Chapter III

PROCEDURE

In this chapter the procedure adopted for the selection of subjects, selection of physical and physiological variables, criterion measures, administration of tests, experimental design, statistical techniques for analysing the data and training programmes are described.

Subjects

Two hundred and twenty, newly enrolled recruits in the branch of Artillery of the Indian Army were selected for the experiment of this study with the permission of Army Headquarters, Military Training-8. The recruits were enrolled from different States/Union Territories viz. Andhra Pradesh, Arunachal Pradesh, Assam, Bengal, Bihar, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Pondicherry, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh etc. It was ensured from the service health examination record of the subjects completed during enrolment in the Army that all the
subjects were medically fit to undergo physical and allied training during the Recruits Training Programme.

The requirements of the project was explained to ensure maximum co-operation from the Commanding Officer, Training Officer, Physical Training Officer, Instructional Staff, subjects and convinced them so that there was no ambiguity among all the agencies and the authority regarding their maximum possible cooperation for proper implementation of the physical training programmes and to get positive response from the subjects for successful completion of the investigation.

A thorough orientation of the requirement of experimental procedure, testing as well as training schedule, were explained to them. Proper hygienic and sterilization care was taken while taking blood sample and lung tests. The Commandant Artillery Centre exhorted each agency to co-operate in the project even though they might have to work hard to their utmost limit of capacity in the interest of scientific enquiry.

According to the enrolment records, the average age of the subjects was nineteen years ranging between seventeen and twenty one years.
The subjects were randomly divided into two different groups viz. control group and experimental group. Each group consisted of one hundred and ten subjects. The control group was imparted physical training as per the existing syllabus in vogue in the Indian Army for recruits physical training. The experimental group was trained with modern physical training programme prepared on scientific basis with the latest techniques by the investigator himself keeping in view all the feasibilities for further implementation in the army. The modern physical training programme was a combination of endurance training, circuit training, speed training, weight training and stretching exercises. Keeping in mind the aim of recruits training, subjects of both control and experimental groups were also put through the remaining military training which included mainly, drill, education, field craft and weapon training to bring them up to the desired standard to perform their duties efficiently and effectively as a soldier.

Measurements of experimental variables were taken at the beginning and after an experimental period of ten weeks. This period commenced from February 1, to April 23, 1988. The actual ten weeks duration of the
experiment was from February 7, to April 16. This time was chosen for the experiment because of the favourable climatic conditions for physical training at Hyderabad and availability of subjects.

**Selection of Variables**

The research scholar gleaned through all the scientific literature pertaining to the physical fitness from books, magazines, journals and periodicals. The selection of variables was done in consultation with experts keeping the feasibility criterion in mind specially in the cases of availability of testing instruments, acceptability to the subjects and the legitimate time that can be devoted for tests in relation to the treatment requirements and to keep the entire study unitary and integrated.

With the above criteria in mind the following motor components, physiological variables were selected as they are directly related to the total fitness of an individual and are also associated with the efficient functioning of the circulatory and respiratory systems.

**Motor Components**

1. Strength:
   a) Arms Strength (Pull Ups)
b) Abdominal Strength (Sit Ups)
c) Grip Strength
d) Back Strength.

2. Power:
   a) Sargent Jump
   b) Margaria's Anaerobic Power Test.

3. Speed:
   a) 50 Meter Run.

4. Flexibility:
   a) Spine Flexibility
   b) Shoulder Flexibility
   c) Sit and Reach.

5. Agility:
   a) Boomerang Run Test
   b) Squat Thrust.

6. Balance:
   a) Dynamic Balance.

**Physiological Variables**

1. Tidal Volume
2. Vital Capacity
3. Maximum Breathing Capacity
4. Resting Minute Ventilation
5. Pulse Rate
6. Respiratory Rate
7. Haemoglobin Concentration
8. Cardio-respiratory Endurance

9. Breath Hold
10. Respiratory Endurance (40 mm)
11. Cardiac Assessment Factor
12. Reaction Time
13. Speed of Movement
14. Heart Rate after Exercise.

**Anthropometric Measurements**

1. Ponderal Index
2. Body Density
3. Fat Percentage.

**Reliability of Data**

The reliability of data was ensured by establishing the instrument reliability, tester competency, reliability of the tests and the subjects.

**Instrument Reliability**

The grip dynamometer, leg lift dynamometer and skin fold caliper for measuring grip strength, back
strength and skin folds to calculate body density were manufactured and supplied by Anand Agencies, Pune. The sphygmomanometer used to measure respiratory endurance (40 mm) was supplied by Bionix, Ernakulam, Cochin. The reliability and accuracy of these instruments were ensured by the manufacturers.

The timings for 50 meter run and boomerang run tests were measured with the synchronised stop watch of 1/100th of a second.

For measuring the speed of movement, trunk extension, shoulder flexibility and sit and reach, centimeter scale and stadiometer to measure height were also calibrated before use.

The weighing machine used in this study to measure weight of the subjects was also calibrated.

The expirograph used to measure tidal volume, vital capacity and maximum breathing capacity was manufactured by Toshniwal Instruments & Engg. Co. Its reliability was ensured by the manufacturers.

Electronics timer and footmats used to measure reaction time and to conduct Margaria's anaerobic power test were quite reliable as they were imported by the services sports Control Board.
The maximum heart rate after 5 minutes exercise on Harvard step test was recorded with the help of sport tester PE-3000 Heart Rater meter made in Finland.

Thus all the instruments used for measuring performance of the subjects on different variables were considered reliable and precise enough for the purpose of the study.

**Tester Competency and Reliability of Tests**

The tests competency was evaluated together with the reliability of the tests. To determine the reliability of tests, the performance of 10 subjects selected at random on the selected variables were recorded twice under identical conditions by the scholar.

A Pearson's product moment correlation was computed between the two measures of each variable and reliability co-efficients ascertained have been shown in Table 1 and Table 2.
<table>
<thead>
<tr>
<th>Components</th>
<th>Co-efficient of Reliability</th>
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<tbody>
<tr>
<td>Pull-ups</td>
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<td>Sit ups</td>
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<td>Grip Strength</td>
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<tr>
<td>Variables</td>
<td>Co-efficient of Correlation</td>
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<tr>
<td>Tidal Volume</td>
<td>.88</td>
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<td>Vital Capacity</td>
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<tr>
<td>Maximum Breathing Capacity</td>
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<tr>
<td>Resting Minute Ventilation</td>
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<td>Resting Pulse Rate</td>
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<tr>
<td>Reaction Time</td>
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<tr>
<td>Nelson Speed of Movement</td>
<td>.82</td>
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<tr>
<td>Heart Rate After Exercise</td>
<td>.94</td>
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<tr>
<td>Weight</td>
<td>.99</td>
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<tr>
<td>Height</td>
<td>.98</td>
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</table>
From the test retest co-efficient of correlation (Table 1 and 2) it was obvious that the tester reliability was significantly high in establishing the competency of the scholar to administer the tests.

The co-efficient correlation also indicated the reliability of the tests selected as very high correlations were obtained when the tests were repeated.

Subjects Reliability

The above test retest co-efficient of correlation also established that the reliability of subjects was significant at .01 level of confidence, as the same subjects were used under similar condition by the same tester and no motivational techniques were used during testing and training.

Criterion Measures

1. Arms and shoulder strength was measured with the correct executed pull ups (maximum) on the horizontal bar with overgrip.

2. Maximum number of correctly executed bent knee sit ups, measured the abdominal strength.

3. Grip strength was measured with the help of grip dynamometer and performance recorded in kilograms.
4. Back muscles strength was recorded in kilograms with the help of leg lift dynamometer.

5. Vertical distance covered/jumped by the subject using sargent jump, recorded in centimeters was used to measure explosive strength of the legs.

6. To measure power of the legs, Margaria's Anaerobic power test was used and power was computed with the formula as under:

\[
\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Body Weight} \times \text{Distance}}{\text{Average Time Seconds}}
\]

The scores were recorded in kilograms/meter/phi second.

7. Speed was measured in terms of time taken by the subject to run a distance of 50 meters recorded to the nearest $1/100$ of a second.

8. Vertical distance in centimeters from the ground to the extended chin raised upward along with chest from pronelying position was the measure of spine flexibility.

9. The distance recorded in centimeters between the hands after execution of the backward arms rotation measured the shoulder flexibility.
10. Forward bend of trunk in sitting position was selected to measure the flexion of trunk and extension of hamstring muscles. Measurement was recorded to the nearest 0.5 centimeter.

11. Agility was measured in terms of time taken by the subject to run over and under the fixed pattern of obstacles and recorded to the nearest 1/100th of a second.

12. Maximum number of correctly executed squat thrusts were used to measure the agility.

13. Points scored out of hundred by the subject while performing modified Bass dynamic balance test was the measure of balance.

14. The volume of air inspired and expired in one breath, was the tidal volume measured in liters with the help of Toshniwal Expirograph.

15. Maximum volume of air forcefully expired after maximum inspiration was measured with the help of Toshniwal Expirograph and recorded in liters was the vital capacity.

16. The amount of air the subject exhaled after maximal inhalation in one minute, measured with the help
of Toshniwal expirograph and recorded in liters was the maximum breathing capacity.

17. Minute ventilation was the volume of air that a subject inspired or expired in one minute, measured in liters and was calculated using the formula:

\[
\text{Minute Ventilation} = \text{Tidal Volume} \times \text{Respiratory Frequency}
\]

\[
\text{(Liters per minute)} \times \text{Liters} \times \text{Breaths p.min.}
\]

18. To analyse haemoglobin concentration, blood sample was taken by pricking the tip of finger and examined with the Sahli's method in which 100% reading corresponds to 17.3 grams of Hb per 100 ml of blood and an average normal sample of blood contains about 14.5 grams of Hb per 100 mililiter of blood.

19. Cardiorespiratory endurance was measured in distance covered in twelve minutes and was recorded to the nearest 10 meters.

20. Cardiac assessment factor was calculated with the under mentioned formula:

\[
\text{CAF} = \frac{(\text{Maximum Pulse Rate} - \text{Resting Pulse Rate})}{\text{Resting Pulse Rate}} \times 10
\]

21. The distance scores obtained by using the Nelson speed of movement of the hands test was converted
into time scores using the following formula, measured the speed of movement.

\[
\text{Time} = \frac{2 \times \text{Distance the Stick Falls}}{\text{Acceleration due to Gravity}}
\]

22. Reaction time was recorded as the average of three trials taken on the electronic reaction timer to the nearest 1/100 of a second.

23. The duration for which the subject held the breath by closing his mouth and nose was recorded to the nearest of 1/100 of a second.

24. Respiraotry endurance test was conducted with the help of sphygmononometer. The time for which the subject maintained the mercury level at 40 mm was recorded in 1/100 of the second.

25. Ponderal Index was computed by using the formula:

\[
\text{Ponderal Index} = \frac{\text{Standing Height}}{3/\text{Weight}}
\]

26. Body density computed from the skin fold measurements taken at four selected sites in the body namely biceps, triceps, subscapular and supra-iliac with the help of an equation devised by Durnin and
Womerslay. Different formulae for different age groups were applied such as:

a) Body Density for 17 to 19 years of age:
   \[1.1620 - 0.0630 \log (\text{Biceps} + \text{Triceps} + \text{Subscapular} + \text{Supra-iliac})\]

b) Body Density for 20 to 29 years of age:
   \[1.1631 - 0.0632 \log (\text{Biceps} + \text{Triceps} + \text{Subscapular} + \text{Supra-iliac})\]

c) Percent Body Fat = \left(\frac{4.57}{\text{Body Density}} - 4.142\right) \times 100

Collection of Data

The required data was collected by administering the field and laboratory tests for the selected variables before start of the experimental training and on completion of 10 weeks of the same. All the tests were administered at the athletics track and medical inspection room of the Artillery Centre, Hyderabad.

Before administration of the tests, all the subjects were briefed on the objectives and requirements of the

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variables that were to be tested. All the subjects were given enough time and practice to get well conversant with the desired test. The handling of apparatus and its procedure was explained to each subject prior to the administration of the pre and post tests.

**Experimental Design**

A random group design was adopted for this study. Equal number of subjects were assigned randomly to two groups of one hundred and ten subjects each. Experimental treatment was also assigned randomly to one of the groups and the other group served as the control group. The control group (group C) was administered the traditional physical training methods as per the existing syllabus of physical training for recruits in the Indian Army. The experimental group (group E) was administered the modern physical training programme i.e. a combination of endurance training, circuit training, speed training, weight training and stretching exercises.

The training was conducted for both the groups for ten sessions a week from Monday through Saturday. One session of forty minutes on each training day of the week in the morning and four sessions of one and half an hour duration in the evening. The reason for having
only four sessions in the evenings was that no training was conducted on Wednesdays and Saturdays as the evenings on these days were officially off for the subjects.

Measurement of motor components and physiological variables were taken before and after an experimental period of ten weeks. The subjects also underwent the remaining military training along with the experimental training so that their all activities remained uniform other than experimental training. The training programme for group C and group E are given in Table 3 and 6 respectively.

To find out the significance of pretest and post test differences if any of the effects of traditional training and modern training on the selected variables, the mean gains method was applied. To compare the significance of differences of performance between group C and group E, the 't' test was applied at .05 level of significance.

The secondary purpose of the study was to find out the relationship of selected physiological variables to motor fitness component, 'r' values were obtained by using Product moment correlation raw data method (zero order).
Procedure for Administration of the Tests

The detailed procedure followed for administration of the tests is given below:

**Physical Components**

**Pull Ups**

This test helps in measuring the strength and endurance of arms and shoulder muscles.

A horizontal bar was fixed at such a height so that the subject could freely hang on the bar with arms and legs fully extended and without touching feet to the floor. The subject was asked to grasp the bar with hands shoulder width apart in an overgrip position and maintained stationary hang position. From stationary hang position the subject was directed to pull his body up with the help of arms only until his chin was over the bar and then lower his body to the starting position. The whole movement was counted as one pull up. During this process the subject was not allowed to take swing and bend his knees. The subject was made to execute as many pull ups as possible with correct technique and without taking rest in between the repetitions. The number of
completed pull ups was recorded as final score of the subject.\(^2\)

**Bent Knee Sit Ups** (Abdominal Strength)

From a lying position on the back, the subject flexed his knees over the yard stick while sliding his heels as close to his seat as possible. The yard stick was held tightly under the knees until the subject was instructed to slowly slide his feet forward. At the point where the yard stick dropped on the mat, the tester marked the heel line and seat line in order to indicate how far the feet should remain from the seat during the bent knee sit up test. A helper held the subject's feet to give support. The hand fingers of the subject remained inter locked behind the neck and performed sit-ups by bringing in the body vertically upward (Fig.1). The exercise was repeated as many times as possible.\(^3\)

The total number of repetitions made following the above procedure were recorded as score of the subject.


However, repetitions were not counted when finger tips did not maintain contact behind the neck or when the upper body was not raised in or vertical position while the subject pushed off the floor with elbows.

**Grip Strength Test**

Fig. 1. Bent Knee Sit Ups.

Static strength of the back muscles was measured with the help of this test by using Log Dynamometer.

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However repetitions were not counted when finger tips did not maintain contact behind the neck or when the upper body was not raised in or vertical position while the subject pushed off the floor with elbows.

**Grip Strength Test**

The grip strength of the subject was measured with the help of grip dynamometer. The subject stood erect without any support, holding dynamometer in his right hand and thereafter in the left hand. Grip handle of the dynamometer was adjusted as per the size of hand of the subject. The elbow was slightly bent and hand described the sweeping arch downward as the subject squeezed the dynamometer (Fig.2). The subject was instructed not to touch or take support from any object while performing the test. Two trials were given and reading of the best trial was recorded to the nearest 0.5 kilogram as score of the subject.⁴

**Back Strength**

Static strength of the back muscles was measured with the help of this test by using Leg Dynamometer.

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However, repetitions were not counted when finger tips did not maintain contact behind the neck or when the upper body was not raised in or vertical position while the subject pushed off the floor with elbows.

**Grip Strength Test**

![Fig. 1. Bent Knee Sit Ups.](image)

**Back Strength**

Static strength of the back muscles was measured with the help of this test by using a Log Dynamometer.

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The subject assumed standing erect position with both feet on the base of the dynamometer and hands on front of the thighs, fingers extended downward. Then the chain was adjusted in such a way so that the handle level was just below the finger tips. The subject grasped the handle with over hand grip by slight flexion of the hip joint and then pulled the handle upward by using his upper back muscles without bending knees (Fig.3).

Three trials were given to all the subjects. At the end of maximum pulling effort; the reading on the scale was recorded in kilograms. The best of three trials was taken as the score of the subject.\(^5\)

**Sargent Jump**

This test was conducted to measure the power of the legs in jumping vertically upward. A scale in centimeters was marked on the smooth plank and fixed with the tree. The subject was asked to stand with one side towards the tree, heels closed and extended his arm upward keeping the heels on the ground to take the distance of reach (Fig.4). The subject then dipped his finger tips in powder and assumed proper position for

\(^5\)Ibid., p.130.
Fig. 3. Measurement of Back Strength.
Fig. 4. Sargent Jump (Standing Height).
jumping upward. He flexed his knees, took swing with arms and touched his finger tips at the peak height of his jump on the scale (Fig.4a). The distance between standing reach and jump was recorded to the nearest centimeter as score of the subject. 6

Three trials were given to each subject and best trial was recorded as the time score.

**Margaria's Anaerobic Power Test**

This test was conducted to measure maximal anaerobic leg power of the subject by using Margaria's anaerobic power test. The subject was weighted in Kilograms in the clothes and shoes he was to run. A stair case of 16 steps of a normal inclination with each step 20 centimeters high with two footmats and a timer sensitive to hundredth of a second was used to record the performance of the subject. The footmats were placed on the fourth and 12th step to start and stop the timer (Fig.5). The subject was asked to start 2 meters in front of the first step and run up the stairs as fast as possible running over two stairs at a time. The average time of three trials between fourth and 12th step were recorded to the nearest .01 second for calculation of

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Fig. 4a. Sargent Jump (Jumping Height).
vertical distance
8 steps x 20 cm each
= 1.6 metres.

fig. 5. margaria's anaerobic power test.

floor diagram.
power scores of each subject by using the following formula. 7

\[
\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Body Weight (kgs)} \times \text{Distance (Meters)}}{\text{Seconds}}
\]

50 Meters Run

This test was considered the most suitable test to measure the running speed component of physical fitness of the subjects. To avoid and minimize the effect of starting technique, all the subjects were given standing start. The equipment required were four stop watches and starting clapper.

Four subjects started together to have competitive performance. The subjects were asked to stand behind the starting line and to take a standing start. The clapper was clapped after the caution "ready" was given to the subjects. The starter stood at such a position so that the 'V' of the clapper (open clap) was visible to the time keepers. As the 'V' closed when the clap was executed, the time keepers at the finish line started the stop watches. The subjects sprinted as fast

7Ibid., p.459.
as possible across the finish line and the stop watches were stopped, as soon as subject's torso crossed the finish time. The time elapsed between starting signal (clap) until the subject crossed the finish line was recorded to the nearest one hundredth of a second as the running speed score.\textsuperscript{8}

**Spine Flexibility Test**

The subject assumed a prone position (face downward) on a mat, with his hands resting on the small of his back then he raised his trunk upward as high as possible off the floor. An assistant held the subject by placing his hands on the back of the legs. The investigator positioned himself on the front of the subject, placed the zero end of the yard stick on the mat at 90° and slid the flexomomeasure case vertically upward until the upper edge of the ruler guide touched the tip of the subject's nose (Fig.6). The vertical distance was measured to the nearest 0.5 centimeter from the mat to the tip of the subject's nose and was recorded as score of each subject.\textsuperscript{9}

\textsuperscript{8}Ibid.,p.251.

\textsuperscript{9}Ibid.,p.84.
Shoulder Flexibility Test

The subject grasped one end of the rope in his left hand and other rope with right hand few centimeters away. The rope was held at arm's length in front of the subject's chest. The subject then raised his arms overhead and rotated the rope over his head. No disc grip was used.

Fig. 6. Measurement of Spine Flexibility.

Sit and Reach Test

To determine the development of hip and back flexibility as well as the preservation of the posterior muscles of the subject, sit and reach test was administered. A yard stick was used. The 15th neck of the
Shoulder Flexibility Test

The subject grasped one end of the rope in his left hand and other rope with right hand few centimeters away. The rope was held at arms length in front of the subject's chest. The subject then raised his arms upward and rotated the rope over his head. As the subject met with resistance in rotating the shoulders with locked elbows, he slid the rope within the grip of his right hand so that arms could spread and allow the shoulders to rotate to lower the rope with locked elbows across the back of the subject. The subject was directed to rotate the shoulder with elbows locked and bring the rope in front of the chest. The distance of rope between thumb of the subject's hands was recorded to the nearest 0.5 centimeter as score of shoulder flexibility. Best of three trials was credited to the subject.\(^{10}\)

Sit and Reach Test

To determine the development of hip and back flexion as well as the extension of the hamstring muscles of the subject, sit and reach test was administered. A yard stick was used. The 15 inch mark of the

\(^{10}\)Ibid., p.85.
yard stick was lined up with a line on the floor and the ends of the yard stick were taped to the floor. The subject sat down and lined up heels with the near edge of the 15 inch mark and slide his seat back beyond zero end of the yard stick with heels not more than 5 inches apart. Slowly the subject stretched forward while pushing the flexomeasure case as far down the stick as possible with the fingers of both hands. Reading on the flexomeasure was recorded to the nearest 0.5 centimeter as score of the subject.  

**Boomerang Run Test**

Boomerang run test was conducted to evaluate the agility of the subject. Floor plan course of run is given in Fig.7. The subject was asked to stand behind the starting line. On signal 'go' the subject ran forward, made forward roll on the mat and ran towards medicine ball, turned around the ball and ran to hurdle number 1, jumped over it, turned around and crawled underneath the hurdle (Fig.7a). The subject further ran to hurdle number 2 taking turn over the medicine ball, jumped over hurdle number 2, turned around and crawled

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11 Ibid., p.78.
Fig. 7. Boomerang Run Test.
Floor Diagram.
underneath the hurdle and finally ran toward hurdle number 3 keeping the medicine ball on his right. Jumped over the hurdle number 3, turned around crawled from underneath the hurdle and ran to the medicine ball, turned around and ran across the finish line. The total time taken to complete the course run was recorded to the nearest 0.01 second. Two attempts were given.

![Fig. 7a. Boomerang Run Test.](image-url)
underneath the hurdle and finally ran toward hurdle number 3 keeping the medicine ball on his right, jumped over the hurdle number 3, turned around crawled from underneath the hurdle and ran to the medicine ball, turned around and ran across the finish line. The total time taken to complete the course run was recorded to the nearest 0.01 second. Two attempts were given and best of the two was recorded as final score of the subject.  

**Squat Thrust**

Squat thrust test was conducted to measure agility of the subject. The subject assumed standing position. From the standing position on count one the subject sat on toes by bending his knees and waist and placed both hands on the floor in front of the feet. On count two he thrust his legs backward to maintain a front lean position. On count three he returned to the sitting position and on count four raised to a starting standing position. This whole movement was counted as one repetition (Fig.8). The subject was asked to do as

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Fig. 8. Squat Thrust.
many repetitions as possible for him. The repetition was not counted if the subject moved his legs to the rear before the hands were placed on the floor, lifted his hands from the floor before the feet were drawn to assume sitting position and the subject did not stand erect with head up. Total number of correct executed repetitions were recorded as score of the subject.  

**Dynamic Balance**

The subject stood with his right foot on the starting mark and leaped to the first tape mark with his left foot and tried to hold a steady position on the ball of his left foot for five seconds (the stop watch and counts both were used). After every five seconds he leaped from tape to tape. The subject was asked to stand on each tape mark for five seconds in such a way that his foot completely covered the tape mark. No trials were allowed (Fig.9).

The score for each mark successfully covered was five points and in addition one point was awarded for each subsequent second balance held. Thus, a subject

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Fig. 9. Modified Bass Dynamic Balance Test.

Floor Diagram.
could get a maximum of ten points per mark as a total of 100 points for complete test.

The subject had to lose five points for improper landing such as (a) failing to step upon the mark from a leap, (b) touching the heel or any part of the body to the ground, (c) failing to completely cover the mark with the ball of the foot.

The subject had to lose points at the rate of one point per second for (a) touching any part of the body with the floor other than the ball of the supporting foot, or (b) moving the foot while in balance position or (c) if he lost his balance he has to step back on the proper mark and then leap to the next mark.  

Physiological Variables

**Tidal Volume**

Tidal volume was measured with the expirograph. Before the actual graph was taken, all the subjects were explained, demonstrated and given practice. The expirograph was placed on the table and to calculate the tidal

\[ ^{14}\text{Ibid.}, p. 233. \]
volume of the subject the result was recorded in the
standing position (Fig. 6). The subject placed the
mouth piece attached to the spirometer in the mouth,
taking care that no air escaped through the edges
of the mouth piece. The nose of the subject was also
closed with the nasal clip to prevent the air escaping
through the nose. As the subject sat quietly in all
the his

Fig. 10. Measurement of Tidal Volume.
volume of the subject the graph was recorded in the standing position (Fig. 10). The subject placed the mouth piece attached to the expirograph, in the mouth, taking care that no air escaped through the edges of the mouth piece. The nose of the subject was also closed with the nasal clip to prevent the air escaping through the nose. As the subject got ready in all respect he was asked to take normal breathing. Once his breathing stabilized, the switch of the expirograph was put on to get the graph on the graph paper and few oscillations were recorded.\textsuperscript{15}

Thereafter, height of three oscillations were measured and average height was calculated. To take out the tidal volume the following formula was used and score recorded in liters:

\[
\text{T.V.} = \frac{\text{Average Height of the Oscillation} \times 330}{1000}
\]

\textbf{Vital Capacity}

Vital capacity was also measured with the expirograph following the same procedure as Tidal Volume.

Expirograph was placed at such a height so that all the subjects could perform the test in standing position (Fig. 10). Once subject's breath stabilized the switch for the graph was put on and the subject was asked to take one or two long breath followed by a long and deep inhalation, and the same air was exhaled in to the expirograph by bending forward. Alongwith the inhalation and exhalation a graph on the paper was drawn. The capacity was recorded in liters after converting the graph into figures with the formula given below: \(^{16}\)

\[
VC = \frac{\text{Length of the Oscillation} \times 330}{1000}
\]

**Maximum Breathing Capacity**

This test was also conducted on the expirograph. The subject was made ready to perform the test in the same manner as that of tidal volume and vital capacity (Fig. 10). When normal breathing of the subject was stabilized, the switch of the graph was put on. On signal 'ready' 'go', the subject started taking deep inhalation and exhalation and continued till 15 seconds. The same

\(^{16}\text{Ibid.}, p. 10.\)
movements of deep breathing was recorded on the graph. The total capacity for 15 seconds was recorded on the graph and then converted into liters per minute by calculating the graph. The performance was recorded in liters as under: \^{17}

$$\text{MBC} = \frac{\text{Total Height of Oscillations} \times 330 \times 4}{1000}$$

**Minute Ventilation**

Resting minute ventilation was calculated by using the following formula:

$$\text{Minute Ventilation} = \text{Tidal Volume} \times \text{Respiratory Rate}$$

(Liters BTPs) (Breath per min.)

= Liters per min. BTPS

The procedure for taking tidal volume and resting respiratory rate for finding out minute ventilation was same as given under tidal volume and resting respiratory rate. \^{18}

\^{17} \text{Ibid., p. 9.}

\^{18} \text{Ibid.}
Resting Pulse Rate

The resting pulse rate was taken at the time when the subjects reported for physiological tests in the morning at 0700 hrs.

As the subjects reported for the test at the medical inspection room of the Artillery Centre, Hyderabad. All the subjects were asked to lie down supine and rest themselves for thirty minutes. The pulse rate was counted by palpating at the wrist (radial artery) for one minute. The score was expressed in terms of number of pulse beats per minute.19

Respiratory Rate

The resting respiratory rate was taken in the morning at about -630 hrs. The subject was asked to lie down supine and rest for 30 minutes. Thereafter the respiratory rate was counted by observing the movement of abdomen of the subject. Where the movement of the abdomen was not clearly visible, an open hand was placed on the abdomen to feel the up and down movement. The score was expressed in terms of numbers of

19 Lawrence E. Morehouse and Augustus T. Miller, Physiology of Exercise (Saint Louis: C.V. Mosby Co.,1971), p.82.
respirations in one minute.\textsuperscript{20}

**Haemoglobin Concentration**

The scholar ensured that all the apparatuses required to take the blood samples were ready on the table. The subject was made to sit on a stool. The scholar held the ring finger of the subject in his left hand, cleaned it and pricked with puncturing needle, when adequate blood drop was formed the sample was taken by sucking through the pipette up to the mark of 02 mm. Then dipped it in the acid and blew out gently to deposit the whole blood at the bottom. Then the superficial acid was sucked and rinsed repeatedly till the whole blood in the pipette was washed out. Thereafter the blood and acid was mixed with the glass rod and compared with the standard colour in bright light. The result was recorded in percentage.\textsuperscript{21} (Fig.21).


Cardio-respiratory Endurance

To measure the cardio-respiratory endurance, the test was conducted on 400-meter eight lanes track of Artillery Centre, Enderahm. The track was marked in 10-meter segments. The subjects were made to run in groups. The subjects were assembled behind the starting lane on the track and explained regarding the test in detail.

![Image of two individuals measuring Haemoglobin concentration]

Fig. 11. Measurement of Haemoglobin Concentration.

Breath Hold Test

Breath hold test was conducted to determine the \textit{appreciable endurance of the lungs}.

---

[Johnson and Wilson, Practical Measurement for Evaluation in Physical Education, p. 14]
Cardio-respiratory Endurance

To measure the cardio-respiratory endurance, the test was conducted on 400 meters eight lanes track of Artillery Centre, Hyderabad. The track was marked in 10 meters segments. The subjects were made to run in groups. The subjects were assembled behind the starting line on the track and explained regarding the test in detail. At the starting signal, they ran or some time walked covering as much distance as possible with in the time limit of 12 minutes. At the signal to stop, the subjects stopped at once and then remained at their respective place. The tester went around and recorded the distance covered by each subject (Fig. 12).

The maximum distance covered by each subject in Cooper's 12 minutes run/walk test was recorded to the nearest 10 meters as the cardio-respiratory endurance score. 22

Breath Hold Test

Breath hold test was conducted to determine the apnoeatime (endurance of the lungs).

Fig. 12. Cooper's 12 Minutes Run/Walk Test.

Floor Diagram.
The subject was provided suitable chair to sit in comfortably and nasal clip was put on his nose. The subject was asked to take deep breath (hyperventilation followed by a deep inspiration) and close the mouth. As he closed his mouth after deep inhalation, the watch was put on and he ceased the breath as long as possible. The watch was stopped as he expired the air held in the lungs. It was ensured that the subject does not breathe in or out through the loose mouth and nose. Two trials were given after interval of 3 minutes. The time for best of two trials was recorded to the nearest of 1/100 of the second as final score of the subject.  

Respiratory Endurance Test (40 mm)

Forty millimeter was also a test for the respiratory endurance. The manometer was placed at such a height so that the subject stood straight, not leaning forward and pipe of the manometer reached to the subject's mouth easily. A nasal clip was put on the nose of the subject so that air through the nose did not leak. The subject was asked to take one or two long breath through

23 Ranade Joshi and Pradhan, A Text Book of Practical Physiology, p. 636.
the mouth. Now the subject performed maximum forceful inspiration and breathe out in the mercury manometer to bring the mercury level only up to 40 mm level and to maintain it there while breathing out as long as possible. The stop watch was put on when the mercury level reached 40 mm. The duration to which the mercury level maintained at 40 mm was recorded to the nearest 1/100 of a second.24

**Reaction Time**

Reaction time (audio and visual) was measured on the electronic reaction time apparatus (Fig. 13). This test was selected as the instrument measured reaction time directly and accurately. This apparatus consisted of two parts, chronoscope and hand set with selector switch and press button to stop the chronoscope. The chronoscope had two press buttons to select and measure audio and visual reaction time.

To conduct the test, the hand set was connected with chronoscope and partition was made between the chronoscope and hand set. Tester and subject sat down on chairs comfortably facing each other on their respective sides. The subject placed his hands on the

Fig. 13. Measurement of Reaction Time.
table on either side of the hand set. Tester pressed the audio button to record audio reaction time. As the tester pressed the audio button, chronoscope started gaining time along with the stimulus with buzzer. As soon as the subject received the stimulus, he lifted his dominant hand and pressed the stop button with index finger, chronoscope also stopped. The time displayed on the chronoscope was the audio reaction time. Three trials were given to each subject and average of the three trials was the audio reaction time score.²⁵

Then the selector switch was switched over to visual reaction time position. Visual reaction was also measured as per the same procedure of audio reaction.

**Speed of Movement**

Nelson's speed of movement test was used to measure speed of movement. Nelson's test was meant to measure the combined reaction and speed of movement of the hands and arms and was suitable for both sexes and all age groups. The equipment needed was a yard stick, table, chair and a chalk piece. The subject was seated in a chair, facing the table with his hands resting over the edge of the table. The palms were kept facing each other

with the inside border of the small fingers resting along two lines which were marked on the edge of the table 12 inches apart. The research scholar held the stick near the top so that it hanged midway between the subject's palms with the "base line" of the stick positioned evenly with the upper edges of the subject's index finger and subject looked on the concentration zone (Fig.14). After a preparatory command "Ready" was given, the stick was dropped and the subject stopped it as quickly as possible with an inward horizontal movement of the hands and arms (Fig.14a). Twenty trials were given and the distance the stick fell through the hands before it was stopped every time was recorded. The average of the middle ten trials, after the slowest and fastest five trials each having been eliminated was taken as the distance score. This distance score was then converted into time score by applying the following formula:  

\[
\text{Time} = \frac{2 \times \text{Distance the Stick Falls}}{\text{Acceleration due to Gravity}}
\]

---

Fig. 14. Measurement of Speed of Movement (Ready Phase).
before measuring speed of movement. All the details of the test were clearly explained to the subjects and each subject was given a rest period before the test.

Fig. 14a. Measurement of Speed of Movement (Final Phase).
Before measuring speed of movement, all the details of the test were clearly explained to the subjects and each subject was given five practice trials.

**Heart Rate After Exercise**

To take heart rate after exercise the equipment required was a bench of 20" height, stop watch and sport tester, PE 3000.

Before start of the test, the transmitter of the sport tester was fixed over the heart under the left nipple of the subject with the help of a adjustable belt and meter was tied on the wrist of left hand of the subject. If transmitter started transmitting heart rate and reading was displayed on the meter (Fig.15).

When the subject was ready after fixing the sport tester infront of the bench on signal 'go' the subject started exercise by going up and down over the bench in the prescribed manner and the watch for recording time was also put on. The subject continued performing exercise for five minutes at a speed of 30 steps per minute. The speed was fixed with the help of Metronome recorded in the cassette. Signal 'stop' was given to the subject on expiry of 5 minutes. As the subject stopped the reading of
Fig. 15. SPORT TESTER
PE 3000

Heart Rate Meter.
heart rate displayed on the meter was recorded as score of the subject. 27

**Anthropometric Measurements**

**Ponderal Index**

Ponderal Index for each subject was calculated by substituting in the formula the score of standing height of the subject in centimeters, corrected to 0.5 of a centimeter and the score of weight in kilograms corrected to the nearest 0.5 of a kilogram. The obtained value of this ratio was recorded and corrected to two decimal places. 28

\[
\text{Ponderal Index} = \frac{\text{Standing Height}}{3/\text{Weight}}
\]

**Skinfold Measurements**

Harpendon skinfold caliper was employed for measuring the fat component at specified sites. The skin at

---


specific site was held between the thumb and index finger and pulled out to form a fold so as to include two thickness of skin and subcutaneous fat in between them. The subject was asked to make appropriate movements to ensure that only the skinfold enclosing the subcutaneous fat was pinched and the muscle tissue which freely contracted and relaxed with movement was not included in the fold. The caliper was applied about one centimeter away from the spot pinched with thumb and finger and to a depth equal to the fold approximately. The measurement was read nearest to one tenth of a millimeter. Three readings were taken and the average of the three readings was recorded as the thickness of the skinfold at that site.\(^{29}\)

This measurement was taken at four sites namely biceps, triceps, subscapular and supra-iliac as recommended by Durning and Rehman. All the measurements were taken on the dominant side of the subjects.

**Skinfolds**

**Biceps** The subject was asked to stand in anatomical position with arms freely hanging. A point on the biceps midway was located and skinfold measurement was taken as described above (Fig.16).

Triceps: The subject was asked to stand in the anatomical position with his elbows flexed. He was asked to flex the arm at the elbow at 90 degrees. A point on the triceps midway between the acromion and olecranon was taken as the anatomical position of the triceps. The triceps was pinched with the thumb and index finger as near the bone as possible and a spring caliper was used to measure the thickness of the skinfold.
**Triceps** The subject was asked to stand in the anatomical position with arm hanging freely. He was asked to flex the arm at the elbow at 90 degree. A point on the triceps midway between the acromial processes of the shoulder and olecranon processes of the ulna was located and skinfold measurement was taken as described above (Fig.17).

**Subscapular** The subject was asked to stand in anatomical position. A site parallel to the inferior angle of scapula was chosen. The fold in this position made a diagonal line, upper end towards the medial side and lower end towards the lateral side. The thickness of the fold was measured as per description given above (Fig.18).

**Supra-Iliac** The subject was asked to stand in anatomical position. A site on the abdomen (on the side of the trunk) above the iliac crest at the level of the umblicus was selected. The thickness of the skinfold was measured as per the description given above (Fig.19).

**Body Density and Fat Percentage**

For the estimation of body fat, the body density was calculated with the help of an equation devised by Durnin and Womerslay (1974). The different formulae for different age groups have been devised, so according to
Fig. 17. Skinfold Measurement - Triceps.
Fig. 18. Skinfold Measurement - Subscapular.
Fig. 19. Skinfold Measurement - Supra-iliac.
the age of the subjects body density was calculated with the following formulae: 30

\[
\text{Body Density} = 1.1620 - 0.0630 \log (\text{Biceps } + \\
\text{Triceps } + \text{Subscapular } + \text{Supra-iliac})
\]

(for 17-19 yrs) = 1.1631 - 0.0632 \log (\text{Biceps } + \\
\text{Triceps } + \text{Subscapular } + \text{Supra-iliac})

The body fat percentage was calculated as under:

\[
\text{Percent Body Fat} = \left[\frac{4.57}{\text{Body Density}} - 4.142\right] \times 100
\]

Administration of the Training Programmes

Traditional Training Programme

The traditional physical training programme was imparted to the control group with the help of trained physical training instructors of the Army Physical Training Corps qualified at the Army School of Physical Training, Pune, according to the existing syllabus for recruits

under the supervision of the scholar. The existing syllabus of physical training for recruits includes recruit Training Tables from one to six, Endurance training and organised games. The control group was imparted physical training for six sessions of 40 minutes each from Monday to Saturday in the morning and participated in the organised games of one and half an hour duration four times a week in the evening. The physical training programme consisted of two broad categories i.e. Recruit Training Tables where emphasis is placed on general fitness exercises and calisthenics, and the other was Endurance Training. The training schedule, therefore, consisted of participants in Recruits Training Table on Mondays, Wednesdays, Thursdays, Saturdays, the other two days Endurance Training was followed on all mornings. This training was continued for the initial ten weeks of the recruits training. The block syllabus of the traditional physical training programme is displayed in Table 3. The lay out of the Recruits Training Table and Endurance Training as per the syllabus are given in Table 4 and 5 respectively.
<table>
<thead>
<tr>
<th>Weeks</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Week</td>
<td>Recruit</td>
<td>Endurance</td>
<td>Lecture</td>
<td>Recruit</td>
<td>Endurance</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td>Table 1</td>
<td>Training</td>
<td></td>
<td>Table 1</td>
<td>Training</td>
<td>Table 1</td>
</tr>
<tr>
<td>Second Week</td>
<td>-do-</td>
<td>-do-</td>
<td>Recruit</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Third Week</td>
<td>Recruit</td>
<td>-do-</td>
<td>Recruit</td>
<td>Recruit</td>
<td>-do-</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td>Table 2</td>
<td>Table 2</td>
<td>Table 2</td>
<td>Table 2</td>
<td>Table 2</td>
<td>Table 2</td>
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<tr>
<td>Fourth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>Demonstration</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Fifth Week</td>
<td>Recruit</td>
<td>-do-</td>
<td>Recruit</td>
<td>Recruit</td>
<td>-do-</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td>Table 3</td>
<td>Table 3</td>
<td>Table 3</td>
<td>Table 3</td>
<td>Table 3</td>
<td>Table 3</td>
</tr>
<tr>
<td>Sixth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Table 4</td>
</tr>
<tr>
<td>Seventh Week</td>
<td>Recruit</td>
<td>Recruit</td>
<td>Endurance</td>
<td>Recruit</td>
<td>Recruit</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td>Table 4</td>
<td>Table 4</td>
<td>Training</td>
<td>Table 4</td>
<td>Table 4</td>
<td>Table 4</td>
</tr>
<tr>
<td>Eighth Week</td>
<td>-do-</td>
<td>Recruit</td>
<td>-do-</td>
<td>Recruit</td>
<td>Recruit</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td>Table 5</td>
<td>Table 5</td>
<td>Table 5</td>
<td>Table 5</td>
<td>Table 5</td>
<td>Table 5</td>
</tr>
<tr>
<td>Ninth Week</td>
<td>Recruit</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>Recruit</td>
<td>Recruit</td>
</tr>
<tr>
<td></td>
<td>Table 5</td>
<td>Table 5</td>
<td></td>
<td></td>
<td>Table 6</td>
<td>Table 6</td>
</tr>
<tr>
<td>Tenth Week</td>
<td>Recruit</td>
<td>Recruit</td>
<td>-do-</td>
<td>Recruit</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td></td>
<td>Table 6</td>
<td>Table 6</td>
<td></td>
<td>Table 6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TABLE 4

RECRUIT TRAINING PROGRAMME (TRADITIONAL)

There were total six tables and duration of each table was 40 minutes. Each table was further divided into five groups and time was allotted for each group. All the exercises contained in each table were performed within the specified time allotted for each group as well as for the complete table. A broad outline of one of the six tables is given below: 31

1. Mobility Group - (6 Minutes)

   Exercises: a) A small game for warming up.

      b) Six calisthenics, two exercises for arm, trunk and legs alternately.

      c) Breathing.

2. Strengthening Group - (12 Minutes)

   Exercises: a) Strengthening Game.

      b) Lateral, abdominal, dorsal exercises either free hand or with medicine ball or log or on wall-bars.

      c) Pulling, pushing, carrying, lifting heaving and abdominal exercises.

---

3. Group Activity – (14 Minutes)

Exercises: a) Jumping and skipping.
   b) Vaulting over the wooden horse.
   c) Climbing and Balancing.
   d) Ground work which includes forward roll,
      backward roll cart-wheel and hand spring
      etc.
   e) Competitive game.

4. Endurance Group – (6 Minutes)

Recruits were made to run and walk alternately for
3 minutes each at different paces.

5. Carriage Group – (2 Minutes)

All the recruits were made fallen in three ranks,
correction in attention position, for marching,
turning and body posture were done.

**TABLE 5**

**ENDURANCE TRAINING (TRADITIONAL)**

Sixteen periods were allotted for endurance train-
ing. It was ensured that endurance training is not imparted
more than twice a week as per the syllabus. Distribution
of the endurance training periods has been given below:

<table>
<thead>
<tr>
<th>Period</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Technique of Running and Waling on the ground.</td>
</tr>
<tr>
<td>2.</td>
<td>Technique of Running and Walking on the ground.</td>
</tr>
<tr>
<td>3.</td>
<td>Road Run and Walk with ankle boots.</td>
</tr>
<tr>
<td>4.</td>
<td>Road Run and Walk with ankle boots.</td>
</tr>
<tr>
<td>5.</td>
<td>One Mile Practice with ankle boots.</td>
</tr>
<tr>
<td>6.</td>
<td>Two Miles Practice with ankle boots.</td>
</tr>
<tr>
<td>7.</td>
<td>Two Miles Practice with Field Service Marching Order.</td>
</tr>
<tr>
<td>8.</td>
<td>Two Miles Practice with Field Service Marching Order.</td>
</tr>
<tr>
<td>9.</td>
<td>Two Miles Practice with boots.</td>
</tr>
<tr>
<td>10.</td>
<td>Four Miles Practice with boots.</td>
</tr>
<tr>
<td>11.</td>
<td>Five Miles Practice with boots.</td>
</tr>
<tr>
<td>12.</td>
<td>Four Miles Practice with Field Service Marching Order.</td>
</tr>
<tr>
<td>13.</td>
<td>Five Miles Practice with Field Service Marching Order.</td>
</tr>
<tr>
<td>14.</td>
<td>Six Miles Practice with ankle boots.</td>
</tr>
<tr>
<td>15.</td>
<td>Ten Miles Practice with ankle boots.</td>
</tr>
<tr>
<td>16.</td>
<td>Ten Miles Practice with ankle boots.</td>
</tr>
</tbody>
</table>

---

32 Basic and Battle Physical Training Pamphlet No.4 (Delhi: Manager of Publication, Army Headquarters, 1945), pp.5-20.
Organised Game

All the subjects of the control group participated in organised games of one and half an hour duration four days (Monday, Tuesday, Thursday, Friday) a week in the evening for the duration of ten weeks.

Modern Training Programme

The modern physical training programme was prepared by the investigator himself. The programme was based on the general principles of training. The training of the experimental group was personally conducted and supervised by the research scholar with the help of trained coaches, (trained from the Netaji Subhas National Institute of Sports, Patiala) of the army who strictly followed the instructions of the investigator. The training was conducted keeping in view the feasibility for implementation of the modern physical training programme without affecting the other military training syllabus. Experimental group was also trained for the duration of ten weeks. The training of the experimental group was carried out for six sessions of forty minutes each from Monday to Saturday in the morning. Two evening sessions, however, on Tuesdays and Saturdays were devoted to weight training and the other two days for organised games. The block syllabus of the modern training programme is given in Table 6.
<table>
<thead>
<tr>
<th>Weeks</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Week</td>
<td>Endurance Training</td>
<td>Circuit Training</td>
<td>Endurance Training</td>
<td>Circuit Training</td>
<td>Endurance Training</td>
<td>Circuit Training</td>
</tr>
<tr>
<td>Second Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Third Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Fourth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Fifth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do- Speed Training</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Sixth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do- Speed Training</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Seventh Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Eighth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
<tr>
<td>Tenth Week</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
<td>-do-</td>
</tr>
</tbody>
</table>
Endurance Training

Endurance has a very significant value in various games and sports activities. There are different types of endurance such as muscular endurance, strength endurance, speed endurance and cardio-respiratory endurance and different methods are employed to develop each type of endurance. In this study more stress is given for the development of cardio-respiratory endurance.

Adequate emphasis is required to be given for the development of this important component depending upon the nature of sports and type of endurance needed. A sprinter, a jumper or a thrower might develop sufficient amount of endurance by devoting two training sessions per week, whereas in case of middle and long distance runner, the training session may be more frequent.

The endurance training was imparted with three different methods viz. slow continuous run, variable pace run and repetition run on alternate days employing each method once a week throughout the experiment. Endurance training programme of all the three methods is given in Table 7.
## TABLE 7
### ENDURANCE TRAINING (MODERN PROGRAMME)

<table>
<thead>
<tr>
<th>Week</th>
<th>Method</th>
<th>Duration</th>
<th>Intensity of Stimulus</th>
<th>Repetitions/Tempo</th>
<th>Recovery/Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Week</td>
<td>Slow Continuous Run</td>
<td>30 Min.</td>
<td>4 to 4.5 Km.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>to</td>
<td>Variable Pace Run</td>
<td>30 Min.</td>
<td>7 X 400 Mtr.</td>
<td>Slow Pace</td>
<td></td>
</tr>
<tr>
<td>Third Week</td>
<td>Repetition Run</td>
<td>25 Min.</td>
<td>1.30 Min.</td>
<td>5 X 400 Mtr</td>
<td>4 Min.</td>
</tr>
<tr>
<td>Fourth Week to Sixth Week</td>
<td>Slow Continuous Run</td>
<td>30 Min.</td>
<td>5 to 5.5 Km.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Variable Pace Run</td>
<td>30 Min.</td>
<td>5 X 600 Mtr.</td>
<td>Slow Pace</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 X 300 Mtr.</td>
<td>Fast Pace</td>
<td></td>
</tr>
<tr>
<td>Sixth Week</td>
<td>Repetition Run</td>
<td>25 Min.</td>
<td>1.30 Min.</td>
<td>6 X 400 Mtr</td>
<td>3 to 3½ Min.</td>
</tr>
<tr>
<td>Seventh Week to Tenth Week</td>
<td>Slow Continuous Run</td>
<td>30 Min.</td>
<td>6 to 6.5 Km.</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Variable Pace Run</td>
<td>30 Min.</td>
<td>5 X 800 Mtr.</td>
<td>Slow Pace</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 X 400 Mtr.</td>
<td>Fast Pace</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Repetition Run</td>
<td>25 Min.</td>
<td>1.30 Min.</td>
<td>7 X 400 Mtr</td>
<td>2 to 2½ Min.</td>
</tr>
</tbody>
</table>
Slow Continuous Run

The training load for each subject was determined empirically at the beginning of the experimental period. Duration of the session was fixed for 40 minutes throughout the experiment. The training for slow continuous run was carried out on the athletic track for 30 minutes. The speed of running at uniform pace for each subject was so determined so as to raise the heart rate between 140 and 150 beats per minutes, which is essential for producing training effects.\textsuperscript{33,34} A duration of 15 days was considered sufficient for adaptation for the body system to the exercise load. This is based on the conclusions of Harre Dietrick et al.\textsuperscript{35} who have indicated that a load cannot be raised in a linear way i.e. from day to day, but one maintains a certain level of load for two to three weeks and then


\textsuperscript{34} Arun Kumar Uppal, "Comparative Effects of Two Duration Load Methods and Interval Running Method on Cardio-Respiratory Endurance and Selected Physiological Variables," (Unpublished Ph.D. Thesis, Jiwaji University, Gwalior, 1980), p. 166.

\textsuperscript{35} Harre Dietrick et al. \textit{Introduction Into the General Theory and Competition} (Leipzig, 1967) Draft Reproduction: Study Material for the German College of Physical Culture,
makes stronger demand so that the increased load can be felt suddenly. The total distance for running was kept three kilometers in the beginning and progression of the training load was ensured by increasing the distance after every three weeks.

**Variable Pace Run**

Variable pace running was carried out on the same lines as slow continuous run. The main difference was the change of pace as planned earlier. The initial intensity given to the subject was to run 400 meters slow pace and 200 meters at fast pace for the duration of 30 minutes. The intensity was increased in terms of increase in distance for slow and fast runs after every three weeks.

**Repetition Run**

In one session of forty minutes the schedule for repetition run was given only for 25 minutes. The remaining 15 minutes were devoted for warming up and limbering down. In the beginning of the repetition runs, the intensity of the load given was five repetitions of 400 meters each and each repetition was carried out in one and half minute with four minutes recovery in between repetitions. This schedule continued for three weeks. The overload in this method was given by increasing the number of repetitions
and reducing the recovery period. The intensity of stimulus for each repetition was kept constant till the end of experimental period. The change of load was made after every three weeks.

**Circuit Training**

Circuit training programme is a very effective for the alround development of the body. Generally, circuit training is imparted during off season and more stress is given for the development of motor components and cardiovascular systems of the body. Circuit training can be classified according to the nature of exercises to be performed i.e. general and specific circuit training. Circuit can also be formed of exercises to be done with the weights or without the weights (calisthenics).\(^{36}\) In certain cases circuit training also be framed purely of the game skills for learning new technique and stabilisation of already acquired motor skills.

Circuit training is not designed to supplant weight training for weight lifters and endurance running for the

long distance runners, though both of those types of athletes could use it with advantage.\textsuperscript{37}

This method is very economical to impart physical training exercises with less equipment to more number of persons in less time effectively. In this study circuit training has been selected as one of the means for physical fitness of the recruits.

For this study, two circuits of 8 exercises each were made in which two exercises, rope climbing and skipping were common in both the circuits. The sequence of exercises was planned in such a manner so that different muscle groups were exercised in rotation.

In the first six weeks, circuit training was imparted with the exercises of circuit number one with continuous method. Repetitions for all the exercises were so fixed (except rope climbing) that all the exercises terminate at the same time and all groups change to next station together. In the first week the load was of 2 rounds, thereafter load was increased to three rounds and continued throughout the experimental training. The load was increased by increasing the number of repetitions after every two weeks.

In the last four weeks to break the monotony and improve the explosive strength, the training was switched over to circuit number two on interval method, in which the time for exercise and recovery were fixed. During eight sessions the load remained unchanged but intensity was increased by stressing the subjects to make the movement fast. Programme of circuit training is given in Table 8.

**TABLE 8**

**CIRCUIT TRAINING (MODERN PROGRAMME)**

**Circuit One (Continuous Method)**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Exercises</th>
<th>1st &amp; 2nd Week</th>
<th>3rd &amp; 4th Week</th>
<th>5th &amp; 6th Week</th>
<th>Recovery between Rounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rope Climbing</td>
<td>3 m.climb</td>
<td>3 m. climb</td>
<td>4 m.climb</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Step Up</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Pull ups (under grip)</td>
<td>4 - 6</td>
<td>6 - 8</td>
<td>8 - 12</td>
<td>3 to 5 minutes</td>
</tr>
<tr>
<td>4.</td>
<td>Skipping</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Sit-ups (Straight legs)</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Squat Jump</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Push Ups</td>
<td>10</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>4 X 10 Meters Shuttle Run</td>
<td>Once</td>
<td>Twice</td>
<td>Thrice</td>
<td></td>
</tr>
</tbody>
</table>

Intensity 2 Rounds 3 Rounds 3 Rounds
### TABLE 8 (Contd.)

**Circuit Two (Interval Method)**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Exercises</th>
<th>Intensity</th>
<th>Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Rope Climbing</td>
<td>15 Seconds Exercise</td>
<td>Between Rounds 3 to 4 Minutes</td>
</tr>
<tr>
<td>2.</td>
<td>Depth Jump</td>
<td>30 Seconds Recovery</td>
<td>between exercise</td>
</tr>
<tr>
<td>3.</td>
<td>Pushing in Pair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Skipping</td>
<td>3 Complete Rounds</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Sit ups with</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medicine ball</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Squat Thrust</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Rope Pulling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Spot Running</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Speed Training

Speed training is the ability to execute motor actions, under given conditions, in minimum possible time. Speed depends much upon the nervous system and as a result is of more complex nature is comparatively less trainable. Speed performance usually can not be improved through training by more than twenty percent (Letzelter 1979).  

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Speed depends much upon factors which are genetically determined. However, training means are employed in order to bring out whatsoever maximum possible talent is available with the individual.

In this study, speed training started in the fifth week because of the fact that the recruits were newly enrolled and had never been undergone such a strenuous training before. So, it was very essential for them to develop strength to make the speed training effective. Since the speed is very less trainable and keeping in view the aim of physical training of recruits, speed training was imparted for eight sessions.

Speed training was started from fifth week onward with one session a week and in the last two weeks, two sessions per week. Speed training during all the sessions were given for twenty minutes only, ten minutes for warming up and the remaining ten minutes for limbering down with stretching and relaxing exercises. Different distances were selected for speed training and these distances were changed after every two weeks but the number of repetitions kept constant. After each repetition complete recovery was given. The programme of speed training is given in Table 9.
<table>
<thead>
<tr>
<th>Week</th>
<th>Duration</th>
<th>Type of Start</th>
<th>Intensity</th>
<th>Repetition</th>
<th>Recovery</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fifth and Sixth Week</td>
<td>20 Min.</td>
<td>Standing Start</td>
<td>50 Meters</td>
<td>2</td>
<td>Complete 3 Min.</td>
<td>One</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 Meters</td>
<td>2</td>
<td>Complete 4 Min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>70 Meters</td>
<td>2</td>
<td>Complete 5 Min. per week</td>
<td></td>
</tr>
<tr>
<td>Seventh and Eighth Week</td>
<td>20 Min.</td>
<td>Standing Start</td>
<td>80 Meters</td>
<td>2</td>
<td>Complete 5 Min.</td>
<td>One</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>70 Meters</td>
<td>2</td>
<td>Complete 4 Min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60 Meters</td>
<td>2</td>
<td>Complete 3 Min. per week</td>
<td></td>
</tr>
<tr>
<td>Ninth and Tenth Week</td>
<td>20 Min.</td>
<td>Flying Start</td>
<td>50 Meters</td>
<td>2</td>
<td>Complete 3 Min.</td>
<td>Two</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>40 Meters</td>
<td>2</td>
<td>Complete 3 Min.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50 Meters</td>
<td>2</td>
<td>Complete 4 Min. per week</td>
<td></td>
</tr>
</tbody>
</table>

Warming Up: 10 Minutes General Warming Up.

Cooling Down: 10 Minutes Stretching Exercises for Limbering Down.
Weight Training

The system of physical training with weights has generally been accepted. It is also recognised that a planned schedule of exercises using progressively heavier weights or more repetitions, leads to greater strength for the athlete and harmonious, fully developed physique for the body builders. A big advantage of weight training is that more can be accomplished in a relatively short time. To achieve greatest proportional gains weight training three days a week is good enough.\(^\text{39}\)

The length severity and frequency of a training session, together with the number of exercises and repetitions, vary according to the person and the objectives.\(^\text{40}\)

The training programme was carried out under the supervision of the investigator. The weight training


always started after proper general and specific warming up and a set of stretching exercises was given at the end for cooling down. All the subjects were also given training with light weights for correct technique and movement of each exercise before start of the experimental training.

The weight training schedule was performed twice a week on Tuesdays and Saturdays. Before start of the experimental training, maximum capacity of all the subjects on each exercise was recorded. All the subjects were further divided into three groups according to their maximum capacity so that there was no much variation among their maximum capacity performances.

Initial intensity was determined as 50% of the maximum. Eight weeks schedule was given for the development of maximum strength and last two weeks for explosive strength. The set of selected weight training exercises and progressive weight training programme imparted to the experimental group is shown in Table 10 and 11.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Exercises</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Two Arms Standing Press (Military Press)</td>
</tr>
<tr>
<td>2.</td>
<td>Sit Ups on Inclined Bench</td>
</tr>
<tr>
<td>3.</td>
<td>Hall Squat</td>
</tr>
<tr>
<td>4.</td>
<td>Pulling behind Neck (Kneeling position)</td>
</tr>
<tr>
<td>5.</td>
<td>Leg Press</td>
</tr>
<tr>
<td>6.</td>
<td>Bench Press</td>
</tr>
<tr>
<td>7.</td>
<td>Good Morning Exercise against own Body Weight</td>
</tr>
<tr>
<td>8.</td>
<td>Arms Curl</td>
</tr>
<tr>
<td>9.</td>
<td>Legs Curl</td>
</tr>
<tr>
<td>10.</td>
<td>Pull Up High</td>
</tr>
<tr>
<td>11.</td>
<td>Heel Raise</td>
</tr>
<tr>
<td>12.</td>
<td>Bent Arms Pull Over (Standing Position)</td>
</tr>
<tr>
<td>Weeks</td>
<td>Intensity</td>
</tr>
<tr>
<td>----------</td>
<td>------------------------</td>
</tr>
<tr>
<td>1st Week</td>
<td>50% of the Maximum</td>
</tr>
<tr>
<td>2nd Week</td>
<td>55% of the Maximum</td>
</tr>
<tr>
<td>3rd Week</td>
<td>60% of the Maximum</td>
</tr>
<tr>
<td>4th Week</td>
<td>60% of the Maximum</td>
</tr>
<tr>
<td>5th Week</td>
<td>65% of the Maximum</td>
</tr>
<tr>
<td>6th Week</td>
<td>65% of the Maximum</td>
</tr>
<tr>
<td>7th Week</td>
<td>70% of the Maximum</td>
</tr>
<tr>
<td>8th Week</td>
<td>70% of the Maximum</td>
</tr>
<tr>
<td>9th Week</td>
<td>50% for 15 Sec.</td>
</tr>
<tr>
<td>10th Week</td>
<td>50% for 15 Sec.</td>
</tr>
</tbody>
</table>
Stretching Exercises

The limbering down activity with jogging, calisthenics and stretching exercises was considered the most important phase of the training session.

It is very essential to practice light stretching exercises during warming up and equally important to perform full stretching immediately following competition and training session. There are sound physiological basis for such practice as level of lactic acid in the blood decreases more quickly and rapidly during exercise recovery than during rest recovery. These stretching also help to reduce muscle tension, muscles soreness and make the body feel more relaxed after the strenous work out. These exercises contribute flexibility (increase of range of motion of the joints). It further helps to prevent injuries and muscles strain. It also promotes blood circulations which helps for removal of the lactic acid, quickly recovery and relaxation for the body.

A few stretching exercises which include the major muscle groups and joints of the body such as neck, back, hamstring, gastrocnemius, achilles tendon, chest, hip, supine, shoulder, ankles, abdominal, knee and quadriceps were performed with slow stretching and
holding for 5 to 8 seconds. In this study, the stretching exercises were given on conclusion of each training session after a little jogging and calisthenics for a period of ten minutes.

Statistical Technique for Analysis of Data

Data pertaining to motor components, physiological variables and anthropometric measurements of both the control group and the experimental group was examined separately. The correlated data was treated with 't' ratio using Mean Gains Method (Paired 't' test) in order to determine the significance of differences, if any between pre-tests and post tests within the group. Paired 't' test procedure of computation as given by Clarke and Clarke\textsuperscript{41} was used for the analysis of data.

To find out significance of differences, if any, between the control and the experimental group performance (uncorrelated data) an unpaired 't' test was employed according to the procedure of computation explained by Clarke and Clarke.\textsuperscript{42}


\textsuperscript{42} Ibid., p.205.
The secondary purpose of the study was to evaluate the relationship of the selected physiological variables and anthropometric measurements to motor fitness components. The post score of all the physical components were correlated with the post score of each of the physiological variables and anthropometric measurements with the help of product moment correlation zero order. The Raw Data Correlations were achieved using method given by Clarke and Clarke\(^4\) The level of significance for testing the hypothesis was set at .05 level.

\(^4\)Ibid., p.226.