Chapter III

PROCEDURE

The subjects, criterion measure, administration of test and the statistical model for analysing the data are described in this chapter.

Subjects

All the 165 male students of K.D.B. High School, Sarigam, Bhilad (Gujarat) studying in class IX to XII were medically examined to ensure that they were fit to undergo 12 minute Cooper's Run-Walk Test. All those declared medically fit were asked to take part in the Cooper's Test. The test was held on the 200 metres track of the school. The students participated in the test in batches of fifty each and the total distance run by each subject in 12 minutes was recorded. With the help of the test score and students scoring above eightieth percentile and below twentieth percentile were grouped as high cardio-respiratory and low cardio-respiratory fitness groups respectively. Thus, twenty boys each in high and low cardio-respiratory fitness groups were finally selected as subjects for the study. According to the school records the age of the subjects
ranged between sixteen and eighteen years.

**Criterion Measure**

The criterion measure chosen to test the hypothesis were:

1. Weight of the subject recorded in kilograms with a lever type laboratory anthropometric weighing machine.

2. Standing height of the subject recorded to nearest half centimetre with the help of wall scale.

3. Foot length recorded to nearest half-centimetre with the help of spreading caliper.

4. Foreleg length recorded to nearest half centimetre with the help of flexible steel tape.

5. Thigh length recorded to the nearest half centimetre with the help of flexible steel tape.

6. Trunk length recorded to the nearest half centimetre with the help of flexible steel tape.

7. Calf girth recorded to the nearest half centimetre with the help of flexible steel tape.
8. Thigh girth recorded to the nearest half centimetre with the help of flexible steel tape.

9. Abdominal girth recorded to the nearest half centimetre with the help of flexible steel tape.

10. Hip width recorded to the nearest half centimetre with the help of spreading caliper.

11. Shoulder width recorded to the nearest half centimetre with the help of spreading caliper.

12. Fonderal index obtained using the formula standing height divided by $3/\text{weight}$ and recorded to two decimal places.

13. The ratio of leg length and trunk length using the formula leg length divided by trunk length recorded to two decimal places.

14. Crucral index computed using the formula foreleg length over thigh length and recorded to two decimal places.

15. The ratio of shoulder width and hip width computed using the formula shoulder width divided by hip width and recorded nearest to two decimal places.
16. Body density computed from skinfold measurement using the equation:

\[
\text{Body density} = 1.1043 - 0.00132 \text{ (thigh skinfold)} - 0.00131 \text{ (subscapular skinfold)} \] 

and recorded to three decimal places:

17. Percentage of body fat obtained by taking skinfold measurements at four selected sites namely biceps, triceps, inferior angle of scapula and supra-illiac and the total value of four sites compared to a ready reckoner prepared by Durmin and Rahaman\(^2\) to obtain the percentage of body fat.

18. Lean body mass obtained by subtracting total weight of fat from total body weight and recorded in kilograms.

19. Total weight of fat recorded by multiplying body weight with obtained percentage of body fat divided by 100 and recorded in kilograms.

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Procedure for Administration of Tests

Cardio-respiratory Endurance

All the subjects were assembled at the 200 M. track of K.D.B. High school, Sarigam one evening. They were briefed on the objectives and the requirements of the Cooper's 12 Minute Run-Walk Test. It was clearly explained to them that they were expected to cover maximum distance possible by running in twelve minutes, and falling back if they were exhausted even before the completion of twelve minutes. The test was conducted on the 200 meter track of K.D.B. High school, Sarigam. The track examiner, if present, ensured that their cardio-respiratory systems were not overloaded. A demonstration run was conducted in order to familiarise them with the manner in which they would start, on what signal they would stop and how the measurement would be taken. They were asked to remove their doubts, if any, for about a week they practised the test-run under the strict conditions of the administration of the test recommended in the Test Manual in order to eliminate learning effects before the initial measurements were recorded. The co-efficient of correlation, of their performances of the last two
days of this training phase was found to be 0.91. As this was fairly high coefficient of correlation, the scores of the last day were recorded as the initial test scores.

The test was conducted on the 200 metres six lane track of K.D.B. High school, Serigam. The track was marked off in 10 metres segments. The subjects were started in groups of twenty, a lap scorer was assigned for every batch of five subjects. The subjects had cheat numbers of identification by the lap scorers.

Simultaneously with starting off a group by sounding a clapboard by the investigator a stop watch was started by the time keeper. The time keeper blew a whistle at the end of twelve minutes at which the subjects stopped in their places. The lap scorers noted down the distance covered by each subject to the nearest five metres.

The maximum distance covered by each subject in Cooper's 12 minute Run-Walk Test was recorded nearest to five metres as the cardio-respiratory endurance score.
Absolute Anthropometric Variables

Weight

The weight of the subject was taken with a lever type laboratory anthropometric weighing machine. The subject, bare footed wearing short and vest only, stood at the centre of the weighing machine. The weight was read and recorded correct to quarter of a kilogram.

Standing Height

The standing height was taken with the subject standing erect without shoes, against a marked scale on a wall touching the heels, buttocks and backs. The subject was instructed to keep the heels together, head level without tilt and to take and hold a full breath while measurement was taken. A stiff hard board was held horizontally on his head, slightly pressing his head and touching the scale marked on the wall. The subject was asked to step out and the reading indicated by the hard board was read on the scale. Height was recorded correct to the nearest half centimetre.\(^3\)

\(^3\)Carter, Physical Structure of Olympic Athletes, p.151.
with the subject seated, the distance between the base, connecting point of the rod and the tip of the longest toe was measured from the metatarsal phalangeal joint. The opposite edge of the rod was placed on the lower end of the calcaneus (heel) bone, with the edge of the savin arm closest to the back and the opposed arm over the metatarsal bones toward with the opposite edge of the savin arm closest to the tip of the longest toe. The foot length was measured accurately to the nearest millimeter.

Fig.1. Anthropometer Rod (Spreading Caliper) to Determine Anthropometric Measurements.

Fig.2. Skinfold Caliper to Determine Skinfold Thickness.
Foot Length

With the subject standing, the distance between the most posterior point of the heel and the tip of the longest toe was measured with the spreading calipers. The inside edge of the fixed arm of the calipers was kept resting on the most posterior point of the heel and the moving arm of calipers was brought inward until inside edge of the moving arm rests on the tip of the longest toe. The foot length was recorded correct to the nearest half centimetre.\(^4\) (Fig.3)

Foreleg Length

Foreleg length of the subject was measured with the help of flexible steel tape vertically from the bottom outside edge of the centre of the foot to the most protruberant part of the patella bulge (coinciding with centre at the knee bend at the back). Foreleg length was recorded correct to the nearest half centimetre.\(^5\)

\(^4\)Ibid., p.152.

\(^5\)Cureton, Physical Fitness of Champion Athletes, p.48.
Thigh Length

Thigh length of the subject was measured with a flexible steel tape vertically from the most protruberant part of the patella bulge to the upper edge of the greater trochanter. Thigh length was recorded correct to the nearest half centimetre.\textsuperscript{6,7}

Trunk Length

Trunk length of the subject was measured with a flexible steel tape vertically from the end of the spinal column to the top of the shoulder at the base of the neck. Trunk length was recorded correct to the nearest half centimetre.\textsuperscript{6}

Leg Length

Leg length of the subject was measured with a flexible steel tape from outside edge of the center of the foot to the upper edge of the greater trochanter. It was recorded to the nearest half centimeter.\textsuperscript{9}(Fig.4).

\textsuperscript{6}Ibid.


\textsuperscript{8}Cureton, \textit{Physical Fitness of Champion Athletes}, p.47.

\textsuperscript{9}Johnson and Nelson, \textit{Practical Measurements for Evaluation in Physical Education}, p.70.
Calf girth was taken with a flexible steel tape at the maximum circumference of the calf in a plane at right angles to its long axis. The leg was extended over a table top so the tape measures was in a horizontal plane. In this position, the calf muscle is quite relaxed. Calf girth was recorded correct to the nearest half centimeter.¹⁰

Thigh girth was measured with a flexible tape just under the fold of the buttocks. The subject stood with his weight equally distributed on both feet. Thigh girth was recorded correct to the nearest half centimeter.¹¹ (Fig. 3.)

Adventitial girth was measured with a flexible tape just above the knee.¹² (Fig. 4.)

¹¹ Beetle, The Analysis of the Human Figure, 1956.
¹² Beetle, The Analysis of the Human Figure, 1956.
Calf Girth

Calf girth was taken with a flexible steel tape at the maximum circumference of the calf in a plane at right angle to its long axis. The leg was held dangling over a table top so the tape measures was in a horizontal plane. In this position, the calf muscle is quite relaxed. Calf girth was recorded correct to the nearest half centimetre.\(^{10}\)

Thigh Girth

Thigh girth was measured with a flexible steel tape placed round the thigh horizontally with its top edge just under the fold of the buttocks. The subject stood with his weight equally distributed on both feet. Thigh girth was recorded correct to the nearest half centimetre.\(^{11}\) (Fig.5).

Abdominal Girth

Abdominal girth was measured with a Flexible


\(^{11}\)Ibid.
steel tape placed round the abdomen exactly on the middle of the abdomen touching the naval. The subject stood with his weight equally distributed on both feet. Abdomen girth was recorded correct to the nearest half centimetre.\textsuperscript{12} (Fig. 6)

**Hip Width**

The subject stood with his heels together wearing underwear only and the arms of the spreading calipers were brought into contact with the top of the hip bone (iliac crest) at the place where it sticks out most, that is at the place which gives the greatest hip width. Hip width was recorded correct to the nearest half centimetre.\textsuperscript{13} (Fig. 7)

**Shoulder Width**

The subject stood with his shoulder relaxed. The inside edge of the fixed arm of the modified sliding calipers was kept resting on the outside edge of the acromial process of one shoulder blade and the moving arm of sliding calipers was brought inward until inside

\textsuperscript{12} Ibid.

\textsuperscript{13} Ibid.
edge of the moving arm rested on outside edge of acromial process of the other shoulder blade. It was recorded correct to the nearest half centimetre.\textsuperscript{14} (Fig.\textsuperscript{8})

Relative Anthropometric Variables

\textbf{Standing Height}\n3/\textbf{Weight}

This ratio for each subject was calculated by substituting in the formula the score of the height of subject in centimetre, correct to the nearest centimetre and the score of weight in kilograms correct to the nearest kilogram. The obtained value of this ratio was recorded correct to the decimal places. This ratio is named as Fonderal Index in literature.\textsuperscript{15,16}

\textsuperscript{14} Ibid.


\textsuperscript{16} Cureton, \textit{Physical Fitness of Champion Athletes}, p.49.
Fig. 5. Determination of Thigh Girth.

Fig. 6. Determination of Abdominal Girth.
This ratio was obtained by dividing the centre of leg length by the corresponding centre of thigh length and values so obtained were recorded across the central line.

Fig. 7. Determination of Hip Width.

Fig. 8. Determination of Shoulder Width.
Leg Length
Trunk Length

This ratio was computed by dividing the score of leg length by the corresponding score of trunk length and the obtained value was recorded correct to two decimal places.\textsuperscript{17}

Foreleg Length
Thigh Length

This ratio was computed by dividing the score of foreleg length by the corresponding score of thigh length and the obtained value was recorded correct to two decimals. This ratio is named as Crural Index in literature.\textsuperscript{18}

Shoulder Width
Hip Width

This ratio was computed by dividing the score of shoulder width by the corresponding score of hip width and the obtained value was recorded correct to two decimal places.\textsuperscript{19}

\textsuperscript{17} Ibid.

\textsuperscript{18} Ibid.

\textsuperscript{19} Ibid.
Body Composition Variables

Body Density

This score was computed from two skinfold measurements and the equation used by the Sloan as Body Density

\[ = 1.1043 - .00132 \text{ (Thigh skinfold)} - .00132 \text{ (subscapular skinfold)} \]  

Front thigh skinfold was recorded while standing equally on both feet and then one foot was placed on a 20 cm. step with knee slightly flexed and thigh relaxed. The skinfold was raised midway on the anterior of the thigh between the trochanterion and the proximal border of the patella. The fold was lifted parallel to the long axis of the thigh. The skinfold caliper was applied about 1 cm. from the fingers holding the skinfold and at a depth that was about equal to the thickness of the fold. The reading was recorded in millimetres.  

\[ 20 \text{ Sloan, The Journal of Applied Physiology, pp. 312-315.} \]

\[ 21 \text{ Sheaver, Essentials of Exercise Physiology, p. 192.} \]

\[ 22 \text{ Johnson and Nelson, Practical Measurement for Evaluation in Physical Education, p. 76.} \]
Subscapular skinfold was measured by picking up the skinfold just beneath the inferior angle of scapula in a direction which is obliquely downwards and outwards.\textsuperscript{23}

Skinfold measurements were determined with the help of Harpenden Skinfold Caliper, designed and manufactured in U.K. which was made available by research scholar from the Research Division, Netaji Subhas National Institute of Sports, Patiala.

**Percentage of Body Fat**

Percentage of body fat was measured with the help of skinfold measurements. Skinfold was recorded at four sites of the body i.e., biceps, triceps, subscapular and supra-illiac and the total corresponding value of skinfold at four sites was referred to the help of converting chart prepared by Durnin and Rahaman.\textsuperscript{24}

In case of in-between values it was plotted graphically and actual value was recorded correct to one tenth of millimetre.

\textsuperscript{23}Ibid.

\textsuperscript{24}Durnin and Rahaman, *British Journal of Nutrition*, p.691.
Skinfold Measurements

Harpenden Skinfold Caliper was employed for measuring the fat component at specific site. The skin at a specific site was held between the thumb and index finger and pulled out to form a fold so as to include the thickness of skin and subcutaneous fat in between them. The subject was asked to make appropriate movements to ensure that only the skinfold enclosing subcutaneous fat was pinched and the muscle tissue which freely contracted and relaxed with movements was not included in the fold. The caliper was applied about one centimetre from the spot pinched with thumb and finger and to a depth approximately equal to the fold. The measurement was read nearest to one tenth of a millimetre. These readings were taken and the average of the three readings was recorded as the thickness of the skinfold at that site.

Front of the Upper Arm (Biceps)

The subject was asked to stand in an anatomical position with the arms freely hanging. A point on mid-way on the biceps was located and skinfold measurement was taken. (Fig. 9(a))
Back of the Upper Arm (Triceps)

The subject was asked to stand in anatomical position with the arms freely hanging. He was asked to flex the arm at the elbow at 90 degrees. A point on the triceps midway between the acromial process of the shoulder and the coronoid process of the ulna was located and skinfold measurement was taken. (Fig.9(b)

Inferior Angle of Scapula

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 and towards the medial side and lower and towards the lateral side. The thickness of the fold was measured as per description given above. (Fig.10(a).

Supra Iliac

The subject was asked to stand in anatomical position. A site on the abdomen (one side of the trunk) above the iliac crest at the level of the umbilicus was selected. The thickness of the skinfold was measured as per description given above. (Fig.10(b))
Fig. 9(a) Determination of Skinfold Thickness (Front of the Upper Arm)

Fig. 9(b) Determination of Skinfold Thickness (Back of the Upper Arm)
Fig. 10(a). Determination of Skinfold Thickness (Inferior Angle of Scapula)

Fig. 10(b). Determination of Skinfold Thickness (Supra-Iliac).
Total Weight of Fat

Total weight of fat was recorded by multiplying body weight with obtained percentage of body fat and divided by constant 100. It was recorded in kilograms.25

Lean Body Mass

Lean body mass was obtained by subtracting total weight of fat from total body weight and recorded in kilograms.26

Analysis of Data

To compare the mean differences between high and low cardiorespiratory fitness groups, t test was employed with respect to each of the anthropometric and body composition variables. The level of significance chosen was .05.


26 Ibid.
To obtain inter correlation among the anthropometric and body composition variables of high and low cardio-respiratory fitness groups Product Moment Method was employed and correlation matrix was prepared.

To obtain the combined effects of significant absolute variables with each one of it placing as a criterion variable, multiple correlation was computed.

**RELIABILITY OF DATA**

The cardio-respiratory endurance was measured by the distance run in Group A's 15-minute New York Test on ten days with a gap of one day in between. The coefficient correlation of the scores made by the subjects on the ten days was computed to measure the reliability of the performances. The reliability coefficient was 0.91.

In the case of anthropometric measurements such as height, weight, foot length, forearm length, leg length, thigh length, trunk length, arm width, thigh girth, abdominal girth, hip width, shoulder width and scalp fold occipitofrontal breadth of the upper arm, inferior angle of occiput, main filled and frontal thigh the measurements were made three times at the beginning of