Chapter IV

ANALYSIS OF DATA AND RESULTS OF THE STUDY

The analysis of data collected on seventy four hockey players is presented in this chapter. The data on playing ability along with physical, physiological and psychological variables was examined by Pearson's Product Moment Correlation\(^1\) to find out the relationships of playing ability to each of these variables separately. Multiple Correlations\(^2\) between physical variables and playing ability as well as physiological variables and playing ability were computed to assess the combined effects of speed, right grip strength, left grip strength, agility, balance and kinesthetic perception to playing ability and cardio-respiratory endurance, resting pulse rate, hand reaction time, speed of movement, response time and body composition.


to playing ability respectively. Multiple regression equation\(^3\) was developed in order to predict the hockey playing ability on the basis of either physical or physiological variables. The data was further examined by partial correlations\(^4\) of physical variables to playing ability and physiological variables to playing ability so as to eliminate the influence of one or the others of either the physical or physiological variables.

The level of significance to check the relationship obtained by Pearson's Product Moment Correlation and Multiple Correlation was set at .05 level of confidence, which was considered appropriate because the research processes adopted did not involve highly sophisticated equipment demanding the application of more stringent levels of significance. In using the product moment correlation, a value of .227 was needed for significance at the .05 level of confidence for 72 degrees of freedom.\(^5\)


\(^4\) Ibid., pp. 301-03.

\(^5\) Clarke and Clarke, Research Processes in Physical Education, Recreation and Health, p. 231.
Findings

Relationship of Physical, Physiological and Psychological Variables to Playing Ability

The scores of each of the independent variables of physical, physiological and psychological domains were correlated with criterion variable, the hockey playing ability in order to find out relationship between the dependent and independent variables which are presented in Tables 2, 3 and 4.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agility and Playing Ability</td>
<td>r = .08</td>
</tr>
<tr>
<td>Balance and Playing Ability</td>
<td>r = .27</td>
</tr>
<tr>
<td>Trunk Flexibility and Playing Ability</td>
<td>r = .45</td>
</tr>
<tr>
<td>Shoulder Flexibility and Playing Ability</td>
<td>r = .10</td>
</tr>
<tr>
<td>Kinesthetic Perception and Playing Ability</td>
<td>r = .42</td>
</tr>
</tbody>
</table>

Significant at .01 level of confidence.

\[ r_{0.01(74)} = .31 \]
TABLE 2

RELATIONSHIP OF PHYSICAL VARIABLES TO PLAYING ABILITY

<table>
<thead>
<tr>
<th>Variables Correlated</th>
<th>Correlation Coefficient (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed and Playing Ability</td>
<td>-0.29*</td>
</tr>
<tr>
<td>Right Grip Strength and Playing ability</td>
<td>0.29*</td>
</tr>
<tr>
<td>Left Grip Strength and Playing ability</td>
<td>0.47*</td>
</tr>
<tr>
<td>Standing Broad Jump and Playing ability</td>
<td>-0.19</td>
</tr>
<tr>
<td>Agility and Playing Ability</td>
<td>-0.30*</td>
</tr>
<tr>
<td>Balance and Playing Ability</td>
<td>0.27*</td>
</tr>
<tr>
<td>Trunk Flexibility and Playing ability</td>
<td>-0.10</td>
</tr>
<tr>
<td>Shoulder Flexibility and Playing ability</td>
<td>0.16</td>
</tr>
<tr>
<td>Kinesthetic Perception and Playing ability</td>
<td>-0.29*</td>
</tr>
</tbody>
</table>

N = 74

* Significant at .05 level of confidence.

$r_{.05}^{(72)} = .227$. 
Table 2 indicates that the playing ability in hockey is significantly related to speed ($r = -0.29$), Fig.10, right grip strength ($r = 0.29$) Fig.11, left grip strength ($r = 0.47$) Fig.12, agility ($r = -0.30$), Fig.14, balance ($r = 0.27$) Fig.15, and kinesthetic perception ($r = 0.29$) Fig.18, whereas no significant relationship was obtained between standing broad jump and playing ability ($r = -0.19$), Fig.13, trunk flexibility and playing ability ($r = -0.10$) Fig.16 and shoulder flexibility and playing ability ($r = 0.16$) Fig.17. Therefore, it is evident that speed, grip strength, agility, balance and kinesthetic perception contribute to playing ability in hockey whereas static power and flexibility do not underlie the performance in this sport.
FIG. 10. Relationship between Speed and Playing Ability

$r = 0.29$
Fig. 11. Relationship between Right Grip Strength and Playing Ability

$r = 0.29$
Fig. 12. Relationship between Left Grip Strength and Playing Ability
Fig. 13. Relationship between Standing Broad Jump and Playing Ability
Fig. 14. Relationship between Agility and Playing Ability
Fig. 15 Relationship between Balance and Playing Ability
Fig. 16. Relationship between Trunk Flexibility and Playing Ability
Fig. 17. Relationship between Shoulder Flexibility and Playing Ability
Fig. 18. Relationship between Kinesthetic Perception and Playing Ability
## Table 3

**Relationship of Physiological Variables to Playing Ability**

<table>
<thead>
<tr>
<th>Variables Correlated</th>
<th>Correlation Coefficient (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardio-respiratory Endurance and Playing Ability</td>
<td>0.30*</td>
</tr>
<tr>
<td>Resting Pulse Rate and Playing Ability</td>
<td>-0.48*</td>
</tr>
<tr>
<td>Hand Reaction Time and Playing Ability</td>
<td>-0.49*</td>
</tr>
<tr>
<td>Speed of Movement and Playing Ability</td>
<td>-0.58*</td>
</tr>
<tr>
<td>Response Time and Playing Ability</td>
<td>-0.38*</td>
</tr>
<tr>
<td>Body Composition and Playing Ability</td>
<td>-0.23*</td>
</tr>
</tbody>
</table>

\[ N = 74 \]

*Significant at .05 level of confidence

\[ r_{.05}(72) = .227. \]
Table 3 indicates that the physiological variables of cardio-respiratory endurance, resting pulse rate, hand reaction time, speed of movement, response time and body composition are significantly related to playing ability in hockey as the obtained values are more than the desired value of .227 required for the coefficient of correlation to be significant at .05 level of confidence with 72 degrees of freedom. It is, therefore, evident that cardio-respiratory endurance, resting pulse rate, hand reaction time, speed of movement, response time and body composition are underlying factors of playing ability in hockey as shown in Figures 19, 20, 21, 22, 23 and 24.

**TABLE 4**

**RELATIONSHIP OF PSYCHOLOGICAL VARIABLES TO PLAYING ABILITY**

<table>
<thead>
<tr>
<th>Variables Correlated</th>
<th>Correlation Coefficient (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety and Playing Ability</td>
<td>-0.46*</td>
</tr>
<tr>
<td>Intelligence and Playing Ability</td>
<td>0.003</td>
</tr>
</tbody>
</table>

N = 74

*Significant at .05 level of confidence.

r_{.05}(72) = .227.
Fig. 19. Relationship between Cardio-respiratory Endurance and Playing Ability
Fig. 20 Relationship between Resting Pulse Rate and Playing Ability

$r = -0.68$
Fig. 21 Relationship between Hand Reaction Time and Playing Ability
Fig. 22 Relationship between Speed of Movement and Playing Ability
Fig. 23. Relationship between Response Time and Playing Ability
Fig. 24 Relationship between Body Composition and Playing Ability

$r = -0.23$
Table 4 reveals that anxiety and playing ability in hockey are significantly related to each other which further revealed that low level of anxiety contributes to superior performance in hockey as depicted in Fig. 25. Insignificant relationship was obtained between intelligence and playing ability in hockey which showed that intelligence was not an important variable to contribute to success in hockey as shown in Fig. 26.

Combined Contribution of Physical Variables to Playing Ability and Physiological Variables to Playing Ability

Multiple correlation was used to assess the combined contribution of speed, right grip strength, left grip strength, agility, balance and kinesthetic perception to playing ability, as multiple correlation gives the correlation between a dependent variable and the combined effect of a number of independent variables, which are weighted so as to give a maximum correlation. To obtain this correlation, playing ability in hockey (c) was treated as the dependent variable and the

Fig. 25 Relationship between Anxiety and Playing Ability

$r = -0.46$
Fig. 26. Relationship between Intelligence and Planning Ability

$r = 0.003$
speed (1), right grip strength (2), left grip strength (3), agility (4), balance (5) and kinesthetic perception (6), were considered the independent variables. The multiple correlation coefficient ($R_{C.351}$) computed between criterion variable and independent variables has been presented in Table 5.

### TABLE 5

**COMBINED CONTRIBUTION OF PHYSICAL VARIABLES TO PLAYING ABILITY**

<table>
<thead>
<tr>
<th>Criterion Variable</th>
<th>Independent Variables</th>
<th>Multiple Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Grip Strength (2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing Ability (c)</td>
<td>Left Grip Strength (3)</td>
<td>$R_{C.351}$ 0.5631*</td>
</tr>
<tr>
<td>Agility (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balance (5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinesthetic Perception (6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$N = 74$

*Significant at .05 level of confidence.

$r_{.05 (70)} = .232$. 
Table 5 has disclosed that the combined contribution of left grip strength, balance and speed to playing ability is significant at .05 level of confidence, as the computed value of .5631 (R.351) for multiple correlation was more than the value of .232 required for the multiple correlation coefficient to be significant at .05 level of confidence with 70 degrees of freedom. From the obtained value of multiple correlation it can be deduced that the left grip strength, balance and speed taken together contribute to hockey playing ability as shown in Fig.27.

Multiple correlation was used again with physiological variables to assess the combined contribution of cardio-respiratory endurance, resting pulse rate, hand reaction time, speed of movement, response time and body composition to playing ability. To obtain this correlation playing ability was treated as the dependent variable and the cardio-respiratory endurance (E), resting pulse rate (S), hand reaction

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7Clarke and Clarke, Advanced Statistics with Applications to Physical Education, p.129.
Fig. 27. Combined Contribution of Left Grip Strength, Balance and Speed to Playing Ability
time (R), speed of movement (S), response time (T)
and body composition (U) as the independent variables.
The multiple correlation coefficient ($r_{C,SRT}$) computed
between criterion variable and independent variables
has been presented in Table 6.

**TABLE 6**

**COMBINED CONTRIBUTION OF PHYSIOLOGICAL VARIABLES TO PLAYING ABILITY**

<table>
<thead>
<tr>
<th>Criterion Variable</th>
<th>Independent Variables</th>
<th>Multiple Coefficient of Multiple Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardio Respiratory Endurance (F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resting Pulse Rate (Q)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing Ability (C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Reaction Time (R)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed of Movement (S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Time (T)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body Composition (U)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$N = 74$

*Significant at .05 level of confidence.

$r_{.05} (70) = .332.$
Table 6 revealed that the combined contribution of speed of movement, hand reaction time and response time to playing ability was significant at .05 level of confidence, as the computed value of $.7279 (R_{C:SRT})$ for multiple correlation was more than the value of $.232$ required for the multiple correlation coefficient to be significant at .05 level of confidence with 70 degrees of freedom. From the obtained value of multiple correlation it can be deduced that the speed of movement, hand reaction time and response time together favourably contribute to hockey playing ability as shown in Figure 28.

Multiple Regression Analysis

The multiple regression analysis performed to develop equations for the prediction of playing ability on the basis of the physical and physiological variables separately resulted in the following equations.

Physical Variables

\[ X_C = .0552 X_3 - .2345 X_5 - .8883 X_1 - 63.18 \]
Fig. 28. Combined contribution of Speed of Movement, Hand Reaction Time and Response Time to Playing Ability
Physiological Variables

\[ X_C = -0.1184 X_S - 13.13 X_R - 0.921 X_T - 41.44 \]

Where \( X_C \) is the predicted playing ability score in numbers.

Partial Correlation

The coefficient of partial correlation (1st and 2nd order) between physical variables (left grip strength, balance and speed), and playing ability with the effect of one or two variables eliminated, are presented in Table 7.

Left grip strength had a significant relationship with hockey playing ability when the effects of either agility or speed, or both are partialled out, as the obtained coefficients of partial correlation were greater than the value needed for significance at .05 level.

\[ ^8 \text{Barrow and McGee, A Practical Approach to Measurement and Physical Education, p.573.} \]

\[ ^9 \text{Clarke and Clarke, Advanced Statistics with Applications to Physical Education, p.130.} \]
<table>
<thead>
<tr>
<th>Variables Correlated</th>
<th>Variable/s Partialled</th>
<th>Symbolic representation of Partial correlation</th>
<th>Coefficients of Partial correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left Grip Strength-Playing Ability</td>
<td>Agility</td>
<td>$F_{C} 3.5$</td>
<td>$0.4690^*$</td>
</tr>
<tr>
<td>Left Grip Strength-Playing Ability</td>
<td>Speed</td>
<td>$F_{C} 3.1$</td>
<td>$0.4531^*$</td>
</tr>
<tr>
<td>Agility-Playing Ability</td>
<td>Left Grip Strength</td>
<td>$F_{C} 5.3$</td>
<td>$-0.2933^*$</td>
</tr>
<tr>
<td>Agility-Playing Ability</td>
<td>Speed</td>
<td>$F_{C} 5.1$</td>
<td>$-0.2958^*$</td>
</tr>
<tr>
<td>Speed-Playing Ability</td>
<td>Left Grip Strength</td>
<td>$F_{C} 1.3$</td>
<td>$0.2565^*$</td>
</tr>
<tr>
<td>Speed-Playing Ability</td>
<td>Agility</td>
<td>$F_{C} 1.5$</td>
<td>$0.2857^*$</td>
</tr>
<tr>
<td>Left Grip Strength-Agility</td>
<td>Speed</td>
<td>$F_{35.1}$</td>
<td>$0.0724$</td>
</tr>
<tr>
<td>Left Grip Strength-Speed</td>
<td>Agility</td>
<td>$F_{31.5}$</td>
<td>$0.1359$</td>
</tr>
<tr>
<td>Agility-Speed</td>
<td>Left Grip Strength</td>
<td>$F_{51.3}$</td>
<td>$0.0494$</td>
</tr>
<tr>
<td>Left Grip Strength-Playing Ability</td>
<td>Agility and Speed</td>
<td>$F_{C 3.51}$</td>
<td>$0.4531^*$</td>
</tr>
<tr>
<td>Agility-Playing Ability</td>
<td>Left Grip Strength and Speed</td>
<td>$F_{C 5.31}$</td>
<td>$-0.2917^*$</td>
</tr>
<tr>
<td>Speed-Playing Ability</td>
<td>Left Grip Speed and Agility</td>
<td>$F_{C 1.35}$</td>
<td>$-0.2534^*$</td>
</tr>
</tbody>
</table>

*Significant at .05 level.*
Agility correlated significantly with hockey playing ability when the effects of either left grip strength or speed, or both were partialled out, as the obtained coefficients of partial correlation were greater than the value needed for significance at .05 level.

Speed also showed a significant relationship with hockey playing ability when the effects of either left grip strength or agility, or both are partialled out, as the obtained coefficients of partial correlation were greater than the value needed for significance at .05 level.

The coefficients of partial correlation (1st order and 2nd order) between physiological variables (speed of movement, hand reaction time and response time) and playing ability with the effect of one or two variables eliminated, are presented in Table 8.

All the three coefficients of partial correlation between speed of movement and playing ability were statistically significant, when the effect of hand reaction time and/or response time was/were partialled out.
<table>
<thead>
<tr>
<th>Variables Correlated</th>
<th>Partialled Variable(s)</th>
<th>Symbolic Representation</th>
<th>Coefficients of Partial Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed of Movement-</td>
<td>Hand Reaction Time</td>
<td>$r_c 4.3$</td>
<td>$.5508$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed of Movement-</td>
<td>Response Time</td>
<td>$r_c 4.5$</td>
<td>$.5719$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Reaction Time-</td>
<td>Response Time</td>
<td>$r_c 3.5$</td>
<td>$.4875$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Reaction Time-</td>
<td>Speed of Movement</td>
<td>$r_c 3.4$</td>
<td>$.3666$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Time-</td>
<td>Hand Reaction Time</td>
<td>$r_c 5.3$</td>
<td>$.3765$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Time-</td>
<td>Speed of Movement</td>
<td>$r_c 5.4$</td>
<td>$.3619$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed of Movement-</td>
<td>Hand Reaction Time</td>
<td>$r_c 4.35$</td>
<td>$.5468$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td>and Response Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand Reaction Time-</td>
<td>Speed of Movement and</td>
<td>$r_c 3.45$</td>
<td>$.3639$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td>Response Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response Time-</td>
<td>Speed of Movement and</td>
<td>$r_c 5.43$</td>
<td>$.3591$ *</td>
</tr>
<tr>
<td>Playing Ability</td>
<td>Hand Reaction Time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Significant at .05 level.*
All the three coefficients of partial correlation between hand reaction time and playing ability were statistically significant with the effect of response time and/or speed of movement being eliminated.

All the three coefficients of partial correlation between response time and playing ability were also statistically significant at .05 level with the influence of hand reaction time and/or speed of movement being partialled out.

Discussion of Findings

Relationship of Physical, Physiological and Psychological Variables to Hockey Playing Ability

The statistical analysis of data revealed that hockey playing ability was significantly related to speed, right grip strength, left grip strength, agility, balance and kinesthetic perception whereas no significant relationship was obtained between hockey playing ability and standing broad jump, trunk flexibility and shoulder flexibility. The findings of this study are in agreement with the conclusions reached by Chapman.\(^\text{10}\)

\(^{10}\)Chapman, *Dissertation Abstracts International*, p.1947-A.
and by Wharton.\textsuperscript{11} Apparently the speed, right grip strength, left grip strength, agility, balance and kinesthetic perception are essential for hockey players in order to give efficient performance.

Speed is a vital factor for good performance. Players who reveal themselves to be slow runners during a match are pushed into the background, while speedier players come more and more to the fore. Consequently coaches strive to include in either attack or defence as many fast players as possible. It is generally seen that the player with better speed can reach the ball quickly either to receive a pass or to control the common ball, to initiate the attack, counter attacks and fast break and to score or to defend. Thus speed correlated significantly with playing ability in hockey.\textsuperscript{12}

Muscular strength is required in all types of sports. The game of hockey is no exception to it.

\textsuperscript{11}Wharton, \textit{Completed Research in Health, Physical Education and Recreation}, p.49.

\textsuperscript{12}Wein, \textit{The Science of Hockey}, p.203.
Physical strength, particularly in the forearms and wrists is one of the contributory factors to success. In every minute of the game, a player is called upon to carry out a hard hit, push and flick besides executing other fundamentals which demand strong grip, because mostly the stick is held in both hands to execute these fundamentals. It is evident that the correlation value of left grip strength and playing ability was more than the correlation of right grip strength and playing ability which may be because of the dominant role played by left hand in manipulating the hockey stick.  

The other characteristic of the game of hockey is the multiplicity of skills involving movement: running forwards, sideways and backwards with or without ball, coming to a sudden halt, dodging and body swerves. Modern hockey demands that the player not only masters all these movements and understands exactly when to use them but also that he can perform quickly and as accurately as possible as and when demanded. Agile and sprightly players who are capable

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of following each situation as it arises by skilful
and quick movements have a great advantage over those
players who, for instance, are not agile enough to
shake off the man who is marking them out of the
game, or to do the same to an opposing forward. For
a forward to be able to escape from a man marking him
or for a defender to be able to mark his opposite
number out of the game, the player, apart from being
a top class runner, needs agility and balance, quali-
ties that are displayed in sudden stops, unexpected
changes in direction, body swerves, surprise variations
in speed etc. which occur repeatedly every minute of
the match. Because of such demands, hockey playing
ability has been found to be significantly related to
agility and balance. 14

Kinesthesia supposedly accounts in part for
individual differences in motor ability, provides
error in sensing, and is a factor in learning move-
ments. In the game of hockey one has to use this
sense in order to be an effective player. For instance,

while dribbling one has to look up for openings, passing to a person without looking at him or looking in a particular direction and passing in a different direction, to know the changing position of opponents while concentrating on the ball, dodging and shooting into the goal. All these aspects when practised regularly might improve the kinesthetic perception.

The insignificant relationship between playing ability to each of the physical variables of standing broad jump and shoulder and trunk flexibility, may probably be due to the fact that static explosive power of legs, forward bend of trunk and upward backward movement of arms are not used very often during a game, and hence are not the contributing factors in hockey performance.

The statistical analysis of data (product moment correlation) revealed that there is a significant relationship between cardio-respiratory endurance, resting pulse rate, hand reaction time, speed of movement, response time and body composition to hockey playing ability.

Fitness is of utmost importance, Without it one cannot be in the right place at the right time. It
is no use having superb stickwork and footwork without fitness, otherwise a player will never have the breath to carry out his skills having run the length of the field repeatedly. It has been said that skill alone will not win against extremely fit opposition as the game of hockey is a fast running game. Teams aspiring for modern, exacting standards of competition need players who are not only highly skilled, but also strong, fast and fit. There is no doubt that, by comparison with past years, the game of hockey has become faster, livelier, more intensive and more competitive. It is therefore natural that, now-a-days, players should possess the above mentioned qualities.  

During a match, players must frequently react quickly and in varied ways to different stimuli. This is particularly difficult, because simple actions, to which there is a well practiced response known in advance such as running out at penalty corner, occur only rarely. Morst Wein writes that a player requires

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16 The Hockey Association, Hockey Coaching, p.327.

0.2 seconds to react to a simple action, it will take him an additional 0.1 second to find a correct response to complicated situation which predominate in a match. Because of constant reaction to different stimuli, the successful player must possess improved reaction time to a considerable extent.

The relationship between percentage of body fat and playing ability shows that a higher percentage of body fat may be considered as an extra burden or "dead weight" which the individual has to carry, and which consequently reduces the efficiency of the player as suggested by Mc Ardle, Katch and Katch and Shaver. It is interesting to note that those hockey players who have scored better in hockey playing ability had a lower percentage of fat as compared to those who scored poor in hockey playing ability.

The significant relationship between response time and hockey playing ability may probably be due to

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19 Shaver, Essentials of Exercise Physiology, p. 186.
the reason that hockey players have to execute quick movements in different directions either to control the ball, to receive a pass besides dodging an opponent.

The statistical analysis of data revealed that there is a significant relationship between anxiety and hockey playing ability whereas relationship between intelligence and hockey playing ability is insignificant. The findings of this study are in agreement with the conclusions reached by Chapman and Bobb.

It occurs quite frequently that teams as well as individual players do not produce the quality of performance in a match which would normally be expected of them, despite their great ability, both technically and tactically, and their excellent physical condition. Experience has frequently shown that teams, or players, that are considered rather weak can play above themselves and are capable of producing outstanding performances. The reason for this lies in the realm of


psychology. A good coach knows that the team's or the player's ability does not depend merely on physical, technical and tactical qualities, but also on psychological considerations. A possible explanation for this is that those who have scored high on anxiety get too much excited and lose cognitive control which probably had a detrimental effect on performance. On the other hand some players who have scored comparatively lower on anxiety were good in hockey playing ability. The reason for this may be that these players remain calm and play cool with confidence, which might have been a factor towards their scoring better marks in hockey playing ability.\textsuperscript{22,23}

The insignificant relationship between intelligence and hockey playing ability may be due to the fact that the players in general become conditioned to the play patterns because of repeated practices, mental rehearsals and continuous training which limits the intelligence component because it is very rarely that

\textsuperscript{22} Wein, \textit{The Science of Hockey,} p.229.

\textsuperscript{23} Harris, \textit{Journal of Physical Education, Recreation and Dance,} p.31.
new situations come up which need intelligent expressions of movements. This may account for the insignificant correlation of intelligence with playing ability.

Combined Contribution of Physical and Physiological Variables to Hockey Playing Ability

The findings of this study revealed that the physical variables (left grip strength, balance and speed) and physiological variables (speed of movement, hand reaction time and response time) contribute significantly towards hockey playing ability. The significant combined effects of left grip strength, balance and speed to hockey playing ability and speed of movement, hand reaction time and response time to hockey playing ability may be attributed to the fact that hockey playing ability depends on strength, dynamic power and maintenance of dynamic equilibrium while performing various techniques besides the faster or quicker execution of skills; quick reaction time and time it takes to respond to a stimulus. The same has been emphasized in a book written by the Hockey Association which states that the fundamental requirements
of a game are speed, agility, endurance, and strength.²⁴ Read and Walker²⁵ in their book "Advance Hockey for Women" have written that hocky is a fast moving and exciting game, requiring quick thinking as well as physical skills. S.D. Dickens²⁶ a well known hockey coach of England's team, has said "We must concentrate on essentials: fitness, speed and teamwork."

Multiple Regression Analysis

Results of the multiple regression analysis presented in the preceding sections of this chapter seem to indicate that it is possible to make predictions regarding hockey playing ability on the basis of physical and physiological variables with a reasonable degree of accuracy under the limitation of this study.

²⁴ The Hockey Association, Hockey Coaching, p.325.


Speed has greater loading in the regression equation followed by balance and left grip strength in the physical variables.

Though the game of hockey is a team game, there are certain players who are more gifted to contribute individually for the success of the team. Speed is one quality which a successful hockey player must possess, no matter whether he is an offensive or defensive player. Speed is not everything, but it is a vital fundamental factor in most athletic contests and especially in hockey. One of the reasons for European's success can be attributed to speed besides other physical variables. 27 Horst Wein 28 also wrote that on artificial turf players relying mainly on techniques and tactics, but without the highest standard of physical fitness, would be outplayed by others with limited skills and little hockey experience but


possessing endurance, power and speed. Malhotra\textsuperscript{29} and associates have pointed out that on astro turf field the game is faster, requires more energy expenditure and causes greater stress on the cardio-respiratory system than on the grassy field. Bal Kishan Singh\textsuperscript{30} writes that the speed of play has almost been doubled on astro turf.

Reaction time has greater loading in the regression equation followed by speed of movement and response time amongst the physiological variables.

With the slower reflexes skills are natural sufferers and in consequence the execution of moves become poor, bringing to naught several good openings to be exploited. Hockey is a fast moving and exciting game, requiring quick thinking as well as physical skills. Today hockey ranks among the fastest, most scientific and attractive sports in the world. In a

\textsuperscript{29} Malhotra, Ghosh and Khanna, \textit{SNIFES Journal}, p.13.

\textsuperscript{30} Singh, \textit{SNIFES Journal}, p.3.
game of hockey where high level of competition is involved, there would be literally no time for thinking and doing and much would depend upon quick reflexes, resulting in the superb execution of the skills.\textsuperscript{31,32}

**Partial Correlations**

The findings of this study with regard to relationship between physical variables of agility, speed and left grip strength to playing ability, when the effect of one or both of the remaining variables was/were partialled out indicates that the zero order correlations between each physical variable and playing ability almost remain unchanged when either one or both were partialled out.

It was also noticed that the relationship of speed and playing ability, were reduced to a low but still significant level when the effect of left grip strength and agility were partialled out, the magnitude


of co-efficient reducing from -.29 to -.25.

Such a trend can only be interpreted to mean that agility, speed and left grip strength are the variables each of which has a unchangeable relationship with playing ability inspite of partialling out the effects of one or both variables. It may probably be due to the reason that each of the three variables has a pure relationship with the playing ability and is not affected or influenced by others as grip strength does not seem to have a relationship with either speed or agility. The absence of influence of speed on the relationship of agility and playing ability may be attributed to unknown reasons.

The findings of this study with regard to relation between each physiological variable (reaction time, speed of movement and response time) to playing ability, when the effect of one or both of the remaining variables was partialled out indicates that the zero order correlations between each physiological variable and playing ability are reduced to a low but still significant level.

From the analysis of data it is observed that
speed of movement had a significant relationship with hockey playing ability inspite of the elimination of reaction time and response time which had very little influence. Any speed of movement is contributed by reaction time, response time and other related neuromuscular qualities whereby the quickest possible movement is operated. The reason underlying the results may be that speed of movement is predominantly dependent upon the type of muscle fiber (white muscle fiber) though reaction time and response time also contribute a little. 33

In the relationship between reaction time and playing ability, speed of movement seems to be a more dominant factor than response time. The reason for this may be that the procedure adopted in the assessment of hand reaction time in which the subjects had to move their finger from a pressed button after receiving the optical stimulus and in this process speed of movement plays a very significant role.

Speed of movement and hand reaction time do

33 Shaver, Essentials of Exercise Physiology, p.126.
not contribute significantly in the relationship between response time and playing ability because when response time is correlated with playing ability the main emphasis is laid on response time itself. One of the reasons for the above observation may be the final rate of discharge from motor cortex followed by receipt of sensory responses.