Chapter III

PROCEDURE

In this chapter the selection of subjects, selection of variables, criterion measures, reliability of data, collection of data and statistical techniques for analysing the data have been described.

Selection of Subjects

Seventy-four male hockey players in the age group of 18 to 24 years, studying in different Indian Universities, who had reported at Lakshmibai National College of Physical Education, Gwalior during the trials held for the selection of Combined Universities Hockey Team (Men Senior) in November, 1983 were selected as the subjects for the study. A total number of 91 players reported for the selection trials. From among these players, only seventy-four players were considered as subjects because they completed all the test items. Those who could not complete all the tests were thus, eliminated.

The subjects belonged to different parts of India and were of varying socio-economic status. All the players had fairly well developed physique as all of
then had been participating in a game of hockey regularly for a number of years.

Prior to the administration of tests, a meeting of all the subjects was held in which the Sports Officer, Association of Indian Universities and selectors were also present. The requirements of the testing procedures were explained to them in detail so that there was no ambiguity in their minds regarding the efforts required of them and the strain they had to endure in addition to their participation in the selection trials. All the subjects agreed voluntarily to cooperate in the testing procedures explained to them. The Sports Officer, Association of Indian Universities and the selectors also exhorted them to put-in their best efforts in the interest of the scientific investigation and in order to enhance their own performance and achievement standards. Though no special techniques were used to motivate the subjects to put in their best efforts, the subjects were very enthusiastic and cooperative throughout the project.

Selection of Variables

The physical, physiological and psychological variables that influence the performance in competitive
hockey as gleaned from a review of professional literature are:

Physical Variables

1. Speed
2. Strength
   (a) Grip Strength
   (b) Arm Strength
3. Power
4. Agility
5. Dynamic Balance
6. Flexibility
   (a) Wrist Flexibility
   (b) Trunk Flexibility
   (c) Shoulder Flexibility
7. Coordination
   (a) Total Body Coordination
   (b) Hand-Eye coordination
   (c) Arm-Foot Coordination
8. Kinesthetic Perception
9. Vision Measures
Physiological Variables

1. Cardio-respiratory Endurance
2. Resting Pulse Rate
3. Reaction Time
4. Movement Time
5. Response Time
6. Body Composition
7. Vital Capacity
8. \( V_o_2 \) Max.
9. Type of Muscle Fibres
10. Haemoglobin

Psychological Variables

1. Anxiety
2. Intelligence
3. Desire to Achieve
4. Attitude Towards Success and Failure
5. Creativity
6. Aggression Level
7. Competitive Ability

A feasibility analysis as to which of the variables mentioned above could be taken up for investigation in keeping with the availability of equipment,
acceptability to the subjects and the legitimate time
that could be devoted for tests as well as to keep the
entire study unitary and integrated, was made in
consultation with experts.

With the above criteria in mind the following
physical, physiological and psychological variables
were selected because they are directly related to
the performance of hockey players in competitive
situation.

Physical Variables

1. Speed
2. Grip Strength
3. Power
4. Agility
5. Dynamic Balance
6. Flexibility
   (a) Forward bend of trunk (Trunk Flexibility)
   (b) Upward backward movement of arms
       (Shoulder Flexibility).
7. Kinesthetic Perception
Physiological Variables

1. Cardio-respiratory Endurance
2. Resting Pulse Rate
3. Reaction Time
4. Movement Time
5. Response Time
6. Body Composition

Psychological Variables

1. Anxiety
2. Intelligence

Criterion Measures

The criterion measures chosen for testing the hypothesis were:

Playing Ability

The judgement of hockey playing ability of each player was based on the Strait Field Hockey Rating Scale, which was made use of by three expert judges in a game situation.

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Physical Variables

1. Time taken by an individual to run a distance of 50 yards recorded to the nearest 1/10th of a second.

2. The score made by an individual on Hand Grip Dynamometer recorded to the nearest kilogram.

3. The horizontal distance covered in metres and centimetres between the take-off line and the nearer break made in landing using standing broad jump.

4. The dodging run constructed by McCloy and Young was chosen to record the time taken to the nearest 1/10th of a second.

5. Johnson Modification of Bass Test was chosen to measure dynamic balance, recorded in units of number (points).

6. (a) Forward bend of trunk was chosen to measure the flexion of trunk, measured to the nearest quarter inch.

(b) Upward backward movement of arms was chosen to measure the flexibility of shoulders and shoulder girdles, measured to the nearest quarter inch.
7. A test of horizontal distance was made to
measure kinesthetic perception. The score is the
total deviation from the desired mark, measured to
the nearest quarter inch, in all three trials.

**Physiological Variables**

1. Distance covered in Cooper's 12 Minute Run/
Walk Test, to the nearest 50 metre.

2. Number of heart beats per minute during
resting condition.

3. Reaction time was recorded in terms of the
average of the five trials measured by Nelson's Hand
and Arm Reaction Test.

4. Speed of movement was measured by Nelson's
Speed of Movement Test and was recorded in terms of the
average of middle ten trials, after the slowest and the
fastest five trials were eliminated.

5. Total time taken in all twenty trials in
Jensen's Test of Response Time.

6. Skinfold measurements taken and expressed
in millimetres using skinfold calipers, at subscapular,
triceps, biceps and supra-iliac sites.
Psychological Variables

1. The IPAT Anxiety Scale was used to measure anxiety.

2. Culture Fair Test was used to measure intelligence.

Reliability of Data

The reliability of data was ensured by establishing the instrument reliability, tester competency and reliability of tests and subject reliability.

Instrument Reliability

Hand Grip Dynamometer, Hand and Foot Reaction Time Apparatus, Skinfold Calipers, Stop watches, tape and yard stick used in the study were obtained from standard firms which cater to the needs of various research laboratories in India and abroad. All the instruments used were available in the Research Laboratory of the Lakshmibai National College of Physical Education, Gwalior, and their calibrations were accepted as accurate enough for the purpose of the study.
IPAT Anxiety Scale and Culture Fair Tests were chosen in consultation with Dr. S.D. Kapoor, a renowned Psychologist at the Psycho Center, New Delhi. Both of these tests were standard tests which had a high reliability and were accompanied by Indian norms, hence, these tests were chosen.

Tester Competency and Reliability of Test

To ensure that the investigator was well versed in the techniques of conducting the tests, the investigator had a number of practice sessions in the testing procedures under the guidance of the expert Dr. A.K. Uppal, Reader in Research, Lakshmibai National College of Physical Education, Gwalior. All the measurements were taken by the investigator with the assistance of Master Degree Scholars, 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 consistance of results were obtained by product moment correlation. The data collected from a random selection of ten subjects in test retests were computed for each variable and obtained correlations have been shown in Table 1.
Since very high correlations from .77 to .96 were obtained, this establishes investigator's competency to administer the tests as well as reliability of tests.

**Table 1**

<table>
<thead>
<tr>
<th>Tests</th>
<th>Coefficient of Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Yard Dash</td>
<td>.81*</td>
</tr>
<tr>
<td>Grip Strength</td>
<td>.93*</td>
</tr>
<tr>
<td>Standing Broad Jump</td>
<td>.77*</td>
</tr>
<tr>
<td>Dodging Run</td>
<td>.86*</td>
</tr>
<tr>
<td>Johnson Modification of Sass Test</td>
<td>.79*</td>
</tr>
<tr>
<td>Forward Bend of Trunk</td>
<td>.87*</td>
</tr>
<tr>
<td>Upward Backward Movement of Arms</td>
<td>.92*</td>
</tr>
<tr>
<td>Test of Horizontal Distance</td>
<td>.78*</td>
</tr>
<tr>
<td>Cooper's 12 Minute Run/Walk Test</td>
<td>.80*</td>
</tr>
<tr>
<td>Heart Beats per Minute</td>
<td>.96*</td>
</tr>
<tr>
<td>Reaction Time Test</td>
<td>.81*</td>
</tr>
<tr>
<td>Nelson Speed of Movement Test</td>
<td>.83*</td>
</tr>
<tr>
<td>Jensen's Test of Response Time</td>
<td>.88*</td>
</tr>
<tr>
<td>Skinfold Calipers</td>
<td>.94*</td>
</tr>
</tbody>
</table>

N = 10  *Significant at .01 level of confidence.  
$r_{.01} (8) = .765$.  

From the test-retest coefficients of correlations (Table 1) it was obvious that the tester reliability was significantly high, establishing the competency of the scholar to administer the tests.

The correlation coefficients also indicated the reliability of the tests selected, as very high correlations were obtained, when the tests were repeated.

**Subject Reliability**

The above test-retest coefficients of correlation method also established that subject reliability was significant at .01 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 given.

**Collection of Data**

The necessary data was collected by administering the tests for the chosen variables. All the tests were administered in the Research Laboratory and Track and Hockey Fields of Lakshmibai National College of Physical Education, Gwalior.

Before the administration of tests the subjects were given a chance to practice the prescribed
tests so that they became familiar with the tests and knew exactly what was to be done. The use of apparatus was explained to them prior to the administration of tests. Four days were utilized for conducting the tests. To ensure uniform testing conditions the subjects were tested only during the morning and evening sessions for physical and physiological variables respectively. However, psychological tests were administered in the evening between 8 P.M. and 11 P.M.

**Test Administration**

**Physical Variables**

**Speed**

**50 Yard Run**

The purpose of this test was to measure the speed of the performer in running.

**Equipment:** Clapper and stop watches.

**Description:** Four subjects selected at random were started off at a time with a clapper and they ran a distance of 50 yards. The time for each subject was recorded with the help of a stop watch.
Scoring: The time was recorded to the nearest 1/10th of a second.

Grip Strength

Hand Dynamometer

The purpose of this test was to measure grip strength of both right and left hands.

Equipment: Hand dynamometer.

Description: The concave edge of the dynamometer was placed between the first and second joints of the fingers with the dial towards the palm as shown in Fig.1. The subjects were allowed any type of movement while squeezing the instrument, provided they did not hit any object with their fists. The right grip was tested first.

Scoring: The score of grip strength was recorded to the nearest kilogram.

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2Clarke, Application of Measurement to Health and Physical Education, p.179.

Fig. 1: Grip Strength Test on Hand Dynamometer.
Standing Broad Jump

The purpose of this test was to measure the explosive power of legs.

**Equipment:** Tape.

**Description:** Each subject was asked to stand behind a take-off line with his feet comfortably apart. Before jumping, the subject was allowed dipping at the knees and swinging the arms backward. He then jumped forward by simultaneously extending the knees and swinging the arms forward to cover maximum possible horizontal distance, landing on both the feet. Three trials were permitted and the best jump was credited to him.

**Scoring:** The score was the horizontal distance measured in feet and inches to the nearest inch between the take off line and the nearest point where any part of the student's body touched the ground.\(^4\)

\(^4\)Ibid., p.129.
Agility

Dodging Run

The purpose of this test was to measure the total body agility of the subject while running.

Equipment: Four hurdles and stop watch.

Description: The subject was asked to stand behind the starting line and on the signal to start, he ran and followed the course indicated by arrows on the dotted lines as shown in Fig.2.

Scoring: The score was the time taken to run the course twice, recorded to the nearest 1/10th of the second.5

Dynamic Balance

Johnson Modification of the Bass Test

The purpose of this test was to measure the dynamic balance of the subject.

Equipment: Stop watch.

Fig. 2. Course for the Dodging Run.
**Description:** To perform the test the subject stood with his right foot on the starting mark. He then jumped to the first mark and landed on the left foot, balancing on the ball of the foot as long as possible up to a maximum of five seconds. Then he jumped to the next mark, landing on the right foot and balanced again for five seconds. He continued this procedure, balancing on each mark as long as possible up to five seconds.

**Scoring:** The subject scored five points each time he landed successfully on the mark, plus one point for each second he maintained balance on the mark up to five seconds. The total points made by the subject were regarded as the final score.

**Flexibility**

**Wells and Dillon Sit and Reach Test**

The purpose of this test was to measure the flexion of the trunk and hips.

**Equipment:** Platform Scale, two gymnasium (stall-bar) benches and a mat.

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6 Ibid., pp.213-215.
Description: The subject sat on the mat with feet placed in the footprints and pressed firmly against the cross board. The arms were extending 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.

Scoring: The maximum distance reached, taken to the nearest half inch, was recorded as the score in the measure of trunk and hip flexibility.\(^7\)

Upward-Backward Movement of Arms

The purpose of this test was to measure flexibility of the shoulder and shoulder girdles.

Equipment: Measuring tape, two feet long stick and a mat.

Description: The subject lay in a prone position on a mat with his chin touching the mat and his arms

reaching forward directly in front of his shoulders. He held the stick horizontally with both hands. Keeping his elbows and wrists straight and his chin on the table, he raised his arms upward as far as possible.

**Scoring:** The vertical distance from the bottom of the stick to the mat was recorded as the measure of flexibility of the shoulders and shoulder girdles.²

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**Kinesthetic Perception**

**Horizontal Space Test**

The purpose of this test was to measure the kinesthetic ability to determine specific positions along the horizontal line.

**Equipment:** Yardstick, blindfolds and a chair.

**Description:** The yardstick was placed on the wall so that it was at approximately eye level while the student was in the sitting position. The subject was asked to sit in the chair facing the yardstick and

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attempt to establish in his mind a sense of its position. Then while blindfolded and without a practice trial he points the index finger of his right hand to the point indicated by the instructor.

**Scoring:** The score was the deviation from the desired mark, measured to the nearest quarter inch. The final score was the total of the deviation on three trials.  

**Physiological Variables**

### Cardio-respiratory Endurance

**Cooper's 12 Minute Run/Walk Test**

The purpose of this test was to measure the cardio-respiratory endurance of the subjects.

**Equipment:** Stop watches.

**Description:** For this test, the 400 metre track was marked into eight divisions of 50 metres each. The runners started behind a line, upon the starting signal, run and/or walk as many laps as

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possible around the track within the twelve minutes. The spotters maintained a count of each lap, and when the signal to stop was given, they immediately ran to the sports at which their runners were at the instant when the whistle was blown.

**Scoring:** The score in metres was determined by multiplying the number of completed laps with the distance of each lap plus the distance of number of segments of an incomplete lap.\(^{10}\)

**Pulse Rate**

**Resting Pulse Rate**

The purpose of this test was to measure the number of beats of the subjects in a minute.

**Equipment:** Stop watch and stethoscope.

**Description:** Pulse rate was taken in the morning. Ten minutes before taking the pulse rate the subjects were asked to lie down in a supine position and rest themselves on the bed. The scholar used the stop watch and stethoscope for taking the pulse rate.

Scoring: Total number of pulse beats per minute for each subject was recorded as the score.

Reaction Time

Hand Reaction Time

The purpose of this test was to measure the subject's hand reaction time.

Equipment: Anand Electronic Reaction Time apparatus.

Description: For measurement of reaction time the apparatus was set according to the prescribed procedure. The detachable screen was fixed in the desired holes which divided the reaction time apparatus in two sides - one subject's side and other tester's side. The subject sat in a chair on subject's side and the tester stood on tester's side. The tester rang a bell which was a signal for the subject to press the right or left key as selected by the tester with selector switch. Then the tester pressed one of the short keys giving the required stimulus (light stimulus). The short key was a double key which gave stimulus and also started the chronoscope. As soon as the subject received the stimulus, he lifted his
finger from the right or left key which stopped the chronoscope and the reaction time to the light stimulus was read and recorded from the chronoscope as shown in Fig.3.

**Scoring:** Five trials were given to each subject and the average of the five trials was recorded as the hand reaction time score.\(^{11}\)

**Speed of Movement**

**Nelson's Hand and Arm Reaction Test**

The purpose of the test was to measure the speed of movement of the subject.

**Equipment:** Table, chair and a stick.

**Description:** The subject was seated in a chair, facing the table, with his hands resting over the edge of the table. The palms were kept facing each other with the inside border of little fingers resting along two lines which were marked on the edge of the table twelve inches apart. The research scholar held

\(^{11}\textit{Manual of Reaction Time Apparatus (Bombay: Anand Agencies), p.1.}\)
the subject near the edge of the table. The subject's eyes were focused on the subject's face. The subject's hands were placed on the apparatus. The subject was given a stick and dropped it on the table as soon as possible. After a response was made, the stick was dropped and the subject stopped it as quickly as possible. The table was turned to the subject. In Fig. 3, the table was turned to the subject and he dropped the stick. The purpose of this was to measure the subject's reaction time. The subject's reaction time was measured for a total of five trials.
the stick near the top so that it hanged midway between the subject's palms and the "base line" of the stick position evenly with the upper edges of the subject's index fingers and subject looked on the concentration zone as shown in Fig. 4(a). After a preparatory command "ready" was given, the stick was dropped and the subject stopped it as quickly as possible with an inward horizontal movement of arms as shown in Fig. 4(b). Before measuring speed of movement, all the details of the tests were clearly explained to the subject and each subject was given five practice trials. Twenty trials were given and the distance the stick fell through the hands before it was stopped every time was recorded.

**Scoring:** The average of middle ten trials, after the five slowest and the five fastest trials had been eliminated was taken as the distance score.  

### Response Time

**Four Way Alternate Response Test**

The purpose of this test was to measure the response time of a subject.  

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Fig. 4(a): Measurement of Speed of Movements: Ready Phase

Fig. 4(b): Measurement of Speed of Movements: Completion Phase.
Equipment: Stop watch.

Description: The subject stood at point X on the floor as shown in Fig. 5 and was asked to concentrate on the right hand of the test administrator standing at point Y on the floor. After a preparatory command "ready" was given, the test administrator made an obvious movement with his hand in one of four directions. On the signal the subject moved in the designated direction as rapidly as possible and crossed over the line five yards from point X. If tester moved his hand up, the subject moved forward across the line. If he moved his hand down, the subject moved backward. If he moved his hand to either side, the subject moved in the direction of his motion. The subject was given 20 trials, five in each direction. The trials in the different directions were given in the order as decided by the tester.

Scoring: The tester held a stopwatch which he started at the beginning of each hand movement. He stopped the watch when the subject crossed the correct line and recorded the time to the nearest tenth of a second. The score was the total of the times on all
Fig. 6. Floor area for Four-way Alternate Response Test.
20 trials:

**Body Composition**

**Skinfold Measurements**

The purpose of this test was to measure the percentage of body fat in the subject.

**Equipment:** Lange Skinfold Calipers.

**Description:** The research scholar picked up a fold of subcutaneous tissue firmly between the thumb and the index finger of the left hand and pulled away the underlying muscle from the marks marked on the subject's body. The jaws of calipers were then applied a little below the fingers of the left hand and allowed to exert their full pressure before taking the reading of the thickness of the fold as shown in Figures 6, 7, 8 and 9. In order to be sure that the muscular tissue was not included in the pinch was ensured by asking the subject to use the muscle in appropriate movement. Measurements were taken on the right side of the body.

The anatomical sites that were utilized were as follows:

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Fig. 6: Skinfold Measurement: Inferior Angle of Scapula

Fig. 7: Skinfold Measurement: Back of Upper Arm
Fig. 8: Skinfold Measurement: Front of Upper Arm

Fig. 9: Skinfold Measurement: Supra Iliac.
1. Subscapular: The skinfold was taken at the tip of the scapula (inferior angle) with the subject in a relaxed standing position. The fold was lifted in the diagonal plane at about 45 degrees from the vertical and horizontal planes.

2. Triceps: The skinfold was taken over the triceps muscle at a point halfway between the tip of the shoulder (acromial process) and the tip of elbow (olecranon process). The point was located with forearm flexed to 90 degrees; in making the measurement, however, the arm was hanging free. The fold was lifted parallel to the long axis of the arm.

3. Biceps: The skinfold was taken midway on front of upper arm over biceps. Skinfold was lifted parallel with the long axis.

4. Supra-iliac: The skinfold was lifted diagonally, following the natural line of the iliac crest, just above the crest of the ilium at the mid axillary line.

Scoring: The readings of the four sites were recorded in millimetres and added up. 14

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Psychological Variables

Anxiety

A survey was made of different standard tests to measure anxiety of the university students. After discussion with faculty members guiding research and a psychologist at the Psycho Centre, New Delhi, it was decided to use the IPAT Anxiety Scale. This scale has been widely used in psychological research in many English speaking countries. A major consideration for the choice of this test was that S.D. Kapoor has computed norms for Indian population after establishing its validity and reliability under Indian conditions. Moreover, it is a brief, non-stressful, clinically-valid questionnaire for measuring anxiety. Another reason for choosing this scale was that it can be easily administered to large groups at one time. Besides the above reasons this scale obtains information with a good deal of economy of time and objectively. In a pilot study the scholar administered a few of the questions to a sample of students comparable to the experimental group. It was observed that the linguistic vocabulary, expressions and experimental situations in the questions of the IPAT Anxiety Scale was within the competence of the subjects in the experimental group.
to respond adequately without feeling any linguistic
or conceptual difficulties.

The subjects were assembled in batches of 25
each in a room and were acquainted with the purpose of
the questionnaire along with the introductory remarks
for good rapport after which test booklets were distrib-
uted to them. They were asked to write their names on
it along with the name of the universities they repre-
sented and the positions at which they play in the team.
They were asked to follow the instructions written on
the test booklet while the research scholar read it
aloud at dictation speed. When answering examples, the
research scholar told them to mark whatever alternatives
seemed to be most appropriate answers to the individual
subjects. If it is impossible for them to decide
definitely yes or no, they should mark the middle box.
The research scholar and his associates went around
and verified the answers for the examples entered by
the subjects.

After making sure that the subjects had under-
stood the procedure clearly, how to enter their res-
ponses in the answer sheet, they were asked to turn
the page and proceed with answering the questions.
The research scholar and his associates went around verifying that the subjects were recording answers sequentially and that all of them completed all the 40 items.

The test booklets were scrutinized to eliminate those answer sheets which were incomplete and those in which more than one answer were given to an item and those in which answers fell into a pattern of yes or no or in between predominantly.

Scoring

Applying the card board stencil key directly to the form with simple digital weighting, the raw scores for all the 40 items were counted and entered in the space provided for it in the test booklet. The stem scores corresponding to the raw scores were read from the norms for the Indian male subjects, compiled by Kapoor and entered against the corresponding raw scores on the test booklet.\textsuperscript{15,16}


Intelligence

A survey was made of various standard tests to measure intelligence for university students. After discussing with faculty members guiding research and a psychologist at the Psycho Centre, New Delhi, it was decided to use the Culture Fair Intelligence Test. Since the Culture Fair Scales are non-verbal, there is no necessity for translating the items when the test is administered to non-English speaking people. This feature contributes to the accuracy of cross-cultural comparisons with this Culture Fair Scales. Editions of the tests are currently available in 23 foreign countries. The test manual documents have high validity and reliability of various kinds.

The subjects were assembled in batches consisting of twenty five each in a room and the purpose of the questionnaire along with the introductory remarks were explained to them to establish good rapport. Before distributing the test booklets and answer sheets, they were cautioned that the booklets are not to be opened until they are told to do so. The instructions were read exactly as they were given in the Manual, in an unhurried, friendly conversational
manner, so that the subjects were prepared to enjoy
the test and to do their best. A special care was
taken at the beginning of the test to see that the
examples had been marked in the right places. The
research scholar and his associates went round and
verified that the subjects did not stop after the first
line or page.

Booklets and answersheets were collected
quickly to avoid any subsequent alterations in answers.
The answer sheets were scrutinized to eliminate those
answer sheets which had patterned responses. The
answer sheets in which inappropriate multiple respon-
ses were encountered, the item was treated as if left
blank.

Scoring

Applying the cardboard stencil key directly on
the answer sheet in which specific directions for using
the key was printed, the raw scores were counted and
entered in the space provided to it in the answer
sheet. The raw scores were transformed to I.Q. Scores
from the Manual of Instructions and Norms for the Hindi

**Analysis of Data**

The relationship between dependent variable (Playing Ability) and Independent variables (Physical, Physiological and Psychological) was established by computing Pearson Product Moment Correlation (Zero Order) and the combined effect or contribution of physical/physiological variables to playing ability was obtained through Multiple Correlation. Hockey playing ability was predicted from physical/physiological variables by utilising regression equations. The relative contribution of a single independent variable (Physical or Physiological variable) to dependent variable (Playing Ability) by eliminating or partialing out the effect of one or the others was found through partial correlation.

For testing the hypothesis, the level of confidence was set at .05.

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