CHAPTER III

METHODOLOGY

Research is a purposeful and systematic study of a problem. For any systematic study, methodology is vital and it is a science of orderliness. “Scientific thinking, exploring new ideas and innovation of new concepts together constitute research. Research is the application of human intelligence in a systematic manner to a problem, the solution to which is not immediately available; the journey to the solution is called research. Doing research is an effective process which helps us to advance our knowledge and understand the educational process. Research is actually a voyage of discovery” (Kothari, 2004). Research comprises of defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and last carefully testing the conclusions to determine whether they fit the formulating hypothesis.

3.1.1 Social Science Research

Definition

The successful outcome of research depends upon the appropriate methodology adopted for the purpose of arranging facts and principles in an organized manner. The various stages involved in research are measuring variables and verifying existing theories by framing hypotheses and the methods involved in investigating them. Researchers use different methods in their investigation. The appropriate method selected helps the investigator to utilize time, money and energy in an efficient manner.
The methodology adopted for the investigation is discussed under the following headings:

1. Method used in the Present Study
2. Sample for the study
3. Variables selected for the study.
4. Research Design
5. Criterion Measures
6. Pilot Study
7. Reliability of Data
8. Administration of Tests
9. Collection of data
10. Statistical Procedure for analysis of data.

3.2 METHOD USED IN THE PRESENT STUDY

After having gone through all the types of research and methods of research, the researcher selected comparative analysis method for this study. This method is one of the most commonly used methods for descriptive research.

3.1 SAMPLE FOR THE STUDY

The generalisability of research results is the selection of sample which will provide the research data. A sample is a small proportion of a population selected for observation and analysis. A sample reflects the characteristics which define the population from which it is selected.
The present study was confined to the randomly selected 150 netball players consisting of 75 men and 75 women and 150 volleyball players consisting of 75 men and 75 women from different colleges of Kerala State located at various places in the University of Kerala Region. The age group of the subjects were between 18-25 years with standard deviation ± 2.15. The colleges were located at various places at university of Kerala.

All the subjects were oriented with regard to the purpose of the study, the benefits, significance of the study, test procedures and all the subjects volunteered to participate in this research. Table I shows the names of the colleges, number of subjects selected from each college.
### Table I

**Names of the Colleges and Number of Subjects Selected**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of the College</th>
<th>Number of Players</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Netball</td>
<td>Volleyball</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>1</td>
<td>Mar Baselios Engg. College</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>St. Thomas Engg. College</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Heera College Engg. College</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Lourd Matha Engg. College</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Mar Ivanios College</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>St. Xaviers College</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Mother Teresa Arts &amp; Science College</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>University College</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>75</strong></td>
<td><strong>75</strong></td>
</tr>
</tbody>
</table>

#### 3.2 SELECTION OF VARIABLES

The research scholar reviewed research articles, journals on selected physical fitness and mental fitness components. Taking into consideration the importance, feasibility, criteria, availability of instruments and the relevance of the variable of the present study, the following dependent and independent variables were selected.

### 3.2.1 Dependent Variables

**Anthropometric Variables**
1. Standing Height measured through Stadiometer
2. Weight measured through weighing machine
3. Arm Length measured through Non extensible Measuring Tape
4. Leg Length measured through Non extensible measuring tape
5. Percent Body Fat measured through Skin fold Caliper
6. Body Mass Index measured through height and weight
7. Upper arm girth measured through Non extensible measuring tape
8. Thigh Girth measured through Non extensible measuring tape

**Physical Fitness Variables**

1. Arm and Shoulder strength Measured through Pull ups
2. Abdominal Strength measured through Sit ups
3. Agility measured through Shuttle run
4. Explosive Power measured through standing broad jump
5. Speed measured through 50 M run
6. Endurance measured through 600 yard run / walk test

**Physiological Variables**

1. Vital Capacity measured through Spirometer
2. Systolic Blood Pressure measured through Sphygmomanometer
3. Diastolic Blood Pressure measured through Sphygmomanometer
4. Resting Pulse Rate measured through palpation method
5. Breath Holding Time measured through ‘nose clip’ method
6. Haemoglobin (gm%) ( HB testing apparatus)

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3.2.2 **Independent Variables**
1. 75 Men Netball Players
2. 75 Women Netball Players
3. 75 Men Volleyball Players
4. 75 Women Volleyball Players

3.3 RESEARCH DESIGN

This research adapted “Comparative Research” method to compare anthropometric, physical fitness and physiological variables of netball and volleyball players. Comparative research aims comparing two or more groups of subjects with a view to discovering something about one or all of the things being compared. In this study, men and women netball players and volleyball players of anthropometric, physical fitness and physiological variables were compared.

Data on anthropometric variables, height, weight, leg length, arm length, percent body fat, body mass index, physical fitness variables, arm and shoulder strength, abdominal strength, agility, explosive power, speed and endurance, physiological variables, vital capacity, systolic blood pressure, diastolic blood pressure, resting pulse rate, breath holding time, haemoglobin were collected by administering standard tests.

The collected data were statistically analysed using ‘t’ test to compare two groups, that is, boys and girls of netball and volleyball players.. In all cases 0.05 level was fixed to test the hypothesis of this study.

3.4 CRITERION MEASURES
The selected anthropometric variables, physical fitness and physiological variables were measured and scores obtained through the following criterion measures.

1. Anthropometric variable, height is measured through Stadiometer and scores recorded in centimeters.

2. Weight is measured through weighing machine and scores recorded in kilograms.

3. Body mass index was measured through height and weight.

4. Percent body fat was measured through skinfold calibers in three sites.

5. Leg length, arm length, upper arm girth and thigh girth were measured through non extensible measuring tape and scores recorded in centimeters.

6. Arm and Shoulder strength Measured through Pull ups and scores recorded in number of pull ups.

7. Abdominal Strength measured through Sit ups and number of sit ups performed in one minute.

8. Agility measured through Shuttle run and scores recorded in seconds.

9. Explosive Power measured through standing broad jump and scores recorded in meters.

10. Vital Capacity measured through Spirometer and scores recorded in milliliters.
11. Systolic Blood Pressure measured through Sphygmomanometer and stethoscope and scores recorded in mmHg

12. Diastolic Blood Pressure measured through Sphygmomanometer and stethoscope and scores recorded in mmHg

13. Resting Pulse Rate measured through palpation method

14. Breath Holding Time measured through ‘nose clip’ method

15. Haemoglobin was measured through (HB testing apparatus) and scores recorded in (gm%).

3.5 PILOT STUDY

Prior to collection of data the investigator conducted a pilot study, which enabled the investigator and assistants well versed with conduct of tests. This phase of research further enabled for accurate collection of data and determining reliability of tests and subjects.

3.6 RELIABILITY OF DATA

Reliability of data was determined for reliability of instruments, reliability of tests, subject reliability. Reliability is the degree of consistency. In the opinion of the Best and Khan(2003), “A test is reliable to the extent that it measures whatever it is measuring consistently”. The test and retest method was adopted for the calculation of reliability coefficient for the present tool. The correlation was obtained between the scores of these two halves. The reliability test was administered on individual categories as well as the entire scale as a whole.
3.6.1 INSTRUMENT RELIABILITY

To measure anthropometric variables, stadiometer, weighing machine, skinfold caliber and non extensible tape and for physical fitness components, stop watches, tapes, for physiological variables, spirometers, Sphygmomanometer and stethoscope, HB testing apparatus were used. The instruments were procured from reputable companies and were standard ones and being used for research department. The reliability of data was determined through test and retest method and found reliable for the purpose.

3.6.2 RELIABILITY OF TESTERS

The investigator administered tests with the help of 5 professionally qualified and experienced physical educationists During the pilot study process the tests were administered by the investigator and the assistants. The test and retest process conducted during pilot study process enabled the testers to get refreshed and the testers were well acquainted with administration of tests. The test and retest scores were subjected to statistical treatment using Pearson Coefficient Correlation test. The obtained reliability coefficients and the level of significance were presented in Table II.

Table II
Test and Rest Quotient Correlation Scores on Tests Administered

<table>
<thead>
<tr>
<th>S.No</th>
<th>Names of Variables</th>
<th>Measures / Units</th>
<th>Obtained ‘r’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ANTHROPOMETRIC VARIABLES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Height</td>
<td>Cms</td>
<td>0.99*</td>
</tr>
<tr>
<td>2</td>
<td>Weight</td>
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<td>0.98*</td>
</tr>
<tr>
<td>3</td>
<td>Leg Length</td>
<td>Cms</td>
<td>0.97*</td>
</tr>
<tr>
<td>4</td>
<td>Arm Length</td>
<td>Cms</td>
<td>0.98*</td>
</tr>
</tbody>
</table>
5 Percent Body Fat Percentage 0.88*
6 Body Mass Index Index Number 0.98*
7 Arm Girth Cms 0.97*
8 Thigh Girth Cms 0.98*

**PHYSICAL FITNESS VARIABLES**
9 Arm and Shoulder Strength Numbers 0.87*
10 Abdominal Strength Numbers 0.88*
11 Agility Secs 0.91*
12 Explosive Power Meters 0.92*
13 Speed Secs 0.82*
14 Endurance Meters 0.83*

**PHYSIOLOGICAL VARIABLES**
15 Vital Capacity Milli liters 0.82*
16 Systolic Blood Pressure mmHg 0.79*
17 Diastolic Blood Pressure mmHg 0.78*
18 Resting Pulse Rate Beats/minute 0.82*
19 Breath Holding Time Secs 0.81*
20 Hemoglobin (gm%) 0.77*

*Significant at 0.05 level.

### 3.6.3 RELIABILITY OF SUBJECTS

The correlation coefficient shown in Table II also served as reliability of subjects as similar subjects were selected and tested for the purpose of the study. Thus, the subjects were also found to be unbiased and reliable for the purpose of the study.

### 3.7 ADMINISTRATION OF TESTS

#### 3.7. ANTHROPOMETRIC VARIABLES

##### 3.7.1.1 HEIGHT:
Objective:

To measure height

Apparatus used:

Stadiometer and Anthropometric rod

Test Description:

Height will be measured by anthropometric rod. The subject stand erect bare footed on a plane horizontal surface against a wall with her heels, back of the shoulder and head touching the wall and stretch the body. Stretched upwards as much as possible without her heel leaving the ground. Than anthropometric rod is kept in front of the subject and the crossbar of the anthropometry is adjusted so that the lower edge touches the highest point of the subject’s head. Height will be recorded in meters.

3.7.1.2 WEIGHT

Objective:

To measure weight

Apparatus used:

Weighing Machine

Test Description:

The weights of the subjects were taken on a weighing machine with the subjects wearing short and vest only. They stood on the weighing machine and weight was recorded nearest to half a kilogram.
3.7.1.3  LEG LENGTH

Objective:

To measure Leg Length

Apparatus used:

Flexible Steel Tape

Test Description:

To determine the leg length, the examiner faced the subject the hands approximately four to six inches below the subject's waist on the hip and asked the subject to swing the right leg back and forth slowly and lifting it to the outside. By manipulation, the examiner could locate the spot where the greater trochanter entered the pelvic girdle. The height of the greater trochanter from the floor was measured. This procedure was followed five times with each subject. The measurement was recorded in centimeters.

3.7.1.4  ARM LENGTH

Objective:

To measure Arm Length

Apparatus used:

Flexible Steel Tap, Rod, Pencil and Paper
**Test Description:**

Reposition the end of the measuring tape to a spot about 5 inches from one end of the rod. The subject was asked to grasp the rod and to hold in his arm at about 45 degrees from the midline of the body. The elbow must be extended fully during this measurement.

The arm length was the distance from the rod to the acromion process. The acromion process is the bone like protuberance at the edge of the shoulder.

Care was taken the measurement was taken from the top of the rod.

**Scoring**

After taking several measurements, record on the fit kit sheet under corrected arm length of the subject was recorded.

3.7.1.5 PERCENT BODY FAT

**Skinfold Measurements**

**Purpose**

To measure the body fat of the subjects.

**Equipment used**

Skinfold caliper is a device which measure the thickness of fold of skin with its underlying layer of fat. Skinfold caliper had spring and which exerted 10 gm/sq mm pressure on
the skin fold and an accurate scale which measured the thickness in millimeters. The skin fold caliper which was used for the test had maintained same tension through out the range of motion.

**Description**

All the skinfold measurements were taken on right side of the body with the subjects standing.

**Biceps Skinfold**

The skinfold was measured by raising a vertical fold at the marked mid acromiale – radilac line on the anterior surface of the arm.

**Triceps Skinfold**

Triceps skin fold is the vertical fold measured at the middle of the upper arm half way between the tip of the shoulder and tip of the elbow.

**Subscapular skinfold**

Subscapular skinfold is the oblique fold measured just below the bottom tip of the scapular.

**Suprailliac Skinfold**

Slightly oblique fold measured just above the hip bone. The fold is lifted to follow the natural diagonal line of this point.

**Abdominal Skinfold**
A mark was made 5 cm adjacent to the umbilicus (belly-button), to the right side. The vertical pinch was made at the marked site, and the calipers placed just below the pinch.

**Thigh skinfold**

Subject was asked to sit and the knee bent at right angles. If there is difficulty in lifting a fold of skin, it may be easier with the leg extended, or with the thigh supported from below by the subject.

The mid-point of the anterior (front) surface of the thigh, midway between patella (knee cap) and inguinal fold (crease at top of thigh) was marked. A vertical pinch was made at the marked site.

**Calf skinfold**

The subject should place their foot on a chair or box so that the knee is at approximately 90 degrees. A point on the medial (inside) surface of the calf, at the level of the largest circumference was made. A vertical pinch parallel to the long axis of the leg was measured.

Based on the Seven Skinfold Sites (all 7 sites from above, SUM7 is the sum of all the measurements in mm) percent body fat was calculated using the following formulae.

\[
\text{Bone Density} = 1.112 - (0.00043499 \times \text{SUM7}) + (0.00000055 \times \text{SUM7}^2) - (0.00028826 \times \text{Age})
\]

\[
\text{Body Fat Percentage} = \left[\frac{4.95}{\text{Bone Density}} - 4.5\right] \times 100
\]

### 3.7.1.6 BODY MASS INDEX

**Calculation of Body Mass Index**
From the height and weight obtained following above procedures, body mass index of each subject was calculated. Body mass index was calculated by dividing the subject’s body weight in kilogram by their height in metres squared. (Palanivel, 2004)
3.7.1.7 ARM GIRTH

Purpose

To measure the circumference of the upper arm girth.

Equipment

Flexible measuring steel tape and score sheet.

Procedure

The upper arm girth was measured at the maximum circumference of the upper arm in a plane at right angle to its body axis. The measurement was taken to the nearest centimeter.

3.7.1.8 Thigh Girth

Objective

To measure the circumference of the thigh.

Equipment

Flexible measuring steel tape and score sheet.
Procedure

The thigh girth was measured in the maximum circumference of the thigh at a place right angle to the body axis and at the two third distance from the mid knee to the crotch. The measurement was taken to the nearest centimeter. (Yobu, 1983).

3.7.2 PHYSICAL FITNESS VARIABLES

3.7.2.1 Arm and Shoulder Strength (Pull ups)

Purpose

To assess the arm and shoulder strength of the subjects.

Equipment Used

Horizontal overhead bar, at an adequate height so that the subjects can hang from with arms fully extended and feet not touching the floor.

Procedure

The subject was asked to Grasp the overhead bar using either an overhand grip (palms facing away from body) or underhand grip (palms facing toward body), with the arms fully extended. The subject then raised the body until the chin clears the top of the bar, then lowered again to a position with the arms fully extended. The pull-ups should be done in a smooth motion. Jerky motion, swinging the body, and kicking or bending the legs was not permitted. The subject was asked to perform as many full pull-ups as possible.

Scoring
The total number of correctly completed pull-ups was recorded. (Johnson and Nelson, 1982)

3.7.2.2 Abdominal Strength (Sit ups)

**Purpose**

To measure abdominal strength

**Equipment**

Mats were used if they were available otherwise the floor was satisfactory.

**Procedure**

The subjects lay flat on the back with knees bent and feet on the floor with the heels not more than one foot from the buttocks. The knee angle was not less than 90 degrees. The fingers were interlocked and placed behind the neck with the elbow touching the floor, the feet were held securely by the partner. The subjects then curled up to the sitting position and touched the elbow to the knees. This exercise was repeated as many times as possible.

**Scoring**

The number of correctly executed sit ups, the subject was able to do in 60 seconds was recorded. A foul nullifies the count for those sit ups.

3.7.2.3 Agility (Shuttle run)
Objective

The purpose of this test was to measure agility.

Facilities and Equipments

Floor, stop watch, whistle, score sheet, measuring tape, chunnam powder, two wooden blocks (2”x2”x4”), score card and pencil.

Administration

Two parallel lines were drawn on the floor 10 metres apart. The blocks were placed behind one of the lines. The subjects were instructed to start from behind the other line. To start the shuttle run a whistle was blown and the subject ran to the blocks up one block, run back to the starting lines and placed the block on the ground beyond the line. Then the subject ran back picked up the other block and run across the starting line as fast as possible. The stop watch was started as the whistle blew and stopped when the subject crossed the starting line.
Scoring

The trials were administered with a rest period of five minutes in between the best of the two times were recorded as the scores in seconds.

3.7.2.4 Explosive Power (Standing Broad Jump)

Purpose

To assess the explosive power.

Equipments Used

Jumping pit and measuring tape.

Procedure

The subject was asked to stand with the feet parallel to each other and behind the starting mark, then the subject bent the knees and swings the arms and jumps far forward as possible. Three trials were given with adequate rest.

Scoring

The distance between the starting mark and the nearest landing point was measured as score. The best of three trials was the final Score (Johnson and Nelson, 1982)

3.7.2.5 Speed (50 M run)

Objective

To measure the maximum speed of the subjects.
Facilities and Equipments

An area on a track, with a starting line, a 50 meters course and a finish line, stop watches and whistle were used to collect the data.

Administration

The subjects were asked to take a position behind the starting line. The subject was asked to start on hearing ‘clapper sound’ and so cover the fifty meters with maximum effort.

Scoring

The score was the elapsed time to the nearest tenth of a second between the starting and the instant the subject crosses the finish line.

3.7.2.6 Endurance (600 yard run / walk test)

Purpose

To measure health related physical fitness component, endurance
Equipments

Track and Field with field markings, cones, recording sheet and stop watch.

Procedure

Subjects assemble behind the starting line at the starting signal, they, run or walk as far as possible within the 9 minutes time limit. An experienced pacer should accompany performers around the running area during the actual test. At the signal 'to stop' performers should remain where they finished long enough for test administrators to record the distance covered. Ample time should be given for stretching and warm-up as well as cool down.

Scoring

The distance in meters covered in 9 minutes

3.7.3 PHYSIOLOGICAL VARIABLES

3.7.3.1 VITAL CAPACITY

Purpose

To measure vital capacity

Equipments

Spirometer, chair, and nose clips.

Procedure

The vital capacity of the subject was determined by the Spirometer in sitting position. The subject was allowed to inspire the maximum amount of air voluntarily and
then the subject was asked to blow into the Spirometer to the maximum extent. While taking the test the nose of the subject was clipped using a nose clip. The vital capacity of the subject was obtained from the movement of circular volume indicator which was set at ‘0’ before the vital capacity measure was taken. The result was calculated in milliliter. (Baumgartner, T. and A. Jackson, 1987)

Scoring

Vital capacity of the subject was recorded as indicated in the dial of the Spirometer.

3.7.3.2 BLOOD PRESSURE (Systolic and Diastolic)

Purpose:

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

Equipment:

Sphygmomanometer and stethoscope.
Procedure:

A sphygmomanometer and a stethoscope were used to measure blood pressure (systolic and diastolic). The subjects were asked to be in sitting position throughout the study.

The left upper arm of the subjects was encircled by an inflatable rubber bag which was connected to a pressure pump and manometer. By pumping air, the pressure in the bag was rapidly raised approximately to 200 mmHg. This was sufficient to completely obliterate the brachial artery so that no blood comes through and the radial pulse disappeared. The pressure was then lowered to a point where the pulse could be felt by using a stethoscope, pulsating of the brachial artery at the bend of the elbow could be distinctly heard. At this particular point, pressure shown on the dial was considered to be the systolic pressure.

The pressure on the brachial artery was then gradually reduced until the arterial pulse rate beats could be distinctly heard and the point at which the sound disappeared was taken as the diastolic pressure. The scores recorded in mmHg.

3.7.3.3 RESTING PULSE RATE

Purpose

To measure the resting heart rate of each subject per minute

Equipments

Digital Heart Rate Measuring Machine, Model No. EW 243, manufactured by National Company, Japan.
The pulse rate of all the subjects were recorded in a sitting position, in the evening between 4 and 5 p.m. Before taking pulse rate the subjects were asked to relax for about 30 minutes.

Then the subjects were instructed to sit in a back supported chair and maintain in a slight incline position and placed the left hand on the table. Next the researcher was collected Heart Rate or pulse rate by using Digital Heart Rate measuring machine which was placed in the chest level on a table. In this way the researcher was measured the heart rate of the subject. (Authors Guide, 1984)

**Scoring**

The number of pulse beats per minute was recorded as the scores.

### 3.7.3.4 BREATH HOLDING TIME

**Purpose**

The purpose of this test was to measure the breath holding time.

**Equipments**

For recording the breath holding time, a stop watch (1/10th of second) and nose clip were used.

**Procedure**
The subject was instructed to stand at ease and to inhale deeply after which he holds his breath for a length of time possible by him. A nose clip was placed on nose to avoid letting the air through nostrils. The duration from the time of holding his breath until the movement he let air out was clocked by using the stop watch to the nearest one tenth of a second as breath holding time. The co-operation of the subject to let out the air by opening the mouth was sought to clock the exact breath holding time.

**Scoring**

The time is recorded in seconds and the beset of two trials were recorded (Mathew, 1988).

### 3.7.3.5 HEMOGLOBIN

Hemoglobin was estimated by the acid hematin method using Sahle's haemocytometer.

**Principle**

The hemoglobin was converted into acid haematin by reacting with dilute hydrochloric acid. The resulting brownish mixture was matched with a standard in a colorimeter.

**Procedure**

Upto two marks of the square tube, the 0.1N hydrochloric acid was taken. To this 20 micro liter of blood was added and then mixture was allowed to stand until acid hematin was developed. Distilled water was added drop by drop till the colour matched with standard colour of the haemometer. Once the colour matched, the readings were recorded directly.

**Result:**
3.7 COLLECTION OF DATA

The purpose of the study was to assess selected anthropometric, physical fitness and physiological variables among netball and volleyball players. For this purpose, the research scholar collected data from the selected subjects as explained above. Thus, data of netball and volleyball players such as, height, weight, leg length, arm length, percent body fat, body mass index, arm girth, thigh girth, arm and shoulder strength, abdominal strength, explosive power, agility, speed, endurance, vital capacity, systolic blood pressure, diastolic blood pressure, resting heart rate, breath holding time and hemoglobin were measured through standard tests. The collected data were tabulated and subjected to statistical treatment.

3.10 STATISTICAL TECHNIQUES USED FOR ANALYSIS

The following statistical procedures were followed to compare differences between two groups, that is, netball players and volleyball players. To compare differences all four groups, namely, girls netball players, boys netball players, girls volleyball players and boys volleyball players on selected criterion variables ANOVA was employed. Whenever the ‘F’ ratio is significant, Scheffe’s post hoc test was computed.