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Effectiveness of taurine supplementation during resistance training on selected biochemical parameters in boys

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Abstract
In this study 30 students of Bachelor of Physical Education and Sports Sciences, Annamalai University, who volunteered were selected as subjects on random basis. They were randomly drawn into three equal groups of 10 each namely placebo, taurine and control groups. The two independent variables selected were resistance training and taurine supplementation. Experiment group I and II underwent same resistance training regiments for eight weeks and in addition taurine was given during experimentation for group II and control group was kept idle. The independent variable selected were four biochemical parameters such as: TGL, LDH, TBARS and GPx and they were tested before and after experimentation. Blood sample was collected from the subjects and these parameters were estimated in Medical College laboratory by adopting standard methods. In this study randomized double - blind placebo 3x2 factorial design was followed. The Analysis of Covariance (ANCOVA) and Scheffe's Post-Hoc tests were computed for the data collected. It was concluded that a) the decrease on TGL level differs significantly between placebo and taurine groups in favour of taurine group, b) the increase on LDH activity between placebo and taurine groups does not differ significantly, c) the TBARS level has increased in placebo group and decreased in taurine group and, d) the GPx activity has increased in placebo group and decreased in taurine group.

Keywords: resistance training –taurine supplementation - biochemical parameters

Introduction
Strength is the fore that a muscle or muscle group can exert against a resistance in one maximal effort (Fox & Mathews, 1985) [7]. Strength is key to success in sports and games. There is a vast need for everyone involved in sports for a better understanding to strength. Most coaches recognize that strength is a valuable asset to athletic success. Strength is largely depends on the energy liberation processes in the muscle. Strength, the most important motor ability in sports is a direct product of muscle contraction. Strength is part and parcel of technical skills, tactical actions and for better sports performance, (Hooks, 1974) [11].

How strong a particular muscle is depends upon the number and size of the fibers. The number of fibers is determined at birth, but resistance training make the fibers biggers and make the muscle stronger. Strength conditioning is a training in which the resistance against a muscle generate force is progressively increased over time. The key to an effective resistance training programme depends on apt and adequate selection of exercises. The selection of exercise has to be done on the basis of age, level of performance, need of sports, availability of equipments, phase of training, the specific muscle action that need to be trained and so forth. Different combination of repetition, set, rhythm, rest etc. is required to develop maximum strength, elastic strength and strength endurance. For many years the order of exercise in resistance training has proceeded from large to small muscle groups and exercise the priority muscle groups first (Moran & Mc Glynn, 1990) [17].

Taurine is one of the most abundant free amino acids in the body. It is not incorporated into proteins, yet taurine is very important in metabolism and present in particularly high level in the brain, heart and retina of the eye, where it serves several important functions. Regulation of taurine content in body depends on various factors such s daily dietary intake, synthesis, utilization and loss through bile and urine. The kidney is a major regulator of body taurine

pool (Huxtable, 1992) [12].

Taurine is involved in a number of physiological roles including cell volume regulation, antioxidation, detoxification and carbohydrate metabolism (Chesney *et. al*., 1998 & Stapelton *et. al*., 1998) [2]. For this reason taurine has been commonly included in cell volumizing supplements. There is evidence that taurine supplementation in deficient patients may enhance cell volume and metabolism. If taurine affects cell volume, taurine supplementation during training may enhance protein synthesis. Intense exercise is thought to increase oxidative stress and damage muscle tissue. Taurine is present in high concentration in skeletal muscle and may play a role in cellular defenses against free radical mediated damage (Dawson *et. al*., 2002) [5]. Several taurine supplementation studies are reported in normal human, patients and players and which are conducted for different purpose.

The biochemical variables selected are: a) the fatty acids on a glycerol molecule are known as triglycerides (Fox, 1985) [7]. Triglycerides are used in the body mainly to provide energy for the different metabolic processes; this function they share almost equally with the carbohydrates (Guyton, 1991) [9], b) Lactate dehydrogenase is an enzyme that catalyzes the reaction: Lactate + NAD^+ Pyruvate + NADH + H^+. The equilibrium of the reaction greatly favours lactate and NAD^+ at neutral pH. In this direction, the reaction allows muscle glycolysis to occur under anaerobic conditions, the lactate passing into the blood and it is formed, c) Glutathione peroxidase removes H_2O_2 through peroxidative mechanism. Two types are found, selenium containing and non-selenium containing glutathione peroxidase. Selenium containing glutathione peroxidase has been shown to cause enzymatic removal of hydrogen peroxide.

Methodology

The male students who studied Bachelor of Physical Education and Sports Sciences (B.P.E.S), Department of Physical Education and Sports Sciences, Annamalai University, who were new to resistance training and who qualified the medical examination conducted by the Medical Officer of Rajah Muthiah Medical College, Annamalai University were selected as subjects. The purpose, nature, the procedure to be employed in the collection of blood and the role of the subjects during experimentation and testing periods were explained to the subjects elaborately. Finally 30 subjects were selected at random by lot sampling technique from those students volunteered to participate in the present study. Separe written consent were received from each subjects. Their age ranged from 19 through 21 years. The two independent variables selected for the present study were resistance training and supplementation of taurine. The dependent variable selected were four biochemical parameters namely: Triglycerides (TGL), Lactate dehydrogenase (LDH), Thiobarbituric acid reactive substances (TBARS) and Glutathione peroxidase (GPx).

Experimental Protocol

The chosen 30 subjects were randomly drawn into three equal groups of 10 each namely experimental group I, II and control group. The experimentation composed of resistance training and taurine supplementation for eight weeks. Experimental group I undergone resistance training and taurine supplementation was given to experimental group II in addition to the same resistance training. The control group was kept idle. The chosen biochemical parameters were tested for all the three groups before and after experimentation.

Resistance Training Regiments

After selecting nine resistance exercises, 1 RM was found for each subjects of both experimental groups for each exercise separately at the beginning of each week. The 1 RM denotes one repetition maximum that is the amount of weight a person can successfully lift at a time through the full range of motion. The investigator assessed the 1 RM for all the resistance exercise accurately by increasing and decreasing the weight with the able assistance of testing personnel. The resistance training regimens followed in the present investigation is described below:

Number of resistance exercises	9
Order of resistance exercise	Presented in table 1
Progression of load	Commenced with 60% of 1 RM and end with 95% of 1 RM
Training frequency	3 days per week
Training session	Morning
Number of sets in each unit	3 After the completion of the first exercise for three sets, the subsequent exercises were performed one after another
Number of repetitions	6, 7 and 8
Rhythm	Medium
Rest period	1 minute between sets
Activity during rest	specific moderate stretching exercise
Equipments used for resistance Training	Multigym and free weights
Duration of resistance training	8 weeks
Training	The both placebo and taurine supplementation groups undergone the same progressive resistance training. Training includes warming –up, resistance training, suitable relaxation exercises between resistance exercises and limbering down process at the end of training session.

The resistance exercise followed in the present study is given in table I.

Table I: Order of resistance exercise followed in the present study

S. No	Name of Resistance Exercise	Body Region Involved	Major Muscles Involved	Body Positions	Equipments Used
1	Full Squat	Upper leg and hip	Gluteus, quadriceps hamstring group and lower back	Standing	Multigym
2	Bench Press	Chest and upper arm	Pectoralis major, anterior deltoid, biceps brachii and triceps brachii	Supine lying	Multigym
3	Back hyper extension	Back	Erector spinal group and hip	Prone lying	Multigym
4	Upright rowing	Shoulder	Trapezius, deltoid, supraspinatus and forearm flexors	Standing	Free weights
5	Heel rise	Lower leg and ankle	Gastrocnimus, soleus and tibial posterior	Standing	Multigym
6	Crunches	Abdomen	Rectus abdominus, internal obliques, external obliques and transverse abdominus	Supine lying	Bench and free weights
7	Pully push down	Upper arm	Triceps brachii, posterior deltoid and latissimus dorsi	Standing	Multigym
8	Leg curl	Upper leg (Posterior)	Hamstring group	Prone lying	Multigym
9	Arm curl	Forearm	Forearm flexors, flexor carpi radialis and flexor carpi ulnaris	Sitting	Free weight

(Gray Moran & George McGlynn, 1990; Pattesonlombardi, 1989; John Garhammer 1986 & Brauman, 1979) [17, 18, 14].

Supplementation of taurine

Taurine group (experimental group II) was orally supplemented 0.5 gm of taurine capsules based on reviews and suggested by sports medicine expert. The placebo group (experimental group I) was supplemented proxy capsules. Both taurine and placebo capsules were supplemented to the concerned group every day morning after the breakfast along with water for a period of 56 days (8 weeks). The appearance and weight of both capsules were similar but it was distinguished by colour. Double - blind placebo experimental method was adopted in this study. The Madras Medical Company, which have supplied the capsules Chennai, India, alone knew the placebo and taurine capsules. The subjects of both groups were under the impression that they were taking taurine.

Estimation of biochemical parameters

To estimate biochemical parameters, 10ml of venous blood sample was collected with the help of trained personnel using standard disposable syrings before and after experimentation for the subjects of three groups. The chosen biochemical parameters were estimated by using standard procedure, equipments and reagents in the research laboratory of Biochemistry Wing, Rajah Muthiah Medical College, Annamalai University.

Biochemical parameters: a) Serum triglycerides (TGL) was estimated by Smart LAB, Autoanalyzer using Boehringer Mannheim Kit and it is expressed as mg/dl. b) Serum lactate dehydrogenase (LDH) was estimated by the Optimized Standard Method confirming to the recommendation of the Deutsche Gesellschaft fur Klinische Chemie (1970) using the Boehringer Mannheim kit and it is expressed as U/l. c) Lipid peroxidation was estimated as evidenced by the formation of thiobarbituric acid reactive substances (TBARS). TBARS in plasma was assayed by the method of kunio yagi, 1987. This method is based on the formation of red pigment by condensation of lipid peroxidation breakdown products like MDA with thiobarbituric acid and it is expressed as nmol/ml. d) Glutathione peroxidase (GPx) was assayed in hemolysate by the method of Rotruck *et.al*., (1973) with modification. A known amount of enzyme preparation was allowed to react with H_2O_2 in the presence of reduced glutathione. After a specified period of enzyme action, the remaining reduced glutathione content was measured by the method of Beutler and Kelley (1984) and it was expressed as μmol of GSH consumed /min/mg Hb.

Experimental design and statistical technique

The present study is a randomized double - blind placebo 3x2 factorial design. The first factor indicates three groups and second factor denotes two testing periods. Analysis of Covariance (ANCOVA) was computed for the data collected from three groups during pre and Post tests and whenever the 'F' ratio was found to be significant Scheffe's test was used as a post-Hoc test (Clarke, 1972). The level of significance was fixed as 0.05.

Analysis of triglycerides (TGL)

The statistical analysis of the data collected among control, placebo and taurine groups on triglycerides during pre and post tests have been presented in table II.

Table II: Analysis of covariance for the pre and post-tests data on triglycerides (mg/dl) among control, placebo and taurine groups

Testing periods	Groups			Source of Variance	Sum of Squares	df	Mean Squares	F Ratio	Level of Signifi-cance
	Control	Placebo	Taurine						
Pre-test Mean S.D	92.31 7.48	92.06 7.55	98.34 8.06	B: W:	2352.59 1601.44	2 27	126.29 59.31	2.13	NS
Post-test Mean S.D	92.02 7.31	80.18 7.23	75.86 7.45	B: W:	1400.19 1450.28	2 27	700.10 53.71	13.03	0.01
Adjusted Post-test for the differences in Pre-test Mean	93.84	82.23	71.99	B: W:	2164.95 27.35	2 26	1082.48 1.05	1029.18	0.01

The tabulated F ratio for: 0.05 0.01 level NS : Not Significant
df 2 & 27 = 3.35 5.49 B : Between Sets
df 2 & 26 = 3.37 5.53 W : Within Sets

It is evident from II that the calculated F ratio 2.13, for the pre-test is not significant. It reveals that before starting the experimentation, no significant difference existed among the three groups in their triglycerides level. The obtained F ratio

13.03, for the post-test is significant at 0.01 level and it implies that at the end of the experimentation there is significant difference exists among the three groups in their triglycerides level. The F ratio arrived by the statistical calculation for the adjusted post-test mean for the difference in pre-test is 1029.18 and it is significant at 0.01 level. It is inferred that significant variation exists among the three groups in their triglycerides level owing to experimentation.
The results of Scheffe's test is given in table III.

Table III: Scheffe's Test of significance between adjusted paired post-test means for pre-test means on triglycerides (mg/dl) among Control, placebo and taurine groups

S. No	Adjusted Post-test Mean			Means Difference	Level of Significance
	Control	Placebo	Taurine		
1	93.84	82.23		11.61	0.01
2	93.84		71.99	21.85	0.01
3		82.23	71.99	10.24	0.01

The confidence intervals required for 0.05 and 0.01 level of significance are 1.20 and 1.53 respectively.

It is evidence from the table III that there is significant variation exists among the adjusted post-test means of all the three groups at 0.01 level.

The details of triglycerides during pre and post-test among three groups are shown graphically in figure1.

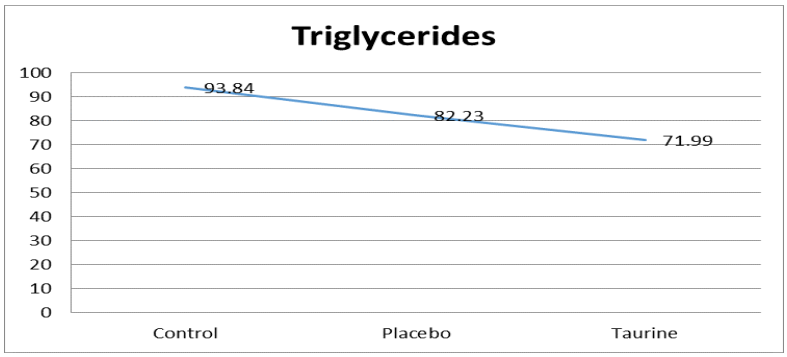

Fig 1: Graphical Representation for the Adjusted Means on Triglycerides (mg/dl) among Control, Placebo and Taurine Groups

Analysis of Lactate Dehydrogenase (LDH)

As far as LDH activity is concerned, the data collected among control, placebo and taurine groups during pre and post-tests have been presented in table IV.

Table IV: Analysis of covariance for the pre and post – tests data on LDH (U/l) among control, placebo and taurine groups

Testing periods	Groups			Source of Variance	Sum of Squares	df	Mean Squares	F Ratio	Level of Signifi-cance
	Control	Placebo	Taurine						
Pre-test Mean	63.60	61.90	56.20	B:	300.74	2	150.23	0.38	NS
S.D	21.27	19.81	18.23	W:	10592.90	27	392.33		
Post-test Mean	64.50	93.30	76.60	B:	4182.47	2	2091.23	2.74	NS
S.D	20.96	32.87	22.68	W:	20583.00	27	762.33		
Adjusted Post-test for the differences in Pre-test Mean	61.60	92.03	80.77	B:	4715.07	2	2357.54	5.61	0.01
				W:	10924.15	26	420.16		

The tabulated F ratio for: 0.05 0.01 level NS : Not Significant
df 2 & 27 = 3.35 5.49 B : Between Sets
df 2 & 26 = 3.37 5.53 W : Within Sets

It is clear from table IV that the obtained F ratio 0.38 for the pre-test is not significant. It reveals that before the commencement of the experimentation there is no significant difference among the three groups in their LDH activity. The obtained F ratio for the post-test 2.74 is also not significant. It reveals that the end of the experimentation also there is no significant variation among the three groups in their LDH activity. The F ratio obtained for the adjusted post-test mean for the differences in pre-test is 5.61, which is significant at 0.01 level. It inferred that significant variation exists among the three groups, in their LDH activity due to the experimentation.
The results of Scheffe's test is given in table V.

Table V: Scheffe's test of significance between adjusted paired post-test means for pre-test means on LDH (U/I) among control, placebo and taurine groups

S. No.	Adjusted Post-test Mean			Mean Difference	Level of Significance
	Control	Placebo	Taurine		
1.	61.60	92.03		30.43	0.05
2.	61.60		80.77	19.17	NS
3.		92.03	80.77	11.26	NS

NS = Not Significant
The Confidence intervals required for 0.05 and 0.01 level of significance are 23.4 and 30.54 respectively

It is clear from the table V that the adjusted post-test means of control and placebo group is significant at 0.05 level. Rest of the groups do not differ significantly.

The details of LDH activity during pre and post-tests among three groups are graphically illustrated in figure 2.

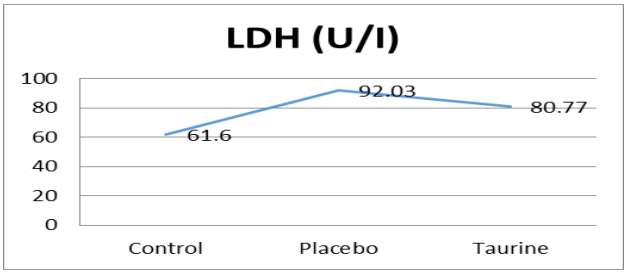

Fig 2: Graphical Representation for the Adjusted Means on LDH (U/l) among Control, Placebo and Taurine Groups

Analysis of thiobarbituric acid reactive substances (TBARS)

The statistical analysis of the data collected among control, placebo and taurine groups on TBARS during pre and post - tests have been presented in table VI.

Table VI: Analysis of covariance for the pre and post – tests data on plasma TBARS (nmol/ml) among control, placebo and taurine groups

Testing periods	Groups			Source of Variance	Sum of Squares	df	Mean Squares	F Ratio	Level of Signifi-cance
	Control	Placebo	Taurine						
Pre-test Mean S.D	3.60 0.37	3.58 0.29	3.70 0.30	B: W:	0.06 2.80	2 27	0.03 0.10	0.33	NS
Post-test Mean S.D	3.50 0.41	4.81 0.51	2.41 0.24	B: W:	28.97 4.36	2 27	14.49 0.16	89.78	0.01
Adjusted Post-test for the differences in Pre-test Mean	3.52	4.84	2.36	B: W:	30.13 3.06	2 26	15.07 0.12	128.21	0.01

The tabulated F ratio for: 0.05 0.01 level — NS : Not Significant
df 2 & 27 = 3.35 5.49 — B : Between Sets
df 2 & 26 = 3.37 5.53 — W : Within Sets

It is evident from table VI that the calculated F ratio 0.33, for the pre test is not significant. It reveals that before starting the experimentation, no significant difference exists among the three groups in their TBARS level. The obtained F ratio 89.78, for the post-test is significant at 0.01 level and it implies that at the end of the experimentation there is significant difference exists among three groups in their TBARS level. The F ratio by the statistical calculation for the adjusted post-test mean for the difference in pre-test is 128.21 and it is significant at 0.01 level. It is inferred that significant variation exists among the three groups in their TBARS level owing to the experimentation.

The results of Scheffe's test is given in table VII.

Table VII: Scheffe's test of significance between adjusted paired post-test means for pre-test means on plasma-TBARS (nmol/ml) among control, placebo and taurine groups

S. No.	Adjusted Post-test Mean			Mean Difference	Level of Significance
	Control	Placebo	Taurine		
1.	3.52	4.84		1.32	0.01
2.	3.52		2.36	1.16	0.01
3.		4.84	2.36	2.48	0.01

The confidence intervals required for 0.05 and 0.01 level of significance are 0.39 and 0.50 respectively

It is evidence from the table VII that there is significant variation exists among the adjusted post-test means of all the three groups at 0.01 level.

The details of TBARS during pre and post-tests among three groups are shown graphically in figure 3.

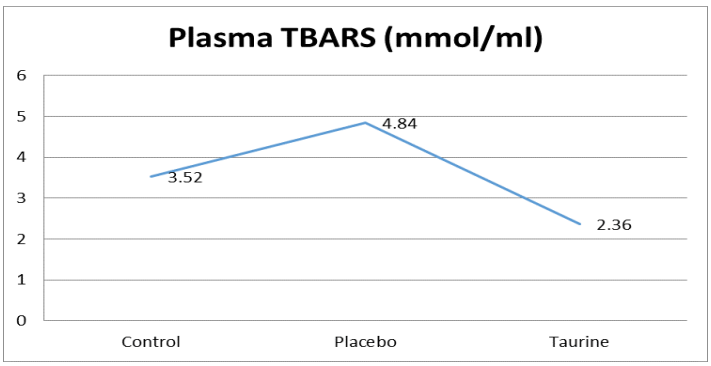

Fig 3: Graphical Representation for the Adjusted Means on Plasma TBARS (mmol/ml) among Control, Placebo and Taurine Groups

Analysis of Glutathione Peroxidase (GPx)

As far as the GPx activity is concerned, the data collected among control, placebo and taurine groups during pre and post-tests have been presented in table VIII.

Table VIII: Analysis of covariance for the pre and post-tests data on GPx (µmol of GSH consumed/min/mg Hb) among control, placebo and taurine groups

Testing periods	Groups			Source of Variance	Sum of Squares	df	Mean Squares	F Ratio	Level of Signifi-cance
	Control	Placebo	Taurine						
Pre-test Mean S.D	10.81 1.04	11.21 1.26	11.23 1.09	B: W:	1.16 34.87	2 27	0.58 1.29	0.45	NS
Post-test Mean S.D	1061 1.22	12.70 0.87	10.72 1.06	B: W:	27.72 30.13	2 27	13.86 1.12	12.42	0.01
Adjusted Post-test for the differences in Pre-test Mean	10.80	12.61	10.62	B: W:	24.29 14.53	2 26	12.15 0.56	21.73	0.01

The tabulated F ratio for: 0.05 0.01 level — NS : Not Significant
df 2 & 27 = 3.35 5.49 — B : Between Sets
df 2 & 26 = 3.37 5.53 — W : Within Sets

It is clear from table VIII that the obtained F ratio 0.45 for the pre-test is not significant. It reveals that before the commencement of the experimentation there is no significant difference among the three groups in their GPx activity. The obtained F ratio for the post-test 12.42 is significant at 0.01 level. It reveals that at the end of the experimentation there is significant variation exits among the three groups in their GPx activity. The F ratio obtained for the adjusted post-test mean for the differences in pre-test is 21.73, which is significant at 0.01 level. It inferred that significant variation exists among the three groups, in their level of GPx due to the experimentation.

The result of Scheffe's test is given in table IX.

Table IX: Scheffe's Test of significance between adjusted paired post-test means for Pre-test Means on GPx (µmol of GSH consumed/min/mg Hb) among control, placebo and taurine groups

S. No	Adjusted Post-test Mean			Mean Difference	Level of Significance
	Control	Placebo	Taurine		
1.	10.80	12.61		1.81	0.01
2.	10.80		10.62	0.18	NS
3.		12.61	10.62	1.99	0.01

NS= Not Significant

The confidence intervals required for 0.05 and 0.01 level of significance are 0.45 and 0.53 respectively.

It is clear from the table IX that the adjusted post-test means of control & placebo groups and placebo & taurine groups are significant at 0.01 level.

The details of GPx activity during pre and post-test among three groups are graphically illustrated in figure 4.

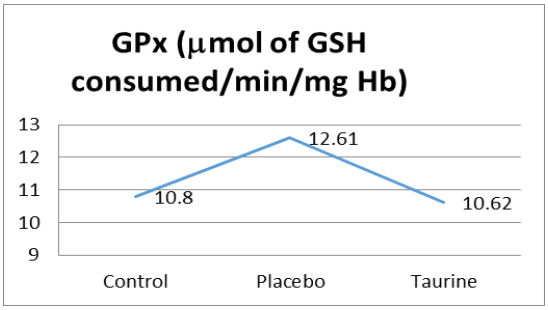

Fig 4: Graphical Representation for the Adjusted Means on GPx (µmol of GSH consumed/min/mg Hb) among Control, Placebo and Taurine Groups

Discussion on Findings

The results obtained for triglycerides are in confirmity with the following reports. Larry *et. al*., (2003) [15] observed the plasma triglycerides reduction, when they analysed the relationship between exercise training volume and lipid changes, the reduction are often observed to those characterized to increase HDL-c. Taurine treatment significantly decreased fat accumulation and blood levels of cholesterol and triglycerides, which might improve insulin resistance and utilization on fat and glucose (Manbe, 2003) [16].

Recording lactate dehydrogenase, a study on five healthy male served as subjects, one leg was trained using 10 repeated 6-8 maximal work bouts and the other leg performed repeated 30-S maximal knee extension exercise, revealed that the LDH activity has increased from 321 to 329 for 6-8 leg. It increased from 295 to 318 for 30-S leg (Costill *et. al*., 1979) [3]. Higuchi *et. al*., (1994) [10] found that a group of men who rarely exercised had lower levels of serum LDH than those who exercised some times or usually. The treadmill group's LDH activity was higher compared to bicycle ergometer group which indicates much higher production and lower elimination of acid metabolic products that occurred during test on bicycle ergometer group.

The general tendencies of the response of thiobarbituric acid reactive substances are in confirmity with following reports. A large increase of oxygen utilization is turned oxidative stress. In the process of energy formation, oxidative stress may lead to incomplete electron reduction of molecules, which in consequence may lead to peroxidation via radicals (Dormandy, 1978) [6]. Aerobic exercise increased TBARS in plasma of male Sprangue - Dawley rats (Goldfrab *et. al*., 1993) [8]. Training for a period of 6 weeks-resulted in increased lipid peroxidation as indicated by TBARS test (Anuradha *et. al*., 1998).

With regard to glutathione perxiodase, the results of present study indicates that the resting state GPx activity of the experimental groups during post-test was significantly higher

as compared to the pre-test state GPx activity. The reason may be training adaptation. Resistance exercise might trigger the production of toxic free radicals and subsequent antioxidant activity to counter them. Training results in continuous presence of large amount of free radicals and hence elevated GPx activity. The findings are in confirmity with the following report that GPx activity was higher after higher intensity exercise compared to control (Criswell, 1993) [4].

Conclusions

1. Both placebo and taurine groups have shown significant decrease on TGL level.
2. The decrease on TGL level differs significantly between placebo and taurine groups in favour of taurine group.
3. Placebo group has shown significant increase on LDH activity than control group.
4. The increase on LDH activity between placebo and taurine groups does not differ significantly.
5. The TBARS level has increased in placebo group and decreased in taurine group.
6. Significant difference exists between placebo and taurine groups for the changes on TBARS.
7. The GPx activity has increased in placebo group and decreased in taurine group.
8. The difference between placebo and taurine groups for the changes on GPx activity is significant.

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