DISCUSSION
DISCUSSION

In response to various types of exercise training respiratory efficiency and cardiovascular efficiency tests were performed before and after exercise training. The changes were noted and results were analysed. Only those tests where significant changes were observed, are discussed here.

(A) RESPIRATORY EFFICIENCY TESTS:

1. Forced Vital Capacity (FVC) in ml

The normal range for healthy adult males is 3000 to 5000 ml. The average is 4600 ml.

Forced vital capacity depends upon following changes in thoracic cage and in other body systems.

(a) Increased expansion and contraction of lungs.
(b) Increased elasticity of joints concerned with respiratory movements.
(c) Increased power of contraction and relaxation of respiratory muscles.
(d) Compliance of lungs and chest wall.

These are significantly increased in response to whole body (upper limb and lower limb exercise on
Hero Allegro exerbike and walking) and walking exercise training in test subjects. Since this test was done on male subjects only the results are shown for males only (Table No. 10; Graph No. 2). Similar changes are expected in females also.

Since whole body and walking exercises involve most of skeletal muscle mass, the effects of these exercises are significant on this parameter.

Similar findings have been reported by Lakhera S.C. et al., (1994) and Ries A.L. et al., (1988). They have given similar reasons for the increase. They have also mentioned following important points:

(a) Running training during growth may help in developing a reduced resistance to expiration and greater endurance in respiratory muscles.

(b) An improved ventilatory muscle endurance was also seen which helped the activities of daily living.

Lake F.R. et al., (1990) and Knox A.J. et al., (1988) have also worked on the same test, however, their findings are not similar to our findings because of following reasons:
(i) Work was done on patients with chronic air flow obstruction.

(ii) The training period was shorter than in our case.

(iii) In disease their respiratory muscles are weak.

 Forced expiratory volume in one second (FEV₁) in ml.

The normal range for healthy adult males is 2000 to 4000 ml. The average is 3,600 ml.

Forced expiratory volume in one second (FEV₁) depends upon following factors.

(a) Airway resistance and expansibility of lungs.
(b) Lung compliance (lung expansibility).
(c) Contraction power of respiratory muscles.

FEV₁ is significantly increased in response to whole body, combined limbs (Rowing and Pedaling) and walking exercise training in test subjects (Table No. 10; Graph No. 3). In this group testing was done with BENEDICT ROTH RECORDING SPIROMETER.

During the later part of study SPIROMETER
SP-1A (Battery operated digital spirometer for measurement of $\text{FEV}_1$ in liters) was used (Dearnaley D. P. et al., 1989). Since this instrument is more sensitive, other groups (Group II male and female subjects) were studied on this and results obtained (Table Nos. 16 and 22; Graph Nos. 15 and 24).

The results were similar in case of male subjects in both groups, however in case of females the response was obtained only in case of combined limbs and walking exercise training. This was not obtained in the group of female subjects in whole body exercise training, perhaps this group of subjects had not undergone the training seriously (Table No. 22, Graph No. 24).

Similar findings have been reported by Knox A.J. et al., (1988); McGavin et al., (1976); Chatterjee S., (1993-1994) and Lakhera S. C. et al., (1994). Confirming that in response to above mentioned exercise training air way resistance is decreased, lung expansibility is increased and lung compliance is also increased. There is better contraction power of respiratory muscles. This is due to increased elasticity of joints concerned with respiratory movements leading to greater expansion and recoil of thoracic cage. Endurance
of respiratory muscles is also increased. Gimenez M. et al., (1992); Lake F.R. et al., (1990) and Clark C.J., (1992) have also worked on the effects of exercise training on FEV₁. Although they have noted slight improvement in FEV₁ in asthmatic cases. However, the effect was not significant. They have assigned respiratory muscle weakness as the reason for this.

3 FEV₁/FVC %

The normal range for healthy adult males is 80 to 85 %. The average is 84 %. FEV₁/FVC % tells about contraction power of expiratory muscles and elastic recoil tendency of lungs.

These are significantly increased in response to whole body and combined limbs exercise training in test subjects of this study. Since this test was done in male subjects only the results are shown for male only (Table No. 10, Graph No. 4). Similar changes are expected in females also.

Whole body and combined limbs exercise training increases contraction power of expiratory muscle and also increases elastic recoil tendency of lungs.

Similar findings have been reported by
Chatterjee S., (1993-94) and Lakhera S.C. et al., (1994). They have given similar reasons for the increase. They have also mentioned following important points:

(a) Physical training improves respiratory muscles endurance.

(b) Running training during growth may help in developing a reduced resistance to expiratory muscles and greater endurance in respiratory muscles.

Ries A. L. et al., (1988) have also worked on the same test however, their findings are not similar to our findings because of following reasons:

(1) Their work was done in patients with CAO (Chronic Airway Obstructive diseases).

(2) In CAO patients the effect of exercise training is not marked on FEV₁/FVC % because their respiratory muscle are weak. In asthma and emphysema of lungs this recoil tendency is reduced and airways are constricted respectively and thus FEV₁/FVC % is reduced.
The normal range for healthy adult males is 5.0 to 7.5 litres/second. The average is 5.23 litres/second. The mean forced expiratory flow between 0.2 litre and 1.2 litre of FVC [\(\text{FEF}(0.2-1.2\text{L})\)] in litres/second is significantly increased in response to whole body and combined limbs exercise training. This depends upon:

(a) Airway resistance.

(b) Contraction power of expiratory muscles.

(c) Compliance of lungs and thorax.

This shows that whole body and combined limbs exercise training decrease airway resistance, increase contraction power of expiratory muscles and increases expansibility of lungs and thorax (Table No. 10; Graph No. 5).

Similar findings have been reported by Chatterjee S., (1993-94) and Ganguli A. K., (1990). They have given similar reasons. They have also mentioned that:

(a) Physical training improves respiratory muscles endurance.
(b) Decreased airway resistance.
(c) Increased elasticity of lungs and thorax.

\[ V_{max} \text{ 25\% (Maximum expiratory flow at 25\% of FVC)} \]

in litre/second

The normal range for healthy adult male is 3.0 to 7.5 litre/second. The average is 4.5 litre/second. This test depends upon following factors:

(a) Activity of the expiratory muscles.
(b) Airway resistance, pulmonary tissues and chest wall resistance.
(c) The work done by the respiratory muscles in overcoming elastic tissue resistance and airway resistance.

The result is significantly increased in response to combined limbs and walking exercise training in test subjects indicating above effects on trained subjects (Table No. 10; Graph No. 6).

In available literature work on this test could not be found.
$V_{max}$ 75% (Maximum expiratory flow at 75% of FVC) in litre/second.

The normal range for healthy adult males is 1.5 to 3.5 litre/second. The average is 1.6 litres/second.

This test depends upon following factors:

(a) The patency of smaller air ways at the time of forceful expiration.
(b) Recoil tendency of lungs.
(c) Contraction power of respiratory muscles.

There was significant increase in findings of this test in combined limbs, upper limb and lower limb exercise training in male subjects (Table No. 10; Graph No 7), it is postulated that these exercises are more effective in opening smaller bronchi and bronchioles.

7. MVV (Maximum Voluntary Ventilation) in Litre/minute

The normal range for MVV in healthy adult males is 100 to 180 litre/minute. The average is 140 litre/minute. MVV is significantly increased in response
to whole body exercise training in test subjects. Since this test was done on male subjects only the results are shown in (Table No. 10; Graph No. 8).

The maximum voluntary ventilation (MVV) (also referred as maximal breathing capacity) depends upon:

(a) The factors concerned with forced vital capacity.
(b) Mechanical properties of lungs and chest wall.
(c) Voluntary effort of breathing as rapidly and as forcefully as possible.
(d) Amount of co-ordination with subject for maximum rate and depth of breathing.

These are significantly increased in response to whole body exercise training in test subjects (Table No. 10; Graph No. 8). Similar results have been reported by Chatterjee S., (1983-94); DAs Gupta P.K. and De A. K., (1991); Lakhera S. C., (1994) and Casaburi R. et al., (1989). They mentioned that by improving MVV more oxygen will be available for active muscles during strenuous Physical work.

Findings of Clark C. J., (1992) are not
similar to us because the work was done on asthma cases who have greater air way resistance and their respiratory muscles are weak. It has been shown by Chatterjee S., (1993-94) that in tobacco and cigarette smokers M.V.V. is reduced because there is secretion in respiratory passages, these passages are narrowed and amount of carboxy haemoglobin is increased. Similar results have been reported in smoker athletes also by above scientists.

8. Breath Holding Time (BHT) in Sec.

The normal range for healthy adult males is 30 to 60 seconds. The average is 50 to 55 seconds.

Breath holding time is significantly increased in response to whole body, combined limbs; walking, upper limb and lower limb exercise training in test subjects. The results are shown in Table No. 10 and Graph No. 9.

Breath holding time depends upon following factors:

(a) $PCO_2 : CO_2$ build up will be less if cardio-respiratory efficiency is better and in this
condition a person will be able to hold the breath for longer time.

(b) Breath holding will bring about a fall in $P_O_2$, this will act through chemoreceptors of carotid bodies and aortic bodies and will force a person to take breath ending the process of breath holding.

(c) Impulses from stretch receptors of lungs and thoracic wall muscles also stimulate inspiratory centre.

(d) $P_CO_2$ rise stimulates inspiratory centre directly as well as reflexly through carotid bodies and aortic bodies.

(e) Test training, will-power and co-operation from the subjects will also increase breath holding time.

The breath holding time increases in whole body, combined limbs, walking, upper limb and lower limb exercise training of test subjects.

Similar findings have been reported by Levine S et al., (1986), Chatterjee P. et al., (1975); Astrand P. O. (1960; McConnell A. K. and Semple E.S.G., (1989). They have given similar reasons for the improvement.
They have also mentioned that:

(a) Exercise training decreased arterial PCO$_2$.
(b) Exercise training increased will power and co-operation from subjects.
(c) Exercise training might alter the responsiveness of medullary and/or systemic arterial chemoreceptors with consequent prolongation of breath holding time.
(d) Air way resistance is reduced.

9. Respiratory Endurance Test (40 mmHg) in Sec

The normal range for healthy adult males is 20 to 60 seconds. The average is 52 seconds.

The respiratory endurance test is significantly increased in response to whole body, walking, upper limb and lower limb exercise training in test subjects. The results are shown in Tables No. 10 and Graph No. 10.

The respiratory endurance test depends upon the factors already mentioned with breath holding time test. Along with that following additional factors also operate:
(a) Strength and contraction power of respiratory muscles.

(b) Patency of airways.

These are better by whole body, walking, upper limb and lower limb exercise training of test subjects.

Similar findings have been reported by Richard Dekhuijzen, P. N. et al., (1991); Levine S. et al., (1986) and Mc Connell A. K., (1989). They have given similar reasons for the increase. They have also mentioned following additional factors:

(a) Exercise training causes significant improvement in respiratory muscles strength and endurance due to increased minute ventilation during training sessions.

(b) Exercise training caused better \( O_2 \) and \( CO_2 \) diffusion through respiratory membrane of alveoli.

Lake F. R. et al., (1990) have also worked on the same test however, their findings are not similar to our findings due to work was done in patients with chronic air flow obstruction (CAO).
Maximum Expiratory Pressure (MEP) in \text{mmHg}

The normal range for healthy adult males is 80 to 140 \text{mmHg}. The average is 120 \text{mmHg}.

Maximum expiratory pressure (MEP) is significantly increased in response to lower limb exercise training in test subjects. The results are shown in male subjects (Table No. 10 and Graph No. 11).

Maximum expiratory pressure (MEP) depends upon following factors.

(a) Strength; endurance and contraction power of respiratory muscles.
(b) Patency of smaller and larger airways.
(c) Elastic nature of tissues of lungs and thorax.

Above factors are expected to improve by exercise training.

Similar findings have been reported by Black L. E. and Hyatt R. E., (1969); Chen H. and Kuo C., (1989); Copestake and McConnell, (1993). They have given similar reasons for this improvement.
Lake F. R. et al., (1990) have worked on the same test however, their findings are not similar to our findings due to following reasons:

(a) Work was done in patients with chronic air flow obstruction (CAO).

(b) In patients with CAO, the recoil of lungs is reduced the expiration is achieved by breathing in more air (trapping of air) and thus stretching the lungs at higher volumes.

11 Peak Expiratory Flow Rate (PEFR) in litre/minute

The normal range for healthy adult males is 500 to 622 litre/minute. The average is 550 litre/minute.

Peak expiratory flow rate is significantly increased in response to whole body, combined limbs and walking exercise training in group II male subjects (Table No. 16 and Graph No. 16).

It is significantly increased in response to whole body and walking exercise training in group II. Female subjects (Table No.22, Graph No. 25).

Peak expiratory flow rate depends upon
following factors:

(a) Height, weight and age (Rao N.M. et al., 1981).
(b) Respiratory muscles strength.
(c) Airway resistance.
(d) Elastic recoil of lungs.
(e) Body fat content (De A.K. 1992).
(f) Variability of extra and intra thoracic pressure (Bosse C.G. and Criner G.J., 1993).

These are improved by whole body, combined limbs and walking exercise training in group II. Male subjects and whole body and walking exercise training in group II female subjects.

In male subjects significant improvement was observed in whole body, combined limbs and walking exercise training where as in the female subjects the improvement was observed only in whole body and walking exercise training. It is expected that the improvement should have been in combined limb exercise also which was done on Hero Allegro exerbike. It appears that will power and co-operation in female subjects of this particular group of subjects were lacking.
Similar findings have been reported by De A. K., (1992) and Chatterjee S., (1993-94). They have given similar reasons for increase.

Knox A. J. et al., (1988) have worked on the same test however, their findings in response to exercise training are not similar to our findings due to following reasons:

(a) Their work was done in patients with chronic obstructive airway disease.
(b) The patients were under drug treatment and the drug itself could affect the results of this test.

B CARDIAC EFFICIENCY TESTS:

1. Harvard Step Test (Fitness Index) =

\[
\frac{\text{Duration of exercise in seconds}}{2} \times \frac{\text{sum of recovery pulse counts}}{\text{x 100}}
\]

The normal range of fitness index for healthy males is 50 to 80. More than 80 is better. Harvard step test (fitness index) is significantly increased in response to whole body, combined limbs, walking and lower
limb exercise training in test subjects. This test was done on healthy young male subjects, the results are given in Table No. 10 and Graph No. 1. Similar changes are expected in females also.

This test depends upon following factors:

(a) Pulse recovery time:
If pulse recovery time is less when the exercise is over. Harvard step test (fitness index) is better (Johnson B. L. and Nelson J. K., 1982).

(b) Cardio-respiratory efficiency increase:
There will be less CO$_2$ build up in the blood during exercise, consequently PCO$_2$ will come down to normal resting value earlier, reflex stimulus to Cardio-accelerator centre will be less and it will take less time for pulse to return to normal and the Harvard step test (fitness index) will increase.

(c) Maximal O$_2$ consumption:
Exercise training increased maximal O$_2$ uptake. This will decrease pulse recovery time.

Similar findings have been reported by
Banerjee P. K. et al., (1970); Rythming I., (1953) and Banerjee P. K. et al., (1983). They have given similar reasons for increase in Harvard fitness index after exercise training in sedentary humans.

2. **Resting Pulse Rate/Minute**

The normal range for healthy adult males is 70 to 80 beats/minute. The average is 75 beats/minute. Resting pulse rate is significantly decreased in response to whole body, combined limbs, walking, upper limb and lower limb exercise training in group II male subjects (Table No. 16, Graph No. 12) and group II female subjects (Table No. 22 and Graph No. 21). It is also significantly decreased in response to combined limbs and walking exercise training in group III male subjects (Table No. 25).

Resting pulse rate depends upon following factors:

(a) Resting Vagal and Sympathetic tone, out of these Vagal tone predominates (John B. W., 1984). In response to exercise training Vagal tone increase and sympathetic tone decreases.
(b) In response to exercise training, concentration of circulatory catecholamines level decreases.

(c) Reflex activation of heart rate due to cardiovascular and pulmonary reflexes is reduced and the effect of stretch receptors of muscles and joints on increase in heart rate is also reduced.


Gimenez M., (1992); Saltin B. et al, (1968) and Jones D. R. et al, (1989) have also worked on the same test however, their findings are not similar to our findings because:

(a) They used low load of work and period of training was shorter than our training
period.

(b) Work was done in patients with postpoliomyelitis sequelae.

3. Resting Systolic Blood Pressure in mmHg

The normal range for healthy adult males is 90 to 120 mmHg. The average is 120 mmHg. Resting systolic blood pressure is significantly decreased in response to whole body, combined limbs, walking upper limb and lower limb exercise training in group II male subjects (Table No. 16 and Graph No. 13). It is also significantly decreased in response to combined limbs exercise training in group III male subjects (Table No. 25).

It is significantly decreased in response to whole body, combined limbs, walking and lower limb exercise training in group II female subjects (Table No. 22 and Graph No. 22).

Resting systolic blood pressure depends upon following factors:

(a) Central and peripheral mechanisms of regulation of blood pressure.
(b) Peripheral vascular resistance and flow through the peripheral circulation.
(c) Mechanical efficiency of heart.
(d) Cardiac output.

Exercise training decreased the magnitude of central and peripheral mechanisms to raised systolic blood pressure. This also reduced peripheral vascular resistance, cardiac output and it increased the mechanical efficiency of heart.

The upper limb exercise training did not produce a significant decrease in resting systolic B. P. in females. This may be due to lack of co-operation on the part of female subjects.

Similar findings have been reported by Jennings G. et al., (1986); Scheuer and Tipton, (1977) and Peronnet F. et al., (1981). They have given similar reasons for the significant decrease in resting systolic B. P. They have also mentioned following additional factors:

(a) Decrease in sympathetic tone will reduce total peripheral resistance.
(b) There is a change in baroreceptor activity.

(c) After the period of exercise training, most organisms show fairly prolonged decrease of blood pressure. Exercise training reduced activation of stretch receptors of muscles and joints, leads to a central release of endorphins which tend to cause mental relaxation and also damp sympathetic activity. This reduces blood pressure (Flokow B. and Svanborg, 1993; Herber and Sutton, 1984; Hokfelt T. et al, 1980 and Allen M., 1983).

Hoof R. V. et al, (1989); Jones D. R. et al., (1989); Silber D. et al., (1991) and Martin III W. H. et al., (1987) have also worked on the same test however, their findings are not similar to our findings due to following reasons:

(a) Low load of work and short period of exercise training.

(b) Work was done in patients with postpoliomyelitis sequelae.

4. Resting Diastolic Blood Pressure in mmHg

The normal range for healthy adult males is
60 to 90 mmHg. The average is 80 mmHg. Resting diastolic blood pressure is significantly decreased in response to whole body, combined limbs and walking exercise training in group II male subjects (Table No. 16, Graph No. 14). It is significantly decreased in response to whole body and walking exercise training in group II Female subjects (Table No. 22, Graph No. 23).

Resting diastolic blood pressure depends upon following factors:

(a) The factors concerned with resting systolic blood pressure.

(b) This mainly depends upon peripheral resistance to blood flow, which in turn depends upon sympathetic tone.

Similar findings have been reported by Jennings G. et al., (1986); Hoof R. V. et al., (1989); Jones D. R. et al., (1989); Scheuer J. and Tipton C. M., (1977). They have given similar reasons for the significant decrease in resting diastolic pressure. The additional factors given by Folkow B. and Svanborg, (1993); Harber V. J. and Sutton J. R., (1984); Hokfelt T.
et al., (1980) are given below:

Exercise training reduced activation of stretch receptors of muscles of joints, leads to a central release of endorphins which tend to cause mental relaxation and also damp sympathetic activity. This reduces diastolic blood pressure.

Saltin B. et al., (1968); Silber D. et al., (1991) and Martin III W. H. et al., (1987) have also worked on the same test however, their findings are not similar to our findings due to short period of training in comparison with our training period.

C EXERCISE PERFORMANCE TESTS

1. Walking tests

(a) 6 MWD (six minute maximum walking distance) in meters.

(b) 12 MWD (Twelve minute maximum walking distance) in meters.

6 MWD and 12 MWD are significantly increased in response to whole body, combined limbs and walking exercise training in group II. Male subjects (Table No.
Walking tests depend on various factors, including motivation, general endurance, respiratory function, cardiovascular fitness, Maximal O$_2$ consumption daily physical activity, muscular efficiency and many other factors. These are improved by exercise training in group II male subjects.

Similar findings have been reported by Lake F. R. et al., (1990); Knox A. J. et al., (1988); Butland R. J. A. et al., (1982); Lipkin D. P. et al., (1986); Richard Dekhuijzen P. N. et al., (1991) and Claassen H. et al., (1989). They have given similar reasons for this improvement. They have also mentioned following additional factors:

(a) Walking distance is correlated with FEV$_1$, FVC and PEFR. Due to training the above Harvard fitness index and muscular efficiency are significantly increased, which in turn increase maximum walking distance for 6 to 12 minutes.

(b) The individual variance of 12 minute maximum walking test was slightly greater than that
of the six minute test as such six minute maximum walking distance test seems to be more reliable for testing the effect of training.

Evans W. V., (1984) has worked on six minute test however, his findings are not similar to our findings due to following reasons:

(a) Work was done in patients with CAO.
(b) The effect of drugs used for treatment may have affected the results.

2. Six Minute Maximum Bicycle Ergometer Test (6 MBE) in Kms.

The details of performance of this test have been described in Material and Methods chapter of this work. Six minute bicycle ergometer test (6 MBE) significantly increased in response to whole body, combined limbs, walking and lower limb exercises training in group II male subjects (Table No. 16; Graph No.19). It is significantly increased in response to whole body and combined limbs exercise training in group II female subjects (Table No. 22; Graph No. 26).
Six minute bicycle ergometer test (6 MBE) depends upon the same factors which have already been mentioned with 6 MWD and 12 MWD tests.

Similar findings have been reported by Ahmaidi S. B. et al., (1993); Ekblom B. et al., (1968); Richard Dekhuijzen P. N. et al., (1991); Davey P. et al., (1992); Giannuzzi P. et al., (1992); Patessio A. et al., (1992) and Jones N. L. et al., (1985). They have given similar reasons for increase in 6 MBE after exercise training. They have also given following additional factors:

(a) Increased work capacity due to exercise training increased blood supply to the skeletal muscles of legs and increased the level of energy producing enzymes particularly fatty acid oxidative enzymes. Exercise training also resulted in greater delivery and extraction of oxygen in the legs. This delayed anaerobic glycolysis.

(b) Exercise training increased capacity for aerobic work by increasing capillary density, number of mitochondria and the concentration of oxidative enzymes and glycogen store.
Lake F. R. et al., (1990) and Ries A. L. et al., (1988) have also worked on the same test however, their findings are not similar to our findings due to work being done in patients with Chronic obstructive pulmonary disease.

3. Six Minutes Maximum Arm Ergometer Test (6 MAE) in Nos.

6 MAE test is significantly increased in response to whole body, combined limbs and upper limb exercise training in group II male subjects (Table No. 16; Graph No.20).

6 MAE test depends upon following factors in addition to the factors already mentioned.

(a) Upper arm training has greater effect on ventilatory muscle endurance.

Similar findings have been reported by Lake F. R. et al., (1990) and Ries A. L. et al., (1988). They have given similar reasons for increase 6 MAE Test after exercise training.

(D) TREAD MILL WALKING EXERCISE FATIGUE TIME (TWEFT) IN SECONDS.

TWEFT is significantly increased in response
to combined limbs exercise training in group III male subjects (Table No. 25; Graph No. 27). It depends upon following factors which are affected by the training in the manner given below:

(a) Maximal exercise tolerance is increased.
(b) Mechanical efficiencies of joints and muscles is increased.
(c) Maximal $O_2$ uptake is reduced.
(d) Blood lactate level rise is reduced hence fatigue time is increased.
(e) Extraction of $O_2$ by working muscles is increased but utilization is decreased.
(f) $CO_2$ output is decreased.
(g) Cardio-respiratory fitness is increased.

Similar findings have been reported by Hardman A. et al., (1989); Lipkin D. P. et al., (1986); Das Gupta P. K. and De A. K., (1991); Davey P. et al., (1992); Jones D. R. et al., (1989) and Kiens B. et al., (1993). They have given similar reasons for significant increase in "Tread mill walking exercise fatigue time" (TWEFT) after exercise training.

It is also observed in our study that Maximal
systolic blood pressure immediately after treadmill exercise was less in comparison to maximal systolic blood pressure immediately after treadmill exercise, after combined limbs exercise training (Table No. 23).

Similar results have been reported by Hoof R. V. et al., (1989). This could be explained on the basis that cardio-respiratory and muscular efficiency as well as other physiological, anatomical and biochemical changes are more marked in cases of combined limbs exercise training on exerbike in comparison to walking exercise training. Apparently combined limbs exercise training on exerbike is more strenuous in comparison to walking.

**PSYCHOLOGICAL EFFECTS OF EXERCISE TRAINING**

**GOLDBERG HEALTH QUESTIONNAIRE (G.H.Q.) SCORE.**

This test was used as described by Goldberg et al, (1979) before and after exercise training. This (G.H.Q.) is a health questionnaire. It is an objective type scoreable test and depends upon self reporting. Each subject has to answer all questions on a four point scale.
(G.H.Q.) score is significantly decreased in response to walking exercise training in Group III male subjects (Table No. 25 and Graph No. 28).

(G.H.Q.) score depends upon following psychological aspects:

(a) The concept of body-mind relationship.
(b) General level of social adjustment.
(c) Emotional variables (Depression, irritation, interest in work, joy etc.)
(d) Fatigue (of psychological nature).
(e) Anxiety reduction.

These are improved by physical training in sedentary humans.

Similar findings have been reported by Martinsen E. W. et al., (1985); Richard Dekhuijzen P. N. et al., (1991) and Edwards R. H. T. et al., (1983). They have given similar reasons for significant decrease in (G.H.Q.) score after exercise training.