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Recovery Heart Rates Correlates Aerobic Fitness Levels of High Altitude Male Habitat (A Comparative Study)

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Abstract

The objective of the study was to compare the selected recovery heart rate variables between high fitness group (HFG) and low fitness group (LFG) of high altitude male youth. The high fitness group (n1=35) and low fitness groups (n2=35) were determined by VO2max ranks of 242 healthy male youth samples of Kashmir (attitude: 6070 feet/1850 meters). The selected 70 samples out of 242 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. A heart rate monitor with chest strap was fixed on the subject and the wrist watch was tied after calibration to check the heart rate of the subjects. The youth were administered with sub maximal bench step test (American College of Sports Medicine Protocol) to determine the VO2max by plotting HR-workload combinations calculated by Karvonen heart rate reserve method. Data was collected using Cardio-Sport heart rate monitor and step test protocol. The selected variables were age in years, body weight in kilograms (B.Wt.), height in centimeters (Ht.), resting heart rate (HR rest), Heart Rate at Two minutes of step testing with cadence 20 steps/min (ExHR2), Heart Rate at Four minutes of step testing with cadence 25 steps/min (ExHR4), Heart Rate at Six minutes of step testing with cadence 30 steps/min (ExHR6), recovery heart rate at one minutes of rest (RcvHR1), recovery heart rate at two minutes of rest (RcvHR2) and recovery heart rate at third minute of rest (RcvHR3), heart rate change one (HRC1), heart rate change two (HRC2), heart rate change three (HRC3), heart rate change four (HRC4), heart rate change five (HRC5), heart rate change six (HRC6), percentage change one (PC1), percentage change two (PC2), percentage change three (PC3), percentage change four (PC4), percentage change five (PC5) and percentage change six (PC6). For statistical analysis the collected data was computed with mean, standard deviation, coefficient of variance, percentage change and independent sample "t" test. The major findings reflect significant difference between HFG and LFG in regard toVO2max (t =47.66),(r=0.99); HR rest(t =-4.28), (r=0.46); RcvHR2 (t =-3.00), (r=0.34); RcvHR3 (t =-6.19), (r=0.60); HRC3 (t=4.13), (r=0.45); HRC4 (t=2.84), (r=0.33); HRC5 (t=5.41) ,(r=0.55); HRC6 (t=4.52), (r=0.48) and PC2 (t=2.27), (r=0.27). Moreover, although the two groups didn't showed a significant difference regarding the variables PC3, PC4, PC5 and PC6 but three of them (PC3, PC5, PC6) show a high effect size of groups with values of r = 0.52, 0.61, 0.56 respectively and PC4 show a medium group effect size with r = 0.36.The study concluded that HFG having better recovery heart rate pattern than that of LFG and all the recovery heart rates were faster in HFG than that of LFG.

Key words: Maximal Oxygen Uptake, Recovery Heart Rate, Exercise Heart Rate, High Altitude, Kashmir.

1. Introduction:

VO2max also known as maximal oxygen consumption, maximal oxygen uptake, peak oxygen uptake or maximal aerobic capacity is the maximum rate of oxygen consumption as measured during incremental exercise, most typically on a motorized treadmill or on a bench step test.(Dlugosz 2013) Maximal oxygen consumption reflects the aerobic physical fitness of the individual and is an important determinant of their endurance capacity. The name is derived from V = volume, O2 = oxygen, max. = maximum.

VO2 max is expressed either as an absolute rate in (for example) liters of oxygen per minute (l/min) or as a relative rate in (for example) milliliters of oxygen per kilogram of body mass per minute (e.g. ml/kg/min). The latter expression is often used to compare the performance of endurance sports athletes. However, VO2 max generally does not vary linearly with body mass. (Wikipedia, July 2017).

VO2max is the very important determinant of cardio-respiratory fitness and aerobic performance.VO2 max (ml/min/kg) is a measure of the maximum amount of oxygen that one use during intense physical activity. This measurement determines fitness level by calculating how efficiently cells use oxygen for energy.(Tipton, 1977) There are

several methods one can use to measure VO2max but many require sophisticated equipment such as a treadmill or a specially calibrated exercise cycle with calorimetry/ spirometry /gas analyzer. The step test with heart rate recordings is quickest, easiest and safest as well as feasible way to measure ones VO2max for basic calculation after taking in consideration the Karvonen formula for a step testing protocol and sub maximal exercise heart rate (Practical Math for Health Fitness Professionals, 1996). It is postulated that a correlation between VO2max and recovery heart ratewill be a step advance for understanding the aerobic fitness of high altitude male youth.

The number of contraction range from 60 to 80 bts/min. The rate and intensity of the cardiac contractions is affected by exercise, long term training, age, sex, disease, stress, environmental temperature, altitude etc. However 72 beats per minute (bts/min) in is generally considered as a normal heart rate, however a lower resting heart rate is recorded in trained individuals then that of untrained. One of the hallmark of the endurance athlete is a slower heart rate at rest (Bradycardia). The lower heart rate may be caused by any combination of three factors, a reduction in the intrinsic rate of heart, decreased sympathetic tone and increased parasympathetic tone (Lewis 1980).

Heart rate is arguably a very easy cardiovascular measurement, especially in comparison to the invasive or noninvasive procedures used to estimate stroke volume and cardiac output. Consequently, measurement of heart rate is routinely used to assess the response of the heart at rest, to exercise, or the recovery from exercise, as well as to prescribe exercise intensities (Froeliche, 2000). Given that the increase in heart rate during incremental exercise mirrors the increase in cardiac output, maximal heart rate is often interpreted as the upper ceiling for an increase in central cardiovascular function. Indeed, research for the last 100 years has demonstrated that heart rate does in fact have a maximal value; one that cannot be surpassed despite continued increases in exercise intensity or training adaptations. The regular exercise leads to adoptive changes in cardiac and physical performance and oxygen uptake capacity and ultimately the onset of slower resting heart rate medically called as Bradycardia. (Robert 2008).

Recent research revealed that the Queens College step test provides a valid estimate of VO2max. Step test performance at the altitude of 3800 meters was reduced by 11% compared to sea level, whereas no change was observed at 2040 meters. These data corroborate previous findings that indicate a threshold at which altitude adversely affects aerobic capacity (Bates 2015).

"Recovery heart rate" refers to the heart's ability to return to normal levels after physical activity. Fitness level and proper function of heart are measured by the recovery phase. A heart that is healthy will recover at a quicker rate than one that is not healthy or is not accustomed to regular exercise. If one's heart does not recover in reasonable time, one may have a heart problem. High fitness group and healthy persons demonstrating faster recovery rate than that of their counterparts (Wolfe and Smith 2017).

First Minute of Recovery:

The first minute of recovery is the most crucial. After exercise, heart rate experiences an abrupt drop during the first minute. This recovery period can indicate fitness level and give an early warning of potential heart problems. In a study performed by the Cleveland Clinic Foundation classified a heart rate decrease of 12 beats or less in the first minute as abnormal. The study also reported that people with an abnormal decline in heart rate had a greater chance of mortality in the subsequent six years due to heart problems. (The New England Journal of Medicine, October 1999)

Two-Minute Recovery:

The heart rate two minutes after exercise is referred to as the recovery heart rate. This is the most common measurement in determining cardiovascular fitness. To test for improvements, record the working heart rate during exercise, then record recovery heart rate at the two-minute mark. Subtract the two-minute recovery rate from the working heart rate to determine a baseline for improvement. For example, if working levels were 150 beats per minute and the two-minute recovery rate was 95, then 55 is the recovery heart rate.(Apr 23,2015)

Recovery heart rate is simply your pulse rate after exercise. Some fitness specialists refer to it as post-exercise heart rate. The pulse number is used for different reasons in different settings.Recovery heart rate is also used in popular fitness tests like the YMCA Submaximal Step Test. During the fitness assessment, an exerciser steps up and down on a 12-inch box at a rate of 24 steps per minute.The test lasts for three minutes. Recovery heart rate is measured for one full minute immediately following the test.

There are numerous studies which documents the norms of Recovery Heart Rate (RcvHR). The findings of one of the study have been illustrated vide table-1 below:

Table-1
Ratings for Men, Based on Age

	(18-25) years	(26-35) years	(36-45) years	(46-55) years	(56-65) years	65+ years
Excellent	50-76	51-76	49-76	56-82	60-77	59-81
Good	79-84	79-85	80-88	87-93	86-94	87-92
Above Average	88-93	88-94	92-88	95-101	97-100	94-102
Average	95-100	96-102	100-105	103-111	103-109	104-110
Below Average	102-107	104-110	108-113	113-119	111-117	114-118
Poor	111-119	114-121	116-124	121-126	119-128	121-126
Very Poor	124-157	126-161	130-163	131-159	131-154	130-151

Source: Age-adjusted standards based on guidelines published by YMCA.

2. Methodology:

2.1 Selection of Subjects:

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

2.2 Selection of Variables:

The selected variables were as follows:

Table-2
Abbreviation and Description of Selected Variables

S.No	Abbreviation	Description	S.No	Abbreviation	Description
1	AGE	Age in years	**14**	HRC1	heart rate change from HRmax to RcvHR1
2	HGT	Height in centimeters	**15**	HRC2	heart rate change from HRmax to RcvHR2
3	WGT	Weight in kilograms	**16**	HRC3	heart rate change from HRmax to RcvHR3
4	VO_2max	Maximal Oxygen Consumption	**17**	HRC4	heart rate change from RcvHR1 to RcvHR2
5	BslSBP	Basal systolic blood pressure	**18**	HRC5	heart rate change from RcvHR1 to RcvHR3
6	BslDBP	Basal diastolic blood pressure	**19**	HRC6	heart rate change from RcvHR2 to RcvHR3
7	MAP	Mean arterial pressure	**20**	PC1	Percentage change from HRmax to RcvHR1
8	PP	Pulse pressure	**21**	PC2	Percentage change from HRmax to RcvHR2
9	HRrest	Resting heart rate	**22**	PC3	Percentage change from HRmax to RcvHR3
10	HRmax	Maximum heart rate	**23**	PC4	Percentage change from RcvHR1 to RcvHR2
11	RcvHR1	Recovery heart rate 1 minute	**24**	PC5	Percentage change from RcvHR1 to RcvHR3
12	RcvHR2	Recovery heart rate 2 minute	**25**	PC6	Percentage change from RcvHR2 to RcvHR3
13	RcvHR3	Recovery heart rate 3 minute			

Total 25 variables have been selected for the study among which thirteen variables have been measured and six variables of heart rate change and six variables of heart rate percentage change have been computed.

2.3 Administration of Test:

For collecting the data of different heart rate variables, sensor of the heart rate monitor(Cardio-Sport heart rate monitor) with chest strap was comfortably fixed on the subject and plastic electrode on the reverse (inner side) of the strap was moistened with the ECG gel and it was ensured that whether the moist electrode areas were firmly attached to the skin of the subject and the connector was placed in the central and upright position so that a good heart rate signal could be detected for a reliable data.

2.4 Collection of Data:

The heart rate monitor wrist watch was tied after calibration to check the reading of the sensor strapped on the chest and monitor the heart rate of the subjects. Subjects were motivated to give their best effort and the data was collected using standardized step test protocol.

2.5 Statistical Analysis:

The collected data was computed with mean, standard deviation, coefficient of variance, percentage change. Levene's test have been done for checking the homogeneity of group variances and the variables have been compared on the basis of independent sample "t" test.

3. Result & Findings of the Study:

Table-3

Descriptive Statistics of the selected Variables of High and Low fitness Group in regard to Recovery Heart Rate (High Altitude 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	Height	172.23	5.68	3.30	170.43	6.50	3.81
3	Weight	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	HRmax	198.89	6.92	3.48	200.60	6.10	3.04
11	RcvHR1	155.69	7.14	4.58	158.34	10.36	6.54
12	RcvHR2	133.77	8.65	6.47	140.57	10.23	7.28
13	RcvHR3	113.91	7.66	6.73	126.63	9.42	7.44
14	HRC1	43.20	9.22	21.33	42.26	13.11	31.02
15	HRC2	65.11	9.47	14.54	60.03	13.09	21.80
16	HRC3	84.97	10.79	12.70	73.97	11.47	15.51
17	HRC4	21.91	7.03	32.09	17.77	5.01	28.17
18	HRC5	41.77	7.85	18.80	31.71	7.70	24.29
19	HRC6	19.86	6.20	31.21	13.94	4.63	33.19
20	PC1*	21.64	4.28	19.78	20.96	6.23	29.74
21	PC2*	32.70	4.44	13.57	29.82	6.03	20.23
22	PC3*	42.64	4.53	10.63	36.81	5.18	14.07
23	PC4*	14.06	4.40	31.31	11.22	3.03	26.99
24	PC5*	26.77	4.56	17.03	19.96	4.33	21.70
25	PC6*	14.74	4.46	30.23	9.87	3.15	31.89

N_1=35;N_2= 35; N_1+N_2 = 70

Where N_1= Number of subjects in high fitness group (HFG); N_2= Number of subjects in low fitness group (LFG).
Heart Rate is expressed in bts/min; *Expressed in percentage (%).

Table-4
Comparison Between High and Low Fitness Groups in regard to Maximum Exercise Heart Rate and Recovery Heart Rate (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	0.20	0.12
2	HGT	2.01 NS	1.23(NS)	68	1.8	1.45	0.15
3	WGT	0.44 NS	0.89(NS)	68	1.6	1.79	0.11
4	VO_2max	0.00 NS	**47.659***	68	14.92	0.31	**0.99**
5	BslSBP	**6.72***	0.76(NS)	59.13	2.31	3.04	0.10
6	BslDBP	3.09 NS	0.15(NS)	68	0.34	2.23	0.02
7	MAP	**5.26***	0.26(NS)	62.26	0.6	2.24	0.03
8	PP	0.00 NS	0.83(NS)	68	1.97	2.36	0.10
9	HRrest	0.65 NS	**-4.27***	68	-10.74	2.51	**0.46**
10	HRmax	1.85 NS	-1.09(NS)	68	-1.71	1.56	0.13
11	RcvHR1	**8.81***	-1.25 (NS)	60.34	-2.65	2.12	0.16
12	RcvHR2	1.24 NS	**-3.00***	68	-6.8	2.26	**0.34**
13	RcvHR3	2.29 NS	**-6.19***	68	-12.71	2.05	**0.60**
14	HRC1	**3.67***	0.34(NS)	61.01	0.94	2.70	0.04
15	HRC2	2.93 NS	1.86(NS)	68	5.08	2.73	0.22
16	HRC3	0.38 NS	**4.13***	68	11	2.66	**0.45**
17	HRC4	2.39 NS	**2.84***	68	4.14	1.45	**0.33**
18	HRC5	0.14 NS	**5.41***	68	10.05	1.85	**0.55**
19	HRC6	3.00 NS	**4.52***	68	5.91	1.30	**0.48**
20	PC1	**4.47***	0.53(NS)	60.24	0.68	1.27	0.07
21	PC2	2.79 NS	**2.27***	68	2.87	1.26	0.27
22	PC3	1.04 NS	5.01(NS)	68	5.83	1.16	**0.52**
23	PC4	2.78 NS	3.14(NS)	68	2.83	0.90	**0.36**
24	PC5	0.27NS	6.41(NS)	68	6.81	1.06	**0.61**
25	PC6	**4.24***	5.27(NS)	61.164	4.86	0.92	**0.56**

N_1= N_2=35; *= significant at 0.05 levels of significance, NS= insignificant

Table-4 documents the F- statistic of Levene's Test for checking the homogeneity of group variances. On the basic of Levene's test appropriate t-statistic (t-statistic with Equal variance assumed when Levene's test is not significant and t-statistic with equal variance not assumed when Levene's test is significant) has been selected and it was found to be statistically significant between HFG and LFG in regard to VO_2max (t = 47.66),(r=0.99); HRrest (t = -4.28),(r=0.46); RcvHR2 (t = -3.00),(r=0.34); RcvHR3 (t = -6.19),(r=0.60); HRC3 (t=4.13), (r=0.45); HRC4 (t= 2.84), (r=0.33); HRC5 (t= 5.41),(r=0.55); HRC6 (t= 4.52), (r=0.48); and PC2 (t = 2.27), (r=0.27). Moreover, although the two groups didn't showed a significant difference regarding the variables PC3, PC4, PC5 and PC6but three of them (PC3, PC5, PC6) show a high effect size of groups with values of r = 0.52, 0.61, 0.56 respectively and PC4 show a medium group effect size with r = 0.36.

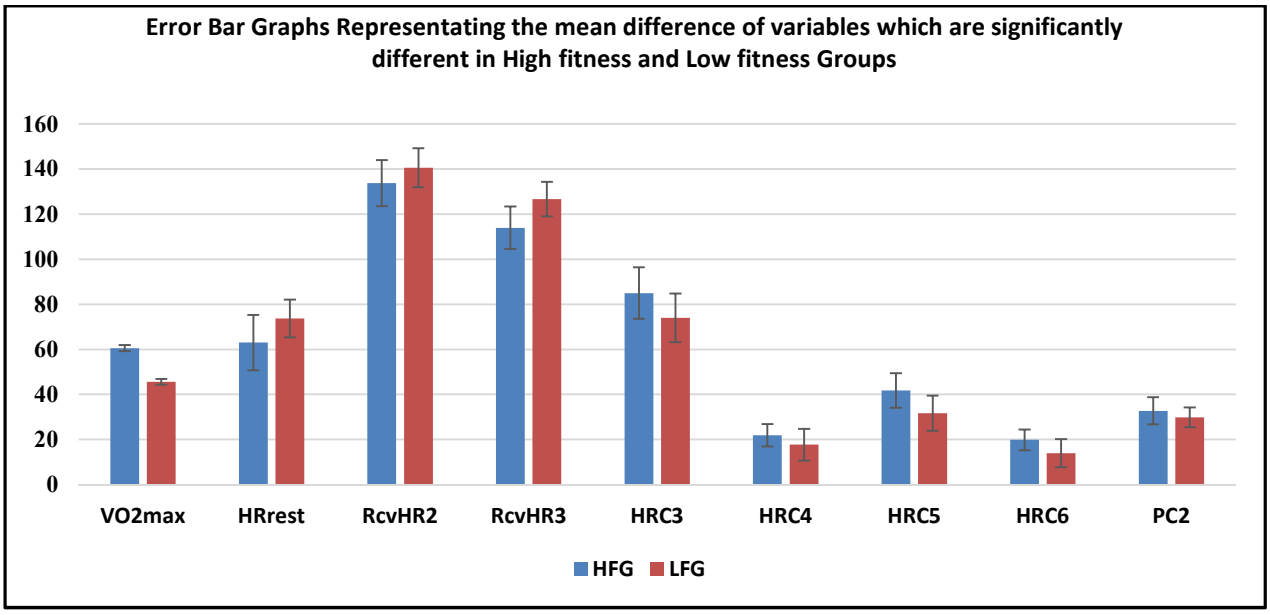

Figure 1. Showing the Difference in Mean Scores of HFG and LFG

4. Discussion of Findings:

The analysis of the tables (2-3) reveals that the recovery of heart rate from exercise heart rate (ExHR) was faster in High fitness group (HFG) than that of Low fitness group (LFG).

5. Conclusion:

It is concluded that HFG having better recovery pattern than that of LFG which corroborates the existing theories in regard to recovery heart rate.

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