CHAPTER - 3

METHODOLOGY
Chapter –III

**Methodology**

The procedure and methodology include selection of the subjects, demographic information about the subject, selection of variables, administration of test and analysis of data.

**Selection of the subjects**

319 male and female players of different games and sports who represented Pt. RSU, Raipur, Chhattisgarh in Inter University competition and student of school of studies in Physical Education, Pt. RSU, Raipur, Chhattisgarh were selected as subject for a survey to assess the status of core muscles strength. The age of the subjects ranged 18-25 years. Out of 319 subjects 55 students who were studying in school of studies in Physical Education, Pt. RSU, Raipur, Chhattisgarh for their bachelors & post graduate degree were purposively selected as sample for the experimental study to impart training on core strengthening.

**Fig 3.1: Number of subjects for Core muscles Assessment Groups**
Variables

Selection of variables for assessment of core muscles strength and fitness level were done on the basis of literature available. The pre and post tests were conducted to observe the effect of the core muscles training. The following variables were selected to assess the status of core strength and physical fitness and body composition, and find out effect of core strength training on the same variables.
### Table 3.1: Physical Fitness Variables

<table>
<thead>
<tr>
<th>FITNESS VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Muscle Test</td>
</tr>
<tr>
<td>Push-Up Test</td>
</tr>
<tr>
<td>Lateral Cone Jump Test</td>
</tr>
<tr>
<td>Shuttle Run</td>
</tr>
<tr>
<td>Sit and reach (Flexibility)</td>
</tr>
<tr>
<td>Lateral trunk endurance test</td>
</tr>
<tr>
<td>Standing broad jump test</td>
</tr>
<tr>
<td>Abdominal curl up test</td>
</tr>
</tbody>
</table>

### Table 3.2: Body Composition Variables

<table>
<thead>
<tr>
<th>Body Composition Variables</th>
<th>Body Composition Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropometric Measurement</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>Height</td>
<td>Body Surface Area</td>
</tr>
<tr>
<td>Weight</td>
<td>Body Fat%</td>
</tr>
<tr>
<td>Skin Fold Measurement</td>
<td>Absolute Total Body Fat</td>
</tr>
<tr>
<td>Calf Skin Fold</td>
<td>Essential Fat Mass</td>
</tr>
<tr>
<td>Triceps Skin Fold</td>
<td>Non Essential Fat Mass</td>
</tr>
<tr>
<td>Biceps Skin Fold</td>
<td>Lean Body Mass</td>
</tr>
<tr>
<td>Subs Scapular</td>
<td>Fat Free Body Mass</td>
</tr>
<tr>
<td>Supra Spinal</td>
<td>Bone Mass</td>
</tr>
<tr>
<td>Waist Girth</td>
<td>Bone Density</td>
</tr>
</tbody>
</table>
Administration of the Test

1. Core Muscle Strength Assessment

Objective: To assess the strength and stability of the athlete’s shoulders, pelvic girdle, abdominal and lower back musculatures.

Equipment Needed: Stop watch, score sheet, writing utensil, score recorders (partners), form observer.

Procedure: Athletes assume a pike position with the elbows under the shoulders, the forearms shoulder width apart on the floor, and toes on the floor.

![Stage 1 – 1 minute](image1)
![Stage 2 – 15 seconds](image2)
![Stage 3 – 15 seconds](image3)

![Stage 4 – 15 seconds](image4)
![Stage 5 – 15 seconds](image5)
![Stage 6 – 15 seconds](image6)

![Stage 7 – 15 seconds](image7)
![Stage 8 – 30 seconds](image8)

Fig 3.3: Core Muscle Strength Assessment
Scoring: Based on stage completed with proper postural alignment without touching down to the floor. Buttock should be in a neutral position; body in a straight line. Slight deviation from this is acceptable, but if the hips are out of position or any part of the body other than the toes or forearms touch the ground then the test was be stopped for those individuals. His/her score was be recorded and represent the stage the athlete completed before breaking posture or dropping to the floor.

1. Push-Up Assessment

Objective: To assess the athlete’s muscular endurance.

Equipment Needed: Score recorder (partners), round cones approximately 6 inches from floor (athlete’s partner’s fist can be used to touch), writing utensils, score sheet, form observer(s).

Procedure: Males performed the standard “military” style push-up with only their hands and toes touching the floor. Female performed the push up in bent knee position. Subjects must come down so they are a fists distance from the floor, if they don’t have proper form, the push-up in question was not counted. During the test subjects can rest as long as they stay in the push-up position. If subject begins to lose range of motion or neutral alignment of hips the test was stopped with the total number of proper pushups completed being recorded.

Fig 3.4: Push-Up Assessment
Chapter – 3: Methodology

Scoring: Scoring for this test is based on the number of repetitions completed using proper form and technique.

2. Lateral Cone Jump Assessment

Objective: To assess the athlete’s anaerobic power, explosiveness, repetitive power and endurance of the athlete.

Equipment needed: Two 12 inch cones/station, stop watch, cross beam 12 inches from the floor, jump counter (athlete’s partner), score sheet and writing utensil and a form observer(s).

Procedure: Two 12 inch cones with a cross bar or tape stretched across was set up and subject stood to the left side of the hurdle. On command, the athlete jumps over the barrier to the right using both feet, then immediately jump back over the barrier to the starting point. The athlete continue jumping over the barrier until the command to stop is given. On breaking the tape barrier, move or knock over the hurdle, the test stops. Subject has a choice of accepting the number of full jumps completed, or starting over with a new 30 second count. The subjects got maximum two attempts to complete this test if they break tape, knock over the cones or barrier. As subjects feet leave the floor, the time started and the number of touches achieved in 30 seconds (lateral jumps) were be counted.

3.5: Lateral Cone Jump Assessment
Scoring: The athletes score is the number of touches completed in 30 seconds (each time they go over the cone and land would be considered a touch). A score was be recorded for lateral (side to side) jumps. The timer starts the watch when the subjects’ feet leave the ground on the first jump and gives a warning 15 seconds into the drill and counts off every 5 remaining seconds for the full 30 seconds. The timer stops the watch at 30 seconds. While the clock is running, the timer or third person counts each foot contact between jumps. A jump in progress when the clock hits 30 seconds does not count. The test result equals the number of completed jumps achieved within 30 sec.

3. Shuttle Run

Objective: This is a test of speed and agility, which is important in many sports.
Equipment Needed: Wooden blocks, marker cones, measurement tape, stopwatch, non-slip surface.
Procedure: This test requires the person to run back and forth between two parallel lines as fast as possible. Set up two lines of cones 30 feet apart or use line markings, and place two blocks of wood or a similar object behind one of the lines. Starting at the line opposite the blocks, on the signal "Ready? Go!" the subject runs to the other line, picks up a block and returns to place it behind the starting line, then returns to pick up the second block, then runs with it back across the line.

Fig 3.6: Shuttle Run Performance
Scoring: Two trials may be performed, and the quickest time is recorded. Results are recorded to the nearest tenth of a second.

4. Sit & Reach Test

Objective: The objective of this test is to monitor the development of subjects' lower back and hamstring flexibility.

Equipment Needed: Box, Meter Ruler, Tape, Assistant

Procedure: The subjects warm up for 10 minutes. The tester secures the ruler to the box top with the tape so that the front edge of the box lines up with the 15cm (6 inches) mark on the ruler and the zero end of the ruler points towards the subject. The subject sits on the floor with his legs fully extended with the bottom of bare feet against the box. The subject places one hand on top of the other, slowly bends forward and reaches along the top of the ruler as far as possible holding the stretch for two seconds. The tester records the distance reached by the athlete’s finger tips (cm). The athlete performs the test three times.

Fig 3.7: Sit & Reach Test Performance
Scoring: The tester calculates and records the average of the three distances and uses this value to assess the subject’s performance

5. Lateral trunk endurance test

Objective: To measure the endurance of the lateral trunk.

Procedure: The participant assumes a full side-bridge position with the legs extended and the top foot placed in front of the lower foot. The participant supports the trunk on one elbow and their feet while lifting their hips off the floor to create a straight line over their entire body length. The uninvolved arm is held across the chest with the hand placed on the opposite shoulder. Endurance is measured in seconds and the test is terminated when the participant moves out of the original position (McGill, 2006).

![Fig 3.8: Lateral trunk endurance test](image)

6. Standing broad jump test

Purpose: To measure the explosive power of the legs.

Equipment needed: Tape Measure to measure distance jumped, non-slip floor for takeoff, and soft landing area preferred. The take off line should be clearly marked.
Procedure: The athlete stands behind a line marked on the ground with feet slightly apart. A two foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The subject attempts to jump as far as possible, landing on both feet without falling backwards. Three attempts are allowed.

![Standing Broad Jump Test](image)

**Fig 3.9: Standing Broad Jump Test**

Scoring: The measurement is taken from take-off line to the nearest point of contact on the landing (back of the heels). The longest distance jumped, the best of three attempts is recorded. **The table below gives a rating scale for the standing long jump test for adults, based on personal experiences. See some athlete results for the long jump test. You can also use this calculator to convert cm to feet and inches.**
7. **Abdominal Curl-Up Test**

**Objective:** The objective of the Curl-Up Test is to assess the endurance of the athlete's abdominal muscles.

**Required needed:** Flat non-slip surface, Mat, Metronome, Assistant etc

**Procedure:** This test requires the subject to complete as many curl ups as possible at a rate of 20/minute. The subject warms up for 10 minutes. The assistant sets the metronome to 20 beats per minute (BPM)The athlete lies on the mat with their knees bent, feet flat on the floor and their hands resting on the thigh. The assistant, using their hands, supports the subject’s head. The assistant gives the command “GO” and the subject curls up sliding their hands up their thighs until the finger tips touch the top of knee caps (see Figure 2) and then returns to the starting position in time with the 20 BPM metronome.

![Abdominal Curl-Up Test](image)

*Fig 3.10: Abdominal Curl-Up Test*
Chapter – 3: Methodology

**Scoring:** The athlete performed as many curls as possible until he is unable to keep in time with the metronome. The assistant is to count and record the total number of curls which is then used to assess the subject’s performance.

**ADMINISTRATION OF TESTS**

**Technique**
All measure various anthropometric variables standard instruments, Weighing machine, GMP Skin fold caliper, GMP Anthropometry, sliding caliper, measuring tape were used. These instruments were reliably calibrated and accurate and are utilized by scientist in the field of anthropology and sports anthropology.

**Body weight:**
Weighing machine was used for recording body weight. Weighing machine was placed on plain surface and the boy was made to stand on the center of platform bare foot without support. Extra clothing and shoes were removed. Body weight recorded in Kilogram (kg).

**Stature:**
Anthropometer was used to measure the height. The child was made to stand upright barefoot and without raising the hells from the ground. Then the horizontal bar of the anthropometer was lowered until it touches the head. The measurement was taken carefully and the bar was not allowed to press the head. The reading to the nearest half cm was recorded.

**Skinfold measurement:**

Skinfold measurement was measured by skinfold caliper.
Biceps skinfold:

This skinfold is raised with the left thumb and index finger on the marked mid-acromiale-radiale line so that the fold runs vestically, that is parallel to the axis of the upper arm. The subject stands with the arm relaxed, the shoulder joint slightly externally rotated and elbow extended. The fold is located on the most anterior aspect of the surface of the right arm. Check that the marked point for the biceps skinfold is on the most anterior surface over the biceps by viewing the arm from the side whilst held in the anatomical position. The marked skinfold site should be just visible from the side, indicating that this is the most anterior point over the biceps (at the level of the mid-acromiale-radiale line).

Triceps skinfold:

This skinfold is raised with the left thumb and index finger on the marked posterior mid-acromiale-radiale line. The fold is vertical and parallel to the line of the most posterior surface of the arm over the triceps muscle when viewed from the side. The marked skinfold site should be just visible from the side indicating that this is the most posterior point over the triceps whilst held in the anatomical position (at the level of the mid-acromiale-radiale line). For measurement, the arm should be relaxed with the shoulder joint slightly externally rotated and elbow extended by the side of the body.

Subscapular skin fold:

The subject should be standing erect with the arms by the side. The thumb palpates the inferior angle of the scapula to determine the undermost tip. The skinfold is raised with the left thumb and index finger at the marked site 2 cm along a line running laterally and obliquely downwards from the subscapular landmark at an angle (approximately 45°) as determined by the natural fold lines of the skin.
Supraspinale skinfold:

This fold is raised at the point where the line from the iliospinale mark to the anterior axillary border intersects with the horizontal line of the superior border of the ilium at the level of the iliocristale. This is about 5-7 cm above the iliospinale depending on the size of the adult subject, and may be as small as about 2 cm in a young child. The fold runs medially downward at about a 45° angle.

Waist girth (cm)

This measure is taken at the level of the narrowest point between the lower costal (rib) border and the iliac crest. If there is no obvious narrowing then the measurement is taken at the mid-point between these two landmarks. The measurer stands in front of the subject to correctly locate the narrowing of the waist. The measurement is taken at the end of a normal expiration with the arms relaxed at the sides.

Body Composition Variables

**Body Composition:** Body composition is used to describe the percentages of fat, bone, water and muscle in human body. Because muscular tissue take up less space in our body than fat tissue, our body composition, as well as our weight, determines leanness. Two people of equal height and body weight may look completely different from each other because they have a different body composition.

**Body fat percentage:** A person’s total body fat percentage is the total weight of the person’s fat. The resulting number reflects both essential fat and storage fat. Arguably, body fat percentage is the superior gauge of an individual’s fitness level, as it is the only body measurement which directly calculates the
Chapter – 3: Methodology

particular individual’s body composition without regard to the individual’s or weight.
It is body fat mass in terms of percentage and estimated from the following (Katch and McArdle 1973).
Equation of Body fat (%) = 0.43 (A) + 0.58 (B) + 1.47
A = Triceps fat fold (mm)
B = Subscapular fat fold (mm)

Absolute (total) body fat mass (kg)
It includes 3% essential fat plus storage (non-essential) fat

Percent fat
Absolute Body Fat Mass (Kg) = \( \frac{\text{Percent fat}}{100} \) x Body Mass

Essential fat mass (kg)
It is a lipid rich store (as much as 3% of body mass in males) in bone marrow, brain, spinal cord and internal organs.


3

Essential Fat Mass (Kg) = \( \frac{3}{100} \) x Body Mass

Storage (Non- Essential) Fat Mass:
It is the storage fat that accumulates in adipose tissues, subcutaneous regions and serves as nutritional reserve to protect the various internal organs from trauma.
Storage Fat Mass (Kg) = Total Body Fat Mass (Kg) – Essential Fat Mass (Kg)

Lean body mass (Kg) [LBM]
It is composed of essential fat (+ sex specific reserve fat in females); muscles and bones. It is considered as in vitro entity of fat free mass.
Lean Body Mass (Kg) = Body Mass (Kg) – Storage Fat Mass (Kg).
Body Surface Area (Sq.m.):
Body Surface Area (A) = \(w^{0.425} \times H^{0.725} \times 71.84\)

**Muscle mass (kg)**
Theoretically, it is 44.8% of the body weight.
Muscle mass (kg) = \([\text{Body mass (kg)} \times 44.8]\) ÷ 100

**Bone mass (kg)**
It is 14.9% of the Body weight.
Bone mass (kg) = \([\text{Body mass (kg)} \times 14.9]\) ÷ 100

**Body density (g/cc)**
It is the body mass per unit volume (density = mass ÷ volume).
It is calculated by siri equation.
\%
Body fat = \(\frac{495}{\text{Body density}}\) - 450
Or

Body density = \(\frac{495}{(\% \text{ body fat} + 450)}\)

**Body Mass Index (BMI):**
BMI or Body Mass Index is another method of estimating a person’s body fat percentage based upon simple weight and height measurements. While the BMI calculation is an indirect measurement, it has been found to be a fairly reliable indicator of body fat measures in most people.
It is the ratio of weight (Kg) to stature (m)^2.
It is an age independent nutritional index. Following categories of nutritional status can be derived as per Ferro-Luzzi et al. (1992):

\[
\text{BMI} = \frac{\text{Weight (kg)}}{\text{Stature (m)^2}}
\]
### Table 3.3: Norms of Body Mass Index

<table>
<thead>
<tr>
<th>SN</th>
<th>Range Variation</th>
<th>Nutrition status</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>&gt; 18.5</td>
<td>Normal</td>
<td>I</td>
</tr>
<tr>
<td>2.</td>
<td>17.0 – 18.49</td>
<td>Mild</td>
<td>II</td>
</tr>
<tr>
<td>3.</td>
<td>16.0 – 16.99</td>
<td>Moderate</td>
<td>III</td>
</tr>
<tr>
<td>4.</td>
<td>&lt; 16.0</td>
<td>Severe</td>
<td>IV</td>
</tr>
</tbody>
</table>
Core Muscles Strength Training Programme

A training program of 8 week, 5 days/week, once/day was developed for core training, the program was started with 10 repetitions, 2-3 second holds on the first day of the exercise week. For timed exercises it was 20 seconds. On the next day 2-5 repetition were added, for repetition exercises or 10 seconds for timed exercises. It was continued with adding repetition or time each day until 20 repetitions are met or 60 seconds are performed for each exercise. A pain-free motion was maintained. The core training program followed the training principles and the load was increased gradually from week 1 through 8. Before actually starting the specific exercise for core 15-20 min of warming up session was planned so that the body gets prepared for core exercises. The core training program included different special exercise and the increase of load was progressive. Its start from simple to complex exercises.

Week 1 Exercises

Pelvic tilts - The subject lays on back and asked to contract abdominals so that back pushes down into the bed.

Supine marching - The subject lays on back and set core muscles. The subject was asked to raise one leg, set it down, and then repeat with the other leg.

Supine arm lifts - The subject lays on back and set core muscles. The subject was asked to raise one arm, set it down, and then repeat with the other arm.

Quadruped arm lift - The subject was asked to go on his hands and knees, and to raise one arm, set it down, then repeat with the other arm.

Week 2 Exercises

Bridge - The subject lays on his back and set core muscles. The subject was asked to lift his bottom off the ground.

Supine arm and leg lifts - The subject lays on his back and set core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.
Chapter – 3: Methodology

**Quadruped leg lift** - The subject was asked to go on his hands and knees and raise one leg, set it down, then repeat with the other leg.

**Week 3 Exercises**

**Bridges with arm lift** - The subject lays on his back and sets his core muscles. The subject was asked to lift his bottom off the ground, and then was asked to raise one arm, set it down, and then repeat with the other arm.

**Supine bilateral lower extremity lift** - The subject lays on his back and sets core muscles. The subject was asked to raise both legs, hold, and then set them down.

**Quadruped opposite arm and leg lift** - The subject lays on his hands and knees. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.

**Week 4 Exercises**

**Single leg lowering** - The subject lays on his back and sets his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.

**Modified plank on knees** - The subject lays on his elbows and knees. The subject was asked to set his core muscles and hold this position.

**On chair bilateral arm lift** - The subject lays on his stomach and sets core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.

**Bridges with leg lift** - The subject lays on his back and sets his core muscles. The subject was asked to lift his bottom off the ground, and raise one leg, set it down, then repeat with the other leg.
Chapter – 3: Methodology

Week 5 Exercises

Plank on toes - The subject lays on his elbows and toes. The subject was asked to set his core muscles and hold this position.

Opposite arm and leg lowering (dying bug) - The subject lays on his back and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.

On chair bilateral leg lift - The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.

Bridges with arm and leg lift - The subject lays on his back and set the core muscles. The subject was asked to lift his bottom off the ground, and then raise one leg and opposite arm, set them down, then repeat with the other leg and arm.

Week 6 Exercises

Plank with arm lift - The subject lays on his elbows and toes. The subject was asked to set his core muscles and lift one arm, set it down, and repeat with the other arm.

Opposite leg lower with knees straight - The subject lays on his back and set core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.

On chair bilateral arm and leg lift - The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.
Chapter – 3: Methodology

Week 7 Exercises

Plank with leg lift - The subject lays on his elbows and toes. The subject was asked to set his core muscles and lift one leg, set it down, and repeat with the other leg.

Opposite arm and leg lowering with knee straight - The subject lays on his back and set core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.

On chair bilateral arm and leg lift with weight - The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.

Week 8 Exercises

Plank with opposite arm and leg lift - The subject lays on his elbows and toes. The subject was asked to set his core muscles and lift one arm and opposite leg, set them down, and repeat with the other arm and leg.

Bilateral leg lower with knees straight - The subject lays on his back and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, then repeat with the other leg and arm

On chair bilateral arm and leg lift with increased weight - The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.
### Table 3.4: Eight Week Core Training Program (Johnson, 2011)

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Exercises</th>
<th>Description</th>
<th>Repetition Rate</th>
<th>Duration</th>
<th>Diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pelvic tilts</td>
<td>The subject lays on back and asked to contract abdominals so that back pushes down into the bed.</td>
<td>10-20 Rep.</td>
<td>20-60 sec hold</td>
<td><img src="image1" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>First week, start with 10 rep with 2-3 sec hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Supine marching</td>
<td>The subject lays on his back and set core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
<td><img src="image2" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>First week, Adding 2-5 rep Each day 10 with 10-20 sec hold</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Supine arm lifts</td>
<td>The subject lays on back and set core muscles. The subject was be asked to raise one arm, set it down, and then repeat with the other arm</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
<td><img src="image3" alt="Diagram" /></td>
</tr>
<tr>
<td></td>
<td>First week, Adding 2-5 rep Each day 10 with 10-20 sec hold up to 60 sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| **4** | Quadruped arm lift  
First week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec | The subject was asked to go on his hands and knees, and to raise one arm, set it down, and then repeats with the other arm. | 10-20 Rep. | 20-60 sec Hold |
| **5** | Bridge  
Second week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec | The subject lays on his back and set core muscles. The subject was be asked to lift his bottom off the ground | 10-20 Rep. | 20-60 sec Hold |
| **6** | Supine arm and leg lifts  
(Second week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec) | The subject lays on his back and set core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. | 10-20 Rep. | 20-60 sec hold |
## Chapter 3: Methodology

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Instructions</th>
<th>Repetitions</th>
<th>Hold Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>7: Quadruped leg lift</td>
<td>The subject was asked to go on his hands and knees and raise one leg, set it down, then repeat with the other leg.</td>
<td>10-20</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td>8: Bridges with arm lift</td>
<td>The subject lays on his back and sets his core muscles. The subject was asked to lift his bottom off the ground, and then was be asked to raise one arm, set it down, and then repeat with the other arm</td>
<td>10-20</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td>9: Supine bilateral lower extremity lift</td>
<td>The subject lays on his back and sets core muscles. The subject was asked to raise both legs, hold, and then set them down.</td>
<td>10-20</td>
<td>20-60 sec Hold</td>
</tr>
</tbody>
</table>
### Chapter 3: Methodology

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10</strong></td>
<td>Quadruped opposite arm and leg lifts</td>
<td>The subject lays on his hands and knees. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.</td>
</tr>
<tr>
<td></td>
<td>(Third week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td>10-20 Rep. 20-60 sec Hold</td>
</tr>
<tr>
<td><strong>11</strong></td>
<td>Single leg lowering</td>
<td>The subject lays on his back and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.</td>
</tr>
<tr>
<td></td>
<td>(Fourth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td>10-20 Rep. 20-60 sec Hold</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td>Modified plank on knees</td>
<td>The subject lays on his elbows and knees. The subject was asked to set his core muscles and hold this position</td>
</tr>
<tr>
<td></td>
<td>(Fourth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td>10-20 Rep. 20-60 sec Hold</td>
</tr>
</tbody>
</table>
| 13 | On chair bilateral arm lift  
(Fourth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec) | The subject lays on his stomach and set his core muscles. The subject was be asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or aball. | 10-20 Rep. | 20-60 sec Hold |
| 14 | Bridges with leg lift  
(Fourth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec) | The subject lays on his back and set his core muscles. The subject was asked to lift his bottom off the ground, and was raise one leg, set it down, then was repeat with the other leg. | 10-20 Rep. | 20-60 sec Hold |
| 15 | Plank on toes  
(Fifth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec) | The subject lays on his elbows and toes. The subject was asked to set his core muscles and hold this position | 10-20 Rep. | 20-60 sec Hold |
<table>
<thead>
<tr>
<th>16</th>
<th>Opposite arm and leg lowering</th>
<th>The subject lays on his back and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.</th>
<th>10-20 Rep.</th>
<th>20-60 sec Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Fifth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>On chair bilateral leg lift</td>
<td>The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td></td>
<td>(Fifth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Bridges with arm and leg lift</td>
<td>The subject lays on his back and set your core muscles. The subject was asked to lift your bottom off the ground, and then was raise one leg and opposite arm, set them down, then repeat with the other leg and arm.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td></td>
<td>(Fifth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Chapter 3: Methodology

<table>
<thead>
<tr>
<th>No.</th>
<th>Exercise Description</th>
<th>Description</th>
<th>Rep.</th>
<th>Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Plank with arm lift</td>
<td>The subject lays on his elbows and toes. The subject was asked to set his core muscles and lift one arm, set it down, and repeat with the other arm</td>
<td>10-20</td>
<td>20-60 sec</td>
</tr>
<tr>
<td></td>
<td>(Sixth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td>Hold</td>
</tr>
<tr>
<td>20</td>
<td>Opposite leg lower with knees straight</td>
<td>The subject lays on his back and set your core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.</td>
<td>10-20</td>
<td>20-60 sec</td>
</tr>
<tr>
<td></td>
<td>(Sixth week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td>Hold</td>
</tr>
<tr>
<td>21</td>
<td>On chair bilateral arm and leg lift</td>
<td>The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.</td>
<td>10-20</td>
<td>20-60 sec</td>
</tr>
</tbody>
</table>
### Chapter 3: Methodology

<table>
<thead>
<tr>
<th>No.</th>
<th>Exercise Description</th>
<th>Instructions</th>
<th>Rep.</th>
<th>Hold Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Plank with leg lift</td>
<td>The subject lays on his elbows and toes. The subject was asked to set his core muscles and lift one leg, set it down, and repeat with the other leg.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td></td>
<td>(Seventh week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Opposite arm and leg lowering with knees straight</td>
<td>The subject lays on his back and set your core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td></td>
<td>(Seventh week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>On chair bilateral arm and leg lift with weight</td>
<td>The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td></td>
<td>(Seventh week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Chapter – 3: Methodology

<table>
<thead>
<tr>
<th>No.</th>
<th>Exercise Description</th>
<th>Description</th>
<th>Reps</th>
<th>Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>Plank with opposite arm and leg lift</td>
<td>The subject lays on his elbows and toes. The subject was asked to set his core muscles and lift one arm and opposite leg, set them down, and repeat with the other arm and leg.</td>
<td>10-20 Rep.</td>
<td>20-60 sec hold</td>
</tr>
<tr>
<td></td>
<td>(Eight week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Bilateral leg lower with knees straight</td>
<td>The subject lays on his back and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, then repeat with the other leg and arm.</td>
<td>10-20 Rep.</td>
<td>20-60 sec hold</td>
</tr>
<tr>
<td></td>
<td>(Eight week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>On chair bilateral arm and leg lift with increase weight</td>
<td>The subject lays on his stomach and set his core muscles. The subject was asked to raise one leg and opposite arm, set them down, and then repeat with the other leg and arm. This may be done while laying on a chair or a ball.</td>
<td>10-20 Rep.</td>
<td>20-60 sec Hold</td>
</tr>
<tr>
<td></td>
<td>(Eight week, Adding 2-5 rep each day 10 with 10-20 sec hold up to 60 sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STATISTICAL ANALYSIS

In order to determine status of core strength fitness and body composition descriptive statistics was done. To observe the effect of 8 weeks core muscles strength training program in experimental and control group on selected variables comparative statistic analysis of covariance (ANCOVA) was applied.
Chapter – 3: Methodology

Photographs of Measurement & Training Schedule

Fig-3.11 Abdominal Skin fold Measurement

Fig-3.12 Sub Scapular Skin fold
Chapter – 3: Methodology

Fig-3.13 Biceps Skin fold

Fig-3.14 Medial Calf Skin Fold
Chapter – 3: Methodology

Fig-3.15 Triceps Skin fold

Fig-3.16 Standing Broad Jump
Chapter – 3: Methodology

Fig-3.17 Shuttle Run

Fig-3.18 Core Muscles Assessment Test
Chapter – 3: Methodology

Fig-3.19 Biceps Skin fold

Fig-3.20 Plank with One Arm Left
Chapter – 3: Methodology

Fig-3.21 Push Up Assessment

Fig-3.22 Lateral Cone Jump Assessment
Chapter – 3: Methodology

Fig-3.23 Push-up

Fig-3.24 Core Muscles Test
Chapter – 3: Methodology

Fig-3.25 Height/Stature

Fig-3.26 Weight
Chapter – 3: Methodology

Fig-3.27 Lateral Trunk Endurance

Fig-3.28 Flexibility
Chapter – 3: Methodology

Fig- 3.29 Stretching Exercise before Core Training

Fig-3.30 Warm-up before Core Training
Chapter – 3: Methodology

**Fig-3.31 Quadruped One Arm Left**

**Fig-3.32 Quadruped One Arm Left (Side View)**
Chapter – 3: Methodology

Fig-3.33 Quadruped One Leg Left

Fig-3.34 Bridge
Chapter – 3: Methodology

Fig-3.35 Bridge (Side view)

Fig-3.36 Supine Position with One Arm and Leg Lift
Chapter – 3: Methodology

Fig-3.37 Giving Instructions

Fig-3.38 Quadruped Position
Chapter – 3: Methodology

Fig-3.39 Making Correction of Core Exercise

Fig-3.40 Bridge with Arm Lift
Chapter – 3: Methodology

Fig-3.41 Supine Both Leg Lift with Swiss Ball

Fig-3.42 Bridge with Swiss Ball
Chapter – 3: Methodology

Fig-3.43 Both Leg Lift with Swiss ball

Fig-3.44 Opposite Arm and Leg Lowering with Knee Straight
Chapter – 3: Methodology

Fig-3.45 Abdominal Crunches with Swiss Ball

Fig-3.46 Plank with One Arm and One Leg Lift
Chapter – 3: Methodology

Fig-3.47 Relaxing After Core Training

Fig-3.48 Plank
Chapter – 3: Methodology

**Fig-3.49 Shoulder Rotation**

**Fig-3.50 Bilateral Arm and Leg Lift with Swiss Ball**