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Effects Of Endurance Training At Moderate And Low Altitudes On Selected Physiological Variables

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Abstract:

The purpose of the study was to analyse the effect of Endurance Training On Selected Physiological Variables At Moderate And Low Altitudes. the endurance training program was designed after ten days of orientation to the training and physical activity to the participants. The dependent variables for the study were VO2 max, positive breath hold capacity and vital capacity. The duration of training program was 12 weeks. Descriptive statistics were used to describe important characteristics of the data. ANCOVA (analysis of covariance) was used as the statistical technique to compare the effects of training at moderate and low-level altitude on selected physiological variables. The results of the study indicated that there was a significant difference between the post test results of the selected physiological variables i.e. VO2 max, positice breath hold capacity and vital capacity after the endurance training at moderate altitude as compare to their low altitude counterparts.

Keywords: Endurance training, moderate altitude, low altitude, physiological variables, VO2 max.

Introduction

Sports have undergone an endless distance accompanied with latest scientific techniques and technological advances. To make progress, various exercise sciences have been discovered. In this connection, the exercise physiology has been the most demanding. Advance researchers, techniques, computer technology associated with bio-chemistry display examination of exercise effects at the cellular level within the muscles.

These days, one of the standard training protocol has been recognized as altitude training in mostly aerobic sports in order to enhance aerobic capacity at lower levels or in case where one has to compete at lower levels of ground (Wilber L, 2007).

After the Olympics were held in 1968, one of the options to enhance the performance was recognized as altitude training (Alvarez-Herms, 2015).

Exercising at altitude has become a modern trend. The performance varies at altitude and sea levels because one who is adapted to perform at sea level gives a different result at high altitude. That‘s why some athletes need greater preparation. Such preparations make athlete psychologically strong followed by his performance. This therapy initiated the use of training at high altitude and also in closed rooms where the presence of oxygen in the room can be affected by humans to give conditions like high altitude. The principal challenge that occurs by doing exercise at high altitude is a deficiency in the amount of oxygen reaching the tissues.

As far as the theoretical back ground of the effects of altitudes training is concerned, there are a number of studies which supports the notion that altitude training causes performance enhancing physiological adaptation (Mattila & Rusko, 1996 and Gore, 2001).

The duration for which the athletes are exposed to higher altitude generally has an impact on physiological adaptation; sudden expose has also been attributed for these changes. These short- term or long-term adaptation has a capacity to enhance performance of athlete at sea level. Basis of these changes are basically recognized as hematological (Levine and Stray-Gunder son, 1997) vantilatory (Townsend., 2016) cardiovascular (Naeiji, 2010). High altitude ranges from 1500-3000m. Very High-Altitude ranges from 3500-5500m. Extreme Altitude range above 5500m comes at extreme altitude. Disorders like hypoxemia, alkalosis and hypocapnia could occur at such level (Mount Everest). . As the altitude increases, the barometric pressure decreases resulting in a drop in oxygen level pressure (West, JB 1996) which causes hypobaric hypoxia with the drop in barometric pressure, the body natural protective system starts automatically also known as acclimatization. The VO2 7 max drops 2% at every 300m elevation above the height of 1500m and 7% drops at every 1000m (Smoliga, J 2009).

Although we have heard about the efficiency of hypoxic training for improving aerobic capacity since around 50 years, still it is pretty difficult to declare its effectiveness straightaway. There are number of studies which indicate that the altitude training has ergogenic effects towards sports performance (Mattile & Ruscko 1996 and Gore, 2001). But on the other hand various studies have produced contrasting results too. (Ashenden, 2000 and Hinckson, 2005. The research studies have also resulted in producing controversial results in terms of effects of altitude training on aerobic performance. A number of causes have been recognized which may be responsible for such difference such as differences in time of hypoxic stress, effect during practice session, the training model, training age of subjects etc. the procedures adopted and the techniques which are used by researcher also play an important role. Other studies in past have reported that there are no clear evidence that how effective are the physiological changes that occur at high altitude while performing in competition at sea level. It may be due to the reason that the training could not be done at higher intensity on high altitude. But the competitions at sea level require performance at high intensity. But at moderate altitude the subjects can perform training at higher intensities as compared to high altitude. It may be noted that training at moderate altitude may lead to changes which can sustained for longer periods. So, in the present study the researcher has made an effort to fill the gap in literature pertaining to training at moderate altitude. This study may help in the enhancement of knowledge according to training effects of moderate altitude.

Objectives of the study

In order to recognize the direction of efforts and to critically analyze the probable outcomes of the study the following objectives were laid down for the present study such as:

The prime objective of the study was to analyse the difference in the effects of endurance training at moderate and low altitudes.

To find out and explain the most suitable underlying factors which may be attributed to the change in physiological variables as a result of endurance training at low and moderate altitude.

Hypothesis

For the study it was hypothesised that there will be a significant difference due to the effects of endurance training at moderate and low levels altitude on selected physiological variables i.e. Vo2 max, Breath hold capacity, Vital capacity.

Methodology:

For the purpose of study twenty-four district level long and middle distance male runners, age ranging between fourteen to seventeen years were selected from two sports hostel of Uttarakhand through purposive sampling. Twelve runners from Maharana Pratap sports hostel Dehradun which is situated at low altitude around 600 meters above from sea level and twelve runners from sports hostel Pithoragarh which is situated at a Moderate altitude around 1550 meters above from sea level at Uttarakhand, India were selected.

Keeping in mind the purpose of the study pre and post-test random group design was used. In this design, by considering the effect of pre-test, which may have an effect on the post-test results, an effort is made to adjust the error variance accordingly. In the present study, the pre-test is considered as a covariate.

O	TREATMENT 1 (S1-S12)	O
O	TREATMENT 2 (S1-S12)	O

O = OBSERVATIONS

S = SUBJECTS

The design depicts that the pre-test for both the groups will be done before the initiation of the experimental protocol begins. After the cessation of treatment, the post-test data were recorded for all the selected dependent variables.

Collection of Data

All the selected subjects from both the altitude participated in 12 weeks of the training programme at their respective place and data has been collected before and after 12 weeks of the training programme. All the physiological testing was done by the research scholar along with some experts at both the altitudes. The testing of hematological variables was carried out in a pathology laboratory. Before the actual testing, the subjects were given a complete demonstration of each test and the purpose of the test was explained in detail. After the demonstration and explanation, the subjects were taken practice trials before final testing. The practice trials were given in order to prevent the effects of learning. The subjects were tested only during morning session for all the variables.

The training was carried out for five days a week for the 12-week duration for both the altitude. The training programme was same for both the altitude. Based on 10 days experimentation trial an expert's suggestion the training programme was given final shape.

Descriptive statistics were used to describe important characteristics of the data. ANCOVA (analysis of covariance) was used as the statistical technique to compare the effects of training at moderate and low-level altitude on selected hematological and physiological variables.

Results:

PRE AND POST DATA ANALYSIS ON VO2 MAX AT MODERATE AND LOW ALTITUDE LEVEL

	Moderate Altitude group	Low Altitude group	Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
Pre-test Mean	43.56	42.84	B:	3.09	1	3.09	.594
S.D	2.17	2.38	W:	114.58	22	5.20	

Post-test Mean **S.D**	47.36 2.06	45.03 2.08	B: W:	32.50 94.64	1 22	32.50 4.30	7.55*
Adj.Post Test Mean	4 7.06	45.33	B: W:	17.55 16.28	1 21	17.55 ..775	22.644*

Significant at 0.05 level.

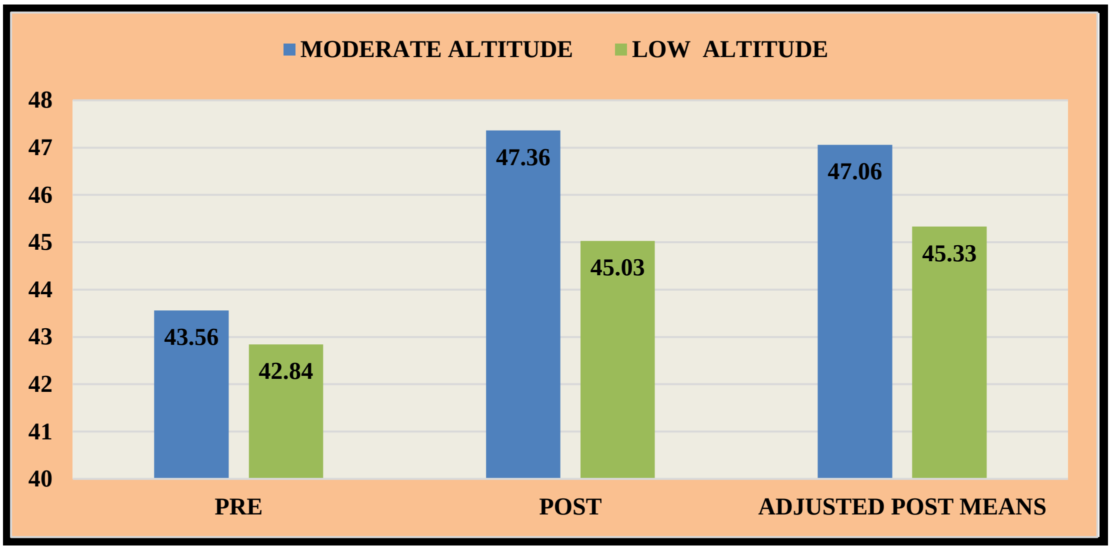
Table value for significance at 0.05 level with 1 & 22 and 1 & 21 degrees of freedom are – 4.30 and 4.47 respectively.

The above table shows the pre-test mean and standard deviation of a Vo2 max of moderate altitude and low altitude group are 43.56±2.17 and 42.84±2.38 respectively, resulting in an 'F' ratio of 0.594, which indicates insignificant difference between the pre-test means at 0.05 level of confidence as the calculated 'F' value 0.594 is less than the critical 'F' value 4.30 at 1 and 22 degrees of freedom.

The results also reveal that post-test mean and standard deviation of Vo2 max of moderate altitude and low altitude group are 47.36±2.06 and 45.03±2.08 respectively, resulting in an 'F' ratio of 7.55, which indicates that there is significant difference between the post-test means of moderate altitude and low altitude group at 0.05 level of confidence as the calculated 'F' value 7.55 is more than the critical 'F' value 4.30 at 1 and 22 degrees of freedom.

From the above table it is also evident that adjusted post-test means of scores of vo2 max of moderate altitude and low altitude group are 47.06 and 45.33 respectively, resulting in an 'F' ratio of 22.644, which indicates that there is significant difference between the adjusted post-test mean value of Both the training groups at 0.05 level of confidence as the calculated 'F' value 22.644 is more than the critical 'F' value 4.47 at 1 and 21 degrees of freedom. The pre-test, post-test and adjusted post-test mean values of a vo2 max of moderate altitude and low altitude group are graphically presented in the figure.

BAR DIAGRAM ON PRE TEST, POST TEST AND ADJUSTED MEANS OF VO2 MAX



PRE AND POST DATA ANALYSIS ON POSITIVE BREATHE HOLD CAPACITY AT MODERATE AND LOW ALTITUDE LEVEL

	Moderate Altitude group	Low Altitude group	Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
Pre-test Mean S.D	69.16 6.53	60.58 7.20	B: W:	442.04 1040.58	1 22	442.04 47.29	9.34 *
Post-test Mean S.D	87.25 7.71	72.25 7.61	B: W:	1350.00 1292.50	1 22	1350.00 58.75	22.97 *
Adj.Post Test Mean	83.17	76.32	B W:	197.73 354.90	1 21	197.73 16.90	11.70 *

Significant at 0.05 level.

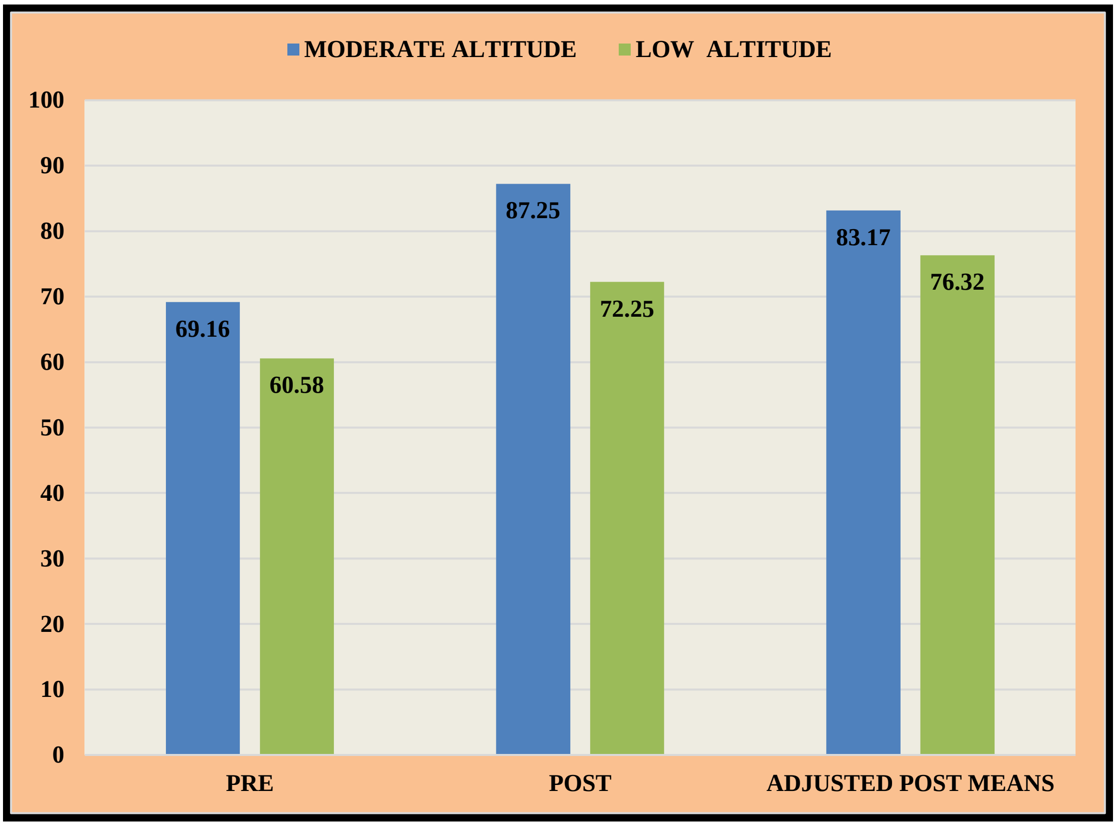
Table value for significance at 0.05 level with 1 & 22 and 1 & 21 degrees of freedom are – 4.30 and 4.47 respectively

The above table shows the pre-test mean and standard deviation of scores of positive breathe hold capacity of moderate altitude and low altitude group are 69.16±6.53 and 60.58 ±7.20 respectively, resulting in an 'F' ratio of 9.34, which indicates significant difference between the pre-test means at 0.05 level of confidence as the calculated 'F' value 9.34 is more than the critical 'F' value 4.30 at 1 and 22 degrees of freedom.

The results also reveal that post-test mean and standard deviation of positive breathe hold capacity of moderate altitude and low altitude group are 87.25±7.71 and 72.25±7.61 respectively, resulting in an 'F' ratio of 22.97, which indicates that there is significant difference between the post-test means of moderate altitude and low altitude group at 0.05 level of confidence as the calculated 'F' value 22.97 is more than the critical 'F' value 4.30 at 1 and 22 degrees of freedom.

From the above table it is also evident that adjusted post-test means of scores of positive breathe hold capacity of moderate altitude and low altitude group are 83.17 and 76.32 respectively, resulting in an 'F' ratio of 11.70, which indicates that there is significant difference between the adjusted post-test means of moderate altitude and low altitude group at 0.05 level of confidence as the calculated 'F' value 11.70 is more than the critical 'F' value 4.47 at 1 and 21 degrees of freedom. The pre-test, post-test and adjusted post-test mean values of positive breathe hold capacity of moderate altitude and low altitude group are graphically presented in the figure.

BAR DIAGRAM ON PRE TEST, POST TEST AND ADJUSTED MEANS OF POSITIVE BREATH HOLD CAPACITY



PRE AND POST DATA ANALYSIS ON VITAL CAPACITY AT MODERATE AND LOW ALTITUDE LEVEL

	Moderate Altitude group	Low Altitude group	Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
Pre-test Mean	3.46	3.29	B:	.189	1	.189	1.82
S.D	.32	.31	W:	2.27	22	.104	
Post-test Mean	4.06	3.62	B:	1.13	1	1.13	11.49*
S.D	.24	.37	W:	2.17	22	.099	

Adj.Post Test Mean	3.98	3.70	B: W:	.435 .437	1 21	.435 .021	20.89 *

Significant at 0.05 level.

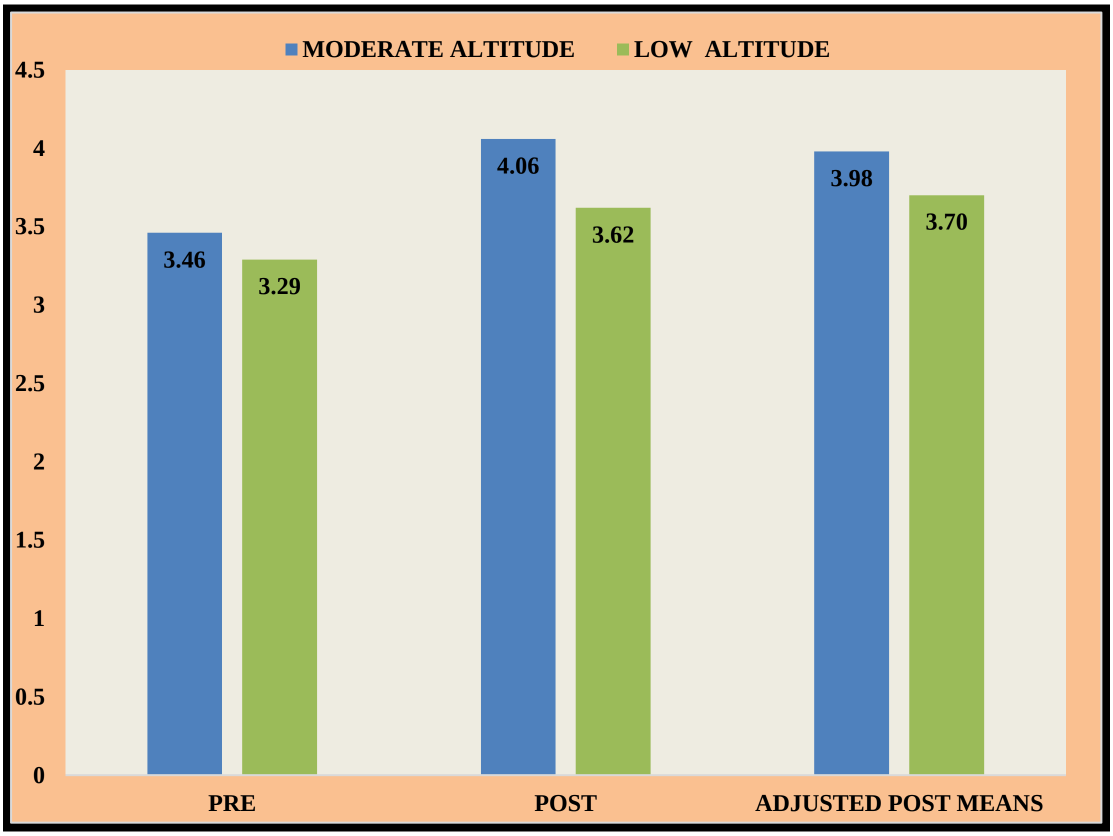
The table value for significance at 0.05 level with 1 & 22 and 1 & 21 degrees of freedom are – 4.30 and 4.47 respectively.

The above table shows the pre-test mean and standard deviation of scores of vital capacity of moderate altitude and low altitude group are 3.46±.32 and 3.29±.31 respectively, resulting in an 'F' ratio of 1.82, which indicates insignificant difference between the pre-test means at 0.05 level of confidence as the calculated 'F' value 1.82 is less than the critical 'F' value 4.30 at 1 and 22 degrees of freedom.

The results also reveal that post-test mean and standard deviation of vital capacity of moderate altitude and low altitude group are 4.06±.24 and 3.62±.37 respectively, resulting in an 'F' ratio of 11.49, which indicates that there is significant difference between the pre-test means of moderate altitude and low altitude group at 0.05 level of confidence as the calculated 'F' value 11.49 is more than the critical 'F' value 4.30 at 1 and 22 degrees of freedom.

From the above table it is also evident that adjusted post-test means of scores of vital capacity of moderate altitude and low altitude group are 3.98 and 3.70 respectively, resulting in an 'F' ratio of 20.89, which indicates that there is significant difference between the adjusted post-test means of moderate altitude and low altitude group at 0.05 level of confidence as the calculated 'F' value 20.89 is more than the critical 'F' value 4.47 at 1 and 21 degrees of freedom. The pre-test, post-test and adjusted post-test mean values of vital capacity of moderate altitude and low altitude group are graphically presented in the figure.

BAR DIAGRAM ON PRE TEST, POST TEST AND ADJUSTED MEANS OF VITAL CAPACITY



Discussion of Findings:

VO2 Max: It can be referred as the peak rate of consumption of O2 which is attainable during maximum exercise intensity. It is one of the most preferred measures of one's cardiovascular endurance capacity. In the present study, it is noted that the VO2 max capacity of participants increased significantly as a result of training at moderate altitude as compared to low altitude, in terms of mean value. This could be explained by following means:- As a result of exposure to the altitude, the stroke volume decreases and a decrease in maximum heart rate is also noted. Due to this the cardio output also decreases. The elevated demand for O2 during exercise is met out by increasing both the components. Due to regular strenuous training at altitude the total functional capacity of respiratory and cardiovascular system increases. So after the training, the VO2 max of athlete also increased.

Positive breath hold capacity: The positive breath hold capacity showed an improvement in the post test results of the high-altitude training group. The improvement in the positive breath hold capacity may be attributed to the reason that due to the training at altitude, there was an enhancement of storage capacity of myoglobin due to increased stress and natural response. Also, the improvements in the other lung capacities simultaneously contributed enhancement of breath hold capacity of the participants.

Vital Capacity: The measures of vital capacity depend upon the capacity of lungs to intake maximum air after forceful maximum exhalation. The vital capacity increases at moderate altitude due to training because of the lungs expanse CO2 at higher rates but are unable to intake air CO2. Due to reduced partial pressure. So in an effort to intake maximum O2 the strength in lung muscles increases and vital capacity increase.

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