

# Innovations

## “Impact of Stable Versus Unstable Surface Exercise Training on Strengthening Core Muscles in Healthy Individuals”- A Study Protocol

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### Abstract

**Background:** Core muscle strengthening positively alters body's stability which in turn improves neuromuscular summations thereby lessening back and lower body pain, is also demanded in many sports and daily tasks. It is a crucial requirement. The complex of core muscles is made up of many muscles. For normal healthy individual, core strength training is a practical and safe training method that significantly improves health and skill-related aspects of physical fitness. An imbalance or weakness in the core muscles can lead to increased fatigue, a decreased ability to sustain sports injuries, and an increased risk of injury. For overall musculoskeletal health, rehabilitation, and performance enhancement, instability resistance training, or IRT, is widely used. Numerous equipments make an effort to create an unstable surface. Literature partially advises to perform strength training on unstable surfaces as opposed to stable ones. Thus the need of this study arises to see the impact of core strengthening exercises using stable and unstable surfaces in normal healthy individuals. **Methodology:** Participants from constituent colleges of Sumandeep Vidyapeeth will be approached and explained about the study. Those who meet the inclusion criteria and are willing to participate in the study will be requested to fill the informed consent form. Those participants who fall under the exclusion criteria will be excluded from the study. Participants will be randomly allocated to either to the Interventional group or the control group with the use of simple randomization. Once the assessment is completed the patient will be treated as per the treatment protocol devised for the Interventional group or control group respectively. Subjects in both the groups (Interventional group and control group) will receive 4 week treatment with a frequency 3days intervention/ week. Both primary and secondary outcome measures will be taken as per the schedule. **Outcome Measures:** Primary Outcome: Core muscle Strength assessment by pressure biofeedback, and Secondary Outcome: Core muscle Strength assessment by Plank Test **Statistical Analysis:** Descriptive statistics will be done by taking help of a Biostatistician. The latest version of SPSS software available with the Biostatistician will be used for doing the statistical analysis. **Conclusion:** This RCT study protocol will see the impact of core strengthening exercises using stable and unstable surface in improving core muscle strength in normal healthy individuals, the results will help in the decision making of the strength training protocols. **Clinical Trial Registration:** The study is registered with Clinical Trials Registry- India (CTRI), with the registration number for the trial being CTRI/2023/06/053533.

**Keywords:** Core muscle, strengthening, stable surface, unstable surface, normal healthy individuals.

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### Introduction

By strengthening the core muscles, body's stability improves neuromuscular summations which in turn lessens back and lower body pain thereby shield the lower limb from injury. <sup>1</sup> Core muscle strength is also demanded in many sports (such as track, field, climbing, etc.) and daily tasks (such as sitting, standing, and walking straight ahead), core muscle strength is a crucial requirement <sup>2, 3</sup> In terms of

function, the core can be understood as the kinetic link that makes it easier for the lower and upper extremities to transfer torques and angular momentum, which is crucial for daily activities and sport-specific activities across a range of age groups.<sup>3</sup>

The complex of core muscles is made up of many muscles.<sup>4</sup> On anatomical background, the diaphragm serves as the roof of a muscular box, containing the pelvic floor and hip girdle musculature at the bottom, the Para-spinals and glutes in the back, and the abdominals in the front.<sup>2</sup> In terms of function, the core can be viewed as the kinetic link that makes it easier for the lower and upper extremities to transfer torques and angular momentum, which is essential for both daily activities and sport-specific movements across a range of age groups. In reality, among young, healthy individuals, data from a cross-sectional study show strong connections between measures of core muscular strength, sprint, throw, and jump performance.<sup>2,5,6</sup>

For young people in good health, both male and female, core strength training is a practical and safe training method that significantly improves health and skill-related aspects of physical fitness.<sup>2</sup> The effects of a 6-week core conditioning program were examined by the authors in school-aged, healthy, untrained children. Consequently, the authors observed notable improvements in several tests of trunk muscle endurance.<sup>2,7</sup>

For overall musculoskeletal health, rehabilitation, and performance enhancement, instability resistance training, or IRT, is widely used. It may entail unstable circumstances with the body's weight or external resistance (such as dumbbells or barbells).<sup>8</sup> In order to simulate the demands of the various tasks in applied settings, devices with varied degrees of instability are widely used for musculoskeletal health, balance promotion, and athletic and daily performance enhancement.<sup>9</sup> Numerous gadgets make an effort to create an unstable surface. Inflatable discs, wobble or balance boards, foam tubes, high- and low-density foam platforms, air pressurized balls (like the Swiss, physio, or exercise balls), hemispherical balls with an inflated dome side and a hard rubber flat side (like the BOSU® ball), and many other related devices are among these.<sup>9</sup>

Training needs to replicate the demands of the task or activity as closely as possible, in accordance with the principle of training specificity.<sup>9</sup> Activities involving sports and fitness, work-related tasks, and daily living frequently take place on surfaces that are somewhat unstable (e.g. walking, skiing, skating, working in icy or muddy conditions and snowboarding).<sup>9</sup> Uneven resistances cause the body to twist unpredictably, which exacerbates instability issues.<sup>8</sup> Based on the principle of training specificity, unilateral exercises might be more advantageous than bilateral exercises because most activities in daily life, work, and sports are unilateral.<sup>8,10,11</sup>

An imbalance or weakness in the core muscles can lead to increased fatigue, a decreased ability to sustain sports injuries, and an increased risk of injury.<sup>12</sup> Running is a dynamic, repetitive activity that may lead to deep core muscle dysfunction. This dysfunction can cause compensatory movement patterns, improper spinal loading, poor muscle coordination, tension in the muscles, or even damage to the spinal structures.<sup>13</sup> Studies have also shown that the body oscillates more when the core muscles weaken, which may lead to an imbalance.<sup>14</sup>

A systematic review by Behm DG et. al.<sup>9</sup> showed that in healthy adolescents and young adults, the application of strength training on unstable surface (STU) in comparison to strength training on stable surface (STS) has minimal additional effects on measures of muscle strength, power, and balance. Thus, it is only partially advised to perform strength training on unstable surfaces as opposed to stable ones. Thus this trial is done to see the effect of core training exercise using unstable surface to that on the stable surface in normal healthy individuals.

**Objectives of the study** are to:

- To measure the strength of core muscle by Pressure Biofeedback.
- To measure the strength of core muscle by Plank Test.

## **Hypothesis:**

### **Null Hypothesis**

There will be no statistical significant effect of core muscle strengthening exercise using stable versus unstable surface on normal healthy individual.

### **Alternative Hypothesis**

There will be statistical significant effect of core muscle strengthening exercise using stable versus unstable surface on normal healthy individual.

### **Ethical Approval:**

All the procedures that will be involved in this study had been taken approval from the Sumandeep Vidyapeeth Institutional Ethics Committee. The approval received from the Sumandeep Vidyapeeth Institutional Ethics Committee had the outward number, SVIEC/ON/Phys/BNMPT22/April/23/22 dated on 27/04/2023.

### **Clinical Trial Registration:**

The study is registered with Clinical Trials Registry- India (CTRI), with the registration number for the trial being CTRI/2023/06/053533.

### **Sample size calculation:**

Group sample sizes of 30 and 30 achieve 80% power to detect a difference of 6.00 between the null hypothesis that both group means are 9.2 and the alternative hypothesis that the mean of group 2 is 15.2 with group standard deviations of 11.7 and with a significance level (alpha) of 0.050 using a two-sided two-sample t-test.

The following formula had been used to calculate the sample size:

$$n = \frac{2 * (z_{\alpha/2} + Z_{1 - \beta})^2}{m_1 - m_2 / \sigma}$$

$$m_1 - m_2 / \sigma$$

Where,

$$Z_{\alpha/2} = 1.96$$

$$Z_{1 - \beta} = 0.84$$

$$M_1 = \text{mean of group 1} = 9.2$$

$$M_2 = \text{mean of group 2} = 15.2$$

$$\sigma = \text{standard deviation} = 11.7$$

Thus the final sample size is 60 so per group sample size is 30.

### **Method:**

Participants from constituent colleges of Sumandeep Vidyapeeth will be approached and explained about the study. Interested participants will be screened as per the routine musculoskeletal assessment. Participants who meet the inclusion criteria will be requested to fill the informed consent form. Those participants who fall under the exclusion criteria will be excluded from the study. Participant information sheet which describes in detail about subject participation during the study will be given to the participants. Participants will be randomly allocated to either to the Interventional group or the control group with the use of simple randomization as shown in flow chart 1. Once the initial enrolment process is completed the subjects will be treated as per the treatment protocol devised for the Interventional group or control group respectively. Subjects in both the groups (Interventional group and control group) will receive 4 week treatment with a frequency of 3 days intervention/ week. Treatment details are given in table 1. Both primary and secondary outcome measures will be taken as per the schedule shown in table 1.

### **Randomization:**

This study is a single blinded randomized controlled trial, where the subjects will not be able to know in which group they are going to get allotted. The allocator and the assessor are not blinded during the study. In this study, subjects will be divided randomly using simple randomization technique i.e. toss of coin method was employed in which it was decided that if head came than odd number subjects will go in the Interventional group & if tail came than odd number subjects will go to the control group. Flip of coin was done by the allocator and tail came so all the even number subjects getting enrolled during the study will go to the Interventional group and all the odd number subjects getting enrolled during the study will go to the Control group.

### **Inclusion Criteria**

- Healthy individuals
- Age 18 to 40 years
- Both genders
- No history of musculoskeletal disorders
- No history of neurological condition
- Patient is able Read and write English, Gujarati, Hindi

### **Exclusion Criteria**

- Low Back Pain
- Pregnancy
- Recent Spinal Surgery

### **Procedure**

All the subjects in the Interventional group and the Control group needs to go through the common step 1 and step 2 for assessing the strength of core muscles using pressure biofeedback method and through the Plank test method which are as follows:

#### **Step 1: To check core muscle strength by use of pressure biofeedback**

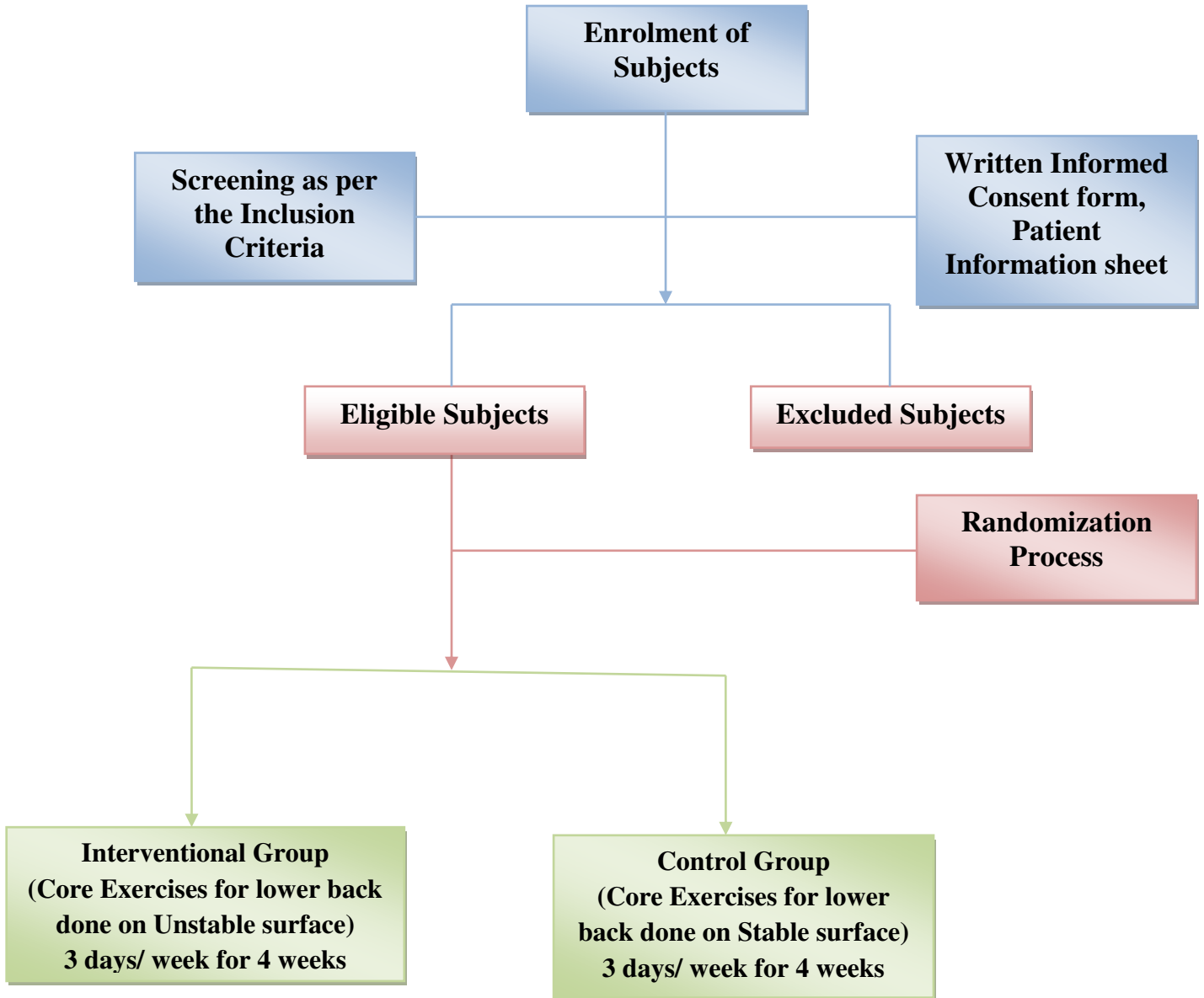
Subject position will be in prone lying with arm 90/90, head turned to one side & feet hanging off the end of the table.

Placement of biofeedback unit: horizontal under the abdomen with the lower edge just below the ASIS.

Then inflate the cuff to 70 mm Hg and instruct the subject to perform drawing -in maneuver.

Subject will perform the process properly if the pressure drops by 6 to 10 mm Hg in 10 secs.

Fig 1: Flowchart describes the overall design of trial



**Table 1: shows the schedule of enrolment, interventions and assessments in accordance with the Standard Protocol Items: Recommendation for Interventional Trials (SPIRIT)**

Time Point	Study Period							
		Enrolment & Allocation	1 <sup>st</sup> day of 1 <sup>st</sup> Week	1 <sup>st</sup> Week (3 days)	2 <sup>nd</sup> Week (3 days)	3 <sup>rd</sup> Week (3 days)	4 <sup>th</sup> Week (3 days)	3 <sup>rd</sup> day of 4 <sup>th</sup> Week
Enrolment	Eligibility Screening	×						
	Informed Consent	×						
	Patient Information zSheet	×						
Intervention	Core Exercises using Stable Surface			×	×	×	×	
	Core Exercises using Unstable Surface			×	×	×	×	
Assessments	Baseline		×					×
	Core muscle Strength assessed by pressure biofeedback		×					×
	Core muscle Strength assessed by Plank Test		×					×

**Table 2: shows the treatment received by the subjects in the Interventional group and the Control group**

Group	Treatment for 3 days for 1 <sup>st</sup> week (Sets/ Repetition (Reps) /Time)	Treatment for 3 days for 2 <sup>nd</sup> week (Sets/ Repetition (Reps) /Time)	Treatment for 3 days for 3 <sup>rd</sup> week (Sets/ Repetition (Reps) /Time)	Treatment for 3 days for 4 <sup>th</sup> week (Sets/ Repetition (Reps) /Time)
<b>Interventional Group</b>	<b>Exercises performed on Unstable Surface</b>			
	<b>Bridging</b> (1set with no hold for 10 Reps)	<b>Bridging</b> (1set with 5 sec hold for 10 Reps)	<b>Bridging</b> (1set with 7 sec hold for 10 Reps)	<b>Bridging</b> (1set with 10 sec hold for 10 Reps)
	<b>Curl ups</b> (1set with 3 sec hold for 10 Reps)	<b>Curl ups</b> (1set with 5 sec hold for 10 Reps)	<b>Curl ups</b> (1set with 7 sec hold for 10 Reps)	<b>Curl ups</b> (1set with 10 sec hold for 10 Reps)
	<b>Side Curl ups</b> (1set with 3 sec hold for 10 Reps)	<b>Side Curl ups</b> (1set with 5 sec hold for 10 Reps)	<b>Side Curl ups</b> (1set with 7 sec hold for 10 Reps)	<b>Side Curl ups</b> (1set with 10 sec hold for 10 Reps)
	<b>Plank</b> (1set with hold as per patient tolerance for 3 Reps)	<b>Plank</b> (1set with hold as per patient tolerance for 5 Reps)	<b>Plank</b> (1set with hold as per patient tolerance for 7 Reps)	<b>Plank</b> (1set with hold as per patient tolerance for 10 Reps)
	<b>Side Plank</b> (1set with hold as per patient tolerance for 3 Reps)	<b>Side Plank</b> (1set with hold as per patient tolerance for 5 Reps)	<b>Side Plank</b> (1set with hold as per patient tolerance for 7 Reps)	<b>Side Plank</b> (1set with hold as per patient tolerance for 10 Reps)
	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 10 Reps)	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 15 Reps)	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 20 Reps)	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 25 Reps)
<b>Control Group</b>	<b>Exercises performed on Stable Surface</b>			
	<b>Bridging</b> (1set with no hold for 10 Reps)	<b>Bridging</b> (1set with 5 sec hold for 10 Reps)	<b>Bridging</b> (1set with 7 sec hold for 10 Reps)	<b>Bridging</b> (1set with 10 sec hold for 10 Reps)
	<b>Curl ups</b> (1set with 3 sec hold for 10 Reps)	<b>Curl ups</b> (1set with 5 sec hold for 10 Reps)	<b>Curl ups</b> (1set with 7 sec hold for 10 Reps)	<b>Curl ups</b> (1set with 10 sec hold for 10 Reps)
	<b>Side Curl ups</b> (1set with 3 sec hold for 10 Reps)	<b>Side Curl ups</b> (1set with 5 sec hold for 10 Reps)	<b>Side Curl ups</b> (1set with 7 sec hold for 10 Reps)	<b>Side Curl ups</b> (1set with 10 sec hold for 10 Reps)
	<b>Plank</b> (1set with hold as per patient tolerance for 3 Reps)	<b>Plank</b> (1set with hold as per patient tolerance for 5 Reps)	<b>Plank</b> (1set with hold as per patient tolerance for 7 Reps)	<b>Plank</b> (1set with hold as per patient tolerance for 10 Reps)
	<b>Side Plank</b> (1set with hold as per patient tolerance for 3 Reps)	<b>Side Plank</b> (1set with hold as per patient tolerance for 5 Reps)	<b>Side Plank</b> (1set with hold as per patient tolerance for 7 Reps)	<b>Side Plank</b> (1set with hold as per patient tolerance for 10 Reps)
	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 10 Reps)	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 15 Reps)	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 20 Reps)	<b>Abdominal Contractions in Quadruped</b> (1set with no hold for 25 Reps)



**Step 2: In the Plank test**, participants maintain a prone posture in which the forearm bears the weight of the body while the hands make a fist. The elbows are placed shoulder distance apart with the ankle joint at 90° angulations. The abdominal drawing-in maneuver will be used to compress the abdomen; the shoulders, trunk, hips, and knees were held in a straight line with toes touching the ground.

While performing the plank test exercises, participants will be instructed to maintain a neutral pelvis and spine position and breathe regularly.

Reason to abort the test: The test will be stopped when the

- (1) Participant become fatigue or voluntarily stopped the test,
- (2) Participant refuses to hold the correct posture, or
- (3) Participant indicates adverse effects from the test (e.g., headache, dizziness, pain not associated with fatigue).

The step 3 for the both groups will be common except for the 20 minutes exercise protocol where Group 1 (Interventional group) will perform exercises on unstable surface (Physio ball) and Group 2 (Control group) participants will perform exercises on the stable surface (Yoga Mat). The details of the exercises along with different parameters that will be performed by the participants of this trial are given in the table 2.

### Step 3: Exercise

#### Exercise Protocol

Total Duration: 30 mins

5 Min Warm up

20 Min Protocol

5 Min Cool Down

Exercise will be given 3 Times in a week for 4 weeks.

**Few of the Exercises performed on Unstable Surface are as follows:**



Fig: 2 (a)



Fig 2 (b)



Fig 2 (c)

Fig 2 (a), (b) and (c) shows Plank, side plank and the Abdominal muscle contraction in quadrupedal position respectively on the unstable surface like physio ball.

**Few of the Exercises performed on Stable Surface are as follows:**



Fig 3 (a)



Fig 3 (b)



Fig 3 (c)

Fig 3 (a), (b) and (c) shows Plank, side plank and the Abdominal muscle contraction in quadrupedal position respectively on the stable surface like mat.



### **Outcome Measures**

Primary Outcome:

- Core muscle Strength assessed by pressure biofeedback (Reliability & Validity ICC-0.97) <sup>15</sup>

Secondary Outcome:

- Core muscle Strength assessed by Plank Test.( Reliability & Validity ICC-0.99) <sup>16</sup>

### **Data Management:**

A master chart file will be generated in Microsoft excel sheet, the data collected from the assessment of the outcome measures on day 1 of 1<sup>st</sup> week (pre) and on last day of 4<sup>th</sup> week (post) along with the baseline assessment of the subjects will be entered on daily basis for the number of subjects included for that particular day. Once the data collection will be completed, the fully filled master chart Microsoft excel sheet will be sent to the Biostatistician for the statistical analysis process.

### **Statistical Analysis:**

Descriptive statistics will be done by taking help of a Biostatistician. The latest version of IBM SPSS 25 for windows statistical software available with the Biostatistician will be used for doing the statistical analysis. Statistical analysis using a paired and unpaired t test will be used to see the difference in the means of the same group and in between two groups respectively. The quantitative analysis of the primary and the secondary outcomes will be done. For all statistical analyses, probability levels of  $p < 0.05$  will be considered as statistically significant.

### **Discussion:**

Exercises on unstable surfaces maintains similar or gives greater core and limb muscle activation as there is impaired movement velocity, force and power. Stable base and strong core are requirements to exert explosive power. <sup>8</sup> A moderate level of instability is involved when performing strength training exercises on stable surfaces (STS), such as Olympic lifts, dead lifts, and squats. Strength training on unstable surfaces (STU) or with unstable implements provides greater degrees of instability. <sup>9</sup> The neuromuscular system may be under more stress from unstable devices' greater instability than from STS, according to their proponents. <sup>9, 17, 18</sup> The reason behind this is that by offering a more varied and potent training stimulus, destabilizing training environments may improve neuromuscular adaptations and training specificity. <sup>9</sup>

Even though with this strong reasoning, the literature doesn't strongly support the strength training exercises on the unstable surfaces to be more statistically significant compared to the strength training exercises performed on the stable surface. This RCT study has proposed a rationale to see the impact of stable surface exercise training to that of unstable surface exercise training on core strengthening in normal healthy individuals.

### **Conclusion:**

This RCT study protocol will see the impact of core strengthening exercises using stable and unstable surface in improving core muscle strength in normal healthy individuals. The results of this study will be important in adding information to the available literature and thereby help in the decision making of the

strength training protocols.

### Conflicts of Interest:

The authors hereby state that we have no potential conflicts of interest to declare.

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