EFFECTS OF CORE STABILITY EXERCISES VERSUS BALANCE TRAINING ON BALANCE, TRUNK ENDURANCE AND LOWER LIMBS STRENGTH: A RANDOMIZED CLINICAL TRIAL

Gihan Samir Mousa[1]*, Mohamed Mohamed Ibrahim Salem[1], Ashraf Abdelaal Mohamed Abdelaal[1], Kadrya H. Battecha[1], Reuf Saad Alotaibi[1], Balsam Amin Alqarf[1], Arwa Fayiz Alharthi[1], Mayadh Mukhlid Alswaihri[1]

[1]Department of Medical Rehabilitation Sciences, College of Applied Medical Science, Umm Al-Qura University, Makkah, Saudi Arabia

Abstract

Background: Both core stability exercises and balance training can result in a significant improvement in the dynamic and static balance, as well as muscular endurance.

Purpose: This study determined effects of core stability versus balance training program on balance, trunk endurance and lower limbs strength in physiotherapy students.

Subjects: Twenty-six female participants were recruited. Participant's age was from 18-25 years with a body mass index ranging from 18 – 32 kg/m^2.

Methods: 26 students (physiotherapy students) were randomly assigned into: group A (n=13) performed core stability (3 sessions/week for 6 weeks) and group B (n=13) performed balance exercises (3 sessions weekly for 6 weeks). Balance (Static and dynamic measurements) were measured by Biodex Balance System. Endurance test (Prone bridge) and five times sit- stand test were performed to evaluate trunk endurance and lower limbs strength. The design of the study was Quasi-experimental study.

Results: The obtained results of the study revealed a significant decrease in overall stability index in postural stability (the static and dynamic) in the balance exercise group B compared with group A of the core stability exercise post treatment. There was no significant difference in the endurance test (prone bridge), five-time sit-to-stand test or limits of stability between groups post treatment.

Conclusion: Both core stability exercises and balance training had a positive impact on balance, trunk endurance and lower limbs strength in physiotherapy students.

Keywords: Core stability, Balance, Trunk endurance, Lower limbs strength

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*Corresponding Author: Gihan Samir Mousa, Department of Medical Rehabilitation Sciences, Faculty of Applied Medical Sciences, Umm Al - Qura University, Makkah, Saudi Arabia

Correo-e: gihanmousa79@gmail.com

Introduction

Core stability can be defined as the capacity of the body to have control over the motion and position of the torso over the pelvis in order to yield prime production, transfer and controlling movement and forces to the final segment, which means maintain stability from proximal to distal mobility [1]. Core stability exercises refer to exercises that stimulate specific motor patterns of the trunk muscles by do stability of spine and postural control of trunk [2].

Balance can be defined as either dynamic or static. According to Hockey, dynamic balance is the ability of the muscles and soft tissues that surround the joints to neutralize external forces acting on the body [3]. Static balance is a body's ability to retain the various positions generated by modifying the contour line and the width of the support surface [4].

The impact of eight weeks of core stability training on the execution of teenage swimmers has been examined by Sedaghati et al. [5] who evaluated the subjects in terms of swimming speed, dynamic balance, and trunk muscle strength and endurance; all of these demonstrated significant enhancements by the end of the training sessions. The impact of 12-week stabilization exercises on trunk muscle strength, static balance, and low back discomfort was evaluated by Kim et al. [6] who found that trunk muscle strength increased after the 12-week period, however the investigated samples' static balance showed no change.

Dynamic balance, spinal stability, and hip mobility can all be effectively increased with six weeks of both static and active core exercises [7]. Also, lower limb strength is positively impacted by core stability exercise. Lower limbs recovered well and continued progress. Furthermore, a recovery in the degree of fitness was also observed [8].

Static and dynamic balance training improved the participants' balance, agility, and ankle stability [9]. Numerous investigations have demonstrated that decreased trunk muscular endurance, altered balance, and changed functional level have been associated with persistent low back pain [10]. So, there are a relationship between muscular endurance, balance, and functional level [11]. Through balance training, older men participants had moderate to large effect sizes of strength in the lower limbs as well as significant improvement in balance and functional mobility [12].

Both core stability exercises and balance training can result in a significant improvement in the dynamic and static balance, as well as muscular endurance. So, the aim of this research was to investigate effects of core stability versus balance training program on balance, trunk endurance and lower limbs strength in physiotherapy students.

Subjects and methods:

Study design

With a blind assessor, A randomized clinical study was done at Umm Al – Qura University, from: November 2022 to May 2023.

Subjects

Twenty-six female students were shared in the study, Students were randomly classified into: group A (n=13) performed core stability and group B (n=13) performed balance exercises. Three sessions of core stability or balance training per week for six weeks. The study was conducted in physical therapy laboratory lab, department of Medical rehabilitation sciences, faculty of applied medical sciences, Umm Al – Qura University.

Inclusion criteria

Female subjects with body mass index, BMI ranged from 18-32 Kg/m2, with age ranged from 18-25 years old and sedentary lifestyle.

Exclusive criteria

Subjects were with body mass index below 18 Kg/m2, pregnant, pulmonary or vascular diseases patients, males.

Before participating in this study, all subjects were requested to review the participant's information sheet and sign an informed consent form. This study was approved by the biomedical research ethics committee- Umm Al -Qura University (EDGQ091122).

Evaluative procedures

Measurement of Balance

Biodex Stability System (Biodex corporation, Shirley, NY) were used to evaluate balance (postural stability and limits of stability) [13].

Trunk endurance and lower limbs strength testing:

A- Endurance test (Prone bridge):

A longer duration indicated stronger core muscular endurance, and it was utilized to assess the back and core stabilizing muscles' endurance [14].

B-Five times sit- stand test:

It was done to evaluate the lower limb muscles' power [15].

Therapeutic procedures:

Group A: Core stability exercises, (table 1):

Thirteen females (group A) performed core stability exercises for six weeks (three times a week). Throughout the 45-minute workout, all of the core muscles were strengthened with a number of exercises [17] designed to enhance core stability. However, it was initially suggested to begin with a warm-up stretching routine that lasted ten to fifteen minutes and included three repetitions of each exercise, a 30-second hold for each repetition, and a 30-second rest in between [16].

Group B: Balance training, (table 2):

Thirteen females (group B) performed balance exercises for six weeks. There were three training sessions per week (30 minutes each session). The exercises started with a single-leg stance on a hard surface and were advanced to a wobble board and foam padding as the level of difficulty increased. The exercises involved the participants performing the foot fixation without stepping, jumping, or performing any translational motions [18].

Statistical analysis

Unpaired t-test was used for comparison of subject characteristics between groups. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Normal distribution of data was checked using the Shapiro-Wilk test. Two-way mixed MANOVA was performed to compare within and between groups effects on endurance test) prone bridge), five time sit- stand test, limits of stability and postural stability. Bonferroni corrections were done for subsequent multiple comparison. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was done through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

Results

Subject characteristics

(Table 3) showed the subject characteristics of core stability and balance exercise groups. There was no significant difference between groups in age, weight, height and BMI ($p > 0.05$).

Effect of treatment on endurance test) prone bridge), five time sit- stand test, limits of stability and postural stability

Two-way mixed MANOVA displayed that there was a significant interaction of treatment and time ($F = 3.75$, $p = 0.01$, $= 0.77$). There was a significant main effect of time ($F = 37.32$, $p = 0.001$, $= 0.97$). There was no significant main effect of treatment ($F = 1.01$, $p = 0.49$, $= 0.48$).

Within group comparison

There was a significant increase in prone bridge endurance time and a significant decrease in five time sit to stand time in both groups post treatment compared with pretreatment ($p < 0.01$). The percent of change in prone bridge endurance time and five time sit to stand time in core stability exercise group was 85.59 and 21.18% respectively and that in balance exercise group was 53.49 and 23.36% respectively. (Table 4).

There was a significant increase in limits of stability in overall static balance and overall dynamic balance in balance exercise group post-treatment compared with pre-treatment ($p < 0.01$) while there was a significant increase in limits

Week 1 to 2	Week 3 to 5	Week 6
• Crook lying abdominal hollowing for 10 s with curl up 3 repetitions\ 2 sets. • Bridge exercise (holding position for 10 s – 3 reps , slowly up and down 2 sets). • Russian twist exercise (3 reps on each side with 2 sets)	• Crook lying abdominal hollowing for 10 s with curl up 6 repetitions\ 3 sets. • Bridge exercise (holding position for 10 s – 6 reps , slowly up and down 3 sets). • Russian twist exercise (6 reps on each side with 3 sets)	• Crook lying abdominal hollowing for 10 s with curl up 10 repetitions\ 5 sets. • Bridge exercise (holding position for 10 s – 10 reps , slowly up and down 5 sets). • Russian twist exercise (10 reps on each side with 5 sets)
• Quadruped position: holding position for 10 s – 3 reps on each side with 2 set . • Cat and camel exercise (Quadruped position) Holding 10s (3 reps. 2 sets)	• Quadruped position: holding position for 10 s – 6 reps on each side with 3 set . • Cat and camel exercise (Quadruped position) Holding 10s (6 reps. 3 sets)	• Quadruped position: holding position for 10 s – 10 reps on each side with 5 set . • Cat and camel exercise (Quadruped position) Holding 10s (10 reps. 5 sets)
• Superman alternatively (3 reps. 2 sets) • Plank from different positions (forearm, forearm supporting on knee) holding position for 10s (3 reps for each. Rest 30 second 1 set then 2 sets then 3 sets.)	• Superman alternatively (6 reps. 3 sets) • Plank from different positions (forearm, forearm supporting on knee) holding position for 10s (6 reps for each. Rest 30 second 1 set then 2 sets then 3 sets.)	• Superman alternatively (10 reps. 5 sets) • Plank from different positions (forearm, forearm supporting on knee) holding position for 10s (10 reps for each. Rest 30 second 1 set then 2 sets then 3,4,5 sets.)

Table 1. Core stability exercises.

Week 1: normal floor	Weeks 2 to 3: foam and Dyna-Discs	Weeks 4 to 6: wobble board
Quiet single-leg stance	Quiet single-leg stance	Quiet single-leg stance
3 × 1 min (eyes open)	3 × 1 min (eyes open)	3 × 1 min (eyes open)
3 × 1 min (eyes closed)	3 × 1 min (eyes closed)	3 × 1 min (eyes closed)
Single-leg stance (3 × 1 min)	Single-leg stance (3 × 1 min)	Single-leg stance (3 × 1 min)
Moving head and trunk (eyes open)	Moving head and trunk (eyes open)	Moving head and trunk (eyes open)
Moving head and trunk (eyes closed)	Moving head and trunk (eyes closed)	Ankle movements (AP and ML)
Single-leg squats	Single-leg squats	Single-leg squats
Eyes open (2 × 10 repetitions)	Eyes open (2 × 10 repetitions)	Eyes open (3 × 10 repetitions)
Eyes closed (2 × 10 repetitions)	Eyes closed (2 × 10 repetitions)	Moving head (3 × 10 repetitions)
Catching a ball while standing	Catching a ball while standing	Catching a ball while standing
Low difficulty (2 × 90 s)	Low difficulty (3 × 90 s)	Low difficulty (3 × 90 s)
High difficulty (2 × 60 s)	High difficulty (3 × 60 s)	High difficulty (3 × 60 s)

Table 2. Balance training.

Table 3. Comparison of subject characteristics between core stability and balance exercise groups.

	Core stability group (A)	**Balance group** (B)			
	mean ± SD	**mean ± SD**	**MD**	**t- value**	**p-value**
Age, (years)	21 ± 0.82	20.92 ± 0.86	0.08	0.23	0.81**
Weight (kg)	62.42 ± 12.25	56.43 ± 10.66	5.99	1.33	0.19**
Height (cm)	159.69 ± 4.09	156.61 ± 6.31	3.08	1.47	0.15**
BMI (kg/m²)	24.41 ± 4.23	22.94 ± 3.66	1.47	0.94	0.35**

*= significant ** = non-significant Level of significance at P<0.05.

Table 4. Mean endurance test) prone bridge), five time sit- stand test, pre and post treatment of group A and B.

	Core stability group (A)	**Balance group (B)**	**MD**	**p value**
	Mean ±SD	**Mean ±SD**		
Prone bridge endurance test (Sec)				
Pre treatment	34.69 ± 6.43	34.38 ± 10.09	0.31	0.92**
Post treatment	64.38 ± 27.80	52.77 ± 14.25	11.61	0.19**
MD	-29.69	-18.39		
% of change	85.59	53.49		
	p = 0.001*	**p = 0.002***		
Five time sit to stand test (Sec)				
Pre treatment	10.15 ± 1.86	10.23 ± 1.01	-0.08	0.89**
Post treatment	8 ± 1.08	7.84 ± 1.21	0.16	0.73**
MD	2.15	2.39		
% of change	21.18	23.36		
	p = 0.001*	**p = 0.001***		

*= significant ** = non-significant Level of significance at P<0.05

Table 5. Mean limit of stability and postural stability pre and post treatment of group A and B.

	Core stability group (A)	**Balance group (B)**		
	Mean ±SD	**Mean ±SD**	**MD**	**p value**
Limits of stability				
Overall static balance				
Pre -treatment	35.76 ± 15.66	38.15 ± 10.82	2.39	0.65**
Post-treatment	48.69 ± 17.21	49.76 ± 11.07	-1.07	0.85**
MD	-12.93	-11.61		
% of change	36.16	30.43		
	p = 0.001*	***p = 0.002****		
Overall dynamic balance				
Pre-treatment	30.76 ± 8.17	29.66 ± 8.23	1.1	0.73**
Post-treatment	35.53 ± 9.13	38.46 ± 9.43	-2.93	0.43**
MD	-4.77	-8.8		
% of change	-15.51	-29.67		
	p = 0.09	***p = 0.004****		
Postural stability				
Overall stability index (static)				
Pre treatment	0.72 ± 0.22	0.77 ± 0.27	-0.05	0.59**
Post treatment	0.58 ± 0.18	0.35 ± 0.14	0.23	0.002*
MD	0.14	0.42		
% of change	19.44	54.55		
	p = 0.01*	***p = 0.001****		
Overall stability index (dynamic)				
Pre treatment	1.33 ± 0.54	1.43 ± 0.53	-0.1	0.65**
Post treatment	0.9 ± 0.41	0.58 ± 0.29	0.32	0.02*
MD	0.43	0.85		
% of change	32.33	59.44		
	p = 0.001*	***p = 0.001****		

*= significant ** = non-significant Level of significance at P<0.05

of stability in overall static balance ($p < 0.001$) with no significant change in overall dynamic balance ($p = 0.09$) in core stability exercise group. There was a significant decrease in overall stability index in static and dynamic postural stability test in both groups post treatment compared with pretreatment ($p < 0.01$). The percent of change in static and dynamic overall stability index in core stability exercise group was 19.44 and 32.33% respectively and that in balance exercise group was 54.55 and 59.44% respectively Table 5.

Between group comparison

There was no significant difference between groups pretreatment ($p > 0.05$). There was a significant decrease in static and dynamic overall stability index of balance exercise group compared with that of core exercise group post treatment ($p < 0.05$). There was no significant difference in prone bridge endurance test, five time sit to stand test, limits of stability between groups post treatment ($p > 0.05$). (Table 4 and Table 5).

Discussion

The present study explored the effects of core stability exercises versus balance training on balance, trunk endurance and lower limbs strength.

Participants performed three sessions of balance or core stability exercises per week for six weeks.

The obtained results of the current study revealed that there was a significant improvement in static postural stability in the group who performed core stability exercise. The current research data are also agreeing with those of Szafraniec et al. [19] who discovered improvements in static postural stability after a single session of core stability training. They noticed greater stability in the upright position 24 hours after exercise.

Also, another study by Mohebi and Norasteh [20] explored the impact of core exercise on the static balance of female students with trunk abnormalities after 6 weeks. The acquired data showed that the exercise had a major effect on the study individuals' static balance. However, Kim et al. [6] explored that static balance did not improve after a 12-week core stability program in elderly women. Their findings and the current study differ because proprioception, muscular activation pattern, vestibular function, and visual feedback are some of the factors that affect static balance. Static balance did not improve because the study's intervention program concentrated on enhancing proprioception and trunk muscle strength without influencing vestibular perception.

The current research showed that there was a significant improvement in the dynamic postural stability test in core stability exercise group after treatment. The observed results of this study come in line with Sadeghi et al. [21] which had significantly emphasized the impact of core stability on the dynamic postural control (balance). Also, Kahle et al. [22] focused on the impact of core stability on dynamic balance. This was clarified by the mechanism of core stability training sessions, which may help with balance improvement by strengthening muscles that are frequently linked to control of the lumber spine.

Also, another study by Mohebi and Norasteh [20] who explored the impact of core exercise on the dynamic balance of female students after 6 weeks. The exercise had a major effect on the study individuals' dynamic balance.

The result of the current work showed a significant improvement in static and dynamic balance variables in the balance exercise group post-treatment compared with pre-treatment. This result is supported by the previous studies [23] [24]. Also supported by a previous study of Shahvali et al. [25] who found a significant increase in both static and dynamic balance in sedentary female students aged 18 to 29 years for four weeks, two sessions per week following balance exercise training.

The significant improvement in static and dynamic balance variables in the balance exercise group post-treatment is consistent with Khalili et al. [26] who found a significant effect when using kinesio taping and balance exercise training on the degree of ankle instability, postural stability, and balance in female athletes with functional ankle instability [26]. Also, another study proved that in patients with persistent ankle instability, balance exercises achieved a clinically and statistically significant relevant improvement in (dynamic) postural stability [27].

Regarding the data from the current study, there was a significant boost in limits of stability tests in the balance exercise group post-treatment compared with pre-treatment. This is consistent with Esmaeili et al. [28] who showed that balance exercises affected for six weeks on limits of stability of balance tests and the strength of lower extremity ligament.

There were significant improvements in the endurance test and five-time sit-to-stand test in the core stability group. Some exercises, such as the side plank, bridging, the plank, and the wall squat enhance the strength of muscles [29]. The stability of the body core region is fundamental to gain balance against the forces utilized by the pelvis, spine, and motor chains to start functional limb movements. The appropriate function of the core muscles enhances the function of the musculoskeletal system through the motor chain; ultimately, this process gives during activity more balance statically and dynamically [30]. From the study of Zarei et al. [31] in 2021, The obtained results of this research are in line with those of the present study. They noticed a significant increase in the endurance test (prone bridge) after 8 weeks (3 times a week) of the core stability training program for deaf children.

Previous study confirmed that there was a significant effect on flexibility and muscle strength in the core strengthening exercises group [32]. Also, another study by Mohebi and Norasteh [20] who reported that improvement of individuals' trunk, muscle strength and endurance after a six-week Core exercise in female high school students with trunk abnormalities. As well as, Kim et al. [6] stated that the degree of back pain and power of the trunk muscles increased after core stability program for elderly women.

The current study results showed a significant boost in the endurance test (prone bridge) and five-time sit-to-stand test in the balance training group. The current study results are similar to those of Bao et al. [33] who concluded that there was a significant improvement in the five-time sit-to-stand test duration after eight weeks of balance training, and they also agreed with the results of Sonthikul et al. [34] who compared the effects of a balance program with a core stabilization program on the endurance test (prone bridge). Their results showed that there was a significant rise in the endurance test in both training groups in favor of the core stabilization group, and that might be because of the mechanism of utilization of some exercises, like pose exercises, in the core stabilization group.

Limitations

The small size of the sample, the short duration of exercises and recruiting only female students were the 3 main limitations in our study.

Conclusion

Both core stability exercises and balance training had a positive impact on balance, Trunk endurance and lower limbs strength in physiotherapy students.

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