovascular response in trained Basket ball and Volley ball players. Hence the present study was under taken to investigate the cardiovascular responses to isometric handgrip exercises in trained Basket ball and Volley ball players in comparison to untrained control subjects.

MATERIALS AND METHODS

The present study conducted after the approval of the institutional Ethical committee of J.S.S. Medical College, Mysore. The study group consisted of 40 trained male and female Basket ball and Volley ball players in the age group of 22-26 years. The control group consisted of 40 age matched untrained male and female adults studying in final year M.B.B.S / Interns / Tutors and Post graduates from J.S.S. Medical College and Hospital. The trained subjects were the students of B.P.Ed and M.P.Ed at University of Mysore, Mysore. The informed and written consent was obtained from all the subjects recruited for the study. 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[31].

PROCEDURE OF STUDY

The exercise was performed in the normal room temperature with bright light[5]. Subjects were examined for hemodynamic changes before, and after the end of isometric hand exercise [6]. 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[5]. HR was recorded by using ECG machine. Isometric exercise was performed by hand grip dynamometer, HGD[7]. The duration of the static exercise is of 3 min timed by stopwatch or performed till fatigue [8, 9]. The subjects were instructed not to hold their breath during the handgrip to avoid performing the Valsalva manoeuvre[4]. These tests were performed in 4 sets.

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

After lying down in supine posture, the BP, and radial pulse was measured by adopting standard procedures. 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.

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 [10]. 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[11] (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[6].
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 [12]. When they were no longer able to hold the exertion, they were instructed to inform. At that moment the BP (SBP & DBP) was recorded. 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. 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 ± 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

Mean SBP at various durations:

There is a significant increase ($p<0.001$) in Mean SBP at various durations for Male and Female Control groups, trained subjects playing basketball and Volleyball respectively, during IHG exercise. However, no significant difference observed in SBP during IHG exercise between the groups. There is a significant increase ($p<0.001$) in SBP at rest, during IHG exercise and PE in Male Control groups compared to Female Control groups, in trained Male Basketball players compared to trained Female Basketball players and trained Male Volleyball players compared to trained Female Volleyball players respectively (Table-1).

Table-1: Mean SBP at various durations for Control and study (Male and Female) subjects playing Volleyball and Basketball. N= 60 subjects in each group.

Category of Players		Mean SBP at			
		REST	20% MVC	40% MVC	Post EXC
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Untrained Players	Male	122.87 ± 5.82	128.33 ± 5.61	137.40 ± 6.17	123.13 ± 5.60
	Female	111.47 ± 6.32	115.93 ± 6.38	120.80 ± 6.53	111.00 ± 5.82
Trained Volleyball	Male	110.53 ± 8.03	114.80 ± 8.01	119.47 ± 8.58	110.47 ± 8.02
	Female	108.93 ± 7.66	112.73 ± 7.23	116.80 ± 6.98	108.73 ± 7.51
Trained Basketball	Male	109.00 ± 6.86	112.07 ± 7.96	116.87 ± 8.20	109.27 ± 7.23
	Female	107.33 ± 8.18	111.93 ± 8.15	116.60 ± 8.11	107.40 ± 8.42

Mean DBP at various durations:

There is a significant increase ($p<0.001$) in Mean DBP at various durations for Male and Female Control groups, trained subjects playing basketball and Volleyball respectively, during IHG exercise. There is a significant increase ($p<0.001$) in DBP at rest, during IHG exercise and PE in Male Control groups compared to Female Control groups, in trained Male Basketball players compared to trained Female Basketball players and trained Male Volleyball players compared to trained Female Volleyball players respectively (Table-2). However, no significant difference observed in DBP during IHG exercise between the groups.

Table-2: Mean DBP at various durations for Control and study (Male and Female) subjects playing Volleyball and Basketball. N= 60 subjects in each group.

Category of Players		Mean DBP at			
		REST	20% MVC	40% MVC	Post EXC
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Untrained Players	Male	80.20 ± 4.71	83.60 ± 4.38	89.07 ± 4.45	81.07 ± 4.75
	Female	70.27 ± 5.87	72.80 ± 5.82	77.33 ± 6.24	68.53 ± 13.25
Trained Volleyball	Male	68.67 ± 7.11	71.47 ± 7.10	75.40 ± 6.95	69.40 ± 7.26
	Female	66.93 ± 4.83	69.73 ± 4.60	73.07 ± 4.42	68.40 ± 4.50
Trained Basketball	Male	68.27 ± 6.25	69.90 ± 6.49	73.67 ± 7.09	69.27 ± 6.74
	Female	66.20 ± 5.57	68.73 ± 6.07	72.73 ± 6.09	66.40 ± 6.71

Mean HR at various durations:

There is a significant increase ($p<0.001$) in Mean HR at various durations for Male and Female Control groups, trained subjects playing basketball and Volleyball respectively, during IHG exercise. However, no significant difference observed in HR during IHG exercise between the groups. There is a significant increase ($p<0.001$) in HR at rest, during IHG exercise and PE in Male Control groups compared to Female Control groups, in trained Male Basketball players compared to trained Female Basketball players and trained Male Volleyball players compared to trained Female Volleyball players respectively (Table-3).

Table-3: Mean MAP at various durations for Control and study (Male and Female) subjects playing Volleyball and Basketball. N= 60 subjects in each group.

Category of Players		Mean MAP at			
		REST	20% MVC	40% MVC	Post EXC
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Untrained Players	Male	94.42 ± 4.96	98.51 ± 4.67	105.18 ± 4.71	95.09± 4.79
	Female	84.00 ± 5.85	87.18 ± 5.83	91.82± 6.00	82.69 ± 9.80
Trained Volleyball	Male	82.62 ±7.12	85.91 ± 7.16	90.09 ±7.29	83.09 ± 7.22
	Female	80.93 ± 5.41	84.07 ± 5.08	87.64 ± 4.85	81.84 ± 5.04
Trained Basketball	Male	81.84 ± 6.30	83.96 ± 6.77	88.07 ± 7.22	82.60 ± 6.74
	Female	79.91 ± 6.20	83.13 ± 6.47	87.36 ± 6.41	80.07 ± 7.01

Mean MAP at various durations:

There is a significant increase ($p<0.001$) in Mean MAP at various durations for Male and Female Control groups, trained subjects playing basketball and Volleyball respectively, during IHG exercise. There is a significant increase ($p<0.001$) in MAP at rest, during IHG exercise and PE in Male Control groups compared to Female Control groups, in trained Male Basketball players compared to trained Female Basketball players and trained Male Volleyball players compared to trained Female Volleyball players respectively (Table-4). However, no significant difference observed in MAP during IHG exercise between the groups.

Table-4: Mean HR at various durations for Control and study (Male and Female) subjects playing Volleyball and Basketball. N= 60 subjects in each group.

Category of Players		Mean HR at			
		REST	20% MVC	40% MVC	Post EXC
		Mean ± S.D	Mean ± S.D	Mean ± S.D	Mean ± S.D
Untrained Players	Male	77.80 ± 3.97	84.53 ± 4.13	96.73 ± 6.74	77.73 ± 4.43
	Female	76.93 ± 3.37	86.90 ± 3.36	98.63 ± 5.71	76.87 ± 3.69
Trained Volleyball	Male	64.93 ± 6.00	71.40 ± 5.92	78.10 ± 6.46	65.37 ± 5.93
	Female	70.73 ± 6.53	76.33 ± 6.52	82.17 ± 6.92	71.30 ± 6.70
Trained Basketball	Male	64.70 ± 7.92	69.17 ± 8.14	74.80 ± 8.72	65.00 ± 7.79
	Female	68.87 ± 5.95	74.90 ± 6.30	82.40 ± 6.07	69.43 ± 5.98

Maximum Voluntary Contraction:

When the Maximum Voluntary Contraction (MVC) between Control and Study groups were compared, it shows a significant decrease ($p<0.001$) in MVC in Females compared to Males in all the groups. There is a significant increase ($p<0.001$) in MVC in trained male and female Subjects compared to untrained (Fig-1).

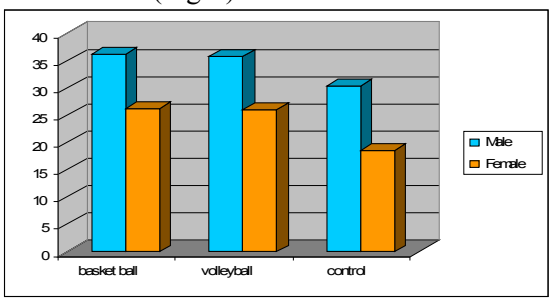

Fig-1: Comparison of Maximum Voluntary Contraction (MVC) between Control and Study groups.

y- axis-MVC in Kg

F for Overall Change in Male=44.869; P<.000 (HS) and in Female=150.362; P<.000 (HS)

DISCUSSION

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[13].

Arterial baroreflexes are important mechanisms for the overall regulation of circulation[14, 15]. Under resting conditions, an increase in arterial pressure stimulates arterial baroreceptors and decreases the heart rate and the peripheral vascular resistance in resting skeletal muscles. Handgrip exercise induces an increase in arterial pressure, and although the increase in pressure should stimulate the arterial baroreceptors, it is accompanied by increases in heart rate and peripheral vascular resistance in resting skeletal muscles. This phenomenon indicates that arterial baroreflex functions are modified during exercise and that this modification may include changes in the gain and/or operating range of the reflex[16, 17]. 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.

The present study explored the relationship between physical training and subsequent changes in autonomic modulation of heart rate and blood pressure. We showed 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. We conclude that physical training at a modest intensity could be a useful adjunct to the pharmacological treatment of hypertension.

In conclusion, the present study may be useful to understand the effect of training and to evaluate the training schedule. Similar benefits if any could also be obtained to same extent in similar age and sex group if they practice physical training regularly.

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