CHAPTER III

METHODOLOGY

Research methodology involves formulating the problem to be investigated, selecting a suitable research design, choosing and applying suitable procedures for data collection, and analyzing and communicating the process and findings through a written report. The research methodology refers to the research decisions taken within the framework of specific determinants unique to the research study. In this chapter refers to the theory of getting knowledge to the consideration of the best ways, methods by which data that will provide the evidence basis for the construction of knowledge about whatever it is. That is being researched is obtained the decision about the methods depends upon the nature of the problem selected and kind of data necessary for its solution. The validity and the reliability of the findings depend upon the method adopted and hence methodology occupies a very important place in any type of research.

Research methodology involves the systematic process by which the research starts from the identification of the problem to its conclusions. The role of methodology is to carry out the research work in a scientific and valid manner. This chapter summarizes how the research has been carried out. In this chapter, procedures and methods were applied in selection of subjects, selection of variables, experimental design, pilot study, criterion measures, reliability of the data, reliability of instruments, tester’s reliability, subject reliability, orientation to the subjects, training programme, training schedule, selection of tests, administration of tests, collection of data and statistical procedure followed in this study.
3.1 SELECTION OF THE SUBJECTS

**Good (1954)** has defined a sample as A finite number of observations or cases selected from all cases in a particular universe often assumed to be representative of the total group of universe of which it is a part. The sample will help to extend the results obtained within the sample to the large population of which the sample is a part. Keeping this in mind, the investigator worked out the procedures for sampling in such a way as to obtain highly dependable results. The most important characteristic of a study is the selection of the sample. A good sample is one which will reproduce the individuality of the population. It is imperative that a suitable sample representative of the population be selected to ensure validity for the results arrived at. The process of sampling makes it possible to draw valid inferences or generalizations on the basis of careful observation or manipulation of variables within a relatively small proportion of the population (**Best & Kahn, 1995**).

To achieve the purpose of this study was Effect of Circuit Training on Grass, Gravel and Synthetic Field on Motor Fitness and Performance Variables of College Men Hockey Players. The 80 subjects were randomly selected from 20 subjects grass field in Adhiyamaan College of Engineering in Hosur, 20 subjects gravel field in Alagappa University College of Physical Education, karaikudi and 20 subjects synthetic turf field in Sourashtra College of Arts and Science, Madurai. Tamil Nadu, during the academic year 2016 - 2017. The subject’s age ranged between 18-25 years only. They were randomly divided into four equal groups. Circuit training group in different fields such as Grass, Gravel and Synthetic Fields and the other group was control group. All the subjects were healthy and physically fit. The nature and importance of the study was explained to the subjects and subjects expressed their willingness
to serve as subjects in this study. The study was formulated as pre and post test random group design.

The methodology used in this research involves the choice of a specified group of subjects, selection of variables administering of standard tests, using of the relevant tools, obtaining predetermined information in the certain chosen factors and subjecting them for a statistical analysis.

3.2 SELECTION OF VARIABLES

The present study was undertaken primarily to assess the investigation on effect of circuit training on grass, gravel and synthetic field on motor fitness and performance variables of college men hockey players. The researcher had gone through the available literature and had discussions with various experts and with his guide before selecting variables. The availability of technique for the purpose of analysis, feasibility, reliability of the procedure and the outcome were extensively taken care before finalizing the variables. The selected independent and dependent variables of this study are as follows.

3.3 DEPENDENT VARIABLES

"Variables are the conditions or characteristics that the experimenter manipulates, controls or observes" (Best & Kahn, 2005). There are mainly two types of variables. These include the dependent variable and the independent variable. The dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces, removes or changes the independent variables.
3.3.1. MOTOR FITNESS VARIABLES

i. Speed
ii. Agility
iii. Leg strength
iv. Endurance

3.3.2. PERFORMANCE VARIABLES

i. Dribbling
ii. Kitting
iii. Trapping (stopping)

3.4 INDEPENDENT VARIABLES

The independent variables are the conditions or characteristics that the experimenter manipulates or controls in his attempt to ascertain their relationship to observed phenomena. The standard of sports is gaining momentum day by day. New records are coming into existence at national and international level. It is all because of technical as well as tactical training to complete with advance sports countries (Sharma, 1997).

Experimental group I - underwent circuit training on grass field
Experimental group II - underwent circuit training on gravel field
Experimental group III - underwent circuit training on synthetic field
Group IV - Control Group
3.5 JUSTIFICATION FOR SELECTION OF MOTOR FITNESS VARIABLES

3.5.1 Speed

Speed in hockey refers often to one's ability to go faster over a short distance. Hockey is a game which involves running with and without a ball in various directions. An essential physical component for successful performance in many activities is speed. Speed players were always an asset to every team in match-winning performances. Dissemination into the opponent region with and without the ball can be achieved more easily with speed and an attack can be launched by speedy runs. So speed appears to be one of the most important factors in the modern hockey. Considering the importance of speed the investigator selected speed as one of the motor fitness variable in this study. Since speed is applicable to all playing positions it is relevant to analyses the speed of the subjects.

3.5.2 Agility

Agility is more important for the hockey teams while playing in different playfields. Agility is to change the direction of the body and its parts quickly and accurately. In the game of hockey agility is more important for all the teams playing in different position to dodge, to tackle and to defend the ball from the attacker. Playing in artificial field teams must have very good agility so that they can turn in the required direction quickly. After the introduction of the artificial field, physical variables were considered as most important for each player to perform well. Taking into consideration
of the above importance the agility was selected as one of the physical variables for this study.

3.5.3 Leg strength

Leg strength is important factors for a hockey player. Artificial fields require more strength on the legs since the game of hockey requires more running. Playing in the artificial field requires more strength than playing in other playfields like grass or gravel. The artificial field is made with artificial grass and to play in the artificial field more leg strength is needed. Playing in the grass field and gravel field may not require strength as in the artificial field. High level of physical fitness is required for good performance in hockey. Fitness requirements will vary according to the team's levels, playing position and according to the different playfields. A special technique implies not only the specific movements necessary for the sport concerned but all the related and general complementary movements such as running and jumping. All the anaerobic activities are related to leg strength. Because of the above reasons strength was selected as a motor fitness variable, for this study.

3.5.4 Cardio vascular Endurance

Endurance permits rapid recovery between bursts, between shifts, between periods, and between games. It also helps tolerate heat and to offset the unfavorable effects of travel. When hockey players tell me they want to increase their endurance they often follow with I am going to start jogging. It’s basically the first thing that comes to everyone when they think of endurance or cardio, however there are much better endurance drills that you can do for hockey.
3.6 JUSTIFICATION FOR SELECTION OF PERFORMANCE VARIABLES

3.6.1 Dribbling

Dribbling is an important aspect of individual tactics. In modern hockey, the man to man dual is decisive. During the game situation when there is no possibility of scoring or passing the ball to the team mates, dribbling helps the player to find the appropriate opportunity for the next pass. The great dribblers have been creative artists. Good dribblers have the magical powers to attract the crowd. Dribbling differs from individual to individual and also from one playfield to another playfield. When a player wants to carry or propel the ball for a longer distance, the dribbling helps to do the same. Dribbling plays a vital role for an individual to possess the ball while the opponent tries to tackle the ball from the dribbler. Recent studies have shown that performance variable dribbling has got direct relationship with the hockey performance and no study has been done to find out the difference of the performance variable in different playfields. Taking into consideration of the above facts dribbling has been selected as one of the performance variable in this study.

3.6.2 Hitting

Hitting is one of the most important fundamental skills in hockey. Hitting plays a vital role in the modern hockey. The hit in, free hit, 16 yards free hit, long corner and the penalty corners are mostly taken by hitting. To score the goal, to clear the ball for a longer distance from the dangerous zone, long pass or crosswise pass and also for cross pass hitting is the prime skill to execute these tactics. It is recognized that among the fundamentals the ability to hit the ball is needed for high level of performance. The
ability to hit the ball is more important in the artificial field, gravel and grass field in all the aspects. The technique of hitting may vary from one playfield to another playfield. Because the ball moves faster in the artificial field than the other two play fields. At the same time more power is required in the artificial field to carry out hitting at a faster rate because the artificial field has got friction due to the water on the field. In the gravel field less power is required than it is required in the grass field. Because of the above qualities hitting was chosen as one of the performance variable for this study.

3.6.3 Trapping

This is also one of the most important basic skills in the game of hockey. A player insists this skill to his or the team’s advantage to carry out the next move. The perfection of trapping not only shows the individual superiority of executing the skill but also to the successful team tactics. Considering the above facts trapping was selected as one of the performance variable for this study.

3.7 EXPERIMENTAL DESIGN

The study was formulated as a true random group design, consisting of a pre test and post test. The subjects (n=80) were randomly assigned to three equal groups of twenty college men hockey players for each. The groups were assigned as three Experimental Groups respectively the Experimental group I underwent circuit training on grass field whereas experimental group II underwent circuit training on gravel field and experimental group III underwent circuit training on synthetic field. The different stations for both experimental group I, experimental group II and experimental group III were similar and the duration of exercises also was the same, only thing which
differentiated both was the different fields. The training was carried out only on week
days. Group III was the control group which did not participate in any training except
their daily routines. Pre tests were conducted for all the subjects on selected motor fitness
variables such as speed, agility, leg strength and Cardio Vascular endurance, and
Performance variables of dribbling, kitting and trapping. The experimental groups
participated in their respective circuit training in different fields like that grass, gravel
and synthetic field. The training programme alternate days of twelve weeks. The post
tests were conducted on the above said dependent variables after the experimental period
of twelve weeks for all the three groups. The training programme was scheduled at 6.30
to 7.30 a.m. on week days excluding Saturdays and Sundays.

"Variables are the conditions or characteristics that the experimenter manipulates,
controls or observes" (Best & Kahn, 2005). There are mainly two types of variables.
These include the dependent variable and the independent variable. The independent
variables are the conditions or characteristics that the experimenter manipulates or
controls in his attempt to ascertain their relationship to observed phenomena. The
dependent variables are the conditions or characteristics that appear, disappear or change
as the experimenter introduces, removes or changes the independent variables.

3.8 PILOT STUDY

A pilot study was conducted to assess the initial capacity of the subjects in order
to fix the exercise load. For this purpose ten hockey players who were not the subjects
for this research were selected and circuit training for grass, gravel and synthetic fields
were given to them. Based on the response of the subjects in the pilot study, training
programme to ensure the suitability, the loads and duration of exercise were scheduled.
Further the pilot study helped to know the subjects capacity, to know the satisfactory effects of exercises and to know the difficulty of conducting training programme and to set a clear understanding about the duration of time which was required for conducting the test.

Thus, training schedules for grass, gravel and synthetic fields were constructed. However the individual differences were not considered. This enabled the investigator to adapt suitable training schedule for this study

3.9 CRITERION MEASURES

By glancing the literature, and in consolation with professionals and experts, the following criterion measures were adopted to measure the test.

1. To find out the effect of 50 meters run, conducted by using stop watch and the scores are recorded in seconds.
2. The agility was measured by ‘T’ test. The measurement was in seconds.
3. To find out the leg strength of the subjects standing broad jump test was conducted.
4. To find out the endurance of the subjects, 12 minutes run / walk test was conducted.
5. The skill variables in hockey, dribbling, hitting and trapping were measured through standard tests prescribed.
Table I

Names of Variables, Tests/ Tools Administered and the Unit Measurement

<table>
<thead>
<tr>
<th>SL. No</th>
<th>Criterion Variables</th>
<th>Test Items</th>
<th>Unit of measurements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Speed</td>
<td>50 mts run</td>
<td>Seconds</td>
</tr>
<tr>
<td>2.</td>
<td>Agility</td>
<td>T-test</td>
<td>Seconds</td>
</tr>
<tr>
<td>3.</td>
<td>Leg strength</td>
<td>Standing broad jump</td>
<td>meters</td>
</tr>
<tr>
<td>4.</td>
<td>Cardio vascular</td>
<td>Harvard step test</td>
<td>Pulse counted</td>
</tr>
<tr>
<td></td>
<td>Endurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Dribbling</td>
<td>“W” form dribbling test</td>
<td>Seconds</td>
</tr>
<tr>
<td>6.</td>
<td>Hitting</td>
<td>hitting for accuracy</td>
<td>Scores</td>
</tr>
<tr>
<td>7.</td>
<td>Trapping</td>
<td>Trapping ability</td>
<td>Scores</td>
</tr>
</tbody>
</table>

3.10 RELIABILITY OF DATA

The reliability of data was ensured by establishing the rater’s reliability, instrument reliability, tester’s competency and reliability of test and the subject’s reliability.

3.11 INSTRUMENT RELIABILITY

Standard equipments were used for this study. The stop watches, measuring tapes, flags, used for measuring hockey skill tests were considered reliable as they were procured from reputed firms and were on use for research purposes. Further these instruments had been calibrated in standard units. To determine the reliability of the instrument, the measurements on each of the variables were recorded five times under
similar conditions using the same instruments and the scores obtained were the same. The scores were compared with other scores taken from the instruments purchased from other reputed firms. Instruments were manufactured and supplied by recognized firms and the standardizations of the instruments were accepted as accurate enough for the purpose of the study.

3.12 COMPETENCE OF THE TESTER

The assistance of four specially trained physical education research scholars were sought for administration of various test items. They were oriented about the procedures of measuring and recording the scores in each variable. The purpose of the study and testing procedures were explained and demonstrated to the testers. The investigator had a number of practice sessions in order to familiarize the correct testing procedure. The testers’ reliability was established by test and re-test method. As very high correlation was obtained, the tester competency in taking measurement and test reliability were accepted.

3.13 TESTERS RELIABILITY

To measure uniformity and reliability of the testing technique, the investigator had a number of practice session in the testing procedure with the guidance of their teacher. The investigator has done all the experimental parameters with the assistance of their teacher and laboratory experts.

3.14 SUBJECTS RELIABILITY

To determine the reliability of the subjects, selected as subject are divided into three groups, experimental group I, experimental group II and experimental group III. The
test conducted for tester’s reliability ensured the subject reliability. As the same subjects and instruments were used under similar candidates by the same testers, the coefficient of reliability were significant at the $P < 0.05$ level for the above tests under investigation. The correlation of coefficient correlation obtained for the tests variables were given in Table II

**Table II**

Intra Class Correlation Coefficient of Test – Retest Scores

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Variables</th>
<th>Co efficient correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Speed</td>
<td>0.91*</td>
</tr>
<tr>
<td>2</td>
<td>Agility</td>
<td>0.89*</td>
</tr>
<tr>
<td>3</td>
<td>Leg strength</td>
<td>0.88*</td>
</tr>
<tr>
<td>4</td>
<td>Endurance</td>
<td>0.90*</td>
</tr>
<tr>
<td>5</td>
<td>Dribbling</td>
<td>0.88*</td>
</tr>
<tr>
<td>6</td>
<td>Hitting</td>
<td>0.90*</td>
</tr>
<tr>
<td>7</td>
<td>Trapping</td>
<td>0.93*</td>
</tr>
</tbody>
</table>

*Table value of 0.05 level = .63 df = N-2 = 10-2 = 8

Tabulated $r = .63$ df = 8 at 0.05 level of confidence since the obtained ‘$r$’s were more than the table value the reliability of the tests were considered reliable at 0.05 level of confidence.

**3.15 ORIENTATION TO THE SUBJECTS**

In order to get full co-operation from the subjects the investigator very clearly explained about the purpose of the study. Prior to the administration of test it was very clearly explained to the subjects in detail about the procedure to be followed in the tests. This explanation helped very much to ensure the effective co-operation from the subjects.
to obtain the reliable data. Model performances by some of the subjects were also done to make the subjects clearly understand the tests related to the study.

3.16 ADMINISTRATION OF TESTS AND DATA ATTAINMENT

The subjects were given clear instructions relating to the training programme and mode of measurements of all criterion measures used in the study. To get optimum results the demonstration of all the exercises was also made, and asked their co-operation for the accurate and better results.

3.17 TRAINING PROGRAMME

Table -III

THE STUDY DESIGN LAYOUT

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Circuit training exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>3 days/week</td>
</tr>
<tr>
<td>Total duration</td>
<td>12 weeks</td>
</tr>
<tr>
<td>Duration /session</td>
<td>45 minutes</td>
</tr>
<tr>
<td>Intensity</td>
<td>55-70%HRmax</td>
</tr>
<tr>
<td>Exercise days</td>
<td>Monday, Wednesday and Friday</td>
</tr>
<tr>
<td>Time of training</td>
<td>Morning (6:20-7:20:00 A. m)</td>
</tr>
</tbody>
</table>

In this study exercise training was done in circuit with instructions and supervisions of researcher and assistants. The training was given in 55 - 70% intensity by the investigator for 12-weeks 3 days per week for 45 minutes. Training session was started with warm up exercises for 8 minutes, workout for 28 minutes; Cool down
activities for 5 minutes and total active rest among each station for 9 minutes. Pre post tests were given on selected motor fitness variables such as speed, agility, leg strength and cardio respiratory endurance. Performance variables such as dribbling, hitting and trapping.

3.17.1 Exercise Training Protocol

The selected subjects were assigned in intervention and comparison groups. The warm up activities consisted: Running on the spot, arm circling, skipping jump, astride jumping, one knee raising and pressing to the chest with assistance of hands (lift/press/lower), through vault in threes, free walking, kicking out-stretched hand with one foot every third step and back pushing. All subjects were divided into 8 groups with 3 members in each group. There were 8 stations where each group was assigned for circuit training. Each group worked at each station for 60 seconds with 30 seconds of active recovery time before proceed to the next station by doing sit ups, Half squats, Stick jumps, Burpees, Body squats, push up, Mountain climbers and Two legged low hops on spot which develop upper, middle, lower and total body region.

The subjects were moved to the station in a clockwise direction as soon as the recovery time was over; they were required to go through the 8 stations. During the recovery periods, subjects engaged in breathing exercises. Standing or walking around as the program progresses. At the end of the circuit training program, subjects were cool down by jogging, walking and static stretching.
<table>
<thead>
<tr>
<th>weeks</th>
<th>Exercise</th>
<th>Duration of Exercises (in Seconds)</th>
<th>Intensity</th>
<th>Repetition</th>
<th>Set</th>
<th>Recovery In-between sets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-3</td>
<td>Sit ups</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Half squats</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Stick jumps</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Burpees</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Body squats</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Push ups</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Mountain climbers</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Two legged low hops on spot</td>
<td>50</td>
<td>55%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td>4-6</td>
<td>Sit ups</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Half squats</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Stick jumps</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Burpees</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Body squats</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Push ups</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Mountain climbers</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Two legged low hops on spot</td>
<td>55</td>
<td>60%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td>7-9</td>
<td>Sit ups</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Half squats</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Stick jumps</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Burpees</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Body squats</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Push ups</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Mountain climbers</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Two legged low hops on spot</td>
<td>60</td>
<td>65%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td>10-12</td>
<td>Sit ups</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Half squats</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Stick jumps</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Burpees</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Body squats</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Push ups</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Mountain climbers</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
<tr>
<td></td>
<td>Two legged low hops on spot</td>
<td>65</td>
<td>70%</td>
<td>3</td>
<td>3</td>
<td>3 min</td>
</tr>
</tbody>
</table>
3.18 TEST ADMINISTRATION ON MOTOR FITNESS

3.18.1 Speed (50 Meters)

Purpose

To measure the speed

Materials used

Two stop watches, measuring tape, clapper, and track marking 50 meters

Instruction

The subjects were advised to run in their own line from the starting to finish, with maximum speed. The command used for starting was ‘on your mark’, ‘set’, ‘clap’

Procedure

Two lines were marked 50 meters apart from the starting line and finish line. On the command, ‘clap’, the subject ran as fast as possible across the finish line to cover 50 meters area.

Scoring

The elapsed time was measured to the nearest one tenth of a second.

3.18.2 AGILITY T-TEST

Purpose:

The T-Test is a test of agility for athletes, and includes forward, lateral, and backward running.

Materials used:

Tape measure, marking cones, stopwatch, timing gates (optional)
Procedure:

Set out four cones as illustrated in the diagram above (5 yards = 4.57 m, 10 yards = 9.14 m). The subject starts at cone A. On the command of the timer, the subject sprints to cone B and touches the base of the cone with their right hand. They then turn left and shuffle sideways to cone C, and also touches its base, this time with their left hand. Then shuffling sideways to the right to cone D and touching the base with the right hand. They then shuffle back to cone B touching with the left hand, and run backwards to cone A. The stopwatch is stopped as they pass cone A.

Scoring:

The trial will not be counted if the subject crosses one foot in front of the other while shuffling, fails to touch the base of the cones, or fails to face forward throughout the test. Take the best time of three successful trials to the nearest 0.1 seconds.
3.18.3 LEG STRENGTH (Standing Broad Jump)

**Purpose**

To assess the leg strength.

**Materials used**

Jumping pit and measuring tap

**Procedure**

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

**Scoring**

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

3.18.4 CARDIOVASCULAR ENDURANCE (Harvard Step Test)

**Purpose**

To measure the cardio respiratory endurance through Physical Efficiency Index. Brouha et al. (1943).
**Materials used**

A stable bench 20 inches high and a stop watch.

**Procedure**

The subject step up and down 30 times a minute on a bench 20 inches high. Each time the subject should step all the way up on the bench with the body erect. The stepping process is performed in four counts, as follows: 1. one foot is placed on bench, 2. other foot is placed on the bench; 3. one foot is placed on the floor; 4. the other foot is placed on floor. The tester may lead off with the same foot each time or any change feet as he desires, so long as the four count step is maintained. The steps were counted the cadence as ‘up, up, down, down’. The stepping exercise continues for exactly five minutes, unless the subject is forced to stop sooner due to exhaustion. In either case the duration of the exercise in seconds is recorded; the maximum number of seconds is 300 for the full five minute period. Immediately after completing the exercise, the subject sits on a chair. The pulse is counted 1 – 1½, 2 – 2½ and 3 – 3½ minutes after the stepping ceases.

**Scoring**

A physical fitness index is computed utilizing the following formula:

\[
PFI = \frac{\text{Duration of Exercise in Seconds} \times 100}{2 \times \text{Sum of pulse counts in recovery}}
\]
3.19 TEST ADMINISTRATION ON PERFORMANCE VARIABLES

3.19.1 Dribbling

“W” form dribbling test

Purpose

The purpose of “W” form dribbling test was to measure the subjects speed and ball control.

Materials used

Hockey balls, hockey sticks, measuring tape, whistle 5 flag posts, stop watches and lime powder.

Marking

Three flag posts A, C and B were placed in a straight line at a distance of 5 meters from one another. An arc of 5 meters is drawn from point A and C and C and B and flag post are placed at the intersecting points namely B and D.

Procedure

The subjects starts from flag A and moves with the ball by dribbling forward on the signal “go” and moves to flag B then takes a left turn move to flag C takes a right turn move to D and takes left turn move to B and return back to the starting point by covering the flag posts D, C, B and A respectively. This test was conducted in all the three playfields.
Score

Two chances were given in each playfields. The watch was operated on the signal “go” and was stopped when the subjects returned back to the starting point flag A. The time was recorded in 1/10th of a second as the score of the subject.

3.19.2 HITTING FOR ACCURACY TEST

Purpose

The purpose of hitting for accuracy was to measure the subject’s accuracy in hitting.

Materials used

Hockey balls, hockey sticks, 2 flag posts, goal post, lime powder.

Marking

A shooting circle is marked. The goal posts either side marked with one meter and flag posts are fixed at this point.

Procedure

The balls are placed at the top of the shooting circle. The player stands on top of the circle and has to take the ball one by one and shoot the stationary ball to the corners of the goals marked alternatively on left side and right side. Test was conducted in all the three playfields.
Score

10 balls were placed at the top of the circle 16 yards away from the nearest goal posts. Two trials were given to each subject. The subject has to hit the ball alternatively to the right side corner and left side corner of the goal post. One point was awarded for each goal scored accurately. The number of goals scored was recorded as the score of the subject. The test was conducted in all the three playfields.

3.19.3 TRAPPING TEST

Purpose

The purpose of trapping test was to measure the subject’s trapping ability.

Materials used

Hockey sticks, hockey balls, measuring tape and lime powder.

Procedure

The subjects were asked to stand on the goal line one by one and other subjects should stand on the top of the shooting circle with 10 balls and were asked to hit it into the goal post. The subject standing on the goal line was asked to stop the ball with the stick using any type of technique. The test was conducted in all the three playfields.

Score

Three chances were given to each subject in all three playfields. Three experts were assessed the trapping ability of the subjects using five point rating scale. The mean score of the experts was the individuals score.
3.20 COLLECTION OF DATA

Subjects of the three groups namely experimental group I: circuit training on grass. Experimental group II: circuit training on gravel. Experimental group III: Circuit training on synthetic field and control group was tested on selected criterion variables such as motor fitness variables (speed, agility, leg strength and cardio vascular endurance. performance variables: dribbling, hitting and trapping. The initial test was performed and considered as pre-test score on the selected criterion variables. On completion of pre-test, they were treated with their respective treatments: weekly three days in the morning session for a training duration of one and half hours for a period of twelve weeks. At the end of twelve weeks, all the four groups were tested again on all selected variables and it was kept as post-test score. The collected data were analyzed with appropriate statistical techniques.

3.21 STATISTICAL TECHNIQUE

1. To find out the differences between the motor fitness and performance variables in different playfields the statistical method repeated measures ANOVA was used.

2. To compare the motor fitness and performance variables among the circuit training on different playfields men hockey players repeated measures ANOVA was used followed by simple effects test as suggested by Clarke and Clarke for interpreting the results. To find the significant differences
3. Scheffé’s post hoc test was used as suggested by Clarke and Clarke. All the statistical analysis was done with the help of SPSS Package version 21.00. The level of significance chosen was at 0.05 level.

3.22 Justifications for Using ANCOVA

Analysis of covariance was used to determine how each dependent variable is influenced by independent variables while controlling for a covariate (Clarke and Clarke, 1972). Analysis of covariance adjusts the mean of each dependent variable to what they would be if all groups started out equally on the covariate. Analysis of covariance gives results preferable to those of a direct comparison of gain scores i.e., post-test minus pre-test for the two groups, because gains are limited in size by the difference between the test’s ceiling and the magnitude of the pre-test score (Tuckman, 1999). In this study, pre-test scores of the selected variables have been shown to correlate with the post test scores and thus they were considered as appropriate covariates.