Chapter III

PROCEDURE

In this chapter the selection of subjects, experimental design, tester reliability, collection of data, training programme and statistical techniques for analysing the data have been described.

Selection of Subjects

Eighty male students in the age group 14 to 16 years, studying in standards nine and ten of the Kendriya Vidyalaya, Gwalior, were selected as the subjects for the study. The total number of students in these two standards was 219. To ensure that only untrained subjects were selected, ninety six students who were undergoing training for participating in competitive sports on behalf of the school were eliminated from the list. From among the rest, eighty students were selected using random sampling procedure of drawing lots. The investigator checked the health records maintained by the school to ensure that the subjects selected were physically fit to undergo the vigorous training programme prescribed as the experimental process for the study.
The subjects belonged to a nation-wide cross section of middle class and upper middle class population as the policy of Kendriya Vidyalaya was to give priority for admission to the children of defence personnel or Central Government employees. All the subjects had fairly well developed physique though most of them had not been participating in sports and games regularly. However, all of them had favourable attitude towards sports and games, as they had been taking part in the required physical education programs as a part of the school curriculum.

Prior to the pre-tests, a meeting of all the selected subjects was held, in which the Principal and the Physical Education Teacher of the school were also present. The requirements of the experimental treatments, testing procedures as well as training schedules were explained to them in detail, so that there was no ambiguity in their minds regarding the efforts required of them and the hard work they would have to put in. All the subjects agreed to co-operate in the experimental procedures which were explained to them. The Principal and the Physical Education Teacher also exhorted them to put in their best efforts in the interest of the scientific investigation and in order to enhance their
own performance and achievement standards. Though no special motivational techniques were used to enhance their performance, the subjects were very enthusiastic and cooperative throughout the project.

**Experimental Design**

Random group design was used for this experimental study because it was considered the most appropriate. The subjects numbering eighty were equally divided into three experimental groups and one control group and each group consisted of 20 subjects. The experimental treatment, to each of the three groups, was assigned at random by drawing lots. The experimental groups were given interval training programme for a period of ten weeks, excluding the period utilized for pre-tests and post-tests. The control group did not participate in any activity during the experimental period. The interval training programme for the three experimental groups was the same throughout the experimental period, the only differential factor being the mode of utilization of the relief-interval; one group performed walking (Group $E_w$), the second group performed jogging (Group $E_j$) and third group performed walking and jogging combined (Group $E_{wj}$). The fourth group served as the control group (Group C). The training for the three experimental groups was given for ten
weeks, thrice a week, on Mondays, Wednesdays and Fridays. This was in accordance with the physiological principle as stated by Mathews and Fox\(^1\) that seven to eight weeks interval training programme with three workouts per week is effective in improving cardio-respiratory system.

**Tester Competency and Reliability of Data**

To ensure that the investigator was well versed in the techniques of conducting the tests, the investigator had a number of practice sessions in the testing procedures under the guidance of an expert Dr. R.N. Dey, Lecturer in Physiology, Lakshmibai National College of Physical Education, Gwalior. All the measurements were taken by the investigator with the assistance of Dr. Dey. To ensure tester-reliability the readings taken on five students in selected variables by the investigator were correlated with those taken by Dr. R.N. Dey under the similar conditions. The co-efficient of correlation of the measurements taken by the investigator and the expert have been shown in Table 1. Since very high correlations from .94 to .99 were obtained, the investigator's competency to administer the tests was established.

\(^1\) Mathew and Fox, *The Physiological Basis of Physical Education and Athletics*, p. 258.
TABLE 1
TESTER COMPETENCY FOR TESTS IN SELECTED PHYSIOLOGICAL VARIABLES

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting Pulse Rate</td>
<td>.99</td>
</tr>
<tr>
<td>Systolic Blood Pressure</td>
<td>.98</td>
</tr>
<tr>
<td>Diastolic Blood Pressure</td>
<td>.94</td>
</tr>
<tr>
<td>Peak Flow Rate</td>
<td>.93</td>
</tr>
<tr>
<td>Air Flow Rate</td>
<td>.99</td>
</tr>
</tbody>
</table>

Instrument Reliability

The peak flow meter, air flow meter, treadmill, sphygmomanometer, stethoscope, bicycle ergometer and stop watches used in the study were obtained from reputed suppliers of standard equipment. All the instruments used were purchased by the research laboratory of the Lakshmibai National College of Physical Education, Gwalior, and were new and, therefore, their calibrations were accepted as accurate enough for the purpose of the study.
Collection of Data

The necessary data was collected by administering the tests for the chosen variables, before and after the experimental period of ten weeks. All the tests were administered in the Research Laboratory of Lakshmibai National College of Physical Education, Gwalior.

Before the administration of tests the subjects were given a chance to practice the prescribed tests so that they became familiar with the tests and knew exactly what was to be done. The apparatus used were explained to them prior to the administration of tests. Four days were utilized for conducting the pre-tests, before the experimental period, and another four days for the post-test, at the end of the experimental period. To ensure uniform testing conditions the subjects were tested only during the specific time, between 14.00 and 16.00 hrs.

Data on Cardio-respiratory Endurance

Harvard Step Test (short form) constructed by Brouha\(^2\) was used for measuring cardio-respiratory

endurance. Karpovitch\textsuperscript{3} had preferred short form of Harvard Step Test to the long form. He justified the use of short form in as much as the correlation between the long form and the short form was .92, indicating a very high relationship and also having an edge over the long form in terms of the economy of time in administering the test. The procedure for conducting the test was strictly followed except for the modification that an 18 inches high bench was used for step-up exercise, instead of 20 inches high bench, as recommended in the original test. Gallanchar and Brouha\textsuperscript{4} have indicated that an 18 inches bench was more suitable for secondary school boys and this change was adopted for this study. The test procedure was explained to the subjects in detail.

Each subject was asked to stand near the 18 inches high bench. On the command "Ready", "Start" the subject began stepping up and down the bench to a four count rhythm which is explained as follows:

\textsuperscript{3}Peter V. Karpovitch and W. Syning, \textit{Physiology of Muscular Activity}, 7th ed. (Philadelphia: W.B. Saunders Company, 1965)

On count one the subject stepped on the bench with one foot, on count two the subject lifted the body up by straightening the leg already placed on the bench and placed the second foot also on the bench, keeping the trunk upright. On count three the subject placed one foot on the floor, and on count four the other foot was also brought down to the floor. The subject was allowed to lead off with either foot or to change the leading foot during the test. The subject was not permitted to step-up with a jump and was instructed to extend the knees fully when both the feet were on the bench or the floor. The four count rhythm was maintained with the help of a metronome. The stepping exercise continued for a maximum of five minutes at the rate of 30 steps per minute, unless the subject was forced to stop through exhaustion. In either case the duration of exercise was recorded in seconds, 300 seconds being the maximum. Immediately after the subject stopped the exercise he was asked to rest in a chair and after one minute the investigator recorded the pulse rate of the subject for a duration of 30 seconds. Pulse was counted by palpating at the radial artery.

The final score of each subject was calculated in terms of physical efficiency index, by the following
\[ P_1 = \frac{\text{Duration of exercise in sec.} \times 100}{5.5 \times \text{pulse count for 30 seconds}} \]

**Data on Physical Work Capacity**

Physical work capacity of each subject was expressed in terms of total work output put in kilogram-meters, on a motor-driven treadmill. The treadmill used for testing physical work capacity in this study was supplied by M/s. Venkay Engineering Works, Madras. The maximum possible speed of the treadmill was 20 km/hr. and the maximum inclination 10 percent (Fig.1).

The subjects were permitted to practice running on the treadmill before the test was administered. The weight of each subject was checked by a weighing scale and recorded in kilograms. The weighing in was done in the sports kit used by the subjects for treadmill running. For the purpose of this study, the inclination was set at four percent and speed at 3 km/hr. The inclination and speed of the treadmill for the subjects were determined

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\[ ^{5} \text{Ibid.} \]
Fig. 1. Physical Work Capacity Test on the Treadmill
after conducting a pilot study using six subjects, so that all the subjects were able to cope up with the load fixed. The subjects were permitted to run on the treadmill either barefooted or in canvas shoes. Each subject was asked to stand on the treadmill, and after a word of caution "ready" the investigator switched on the treadmill, gradually increasing in one minute the speed to 3 km. per hour, as indicated by the speedometer. The stop watch was started simultaneously with the starting of the treadmill. The subject also gradually picked up his speed of running with the treadmill to 8 km. per hour, the set speed of the treadmill. The subject continued the treadmill running exercise at this speed as long as possible. He was instructed to give a signal or press the emergency button to stop the treadmill, if he felt completely exhausted and could no longer continue running at this speed. At the signal from the subject the investigator stopped the treadmill and the stop watch. Each boy was encouraged to do his best. For each subject the total running time in seconds less 60 seconds, (involved in picking up speed to 3 km/hr.) was recorded as the performance time for this test. The work output for each subject was calculated by the following formula:

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Work Output (kg.-m.) = L \times C_1 \times S \times C_2 \times A \times W

where, L is the length of the run in minutes, 
C_1 is a correction factor (hr/60min.) to convert the
length of the run in minutes to part of an hour, S is the
speed of the treadmill in km/hr., C_2 is a correction
factor (1000/km.) to convert km/hr. to meters per hour,
A is the sign of the treadmill percent grade, and W is
the weight of the subjects in Kilograms.

Data on Resting Pulse Rate

The pulse rate of all the subjects was recorded
between 14.00 and 16.00 hrs. Before taking the resting
pulse rate the subjects were asked to sit in a chair
and relax for 30 minutes. To record the pulse rate per
minute the pulse was palpated at the radial artery for
one full minute for each subject.

Data on Resting Blood Pressure

A dial type sphygmomanometer made in Japan and
a stethoscope supplied by Biological Concern, Calcutta,
were used for measuring the systolic and diastolic blood
pressures. Before the measurements were taken each
subject was given 30 minutes to relax in a chair. It was
ensured that each subject was placed in a comfortable
position and adequate time was allowed for the circulatory systems to stabilise the normal functioning.

While taking blood pressure the subject's left arm was completely bared to make certain that the clothing did not constrict the blood vessels. The blood pressure measurement was taken with the subject in a sitting position, his forearm supported on a table. The cuff was wrapped around the arm, evenly, with the lower edge approximately one inch above the antecubital space. The stethoscope receiver was placed firmly over the artery in antecubital space. It was made sure that stethoscope was free from contact with the cuff. The cuff was inflated until the artery was fully collapsed to the extent that no pulse beat could be heard. Pressure was then slowly released as the investigator watched the gauge. When the first sound of the pulse became audible the reading in Millimeters of Mercury (mm.Hg.) at that instant was recorded as the systolic blood pressure. The pressure was further released gradually, as the sounds of the pulse changed in intensity and quality. The index of diastolic pressure was noted in mm.Hg. when the heart sounds completely ceased.7

Data on Recovery Pulse Rate

The recovery pulse rate was recorded immediately after the resting pulse rate. Each subject was given a standard exercise on the bicycle ergometer for five minutes. The exercise stress employed was 50 cycle
per minute with a resistance of 300 kilogram meters (kg.m.) per minute as recommended by de Varies.9

Each subject had relaxed for 30 minutes and the resting pulse rate was recorded. Then the subject was asked to perform exercise on the bicycle ergometer with a fixed load as previously described. The height of the seat was so adjusted that leg of the subject was almost straight at the knee when the pedal came down, with the balls of the feet on the pedals. The metronome was set at 100 beats per minute to allow one beat for each cycle of pedaling, at the rate of 50 cycles per minute. At the signal 'Go' the subject started pedaling, when the stop watch was also started. As soon as five minutes

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9Herbert A. de Varies, Laboratory Experiment in Physiology of Exercise (Dubuque-Iowa: W.C. Brown Company Publishers), p.36.
of exercise were completed the subject was asked to stop. Immediately on cessation of exercise, the pulse of the subject was taken for 15 seconds while the subject was still on the bicycle ergometer. The pulse count for 15 seconds was multiplied by four to record pulse count for one minute. Following the same procedure the pulse of the subject was recorded at the last quarter of the fifth minute and multiplied by four to obtain the rate per minute. Counting the pulse rate for 15 seconds only and multiplying by four was justifiable, as longer period of counting the pulse rate during recovery stage would be misleading, since the pulse rate would slow down considerably during one minute and as such this precaution was taken. Thus, the pulse rate was checked and recorded twice after the bicycle ergometer exercise, once for 15 seconds immediately after the exercise was over and again for the last quarter of the fifth minute, after the exercise. It was adequate to observe the pulse rate of the subjects under study, for five minutes only, as all the subjects showed approximately 90 percent recovery at the end of the fifth minute after the exercise.

Data on Blood Pressure After Exercise

The exercise stress employed and procedure adopted for measuring the response of the circulatory system to
exercise was the same as used for recovery pulse rate described earlier.

The measurement of systolic and diastolic blood pressure was recorded as described under resting blood pressure with the following modifications.

Before starting the exercise the sphygmomanometer was tucked to the cuff with the clip provided at the back of the sphygmomanometer for this purpose. The pressure pump attached to the sphygmomanometer was hung on the sphygmomanometer itself. Immediately on cessation of exercise, the subject rested his left forearm on the left arm of the tester, to prevent venous occlusion. The pressure in inflatable cuff was rapidly raised to 250 mm.Hg. by inflating the cuff. The values of systolic and diastolic pressure were recorded to the nearest mm. Hg. as described earlier (Fig. 2).

Data on Peak Flow Rate

The mini Wright Peak Flow Meter supplied by Clarke International Ltd., Wigmore Street, London, was used for measuring the peak flow rate. The instrument consists of a mouth piece, a marker and a calibrated air tube. When the air is "puffed" into the mouth piece
Fig. 2. Measurement of Blood Pressure After Exercise.
the marker moves along the calibrated air tube, thus, recording the peak expiratory flow rate in litres per minute (Fig.3).

The subject was asked to stand and hold the instrument in one of his hands in such a way that the fingers did not obstruct the slot. The instrument was held in hand lightly with the slot facing away from the hand, with the flattened part of the plastic mouth piece in horizontal position. The subject to be tested had the nose clip on and kept the mouth piece in position. He was asked to inhale through his mouth to the maximum capacity. He then expelled the maximum possible amount of air by blowing out into the mouth piece with a hard blow. The expelled air caused the marker to move up the scale. The value where the marker came to rest was recorded as the peak flow rate in litres per minute. Then the marker was gently pushed to the lower end. Three chances were given and the best reading was recorded as the final score. The mouth piece was disinfected with the Dettol after use by each subject.

Data on Air Flow Rate

The air flow rate of each subject was measured by an Air Flow Meter supplied by Toshniwal Bros. Pvt.
Fig. 3. Measurement of Peak Flow Rate.
Ltd., New Delhi. The instrument has a detachable mouth piece connected to a drum which has a graduated dial with readings ranging from 0 to 100. Inside the dial is an indicator which revolves when air is blown into the drum. When the indicator comes to rest at some point along the graduated dial the reading on the dial shows the air flow rate in 1t./min. After the reading has been noted down, the dial is rotated clockwise or anti-clockwise so that the indicator points to zero.

The subject was asked to stand and hold the instrument in one of his hands as shown in Fig.4. The subject to be tested had the nose clip on and kept the mouth piece in position. He was asked to inhale through the mouth to the maximum capacity. He then expelled the maximum possible air by blow out into the mouth piece with a hard blow. The expelled air caused the inside indicator to move along the graduated dial. The value where the indicator came to rest was recorded as the air flow rate of the subject in litres per minute. Three chances were given and the best reading was recorded as the final score. The mouth piece was disinfected with Dettol after use by each subject.
Fig. 4. Measurement of Air Flow Rate
Administration of Training Schedule

An interval running schedule was prepared by the investigator and the training programme was carried out by the subjects under the supervision of the investigator, with the assistance of six trained post-graduate scholars. The progressive bi-weekly schedule followed by the subjects is given in Table 2.

**TABLE 2**

**BIWEEKLY SCHEDULE OF STIMULUS VOLUME AND STIMULUS INTENSITY OF INTERVAL TRAINING FOR THREE EXPERIMENTAL GROUPS**

<table>
<thead>
<tr>
<th>Week</th>
<th>Distance</th>
<th>Stimulus Volume</th>
<th>Stimulus Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st and 2nd</td>
<td>150 M</td>
<td>6</td>
<td>25 to 27 sec.</td>
</tr>
<tr>
<td>3rd and 4th</td>
<td>150 M</td>
<td>8</td>
<td>25 to 27 sec.</td>
</tr>
<tr>
<td>5th and 6th</td>
<td>150 M</td>
<td>10</td>
<td>25 to 27 sec.</td>
</tr>
<tr>
<td>7th and 8th</td>
<td>150 M</td>
<td>10</td>
<td>23 to 25 sec.</td>
</tr>
<tr>
<td>9th and 10th</td>
<td>150 M</td>
<td>10</td>
<td>23 to 25 sec.</td>
</tr>
</tbody>
</table>

The subject performed the workouts on Mondays, Wednesdays and Fridays after 15 minutes of warming up. To ensure the effectiveness of the training programme each of the three experimental groups was divided into...
two and each sub-group was entrusted to one of the assistants for training.

The training stimulus or activity selected for the three experimental groups was 150 m. runs. The intensity stimulus was so prescribed that the pulse rate of the subjects rose to a level between 170 and 180 beats per minute, which was considered as the main indication of the training effect on cardio-respiratory systems. A duration of 15 days was considered sufficient for adaptation of the body system to the exercise load. This is based on the conclusion of Harre Dietrich et al. 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 makes stronger demands so that the increased load can be felt suddenly.

The volume of stimulus was fixed at six repetitions of 150 m. runs during the first two weeks. The load was increased in stages. For the first six weeks

the volume of training was increased and other factors 
were kept constant, i.e. two repetitions were increased 
at the end of every two weeks. For the next four weeks 
the intensity of stimulus was increased by reducing 
the time run of each 150 m. to 23 to 25 sec. from 25 to 
27 sec. Thus, volume of training was kept constant, by 
retaining 10 repetitions of 150 m. run.

The permitted time for each run, the number of 
repetitions, and duration of density phase were fixed 
after conducting a pilot study with ten subjects, who 
were selected at random for the pilot study. They were 
made to run at various intensities to find out the time 
run required to raise the pulse between 170 and 190 beats 
per minute. After each run the pulse of each subject was 
recorded with the help of ten post-graduate assistants. 
Each run with a new intensity was repeated only when the 
subjects were fully recovered from the previous run. It 
was found that 150 m. run in 25 to 27 seconds was suffi-
cient to raise the pulse rate to a level between 170 and 
190 beats per minute. Six repetitions were adequate for 
the students as they were not a trained group and they 
would not be able to stand a more intense load. The 
distance of each training run was determined as 150 m. so 
that the subjects would not feel it too long to put-forth
their best efforts. The pilot study revealed that recovery period of 1.30 min. to 4 min. for groups E_j, 2.30 min. to 3.30 min. for group E_wj and 1.30 min. to 2.30 min. for group E_w were found adequate to lower the pulse rate between 110-120 during the density phase.

The training programs for all the three groups was the same except the differential factors in utilization of the relief interval, with three different recovery types. Group E_w walked, Group E_j jogged and Group E_wj did a combination of walking and jogging during the relief interval. The relief interval permitted was based on the pulse rate coming down to only 110-120 at which stage the subjects had to repeat the run at the prescribed speed.

Analysis of Data

The differences between the pre-test and post-test means of each group in the chosen variables were tested by applying t test, in order to find out differences if any, on each of the chosen variables before and after the experimental treatment. The Mean Difference Method was applied for this purpose. In order
to find out the differential effects of the three experimental treatments, analysis of variance and covariance, (F test) were carried out for the four groups with respect to the mean gains in each chosen variable. The Scheffe's test was applied in cases where F ratios were significant, to find out which of the differences of the paired means were significant. For testing the hypothesis, the level of confidence was set at .05.