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Research Article

THE PROFILE OF THE RELATIONSHIP BETWEEN EXERCISE INTENSITY INDEX IN AMATEUR MOUNTAINEERS

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ABSTRACT
Intensity of exercise is a primary component of exercise prescription and refers to the relative amount of energy required to perform an aerobic activities. The American college of sport Medicine (ACSM) suggests that a percentage of heart rate reserve (%HRR) provides the same intensity as the percentage of max oxygen uptake (Vo_2 max). But recently some studies demonstrated that while performing exercise by healthy people on sea level, the values for % HRR do not correspond to the values of % Vo_2 max, rather it was shown that %HRR ratio had overlap with % Vo_2 max. The purpose of this study was to estimate linear relationship pattern between exercise intensity indexes (% HRR , % Vo_2r , % Vo_2max) on sea level (1400 m) and altitude (4200m) conditions in the amateur mountaineers with physical characteristics of (age : 18-35 years old, weigh: 67.52 $\pm$ 1.45 kg, height: 172.45 $\pm$ 0.93 cm and mountaineering task history of 6.4 $\pm$ 0.35 years) that voluntarily participated. For each subject, HR and VO 2 and blood variables were measured at 2 different altitudes (sea level and 4200m) at rest condition and at the end of each stage of Astrand protocol (PWC 170) on ergometer bicycle. The findings indicated that at each stage of submaximal ergometery test, there was significant relationship about three work intensity indexes, between fewer than 1400m altitude (Kangavar city) and 4200m altitude (Damavand region). Nevertheless, the magnitude of these relationships was not high enough to make it possible to suggest a comprehensive predictor formula that can replace three indexes in hypoxia condition. % VO2R and % HRR linear regression patterns of mountaineers are not equivalent under 2 conditions of altitudes. Therefore Swain's hypothesis about relationship between work intensity indexes is not supported.

Keywords: *Altitude, Swain's Hypothesis, Work Intensity*

INTRODUCTION
During last 2 decades, hiking as an enlivening and interesting sport has classically obtained a particular place among countries. For this reason and along with development of this sport, several studies have been carried out about altitude factors affecting human body most of which have been carried out since Mexican Olympics Games. These studies have formed an appropriate background about physiological and biochemical interaction between environment and human and animal bodies and also about altitude sicknesses. Activity in high altitude¸ is accompanied by changes in environmental pressure. That is oxygen concentration decreases with increase in altitude. This partial pressure decrease of oxygen brings about the condition of altitude hypoxia that causes emerge of hypoxia physiological responses in body (Astrand, 1958; American College, 1990).These reaction scan appear as changes in hematological parameters such as hemoglobin, hematocrit, plasma volume, serum iron and enzymes that occur in the body of mountaineers (Davis, 1957).These changes along with changes in breathing pattern, heart rate and blood pressure, can have an decreasing effect on the performance of mountaineers and decrease their functional Capacity(VO_{2MAX}) and even result in types of mountain sicknesses (Milledge, 2000; Padilla, 1998). Exercise Intensity Index is the main component in any exercise eprescription program and refers to amount of energy needed for performing aerobic activities. Several physiologic and metabolic indexes have been suggested by sport physiologists in laboratory controlled condition as well as field condition to asses mechanical exercise intensity while having physical activities. The most important factors include: percentages of maximal oxygen uptake, maximal exercise heart rate, maximal heart rate reserve,

equivalent metabolic and recently percentage of oxygen consumption reserve (Acsm, 2000). American College of Sport Medicine (ACSM-1996) suggests that a percentage of heart rate reserve (HRR%) provides the same intensity as the percentage of max oxygen uptake (% VO_{2MAX}). Some of recent researches carried out on sea level conditions have revealed that while performing exercise on sea level the values of HRR% do not correspond to equivalent values of VO_{2MAX}% rather it was shown that the values of HRR% and VO_{2R}% are equivalent. Because of the increasing interest in mountaineering activities it is necessary that some of major changes that occur in bodies of mountaineers as a result of high altitude be examined while responding to aerobic exercises (PWC770) so that Exercise Intensity Indexes (HRR%, VO_{2MAX}%and VO_2R%) can be compared from organism response to maximal exercise point of view. Few researches have shown equivalent HRR% and VO_{2MAX}%. However, one study reported equivalence of HRR% and VO_{2MAX}% indexes (Panton, 1992). Davis has mentioned equivalence of HRR% and VO_{2MAX}% for 9 young healthy females performing exercise on treadmill when the subjects came to permanent heart rate (Davis, 1975). However in another study that was done on adults the overlap of HRR% and VO_{2MAX}% wasn't observed (Padilla, 1998; Pugh, 1957). Also in the research done by Belman and Gasear (1997). According to the importance of the subject and contradiction existing in previous studies, this research aimed contrast of exercise intensity indexes in altitude of 4200m 0f Damavand.

MATERIALS AND METHODS

Methodology

In present study which is an applied one, 21 men that were amateur mountaineers and their ages ranged from 18 to 37 years with average of weight 67.27kg and average of age27 years old and mountaineering task history of 6 years were selected randomly as the experimental group and 15 non-athlete men with average og age 23.93 years and average of weight 69.4kg were selected randomly as the control group. After filling the health questionnaires by subjects of both groups, and measuring their height, weight and body fat percentage measured rest heart rate and measuring maximal oxygen uptake with Astrand submaximal ergometer test and also measuring percentage of uptake oxygen reserve was with Karvonen equation of them.

Karvonen equation: %HRR = HR exercise – HR rest/ HR max – HR rest

48 hours after pre-test, the experimental group headed Damavand summit and after stoppage for rest at altitudes2300m, 2900m, 3300m and 3700m of Damavand and measuring systole and diastole blood pressures and rest heart rate, they settled at altitude 4200m. The second phase of implementing the Astrand submaximal test on the ergometer was carried out on the subjects at altitude 4200m on the second day of staying and after relative adaptation of subjects with the mentioned altitude. Pearson Correlation Coefficient and step wise multiple regression analysis test were applied for testing research hypotheses. Moreover, assumptions of applying parameter tests were examined using Kolmogorov- Smirnov test for distribution of data being normal and Levene statistic for Homogeneity of variance among groups. Data analysis was implemented using SPSS software.

Statistic Results

In present study, the relationship between three work intensity indexes was examined in hypoxia condition (in height 4200) in terms of physiological changes. Results of multiple regression analysis between selected exercise intensity indexes showed that submaximal body activity (PWC170) on sea level that is altitude 1400m, the VO_{2MAX}% index is a quite appropriate index for predicting the other scale of work intensity that is $VO_{2reserve}$% ($P < 0/05, r=0/75$).

The relationship between VO_{2MAX}% and $VO_{2reserve}$% in hypoxia condition (in height 4200) also show a significant correlation ($P < 0/05, r=0/746$).

A significant relationship was observed between VO_{2MAX}% and $VO_{2reserve}$% of mountaineers on sea level ($P < 0/05, r=0/48$) but this relationship is relatively lower than the relationship between $VO_{2\ Max}$% and VO_{2R}% indexes ($P < 0/05, r=75$). These indexes had also significant positive relationship at the time of ergometry standard submaximal activity in high altitude condition ($P < 0/05, r=0.60$) which was higher the relationship between the two index on sea level.

In addition, there was a relatively high level of relationship between these indexes in control group ($P < 0/05, r=0.80$) (tables 1 & 2).

The relationship pattern between VO_{2R}% and HRR% at altitude 4200m is linear but the level of correlation between these work intensity indexes isn't high enough to lead to the conclusion that HRR% scale is an equivalent for VO_{2R}% while performing submaximal activity and replace VO_{2R}% with HRR% at any given work intensity.

Table 1: The relation between work intensity indexes of mountaineers at sea level

Predictor equation	P value	T value	Coefficients Beta	B	Regression model	SE	R^2ADJ	R^2	R	Relationship between indexes
%VO2MAX=1/26+0/918(X)	000/0	116/ -1 967/0	752/0	262/ 1- 918/0	Constant coefficient ofvo2max	445/0	542/0	65/0	752/0	%VO2MAX %VO2R
%HRR=0/803+0/68(VO2MAX)	655/0 028/0	454/0 379/2	479/0	803/0 689/0	Constant coefficient ofvo2max	289/0	189/0	230/0	479/0	%VO2MAX %HRR
%HRR=0/730+0/286(VO2R)	006/0 004/0	09/3 34/1	450/0	730/0 286/0	Constant coefficient ofvo2R	760/0	290/0	324/0	57/0	%VO2R %HRR

Table 1: The relation between work intensity indexes of mountaineers at altitude 4200m

Predictor equation	P value	T value	Coefficients Beta	B	Regression model	SE	R^2ADJ	R^2	R	Relationship between indexes
%VO2R=0/354+0/79(X)	754/0 000/0	318/1- 884/4	746/0	354/0- 79/0	Constant coefficient ofvo2max	457/0	532/0	557/0	764/0	%VO2MAX %VO2R
%HRR=0/293+0/90(X)	875/0 003/0	159/0- 33/3	607/0	293/0- 902/0	Constant coefficient ofvo2max	757/0	336/0	369/0	607/0	%VO2MAX %HRR
%HRR=1/191+0/915(X)	340/0 001/0	978/0 822/3	659/0	91/1 915/0	Constant coefficient ofvo2R	21/1 239/0	405/0	435/0	659/0	%VO2R %HRR

Discussion and Conclusion

Results of this study show that exercise intensity is classically explained by VO_{2MAX}% and HRR% on exercise with assistant submaximal to exhaustive intensity .The linear pattern between changes of HRR and VO_2on exercise with assistant submaximal to exhaustive intensity, makes it possible to predict heart rate from exercise oxygen consumption and vice versa. Some of researchers prefer percentage of HRR in determining heart rate and believe that HRR relative scale has overlap with percentage of $VO_{2MAX.}$

Work intensity is obviously one of most important elements of exercise prescription in age range from teenagers to old people and is explained based on one of mentioned indexes: VO_{2MAX}%, VO_{2R}% and HRR%. Evidences from researches show that this index may differ depending on factors such as readiness level, drowth, age, temperature and partial pressure of the environment, body composition and type of illness.

Results of present research demonstrate no significant overlap or correlation between two indexes, the HRR% and VO_{2R}% while performing ergometer submaximal work (PWC170). Environment hypoxia and barometer pressure decline factors can affect correlation pattern between three work intensity indexes (VO_{2MAX}%, VO_{2R}% and HRR%).

Pollock (1998) and Swain (1997) mentioned that when exercise intensity adjusts in terms of oxygen consumption reserve, percentage value of VO_{2R} is almost equivalent with percentage of HRR (Welt, 1989). Application of VO_{2R}% factor increases accuracy of assessingVO_2 under any given work output of HRR particularly in unready people and beginners.

Results of this research were in contrast with results of Davis and Swain (1997) and Pollock (1998) (David, 1997). This contradiction might probably be due to difference between age range of subjects, their level of readiness and probably environment partial pressure. This study provided results compatible with results of Belman and Gaeser research.

According to results of present study, it was observed that no single comprehensive equation can be suggested to replace HRR%, VO_{2R}% and VO_{2MAX}% in hypoxia (hypoxic) environment.

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