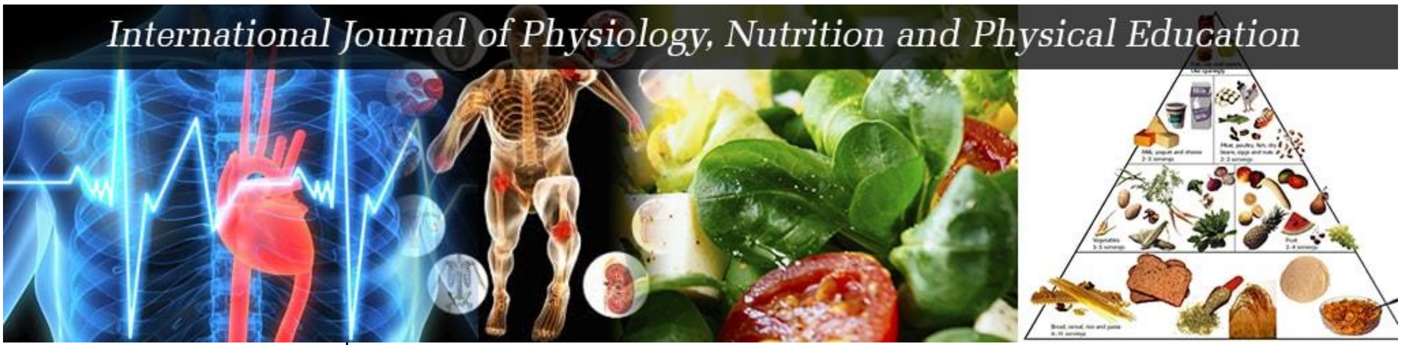

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Sadeep K
(1) Research Scholar, Department of Physical Education, Annamalai University, Annamalainagar, Tamil Nadu, India
(2) Assistant Professor, Department of Physical Education, Sreekrishnapuram VTB College, Mannampatta, Palakkad, Kerala, India

Dr. K Sreedhar
Professor and Head, Division of Sports Training and Sports Nutrition, MYAS-AU, Department of Sports Science, Centre for Excellence, Annamalai University, Annamalainagar, Tamil Nadu, India

Dr. PM Sudhirkumar
Associate professor and Head, Department of physical education, N.S.S College, Manjeri, Kerala, India

Dr. N Saravanan
Lecturer in Bio Chemistry, Rani Meyyammai College of Nursing, Annamalai University, Annamalainagar, Tamil Nadu, India

G Peddappa Raju
Senior Lecturer in Physical Education, Government Degree College (W), Madanapalle, Andhra Pradesh, India

Corresponding Author:
Dr. K Sreedhar
Professor and Head, Division of Sports Training and Sports Nutrition, MYAS-AU, Department of Sports Science, Centre for Excellence, Annamalai University, Annamalainagar, Tamil Nadu, India

Effect of endurance training on body composition blood glucose and insulin among college boys

Sadeep K, Dr. K Sreedhar, Dr. PM Sudhirkumar, Dr. N Saravanan and G Peddappa Raju

Abstract
Identifying potential risk factors associated with the development of hypo kinetic diseases among teen age population and finding out preventive strategies is vital in today scenario as early intervention can prevent the onset of such diseases including coronary heart disease and Diabetes mellitus. The effects of an endurance training program on body composition fasting blood sugar and insulin was examined among forty male under graduate students (Age: 19.63 ± 1.27; Height: 1.70±0.06, Weight: 66.20± 13.35, BMI: 22.99 ± 4.38) who were randomly assigned either to an experimental group (N =20) or a Control Group (N = 20). The experimental group underwent an endurance training program for tewelve weeks while the control group maintained their regular routine. The experimental group trained three to five sessions in a week and 25 to 50 min per session with a gradual increase in the number of sessions and duration as the program progresses. Height, Weight, and BMI were measured before (Pre) and after (Post) the training program. Fasting blood samples were collected 24 hours before, and 48 hours after the training period and analyzed for blood glucose and insulin levels. The obtained data were statistically analyzed using ANACOVA to find out significant difference if any. The result shows a significant reduction in Body Weight, BMI, Fasting blood sugar and Insulin in the experimental group when compared with the control group.

Keywords: Endurance training, glucose, insulin

1. Introduction

Diabetes is fast becoming the epidemic of the 21st century. Type 2 diabetes which accounts for 90% of all diabetes cases affects 5.9% of the world's adult population out of which 80% live in developing countries (Sicree *et al.* 2006) [20]. According to the World Health Organization (WHO) report, diabetes epidemic is more pronounced in India with 32 million people affected in the year 2000 (Wild *et al.* 2004) [30]. The International Diabetes Federation (IDF) estimates the total number of diabetic subjects to be around 40.9 million in India and this is further set to rise to 69.9 million by the year 2025 (Sicree *et al.* 2006) [20] and studies has shown that Indians have a younger age of onset of diabetes compared to other ethnic groups (Viswanathan, 1985) [27-28]. Another report shows that India has more than 69 million people with T2DM, and these numbers are expected to rise to 140 million by 2040, and an almost half of them remain undiagnosed (The World Bank Human Development Network, 2016). It is noticed that in the last two decades, there has been a marked increase in the prevalence of diabetes among urban south Indians. A similar though slower trend is also shown among peri urban population and rural residents as well (Ramachandran *et al.* 1999) [17]. Rapid increase in risk factors in young adulthood identifies the target group for interventions and this facture has to be considered with at most importance in our country as it is apparent that type 2 diabetes has become prevalent even among younger age groups, which could have long lasting effects on the health of the nation and its economy. It has been found that exercise plays a vital role in prevention or slowing of CAD process by controlling various cardiovascular risk factor such as hypertension, diabetes, dyslipidemia, obesity. (Thompson *et al.* 2003) [26]. The American Heart Association and other governing bodies have continued to emphasize the importance of exercise in childhood as a means of preventing CHD later in life (Kavey *et al.* 2003) [10]. Traditionally, it has been promulgated that physical activity improves health by means of an increase in physical fitness especially cardio respiratory fitness. One of the many outcomes of exercise and training is to cause changes in the body composition. The regular physical exercise has a favourable effect on body composition for individuals of all ages. Substrate utilization during exercise is dependent on the exercise intensity and duration and that both training and diet may affect the relative importance of carbohydrate (CHO) and fat as a fuel. As exercise duration progresses, total CHO oxidation decreases while the contribution of plasma glucose and fatty acids to total energy metabolism increases (Wagenmakers et al, 1993) [29]. Prolonged exercise at moderate exercise intensities (60-70% maximum O_2 uptake) results in muscle glycogen depletion and decreased blood glucose concentrations as a result of decreased hepatic glucose production (Starkie *et al.* 1994 and McConell *et al.* 1994). The increase in fat oxidation in the trained muscle during exercise reduces both the oxidation of muscle glycogen and of blood glucose. The regular physical exercise has a favorable effect on body composition for individuals of all ages. Unfortunately, unlike studies involving adults, the role regular exercise has on body composition and glucose metabolism among younger population especially undergraduate students remains unclear. Keeping this in mind this study was conducted to assess the effect of endurance training on body composition, blood glucose and insulin among college students.

2. Materials and methods

The experimental design adopted in the study was similar to a random group design involving forty male students out of 817 students from Sreekrishnapuram VT Bhattathiripad College doing under graduate course in arts and science who volunteered for the study. A written explanation of the experimental procedure and potential risk factors were given to each member. The age of the subjects were ranging from 18 to 20. The 40 subjects were randomly assigned to either Control group (‘CON’, No: 20) or Experimental group, (‘EXP’, No: 20). 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 selected variables were tested 24 hours prior (Pre) and 48 hours after (Post) the training program. The experimental group underwent endurance training for a period of 12 weeks, whereas the control group maintained their regular routine activities.

2.1 Training Program

Endurance training program included 8 to 12 minutes warm-up with stretching motions, walking, running, and then continuous running at a self set constant pace for 25 to 40 minutes with three to five sessions per week for twelve weeks (Total 46 sessions; Average training duration per Session (Mean ± SD= 35.04 ± 5.40)) and a warm down for 10 minutes. The initial load was started at 50 to 60% of maximum heart rate (220-age) so as to improve their self confidence (Owens and Gutin, 1999) [15] and there after they were instructed to complete the set duration of the sessions with their own set pace. The intensity and duration of the training sessions were gradually and progressively increased to induce a training effect throughout the 12-week period. All participants of the experimental group completed at least 41 sessions (Total sessions 46) with the progressive load applied.

Training Schedule with Weekly Load of Training

Week	No. of Training Sessions	Training duration of the sessions(min.)	Weekly Load of Training (WLT)(min.)
1	3	25	75
2	3	25	75
3	3	30	90
4	3	30	90
5	3	35	105
6	4	35	140
7	4	35	140
8	4	40	160
9	4	40	160
10	5	40	200
11	5	40	200
12	5	40	200
Total	46		1535 min.
Average training duration per Session (Mean ± SD) = 35.04 ± 5.40 (Minutes)			

2.2 Assessment and Estimation

Body weight was measured with a platform beam balance (accuracy of 0.01 kg) and standing height was measured with a stadiometre (accuracy of 0.1 cm). BMI was estimated using the formula of body weight (kgs)/height in meter^2.

2.3 Blood Sampling and Assessment

Blood sampling was done 24 hours before the exercise and 48 hours after the last session in both groups. For the first time of blood sampling, the subjects were asked to avoid any strenuous activity from two days before the trial. Ten ml of blood was taken from the right brachial artery after at least 10 hours of fasting. The second stage of blood sampling was done 48 hours after the last training session with the same conditions. Plasma glucose concentrations were measured using the glucose oxidase method with an semi-automated biochemistry analyzer (ERBA chem 5 plus; coefficient of variation for glucose oxidase method ≤ 1.8%.). Serum insulin was measured by ELISA method (Monobind Inc Lake Forest, CA 92630 USA; coefficient of variation for glucose oxidise method ≤ 5.6%.).

2.4 Statistical Analysis

The data collected from the 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). Data were presented as mean ± SD. The pre-test and post test means of experimental and control groups were tested for significance by applying ANOVA. As both the groups (RT 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 post test means of experimental and control group were tested for significance by using ANCOVA. Data were analysed using the Statistical Package for the Social Sciences (SPSS, version 12.0) software. 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.

3. Results

The general baseline characteristics of the 40 subjects who participated in the study are shown in Table I.

Table 1: Baseline characteristics of the Experimental and control groups

	Control group (N=20)		Experimental group (N=20)		Total (N=40)	
Age Mean ± SD	19.1 ±1.21		20.15 ± 1.14		19.63 ± 1.27	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	18	22	18	22	18	22
Height Mean ± SD	1.70 ± 0.06		1.69 ± 0.07		1.70 ± 0.06	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	1.60	1.80	1.58	1.84	1.58	1.84
Weight Mean ± SD	62.95 ± 16.92		69.45 ± 7.56		66.20 ± 13.35	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	44.00	110.00	52.00	84.00	44	110
BMI Mean ± SD	21.80 ± 5.82		24.17 ±1.63		22.99 ± 4.38	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
	15.37	35.92	17.99	25.93	15.37	35.92

Table 2: Analysis of Covariance for the Selected Variables among Experimental Group & Control Groups.

Variable	Test	Experimental Group	Control Group	F-Ratio
Body Weight Mean (SD)	Pre test	69.45(7.56)	62.95(16.9 2)	2.46
	Post test	66.50(7.20)	63.50(16.9 3)	0.53
	Ad Po test	63.28	66.72	131.21*
BMI Mean (SD)	Pre test	24.17(1.63)	21.80(5.82)	3.08
	Post test	23.14(1.48)	21.99(5.83)	0.726
	Ad Po test	21.97	23.17	136.68*
Blood Sugar Mean (SD)	Pre test	83.97(15.82)	83.48(16.2 7)	0.009
	Post test	83.99(15.91)	78.92(13.1 1)	1.209
	Ad Po test	83.77	79.14	38.26*
Insulin Mean (SD)	Pre test	6.69(3.01)	7.05(3.23)	0.128
	Post test	5.899(2.08)	7.24(2.89)	2.819
	Ad Po test	6.02	7.12	6.36*

Table 3: The Pre and Post Test Means of Experimental (EXP) and Control (CON) Groups with Percentage of Gain

Variable	Group	Pre Test	Post Test	Gain	Percentage of Gain
Body Weight Mean (SD)	Experimental	69.45(7.56)	66.50(7.20)	2.95	4.25%↓
	Control	62.95(16.92)	63.50(16.93)	0.55	0.87%↑
BMI Mean (SD)	Experimental	24.17(1.63)	23.14(1.48)	1.03	4.26%↓
	Control	21.80(5.82)	21.99(5.83)	0.19	0.87%↑
Blood Sugar Mean (SD)	Experimental	83.48(16.27)	78.92(13.11)	4.56	5.46%↓
	Control	83.97(15.82)	83.99(15.91)	0.02	0.02%↑
Insulin Mean (SD)	Experimental	6.69(3.01)	5.89(2.08)	0.8	11.96%↓
	Control	7.05(3.23)	7.24(2.89)	0.19	2.70%↑

3.1 Body Weight and BMI

No significant difference was observed among the pre test and post test values of body weight and BMI of the Experimental Group and the Control Group, whereas the adjusted post test means of the Experimental Group and the Control Group shows a significant difference in body weight and BMI ($P \leq 0.05$). The pre test and post test means of body weight for the experimental group (69.45±7.56 vs 66.50±7.20) shows a reduction of 2.95 (4.25%) whereas the pre test and post test means of control group (62.95±16.92 vs 63.50±16.93) shows an increase of 0.55 (0.87%). For BMI in the experimental group, the pre test and post test means (24.17±1.63vs 23.14±1.48) shows a reduction of 1.03 (4.26%) whereas the pre test and post test means of control group (21.80±5.82vs 21.99±5.83) shows an increase of 0.19 (0.87%).

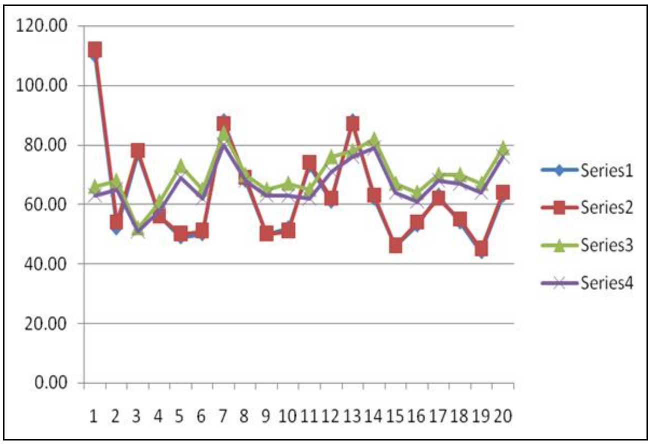

Fig 1: Body Weight

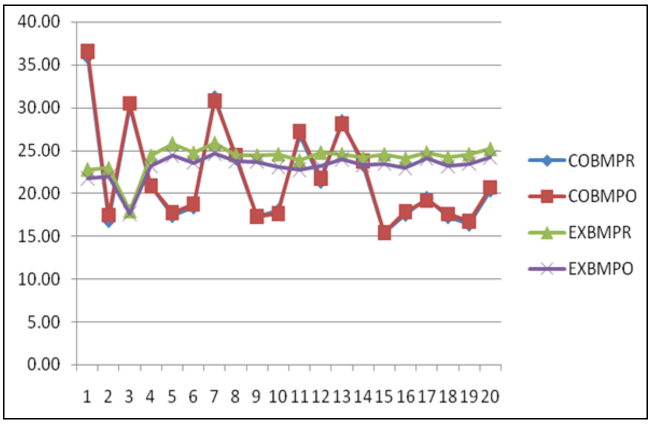

Fig 2: BMI

3.2 Blood sugar and Insulin

No significant difference was observed among the pre test and post test values of fasting blood sugar and insulin of the Experimental Group and the Control Group, whereas the adjusted post test means of the Experimental Group and the Control Group shows a significant difference in fasting blood sugar and insulin ($P \leq 0.05$). The pre test and post test means of fasting blood sugar for the experimental group (83.48±16.27 vs 78.92±13.11) shows a reduction of 4.56 (5.46%) whereas the pre test and post test means of control group (83.97±15.82 vs 83.99±15.91) shows an increase of 0.02. The insulin levels in the experimental group, the pre test and post test means (6.69±3.01 vs 5.89±2.08) shows a reduction of 0.8 (11.76%) whereas the pre test and post test means of control group (7.05±3.23 vs 7.24±2.89) shows an increase of 0.19 (2.70%).

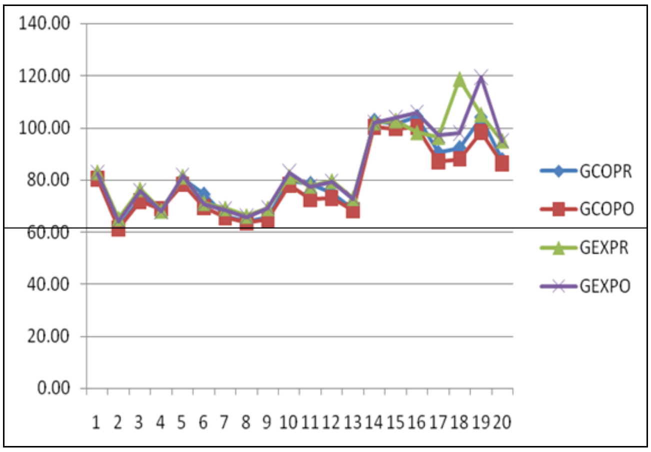

Fig 3: Blood Glucose

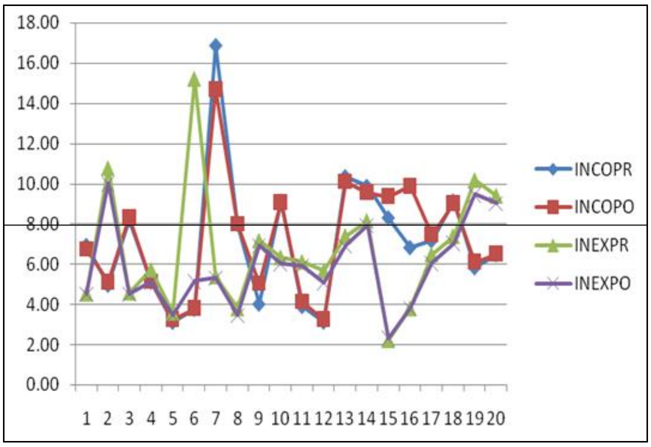

Fig 4: Insulin

4. Discussion

Previous studies done among younger population on factors related to functional abilities, body composition metabolic variables due to exercise training involving endurance type of activities in obese/non obese, gives positive health related changes but there is lack of clarity on the type, intensity and duration of the training. Endurance exercise training results in adaptive changes in muscle metabolic function characterized by a decrease in carbohydrate utilization and an increase in lipid oxidation (Hurley *et al.* 1986; Mendenhall *et al.* 1994; Phillips *et al.* 1996) [8, 13, 16] and the findings of other studies shows a reduction in the reliance on carbohydrate oxidation during exercise includes a sparing of muscle glycogen (McKenzie *et al.* 2000; Tarnopolsky *et al.* 1995; Phillips *et al.* 1996) [12, 23, 16]; a decrease in the rates of appearance and oxidation (Nishida *et al.* 2001; Friedlander *et al.* 1997; Mendenhall *et al.* 1994; Phillips *et al.* 1996) [14, 4, 13, 16] of plasma glucose. The effect of exercise training on insulin action has been well documented (Kahn *et al.* 1990*;* Houmard *et al.* 1993) [9, 7], and published evidence shows that an acute bout of sub-maximal exercise can lower blood glucose concentration (Albright *et al.* 2000; Sigal *et al.* 2007; ACSM, 2009; Ekkekakis *et al.* 2004; Hawley and Lessard,2008) [2, 21, 1, 3, 6] and improve insulin sensitivity for up to 72 h after cessation of any given exercise bout. Endurance training reduces visceral fat (Schwartz., *et al.* 1991) [19] and which in turn results in higher levels of insulin sensitivity and better metabolic capabilities (Goodpaster *et al.* 2003: Goodpaster *et al.* 1999: Kirwan *et al.* 1993: Ross *et al.* 2004: Després *et al.* 1991) [5]. The findings of our study shows s a reduction in body weight and blood glucose level which can be attributed to the reduction of body fat and previous results demonstrate that a reduction in body fat is a prerequisite to improve glucose disposal (Segal *et al.* 1991:). Although Houmard *et al.* (1993) [7] did not show the results of integrated area of insulin after the glucose load. Kahn *et al.* (1990) [9] found a significant decrease in the acute insulin response to glucose after exercise training.

5. Conclusions

In this study we have adopted a training programme for twelve weeks which involves a progressive increase in training load/duration and also in the number of occasions the subjects of the experimental group trained (3-5 sessions per week), which is not adopted in many studies. More over an control group was in place and the training induced gains were compared with the data of the control group. In this study a small but significant positive gain in body composition was observed, which may be attributed to the longer duration of the training. The reduction in blood sugar and insulin observed is due to the metabolic demand placed on the system due to the regular and progressive training. More studies needed to be done on younger population to get a clear understanding on the reason for the insulin level.

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