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Impact of endurance training program on body composition and blood glucose among B.P.ED. Students of C.C.S. University

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Abstract
The aim of the present study was to determine the effect of endurance training on body composition, cardiovascular endurance and blood glucose among B.P.Ed. Students of C.C.S. University, Meerut. A total number of 40 male B.P.Ed., students volunteered for the study and they were randomly assigned to either experimental Group ("EXP": N = 20) or Control Group ("CON": N=20). Physical examination and medical check-up at the initiation of the study yielded normal results in all subjects and none of them received any medication during the period of the study. The experimental group underwent an endurance training program of sloe jogging for a period of 8 weeks, whereas the control group maintained their regular routine activities. The training load was gradually increased with the number of weeks. The subjects of both the groups were tested on body weight, BMI, and fasting blood sugar 24 hours before and after the period of experimentation. The collected data were statistically analyzed by using analysis of covariance (ANCOVA) and the data was analyzed in SPSS statistical computer package. The results of the study showed that there was significant difference among the adjusted post-test mean of experimental group and control group in body weight and BMI with no change in Blood Glucose.

Keywords: Endurance, body composition, blood glucose

Introduction
Endurance training is the act of exercising to increase endurance. The term endurance training generally refers to training the aerobic system as opposed to the anaerobic system. The need for endurance in sports is often predicated as the need of cardiovascular and simple muscular endurance, but the issue of endurance is far more complex. Endurance can be divided into two categories including: general endurance and specific endurance. It can be shown that endurance in sport is closely tied to the execution of skill and technique. A well-conditioned athlete can be defined as, the athlete who executes his or her technique consistently and effectively with the least effort. Key for measuring endurance are heart rate, power in cycling and pace in running.

Endurance sports are activities which are performed during longer time interval and which prevailingly use aerobic metabolism involvement. Aerobic metabolism prevails during physical exercise which is longer than 2-3 minutes at a low, middle or submaximal intensity load. Exercise used are usually locomotion's or repeated cyclic movements. Many scientific works proved that aerobic endurance may last for a longer time before fatique appears and that it can last even in the state of fatique. Also recovery rates are highly related to quality of endurance abilities and faster recovery allows the athlete to shorten rest intervals within and between training sessions and increase overall training load.

The most recognized model of endurance abilities physiology is the Cardiovascular/Anaerobic model, initially suggested by British physiologists A.V. Hill and associates in the mid-1920s. This model basically posits that a lack of oxygen in working muscles is what ultimately limits exercise performance. The cause of fatigue is primarily in cardiorespiratory system and utilization of oxygen. Most adherents to this model use the terms of VO_2 max, lactate threshold, and running economy when discussing aerobic or endurance training or physiology. Thanks to the new knowledge's from this field of exercise physiology were made several new

models from various points of view, e.g Neuromuscular fatigue model, Muscle trauma model, Biomechanical model, Thermoregulatory model, etc. Every of these models have wanted to supplement the initial model of Hill. The most complex revised physiological model proposed Nakes (2002) as a Central Governor Model. He draw from the original cardiovascular anaerobic model and four additional models that regulate short-time, maximal or long-time submaximal exercise. The basis of this idea is that fatigue is caused by CNS, which is not able to activate muscles to following activities or activities on a desired level. The brain protects the body by regulating power output during any form of exercise with the ultimate goal of maintaining homeostasis and protecting life. Muscle fibre power output is not regulated by factors in the muscle itself but in the brain based on continuous information from senses of the whole body. Fatigue is a relative process and as a consequence of it the exercise intensity is constantly changed during exercise as the brain either employs additional fibres to increase power output or to decrease fibre activation to adjust power output (energy) based on its calculations.

The quality of endurance performance is limited by a number of factors out of which the most important are those which are related primarily to oxygen transport, energy utilization (cardiorespiratory system, blood volume, total mass of haemoglobin, oxidative enzymes, fat utilization etc.) and to neuromuscular function and economy of movement (quality of CNS and peripheral nerves, strength, speed, endurance, coordination, technique, performance) and quality of this factors can be called a physiological profile of an athlete.

For training needs, endurance can be divided into four groups according to dominant metabolism which supplies energy to muscles:

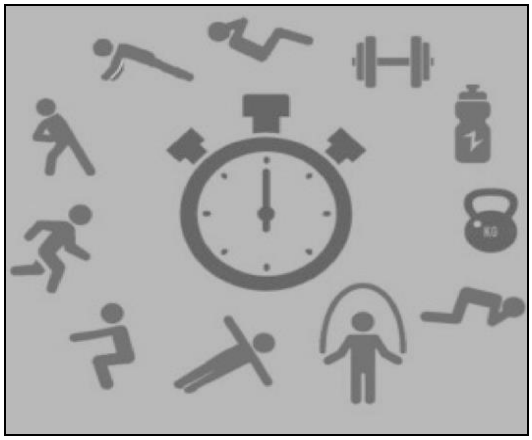

Fig 1: Endurance can be divided into four groups according to dominant metabolism which supplies energy to muscles

- **Speed endurance:** duration 20-30 seconds, alactate anaerobic metabolism is the basic energy system ensuring motor activity at the start of movement (phosphagen system).
- **Short-time endurance:** between 30 seconds and 2 (3) minutes, motor activity of high intensity is primarily supplied with energy by anaerobic lactate system (fast glycolysis).
- **Middle-time endurance:** between 2 (3) minutes and 8-10 minutes, from this period on, aerobic system is dominant but the portion of anaerobic lactate metabolism can still be big (fast and slow glycolysis).
- **Long-time endurance:** from approx. 10 minutes till several hours. Motor activity is ensured by aerobic energy system from more than 90% (oxidative system).

Aerobic and Anaerobic Threshold

As we proceed from walking to jogging and further to running and sprinting, we gradually employ slow and then fast muscle fibres. The start of the exercise involves mostly aerobic energy system, than slowly anaerobic system is activated until it finally becomes dominant, the fibers create lactic acid (LA) the increase in which causes an unpleasant feeling in the muscles and we are forced to slow down or stop. Aerobic threshold (AT) and anaerobic threshold (ANT) represent for us a transition zone which means increasing share of anaerobic energy metabolism.

AT defines the top of easy training load and is defined as the point where LA begins to rise, usually around the level of 2-3 mmol/L. ANT is the point beyond which LA levels rise steeply. Such a range is called maximal lactate steady state (MLSS) and can vary between 3-8 mmol/L depending on every individual. An athlete can move for several hours at AT, but beyond ANT fatique appear quickly. It is the upper limit for utilizing lactate from the muscle and transition zone in which fibers of the II type (fast fibers) get involved more and more. With proper training system, it is possible to increase the intensity or velocity at the level of both thresholds. The level of ANT is highly related to success in events lasting for 15 minutes or more, such as longer running, swimming, cross country-skiing, rowing or cycling and is important for all endurance sports.

The value of proper exercise for the total effectiveness of the individual has been well documented, as has been the need for a physically active life style in our sedentary society despite that doing ones job today requires a minimum of strength and endurance. Excellent cardio respiratory condition reflects a stronger heart, good blood vessels and properly functioning lungs. Body activities performed over long period as walking, riding, running and swimming improve cardiovascular condition. The condition of the cardio-respiratory system is generally a good indicator of endurance of total body and regular physical activity can improve people's overall health and reduce various risks for morbidity and mortality due to a sedentary lifestyle [1]. Regular exercise has been reported to improve cardiopulmonary function and reduce the risk factors of cardiovascular diseases [2]. Bouchard and Shepherd (1993), identifies important aspects of health related fitness which includes factors such as body composition, sub continuous fat distribution, (abdominal or visceral) fat, bone density, strength and endurance of abdominal and dorsa lumbar muscles, heart and lungs functions, blood pressure, maximum aerobic power and tolerance to sub-maximal exercise, glucose and insulin metabolism, blood lipid and lipo-protein profile, and the ratio of lipid to carbohydrate oxidized in a variety of situations [3]. A favorable profile for these various factors presents clear advantages in terms of health outcomes is accessed by morbidity and mortality statistics. Glucose is a monosaccharide or simple sugar, the most common of the naturally occurring sugars which is a white or colourless, odourless and sweet-tasting substance that is soluble in water. Glucose can be either in crystalline or powder form. Glucose is one of the main energy sources for living organisms and is also the primary source of energy for the brain, when glucose is low, psychological processes requiring mental effort is impaired. When the intake of glucose and other carbohydrates exceeds the amounts immediately required for body activities, the excess is stored as glycogen in the liver and as fat in the fatty tissues. Blood glucose levels represent a balance between the rate of glucose and glycogen production by the liver and use by muscle and other tissues. Exercise has pronounced effects on glucose tolerance and action [2] and the peripheral insulin concentration is well known to decrease

during prolonged exercise. Studies conducted in human using measurements of c-peptide and insulin concentration in peripheral blood indicates that both secretion and removal of insulin are altered during exercise. In this context exercise training has been used as a mean to reduce plasma lipids, improve oral glucose tolerance and enhance insulin sensitivity [4]. Available literature strongly recommend endurance type of activities for favourable changes in coronary risk factors and as weight loss is related to energy expenditure and aerobic exercise training has greater potential to yield results than other type of training like resistance training, although studies have reported beneficial effects on weight loss and body composition from both modes of training [5]. There are strong correlations between changes in aerobic fitness (VO2max) and improvements in glycemic control and insulin sensitivity [6] and these effects may be mediated via changes in visceral adiposity [7]. There is very few literature available on the effects of endurance training on these selected variables among Indian population in general and students in particular. The present study was taken up to investigate the effect of endurance training on body composition, and blood glucose level among college boys.

Methods

Subjects

A total number of 40 male B.P.Ed., students of C.C.S. University, Meerut, U.P., volunteered for the study and the Body Mass Index was calculated as the weight (in kilograms) divided by height (in meters) square. Physical examination and medical check-up at the start of the study yielded normal results and none of them received any medication during the period of study. A written explanation of the experimental procedure and potential risks associated with the training program were given to all the subjects and their informed concern was obtained. The 40 subjects were randomly assigned to two equal groups namely Experimental (EXP) and Control Groups.

Training

The "EXP" Group underwent an Endurance Training program for 12 weeks whereas the "CON" Group maintains their routine activities. The training program consisted of slow continuous run with self-set speed for 40 to 55 minutes per session and 3 to 5 sessions per week for 12 weeks. The Weekly Load of Training (WLT) ranges from 120 to 275 min with a progressive increase with the number of weeks. Each session started with a 5-min warming and ends with a 5-min warm down, so the active training period is for 30 to 45 min persession.

Variables

The selected variables namely Body Weight, BMI and Blood glucose were measured prior (pre) and after (post) the training period and recorded 48 hours before the commencement of the training program 10 ml of blood was collected into polystyrene disposable syringe with attached 21 G needle by venepuncture of a large anti cubital vein in the right or left arm. The subjects were seated in the upright position at the time of sampling. Blood samples were drawn between 06.00 and 08.00 hours. All the subjects had not eaten or exercised the preceding 10 hours. The collected samples were transformed into sets of sterilized and labeled tubes. Those tubes were previously heparinised and 10 ml of blood was transformed into them for the purpose of plasma separation. Plasma was separated from white blood within 1 hour and the labeled samples were stored at 4 °C. Blood sugar analysis was completed within 24 hours of sampling (ARCHITECT-1000, 2009-USA). The post test samples were also taken in a similar fashion. After the completion of low intensity endurance training the blood samples was taken 48 hours after the last exercise session in order to eliminate the residual effect from the last exercise.

Statistical Technique

The data collected from Experimental Group 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). The pre-test and post-test means of experimental and

Control Groups were tested for significance by applying ANOVA. 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 post-test 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. 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

Table 1: Analysis of Covariance for the Selected Variables among Experimental & Control Groups

	Tests		Exp. Group	Control group	SOV	Sum of squares	df	M.S.	F-Ratio
	Pre	Mean	69.60	71.10	B	22.50	1	22.50	0.14
Body	Test	SD	13.51	12.02	W	6218.60	38	163.64	
Weight	Post	Mean	66.90	70.80	B	152.10	1	152.10	1.041
	Test	SD	12.08	12.09	W	5553.00	38	146.132	
	Adjusted	Mean	71.63	69.06	B	64.13	1	64.13	13.16*
	Post Test				W	180.23	37	4.87	
	Pre	Mean	23.25	24.10	B	7.24	1	7.24	.713
BMI	Test	SD	3.51	2.82	W	386.13	38	10.16	
	Post	Mean	22.34	24.01	B	27.87	1	27.87	3.31
	Test	SD	2.97	2.83	W	320.37	38	27.87	
	Adjusted	Mean	24.15	23.21	B	8.06	1	8.06	15.73*
	Post Test				W	18.95	37	0.51	
	Pre	Mean	101.80	104.00	B	48.40	1	48.40	
Blood									1.68
Glucose	Test	SD	5.54	5.15	W	1089.20	38	28.66	

	Post	Mean	101.42	104.25	B	60.03	1	60.03	1.97
	Test	SD	5.79	5.42	W	1154.95	38	30.39	
	Adjusted	Mean	102.86	102.93	B	0.036	1	0.036	0.006
Post Test W 209.10 37 5.65									

Discussion

It is generally believed that the glycemic response to moderate intensity exercise is dependent on the pre-exercise metabolic status [8]. Reduction in fasting blood glucose due to endurance training effect was noted in numerous studies [9, 10] but almost all of them involve hyperglycaemic, hyper insulin emic subjects or type-II diabetic patients and usually involve middle or overage patients. In our study the subjects were neither diabetic patients nor aged so that may be the reason for the unchanged blood sugar level observed, it may also because of the limited training duration intensity or both. Future research will be needed to determine the effect of endurance training with variations in duration, intensity on blood glucose and any of a number of the well-known metabolic abnormalities.

Conclusion

From the results of the study it is concluded that the endurance training program has resulted in a significant reduction in body weight and BMI with no change in blood Glucose.

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