Effect of Aerobic Exercise on Haemoglobin and % Saturation of Haemoglobin in Untrained (Medical Students) and Trained Subjects

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Abstract: <u>Background</u>: Physical fitness is required not only by athletes for better performance but also by non-athletes for maintenance of physical and mental health. <u>Objective</u>: The aim of the study was to assess the role of aerobic exercise on Haemoglobin and % Saturation of Haemoglobin among untrained and trained subjects. <u>Methods</u>: The present study was conducted in the Department of Physiology, Dr. S.N. Medical College, Jodhpur after ethical approval. Informed written consent was obtained from all the subjects included in the study. In this study total 200 male subjects were included, which were further divided in two groups. <u>Group II</u>: included 100 randomly selected untrained male subjects (medical students) at the beginning of their training period. <u>Group II</u>: 1t included the same 100 healthy medical students, as in group I, but after their training period of 3 months duration. <u>Group III</u>: 100 randomly selected male Athletes participating in city/district/state competition constituted the trained group. All the subjects in untrained group participated in aerobic exercise for three months. Untrained Subjects were assessed for haemoglobin with the help of complete blood cell count from Automated Hematology Analyzer (Sysmex 5-part fully automatic analyzer xs-800i.Japan) and % Saturation of Haemoglobin with the help of pulse oximeter, before and after training. Values obtained were compared with data obtained from athletes. <u>Result</u>: Aerobic exercise is a physiological stress to body which is healthy and improves the body's ability to use oxygen and regular exercise is important for health and well being.

Keywords: Aerobic Exercise; Medical Education Group; Haematology Parameters

1. Introduction

Aerobic exercise is physical exercise of relatively low intensity that depends primarily on the aerobic energy-generating process. ¹ Aerobic means "with oxygen", and refers to the use of oxygen to adequately meet energy demands during exercise via aerobic metabolism. ² The term and the specific exercise methods were developed by Kenneth H. Cooper and Col. Pauline Potts, a physical therapist, in the United States Air Force.

Most of medical students lead a physically inactive life, probably because heavy academic demands of medical college may cause medical students exhausted or may leave no time to exercise. Recently MCI has made changes in the curriculum of MBBS students including sports as essential part of it.

Athletes on the other hand lead a physically active life as their academic curriculum itself includes daily physical exercise and outdoor games. An impressive accumulation of research data over the past three decades has documented that regular exercise is important for health and well being and physical inactivity is a major health problem. Compelling evidence suggests that physical inactivity is contributing factor in several chronic diseases and conditions.³

- Physiology of Exercise offers the student an opportunity to observe the effect of training and helps to evaluate the changes in Haematology Parameters with it.
- This has created a great enthusiasm in our mind to undergo this study. The present study was undertaken to investigate effect of aerobic exercise on Haematology Parameters in trained and untrained exercise performers.

2. Design of the Study

The present study was conducted to assess and compare important Haematology parameters between students of Medical College and Athletes of Sports Authority of India.

In the present study, none of the ME students gave history of regular physical exercise in the past 9 months where as all the athletes gave history of regular exercise for about 2-4 hours/day for six days a week.

Exclusion Criteria: Subjects suffering from asthma, chronic bronchitis, tuberculosis, muscular, neurological disorder and cardiovascular disease were excluded from the study. At the onset of study written consent was obtained from the participating subjects after explaining the purpose of the study and outcome.

The present study was carried out in the Department of Physiology, Dr. S. N. Medical College Jodhpur on 200 volunteers in the age group 18-26, on male subjects. All the subjects were then divided into three groups.

Group I: It included 100 randomly selected untrained male subjects (medical students) at the beginning of their training period.

Group II: It included the same 100 healthy medical students, as in group I, but after their training period of 3months duration.

Group III: 100 randomly selected male Athletes participating in city/district/state competition constituted the trained group. Trained group (Athletes) performed daily, sports activity and untrained group performed aerobic exercise for one hour under the guidance of qualified instructors for three months.

All the subjects in both the group were subjected to various anthropometric measurements and haematology parameters were recorded with the help of complete blood cell count from Automated Hematology Analyzer (Sysmex 5-part fully automatic analyzer xs-800i.Japan) before and after training. Based on observations obtained before and after training, statistical analysis was done and a comparison was done between trained and untrained group (after 3 months of aerobic exercise) to assess, impact of aerobic exercise on untrained subjects (medical students).

3. Observation and Results

The present study was conducted in three groups. Group I: (n=100) randomly selected untrained male subjects (medical students) at the beginning of their training period and Group II included the same 100 healthy medical students, as in group I, but after their training period of 3 months duration. Group III (n=100) randomly selected male Athletes.

Table I shows the comparison of mean values of haematology parameters in resting and after three months of physical activity in untrained subjects and obtained values are compared with the data obtained from the trained subjects.

Results were presented as Mean \pm SD. For statistical analysis students–t test was used. A significance level of p< 0.05 was chosen.

Table 1. Comparison of fractitationagy rarameters in unitalitied and trained subjects										
		Untrained group	Untrained group	Trained group	p value					
	/	(n=100)	(n=100)	(n=100)						
Parameters	/	Initial	After 3 months	mean±SD	GI&GII	GI & GIII	GII &GIII			
		mean±SD	mean±SD	(Group III)						
	/	(Group I)	(Group II)							
Hb (gm %)	Pre	14.56±1.28	15.99±1.06	13.16±1.03	< 0.0001	< 0.0001	< 0.0001			
	Post	14.65±1.32	16.26±1.54	12.54±0.99	< 0.0001	< 0.0001	< 0.0001			

Table I: Comparison of Haematology Parameters in untrained and trained subjects

Note – All values are showed as Mean ± SD; p value >0.05 (NS) *, p<0.05 (S)**, p<0.01 (HS)*** ; Abbreviation – Haemoglobin(Hb)



Table II: Comparison of Haematology Parameters in untrained and trained subjects

		Untrained group	Untrained group	Trained group	p value		
		(n=100)	(n=100)	(n=100)			
Parameters		Initial	After 3 months	mean±SD	GI&GII	GI & GIII	GII &GIII
		mean±SD	mean±SD	(Group III)			
		(Group I)	(Group II)	_			
% Saturation of Hb	Pre	97.16±1.14	97.45±1.05	96.87±0.98	0.04	0.05	< 0.0001
	Post	96.13±1.50	96.39±1.42	95.98±1.08	0.20	0.42	0.02

Note – All values are showed as Mean \pm SD ; p value >0.05 (NS) *, p<0.05 (S)**, p<0.01 (HS)*** ; Abbreviation – % Saturation of Haemoglobin

International Journal of Science and Research (IJSR) ISSN: 2319-7064 ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426



4. Discussion

Physical fitness is required not only by athletes for better performance but also by non-athletes for maintenance of physical and mental health. Heavy academic workloads in medical college make it difficult for medical students to maintain a regular exercise program.

In our study the trained group (resting) values of haemoglobin (13.16±1.03 v/s 14.56±1.28 gm%) and % saturation of Hb (96.87±0.98 v/s 97.16±1.14 %) were significantly lower than the untrained group (p<0.0001). The results of the present study support the findings reported by a number of authors³⁻⁷ that the major red blood cell variables undergo a change in athletes. All early and late changes in the haematological variables after acute intensive physical exercise regardless of its characteristics (aerobic, anaerobic, or mixed) are caused by factors associated mainly with the processes of haemoconcentration and haemodilution and with changes in the plasma catecholamine concentration and the consequences of these. In chronic daily exercise, continuing for years, changes in red blood cell variables coexist (over the whole period) with training, and the mechanisms involved are probably quite different: chronic intravascular haemolysis, which is associated with strength sports, and changes in serum erythropoietin concentration. A correlation exists between the length a sport had been practiced and the degree of reduction in red blood cell count, packed cell volume, and haemoglobin concentration in pubescent athletes.

In our study increased heamatological parameters {Hb $(14.56\pm1.28 \text{ to } 15.99\pm1.06 \text{ gm}\%)$ and % saturation of Hb $(97.16\pm1.14 \text{ to } 97.45\pm1.05 \%)$ } in case of untrained subjects after 3 months of training can be explained as some amount of formed elements of blood always remain stored in liver, lungs, spleen and bone marrow. They do not normally form the part of general circulation when there is greater demand for Oxygen during exercise this reserve is put into Circulation. It has been reported that during exercise in man the spleen can expel 110 to 258 ml of blood into the general circulation. The blood in the spleen is more concentrated and contains as much as 40% more red blood cells than normal blood.

Arguments for hypoxia as the relevant trigger for exercise induced erythropoiesis are sparse, and are at best indirect. Even during heavy exercise there is only a small decrease in arterial PO₂ that by it will barely be sufficient to cause relevant renal EPO production. There is, however, a considerable decrease in renal blood flow with increasing exercise intensity that decreases renal O₂ supply (Laughlin et al., 2012).⁸

The O_2 supply to renal tubules might be further decreased, because renal cortical arteries and veins run parallel allowing exchange diffusion of O₂ that may cause arterial deoxygenation. PO₂ in cortical veins is low because of the high oxygen consumption required for Na⁺ and water reabsorption of renal cortical epithelial cells (Eckardt and Kurtz, 2005).⁹ It can therefore be speculated that the decreased flow during exercise further decreases renal cortical PO₂ to a level causing significant hypoxia of the peritubular, EPO producing fibroblasts during exercise, and that this effect is aggravated as exercise intensity increases. Interestingly, training attenuates the decrease in renal blood flow, which seems more pronounced following endurance than high-intensity interval sprint training in rats (Musch et al., 1991; Padilla et al., 2011), ^{10, 11} which might explain the weak erythropoietic response in highly trained athletes.

A variety of humoral factors known to affect erythropoiesis also change during exercise. Androgens are long known for their stimulatory effect on erythropoiesis by stimulation of EPO release, increasing bone marrow activity, and iron incorporation into the red cells, which is best indicated by polycythemia as a consequence of androgen therapy (Shahidi, 1973; Shahani et al., 2009).¹², ¹³

Endurance exercise and resistance training cause a transient increase in testosterone levels in men and women (Hackney, 2001; Enea et al., 2009).^{14, 15} Post-exercise values vary with exercise intensity in both genders. Interestingly, post-exercise testosterone levels also directly change with mood (win vs. loss), which seems more pronounced in men than women (for review see Shahani et al., 2009).¹³ Stress hormones such as catecholamines and cortisol stimulate the release of reticulocytes from the bone marrow and possibly also enhance erythropoiesis

(Dar et al., 2011; Huand Lin, 2012).^{16, 17} Erythropoiesis is also stimulated by growth hormone and insulin- like growth factors (Kurtz et al., 1988; Christ et al., 1997)^{18, 19} which also increase during exercise (Hakkinen and Pakarinen, 1995; Schwarz et al., 1996).^{20, 21}

In our study, aerobic exercise resulted in increment of resting value of % saturation of Hb with training in untrained. (97.16 \pm 1.14 to 97.45 \pm 1.05 %; p= 0.04). Trained groups resting (96.87 \pm 0.98 %) and post exercise (95.98 \pm 1.08 %) value were significantly (p<0.05) less than untrained, proving that if exercise is continued to the point of exhaustion, saturation of Hb may diminish.

It was proposed that in moderate exercise for normal individuals, at sea level, the amount of oxygen diffusion is more than sufficient to compensate for the increasing circulation rate. However, when the exertion is of an exhausting character, the volume of blood flow may increase to an extent proportionately greater than the increase in oxygen diffusion and the saturation of hemoglobin might diminish, as is seen in case of trained subjects in our study.

In general, a >5% decrease in the pulse oximeter estimate of arterial saturation during short duration clinical CPX protocols is suggestive of abnormal exercise-induced hypoxemia, consistent with symptomatic pulmonary disease.²² Nonetheless, O_2 desaturation is possible in elite athletes. Endurance athletes with high cardiovascular capacity can demonstrate O_2 arterial desaturation (as much as 5%-10% from baseline) during sustained heavy intensity exercise. Thus, changes in arterial oxygenation do not always denote pathology.

5. Conclusion

- The present findings indicated that training has effects on red blood cell variables. The values of hemoglobin concentration and % saturation of hemoglobin were significantly lower among trained subjects than their sedentary counterparts. Such reductions of red blood cell variables among trained subjects are significantly correlated with duration of the training period.
- In untrained subjects the resting, immediately after termination of exercise and with regular practice of aerobic exercise, increase in values of hemoglobin concentration and % saturation of hemoglobin was seen. Indicating that the exercise is a physiological stress to body which is healthy and improves the body's ability to use oxygen and defense mechanism.

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Volume 8 Issue 7, July 2019

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