

# **EFFECT OF CORE STABILITY EXERCISES ON TRUNK MUSCLES' ENDURANCE AND DYNAMIC BALANCE IN HEALTHY ADULTS**

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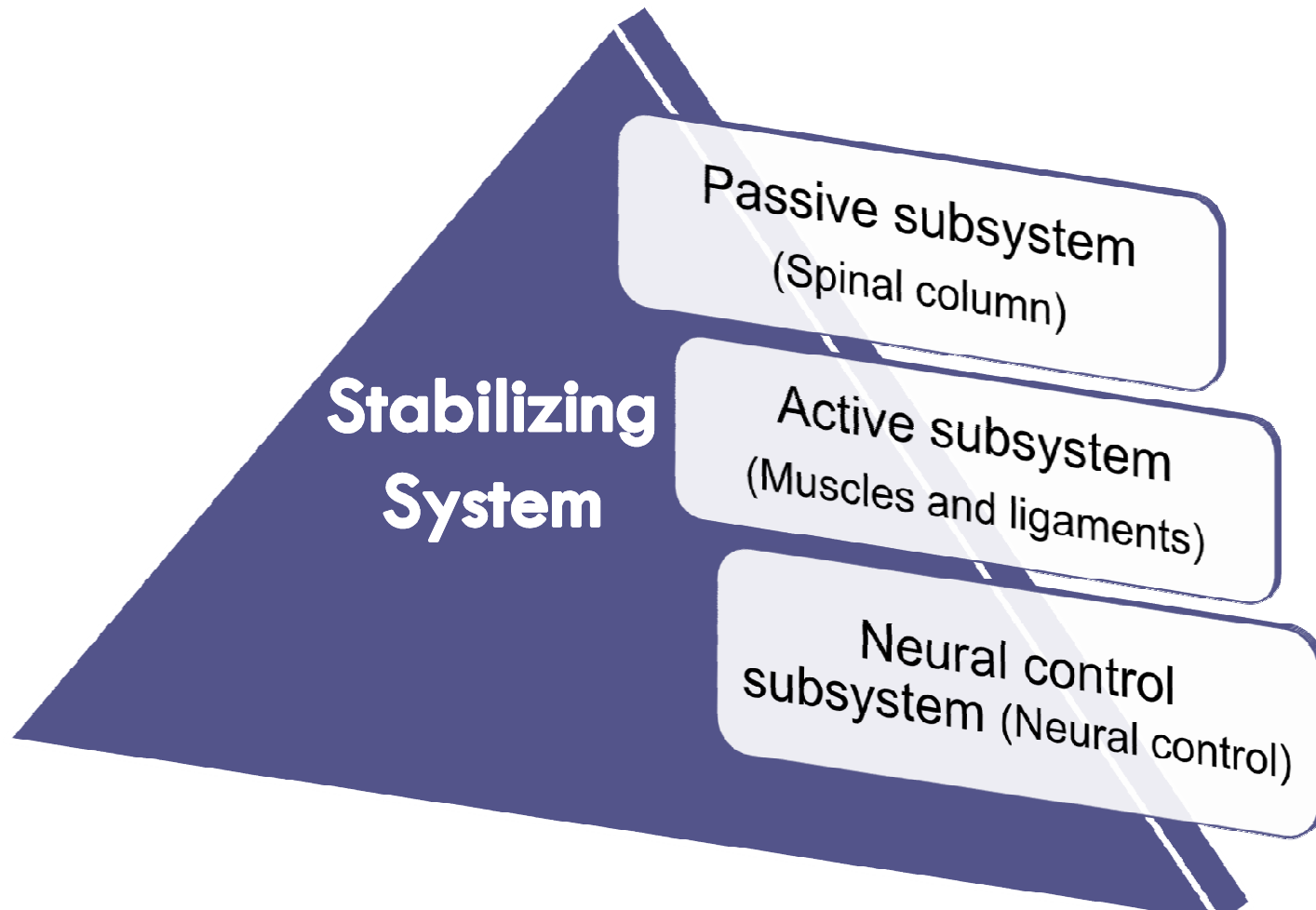
# INTRODUCTION



Many models of the spine consider stability in terms of the **ability** of the spine to withstand compressive forces and resist buckling.

# INTRODUCTION

Panjabi's model of spinal stability (1992):



# INTRODUCTION (cont)

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- The **major** source of spinal stability comes from the **second component** of Panjabi's model because the passively supported spine collapses under 90 N of load.
- This system must activate the correct muscles at the right time by the right amount to protect the spine from injury and also allow the desired movement (**Barr et al., 2005**).



# INTRODUCTION (cont)

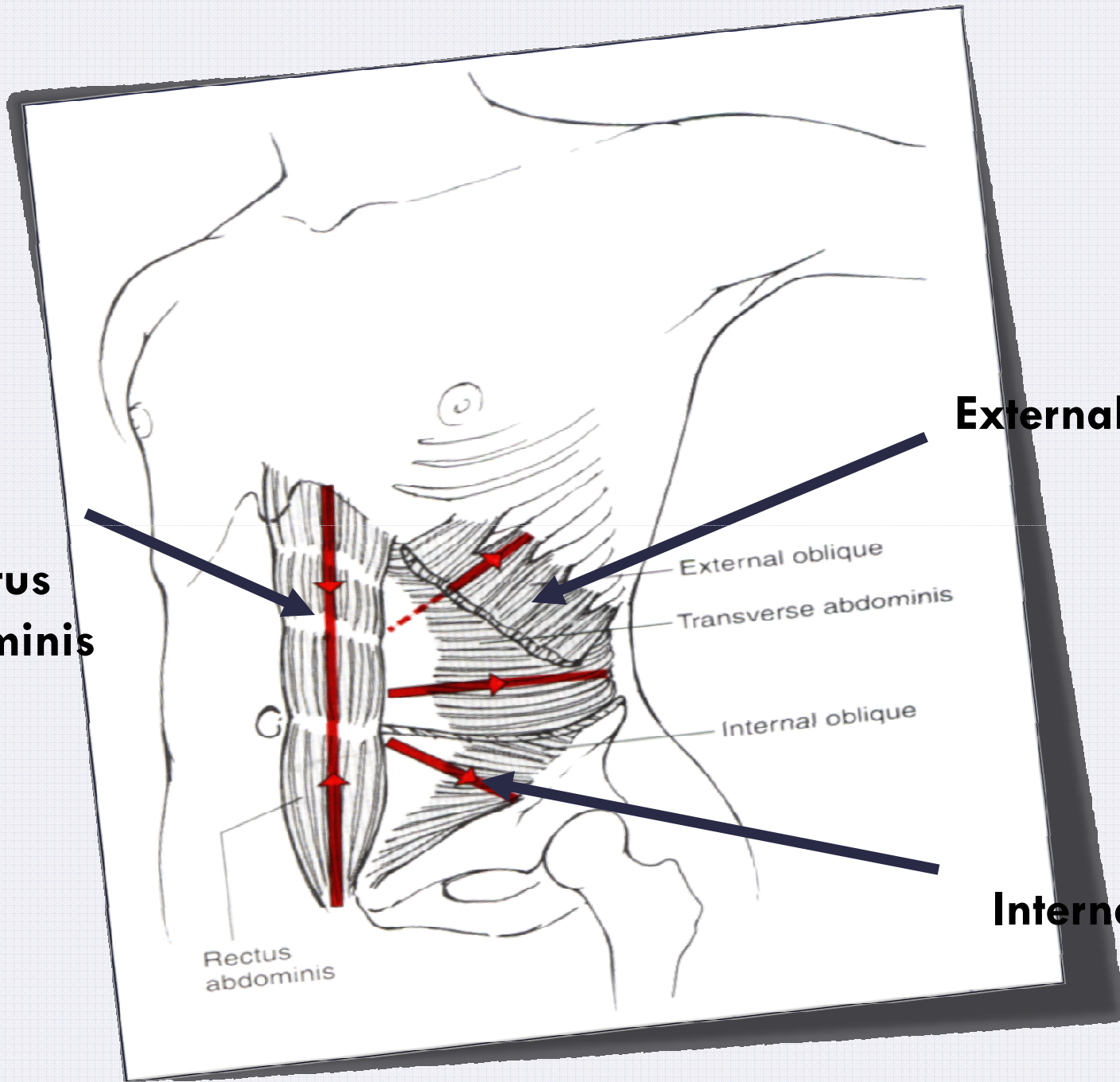


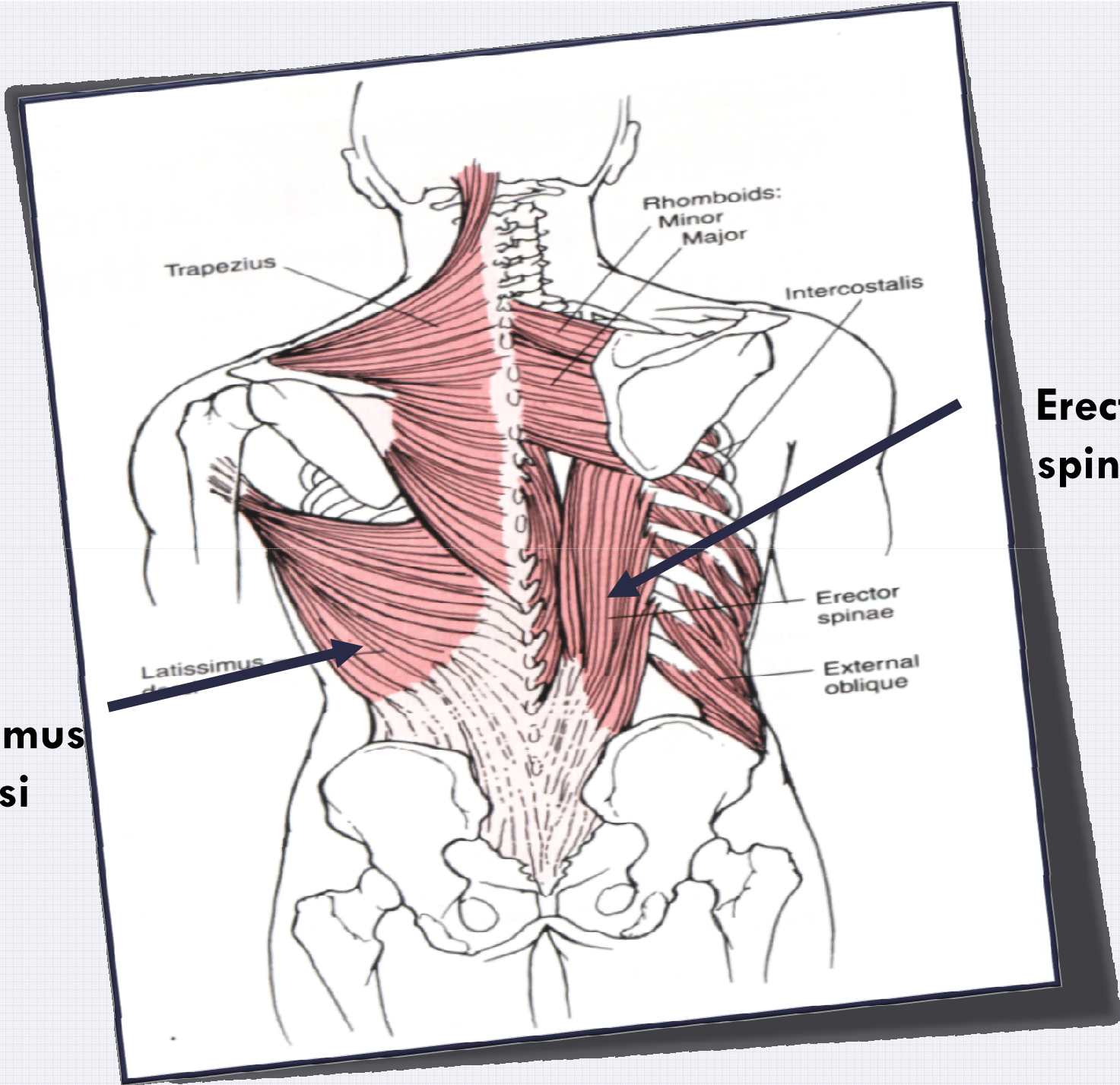
- **Bergmark** (1989) developed a model to summarize the role of the core muscles and their contribution to spinal stability.
  - **Global** muscles
  - **local** muscles

**Rectus abdominis**

**External oblique**

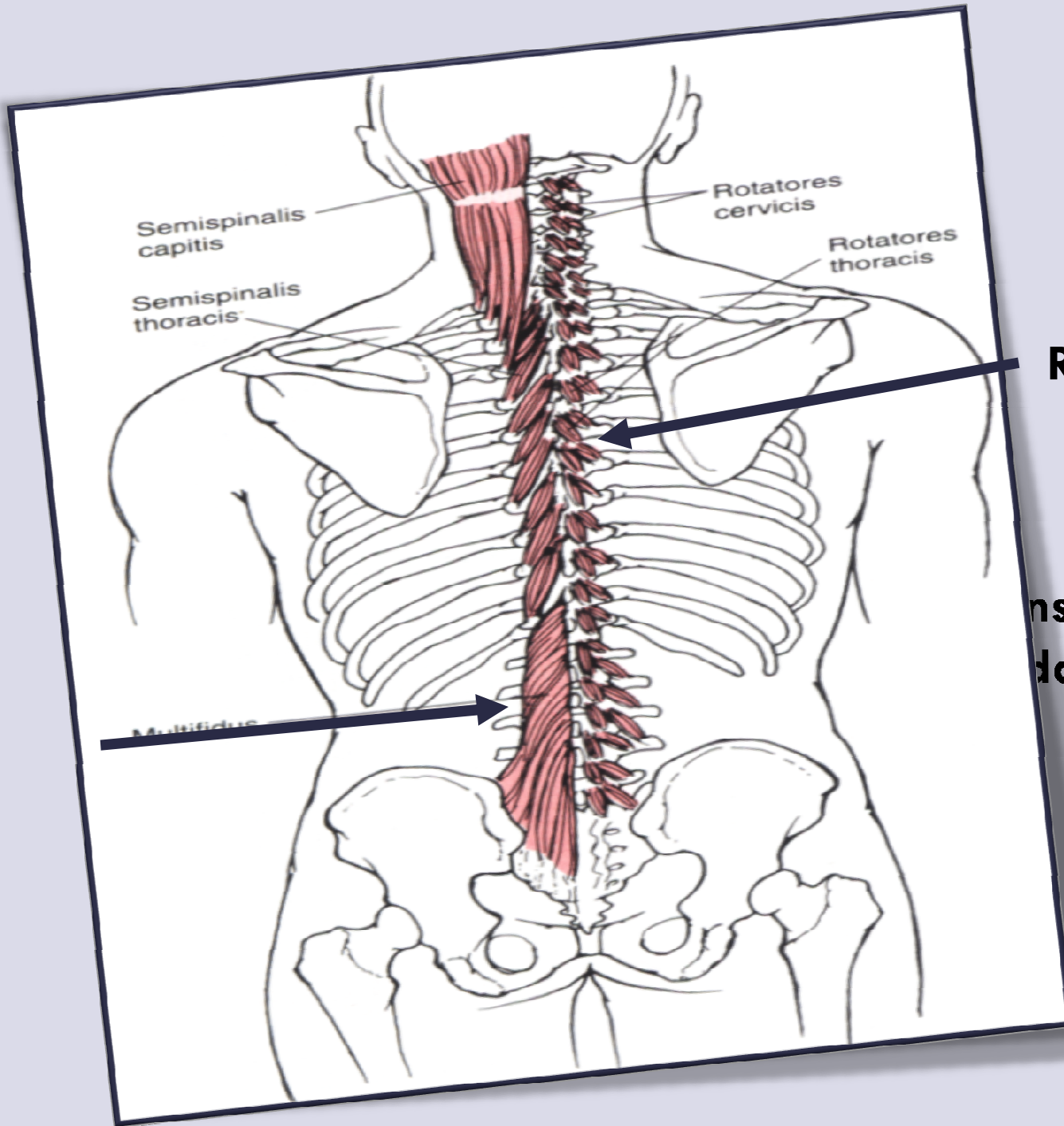
**Internal oblique**





**Latissimus  
dorsi**

**Erector  
spinae**



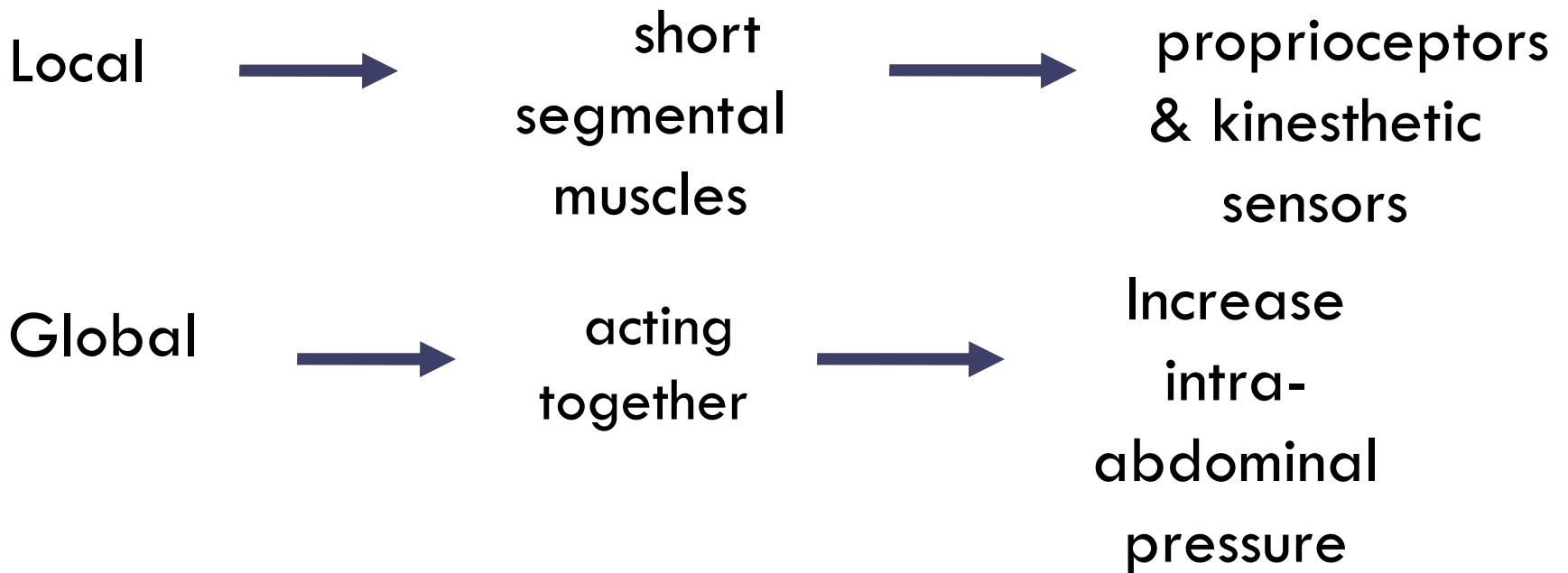
**Rotators**

**transversus  
dominis**

**multifidi**

# INTRODUCTION (cont)

- Contribution of **Local** vs. **Global** system in spinal stability



# INTRODUCTION (cont)



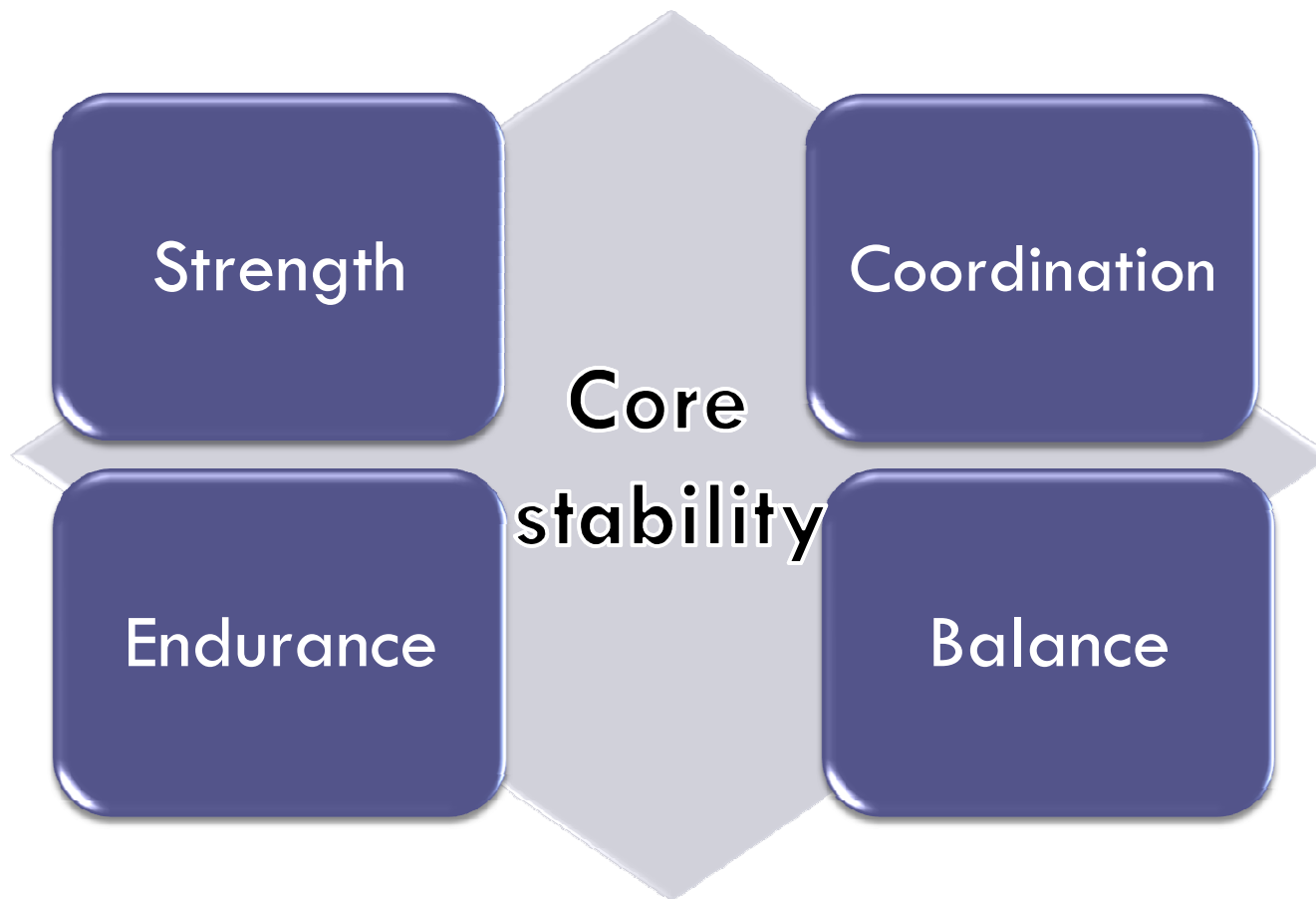
## Core stability can be defined as:

The ability to maintain neutral spine using the **abdominal**, **back**, and **hip** muscles as a stabilizers rather than prime movers.

# INTRODUCTION (cont)

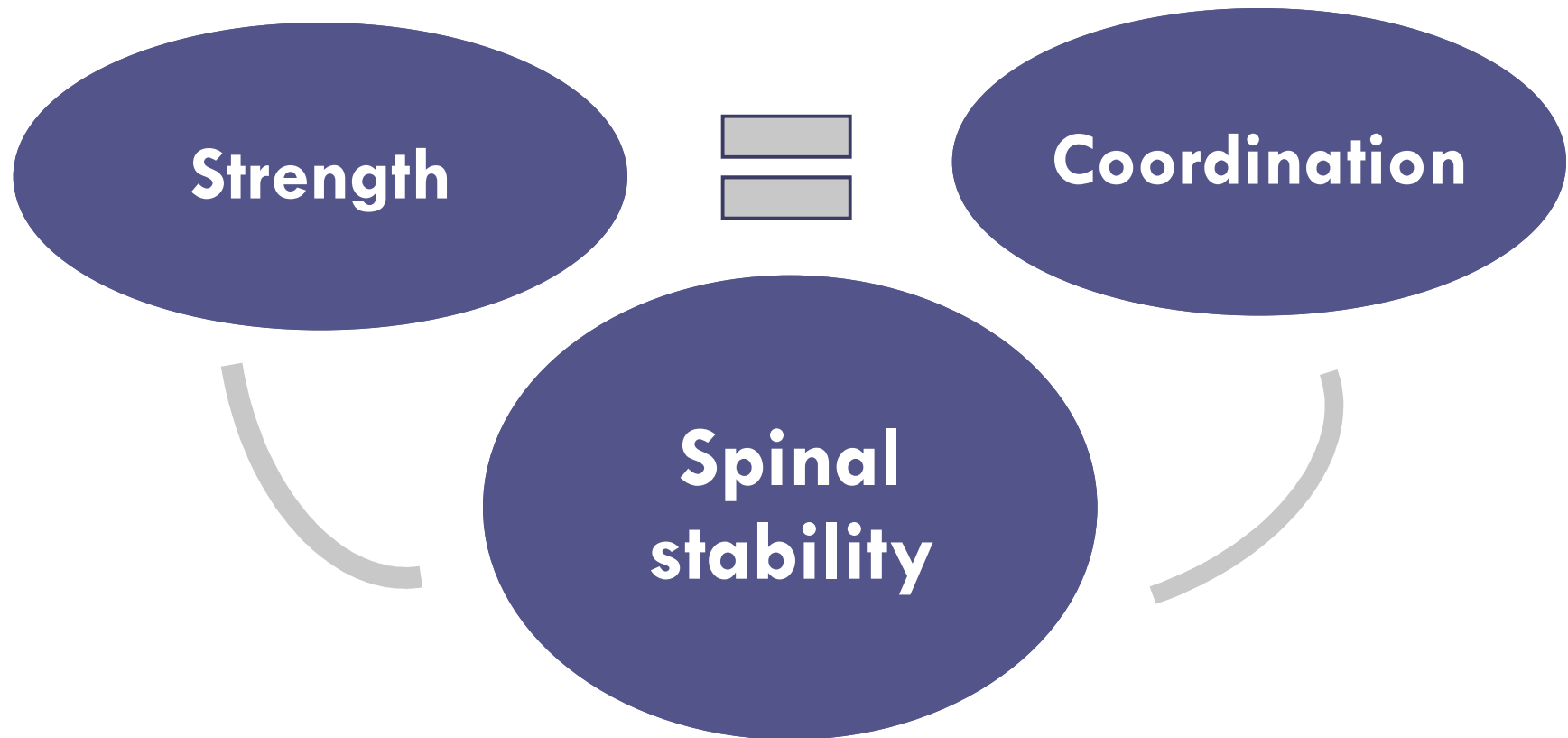
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- **Components of core stability:**



# INTRODUCTION (cont)

- Core stability and trunk muscles' strength and coordination:





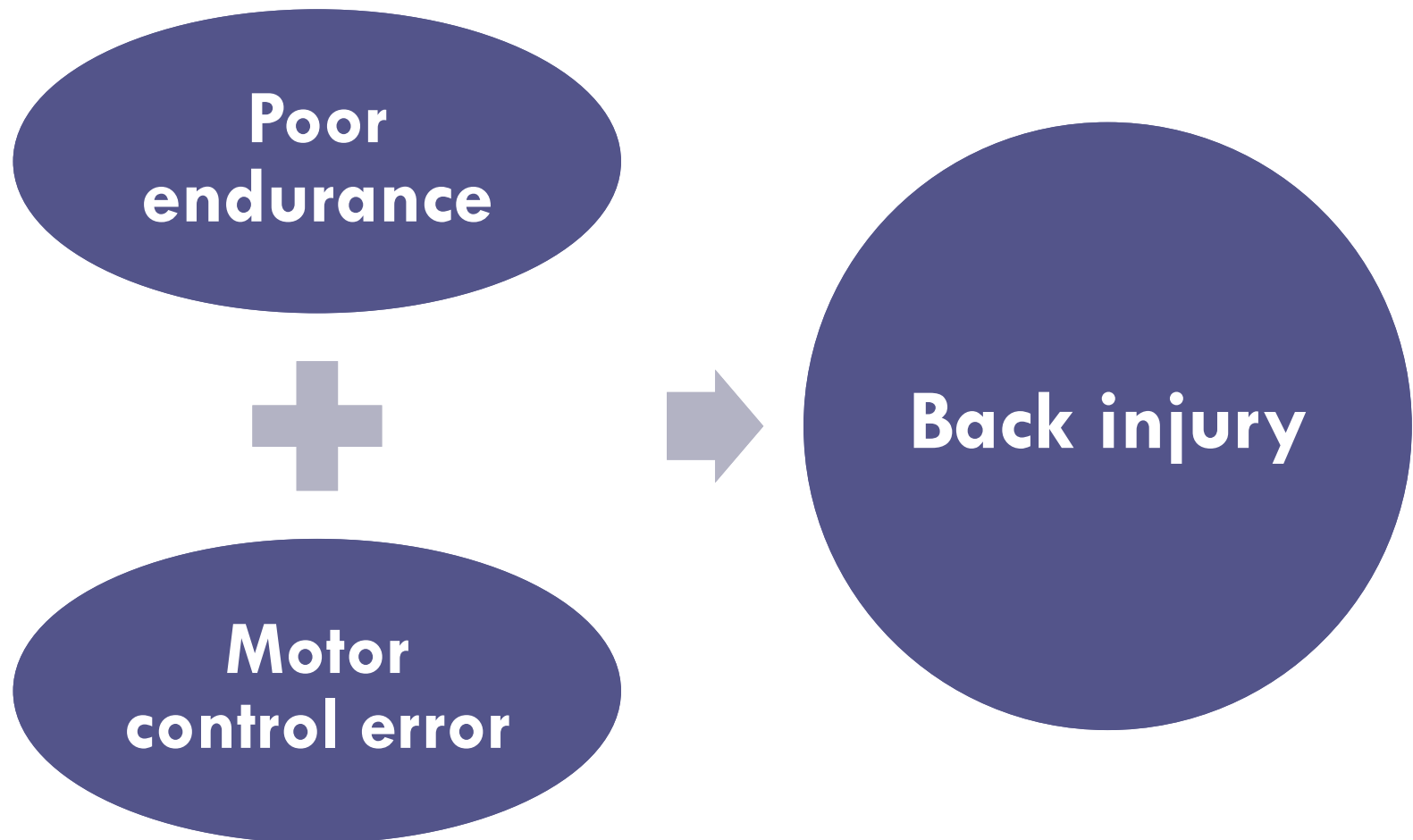
# INTRODUCTION (cont)

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- Core stability and trunk muscles' strength and coordination:
  - sufficient stability of the lumbar spine is achieved in most persons with very **modest** levels of coactivation of the **paraspinal** and **abdominal** muscles.
  - So, maintaining **stability** when performing tasks of daily living is not achieved by sufficient muscle **strength** but rather by sufficient **endurance**

# INTRODUCTION (cont)

- Core stability and trunk muscle endurance:



# INTRODUCTION (cont)



## Core stability and dynamic balance:

- Dynamic **balance** is an **integral** component of core stability.
- The core functions to maintain dynamic balance during activities which helps avoid serious distortion patterns.

# INTRODUCTION (cont)



- With the evidence supporting the importance of trunk muscle **endurance** and **dynamic balance** for improving core stability.
- It is important to emphasize on improving core muscle **endurance** and **dynamic balance** to improve health and reduce the risk of injury.

# INTRODUCTION (cont)



## Purposes of the study:

- To investigate the effect of core stability exercise program on the work fatigue and total work of the trunk extensors and flexors.
- To investigate the effect of core stability exercise program on the antero-posterior, medio-lateral, and over all stability indices.

# Materials and Methods



# MATERIALS & METHODS

## ▪ PARTICIPANTS

- **Thirty five** healthy college students participated in this study. They were randomly assigned to two groups; **Experimental** (A) and **control** (B)

Experimental	Control
Twenty participants	Fifteen participants
▪ (10 male & 10 female)	▪ (6 male & 9 female)
▪ Age $20.7 \pm 2.37$	▪ Age $20.3 \pm 0.61$
▪ Weight $66.6 \pm 12.1$	▪ Weight $68.6 \pm 12.2$
▪ Height $166.7 \pm 7.8$	▪ Height $164.3 \pm 7.6$

# MATERIALS & METHODS

- Inclusion and exclusion criteria:

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"><li>▪ Good abdominal muscle strength.</li><li>▪ Normal flexibility of the lower back muscles</li></ul>	<ul style="list-style-type: none"><li>▪ Previous core stability exercise program experience.</li><li>▪ Low back episodes during the previous year prior to participating in the study.</li><li>▪ Tightness in hip flexors and extensors.</li><li>▪ Any deformity.</li></ul>



# MATERIALS & METHODS (cont)



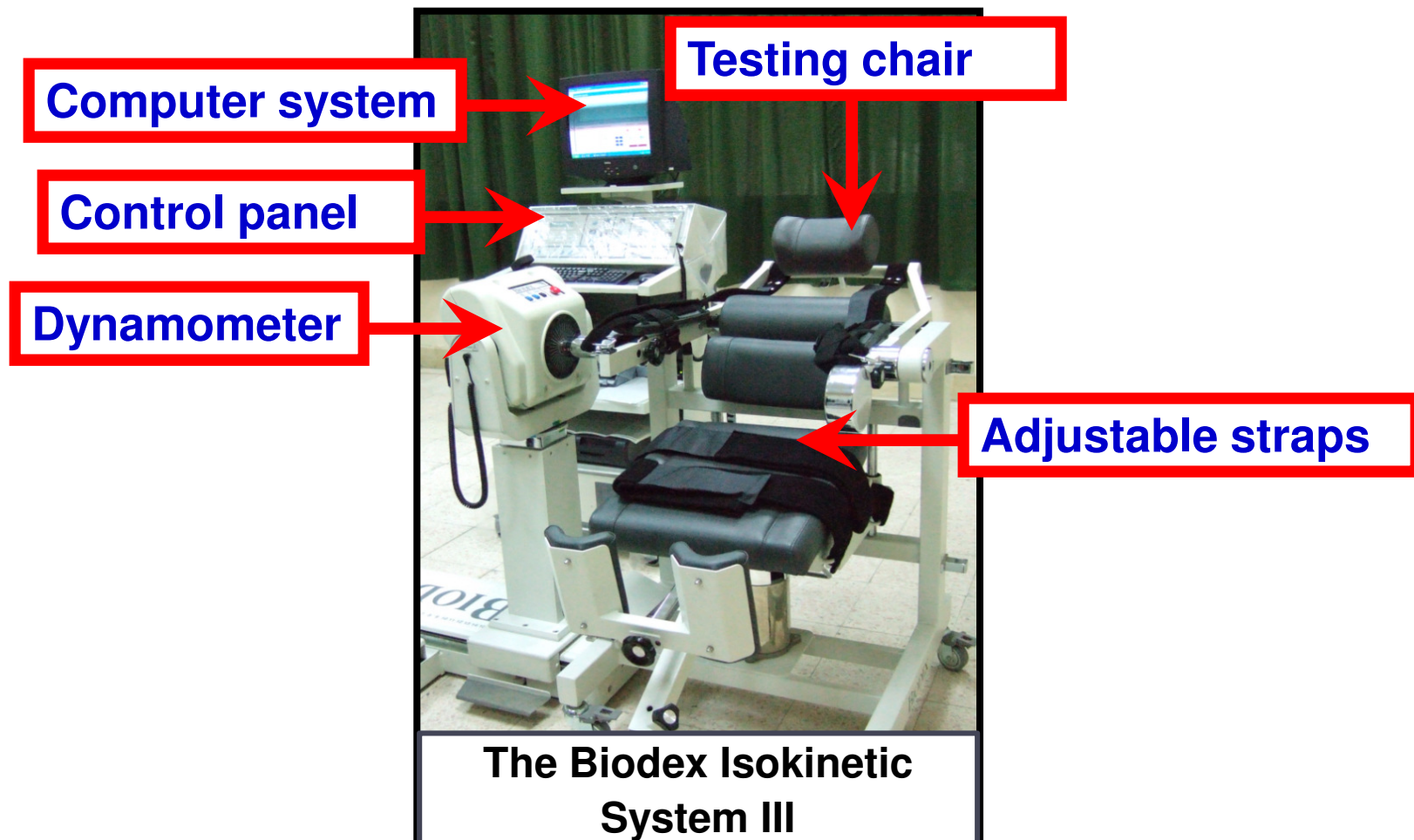
## Instrumentations:

### The Biodex Isokinetic Dynamometer

- Assessment of the trunk muscles' endurance

# MATERIALS & METHODS (cont)

- The Biodex Isokinetic Dynamometer



# MATERIALS & METHODS (cont)



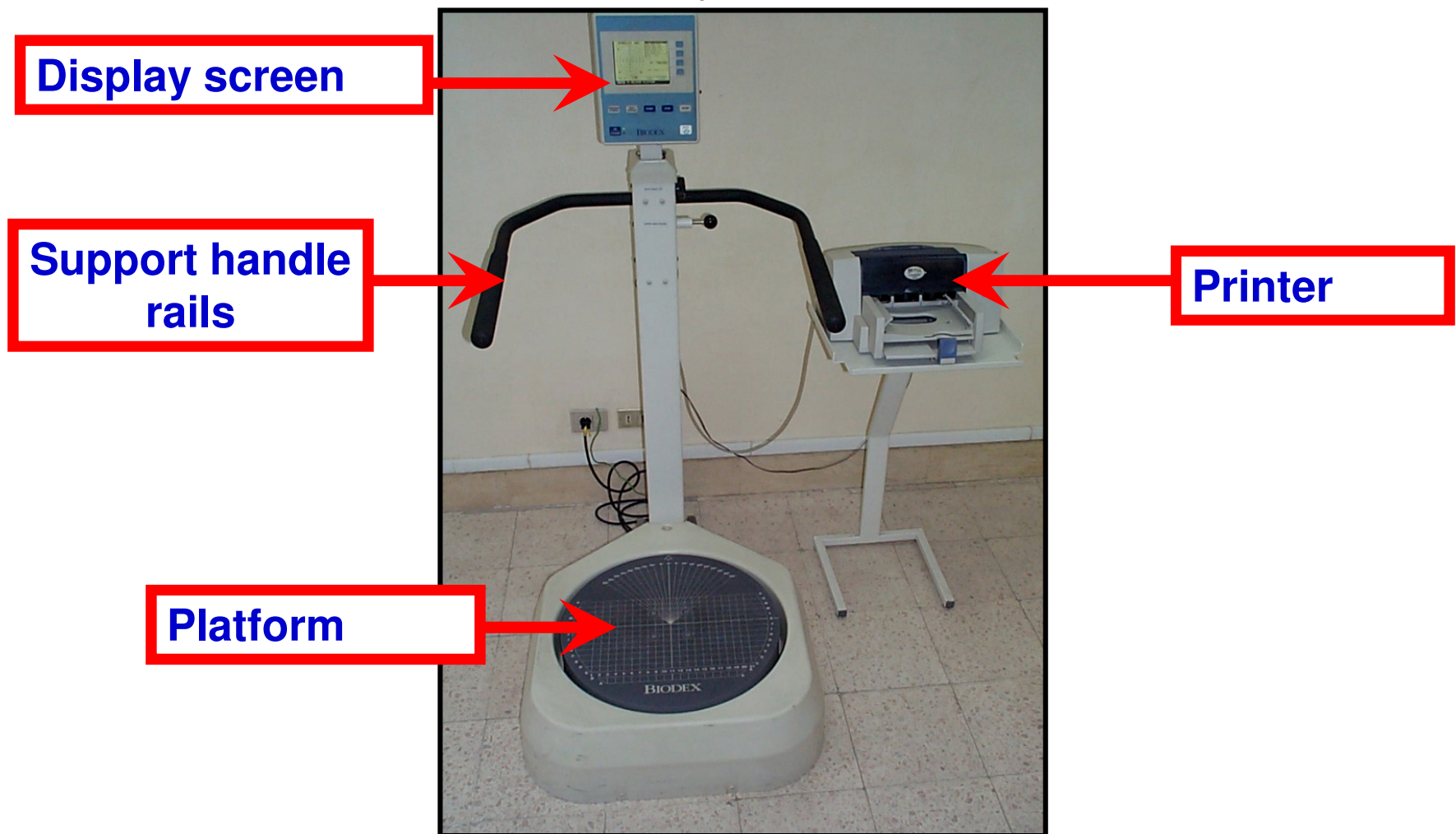
## Instrumentations:

### The Biodex Balance system

- Assessment of dynamic balance

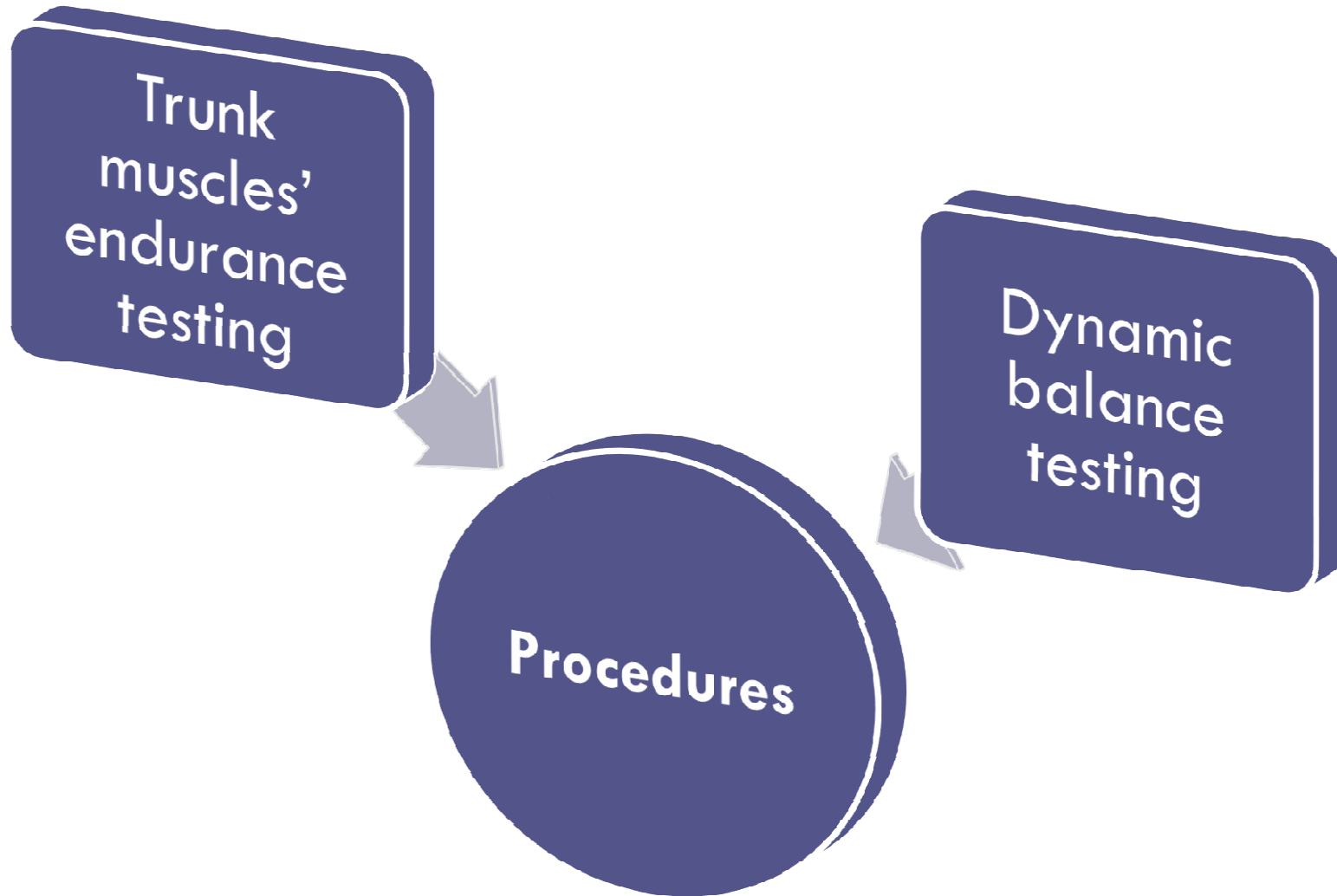
# MATERIALS & METHODS (cont)

- The Biodex Balance system



# MATERIALS & METHODS (cont)

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# MATERIALS & METHODS (cont)

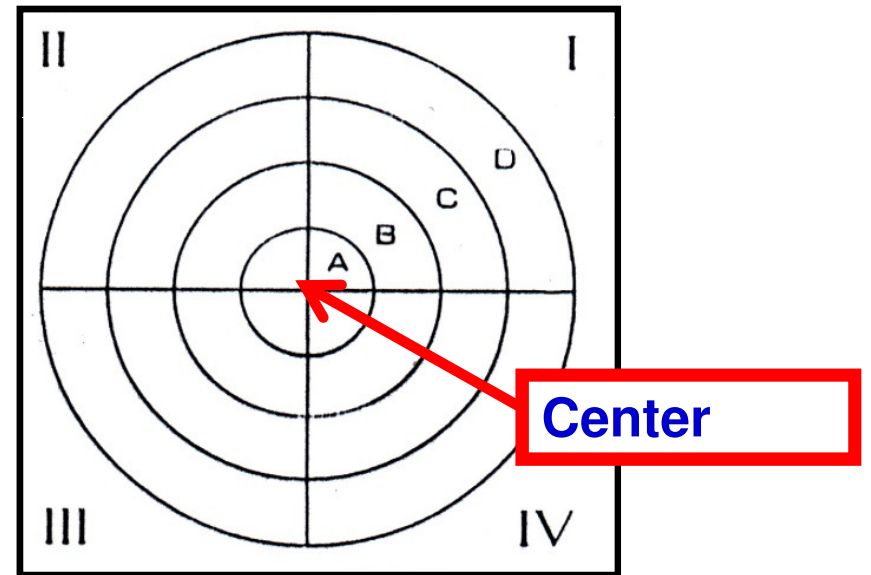
## 1- Isokinetic muscle endurance testing

- **Twenty** sets of flexion and extension.
- trunk ROM (**70°**).
- Angular velocity (**180°/sec**).
- **Concentric** contraction mode.



# MATERIALS & METHODS (cont)

## 2- Dynamic balance testing procedures





# MATERIALS & METHODS (cont)

## Intervention

The core stability exercise program (McGill, 2007):

- Warm up exercise:





# MATERIALS & METHODS (cont)

- Curl up exercise:



# MATERIALS & METHODS (cont)

- Side bridge exercise:



# MATERIALS & METHODS (cont)

- Prone bridge exercise:



# MATERIALS & METHODS (cont)

- Bird dog exercise:



# MATERIALS & METHODS (cont)

- Data and statistical analysis

**Dependent variables**

```
graph TD; DV([Dependent variables]) --- B{ }; B --- IP[Isokinetic parameters  
(endurance parameters)  
Total work and work fatigue]; B --- BP[Balance parameters  
AP, ML, and OSI];
```

**Isokinetic parameters  
(endurance parameters)**  
Total work and work fatigue

**Balance parameters**  
AP, ML, and OSI

# MATERIALS & METHODS (cont)

- Data analysis

- 2x2 Mixed Design (MANOVA)

Experimental/control } Trunk flexors'/extensors'  
"pre"/"post" tests } work fatigue

- 2x2 Mixed Design (MANOVA)

Experimental/control } Trunk flexors'/extensors'  
"pre"/"post" tests } Total work



# MATERIALS & METHODS (cont)

- Data analysis

- Mann-Whitney tests

Experimental/control → AP, ML, and OSI.

- Wilcoxon signed rank tests

“pre”/“post” tests → AP, ML, and OSI.

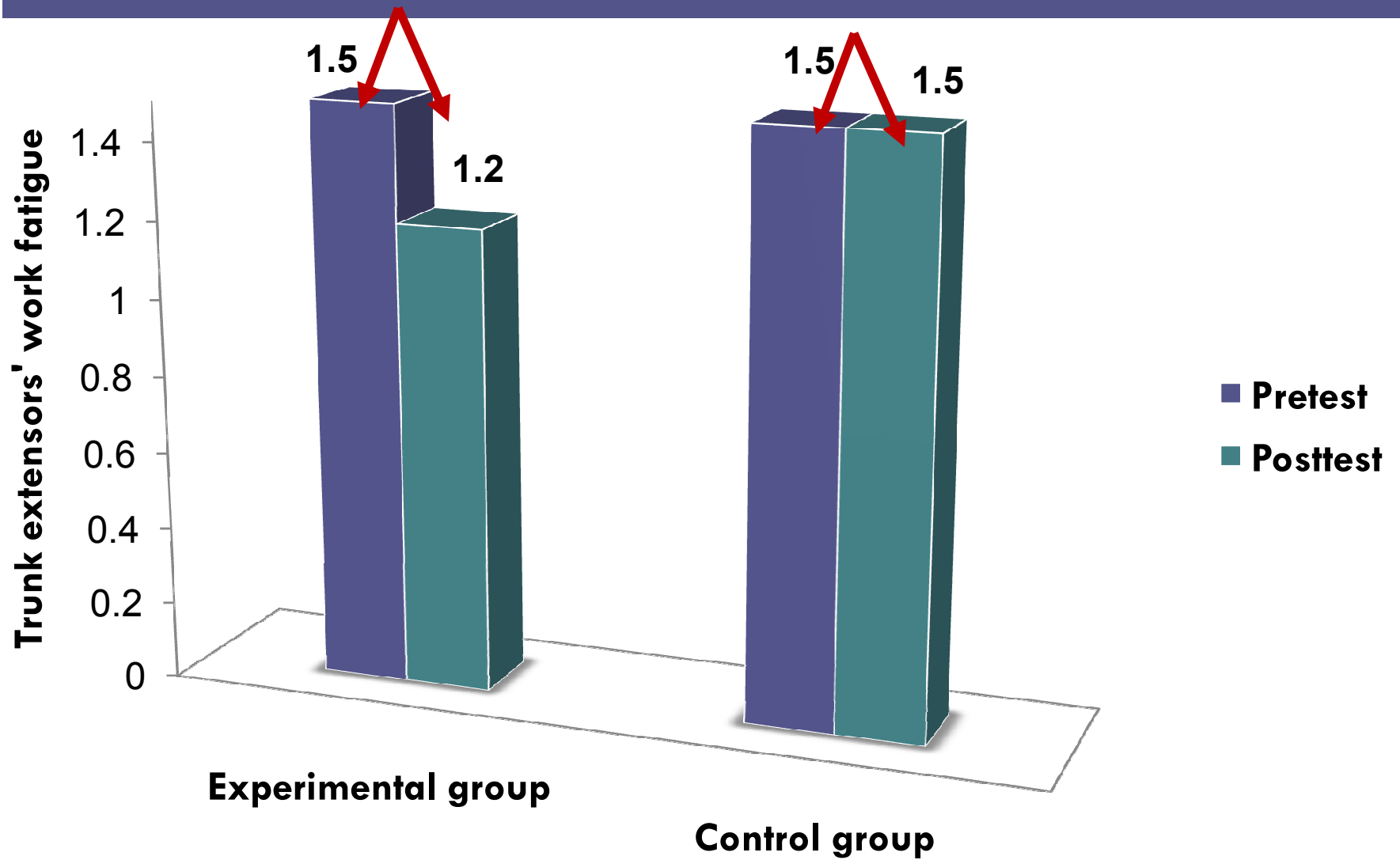
The initial alpha level for parametric and non parametric analysis was set at 0.01



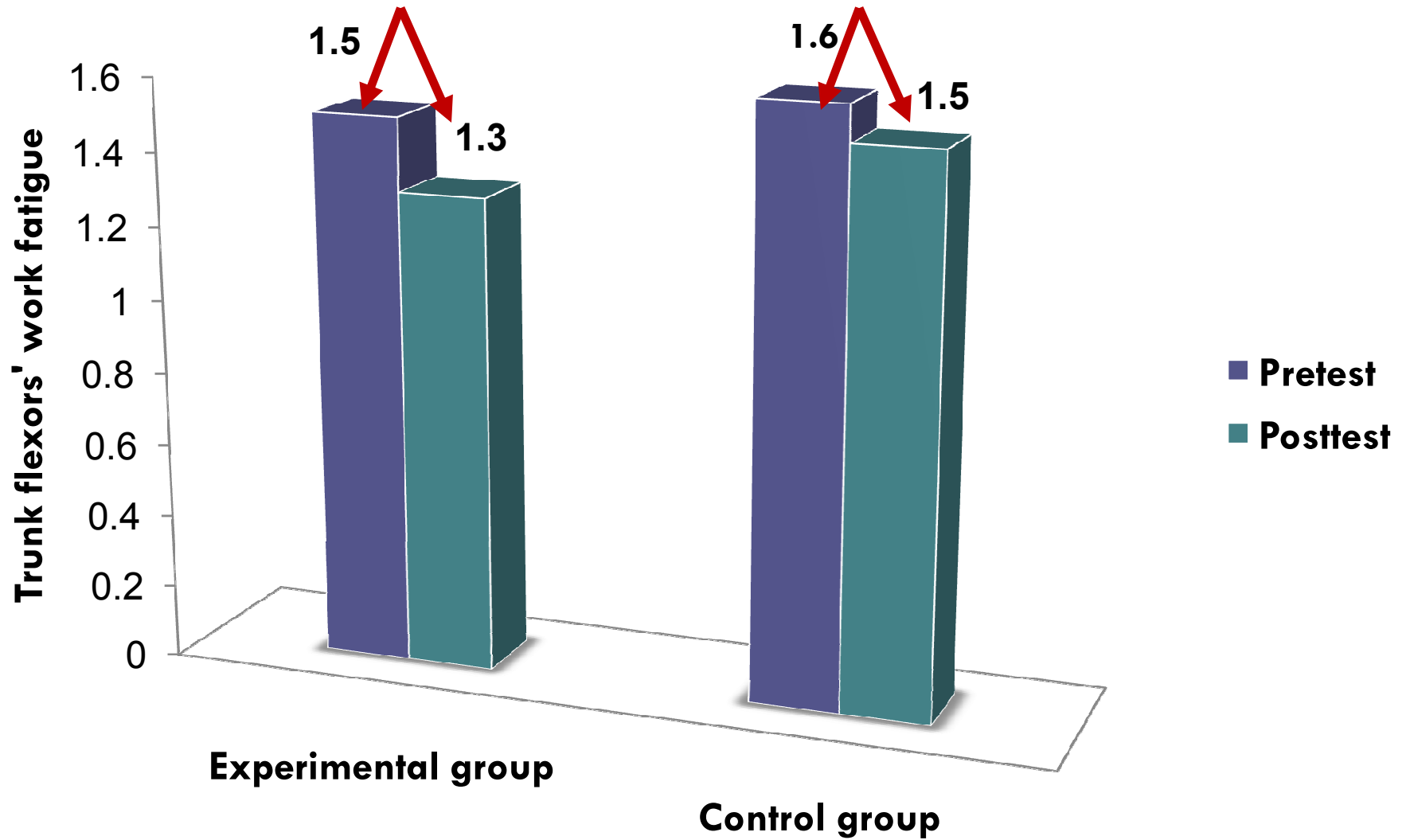
Results



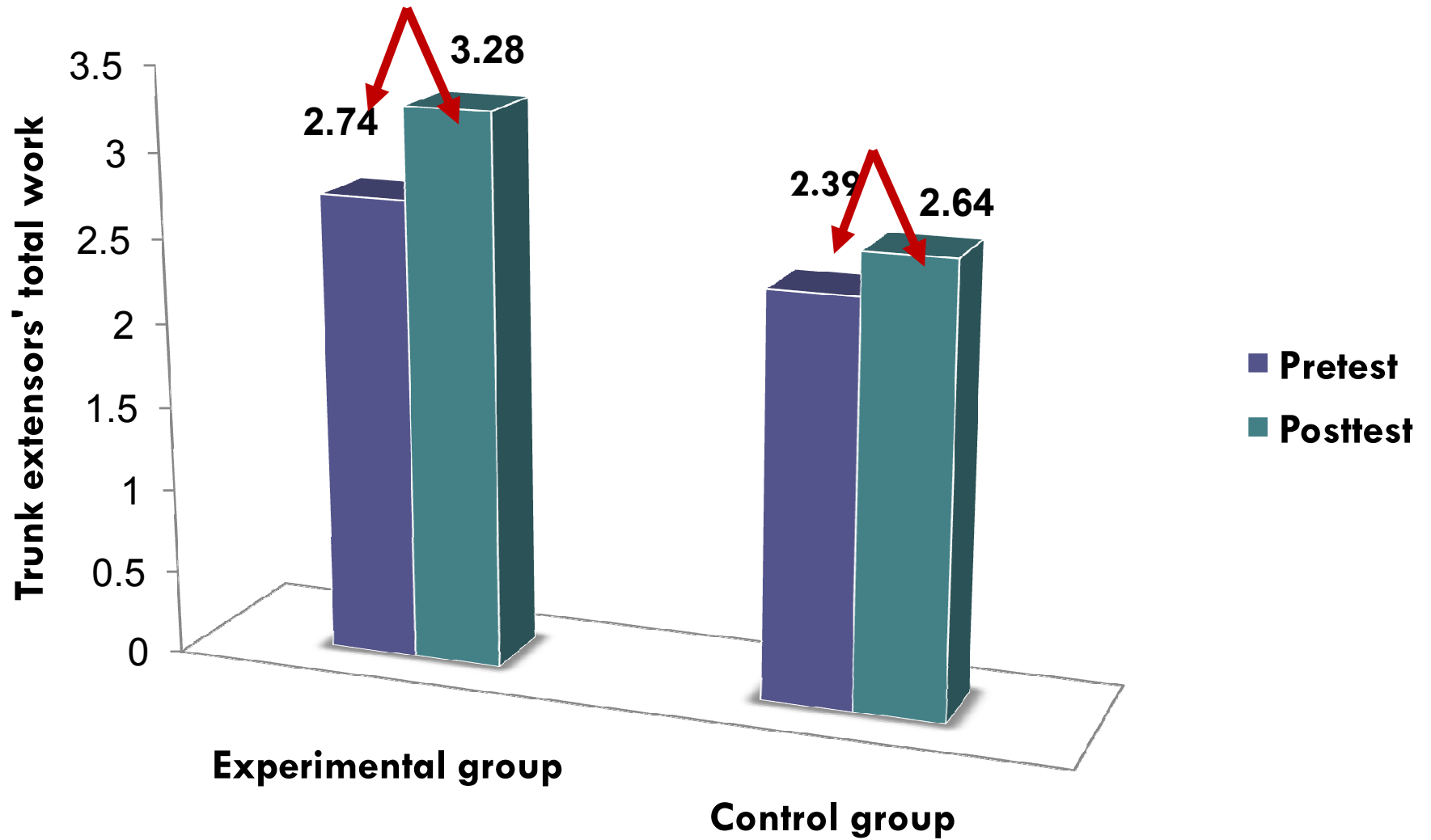
# RESULTS



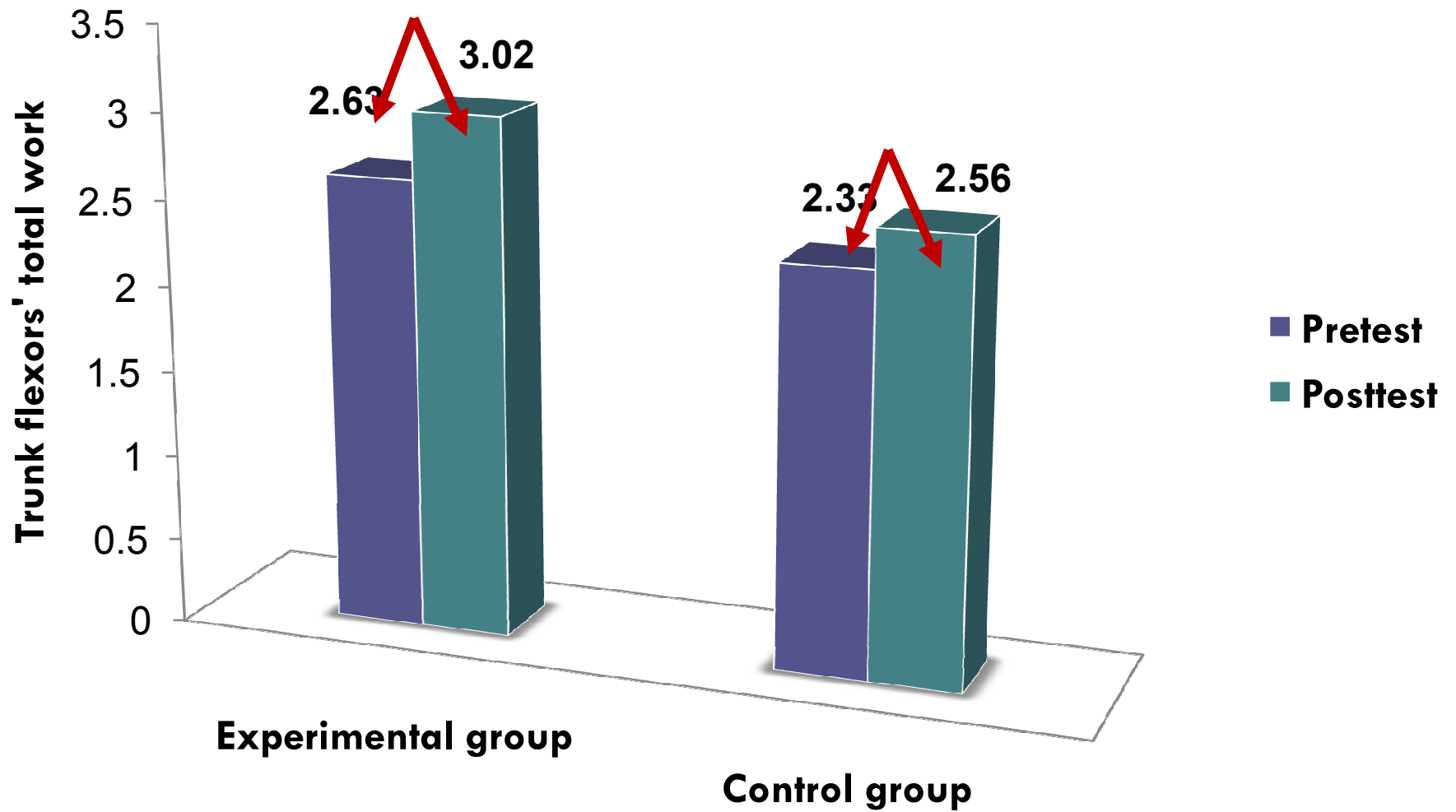
# RESULTS



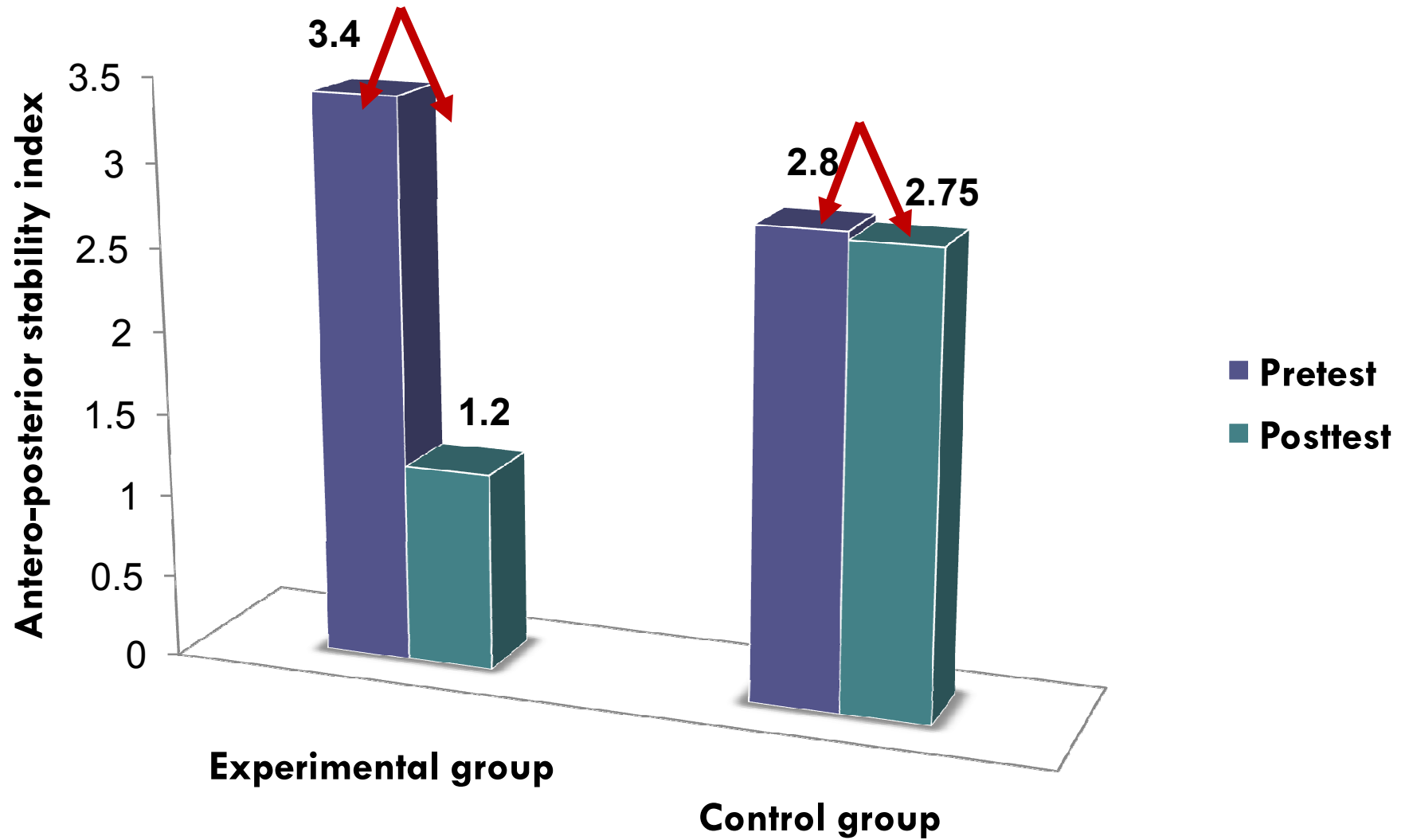
# RESULTS



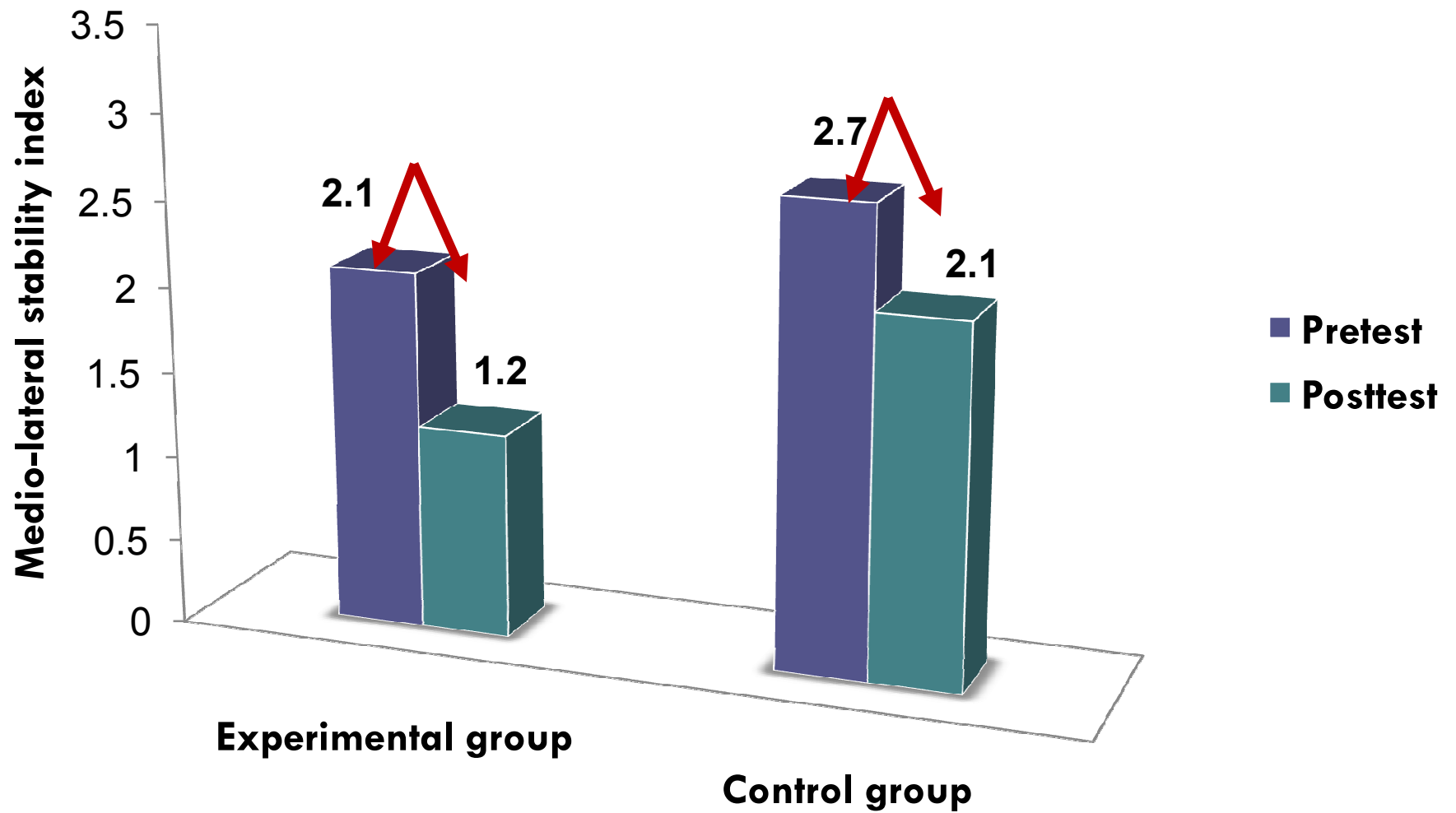
# RESULTS



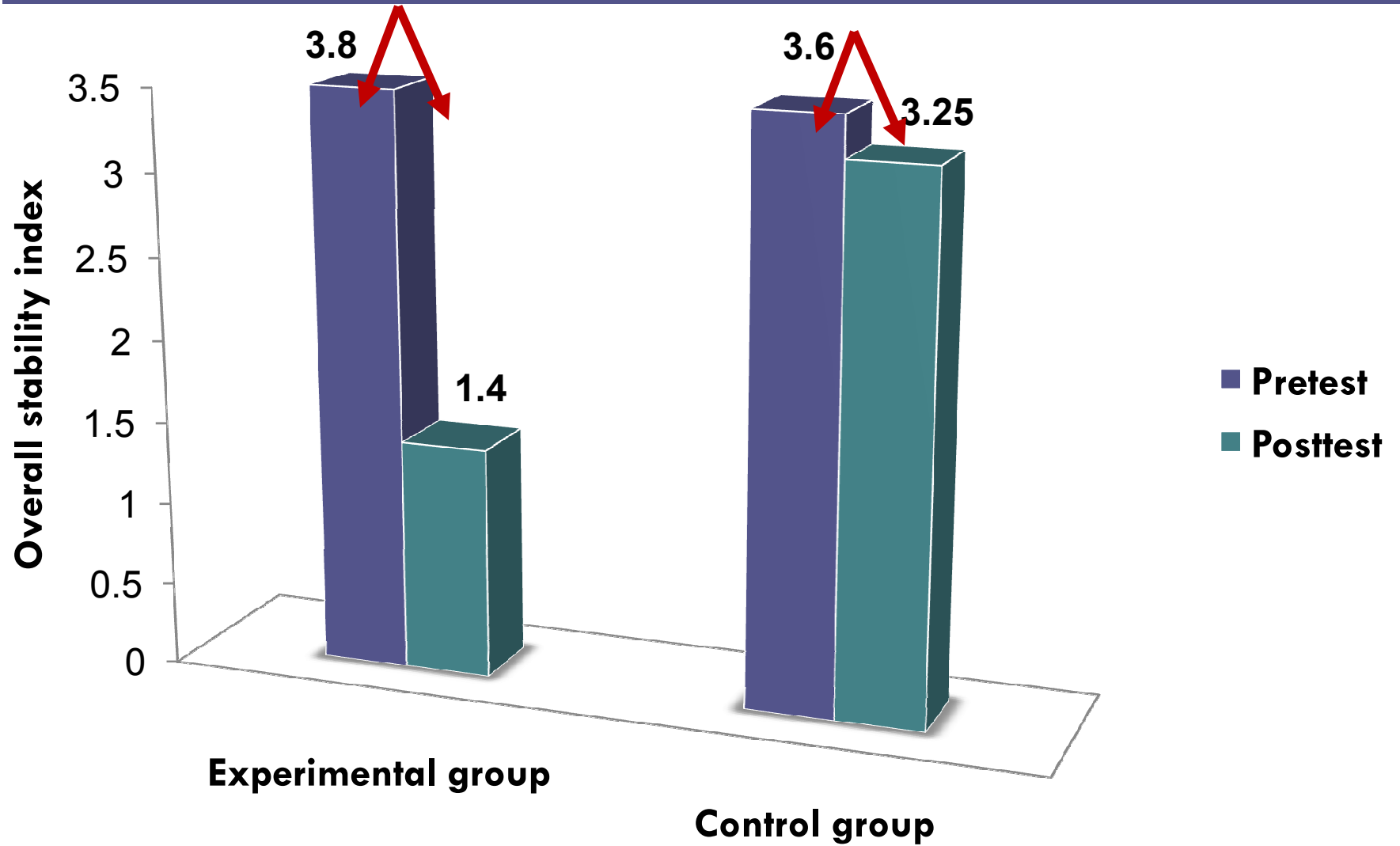
# RESULTS



# RESULTS



# RESULTS



# Discussion





# DISCUSSION (cont)

- The significant improvement in the work fatigue and total work of the trunk extensors and flexors in the “post” condition in the **experimental** group might be attributed to:



The core stability exercise program which lasted for 6 weeks.

# DISCUSSION (cont)

- The significant increase in the total work of the trunk flexors compared to the total work of the trunk extensors in the experimental group in the “**post**” condition might be attributed to



The **number** of exercises that addressed the abdominal muscles at the expense of the back ones.

Abdominals



Curl-up  
Side-bridge  
Prone-bridge

Back muscles



Bird-dog

# DISCUSSION (cont)

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- This improvement in the trunk muscles' endurance in the **experimental** group may result From



- **Physiological adaptations** in muscles induced with training.
- This adaptation can range from muscle **hypertrophy** to fiber type **conversions**.
- Factors affecting the extent of these adaptations are the **frequency, length** and **mode** of training.

# DISCUSSION (cont)

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- The selected exercises in the current study were **isometric** to ensure sufficient activation of the **deep** and **superficial** trunk muscles.
- The **frequency** and **dose** of the exercises were deemed sufficient to demonstrate improvement in trunk muscles' endurance.
- The core stability exercise program used in this study performed for **6 weeks**. These exercises were performed **thrice** per week. The participant began with **one** set of **15** repetitions **once** a day for **3 days** per week in the first **2 weeks**. Then, **2 sets**, each of **15 repetitions**, were performed **a day** for **3 days** per week in the following **2 weeks**. Finally, **3 sets**, each of **15 repetitions**, were performed a day for **three days** in the last **2 weeks**.

# DISCUSSION (cont)

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- The insignificant difference between the “pre” and “post” conditions for the work fatigue and the total work of the trunk extensors and flexors in the **control** group is because:



the control group received no  
treatment program.

# DISCUSSION (cont)

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- The significant decreases in the AP, ML, and OSI in the “post” condition in the **experimental** group might be attributed to:



the core stability exercise  
program which lasted  
for 6 weeks

# DISCUSSION (cont)

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- This improvement in the AP, ML and OSI in the **experimental** group may result From



- trunk muscle **strengthening**.
- **balance** is **specific** for every skill and is improved through repetition of **static** position or **dynamic** movement.

# DISCUSSION (cont)

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- The insignificant difference between the “pre” and “post” conditions for the AP and the OSI in the **control** group is because:



the control group received  
no treatment program



# DISCUSSION (cont)

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- The slight decrease in the MLSI in the “post” condition in the **control** group might be attributed to:



the test retest effect

## Conclusion

**With trunk muscle endurance and dynamic balance being improved, it may be concluded that core stability exercises are effective in improving spinal stability.**

# Recommendations

- Investigate larger sample size.
- Investigate the effects of core stability exercise programs in patients with chronic low back pain.

