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Recovery Blood Pressure reactivity Patterns during Hand Grip Test (one of the Autonomic Testing Protocol) in Relation to Aerobic Fitness Levels

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Abstract

The aim of the study was to compare the blood pressure patterns during hand grip test in relation to aerobic fitness (VO2max) of high and low fitness groups of high altitude male youth. The high and low fitness groups were determined by VO2max ranks of 242 healthy male youth samples of Kashmir (attitude: 6070 feet/1850 meters. The study was conducted on 70 samples among which top 35 ranks were considered in HFG and bottom 35 ranks were considered in LFG. The age of the subjects ranged from 18 to 23 years. The purpose of the study was to compare between the high fitness group (HFG) and low fitness group (LFG) in regard to blood pressure reactivity patterns during hand grip test (CPT) of high altitude male youth, which will be useful for evaluation, grading, grouping and monitoring of their aerobic fitness Data was collected using a standard mercury sphygmomanometer and a stethoscope was used to record the blood pressure of the subjects at various timings of hand grip test (one of the autonomic testing protocol) and by using hand grip dynamometer for measuring the maximal voluntary contraction (MVC)of the subjects and for performing the hand grip test. The selected variables were age in years, body weight in kilograms (B.Wt.), height in centimeters (Ht.), resting heart rate (HRrest), Basal Blood Pressure (BslBP), pulse pressure (PP), mean arterial pressure (MAP), change of diastolic blood pressure at two minutes of hand grip test (HGT2CDBP), change of diastolic blood pressure at four minutes of hand grip test (HGT4CDBP), change of diastolic blood pressure at six minutes of hand grip test (HGT6CDBP),systolic blood pressure at one minute of hand grip test (HGTSBP1),diastolic blood pressure at one minute of hand grip test (HGTDBP1), systolic blood pressure at two minute of hand grip test (HGTSBP2), diastolic blood pressure at two minute of hand grip test (HGTDBP2), systolic blood pressure at four minutes of hand grip test (HGTSBP4), diastolic blood pressure at four minute of hand grip test (HGTDBP4), systolic blood pressure at six minute of hand grip test (HGTSBP6) and diastolic blood pressure at six minute of hand grip test (HGTDBP6), For statistical analysis the collected data was computed with mean, standard deviation, coefficient of variance and independent't' test. The major findings reflect significant difference between HFG and LFG in regard to VO2max (t =47.66), (r=0.99); HRrest (t =-4.28), (r=0.46); CDBPHGT2Min(t=6.16),(r=0.60); CDBPHGT4Min(t=5.36),(r=0.54); CDBPHGT6Min (t=5.61), (r=0.56); DBPHGT2Min (t=2.04), (r=0.24); DBPHGT4Min (t=2.25) ,(r=0.26); SBPHGT6Min (t=2.29), (r=0.27) andDBPHGT6Min (t=2.68), (r=0.31). The results show that the recovery of Blood Pressure Patterns Following Hand Grip Strength Testwas faster in HFG than that of LFG. The study concluded that the HFG were significantly better equipped in recovering their Blood Pressure Patterns than that of LFG.

Key Words: Blood Pressure, Cold Pressor Test, Heart Rate, High Altitude, Kashmir.

1. Introduction:

Blood pressure (BP) is the lateral pressure exerted by blood on the vessel walls while flowing through it. (Lateral pressure is that pressure when force is exerted at right angles to the direction of follow at any point within a tube filled with a circulating fluid). (Chatterjee, 1951)

Systolic Pressure (S.P) is the maximum pressure during the systole. (Contraction of heart muscle is medically called as systole). (Chatterjee, 1951). Diastolic pressure (D.P) is the minimum pressure during the diastole. (Relaxing of heart muscle is medically called as diastole). (Chatterjee, 1951).Pulse Pressure (PP) is the difference between the systolic and accepted diastolic pressure. (Chatterjee, 1951)

PP = Systolic Pressure – Diastolic Pressure

Mean Arterial Pressure (MAP) is defined as the average pressure in subject's arteries during one cardiac cycle. It is considered a better indicator of perfusion to vital organs than systolic blood pressure (Chatterjee, 1951).

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$$MAP = \frac{2 \text{ x Diastolic} + \text{Systolic}}{3}$$

A very recent reviewed study concluded that high-altitude exposure has been well recognized as a hypoxia exposure that significantly affects cardiovascular function. However, the pathophysiologic adaptation of cardiovascular system to high-altitude hypoxia (HAH) varies remarkably. It may depend on the exposed time and oxygen partial pressure in the altitude place. In short-term HAH, cardiovascular adaptation is mainly characterized by functional alteration, including cardiac functional adjustments, pulmonary vascular constriction, transient pulmonary hypertension and changes in cerebral blood flow (CBF). These changes may be explained mainly by ventilatory acclimatization and variation of autonomic nervous activity. In long-term HAH, cardiovascular adaptation is mainly characterized by both functional and structural alterations. These changes include right ventricle (RV) hypertrophy, persistent pulmonary hypertension, lower CBF and reduced utero-placental/ fetal volumetric blood flows. (Ke Wang et.al, 2017)

Altitude exposure is associated with major changes in cardiovascular function. The initial cardiovascular response to altitude is characterized by an increase in cardiac output with tachycardia, no change in stroke volume, whereas blood pressure may temporarily be slightly increased. After a few days of acclimatization, cardiac output returns to normal, but heart rate remains increased, so that stroke volume is decreased. Pulmonary artery pressure increases without change in pulmonary artery wedge pressure. This pattern is essentially unchanged with prolonged or lifelong altitude sojourns. Ventricular function is maintained, with initially increased, then preserved or slightly depressed indices of systolic function and an altered diastolic filling pattern. Filling pressures of the heart remain unchanged. Exercise in acute as well as in chronic high-altitude exposure is associated with a brisk increase in pulmonary artery pressure. The relationships between workload, cardiac output and oxygen uptake are preserved in all circumstances. Altitude exposure carries no identified risk of myocardial ischemia in healthy subjects but has to be considered as a potential stress in patients with previous cardiovascular conditions. (Naeije, 2010)

High altitude exposure may induce important changes in blood pressure (BP) regulation, leading to significant increases in BP levels. By inducing atherosclerotic changes, stiffening of large arteries, renal dysfunction, and arterial baroreflex impairment, advancing age may induce progressive increases in systolic BP levels, promoting development and progression of arterial hypertension. It is also known, although mainly from studies in young or middle-aged subjects, that exposure to high altitude may influence different mechanisms involved in blood pressure (BP) regulation (i.e., neural central and reflex control of sympathetic activity), leading to important increases in BP levels. The evidence is less clear, however, on whether and to what extent advancing age may influence the blood pressure (BP) response to acute or chronic high altitude exposure. (Parati et.al, 2015).

Another study has been conducted on 20 sojourners, between the ages of 20-30 years, to evaluate responses of the autonomic nervous system during acclimatization to high altitude. The responses measured consisted of heart rate (HR), blood pressure (BP), oral temperature (OT), mean skin temperature (SkT), cold pressor response (CPR), orthostatic tolerance to tilt and urinary catecholamines. The subjects were tested initially at Delhi (altitude 260 meters) and thereafter, on acute induction to an altitude of 3500 meters periodically for three weeks. For comparison, the same responses were studied on 10 acclimatized lowlanders (AL) who had been staying at the same altitude for more than a year and on 10 high-altitude natives (HAN). The studies showed a rise in HR, BP, OT and urinary catecholamines and a fall in SkT, CPR and orthostatic tolerance immediately on arrival at high altitude (HA), indicating a relative hyperactivity of the sympathetic system. After a stay of one week, there was a gradual recovery in all the responses, though sympathetic hyperactivity was still maintained throughout the three weeks of stay. In lowlanders (AL) also there was a preponderance of sympathetic activity, though of relatively lesser magnitude than that seen in sojourners. In High Altitude Natives (HAN), on the other hand, there was a relative parasympathetic predomination. It has been concluded that in lowlanders it takes more than a year of stay at altitude for complete recovery of autonomic balance.(Malhotra et.al, 1976) A well-defined battery of five tests namely, deep breathing, valsalva manoeuvre, hand grip, cold presser and lying to standing are used to measure autonomic reflexes.

Blood pressure response test namely cold pressor test (CPT) has been used in the present study on Kashmiri male youth for sympathetic reactivity measurements. The autonomic pathways involved in these cardiovascular reflexes are extremely complex and encompass both sympathetic and parasympathetic fibers to a greater or lesser extent. Most observers now agree that the blood pressure (BP) response to cold pressor is also mediated through sympathetic pathway. It was best verified by the drugs that interfere with sympathetic transmission, inhibited the cold pressor response. (Kern et.al, 1985).

1.1 Isometric Handgrip Test:

A rise in diastolic blood pressure is determined during isometric pressing of a handgrip dynamometer at approximately one third of the maximum contraction strength for 3–5 minutes. Blood pressure measurements are taken at the other arm at one minute interval. An increase in diastolic blood pressure is a result of heart rate acceleration without an increase of peripheral vascular resistance. The test result is presented as the difference between the highest diastolic pressure during the examination/test and the average diastolic pressure at rest. It should normally be higher than 15 mmHg. (Van den Berg et.al, 1997)Special attention is to be paid to the manner of performing the handgrip by the subject as many patients/subjects perform a valsalva manoeuvre during this test and consequently bias its results. (Hilz et.al, 2006)

The Purpose of the study was to compare between the high fitness group (HFG) and low fitness group (LFG) in regard to recovery blood pressure patterns following cold pressor test of high altitude male youth, which will be useful for evaluation, grading, grouping and monitoring of their aerobic fitness.

2. Methodology:

2.1 Selection of Subjects:

The study has been performed on two hundred and forty two healthy male subjects of Kashmir state (altitude: 6070 feet/1850 meters). The age of the subjects ranged from 17 to 23 years. The submaximal bench step test (American College of Sports Medicine Protocol) was administered on the 242 subjects to determine their VO_2max by plotting HR-workload combinations calculated by Karvonen heart rate reserve method. Among the 242 subjects administered, top 35 as HFG and bottom 35 as LFG on the basis of their VO_2max scores have been selected for the purpose of the study.

2.2 Selection of Variables:

Following variables have been selected for the purpose of study:

Table-1
Abbreviation and Description of Selected Variables

S.No	Abbreviation	Description	S.No	Abbreviation	Description
1	AGE	Age in years	11	CDBPHGT4min	change of diastolic blood pressure at four minutes of hand grip test
2	HGT	Height in centimeters	12	CDBP HGT6min	change of diastolic blood pressure at six minutes of hand grip test
3	WGT	Weight in kilograms	13	SBPHGT1min	systolic blood pressure at one minute of hand grip test
4	VO_2max	Maximal Oxygen Consumption	14	DBPHGT1min	diastolic blood pressure at one minute of hand grip test
5	BslSBP	Basal systolic blood pressure	15	SBPHGT2min	systolic blood pressure at two minute of hand grip test
6	BslDBP	Basal diastolic blood pressure	16	DBPHGT2min	diastolic blood pressure at two minute of hand grip test
7	MAP	Mean arterial pressure	17	SBPHGT4min	systolic blood pressure at four minutes of hand grip test
8	PP	Pulse pressure	18	DBPHGT4min	diastolic blood pressure at four minute of hand grip test
9	HRrest	Resting heart rate	19	SBPHGT6min	systolic blood pressure at six minute of hand grip test
10	CDBPHGT2min	change of diastolic blood pressure at two minutes of hand grip test	20	DBPHGT6min	diastolic blood pressure at six minute of hand grip test

Total 20 variables have been selected for the study.

2.3 Administration of Test

The subjects were instructed about the test and demonstrated the method of using hand grip dynamometer. After the demonstration the subject was asked to grip using maximum voluntary force (MVC) with their dominant hand for few seconds and the process was repeated three times. The maximum score of the three readings was considered as subject's MVC. The free hand of the dynamometer was fixed at 30% of MVC of the subject and the subject was asked to maintain the sustained grip on the dynamometer up to the fixed hand of the dynamometer for 6 minutes. (Ewing, 1992)

2.4 Collection of Data:

Before conducting the test the baseline blood pressure was recorded. After the completion of the test the blood pressure (BP) was recorded on the contra-lateral arm at 1st, 2nd, 4th and 6th (or any time just before the release of the grip if it was less than 6 minutes).

2.5 Statistical Analysis:

Mean, standard deviation and coefficient of variancehave been calculated for every selected variable. Levene's test for checking the assumption of homogeneity of group variances have been done and the HGF and LGF have been compared on the basis of independent sample "t" test.

3. Result & Findings of the Study:

All the findings after the calculations and analysis of collected data have been documented in Table 2 and Table 3 as follows:

Table-2
Descriptive Statistics of selected variables of the subjects (High Altitude Kashmiri Male Youth)

S.NO	Variable	HFG			LFG		
		Mean	SD	CV	Mean	SD	CV
1	AGE	18.94	0.91	4.78	18.74	0.82	4.36
2	HGT	172.23	5.68	3.30	170.43	6.50	3.81
3	WGT	55.16	6.20	11.24	53.56	8.62	16.09
4	VO_2max	60.57	1.29	2.12	45.64	1.33	2.92
5	BslSBP	112.51	9.96	8.85	110.20	14.98	13.60
6	BslDBP	66.09	8.66	13.10	65.74	9.96	15.15
7	MAP	81.14	7.85	9.67	80.54	10.73	13.33
8	PP	46.43	9.70	20.89	44.46	10.06	22.63
9	HRrest	63.03	8.37	13.27	73.77	12.28	16.64
10	CDBPHGT2Min	25.14	10.93	43.48	9.74	9.97	102.35
11	CDBPHGT4Min	31.94	14.14	44.28	14.31	13.37	93.46
12	CDBPHGT6Min	39.17	15.68	40.03	19.74	13.19	66.80
13	SBPHGT1Min	131.20	10.88	8.29	128.89	18.18	14.11
14	DBPHGT1Min	87.37	11.44	13.10	83.23	15.42	18.53
15	SBPHGT2Min	132.40	15.24	11.51	128.80	19.97	15.50
16	DBPHGT2Min	90.66	10.77	11.88	84.77	13.20	15.58
17	SBPHGT4Min	141.60	19.33	13.65	133.74	17.62	13.18
18	DBPHGT4Min	97.29	13.02	13.39	89.37	16.29	18.23
19	SBPHGT6Min	152.11	19.09	12.55	141.31	20.38	14.42
20	DBPHGT6Min	105.86	17.14	16.19	95.31	15.70	16.47

$N_1=N_2=35$;
Where N_1= Number of subjects in high fitness group (HFG); N_2= Number of subjects in low fitness group (LFG)
Blood Pressure is expressed in mmhg.

Table-2

Comparison between HFG and LFG in regard to variables of Blood Pressure Reactivity Patterns during Hand Grip Test of (Kashmir High Altitude Male Youth)

S.NO	Variable Name	Levene's Test	t-test for Equality of Means				effect size
		F	t	df	Mean Difference	Std. Error Difference	r
1	Age	0.06 NS	0.97 NS	68	0.2	0.21	0.12
2	Height	2.01 NS	1.23 NS	68	1.8	1.46	0.15
3	Weight	0.45 NS	0.89 NS	68	1.6	1.79	0.11
4	VO2MAX	0 NS	**47.66***	68	14.93	0.31	0.99
5	BLSBP	**6.73***	0.76 NS	59.13	2.31	3.04	0.1
6	BLDBP	3.09 NS	0.15 NS	68	0.34	2.23	0.02
7	MAP	**5.26***	0.27 NS	62.26	0.6	2.25	0.03
8	PP	0 NS	0.84 NS	68	1.97	2.36	0.1
9	HRrest	0.65 NS	**-4.28***	68	-10.74	2.51	0.46
10	CDBPHGT2Min	1.89 NS	**6.16***	68	15.4	2.5	0.6
11	CDBPHGT4Min	0.47 NS	**5.36***	68	17.63	3.29	0.54
12	CDBPHGT6Min	1.24 NS	**5.61***	68	19.43	3.46	0.56
13	SBPHGT1Min	**8.18***	0.65 NS	55.57	2.31	3.58	0.09
14	DBPHGT1Min	2.76 NS	1.28 NS	68	4.14	3.25	0.15
15	SBPHGT2Min	1.77 NS	0.85 NS	68	3.6	4.25	0.1
16	DBPHGT2Min	1.01 NS	**2.04***	68	5.89	2.88	0.24
17	SBPHGT4Min	0.08 NS	1.78 NS	68	7.86	4.42	0.21
18	DBPHGT4Min	2.48 NS	**2.25***	68	7.91	3.53	0.26
19	SBPHGT6Min	0.69 NS	**2.29***	68	10.8	4.72	0.27
20	DBPHGT6Min	0.1 NS	**2.68***	68	10.54	3.93	0.31

$N_1 = N_2 = 35$; *= significant at 0.05 levels of significance, NS = insignificant
Blood pressure is expressed in mmHg.

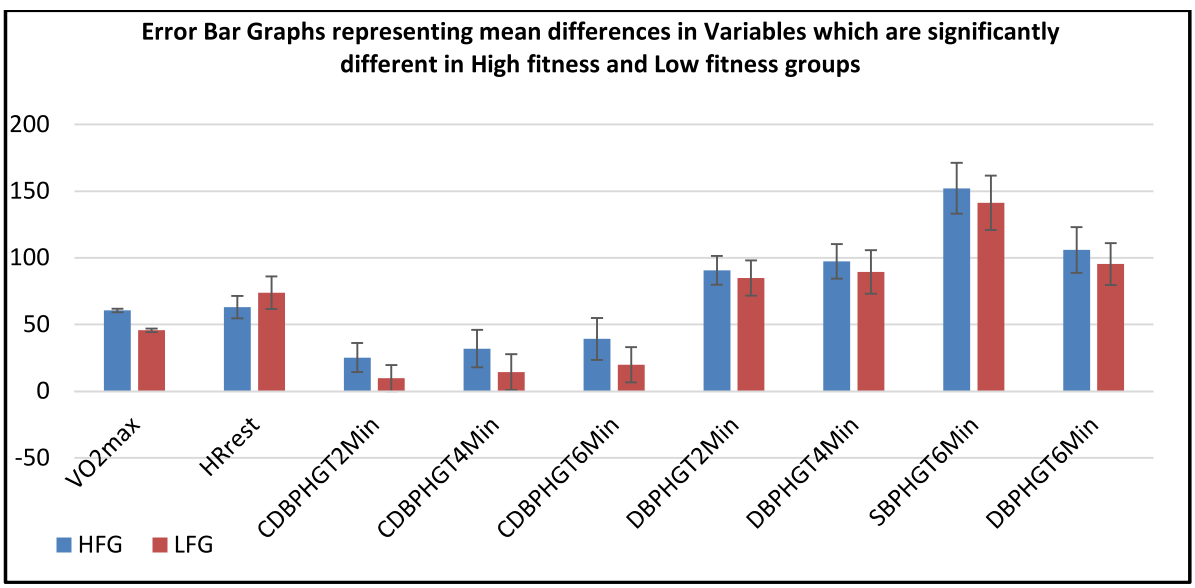

Figure 1. Showing the Difference in mean scores in HFG and LFG

4. Discussion of Findings:

The analysis of the table-2 reveals that the recovery blood pressure reactivity patterns following six minutes hand grip strength test was faster in HFG than that of LFG.

5. Conclusion:

It is concluded that HFG having better recovery blood pressure reactivity patterns than that of LFG following six minutes hand grip strength which corroborates the existing theories.

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