



RESEARCH ARTICLE

EFFECT OF ALTITUDE TRAINING ON BODY COMPOSITION, SELECTED CARDIOVASCULAR PARAMETERS AND 1500 Mts PERFORMANCE AMONG TEEN AGE BOYS

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ABSTRACT

The purpose of the study was to find out the effect of altitude training on body composition cardiovascular parameters, and 1500 mts performance among teen age boys. To achieve this purpose, 45 male students were randomly selected. The age of the subjects were ranged from 15 to 18 years. The subjects were further classified at random into three equal groups of 15 subjects each namely Group - I (Control), group - II (EXP-I -underwent endurance training at altitude) and group - III (EXP-II-underwent endurance training at sea level) for five days per week for eight weeks. The selected criterion variables namely body weight, BMI, cardiovascular endurance, resting pulse rate and 1500 mts performance were assessed before and after the training period. The collected data were statistically analysed by using Analysis of Covariance (ANCOVA). When the F ratio of the adjusted post test mean was found to be significant, Scheffe's post hoc test was employed to find out the paired mean difference. All the data were analyzed using SPSS statistical package. From the results of the study it was found that there was a significant improvement on cardiovascular endurance, 1500 mts performance and significant reduction in body weight, BMI, resting pulse rate among the experimental groups when compared with the control group.

Key words: Altitude Training, Cardiovascular endurance, Body composition, 1500Mts performance.

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INTRODUCTION

The goal in competitive distance running is to run a given distance in the least time, or at least faster than the next best competitor (Barnes and Kilding 2014). Performance in endurance events is heavily dependent upon the aerobic re-synthesis of adenosine triphosphate (ATP), which requires an adequate delivery of oxygen from the atmosphere to the mitochondria, as well as the supply of fuel in the form of carbohydrate and lipid, in order to maintain a given velocity (Jones and Carter 2000). Endurance training aims to enhance the pathway for oxygen from the atmosphere to the mitochondria in four key areas- the pulmonary diffusing capacity, maximal cardiac output, oxygen carrying capacity of the blood, and skeletal muscle characteristics (Bassett and Howley, 2000).

Physiological adaptations in response to acute and chronic exposure to hypoxic environments are well-documented and range from short-term detrimental effects necessitating reduced training loads to longer-term adaptations that can improve performance at altitude and in sea-level competitions. Briefly, red blood cell (RBC) and hemoglobin (Hb) content appear to be major factors contributing to (but probably not solely responsible for) increases in maximal oxygen uptake (VO₂max) observed after altitude training. Additional contributing factors to performance changes after altitude/hypoxic training include ventilation (or the perception of ventilation/dyspnea), the ability to train in hypoxia, timing of return from altitude training before primary performance measures, and the mode of exercise utilized (e.g., swimming, running, cycling). Physiological acclimatisation to a chronically reduced Partial oxygen pressure, is a prerequisite to achieve optimal physical performance in environmental hypoxia (Daniels and Oldridge, 1970). The primary purpose of this study was to measure the effect of an endurance training program at moderate altitude on body weight, BMI, cardiovascular parameters and 1500 mts performance among

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teen age boys and comparing its outcome with a similar program conducted at sea level for similar population.

MATERIALS AND METHODS

Forty five teen age boys studying in different schools in Kozhikode volunteered to act as subjects of this study and their informed consent was obtained. A written explanation of the experimental procedure and potential risk factors were given to each subject. The age of the subjects were ranging from 15 to 18. The 45 subjects were randomly assigned to one of the three groups namely control Group ('CON', No: 15), experimental group-I, ('EXP-I', No: 15) and experimental group-II, ('EXP-II', No: 15). Physical examination and medical check-up at the initiation of the study yielded normal results in all the subjects and none of the subjects received any medication during the period of the study. The experimental group-I underwent an endurance training program at a place of moderate altitude (900 mts above sea level), experimental group-II underwent an endurance training program at sea level (30-42 mts above sea level) for a period of 8 weeks, whereas the control group maintained their regular routine activities.. The criterion variables selected for this study were body weight, body mass index (BMI), cardiovascular endurance, resting pulse rate and 1500 mts performance. The training protocol was planned keeping in the mind the subject's age, fitness level, and the environmental and climatic conditions. The type of activities included in this training program comprises of 10 min warm up, 10- 15 min free hand exercise, stretching, rotation activities, 25-40 min endurance development activities (repetition, slow continuous and varied pace methods) and 10 min of warm down. Even though no intensity was fixed, the subjects were asked to do their best within their safer limits and this process was repeated on a broader basis. Every training session started with instructions and motivation aiming towards getting the best results from the subjects. The duration of the training sessions were planned in such a way that there is a gradual increase in the training duration as the program progresses. At the start of the program it was 55 min and at the end of the program it was 90 min per session including a 30 min warm up and flexibility routine and a 10 min warm down phase.

The volume rather than the intensity of the training program was considered of prime importance to induce beneficial changes in the subjects. The selected variables were assessed by using standard measuring techniques four days before departure to altitude and the day after the return to sea-level for all the three groups. The conditions for both the pre and post training tests were nearly identical the data collected from experimental and control groups prior to and after completion of the training period on selected variables were statistically examined for significant differences if any, by applying Analysis of Covariance (ANCOVA). As both the groups (EXP and CON) were selected from the same population and no attempt was made to equate the groups on the selected dependent variables or any other common variables, initial differences may exist, and there is a possibility of affecting the posttest mean. For eliminating any possible influence of pre test means the adjusted posttest means of experimental and control group were tested for significance by using ANCOVA. When the F ratio of the adjusted post test mean was found to be significant, Scheffe's post hoc test was employed to find out the paired mean difference.

All the data were analyzed using SPSS statistical package. The level of confidence was fixed at 0.05 level of significance as the number of subjects was limited and also as the selected variables might fluctuate due to various extraneous factors.

RESULTS AND DISCUSSION

The pre test and post test means of the three groups (Con. Exp-I, Exp-II) for body weight does not show any significant difference as the obtained F-ratio of 1.98 and 0.97 is less than the required value of 4.08 whereas the adjusted post test for body weight among the groups shows a significant difference (92.65; $P > 0.05$). The pre test and post test means of the three groups (Con. Exp-I, Exp-II) for BMI does not show any significant difference as the obtained F-ratio of 2.64 and 0.74 is less than the required value of 4.08 whereas the adjusted post test for body weight among the groups shows a significant difference (49.22; $P > 0.05$). For cardiovascular endurance there is no significant difference at the pre test level whereas the post test as well as the adjusted post test means shows significant differences (19.32 and 275.3; $P > 0.05$). The pre test and post test means of the three groups (Con. Exp-I, Exp-II) for resting pulse rate does not show any significant difference as the obtained F-ratio of 0.34 and 3.93 is less than the required value of 4.08 whereas the adjusted post test for body weight among the groups shows a significant difference (16.17; $P > 0.05$). As far as 1500 mts performance is concerned there is no significant difference at the pre test level whereas the post test as well as the adjusted post test means shows significant differences (6.83 and 22.02; $P > 0.05$) as the obtained F-ratio was higher than the required value of 4.08. As the F ratio of the adjusted post test mean was found to be significant, Scheffe's post hoc test was employed to find out the paired mean difference. But from the results of the test of the three paired mean differences (Con Vs Exp -I, Con Vs Exp -II and Exp -I Vs Exp -II) for all the variables (except for BMI) namely body weight, cardiovascular endurance, resting pulse rate and 1500 mts running performance were less than the required confidence interval of 2.09, 437.11, 2.68 and 0.79 respectively. Only the mean difference between Control group and experimental group-II for BMI shows a significant difference as the obtained value of 0.71 is greater than the required confidence level of 0.70. Success in elite level middle- and long-distance running involves both aerobic and anaerobic metabolism (Brandon and Boileau 1992). Consequently, middle- and long-distance runners use a variety of training methods that lead to different adaptations (Rabadán *et al.*, 2011). The basic premise of altitude training is that when an athlete ascends from sea level to moderate altitude, the decrease in partial pressure of oxygen (PO₂) initially impairs endurance training and performance. (Bonetti and Hopkins 2009). Altitude is characterized by hypoxia, low temperature, and low atmospheric pressure. Many researchers focused on hypoxia aspect of physiological response, since this component exerts potent effect on human metabolism and there also seems to have further and independent benefits from the practice of physical exercises and improvement of the aerobic condition (Mysers *et al.*, 2002; McGinnis and Foegen, 1993) which speaks for their being practiced more and more frequently. The hypoxia conditions prevailing at places of altitude places additional demand for energy and most of which is derived through fat metabolism which is supported by earlier findings (Salah *et al.*, 2012). The reduction in body weight and the corresponding reduction in BMI noticed in this study is mainly due this.

Table 1. Analysis of Covariance For The Selected Variables Among Experimental Group I.II& Control Groups

Bodyweight		Control Group	Experimental Group-I	Experimental Group-II	F-Ratio
Bodyweight	PRE TEST	50.73(6.75)	52.87(8.11)	56.80(10.19)	1.98
	POST TEST	50.80(6.64)	51.23(7.60)	54.53(9.60)	0.97
	AD PO TEST	58.60	56.01	38.47	92.65(P>0.05)
BMI	PRE TEST	18.10(1.48)	19.43(1.78)	19.62(2.51)	2.64
	POST TEST	18.12(1.42)	18.83(1.63)	18.84(2.34)	0.74
	AD PO TEST	19.10	18.48	18.31	49.22(P>0.05)
Car vas endurance	PRE TEST	2306.(276)	2362.(154)	2189(260)	2.12
	POST TEST	2345(266)	2827(116)	2436(262)	19.32(P>0.05)
	AD PO TEST	2327	2755	2626	275.2(P>0.05)
Resting Pulse Rate	PRE TEST	61.00(3.40)	60.07(2.19)	60.60(3.60)	0.34
	POST TEST	60.27(3.73)	57.27(2.82)	57.27(3.62)	3.93
	AD PO TEST	59.84	57.74	57.42	16.17(P>0.05)
1500 mts Performance	PRE TEST	6.13(0.46)	6.15(0.40)	6.13(0.41)	0.02
	POST TEST	6.25(0.52)	5.52(0.34)	5.85(0.45)	6.83(P>0.05)
	AD PO TEST	6.26	5.51	5.86	22.02(P>0.05)

Table 2. The Pre and Post Test Means of Experimental Group I.II and Control (CON) Groups with Percentage of Gain

Bodyweight		PRE TEST	POST TEST	Gain	Percentage of Gain
Bodyweight	Control	50.73(6.75)	50.80(6.64)	+0.07	0.13% ↑
	Experimental-I	52.87(8.11)	51.23(7.60)	-2.07	3.91% ↓
	Experimental-II	56.80(8.11)	54.53(9.60)	-2.27	4.00% ↓
BMI	Control	18.10 (1.48)	18.13±1.42	+0.03	0.17↑
	Experimental-I	19.43(1.78)	18.84(1.63)	-0.59	3.04↓
	Experimental-II	19.62(2.51)	18.84(2.34)	-0.78	3.97↓
Cardiovascular endurance	Control	2306.(276)	2345(266)	+0.15	0.01% ↑
	Experimental	2362.(154)	2827(116)	+465	19.69% ↑
	Experimental-II	2189(260)	2436(262)	+247	11.28% ↑
Resting Pulse Rate	Control	61.00(3.40)	60.27(3.73)	-0.73	0.11% ↓
	Experimental	60.07(2.19)	57.27(2.82)	-2.80	4.61% ↓
	Experimental-II	60.60(3.60)	57.47(3.62)	-3.13	5.16↓
1500 mts Performance	Control	6.13(0.46)	6.25(0.52)	+0.12	1.96↑
	Experimental	6.15(0.40)	5.52(0.34)	-0.63	10.24↑
	Experimental-II	6.13(0.41)	5.85(0.45)	-0.28	4.6↑

Table 3. Scheffe's Test For Differences Between the adjusted post test paired means

	Adjusted Post test mean difference			Confidence Interval
	Con Vs Exp -I	Con Vs Exp -II	Exp-I Vs Exp-II	
Bodyweight	2.03	1.59	0.44	2.09
BMI	0.53	0.71*	0.17	0.70
Car vas endurance	428.58	199.90	228.68	437.11
Resting Pulse Rate	2.10	2.42	0.32	2.68
1500 mts Performance	0.76	0.40	0.36	0.79

The main aim of altitude training is to increase the total volume of red blood cells and haemoglobin mass to improve the limiting link (i.e. oxygen delivery) by increasing the arterial blood oxygen-carrying capacity, and thus increase VO₂max and improve performance both at sea level and at altitude. The increase in VO₂ max will directly influence the cardiovascular efficiency and hence the improvement in cardiovascular endurance. This finding is in conformation of the findings of Vargese *et al.* (2010). Earlier studies further supports training at altitude helps to improve running performance (Daniels,1998; Saunders *et al.*, 2012; Saunders *et al.*, 2004) and similar increase in 1500 mts performance was noted in this study which is supported by the findings of McConell and Romer, (2004); Martin *et al.*, (2012) and Roohollah and Shadmehr (2016). From the findings of earlier studies it is understood that maximal HR does not tend to change, whereas somewhat smaller values may be seen in rest and, especially,

during submaximal exercise (Fox *et al.*, 1975) and similar reduction was noted in this study also.

Conclusion

It is concluded from the obtained results and interpretations that endurance training at moderate altitude resulted in a significant reduction in bodyweight, BMI, resting pulse rate and a significant increase in cardiovascular endurance, 1500 mts performance among teen age boys.

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