"EFFECTIVENESS OF SWISS BALL VS FLOOR EXERCISES ON CORE MUSCLES STRENGTHENING IN ELITE CRICKETERS"

Project Submitted to

The TamilnaduDr.MGR Medical University

In partial fulfillment for the degree of

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(SPORTS PHYSIOTHERAPY)

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CHERRAAN'S COLLEGE OF PHYSIOTHERAPY

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May -2019

CERTIFICATE

The work embodied in the thesis entitled **'"EFFECTIVENESS OF SWISS BALL VS FLOOR EXERCISES ON CORE MUSCLES STRENGTHENING IN ELITE CRICKETERS"** 'submitted to the **TamilNadu Dr. MGR Medical University, Chennai** in the partial fulfillment for the degree **of Master of physiotherapy (sports physiotherapy)**, was carried out by candidate bearing register number of 27115182 at Cherraan's college of physiotherapy ,Coimbatore under my supervision. This is an original work done by her and has not been submitted in part or full for any other degree/diploma at this or any other university/institution. The thesis is fit to be considered for evaluation for award of the degree of Master of Physiotherapy.

..... ……

Signature of Supervisor **Signature of principal**

Mr.A.CHINNACHAMY MPT (Sports) **Mrs.E.SELVARANI, MPT (Neuro)**

Date:…… **Date:**……

…… ……..

Internal Examiner **External Examiner**

Project work evaluated on…….

DECLARATION

I hereby declare and present my project work entitled ""**EFFECTIVENESS OF SWISS BALL VS FLOOR EXERCISES ON CORE MUSCLES STRENGTHENING IN ELITE CRICKETERS"** ''The outcome of the original research work undertaken and carried out by me, under the guidance of Professor. **Mr.Chinnachamy, MPT (Sports),** Cherraan's college of physiotherapy, Coimbatore.

I also declare that the material of this project work has not formed in anyway the basis for the award of any other degree previously from the Tamilnadu Dr. MGR Medical University.

…….. ……

Signature of Supervisor **Signature of Student**

Mr.A.Chinnachamy MPT (Sports) **AJESH JACOB**

Date:

Place:

ABSTRACT

"EFFECTIVENESS OF SWISS BALL VS FLOOR EXERCISES ON CORE MUSCLES STRENGTHENING IN ELITE CRICKETERS"

BACKGROUND: Cricket is one of the most popular game in India played by men and women of all ages. The increased physical demands on the players may be associated with an increased risk of injuries. Core muscle strength is important to prevent risk of injuries in elite cricketers. The beginners in the cricket must have enough strength of core muscles, as core is the bridge between upper and lower limbs. So, it should be strong enough to prevent low back and lower limb injuries in cricketers. The aim is to determine the effectiveness of swiss ball exercises versus floor exercises on core muscle strength in elite cricketers. The objective is to study and compare the effectiveness of swiss ball exercises and floor exercises in elite cricketers in terms of back strength.

METHODS: The total number of students in this study were 30 elite cricketers between 16-25 years out of which 15 subjects were included each in floor exercise(n=15) and swiss ball group(n=15). Back strength was measured before and after the intervention of 6 weeks using double leg lowering test.

RESULT: After the analysis, the results revealed significant improvement of back strength in boththe groups ($p < 0.00$). The swiss ball group showed significant results when compared with floor exercise group.

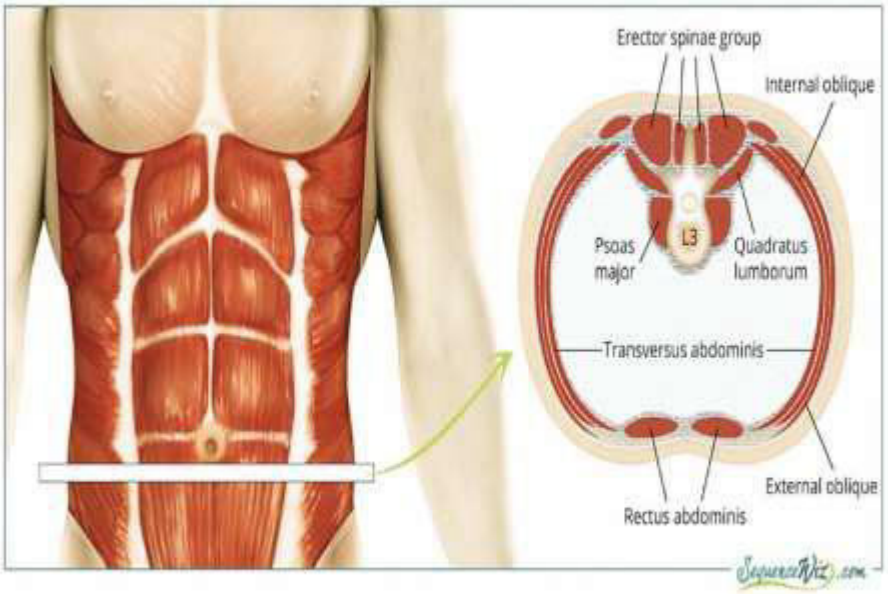
CONCLUSION: Although the study showed beneficial results in both the groups, the results reflected that swiss ball group had better improvement of core muscle strength than the floor exercise group.

KEYWORDS: Swiss Ball, Floor exercise, core muscles, cricketers Double leg lowering test, visual analogue scale.

INTRODUCTION:

Cricket is one of the most popular game in India played by men and women of all ages. The increased physical demands on the players may be associated with an increased risk of injuries. This is because the demands on the body from playing cricket are extremely varied as players are required to bat, bowl and field various times throughout the game. The incidence and nature of cricket injuries during a season have been documented in well-conducted studies.

Anatomically, the sites of injuries in cricket have been reported in a number of studies. Cricketers are sustained by back and trunk injuries by 14 –18%. The frequency of lower limb injuries varies from 25% to 30% has been reported. The major cause of injuries was found to be bowling. 38% of young school boy bowlers and 65.7% of provincial bowlers2 suffer from back injuries.



Core muscle strength is usually operationally defined by a measurement of the strength of core muscles, either in terms of how much weight/ resistance a muscle can lift how many repetitions a muscle can perform, or how long a muscle can hold a neutral stable position.

Core strength should be distinguished from core stability. In the Physical Therapy literatures the historically older term is “core stability”. In the latter part of 1980’s a concept of neutral spine developed among physical therapists and physicians who were treating individuals with back pain.

Spinal stability as consisting of three subsystems, passive components of spinal column, active control by spinal muscles and neuromuscular control or coordination. When the muscles in the hip, shoulder girdle and trunk work together they form a functional segment called the core.

Some experts argue that to measure core muscle strength when the spine is moving is not an appropriate measure of core muscle strength; because the more important measure is how well the core muscles can hold the spine trunk still and relatively stable while the extremities are moving. One measure of core muscle strength is how long an individual can hold a prone or side plank position. Others have measured the amount of force a hip muscle can hold an isometric muscle contraction. Others use a sequence of lying leg lifting while maintaining the spine in a neutral alignment.

The research in trunk control has been an important contribution to the understanding of neuromuscular re organization in back pain and injury. As long as four decades ago it was shown that motor strategies changes in injury and pain. The core stability studies confirmed that such changes take place in motor control of the trunk muscles.

Several assumptions prevalent in core stability training;

Certain muscles are more important for stabilization of the spine than other muscles, in particular transverses abdominals.

The problem with the concept of training specifically for “core” stabilization is that it doesn’t make any sense. Leaving aside the arguments for using it to prevent back pain in sedentary populations, it proceeds from several ridiculous assumptions, and it is completely implacable to an athletic who is training properly on a basic barbell program. While it is absolutely true that all movements in sports that involve a ground reaction – a movement involving the feet generating power against the ground while the body, usually through the

hands, applies it to a resistance – utilize the pelvic and trunk musculature to stabilize the spine during the movement.

ANATOMY OF CORE MUSCLE

The core acts through the thoracolumbar fascia “nature’s belt”. The transverse abdominis has large attachment to the middle and posterior layers of thoracolumbar fascia. The deep lamina of the posterior layer attaches to the lumbar spinous process. The thoracolumbar fascia serves as part of a “hoop” around the trunk that provide a connection between the lower limb and upper limb.

The lumbar spine functions as a complex interplay of musculoskeletal and neurovascular structures creating a mobile yet stable transition between the thorax and pelvis.

The swiss ball is an extremely popular apparatus used for core stability training in populations as varied as spinal disorders to elite athletes. The majority of the research involves abdominal muscle exercises comparing them to the traditional mat (stable surface) styles, however the benefits of swiss ball exercises appear to have been applied to whole body exercises equallly. Performing strength exercises on swiss balls has been advocated that a labile surface will provide a greater challenge to the trunk musculature, increase the dynamic balance of the subject and possibly train subjects to stabilize their spines to prevent and treat injury.

The studies have been published about the effectiveness of swiss ball and floor exercises in elite cricketers. Studies have shown efficacy of swiss ball and floor exercises comparatively but there are no studies on core muscle strength in elite cricketers.

NEED OF THE STUDY

Core muscle strengthening is the ability of the Lumbo pelvic hip complex . The reason of the study is to find the effectiveness of swiss ball vs floor exercise on core muscle strengthening in elite cricketers.

1.2 OBJECTIVES OF THE STUDY

To determine the effect of swiss ball on core muscle strengthening in elit cricketers.

To determine the effect of floor exercise on core muscle strengthening in elite cricketers.

To determine the effect of swiss ball vs floor exercise on core muscle strengthening in elite cricketers.

1.3 STATEMENT OF THE PROBLEM

The study on the efficacy of the core muscle strengthening and its influence on Endurance test variables among in elite cricketers.

1.4 HYPOTHESIS

Null hypothesis

There is no significant different in endurance test variables followed by core muscle strengthening in elite cricketers by swiss ball.

There is no significant different in endurance test variables followed by core muscle strengthening in elite cricketers by floor exercise.

There will be no significant different in endurance test variables followed by core muscle strengthening in elite cricketers by swiss ball vs floor exercise.

Alternative hypothesis

There is significant different in endurance test variables followed by core muscle strengthening in elite cricketers by swiss ball.

There is significant different in endurance test variable followed by core muscle strengthening in elite cricketers by floor exercise.

There will be significant different in endurance test variable followed by core muscle strengthening in elite cricketers by swiss ball vs floor exercise.

1. Dr.Rafael Escamilla (2010) Journal of orthopaedic & sports physical therapy.

To test the ability of 8 swiss ball exercises and 2 traditional abdominal exercises on activating core musculature. A convenience sample of 18 subjects performed 5 repetations for each exercises. The roll-out and pike were the most effective exercises in activating upper and lower rectus abdominus, external & internal obliques & lattismus dorsi muscles, while minimizing lumbar paraspinals & rectus femoris activity.

2. Kwang –Jun kim (2010) international journal of applied sports science.

The purpose of this study is to investigate the effect of 12 weeks combined training in core muscle strengthening on the flexibility, muscular strength & drive shot performance of the core body parts of the female professional golfers.

3. Robert MF, Van soest AJ (1994), medicine & science in sports & exercises.

In this study the effect of systemic manipulation of control & muscle strength on vertical jump height were investigated. After the core muscle strengthening the experiments were made. And the results was satisfactory & the improvement is achieved in jumping.

4. Sato, Kimitake (2009), the journal of strength & conditioning research.

This study was 6 weeks training study completed during a marathon training period. 28 recreational & competitive rare foot-strike runner (10 men, 18 women) initially qualified. Result is that CST significantly improved running times in the CST group during 6 weeks.

5. Okada, Tomoko, Huxel (2011), the journal of strength & conditioning research.

28 healthy men & women were tested. There were significant correlation between core stability & performance tests. These variables accounted for 86% of the variability in total performance.

6. Lisa.S.Bliss, Petu Teeple(2005), current sports medicine reports.

The centre piece of training programme, core strengthening & stability exercise have become key components of training programs for athletes of all levels. A training program should start with exercises that isolate specific core muscles but must progress to include complex movements & incorporate other training principles.

7. Robert Stanton, Peter R.B, Brendon Humphries (2004) journal of strength & conditioning research.

The purpose of this study was to investigate the effect of short term swiss ball training on core stability & running economy. 18 young male athletes were divided into a control & experimental groups. The result appears swiss ball training may positively affect core stability without concomitant improvements in physical performance in young atheletes.

8. Seong Gil Kim, Sang Su Na, PT, PhD (2014) Department of physical therapy, college og rehabilitation science, kyeongbuk, Korea.

This study was conducted to investigate the effects of trunk stabilization exercises on core muscle activities. The results show that there were significant increases swiss ball activities of the core muscles. That is, core muscles such as rectus abdominis, erector spinae, quadratus lumborum, external oblique & gluteus medius were more activated after performing the trunk stabilization exercise programme.

9. Jerrold S. Petrofsky, PhD, Jennifer Batt, BS (2007) Department of physiotherapy, Loma Linda University, California.

Ten subjects were examined to muscle use that occurred during core body exercise using 7 inch diameter mini stability ball. This form of exercise concentrates on the abdominal & lower back

muscles. The advantage of this form of exercise is that it can reduce low back pain & reduce back injury by allowing proper alignment of the spinal column.

10. Marshall PW, Murphy BA (2004), American congress of rehabilitation medicine & the American academy of physical medicine & rehabilitation.

To assess lumbo pelvic muscle activity during different core stability exercises on & off a swiss ball. Subjects performed 4 exercises on & off a swiss-ball; inclined press up & upper body roll out, single leg hold & quadripod exercises. Although there was evidence to suggest that swiss ball provide a training stimulus for the rectus abdominus.

MATERIALS REQUIRED :

Swiss ball.

Towel

Pillows

Blankets

Couch

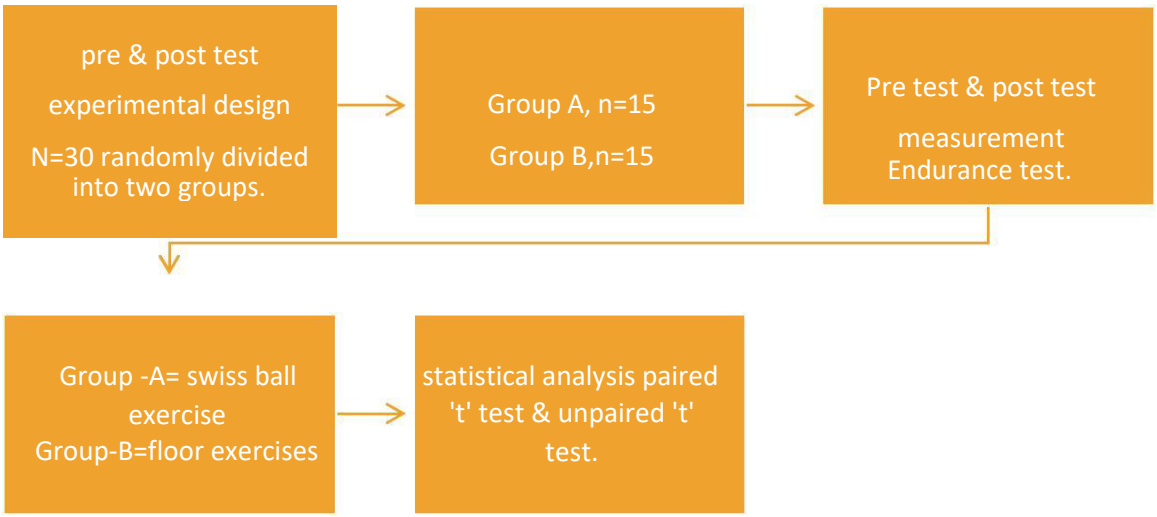
Stopwatch

Note pad

Pen

Pencil

METHODOLOGY:



3.1 STUDY DESIGN

Pre-test Post-test Experimental Design.

3.2 STUDY SETTING

This study was conducted in cherran's institute of health and science college

3.3 SELECTION OF SUBJECTS.

15 subjects aged between 16 to 25 years who fulfilled inclusion and exclusion criteria were selected by purposive sampling method and randomly assigned.

3.4 DURATION OF THE STUDY

The studies duration is 6 weeks.

3.5CRITERIA FOR SELECTION OF SUBJECTS

Inclusion criteria.

- Only male were included for this study.
- The subject belong the age group between16 to 25.

Exclusion criteria

- Musculoskeletal injured athletics.
- Neurological disorder.
- Neuromuscular disorder athletics.
- Limb length difference subjects.
- Recent surgery in lower limb.
- Female subject were excluded.

3.6 VARIABLES

Dependent variables.

Endurance test

Independent variables.

Swiss ball, floor exercises on core muscle strength.

3.7 MEASUREMENT TOOLS:

Endurance test:

The trunk flexor test began with the participant in the sit-up position with their trunk supported at 60 of trunk flexion.

Knees and hips were flexed at 90, arms crossed over chest, and feet secured. The support of the trunk was then removed, and the participant held the position for as long as possible.

The test was terminated when the participant was no longer able to hold the position.

TREATMENT PROCEDURE:

The treatment of core muscle strengthening under the 2 categories, they are

Floor Execises.

Swiss ball execises.

FLOOR EXECISES:

Static Leg and Back

- Lie on your back with your knees bent and your feet flat on the floor.
- Lift your pelvis so that you form a bridge position with a straight line running from your shoulders to your knees

- Lift your right leg off the floor and extend it so that it continues the straight line. You should be able to feel your left buttock, your back, and lower abdomen working to keep the position.
- Hold for 30 seconds then repeat on the other leg.

Plank

- Lie on your stomach. Raise yourself up so that you are resting on your forearms and your knees. Align your head &neck with your back & place your shoulders directly above your elbows. Tighten your abdominal muscles.
- Create resistance by pressing your elbows & your knees toward one another. Neither should move from their positions on the floor. Hold for three deep breaths.
- Return to the start position & repeat.

Segmental rotation

- Lie on your back with your knees bent & your back in a neutral position. Tighten your abdominal muscles.
- Keeping your shoulders on the floor, let your knees falls slowly to the left. Go only as far as is comfortable.
- You should feel a stretch, but not pain. Hold for three deep breaths.
- Return to the start position. Repeat the exercise to the right.

Abdominal crunch

- Lie on your back & place your feet on a wall, so that your knees & hips are bent at 90 degree angles. Tighten your abdominal muscles
- Raise your head & shoulder off the floor. To avoid straining your neck, cross your arms on your chest rather than locking them behind your head. Hold for three deep breaths.
- Return to the start position & repeat

Side plank

- Lie on your left side, raising yourself onto your left forearm. Place your left shoulder directly above your left elbow, keeping your shoulders, hips & knees in alignment. Rest your right arm along the side of your body.
- Tighten your abdominal muscles. Hold for three deep breaths. Repeat on your right side.
- For added challenge, balance on your left hand. Raise your hips off the floor & extend your right hand toward the ceiling. hold for three deep breaths. Repeat on your right side.

SWISS BALL:

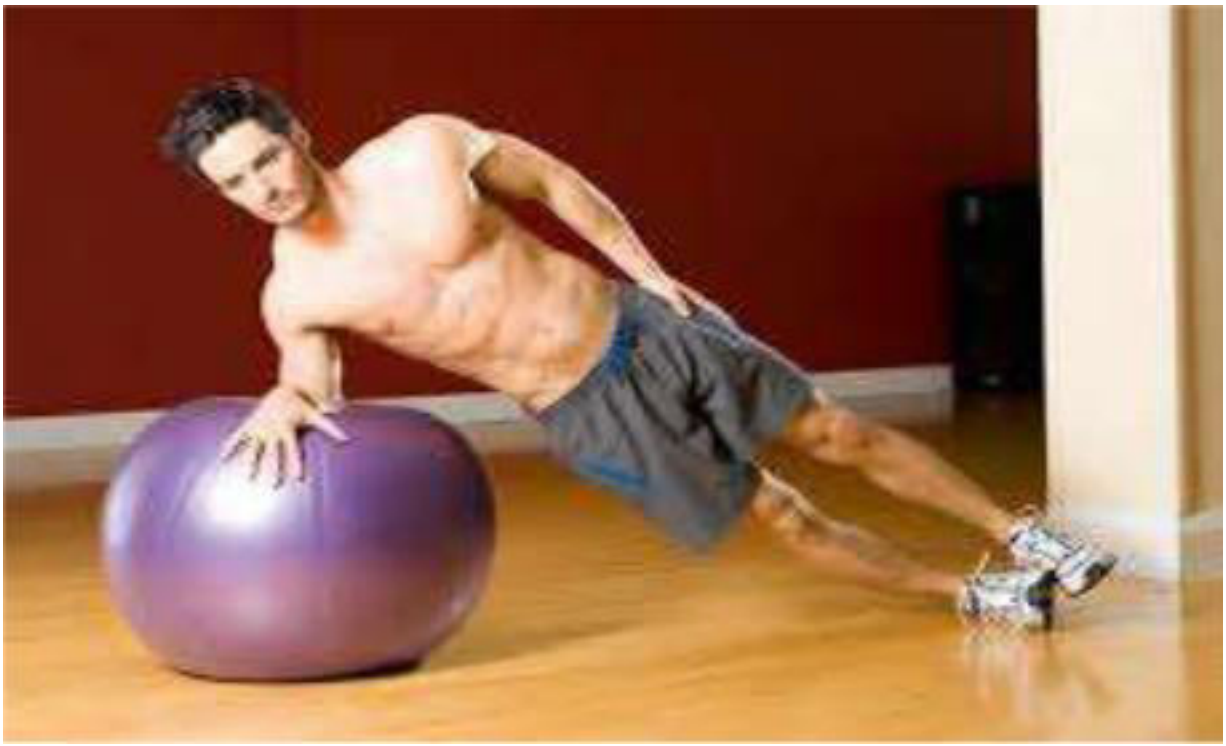
Plank

- Lie on the ball on your stomach, with your feet touching the floor behind the ball. lean forward until you touch the floor with your hands.
- Walks your hands away from the ball until you feel ball reach your upper thighs, as shown.
- Keep your feet suspended above the floor while you balance on your hands & on the ball. Keep you shoulders directly above your hands.
- Tighten your abdominal muscles hold for three deep breaths or as long as you can maintain your balance & form.
- Return to the start position & repeat.

Abdominal crunch

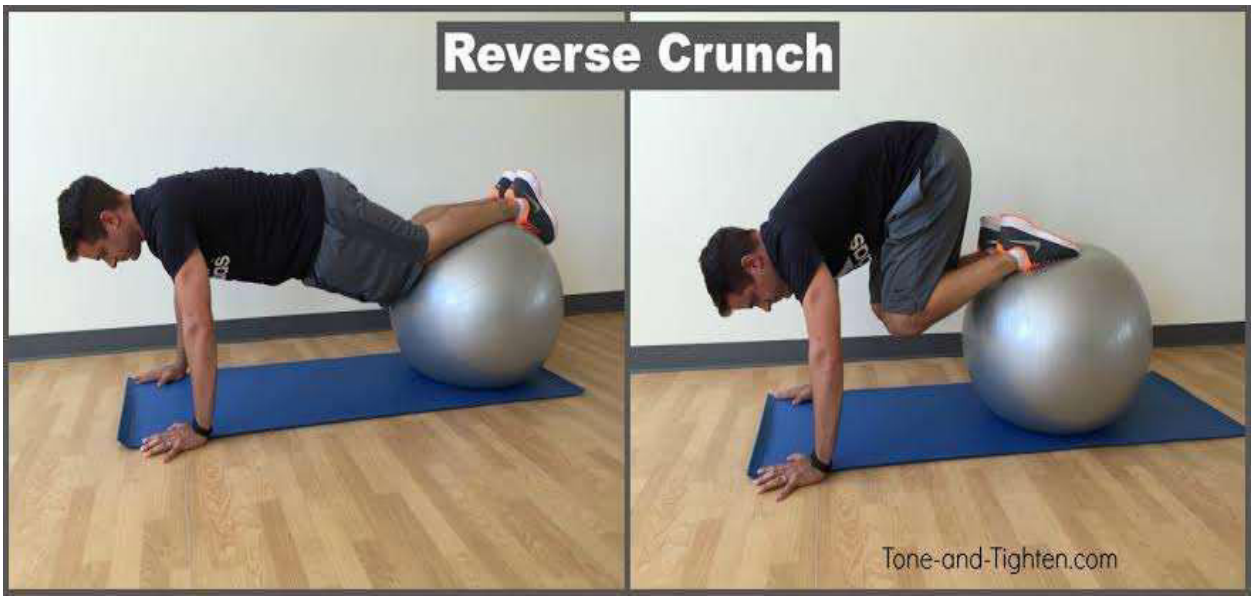
- Sit on the ball with your feet resting on the floor, about hip-width apart. Keep your back straight. Cross your arms on your chest.
- Tighten your abdominal muscles.
- Lean back, ass shown, until you feel the muscles in your midsection tighten. Hold for three deep breaths.
- Return to the start position & repeat.

Side exercise



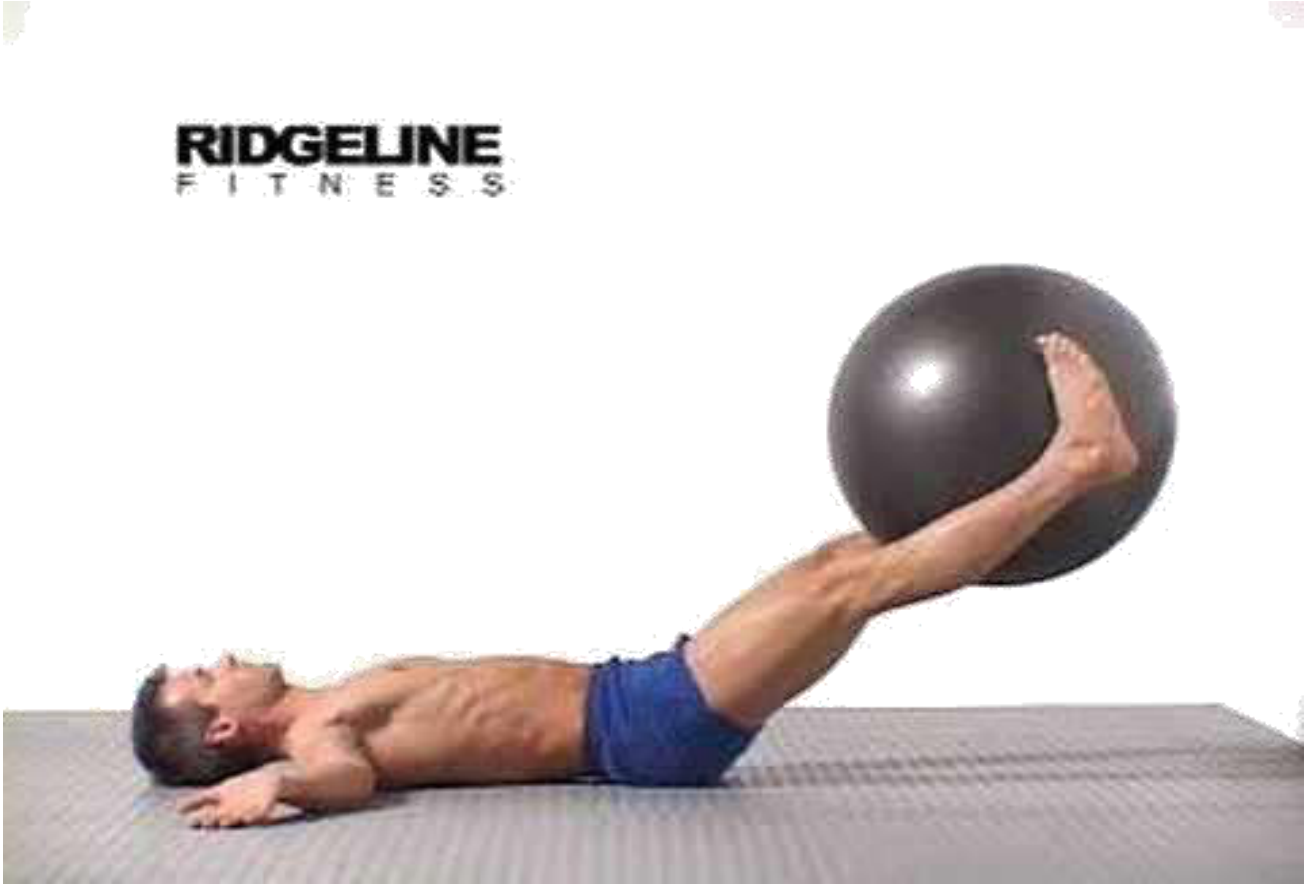
- Lie on your right side, with the ball between your legs. Support yourself with your arm along the floor.
- Tighten your abdominal muscles.
- Keeping the ball between your legs, raise your legs off the floor, as shown. Hold for three deep breaths.
- Return to the start position & repeat. Also try the exercise lying on your left side.

Reverse crunch



- Lie on the ball on your stomach, with your feet touching the floor behind the ball. Lean forward until you touch the floor with your hands.
- Walk your hands away from the ball until you feel the ball reach your upper thighs. Keep your shoulders directly above your hands.
- Tighten your abdominal muscles.
- Press your knees into the ball, as shown. Then use your abdominal muscles to bring your knees toward your chest. Hold for three deep breaths.
- Return to the start position & repeat.

Abdominal ball raise



- Lie on your back & rest your legs on top of the ball with your legs about hip-width apart. Tighten your abdominal muscles & squeeze your legs together.
- Raise the ball off the floor, as shown. To protect your lower back, focus on pulling your bellybutton in toward your spine & keeping your abdominal muscles contracted. Hold for three deep breaths.
- Return to the start position & repeat`
- For added challenge, raise the ball off the floor & let your legs slowly fall to the right. Stop before you reach the floor .
- Hold for three deep breaths, keeping your shoulders on the floor. Return to the start position & repeat on the left side.

Data Analysis and Interpretation

The improvement was calculated by using the endurance test as pre-test and post- test taken before and after treatment. The data obtained are analyzed using paired t-test.

MEAN

STANDARD DEVIATION

PAIRED "t" TEST:

Where,

d – Difference between pre-test and post-test values

= Σ Mean of difference between pre test and post test values

n – Total number of subjects

SD – Standard deviation

UNPAIRED "t" TEST

The unpaired t -test was used to compare the statistical significant difference between group A and group B

FORMULA

$$s = \sqrt{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2 \frac{1}{n_1} + \frac{1}{n_2 - 2}}$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

n_1 = total number of subject in group A.

n_2 = total number of subject in group B.

s_1 = difference between pre-test & post-test values of group A.

s_2 =difference between pre-test & post-test values of group B.

$\bar{x}_1$ = mean difference between pre-test & post-test value of group A

$\bar{x}_2$ = mean difference between pre-test & post-test value of group B.

TABLE .1Comparison of pre-test and post-test values of endurance test for cricketers in **group A (swiss ball).**

Group	Measurements	Mean	Mean difference	Standard deviation	Paired 't' test
A	Pre test	20	2.2	0.6985	12.18
	Post test	53			

The above table shows that out of 15 samples, pre & post-test mean, mean difference, standard-deviation ,'t' value of endurance test of cricketers.

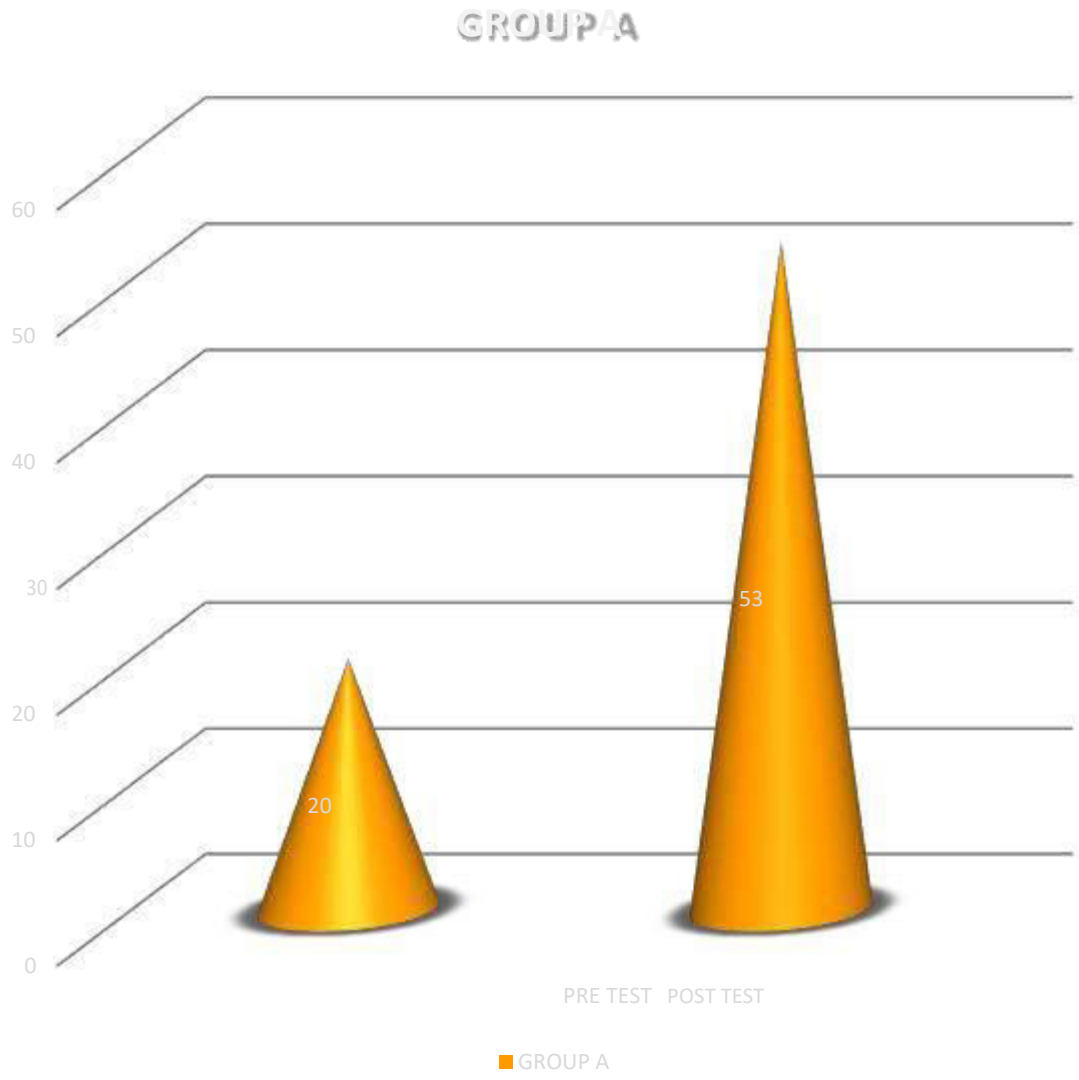

GROUP A
60
50
40
30
20
10
0
20
53
PRE TEST
POST TEST
GROUP A

TABLE .2 Comparison of pre-test and post-test values of endurance test for cricketers in **group B (floor exercise).**

Group	Measurements	Mean	Mean difference	Standard deviation	Paired 't' test
B	Pre test	19	1.2	0.4140	11.22
	Post test	37			

The above table shows that out of 15 samples, pre & post-test mean, mean difference, standard-deviation ,'t' value of endurance test of cricketers.

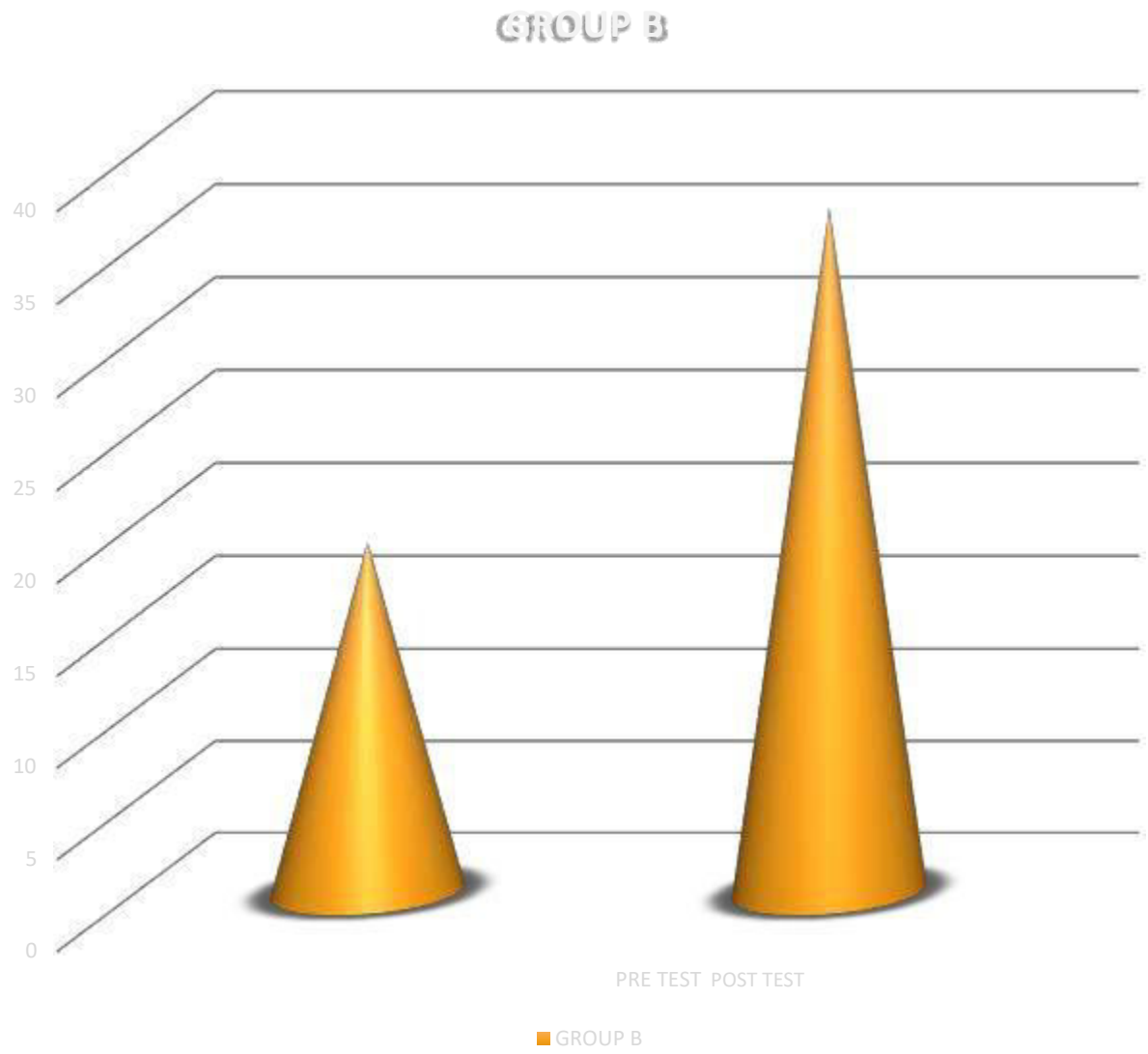
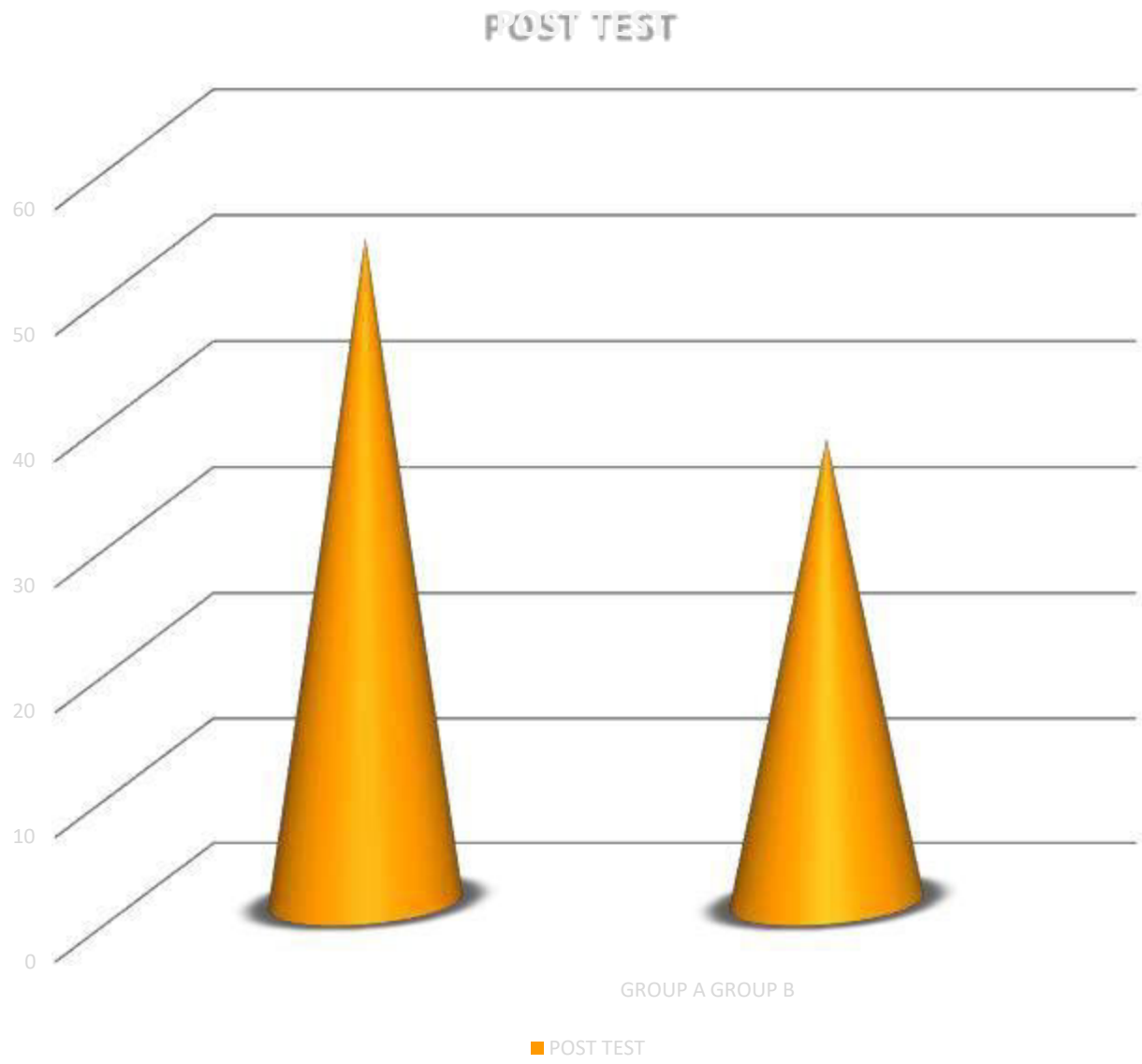

GROUP B
40
35
30
25
20
15
10
5
0
PRE TEST
POST TEST
GROUP B

TABLE.3 Comparison of post-test result of endurance test for cricketers of GROUP A & B.

Groups	Mean	Mean difference	Standard deviation	Unpaired t test	Table t value to 0.025
A	53	16	0.5735	2.036	2.145
B	37				

The table shows that statistically difference in post-test values of endurance test of cricketers. ($p<0.025$).


POST TEST
60
50
40
30
20
10
0
GROUP A
GROUP B
POST TEST

RESULT:

After a 6 week protocol period, the subjects in floor exercise group and swiss ball group had shown improvement with the outcome measures. But on comparing both the groups, swiss ball group had shown a statistically significant improvement at 0.025 level with the outcome measures. On performing the paired sample t-test, it is observed that there is a statistical significance (2.036< 0.025) is existing between floor exercise and swiss ball group with respect to spinal flexor muscle strength. And also it is noticed that the swiss ball group was found to be better with greater mean. Thus the null hypothesis is rejected and alternate hypothesis is accepted.

DISCUSSION:

The present study is carried out to find the effectiveness of floor exercises and swiss ball exercises on core muscle strength in elite cricketers. The total number of subjects were 30, 15 subjects were allotted into floor exercise group and 15 subjects were allotted into swiss ball group. The protocol was given for 6 weeks.

According to the data analysis, a significant difference was found between the pre and post-test values of endurance test in floor exercise group(11.22<0.025). There is a significant difference between pre and post values of endurance test in swiss ball group(12.18<0.025).

The results of the present study shows that subjects in swiss ball group shows a significant improvement in core muscles strength, i.e., there is an improvement in the endurance test. where compared to floor exercise group in elite cricketers. Core stability is an important factor in all sports persons especially in cricketers to prevent the risk of injuries. However, the evidence about the effects of core stability exercises using swiss ball and floor exercises in cricketers has limited studies. Our results show that an exercise programme on swiss ball of 6 weeks duration improves strength of the core muscles and finally decreases the risk of injuries in elite cricketers in both groups but compared to the floor exercise group, more significant changes seen in swiss ball group. The technique behind the swiss ball training is to concentrate and shift the weight to maintain stability on the ball, which will not occur in traditional weight training exercises. Postural control during balancing on a swiss ball consists of adapting the motor program to maintain stability, while

the overall postural strategy is maintained. Swiss ball training improves nervous system function that results in functional strength gain.

The benefits of performing resistance exercises on unstable equipment originated from research on muscle activation and methods of preventing or rehabilitating low back, knee and ankle injuries. Even though the movement patterns on the swiss ball and floor exercises group may look similar, the underlying neural adaptations such as the increase in nervous system activation, more efficient neuromuscular recruitment patterns, improved synchronization of motor units, lowering of neural inhibitory reflexes and proprioceptive feedback may be completely different.

This study showed that both the groups showed significant results but however on comparing swiss ball group showed significant improvement of core muscle strength than floor exercise group. A similar studies abdominal muscles response during curl ups on stable. They showed that greater muscle activation and co-contraction of trunk flexor and extensor muscles were elicited if the curl up exercise was performed on the swiss ball.

CONCLUSION:

The present study was done to find out the effectiveness of floor exercises versus swiss ball exercises by improving the core muscle strength in elite cricketers. For this, 30 subjects were taken & divided in to two groups; floor exercise group received floor exercises and swiss ball group received swiss ball exercises. All the samples were assessed initially for base line values and after six weeks of intervention, the outcome measures were assessed. On comparing the mean differences in both the groups, swiss ball group had shown significant improvement in mean values of outcome measures than the floor exercise group after the intervention. Hence the present study conducted revealed that there is improvement in spinal muscle strength in elite cricketers, there by core training on swiss ball can be selected as the treatment of choice for the physiotherapist to effectively improve spinal muscle strength in elite cricketers.

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CONSENT FORM

I have been informed about the procedures and the purpose of the study. I have under stood that I have the right to refuse my consent or withdraw it any time during the study without adversely affecting my treatment. I am aware that being subject to this study I will have to give my more time for assessments and treatment and these assessments do not interfere with the benefits.

I ---------- under signed & give my consent to be a participant to this investigation/study program/clinical trial.

Signature of subject

Signature of investigator

Date----------

ASSESSMENT CHART

Physical therapy assessment chart

SUBJECTIVE:

Name :

Age :

Gender :

Occupation :

Chief complaints :

Medical history :

Present medical history :

Past medical history :

Family history :

Social history :

Associated problems :

OBJECTIVE:

On observation

Body built :

Posture :

attitude of limbs :

muscle wasting :

edema :

involuntary movements :

gait :

deformity :

On palpation

Tenderness :

Swelling :

Muscle tightness :

Spasm :

Other if any :

On examination

Pain assessment

Onset :

Side :

Site :

Duration :

Type :

Aggrevating factors :

Relieving factors :

Range of motion

Active ROM

Passive ROM

Posture assessment :

Capsular pattern :

Muscle power assessment :

Gait assessment :

Functional assessment :

Investigation

Special test

Clinical impression

Differential diagnosis

Final diagnosis

Problem list

Treatment plan

Swiss ball exercise.

Floor exercise.

Home programme

TABLE 1. Pre and post treatment mean values of endurance test of elite cricketers GROUP:A (SWISS BALL).

SI.NO	PRE-TEST	POST-TEST	D	$(d-\bar{})^2$
1)	2	3	1	1.44
2)	1	4	3	0.64
3)	1	4	3	0.64
4)	1	3	2	0.04
5)	2	4	2	0.04
6)	1	3	2	0.04
7)	1	4	3	0.64
8)	2	4	2	0.04
9)	1	3	2	0.04
10)	1	4	3	0.64
11)	2	4	2	0.04
12)	1	3	2	0.04
13)	2	3	1	1.44
14)	1	4	3	0.64
15)	1	3	2	0.44
TOTAL			$\Sigma = 33$	$\Sigma(-)^2 = 6.84$

$\bar{} = \Sigma$ ⟶ **33/15 = 2.2**

S.D $= \sqrt{\quad}$ ⟶ S.D =0.6985

t = ⟶ t = 12.18

TABLE 2. Pre and post treatment mean values of endurance test of elite cricketers GROUP: B (FLOOR EXERCISE)

SI.NO	PRE-TEST	POST-TEST	D	$(d-\bar{d})^2$
1)	1	2	1	0.04
2)	2	3	1	0.04
3)	1	2	1	0.04
4)	1	3	2	0.64
5)	1	2	1	0.04
6)	2	3	1	0.04
7)	1	2	1	0.04
8)	2	3	1	0.04
9)	1	2	1	0.04
10)	1	2	1	0.04
11)	1	3	2	0.64
12)	2	3	1	0.04
13)	1	2	1	0.04
14)	1	2	1	0.04
15)	1	3	2	0.64
TOTAL			Σ =18	$\Sigma(d-\bar{d})^2$ = 2.4

$\bar{d} = \Sigma$ ⟶ **18/15 = 1.2**

S.D=$\sqrt{\Sigma(d-\bar{d})^2/n-1}$ ⟶ S.D =0.4140

t = ⟶ t = 11.22