Effect of 12-Week Interval Training on Left Ventricular Morphology of Adolescent Boys

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ABSTRACT

Training upsets the internal constancy of an individual periodically. Internal constancy depended upon the physiological systems of body. The key physiological systems of the body, in relation to training, are circulatory and respiratory systems. Sportsman increases the internal environment through scientific and systematic procedure and maintains this through planned training programme. Interval training is one of the best training programme for elevating the performance level of an individual especially adolescent boys.

The purpose of the study was to evaluate the effect of twelve-week Interval Training on LVPW thickness, IVM thickness, LV muscle mass, body surface area and Vo_2max of adolescent boys. Two-dimensional and Doppler Echocardiography studies were performed for measuring left ventricular wall thickness and mass. The difference between the initial and final scores of the subjects were statistically tested using 't' test. Sixteen subjects, of class eight, were selected randomly from Nadia district, West Bengal. Among the sixteen subjects, eight subjects were treated as experimental and the remaining eight subjects were treated as control. Interval training with 60-80% intensity for 400 meters distance (set-5-015) was applied for the experimental group for 12 weeks.

LVM and VO_{2max} were significantly improved ($p>.05$) after the training for experimental group whereas IVS, LVPW and BSA did not change significantly.

INTRODUCTION

Assessment of echocardiographic measurements in athletes should take into account the specific sport and the quantity and quality of training. All parts of athlete's heart are enlarged and its performance increases. Highly trained endurance athletes show the most enlarged hearts (Urhauran & Kindermann, 1992).

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Regular physical exercise induces changes in the body that are caused due physiological adaptation to increased loads. In general, these adaptations are favourable and enable the individual to increase physical performance capacity. Adaptations of training also include the structure and function of cardiovascular system, in addition to its functional control (Pelliccia & Maron, 1997). Strength training induces changes to pressure loads; whereas, endurance training requires volume loads and elicits an increased maximal cardiac output, by increasing stroke volume (Andersen, Scherling & Saltin, 2000; Astrand, Rodahl, Dalh & Stromme, 2003). It has become clear that sports performance and training induced adaptations are determined mainly by genetic factors and to a limited extent by training (Kuipers, 2005). Strength training induces changes to pressure loads; whereas, endurance training requires volume loads and elicits an increased maximal cardiac output, by increasing stroke volume. Long-term athletic training is associated with cardiac morphologic changes, including increased left ventricular cavity dimension, wall thickness and calculated mass that are commonly described as "athlete's heart" (Huston, Puffer & Rodney, 1985; Maron, 1986; Rost & Holmann, 1983; Spirito et al, 1994). These changes seem to present adaptations to the hemodynamic load produced by long term, frequent, intensive exercise programmes (Keul, Dickhuth, Simon & Lehmann, 1981; Longhust, Kelly, Gonyea & Mitchell, 1980 & 1981). Echocardiography has become firmly established in cardiological diagnostics in the last few years. Two dimentional echocardiography yields important information, not only about pathological changes, but also about structural and functional adaptations about healthy hearts. It is useful to the sports cardiology as it is non-invasive and is repeatable (Urhausen & Kindermann, 1992). Oxygen consumption is an important aspect which may detect the athletes working ability. Physically the VO2max assessment is indication of the functional state of the respiratory, circulatory and metabolic system. The greater the capacity of the dimensional and functional factors of an athlete's endurance ability, the higher will be the VO2max of that athlete (Rowland, 1985).

The purpose of the present study was to evaluate the effect of 12-week interval training on echocardiographically determined left ventricular wall thickness, left ventricular muscle mass, body surface area and maximum oxygen consumption capacity of adolescent boys.

METHODOLOGY

Sixteen non-residential untrained male subjects (age ranged between 14-16 years) were selected for the study (experimental =8 and control = 8). Before the 12-week training protocol the body surface area of the subjects were measured using Boothby and Sandiford Nomogram (Methews & Fox, 1966); VO2 max of the subjects determined using Fox equation (1973); and two-dimensional and Doppler Echocardiography studies were performed for measuring left ventricular wall thickness and mass. Images of the heart were obtained in multiple crosssectional planes by using standard transducer position (Tajik et al, 1978). Left ventricular posterior wall thickness and Inter ventricular septum were assessed from two dimensional slope frame images, as described by Pelliccia et al (1921). Left ventricular mass was calculated from end-diastolic wall thickness and cavity dimension by using the formula proposed by Devereux (1987).

After the training protocol the required data were collected from both the groups. Thus, the initial test and final test scores were obtained from the experimental and control groups. The initial and final test scores were compared for significance using t-test (Garat, 1969). The statistical analysis was tested for significance, at 0.05 level of confidance.

Twelve weeks training was imparted for the experimental group. First of all, one hour and four day general conditioning programme was imparted for 4 weeks to the experimental group and for the next 12 weeks the interval training method was adopted, for development of cardiovascular endurance. The intensity of the Interval Training was determined through training heart rates. Table 1 represents the weekly interval training schedule. Before each training session, 20 minutes of general warming up and after the training session and 20 minutes of cool down programmes were conducted.

Table-1 : Weekly Schedule of Training Programme

Method	Interval training
Intensity	60-80%
Duration	70 to 90 sec
Distance	400 meters
Repetitions	5-15
Recovery	Active and incomplete, the next repetition was started when Heart Rate comes down to 110-120 beats per minutes (btpm).
Loan Duration	Thrice a week

RESULT & DISCUSSION

As per Boothby and Sandiford method (Mathews & Fox, 1966) of determining body surface area, the body surface area depended upon the height and weight of the subjects. Neither the height nor the weight of the subjects were remarkably changed following training, which results in insignificant change of body surface area of the subjects (Table- 2).

Table-2 : Significance of difference between the initial and final test means of Experimental and Control groups in height, weight and body surface area.

Parameters	Initial Test	Final Test	DM	σ DM	t-ratio
Exp. Weight (kg.)	42.81	44.01	1.2	.69	1.74
Cont. weight (kg.)	44.87	45.25	0.38	.47	.81
Exp. Height (cm.)	157.75	157.94	.19	.96	.197
Cont. height (cm.)	158.62	158.95	.33	.93	.354
Exp. B.S.A (m^2)	1.396	1.421	0.025	0.0114	2.19
Cont. B.S.A (m^2)	1.399	1.407	0.008	0.012	0.66

t.05 (7) = 2.36

It was obtained that mean inter ventricular septum (IVS) thickness (mm) of experimental and control groups were initially 8.5 mm and 8.625, respectively; and, after the treatment period, it were 8.75 mm and 8.75mm; and t- ratio yielded insignificant values of 1.79 and 1.25, respectively. The Left Ventricular Posterior Wall (LVPW) thickness (mm), of experimental and control groups, were significantly unchanged ($t<0.05$).The mean left ventricular muscle (LVM) mass of experimental and control groups were 155.232 and 158.221 gms, respectively; which was significantly increased following Interval Training in case of experimental group ($t>0.05$). The mean Vo2 max (lit/min) of the training group was increased from 2.562 to 2.969 lit/min, following training, which was significant as the mean difference (13.318) was higher than the tabulated value (Table-3), whereas the control group showed insignificant change.

Table-3 : Significance of difference between the initial and final test means of Experimental and Control groujps in LVPW, IVS thickness, LV Mass and Vo_2 max.

Parameters	Initial Test	Final Test	DM	σ DM	t-ratio
Exp. LVPW (mm)	8.562	8.875	0.313	0.14	2.23
Cont. LVPW (mm)	8.375	8.500	0.125	0.10	1.25
Exp. IVS (mm)	8.500	8.750	0.250	0.14	1.79
Cont. IVS (mm)	8.625	8.750	0.125	0.10	1.25
Exp. LVM mass (gm)	155.232	168.55	13.318	5.26	2.53 *
Cont. LVM mass (gm)	158.221	157.62	0.601	4.8	0.12
Exp. Vo_2 max (lit/min)	2.562	2.969	0.407	0.035	11.63 *
Exp. Vo_2 max (lit/min)	2.566	2.577	0.011	0.02	0.55

** Significant at 0.05 level*

t.05 (7) = 2.36

After the treatment period, the IVS and LVPW thickness were not changed significantly. The athletes who participate in the endurance type events or the individual who participate in isotonic type of activity, their cardiac hypertrophy occurs mainly by increasing the left ventricular volume, not by thickening of left ventricular muscle. Peliccia (1991) found LV wall thickness of 13 to 16 mm in some athletes without physiological findings, using non-invasive diagnostic methods. Rost (1982) also found the greatest wall thickness in rowers; whereas, cyclists and long distance runners had the greatest body dimension-related values. The LV wall thickness, in endurance trained athletes, seems to be similar to that of controls (Maron-18). The findings of IVS and LVPW were found to be in agreement with the views of Rubal and co-worker (1986), Wolee (1985), Ricci (1982), Adams and co-workers (1981), Paronnet (1981) and Urhausen & Kinderman (1992).

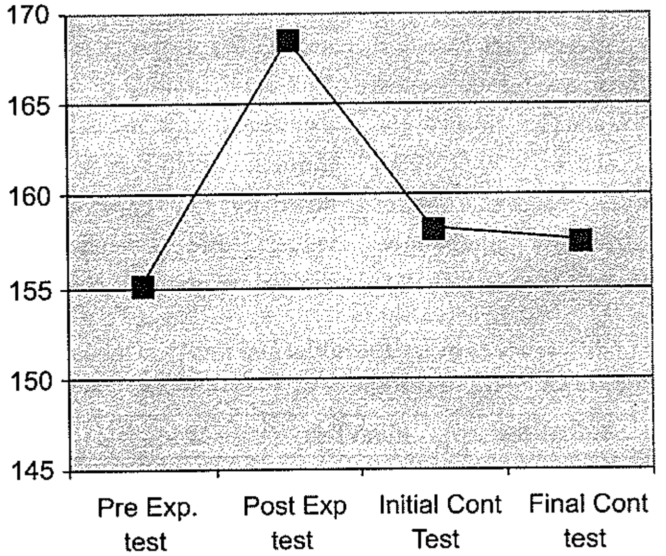

Fig-1 Comparison of Left ventricular muscle mass (gm) of the subjects

The left ventricular muscle mass (LVM) of the experimental group showed significant increment in contrast to the control group. Figure 1 represents the comparison of LVM of the subjects. The calculated LVM of the experimental subjects might have changed due to insignificant increase of IVS and LVPW. The LVM increment was probably due to the adaptive change of the experimental subjects following training. Dickhuth (1985) reported that trained LVM may be up to 75% greater than in untrained persons. All parts of the heart are enlarged similarly, in contrast to many pathological changes. This uniform enlargement has been confirmed by two-dimentional echocardiography (Hauser et al, 1985) children and adolescent are also likely to develop same cardio circulatory adaptations to endurance training, including the heart enlargement, as adults (Rost, 1982).The findings of this parameter were found to be in agreement with the views of Rubal (1986) DeMaria (1978) Maron (1986), Snoeckx (1982) and Mandigou (2002).

The VO2max of the experimental subjects improved significantly, following training, in contrast to the control group (Table-3). Several factors determined the rate at which O2 may be supplied active tissue and these must be properly co-ordinated and integrated with the work of muscle if the body is to attain its highest efficiency. The several contributing factors are (i) Ventilation of lung, which ordinarily increases with the increase in the load of work; (ii) O2 carrying capacity of the blood, determined by the haemoglobin content of the blood; (iii) Unloading of Oxygen at tissue level, during activity; (iv) Minute volume of the heart during exercise, cardiac out, runs parallel to the consumption of O2; and (v) increase in muscle mitochondria.

The significant increase of VO2max of experimental group, following training, may be due to above mentioned reasons and adaptation to training in case of experimental subjects. The finding of VO2max was supported by the findings of Vaccaro (1987) and McArdle, Katch & Katch (2007) and Esteban et al (2002).

CONCLUSION

The maintenance of a constant internal environment of a cell, during transition from rest to vigorous exercise, necessarily represents a tremendous challenge to the circulatory and respiratory systems. The development of the so-called athlete's heart, in highly trained athletes, depends on the intensity and duration of training. The Interval Training for moderate to long duration, with 60 to 80% intensity, plays unique role for cardiological adaptation. The uniformity enlarged and healthy heart is associated with enhanced performance and it is characterised by an increase of left ventricular muscle mass .In endurance trained athletes, the echocardiographic measures increase as parallel to the body dimensions.

Among 16 adolescent boys, 8 subjects were treated as experimental group and remaining 8 were acted as control group. After applying interval training for 12 weeks, the initial and final test of the criterion parameters of control and experimental subjects of the study were obtained, and the standard statistical calculations were done, for interpretation the results of the study.

Height, Body Weight and Body Surface Area of the subjects were not changed significantly in the case of experimental group, following the Interval Training.

The Thickness of the Inter-Ventricular Septum and the Left Ventricular Posterior Wall of the subjects did not change significantly; whereas, the Left Ventricular Muscle Mass of the experimental subjects increased significantly, due to the interval training loads.

The Maximum Volume of Oxygen Consumption of the experimental subjects showed significant improvement, following Interval Training.

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