Chapter-III
Method
And
Material
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METHOD AND MATERIAL

“A research design is the arrangement of conditions for collection and analysis of data in a manner that aim to combine relevance to the research purpose with economy in procedure”.

(Jahoda and others)

In any research one of the most important prerequisite is the collection of appropriate data without which no worthwhile study can be possible. In this regard, Mouley (1964) remarks, “Scientific problem can be resolved only on the basis of data and a major responsibility of the scientist is to set up a research design capable of providing data necessary to the solution of the problem, while the unity of the research makes it impossible to say that one aspect is more crucial than other, the collection of data is of paramount importance in the conduct of research science, obviously, no solution can be more adequate that the data on which it is based.

To achieve the objectives of a study the investigator has to plan the entire process of the work in the terms of research design suited to the study, therefore, the design of present study is presented systematically under following heading:

SELECTION OF SUBJECTS

To accomplish the study random sampling technique has been used to select the subjects. The subjects were one hundred twenty male inter college level Kho-kho players between 18 to 25 years of age. These students were studying in various affiliated colleges and various departments of Himachal Pradesh university, Shimla. All the players used as a subject had participated in
the Himachal Pradesh inter college Kho-kho competition for men during the month of December year 2012.

All the subjects were ensured about their health status from college and department health record, which was regularly maintained by their respective colleges and departments, and it was found that all the selected subjects were medically fit for going through the testing procedure.

Prior to the administration of test, the requirements of the testing procedure were explained to them in details, so that there was no ambiguity in their mind regarding the efforts required of them and the strain that they had to endure in addition to their participation in the competition. All the subjects agreed voluntarily to cooperate in testing procedure explained to them in the interest of scientific investigation and enhancing their own performance. Though no special techniques were used to motivate the subjects to put in their best efforts, the subjects were enthusiastic and cooperative throughout the project.

SELECTION OF VARIABLES

In consultation with the experts of the field, reviewing the literature and considering the feasibility specially from the point of view of availability of equipments and time factor, the following kinanthropometric variables and physical fitness variables which seemed to be related to the performance of Kho-kho players in competition situation, were selected for the study.

A. Independent Variables

1. Age
2. Body weight

Linear Measurements

3. Height
4. Total arm length
5. Fore arm length
6. Leg length
7. Sitting height
8. Lower leg length
9. Foot length

Skeletal diameters (width)
10. Shoulder diameter (biocromial)
11. Abdominal diameter
12. Hip diameter
13. Elbow diameter
14. Femur bicondylar diameter
15. Ankle diameter

Body Circumferences (Girths)
16. Shoulder circumference
17. Chest circumference (normal)
18. Upper arm circumference
19. Thigh circumference
20. Calf circumference

Skin fold Measurements
21. Biceps skin fold
22. Triceps skin fold
23. Chest skin fold
24. Sub scapular skin fold
25. Suprailiac skin fold
26. Thigh skin fold
27. Calf skin fold
Body Composition variables

28. Body density
29. Percentage fat
30. Fat weight
31. Lean body mass

Physical fitness components

32. Muscular strength
33. Muscular endurance
34. Agility
35. Muscular power
36. Speed
37. Cardiovascular endurance
38. Flexibility

TOOLS USED

1. The average score of the three experts was considered to judge kho-kho playing ability.
2. For measuring the height and weight the anthropometer rods, weighing machine were used.
3. A flexible steel tape was used to measure the circumferences.
4. The lange’s skinfold caliper was used to measure the skinfold.
5. Diameters were taken with the help of vernier caliper and anthropometer compass.
6. All the kinanthropometric measurements were taken on the right side of the individual. Standard technique described by Weiner and Lourie's (1969) was followed for measurement. The necessary anatomical landmarks and the sites for skinfolds were marked with a sketch pen. All measurements were recorded to the nearest of centimeter but only
skinfolds measurements were recorded to the nearest of millimetre. Each side was measured twice.

7. To collect the data for physical fitness of AAHPER YOUTH FITNESS TEST (1976) was used.

The original batteries are as follows:

1. Arms/shoulder muscular endurance - Pull ups
2. Muscular strength + endurance - Bent knee sit ups (in 60 sec.)
3. Speed and agility - shuttle run (10 x 4 yards)
4. Explosive strength of legs - standing broad jump
5. Speed and explosive strength - 50 yards dash
6. Cardiovascular endurance - 600 yards run/walk
7. Flexibility - Wrist and Ankle flexibility

B. Dependent Variables

Overall kho-kho playing ability of each player was evaluated by three kho-kho coaches/experts on the basis of individuals running and chasing skills and the average score was taken as final score.

RELIABILITY OF DATA

The reliability of data was ensured by establishing the instrument reliability.

Instrument Reliability

Measuring steel tape, skinfold caliper, vernier caliper, anthropometric rod and stop watches used in the study were obtained from standard firm and most of the instruments were available in the research laboratory of department of physical Education, Himachal Pradesh University, Shimla. Their calibrations were accepted as accurate enough for the purpose of the study.
RELIABILITY OF MEASUREMENTS

To ensure that the investigator was well versed in the techniques of conducting the tests he had a number of practice sessions in the testing procedure under the guidance of the expert Dr. Ramesh Kumar Chauhan, Chairman, Department of physical education, Himachal Pradesh University, Shimla. The measurements for different sites that are linear circumferences, diameters and skinfolds were taken and recorded. After two days, the same measurements were taken on the same subjects and under the similar conditions. Then the coefficient of correlation by person’s product moment method was calculated which provide the reliability.

Co-efficient of correlations of measurements of equipments used are shown in the following tables:

**Table 3.1 (Reliability Co-efficient of correlation)**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Variables correlated</th>
<th>Co-efficient of correlation (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Weight</td>
<td>0.99</td>
</tr>
<tr>
<td>2.</td>
<td>Height</td>
<td>0.99</td>
</tr>
<tr>
<td>3.</td>
<td>Sitting Height</td>
<td>0.98</td>
</tr>
<tr>
<td>4.</td>
<td>Leg Length</td>
<td>0.96</td>
</tr>
<tr>
<td>5.</td>
<td>Lower Leg Length</td>
<td>0.98</td>
</tr>
<tr>
<td>6.</td>
<td>Total Arm Length</td>
<td>0.98</td>
</tr>
<tr>
<td>7.</td>
<td>Fore Arm Length</td>
<td>0.98</td>
</tr>
<tr>
<td>8.</td>
<td>Foot Length</td>
<td>0.91</td>
</tr>
<tr>
<td>9.</td>
<td>Shoulder Diameter (Biacromial)</td>
<td>0.99</td>
</tr>
<tr>
<td>10.</td>
<td>Abdominal Diameter</td>
<td>0.99</td>
</tr>
<tr>
<td>11.</td>
<td>Hip Diameter</td>
<td>0.99</td>
</tr>
<tr>
<td>12.</td>
<td>Elbow Diameter</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Measurements</td>
<td>Value</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>13.</td>
<td>Femur Bicondylar Diameter</td>
<td>0.86</td>
</tr>
<tr>
<td>14.</td>
<td>Ankle Diameter</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td><strong>Circumference Measurements</strong></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Chest circumference (normal)</td>
<td>0.98</td>
</tr>
<tr>
<td>16.</td>
<td>Upper arm circumference</td>
<td>0.95</td>
</tr>
<tr>
<td>17.</td>
<td>Shoulder circumference</td>
<td>0.99</td>
</tr>
<tr>
<td>18.</td>
<td>Thigh circumference</td>
<td>0.97</td>
</tr>
<tr>
<td>19.</td>
<td>Calf circumference</td>
<td>0.92</td>
</tr>
<tr>
<td></td>
<td><strong>Skinfold Measurements</strong></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Biceps skinfold</td>
<td>0.89</td>
</tr>
<tr>
<td>21.</td>
<td>Triceps skinfold</td>
<td>0.88</td>
</tr>
<tr>
<td>22.</td>
<td>Sub scapular skinfold</td>
<td>0.89</td>
</tr>
<tr>
<td>23.</td>
<td>Suprailliac skinfold</td>
<td>0.98</td>
</tr>
<tr>
<td>24.</td>
<td>Thigh skinfold</td>
<td>0.99</td>
</tr>
<tr>
<td>25.</td>
<td>Calf skinfold</td>
<td>0.99</td>
</tr>
<tr>
<td>26.</td>
<td>Chest skinfold</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td><strong>Physical Fitness Measurements</strong></td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>Pull ups</td>
<td>0.99</td>
</tr>
<tr>
<td>28.</td>
<td>Bent knee set-ups (in 60 second)</td>
<td>0.98</td>
</tr>
<tr>
<td>29.</td>
<td>Shuttle run (10 x 4 yards)</td>
<td>0.90</td>
</tr>
<tr>
<td>30.</td>
<td>Standing broad jump</td>
<td>0.84</td>
</tr>
<tr>
<td>31.</td>
<td>50 yards dash run</td>
<td>0.98</td>
</tr>
<tr>
<td>32.</td>
<td>600 yards run/walk</td>
<td>0.93</td>
</tr>
<tr>
<td>33.</td>
<td>Wrist flexibility</td>
<td>0.99</td>
</tr>
<tr>
<td>34.</td>
<td>Ankle flexibility</td>
<td>0.99</td>
</tr>
</tbody>
</table>

N=10 df= 8

significant at 0.01% level, \( r = 0.765 \)

significant at 0.05% level, \( r = 0.632 \)

As is evident from table 3.1 the co-efficient of correlation are significant at 5% level. It is evident that tester reliability was significantly high. This established the competency of the scholar to administrate the test.
RELIABILITY OF SUBJECT

The above test retest co-efficient of correlation method also established that subject reliability was significant at 0.5% level of confidence, as the same subjects were used under similar conditions by the same tester and no motivational techniques were used nor any training was given.

COLLECTION OF DATA

The Necessary data were collected by administering the tests for the chosen kinanthropometric variables, physical fitness variables and kho-kho playing ability. All the tests were administered during H.P. University kho-kho (Men) championship held at G.C. Karsog in December 2012.

The subjects were given a chance to practice the prescribed test so that they might become familiar with the tests and knew exactly what was to be done. All the tests were conducted in three days. To ensure uniform testing conditions the subjects were tested only during the morning and evening sessions. The use of apparatus was explained to them prior to the administration of tests.

An assistant was also trained for recording the data, which was well versed with the chosen kinanthropometric measurements. He accompanied the investigator to all places in connection with collection of data. Standard equipments were used to collect the data. Necessary instructions and demonstrations were given to the subjects before the conduct of the test.

All the kinanthropometric measurements were taken on the right side of the individual. Standard technique, described by Weiner and Lourie’s (1969) was followed for measurements. The necessary anatomical landmarks and the sites for skinfolds were marked with a sketch pen. The body weight was recorded to the nearest of half a kilograms, linear measurements,
circumferences, diameters to the nearest of 1/10 of a centimeter and skinfold measurements to the nearest of a millimeter.

**ADMINISTRATION OF TESTS**

**Independent Variables**

The technique used for taking various kinanthropometric measurements were as follows:

1. **Age**
   - **Objective:** To record the chronological age of the subject.
   - **Equipment:** School Record
   - **Procedures:** The Age of each subject was calculated by subtracting date of birth of the players from the date of observation. The reading thus obtained was converted into year.
   - **Scoring:** The age of the subject was recorded in years.

2. **Body Weight**
   - **Objective:** To measure the total body weight of the subject.
   - **Equipment:** Weighing machine.
   - **Procedures:** The subject, wearing minimal clothes, stood erect in the center of the scaled platform of a standard portable weighing machine and the weight was recorded to the nearest half of kilograms. The zero of the scale was checked before taking each measurement.
   - **Scoring:** The weight was recorded from the reading scale of the weighing machine in kilograms.
Linear Measurements

3. Height

Objective: To measure the height of the subject.

Equipment: Anthropometer Rod.

Procedures: It is the vertical distance from the vertex to the horizontal ground. The stature was measured with an anthropometric rod. The measurement was taken with the subject standing straight against an upright wall, touching it with heels, buttocks and back. The head was oriented in the Frankfurt plane, and the heels were together, and the hands were hanging downwards. The subject was stretched upward by a gentle traction on the mastoid region, taking care that the heels were kept on the ground. The anthropometer was held vertically in front of the subject in mid sagittal plane and the horizontal movable bar was brought down to touch the point vertex.

Fig. 3.2

Scoring: The height was recorded to the nearest of a centimeter.
4. **Total arm length**

Objective: To measure the length of arm.

Equipment: Anthropometer Rod.

Procedures: It is the distance between acromion point and dectylion point. The subject was asked to stand in a comfortable position. One end of the anthropometer was fixed at a acromion point and the anthropometric was adjusted upto dectylion point.

Scoring: The reading was recorded up to nearest 1/10 centimeter.
5. **Fore arm length**

**Objective:** To measure the vertical distance between the radial and stylion.

**Equipment:** Anthropometer Rod.

**Procedure:** It is the straight distance between the points radials and stylion, measured with the anthropometric upper segment while the individual stood erect with his arms hanging down freely.

![Fig. 3.4](image)

**Scoring:** The forearm length was recorded to the nearest centimeter.
6. Leg length

Objective: To measure the length of legs.

Equipment: Anthropometer Rod.

Procedure: The distance between the anterior superior iliac spine and the standing surface was measured with the anthropometric rod with the subject in the same position as that for stature.

Scoring: Length of leg was recorded to the nearest centimeter.

Fig. 3.5
7. Sitting height

Objective: To measure the sitting height of the subject.

Equipment: Anthropometer Rod.

Procedure: It is the vertical distance from the point vertex to the sitting plane. The subject was asked to sit erect on a table with his feet unsupported, the hands resting on the thighs. The head was oriented in the frankfurt plane, gentle upward traction was erected on the mastoid region and the distance between the vertex and the table top was measured with an anthropometric rod touching the back of the subject at the sacral and inter scapular regions in the mid sagittal plane.

Fig. 3.6

Scoring: The sitting height reading was recorded up to 1/10 of a centimeter.
8. **Lower leg length**

Objective: To measure the vertical distance between tibia and Spherion.

Equipment: Anthropometer Rod.

Procedure: It is the straight distance between the superior surface of the medial condyl of the tibia and the floor. The subject was asked to stand in an erect position. The distance between the tibial and the standing surface was measured with anthropometer rod.

![Image](image-url)

Fig. 3.7

Scoring: The result was recorded from the reading scale of the anthropometer rod in centimeter.
9. Foot Length

Objective: To measure the straight distance of foot.

Equipment: Anthropometer Rod.

Procedure: It is the distance between the tip of the most tarsal phalanx and the most posterior part of the calcaneus. The measurement was taken with the help of Anthropometer Rod. The subject was asked to stand in a comfortable position with feet slightly apart.

![Image of measurement](image)

Fig. 3.8

Scoring: Results were recorded from the reading scale of Anthropometer Rod in centimeter.
Skeletal diameters (width)

10. Shoulder diameter (biacromial)

Objective: To measure the diameter of the shoulder.

Equipment: Anthropometer Rod or Rod Compass.

Procedure: With the individual standing in a relaxed position and arms hanging down freely, the distance between the most lateral points of acromial processes on either side was measured with the help of Anthropometer Rod upper segment by standing behind the subject.

Scoring: Results were recorded from the reading scale of the Anthropometer rod or Rod Compass in centimeter.
11. Abdominal diameter

Objective: To measure the abdominal diameter of the subject.

Equipment: Anthropometer Rod or Rod Compass.

Procedure: It measures the minimum girth of abdomen above the navel cavity. The Anthropometer Rod was wound around the place where right and left abdomen wall are most sunk between costal bow and iliac edges.

Scoring: The measurement was recorded in centimeter by the unit of 1/10 centimeter.
12. Hip diameter

Objective: To measure the diameter of the Hip.

Equipment: Anthropometer Rod and Rod Compass.

Procedure: The individual was asked to stand in an erect position with feet together. The measurement was taken with the help of anthropometer compass. The anthropometer upper segment was adjusted on the hip of the level of greater trochanter of the two sides.

Fig. 3.11

Scoring: Measurement was record to the nearest centimeter.
13. **Elbow diameter**

**Objective:** To measure the diameter of the Elbow.

**Equipment:** Sliding caliper

**Procedure:** The individual was asked to stand in an erect position. The elbow was raised horizontally and forearm at 90° the distance between the medial and lateral epicondyles, was measured with the help of sliding caliper with slight pressure on the cross bar.

![Image of measurement](image.png)

**Fig. 3.12**

**Scoring:** Measurement was recorded to the 1/10 of a centimeter.
14. Femur bicondylar diameter

Objective: To measure the straight distance between the outermost points of the condyles on the lower end of Femur.

Equipment: Sliding Caliper

Procedure: With the individual seated on a table and the knee bent at a right angle, greatest distance between the lateral and medial epicondyles of the femur was measured with the help of Sliding calipers with slight pressure on the cross bar.

Scoring: Results was recorded from the reading scale of the Sliding Caliper in centimeter.
15. Ankle diameter

Objective: To measure the diameter of the Ankle.

Equipment: Sliding Caliper

Procedure: It is the straight distance between the medial tibia and lateral malleolus of the fibula. The Sliding Caliper was used to measure the ankle diameter.

Fig: 3.14

Scoring: Results was recorded form the reading scale of the Sliding Caliper in centimeter.
Body Circumferences (girths)

16. Shoulder circumference

Objective: To measure the circumference of the shoulder.

Equipment: Flexible Steel Tape.

Procedure: It was measured along laterally at the maximal protrusion of the deltoid muscles and anteriorly at the articular prominence of the sternum and second rib. The subject was asked to stand in comfortable position. Measurement was taken with the help of a flexible steel tape. The tape was applied in such a manner that it touched the maximal protrusion of the deltoid muscles and the articular prominence of the sternum and second rib.

Fig. 3.15

Scoring: Result was recorded from the reading scale of the steel tape in centimeter.
17. **Chest circumference (normal)**

Objective: Measure the chest circumference of the subject is breathing normally.

Equipment: Flexible Steel Tape.

Procedure: It was measured along with nipple at mid tidal volume. The subject was asked to stand in easy position and measurement was taken in a relaxed phase. The flexible steel tape was applied in such a manner that it touched the lower angle of shoulder blades in the back and was directly above the nipple in front.

![Fig. 3.16](image)

Scoring: Value was recorded to the nearest centimeter.
18. **Upper arm circumference**

**Objective:** To measure maximum circumference of the upper arm.

**Equipment:** Flexible Steel Tape.

**Procedure:** It is the perimeter distance of the right arm parallel to the long axes of the humerus when the subject stands erect and the relaxed arm hangs by the sides. The tape was held at the measured and marked mid-acromiale radiale distance.

![Fig. 3.17](image)

**Scoring:** Result was recorded to the nearest centimeter.
19. Thigh circumference

Objective: To measure the circumference of the thigh at the lowest point in the gluteal furrow and horizontal to the thigh.

Equipment: Flexible Steel Tape.

Procedure: It was measured just below the gluteal fold or maximal thigh girth. Subject was asked to stand in a relaxed position with feet slightly apart and weight equally distributed on both the feet. Steel tape was located horizontally around the left thigh at a point of greatest girth.

Scoring: Result was recorded from the reading scale of the steel tape in centimeter.

Fig. 3.18
20. Calf circumference:

Objective: To measure the circumference of the calf muscles.

Equipment: Flexible Steel tape.

Procedure: The maximum circumference of calf was measured with the help of steel tape, when the subject was standing with his feet slightly apart and his weight equally distributed on both legs.

Fig. 3.19

Scoring: Results was recorded from the reading scale of the steel tape in centimeter.
Skinfold measurement

Body fat was estimated through skinfold measurement which was taken with the help of an Indian version Lange’s skinfold caliper.

The measurements of skinfold are based on the knowledge, that approximately fifty percent of depot fat is stored in special cells within subcutaneous areas. Skinfold is a fold consisting of two layers of skin and subcutaneous structures, which can be picked up with the help of thumb and index finger. The thickness of the fold will depend upon the amount of stored fat and can be measured with a special instrument called a skinfold caliper. A caliper is designed to exert a pressure on caliper force of 10 grams per square millimeter. The calipers are actually designed for measuring the thickness of double layer of skin and interposed layer of fat. There are only slight differences between individuals in the thickness of the skin, so the resulting value is an indirect estimate of individual differences in the thickness of subcutaneous fat. When measuring skinfold thickness, it is essential to determine precisely the location of the site. Likewise it is important to hold the skinfold firmly and maintain a constant distance between the caliper and the thumb and finger holding the site. The number of sites at which skinfold can be measured are practically limitless, but only a few have been found to be of value in estimating body density, percent fat, fat weight and lean body mass. In the present study the following skinfold measurement were selected:-

i) Biceps skinfold  
 ii) Triceps skinfold  
 iii) Chest skinfold  
 iv) Sub scapular skinfold  
 v) Suprailiac skinfold  
 vi) Thigh skinfold  
 vii) Calf skinfold.

All the measurements were taken on the right side of the body with subjects in the standing position. Each side was measured twice, whenever these were a discrepancy of more than one percent between the two values, a third measurement was taken. To eliminate the possibility of experimenter bias,
the first series of measurements was completed prior to starting the second series of measurements so that there was no recollection of the previous measurements for any one site. The mean of the measurements scores was taken as score of individual players.

21. **Biceps skinfold**

**Objective:** The biceps skinfold is measured on the mid-upper arm over the biceps muscles.

**Equipment:** Skinfold Caliper.

**Procedure:** The skinfold was measured by raising a vertical fold at the marked mid acromial radial line on the anterior surface of the arm. The subject stood with the arms hanging down freely. Special care was taken not to grasp the underlying muscular tissues.

**Scoring:** Result was recorded from the circular reading scale of the skinfold caliper in millimeter.

![Fig. 3.20](image-url)
22. Triceps skinfold

Objective: The triceps skinfold measured on the back of the left upper arm over the triceps muscles.

Equipment: Skinfold Caliper.

Procedure: The skinfold was measured in the midline of the posterior aspect of the arm, over the triceps muscle, at a point midway between the lateral projection of the acromion process of the scapula and the inferior margin of the colcannon process of ulna.

![Fig. 3.21](image)

Scoring: The reading was noted in millimeter.
23. Chest skinfold

Objective: The Chest skinfold is measured on the site just lateral to the nipple.

Equipment: Skinfold Caliper.

Procedure: The chest skinfold was measured using a skinfold with its long axis directed to the nipple. The skinfold was picked up on the anterior auxiliary fold as high as possible; the thickness was measured one cm inferior to this.

Fig. 3.22

Scoring: Measurement was recorded up to 1/10 of a millimeter.
24. Sub scapular skinfold

Objective: To measure the sub scapular skinfold of the subject.

Equipment: Skinfold Caliper.

Procedure: The skinfold was picked up on a diagonal inclined infero-laterally approximately 45 degree to the horizontal plane in the natural cleavage lines of the skin. The thickness of the fold was measured with the help of skinfold caliper.

Fig. 3.23

Scoring: Measurement was recorded upto 1/10 of a millimeter.
25. Suprailiac skinfold

Objective: To measure the Suprailiac skinfold of the subject.

Equipment: Skinfold Caliper.

Procedure: It is the measurement of the skinfold immediately superior to the iliac crest at the mid-auxiliary line. The skinfold was held firmly between the thumb and index finger at 45 degree to the anterior suprailiac spine on a diagonal line going downwards and inwards and measurements was taken with the help of caliper.

Scoring: Result was recorded from the circular reading scale of the skinfold caliper in millimeter.
26. Thigh skinfold

Objective: The thigh skinfold is measured on the mid-thigh region of the subject.

Equipment: Skinfold Caliper.

Procedure: The thigh skinfold was measured in the midline of the anterior aspect of the thigh, midway between the inguinal crease and the proximal border of the patella. The thickness of a vertical fold was measured in millimeter while the subject stood relax.

Scoring: Result was recorded from the circular reading scale of the skinfold caliper in millimeter.
27. Calf skinfold

Objective: The medial calf skinfold is measured on the medial side of the calf muscles.

Equipment: Skinfold Caliper.

Procedure: The vertical fold was picked up on the posterior side of the lower leg at the level of the maximum girth of the calf and measurement was recorded.

Scoring: Result was recorded from the circular reading scale of the skinfold caliper in millimeter.
Estimation of Body Composition

The four skinfold measurements were used to estimate body density, percent fat, fat weight and lean body mass as the main constituents of body composition. The description of these variables and the method of their estimation are given below.

28. Body Density

This indicates the weight in grams per cubic centimeter of body tissues. Body density is estimated from the sum of four skinfold measurements (Biceps, Triceps, Subscapular and Superailiac). In the present study body density was estimated using **Durnin and Rehman’s Equation (1967)**. The formula is as follows:-

\[
\text{Body Density (y)} = 1.1533-0.0643 X
\]

(where \( X \) = sum of four skinfold in millimeters converted in logarithms).

29. Percent fat

Percent fat is the amount of fat in 100 Kg. of body weight. It was calculated from body density using **Siri’s (1951)** formula which is given as under:-

\[
\text{Percent fat} = \left(\frac{4.95}{\text{Body Density}} - 4.50\right) \times 100
\]

30. Fat Weight

This is the weight of the overall body fat, which is deposited in the subcutaneous area of the body. About fifty percent of the depot fat is stored in specialised cells under the skin, the thickness of which depends upon the amount of fat in the body. This is calculated from the weight of the body and percent fat. The formula of **Durnin and Rehman** was used to estimate fat weight which is given below:

\[
\text{Fat weight} = \text{Body weight} \times \frac{\text{Percent Fat}}{100}
\]
31. Lean body mass

This is the amount of muscle mass in the body. Lean body mass is considered to be divisible into biological constant proportions. These would include water (70-72%), minerals (7%) and organic substances including an undermined but probably constant percentage (2-3%) of essential liquids in bone marrow, the central nervous system and other organs. In other words, the lean body mass includes the weight of the essential fat (Bahnke and Wilmore, 1974). This is calculated by subtracting the fat weight from the total body weight. Again Durnin and Rahman’s formula is used to estimate the amount of lean body mass.

\[
\text{Lean body mass} = \text{Body weight} - \text{fat weight}
\]

Physical Fitness

To achieve the objectives of the present study, following physical fitness test were used.

1. Arms/shoulder muscular endurance - Pulls ups
2. Muscular strength + endurance - Bent knee sit ups (in 60 sec.)
3. Speed and agility - Shuttle run (10 x 4 yards)
4. Explosive strength of legs - Standing broad jump
5. Speed and explosive strength - 50 yards dash
6. Cardiovascular endurance - 600 yards run/walk
7. Flexibility - Wrist flexibility & Ankle flexibility
32. Muscular Strength (Pull-Ups)

Objective: The objective of this test was to measure arms and shoulder’s strength of kho-kho players.

Equipment: A wooden bar or metal bar approximately 1.5 inches in diameter and a stop watch and lime powder.

Procedure: A horizontal bar was fixed high enough so that the subjects could hang with their arms legs fully extended and their feet being off the floor. The subject were asked to use the over hand grasp (palms facing away from face) on the bar. After assuming the hanging position, the subject raised his body by his arms until his chin crossed over the bar and then lowered his body to a full hang, as in the starting position. The exercise was repeated as many times as possible.

Fig. 3.27

Additional Pointer:

1. The Swing of the body was not allowed during the execution of the movement.
2. The raising of the knees and kicking of the legs were not permitted.

Scoring: Maximum numbers of completed pull-ups are recorded in final score.
33. Muscular Endurance (Bent Knee Sit-Ups)

Objective: To measure the muscular endurance of the abdominal muscles of Kho-kho players.

Equipment: Mat, pen, paper and stop watch.

Procedure: The subjects were asked to assume a supine laying position on the floor with knees bent to an angle, a little less than 90 degrees and hands clasped behind the neck. The feet were held down by a partner. The subject brought his head and elbows forward in a curl-up motion, touching this position, the subject would go back to his starting position i.e. supine position.

Additional Pointer:
1. The fingers remained locked behind the neck throughout the exercise.
2. The feet were held firmly by the partner at one position.

Scoring: The number of correctly executed bent knee sit-ups performed in one minute, were recorded as his score.
34. Agility (Shuttle Run)

Objective: To measure speed and agility of the subjects.

Equipment: Two wooden blocks of size 2" × 2" × 4" a stop watch and lime powders.

Procedure: Two parallel lines, 30 feet apart were marked on the ground. Blocks of wooden were placed on one of the lines. The subjects started from behind the other line. On the sound of the clapper, the subject ran to the blocks, picked up one, ran back to the starting lines and placed the behind the lines. He then ran back picked up the second block, which he carried back across the starting line. As soon as the block was placed on the grounds, timekeeper stopped the watch and recorded the time.

Additional Pointer

1. Two trails were allowed with an interval during which another pair of students were tested.

Scoring: The maximum time taken by subject to place both the blocks behind the starting line will be recorded as the final score for this test.
35. **Muscular Power (Standing Broad Jump)**

Objective: To measure explosive strength of legs.

Equipment: Measuring tape and jumping pit.

Procedure: The subject stood with the feet comfortably apart and the toes just behind the take-off line. Preparatory to jump the subject swung the arm backwards and bent the knees. The jump was accomplished by simultaneously extending the knees and swinging the arms forward.

![Image of a person preparing to perform a standing broad jump](image)

**Fig. 3.30**

Additional Pointer

1. Measurement was taken from the take-off line to the heel or other part of the body that touched the pit nearest to the take-off line.

2. Running or stepping was not permitted.

Scoring: The best out of three trials was recorded in centimeter as his score.
36. Speed (50 Yard Dash)

Objective: The purpose of this test to measure the sprinting speed of the subject.

Equipment: Clapper and stop-watches.

Procedure: On the track, a 50 yard distance was marked with the starting and the finishing lines. After a short warm up, the subjects took their position behind the starting line. On the sound of the clapper, the subjects started their race and ran as fast as possible up to the finishing line.

Additional Pointer

1. The subjects were not allowed to touch or cross the starting line.
2. Stop watch was stopped as soon as the subject touched the tape.

Scoring: The time was recorded to the nearest one tenth of a second.
37. Cardiovascular Endurance (600 Yard Run/Walk)

Objective: To measure cardiovascular endurance of the subject.

Equipment: Stop watch, wooden clapper, measuring tape, marking powder.

Procedure: The test was conducted in 100 yards and 200 yards track as sufficient space was not available in many of the college instructions were given to all the subjects about starting and the number of laps they had to complete. Four to eight subjects ran at a time. The subjects used standing start. At the sound of the wooden clapper, the subjects started running/walking.

Additional Pointer:

1. The subjects were permitted to complete the test by running or walking or both.

2. Without getting the signal “Go” Subjects should not cross the starting line.

Scoring: Time was recorded in minutes and seconds as one’s score.
38. Wrist Flexibility

Objective: The purpose of this test was to measure the wrist flexibility of the subjects.

Equipment: Double armed goniometer, bench, and table.

Procedure: The subject was asked to sit on a bench putting his fore arm forward on the table with hand in the 'shake hand' position, with finger and thumb close together. The elbow was kept flexed. The fixed arm of the goniometer was placed on the radial bone and moving arm in line with the thumb so that axis of the goniometer fell on the wrist joint.

The subject was asked for complete flexion his wrist and then extension his wrist to the maximum. Moving arm of the goniometer moved along with the thumb on the protector.

Scoring: The angle through which the wrist moved from flexion to extension was measured of the both hands of subject separately and the average score was recorded in degree.
39. Ankle Flexibility

Objective: The purpose of this test was to measure the ankle flexibility of this subject.

Equipment: Double armed goniometer, bench.

Procedure: The subject was asked to sit on a bench putting his leg straight and easy on the bench. The fixed arm of the goniometer was placed on the shin bone (tibia) and moving arm in line with the greater toe of the foot so that the axis of the goniometer fell on the ankle joint.

The subject was asked to dorsiflexion and then planter flexion the foot to the maximum. Moving arm of the goniometer moved along with the foot on the protector.

![Image of goniometer being used on a subject's ankle]

Fig. 3.34

Scoring: The angle through which the foot moved from dorsiflexion to planter flexion was measured of the both feet of the subject separately and the average score was recorded in degrees.

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Dependent Variable

Kho-Kho Playing Ability (Five point rating scale)

Objective: The purpose of this test was to judge the playing ability of Kho-kho Players.


Procedure: The Kho-kho playing ability was judged in the light of the five point rating scale by a panel of three judges who had sufficient experience in the game of Kho-Kho. (Five point rating scale is given in the appendix). For this the total eighteen subjects were divided into two equal teams. They were put in a real game situation and the experts on the basis of five point rating scale, assessed each individual according to their performance of the techniques and tactics during play.

![Fig. 3.35](image)

Scoring: The score was the average of the three expert’s ratings.
STATISTICAL DESIGN FOR ANALYSIS OF DATA

The relationship between kinanthropometric variables, physical fitness variables (independent) and Kho-Kho playing ability (dependent variable) were established, by computing Pearson’s product moment coefficient of correlation i.e.

\[
    r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}
\]

Where x and y are the raw scores for independent and dependent variables, N is number of subjects tested.

The independent variables for the computation of multiple regression analysis, were selected by using the Wherry-Doolittle Test selection method as used by Garrett (1981) for Kho-Kho playing ability test separately.

Multiple correlations and corresponding multiple regression equations were computed using Wherry-Doolittle Method to find out the combined effect of independent variables, and for the prediction of Kho-Kho playing ability test (Clarke, H.H. and Clarke, D.H. 1972).

The multiple regression equation utilized is as under:

\[
    Yc = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \ldots + B_nX_n
\]

Where \(X_1X_2X_3, \ldots X_n\) independent variables, \(Yc\) is predicted performance \(B_1B_2B_3, \ldots B_n\) are regression coefficients \(B_0\) is constant.

Standard error of estimate was computed using following formula:

\[
    \text{S.E. of Estimate (\text{est})} = \sqrt{C} \sqrt{1 - R^2 - C(X_1X_2X_3)}
\]

Where \(\sqrt{C}\) is standard Error of Criterion Variable Score i.e. Playing Score
And $R_c (X_1 X_2 X_3 ) = \text{Coefficient of multiple correlation between criterion variables and independent variables } X_1, X_2, X_3 \text{ etc.}$

The percentage contribution of each independent (predictive) variables towards $R^2$ (Multiple coefficient of Determination) was calculated using following procedure (Garrett, 1981).

In the multiple regression equation

$$[\bar{Y}_c = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3]$$

The regression coefficients ($B_x$S) give the weights to be attached to the scores $X_1, X_2, X_3$ independent variables or in other words $B_x$S tells us the amount by which score in $X_1, X_2, X_3$ must be multiplied in order to give the best prediction of $\bar{Y}_c$. But these weight ($B_x$S) do not give us the relative importance or contribution of $X_1, X_2, X_3 \text{ etc.}$ in predicting the Playing Ability ($\bar{Y}_c$). The contribution of each independent variable is given by ‘Beta Weight’ also called ‘Beta Coefficient’ which may be calculated directly from regression coefficient ($B_x$S) as follows :-

| Beta Coefficient ($B_x$) = $B_x \frac{\sqrt{X}}{\sqrt{Y_c}}$ |

Where $B_x = \text{Regression Coefficient of independent variable X}$

$\sqrt{X} = \text{S.D. of independent variables score X and}$

$\sqrt{Y_c} = \text{S.D. of dependent (criterion) variables score.}$

Also $R^2$ the multiple coefficient of determination can be expressed in terms of Beta Coefficient i.e.

$$R^2 = B_{1x1} Y_c + B_{2x2} Y_c + B_{3x3} Y_c \ldots$$
Where $B_1, B_2, B_3$ are Beta Coefficient of independent variables $X_1, X_2, X_3$ and $r_{X_1Y_c}, r_{X_2Y_c}, r_{X_3Y_c}$ are coefficient of correlation of independent variables $X_1, X_2, X_3$ with the criterion variables $Y_c$.

The terms $B_{1r_{X_1Y_c}} Y_c, B_{2r_{X_2Y_c}} Y_c$ and $B_{3r_{X_3Y_c}} Y_c$ denote the contribution of each independent variable towards $R^2$. So $B_{1r_{X_1Y_c}} Y_c \times 100, B_{2r_{X_2Y_c}} Y_c \times 100$ and $B_{3r_{X_3Y_c}} Y_c \times 100$ give us percentage contribution of each independent variable towards the calculation of $R^2$. This value of $R^2$ denotes the proportion of the variance of the criterion measure ($Y_c$) attributable to the joint action of independent variables $X_1, X_2, X_3$ etc.

The statistical parameters like means, S.D. ‘S, S.E. ‘s, r’s (Coefficient of correlation between variables and Playing ability) and between the variables (inter correlations) Multiple Regression Analysis to find out the value of coefficient of multiple correlation (R’s), the multiple coefficient of determination ($R^2$) Regression Coefficient and S.E. of Estimates etc. were computed using the Electric Computer Super-32 available at the Computer Center, Punjab University, Chandigarh.

The statistical parameters, like Beta Coefficients and the percentage contribution of each independent variables were calculated using simple calculator. All the computer programmes were first developed, tested, verified and applied to the present data.