CHAPTER - III
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PROCEDURE

The selection of subjects, selection of variables, reliability of data, administration of tests, collection of data and statistical procedure employed for analysing the data, are described in this chapter.

Selection of Subjects

The subjects for this study were 200 male swimmers, selected out of 260 swimmers, in the age group of 9 to 12 years. A table of random numbers was used for the selection of subjects by following the suggestions of Steel and Torrie\(^1\). It was kept in mind that 50 swimmers remained in each of the four groups i.e. nine years (from 8.6 to 9.5 years), ten years (9.6 to 10.5 years), eleven years (10.6 to 11.5 years) and twelve years (11.6 to 12.5 years). All these subjects had been getting training for competitive swimming at least for the last one year in Delhi, Bangalore, Calcutta, Gwalior and Bombay cities, and some of SAI's NSTC centres. The age of all the subjects and health records maintained by the their coaches /pools were checked by the investigator to ensure that that the subjects selected were physically and mentally sound to undertake various tests chosen for this study.

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Prior to testing them on different tests, a meeting of all the subjects along with their parents and coaches was called. At this meeting the purpose of the study, requirement of testing procedures, demonstration and explanation of various anthropometric, behavioral and physiological tests were given in order to make them understand about what they were actually required to do to fulfil the basic requirements of this study. All the subjects agreed voluntarily to cooperate in the testing procedures explained to them. Their coaches also exhorted them to put in their best efforts in this scientific investigation. Though, no special techniques of motivation were used to motivate the subjects to put in their best efforts yet the subjects were very enthusiastic and cooperative throughout the project.

**Selection of Variables**

A feasible analysis as to which of the important variables could be taken up for investigation in keeping in keeping with the availability of equipments, acceptability to the subjects and the legitimate time that could be devoted to the study unitary and integrated, was carried out on the basis of performance as gleaned from the review of professional literature.

In addition to this the scholar prepared a detailed openinnaire in order to seek opinion of swimming experts working in different parts of the country. Ultimately on the basis of these the following variables were selected which
were further classified into two categories i.e. dependent and independent variables.

**Dependent Variable**

Swimming performance scores denoted by composite scores calculated from the timing in 50 metres free style swimming and subjective rating of the free style swimming technique by five swimming experts was taken as dependent variable for this study.

**Independent Variables**

**A. Anthropometric Variables**

- Standing Height
- Body Weight
- Arm Length
- Hand Breadth
- Leg Length
- Foot Length
- Foot Breadth
- Shoulder Width
- Hip Width

**B. Physical Variables**

- Grip Strength
- Arm and Shoulder Strength
Abdomen Strength Endurance
Shoulder Flexibility
Trunk-hip Flexibility
Average Ankle Flexibility

C. Physiological Variables
Body Fat Percentage
Vital Capacity
Resting Pulse Rate
Respiratory Rate

Criterion Measures For Independent Variables

Anthropometric Variables

1. Standing height of the subject was recorded to the nearest half centimeter with the help of wall scale.

2. Weight of the body was recorded in kilogram taken with a lever type laboratory anthropometric weighing machine.

3. Arm length was recorded to the nearest half centimeter with the help of flexible tape.

4. Hand length was measured as the straight distance between two points and recorded to nearest half centimeter with the help of anthropometric caliper.
5. Hand breadth was measured with same anthropometric caliper and recorded to nearest half centimeter.

6. Leg length was recorded to the nearest half centimeter with the help of flexible steel tape.

7. Foot length was measured by caliper as the straight distance between acropodion and pternion and was recorded to the nearest half-centimeter.

8. Foot breadth was measured the straight distance between metatarsal fibulare and metatarsal tibiale.

9. Shoulder width of each subject was recorded to the nearest half centimeter with the help of caliper.

10. Hip width was recorded to the nearest half centimeter with the help of sliding caliper.

**Physical Variables**

11. Grip strength was measured with the help of grip dynamometer and performance recorded in kilograms.

12. Arm and shoulder strength was measured by using pull-ups test and recorded to the correct number of successfully executed pull-ups.
13. Abdominal strength was measured by administering the sit-up test on the floor and recorded to the correct number of sit-ups performed by subjects.

14. Shoulder flexibility was measured by using standard test and it was recorded in centimeters as the score of each subject.

15. Trunk – hip flexibility was measured by using “Wells & Dillon Sit & Reach Test” and distance was recorded in centimeter as the score.

16. Ankle flexibility was measured by using dorsi and planter flexion and recorded by using goniometer (180 degree protract) .

**Physiological Variables**

17. Body fat percentage was calculated with the help of skinfold measurement using four selected sites on the body i.e. biceps, triceps, sub-scapular and supra-iliac.

18. Vital capacity was measured by using dry Spirometer in cubic centimeters from the indicator dial of the instrument.

19. Resting pulse rate was taken for one-minute duration and total number of pulses was recorded as score of the subject.
20. Respiratory rate was taken by recording the up and down movements of abdomen in supine position. Total numbers in one-minute duration were recorded as score.

Reliability of Data

The reliability of data was ensured by establishing the instrument reliability, tester reliability, reliability of tests and subjects reliability. For this purpose test-retest method was used and Coefficient of Reliability was checked to ensure the reliability of the data.

Instrument's Reliability

To measure selected anthropometric variables, the instruments like weighing machine, spreading caliper, flexible steel tape, and wall scale were used in this study. All these instruments were obtained from standard firm, which cater to the need of various research laboratories in India and abroad, and their calibrations were accepted as accurate enough for the purpose of this study. For measuring selected physiological variables, the instruments like skin fold caliper, dry spirometer, stopwatches, steel tape, leg dynamometer, goniometer, yardstick, and wall scale were used. All these equipments were obtained from standard firms, which cater to the needs of various research authorities in India and abroad. Their calibrations were accepted as accurate enough for the purpose of this study.
Tester's Competency and Reliability of Tests

To ensure that the investigator was well acquainted with the technique of conducting the tests, the investigator had trials and practice sessions with respective experts. The investigator took all the measurements with the help of assistants, who were also well acquainted with the tests and their testing procedures.

Tester competency was evaluated together with the reliability of tests. Reliability of tests was established by test-retest process whereby consistency of results was obtained by product moment correlation. The data collected from a random selection of ten subjects by test-retest process, were computed for each variable and correlations obtained have been presented in Table 1.

Since very high correlations, ranging from .83 to .99 were obtained, this establishes the investigator's competency to administer the tests as well as reliability of tests.
Table-1

RELIABILITY CO-EFFICIENT OF TEST-RETEST SCORES

<table>
<thead>
<tr>
<th>Variables/Tests</th>
<th>Co-efficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Height</td>
<td>.99*</td>
</tr>
<tr>
<td>Body Weight</td>
<td>.96*</td>
</tr>
<tr>
<td>Arm Length</td>
<td>.91*</td>
</tr>
<tr>
<td>Hand Length</td>
<td>.92*</td>
</tr>
<tr>
<td>Hand Breadth</td>
<td>.91*</td>
</tr>
<tr>
<td>Leg Length</td>
<td>.97*</td>
</tr>
<tr>
<td>Foot Length</td>
<td>.96*</td>
</tr>
<tr>
<td>Foot Breadth</td>
<td>.94*</td>
</tr>
<tr>
<td>Shoulder Width</td>
<td>.97*</td>
</tr>
<tr>
<td>Hip Width</td>
<td>.92*</td>
</tr>
<tr>
<td>Grip Strength</td>
<td>.93*</td>
</tr>
<tr>
<td>Arm and Shoulder Strength</td>
<td>.89*</td>
</tr>
<tr>
<td>Abdomen Strength Endurance</td>
<td>.97*</td>
</tr>
<tr>
<td>Shoulder Flexibility</td>
<td>.92*</td>
</tr>
<tr>
<td>Trunk-hip Flexibility</td>
<td>.93*</td>
</tr>
<tr>
<td>Average Ankle Flexibility</td>
<td>.86*</td>
</tr>
<tr>
<td>Body Fat percentage</td>
<td>.94*</td>
</tr>
<tr>
<td>Vital Capacity</td>
<td>.83*</td>
</tr>
<tr>
<td>Resting Pulse Rate</td>
<td>.89*</td>
</tr>
<tr>
<td>Respiratory Rate</td>
<td>.93*</td>
</tr>
</tbody>
</table>

N = 10
r_{0.01} (\theta) = 0.765

*Significant at 0.01 level.

From Table 1 it is evident that tester’s reliability was significantly high thus, establishing the competency of the scholar to administer the tests. The correlation coefficients also indicated the reliability of the tests selected since very high correlations were obtained when the tests were repeated.
Subjects' Reliability

The above test-retest (co-efficient of correlation) method also established that subjects' reliability was significant at .01 level, as the same subjects were used under similar conditions by the same tester and no motivational techniques were used nor any training was given.

Administration of Tests and Collection of Data

The data on anthropometric, physical and physiological variables were collected by administering the tests for the chosen variables at the respective swimming pools where the subjects were undergoing swimming training, keeping in the mind subjects' feasibility and equipments availability.

Before the administrations of tests the subjects were given a chance to practice the prescribed tests, wherever applicable, to make them familiar with the tests and to know exactly what was to be done. The methodology for each apparatus was explained to the subjects prior to the administration. To ensure uniformity in testing conditions, the subjects were tested only during the evenings. The data was collected for the chosen independent and dependent variables as per the procedure mentioned below:
Swimming Performance Test

50 m Swimming Performance

The subjects were asked to swim as fast as possible for a distance of 50 metres with a push-off from the wall on the starting signal. Three timekeepers were assigned for each subject and along with starting signal the timekeepers switched on their watches and took the time for 50 metres. Three subjects were made to swim at a time to provide competitive environment. The official timing, as per existing swimming rules, was recorded in seconds up to two decimal digits.

Subjective Skill Rating

Skill rating was done by the subjective judgment of five qualified swimming coaches who used a 10-point scale\(^2\) and followed the standard rules of the crawl stroke technique. The subjects were asked to swim, one at a time, at a moderate speed over a distance of 25 metres. In judging the technique, each judge considered the stroke rhythm, the relaxation, the power, length of the arm pull, lateral breathing technique, arm recovery, depth and the technique of leg kick.\(^3\) The scale used is as follows:

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Very Good - 8½ to 10 Points
Good - 6½ to 8 Points
Satisfactory - 4½ to 6 Points
Deficient - 2½ to 4 Points
 Unsatisfactory - 0 to 2 Points

The highest and lowest awards were cancelled and the average of the remaining three awards were calculated up to two decimal digits and taken as score of skill learning of each subject.

The swimming performance of the subjects in 50 metres was determined by calculating a sum of the composite scores obtained from the speed of swimming front crawl stroke and technique of standard crawl stroke.

**Anthropometric Variables**

**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 back. The subject was instructed to keep the heels together, head 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 hard board was read on the scale. Height was recorded correct to the nearest half centimeter.\(^4\)

**Body Weight**

The weight of the subject was taken with a standard and calibrated-weighing machine. The subject stood bare footed, wearing only the acrylic swimming trunks, on the weighing machine exerting equal pressure on both feet without any movement there after. The weight was be recorded to the nearest half kilogram.\(^5\)

**Arm Length**

The subject was made to stand straight and relaxed. A flexible steel tape of standard quality was used. The tip of tape was placed on the tip of acromion process and measured to the tip of middle finger. This length was measured to the nearest half centimeter.\(^6\)

**Hand length**

The subject was asked to keep his elbow on a table, with the hand stretched and palm facing upward. The straight distance from the point wrist

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creases baseline to the tip of the middle finger measured hand length. The measurement was recorded to nearest half centimeter with the help of anthropometric compass.⁷

**Hand-breadth**

The subject asked to remain in the same position as in case of hand length measurement. Handbreadth was measured between the points metacarpal radiale and metacarpal ulnare with anthropometric compass and recorded the distance to nearest half of centimeter.

**Leg Length**

Leg length was measured vertically from the bottom outside edge of the foot in the centre of the instep to a line drawn horizontally through the mid-gluteal bulge at the point tangency to a vertical line contacting the buttocks. The tape was placed at the centre of the instep and measured to tip of iliac crest. The leg length was recorded correct to the nearest half centimeter.⁸

**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

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⁷ ibid., p.48.

⁸ ibid., p.49.
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 centimeter.⁹

Foot breadth

The subject remained in above position for foot breadth test also which was measured as the straight distance between metatarsal fibulare and metatarsal tibiale using a sliding calipers.

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 edge or the moving arm rested on outside edge of acromial process of the other shoulder blade. It was recorded correct to the nearest half centimeter.¹⁰

Hip width

The subject was asked to stand erect in relaxed position with relax arms hanging sideward. From this position he was asked to watch straight and

⁹ Ibid.

scholar took the sliding caliper in hand and fixed on one side at the top of hip-
bone (Iliac Crest) at the place where it is stick out most. After fixing at one
side, now the scholar moved the other side of caliper to the other side of hip at
the same height. Distance between two arms of caliper was measured and
recorded to the nearest half centimeter.\textsuperscript{11}

\textbf{Physical Variables}

\textbf{Grip strength}

To measure the grip strength of the subjects' the investigator used grip
dynamometer. A subject was asked to stand straight with having the
dynamometer in his right hand. At this point the subject stood relaxed and
without any contraction in muscles. The subject held the dynamometer with
firm grip and asked to take a deep breadth before executing the movements.
Finally, he pulled the grip of meter towards the base line on the palm and
stopped at his maximum. It was measured on the given scale the performance
was recorded in kgs.\textsuperscript{12}

\textbf{Arm and Shoulder Strength}

To measure the arm and shoulder strength of the subjects, pull up test
was administered on the mental horizontal bar of three centimeters diameter

\textsuperscript{11} Ibid.

\textsuperscript{12} Barry L. Johnson and Jack K. Nelson, \textit{Practical Measurements for Evaluation in Physical
fixed at a convenient height so that subject's feet did not touch the floor while he was hanging with arms straight. From this hanging position, the subject pulled himself up until the chin was above the bar and lowered him until his arms were fully extended. The subject was instructed to avoid kicking and jerking movements.\textsuperscript{13} Maximum number of correctly executed pull-ups was considered as subjects' score.

**Abdomen Strength**

For measuring the abdominal strength of the subjects Bent Knee Sit Ups were used and the subject asked to position on the back, the subject flexed his knees over the yardstick while sliding his heels closer to the seat. Line The yardstick was held tightly under the knees until the subject was instructed to slowly slide his feet forward. At the point where the yardstick dropped on the mat, the tester would mark the heel line and the seat line in order to indicate how far the feet should remain from the seat during the bent knee sit ups exercise. The fingers of the subjects should inter locked behind the neck and perform sit-ups alternating a left elbow touch of the inside right knee and a right elbow touch of the inside left knee. The movement was performed as many times as possible.\textsuperscript{14} The total number of repetitions was recorded as scores of the subject. However, repetitions were not counted when fingertips

\textsuperscript{13} Ibid., p.101.

\textsuperscript{14} Ibid., p.120.
did not maintain contact behind the head, when the knees were not touched, or when the subject pushed-off the floor with the elbow.

Shoulder Flexibility

The subject assumed a prone position on a flat surface, the chin touching the floor, and the arms extended forward shoulder-width apart. The rod is grasped and the elbows and wrists kept straight. Then the rod is raised upward from the floor to the maximum height, possible along the erect kept measuring stick.\textsuperscript{15} The height raised from the floor to the underside-raised rod, measured to the nearest centimeter was recorded as the score of shoulder flexibility.

Trunk-hip Flexibility

To measure the trunk-hip flexibility the wells, Dillon-Sit and Reach Test was administered on the subjects. The subject sat on the mat with feet placed in the footprints and pressed firmly against the cross board. The arms were extended forward with the hands placed palms down on the upper surface of the scale. In this position, the subject bent forward four times and held the position of maximum reach on the fourth count. The knees remained straight. If the hands reached unevenly, the hand reaching the shorter distance determined

the score.\textsuperscript{16} The maximum distance reached, taken to the nearest centimeter, was recorded as the score of trunk and hip flexibility.

**Average Ankle Flexibility**

Average flexibility of the right and left ankles was measured with the help of a goniometer consisting of a 180-degree protractor with two extended arms of 15 inches length; zero line is fixed, the other movable. The fixed arm of the goniometer was placed parallel with the lower leg, with the centre of motion at the ankle joint. Readings were taken with the ankle dorsiflexed as fully as possible, and again with as full planter flexed as possible.\textsuperscript{17} The difference between the two readings (dorsiflexion and planter flexion positions) represented the range of motion in degrees and right and left ankles were averaged.

**Physiological Variables**

**Body Fat Percentage**

Percentage of body fat was measured with the help of skinfold measurement. Skinfolds were recorded at four sites of the body i.e. triceps, back, hip, and stomach.\textsuperscript{18} The four readings were summed and the total


\textsuperscript{17} Ibid., P.131-132.

skinfold reading was converted into percent fat by using the regression
equation of Yuhasz\textsuperscript{19} as follows:

\[ \% \text{ Fat} = 5.783 + (0.153 \times \text{sum of 4 fat measures}) \]

**Skinfold Measurement**

Lange skinfold caliper was used to measure the skinfolds. The
investigator picked up a fold of sub-cutaneous tissue firmly between the thumb
and the index finger of the left hand and pulled out away from the under lying
muscle at the marks marked on the body of the subject. The jaws of the caliper
were then applied at right angles to the raised skinfold about 1 cm. from the
point where the skinfold was lifted. It was allowed to exert full pressure before
taking the reading of the thickness of the fold. The muscular tissue was not
included in the pinch, was ensured by asking the subjects to use the muscle in
appropriate movement. Measurements were taken on the right side of the body
and were recorded to the nearest millimeter. The anatomical sites utilized were
as follows:

1. **Triceps**: The measurement was taken over the triceps at a level halfway
   between the tip of acromion process and the tip of elbow (Olecranon process).
   Arm was hanging freely on the side. Skinfold was lifted on back of the right
   arm parallel to the long axis of the arm about 1 cm. above the site.

\textsuperscript{19} M. S. Yuhasz, "The Effects of Sports Training on Body Fat with Prediction of Optimal Body
2. **Back (Sub scapular):** The skinfold was located 1 cm. below the inferior tip of the scapula with the subject in a relaxed standing position. The fold was lifted parallel to the long axis of the body.

3. **Hip (Supra-iliac):** The skinfold was lifted on the right I mid-axillary line just above the crest of the ileum and to follow the natural diagonal line at this point.

4. **Stomach (Abdominal Skinfold):** The skinfold was lifted about 1 cm. to the right of the umbilicus and parallel to the long axis of the body.

**Vital capacity**

Vital capacity was measured with a dry spirometer supplied by Hindustan Scientific Instrument Co., New Delhi, made in Germany, in liters and the subjects were tested in standing position. The inner dial of the spirometer set on zero mark at the beginning of the test. The subjects took two deep breaths before starting the test and then after fullest inhalation the subjects placed the mouthpiece of the spirometer in his mouth, taking care to see that no air escaped through the edges of the piece. The subjects exhaled forcefully and maximum while bending forward slightly until the maximum volume of air could be expelled without taking in a second breath. The subjects were instructed to take care that they blew out only through the mouth and not through the nose even partially, however, the nose clips were used to prevent
the airflow from escaping through the nose. Each subject was provided a trial 
before the final test. Three trials given to each subject in the final test and the 
score was recorded in cubic centimeters. Best effort of each subject, out of the 
three trials, was recorded as score of vital capacity in cubic centimeters.²⁰

Resting Pulse Rate

The resting pulse rate of subject was taken with the help of stopwatch 
and stethoscope. It was taken in the morning sessions and subjects were asked 
to lie down on their back (supine) for near about 30 minutes duration to rest 
them. The tester with having stopwatch and stethoscope in hands recorded total 
number of pulses as score in 1-minute duration.²¹

Respiratory Rate

Respiratory rate was taken in the morning hours. The subject was asked 
to lie down supine position and rest for 30 Minutes. There after the respiratory 
rate was counted by observing the up and down movements of abdomen. For 
correct number of rate, the investigator placed the open palm/hand on the 
abdomen to feel the real movements of respiration in the one-minute duration. 
Total numbers in one-minute duration were recorded as score²².

²⁰ David H. Clarke, Exercise Physiology (Englewood Cliff N.J.: Prentice-Hall Inc., 1975), pp. 159-
161.

²¹ K. Park, Preventive and Social Medicine 15th ed. (Jabalpur: Banarsidas Bhanot Pub, 1997), pp.223-
229.

²² Ibid.
Statistical Analysis

The purpose of the study was the development of a model for Talent Identification Among Age-Group Swimmers'. The Multiple Correlation and Regression Equations were developed for specific age-groups namely nine years, ten years, eleven years and twelve years. The level of significance was set at .05.