Chapter III

PROCEDURE

In this chapter, sources of data, experimental design, experimental factors, pilot study, training programme, tester competence and reliability, test administration, collection of data and statistical procedure for the analysis of data have been presented.

Source of Data

Since the purpose of the study was to analyse the physiological changes that may occur in higher secondary school girls, as a result of aerobic and anaerobic exercise, it was considered necessary to choose untrained girls who were not in any of the games on sports teams or in any training or coaching programme. However they were participating in their routine physical education classes in the schools. A group of untrained students would indicate the physiological changes due to training, better than a group of trained students or those who were under training. Hence it was decided to choose only untrained students for this study. Since two training methods, the aerobic and the anaerobic, were involved and since during the period of training the subjects were susceptible for changes due to growth, it was decided to have three groups including a control group for this study.
For this purpose one hundred and five girls, free from deformities and ailments, were selected at random by lots from a total strength of two hundred and sixty five girls of the eleventh and twelfth standards of Sri Sarada Vidyala Higher Secondary School, Salem. The majority of the girls were from the rural areas, and over fifty per cent of the subjects were resident in the Vidyala hostels. The age of the subjects selected was in the range of fifteen to eighteen years.

**Experimental Design**

The study was formulated as a random group design. As explained before three groups were required one for each training method, aerobic and anaerobic and one as the control group. The total number of hundred and five students selected at random were divided into three groups again at random by lots, each group having thirty five subjects. Group 'A' was assigned the 'Aerobic Training' and group 'B' the 'Anaerobic Training', while group 'C' served as the control group. The control group was not allowed to participate in any of the training programmes, except their routine physical education classes.

**Experimental Factors**

To assess the physiological adaptations that might result due to the aerobic or the anaerobic training, the following physiological variables were selected, which were
inter-related, in view of their association with the cardio-respiratory functioning:

1. Basal Blood Pressure (Systolic and Diastolic)
2. Basal Heart Rate
3. Haemoglobin Percentage
5. Recovery Heart Rate.

Pilot Study

A pilot study was conducted to find out the maximum heart rate that could be achieved by the subjects after continuous and vigorous activity. For this purpose ten girls from among those who were not selected as subjects were chosen. They were given vigorous and continuous exercises like rope skipping, running on the spot and Jumping Jack for about two minutes without permitting them to slow down very much. Since the purpose of the pilot study was to assess the maximum heart rate, one by one the girls were asked to do the exercises vigorously as long as possible. It was noted that they could not continue the prescribed exercises i.e., rope skipping, running sprinting jogging or jumping jack for more than two minutes at a stretch. When they slowed down they were asked to increase the speed and intensity after ten or fifteen seconds, so that the work load may be increased to the desired level. At the end of the vigorous exercise for about five minutes the pulse rate attained by each girl was recorded. The results of the pilot study are shown in Table I.
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name</th>
<th>Normal Pulse Rate</th>
<th>After Running Jogging</th>
<th>After Rope Skipping</th>
<th>After doing Jumping Jacks</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Vennila, R.</td>
<td>72</td>
<td>160</td>
<td>154</td>
<td>164</td>
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<td>2</td>
<td>Poongodi, C.</td>
<td>76</td>
<td>160</td>
<td>162</td>
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<tr>
<td>3</td>
<td>Muthulakshmi, K.</td>
<td>69</td>
<td>169</td>
<td>158</td>
<td>168</td>
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<tr>
<td>4</td>
<td>Shanthi, A.</td>
<td>75</td>
<td>143</td>
<td>144</td>
<td>144</td>
</tr>
<tr>
<td>5</td>
<td>Kannamma, S.</td>
<td>72</td>
<td>140</td>
<td>162</td>
<td>162</td>
</tr>
<tr>
<td>6</td>
<td>Padmavathy, R.</td>
<td>76</td>
<td>158</td>
<td>160</td>
<td>152</td>
</tr>
<tr>
<td>7</td>
<td>Lalitha, K.</td>
<td>74</td>
<td>161</td>
<td>158</td>
<td>161</td>
</tr>
<tr>
<td>8</td>
<td>Mohana, R.</td>
<td>73</td>
<td>161</td>
<td>163</td>
<td>165</td>
</tr>
<tr>
<td>9</td>
<td>Jayarani, R.</td>
<td>75</td>
<td>159</td>
<td>162</td>
<td>158</td>
</tr>
<tr>
<td>10</td>
<td>Sindu, M.</td>
<td>75</td>
<td>165</td>
<td>165</td>
<td>166</td>
</tr>
</tbody>
</table>
The maximum pulse rate reached was in the range of 140 to 170 while the normal pulse rate was from 69 to 76. The pilot study was also intended to determine the duration through which the subjects can continue the prescribed exercises at a submaximal speed of 60 to 70 per cent. The same group of students were asked to perform the three exercises at submaximal speed changing from one exercise to another. They were encouraged to do at a reasonably fast pace and continue the exercise as long as possible. It was found that the girls were unable to continue the desired speed for over five to six minutes. The maximum pulse rate obtained was 140 to 170, which was considered high enough for the purpose of this study. The submaximal pulse rate to be maintained for the aerobic exercise was decided as 120 to 140 per minute. The duration of six minutes was fixed as the period of one circuit of training involving the three exercises for aerobic training. For anaerobic training the time fixed for each exercise was two to three minutes which included a recovery period for every intensive workout. The total time of the three exercises were also of six to eight minutes duration.

Training Programme

As a result of the pilot study the following training programme was prescribed which included running, jogging, sprinting, rope skipping and jumping jack. The duration of
the work out for both experimental group was six to eight minutes during the first four weeks, eight to ten minutes next four weeks and ten to twelve minutes during the last four weeks, progressively increasing the duration and intensity of exercise.

Group 'A' Aerobic Group

The aerobic group was given continuous work out for two minutes at submaximal speed moving from one exercise to another without any rest. If they slowed down they were encouraged to increase the speed and in no case were permitted to have complete rest. Care was taken to maintain the heart rate at a submaximal speed of 120 to 140 beats per minute. As the days of training progressed the duration of the exercise was increased from six to twelve minutes in a gradual manner during the course of twelve weeks.

Group 'B' Anaerobic Group

For the anaerobic group, care was taken that exercise was done at maximum possible speed. Emphasis was on speed and not on the duration. The subjects were able to continue the prescribed exercise at maximum speed only for about eight to ten second following which, time was given for them to recover almost fully before the next speed work. This was repeated a number of times for two to three minutes for each exercise making a total of six to eight minutes for the three
exercises. The subjects of the anaerobic group did not have any restriction for a longer period of rest if required between the speed work outs.

For both the groups the training programme was for 12 weeks, five days a week excluding Saturdays and Sundays, scheduled for the evening between 4.00 to 5.00 p.m. The training programme started on October 1, 1985 and was completed on December 22, 1985. The period included the time devoted, two days each, for pre-test, mid-test and post-test.

**Tester Competence and Reliability**

The investigator had several practice sessions in conducting the physiological tests under expert medical personnel. The procedure for collecting data on resting blood pressure and resting heart rate were prescribed and supervised by medical personnel. To establish the reliability of the tests results, the research scholar collected data from eight students prior to the testing of the subjects.

To ensure reliability of the test results, the tester repeated the tests several times. For establishing tester competence, the various test results were correlated with those obtained by the expert, by Pearson's product moment correlation raw score method.¹ The reliability coefficients

obtained have been given in table II.

<table>
<thead>
<tr>
<th>Test</th>
<th>(N = 8)</th>
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<tbody>
<tr>
<td>Resting Blood Pressure</td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>.971*</td>
</tr>
<tr>
<td>Diastolic</td>
<td>.980*</td>
</tr>
<tr>
<td>Resting Heart Rate</td>
<td>.972*</td>
</tr>
<tr>
<td>Recovery Heart Rate</td>
<td>.862*</td>
</tr>
</tbody>
</table>

*Significant at the .01 level of confidence.

Tabulated r = .834 for df = 6.

The obtained reliability coefficients were significant at the .01 level of confidence for all the tests as they had reliability coefficients of more than .834 required for 6 degrees of freedom.

The blood analysis of haemoglobin percentage, R.B.C. and W.B.C. (total counts) was done at a well recognised hospital laboratory 'Kuppuswamy Medical Hospital Laboratory' Coimbatore. The blood analysis as done by the above laboratory was accepted as reliable for the purposes of this study. The instruments used for all the tests were those which were
being used in the medical laboratory and as such the reliability of the instruments was also accepted.

**Test Administration**

**Resting Blood Pressure**

The object of this test was to measure the systolic and diastolic blood pressure at rest.

**Equipment**

For recording the blood pressure a sphygmomanometer, a stethoscope and a bed were used.

**Procedure**

The procedure to record the blood pressure was followed as prescribed by Guyton. Each subject was made to rest on the bed for 10 to 12 minutes in a comfortable position, so that the circulatory system had enough time to come back to normal. The blood pressure for all the subjects was checked in the morning session of school working hours. While taking blood pressure, the subject's right arm was completely made bare to make certain that clothing did not press the blood vessels. The instrument was kept at the level of the heart. The blood pressure measurement was taken with

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the subject in a lying position, the forearm being kept straight in a relaxed position. The pressure cuff was wrapped around the arm evenly with the lower edge approximately one inch above the anticubital space. The stethoscope receiver was placed firmly over the brachial artery in anticubital space. The cuff was inflated until the artery collapsed fully to the extent that no pulse beat (sound) was heard.

When no pulse beat was heard, the pressure in the cuff was lowered slowly by releasing air through the valve of the rubber tube and when it fell just below the systolic level a spurt of blood escaped into the artery below the cuff at the peak of each systole. This was checked by listening (with a stethoscope) to the flow of blood just below the cuff. The impact of the small spurs of blood up on the stationery column of blood set up vibrations that were detected as thumping sounds and this was recorded as the systolic pressure.

As the cuff pressure was further released more blood escaped beyond the cuff at each systole and the sound became louder. When the diastolic pressure was reached the blood flowed through the artery under the cuff throughout the cardiac cycle and the sound suddenly muffled and then disappeared entirely. This indicated diastolic blood pressure. Both the recordings were in millimeters (mm. of Hg.).
Basal Heart Rate

The object of the test was to record the number of pulse beats per minute.

Equipments

For recording the basal resting heart rate two stop-watches 1/10th of a second and a cot were used.

Procedure

The subjects were tested in a lying position in the morning session. Finger tips were placed on the radial artery at the wrist and the palpitation of the artery were counted for 30 seconds and then doubled to record the pulse rate per minute.

Haemoglobin Content

The object of the test was to determine the haemoglobin content of the blood.

Equipment

To determine the haemoglobin content 'SAHLI HAEMOMETER' was used, which consisted of haemometer tube, hydrochloric acid (1 : 10), pipette, syringe and distilled water. The instrument was designed and calibrated in accordance with the standards laid down by German Medical Association. The

principle of the test in Sahli acid haematih method is to convert the blood into acid-haemain by the addition of 1 : 10 hydrochloric acid.

Procedure

The haemometer tube was filled with the lowest graduation (0.02 gms) of standard hydrochloric acid, diluted to the ratio of 1 : 10. The finger tip of the subject was sterilised by ether solution and then the skin was pierced by Frank's needle and blood was sucked into the capillary pipette avoiding air bubbles, until the 20 cu. mm. mark was reached. Then the blood was blown-out completely into 2 ml of 1 : 10 hydrochloric acid in the haemometer tube on the stand and was properly mixed till the liquid turned brown in colour and then the tube was left undisturbed for ten minutes. Distilled water was added to this solution in a very thin stream using a dropper, until the colour of the solution in the haemometer matched with the non-fading coloured glass of the haemometer stand.

Readings were recorded at the lower meniscus of the solution from the haemoglobin scale on the tube. This was noted without parallax-error, which indicated the haemoglobin percentage of the subject. The haemoglobin scale was provided in grams of haemoglobin content per 100 ml of blood. The obtained result was converted into percentage by using the standard haemoglobin percentage chart.
Blood Corpuscles

The object of the test is to determine the total count of red blood corpuscles and white blood corpuscles.

Equipment

To record the R.B.C. and W.B.C. counts the 'NEUBOER HAEMOCYTOMETER' diluting solution and cover slip were used.

Procedure

Blood sample was taken separately R.B.C. and W.B.C. pipettes up to the mark 1 graduated on the pipettes and the rest of the bulb was filled by sucking up R.B.C. or W. B.C. diluting solution respectively up to the mark - 3. After shaking it well, one drop of diluted blood from the pipette was introduced in the counting chamber under the cover slip. Then the red cells were counted in the five groups of 16 small squares, this number as multiplied by a fraction which gave the total red blood corpuscles count. The same procedure was followed for obtaining the white blood corpuscles.

Recovery Heart Rate

The object of the test was to record the recovery heart rate after continued strenuous exercise. A physically

⁴Chatterjee, Human Physiology, pp. 174-176.
conditioned person will be less affected by a given amount of exercise then one in poor condition. It is on the basis of these facts that pulse ratio test have been formulated to assess the ability of the heart to compensate for the exercise.\textsuperscript{5}

The Physical Efficiency Index (PEI) suggested for Harward Step Test is a direct indicator of recovery heart rate, due to the fact that 'while the step performance is vigorous, the score is based entirely on the pulse rate evaluation'. Hence the direct method of assessing the recovery heart rate in the modified Harward Step Test for girls was utilised.\textsuperscript{6} Here the cardiovascular efficiency score has been computed by the formula \( CES = \frac{\text{Number of Seconds} \times 100}{5.6 \times \text{pulse count}} \). Comparison of CES will produce the same result as comparison of the heart recovery rate. Hence the computed cardio efficiency scores of the three groups during the pre-test, mid-test and post-test were tested for significant differences by ANOVA.

The pulse count was counted for 30 seconds after one minute after the cessation of the exercise. The obtained

\textsuperscript{5}Clarke, \textit{Application of Measurement to Health and Physical Education}, p. 157.

\textsuperscript{6}Ibid.
data was converted into cardiovascular efficiency score (CES) by using the prescribed formula given earlier.

**Equipment**

To determine the recovery heart rate one stop watch (1/10 of a second), one 18 inch high bench, a metronome and a chair were used.

**Procedure**

After recording the subjects' normal heart rate for one minute, they were exposed to the Harward step exercise for three minutes. For those who were unable to continue the exercise for three minutes, the time such subjects were able to perform the exercise was recorded in seconds. The metronome was adjusted for the rhythm of 24 beats per minute and each subject was to synchronise her stepping to the click of the metronome. Before the exercise the subject assumed an erect standing position near the bench. She stepped up and down 24 times a minute on the bench 18 inches high, each time stepping up all the way on the bench with the body erect. The stepping process was performed in four counts. First, one foot placed on the bench second the other foot placed on the bench and the body lifted and standing erect, third one foot placed on the floor and fourth the other foot placed on the floor. The subject was permitted to lead off with any foot or change foot as she desired.
Following the exercise for three minutes the subjects rested for one minute in a sitting position and thereafter the pulse rate was recorded for 30 seconds. For those who were unable to continue the exercise for three minutes the subjects rested for one minute in a sitting position and thereafter the pulse rate was recorded for 30 seconds. For those who were unable to continue the exercise for three minutes, the actual time for exercise in seconds was noted.

Collection of Data

Data on the selected physiological variables was collected as per the method prescribed above thrice, before the experimental period (pre-test), after six weeks (mid-test) and after the training programme of twelve weeks (post-test). The training programme involved the prescribed aerobic and anaerobic exercises.

Statistical Analysis

The data collected from the three groups on the selected physiological variables were to be compared for significant differences. It was presumed that some of the variables may indicate significant differences early even during the middle of the training period i.e., at the end of six weeks. Hence it was considered necessary to use the two way analysis of variance, providing for pre-test, mid-test
and post-test and thus analysing the data for significant differences between the three groups and the three stages.

To determine the difference between the results obtained at the different stages during the training of the subjects and between the three groups, the two way analysis of variance was computed for each variable. To find out whether there were significant differences between paired means, other than for the pair with the greatest difference, the Scheffe S test of post-hoc significance was used.

As no highly sophisticated or electronic equipment was used justifying more stringent levels of confidence, the level of significance was set at .05 level of confidence.