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Effect of Inspiratory Muscle Training Versus Core Stability Training on Balance Problems in Older Adults

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Abstract: We proposed to compare the implications of inspiratory muscle training versus core stability on the stability of the elderly. A total of 75 older individuals were randomly and evenly split into three groups: (A) the core stability group (n=25) received core stability training plus traditional balance exercises, (B) the IMT group (n=25) received IMT training plus traditional balance exercises, (C) the control group (n=25) was assigned to undergo conventional balancing exercises. The evaluation process included both pre-and post-testing, which encompassed the measurement of the time taken to complete the Time Up and Go (TUG) test, as well as the 30 Second Chair Stand Test (30CST). Following eight weeks of training, there was a significant rise in TUG in group A ($P<0.05$) and 30CST in both groups A and B ($P<0.05$ and $p=0.002$), respectively. Post-training, a significant disparity in the TUG and 30CST scores across the three groups was found, with corresponding p-values of 0.038 and 0.006. So it was concluded that Core muscle stability training with a traditional balance program improves stability in the elderly more than IMT training with a traditional balance program or traditional balance program alone.

Key words: IMT · Core Stability Training · TUG · 30CST

INTRODUCTION

The risk of falling is one of the most common public health concerns impacting the elderly. Worldwide, falls rank as the second most common cause of accidental or unintentional injury deaths. These statistics are from the World Health Organization. Every year, between 28 and 35% of adults 65 and older fall, and the likelihood of falling increases with advancing age and fragility. Elderly falls can lead to functional impairment, death, prolonged hospital stays, and early admission to a nursing home [1].

Having fallen multiple times is often followed by the "post-fall syndrome" of despair, fear of falling, and other mental health problems. People could experience loneliness, confusion, and isolation in addition to a lack of confidence even when there is no physical harm [2].

Age-related restrictions in postural motions and the ability to stabilize balance in response to external postural disturbances worsen loss of balance and fall [3].

Potential causes of impaired balance include disturbances to the vestibular (the ears), proprioceptive (the body's spatial awareness), or visual (the eyes) systems. If any of these systems malfunction or degrade, imbalance could result [4].

Therefore, older adults should exercise in a variety of ways, including walking, stretching, aerobic exercise, and muscle strengthening exercises, to maintain or develop their muscle strength as well as to improve their balance and gait velocity [5]. Due to their capacity to promote flexibility and stability, core strengthening exercises are beneficial for joint, muscle, and balance training [5].

The diaphragm acts as the top boundary, while the core muscles, including the rectus abdominis and oblique muscles, form the anterior-lateral sides. The gluteal and paraspinal muscles make up the anterior-lateral boundary, while the pelvic floor muscles provide the bottom boundary [6]. The intrinsic characteristics of these muscle boundaries may have a stabilizing impact on the spine by

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means of their simultaneous contraction, which is essential for executing trunk and limb motions accurately [6]. There is a hypothesis suggesting that the diaphragm and abdominal muscles collaborate to generate hydraulic implications inside the abdominal cavity, perhaps aiding in spinal stabilization [7]. The floor and diaphragm muscles were seen as synergistic with the transversus abdominis muscle in terms of increasing intra-abdominal pressure and maintaining varied postures [7]. Voluntary respiratory exercises have a direct impact on the concurrent contraction and synchronized movement of the diaphragm, transverse abdominis, and pelvic floor muscles, which are the crucial and basic components of spinal stability [8].

Inspiratory muscle training (IMT), which entails breathing exercises with a pressure threshold device, can improve older people's ability to balance by lessening the physiological impact of aging on inspiratory muscle function [9].

Consequently, we hypothesized that there was no significant difference between the effect of the implications of Inspiratory muscle training (Green Powerlung device) and the core stability training on balance problems in older adults.

Therefore, we carried out this study to compare between the effects of core stability training and inspiratory muscle training (using a Green Powerlung device) on balance issues in older adults.

MATERIALS AND METHODS

Participants: A single-blind randomized controlled trial (RCT) was organized. The research was conducted between February and October 2021. All participants were informed of the study objectives and any risks they might face. All study participants signed a consent form. This study has been approved by the Physical Therapy Faculty's Ethical Committee at Cairo University. (NO: P.T.REC/012/003092).

A total of 75 participants of all genders were chosen from the out clinic of faculty of physical therapy. They were between the ages of 69 and 75, with a BMI of 26.9±8.6 kg/m², a Berg Balance Scale score of 0 to 40, the capacity to walk without assistance, not having played sports in the previous year, and following the intended workout regimen and a history of falling or having difficulty staying upright. The following were excluded: having a chronic lung condition (including asthma or obstructive pulmonary disease), having moderate to severe low back pain, cognitive impairments, fear of falling, vision impairment, having heart conditions that prevent physical activity, taking beta-blocker medication, having experienced vertigo within the previous six months, having defective hearing, currently undergoing exercise balance training, and having any prior experience with IMT.

Procedures: At the start of the study, a competent physiotherapist conducted a physical evaluation of all participants to ascertain their suitability for participation. A survey was used to collect demographic information. The height (cm) and weight (kg) of each participant were recorded, and their body mass index (BMI) was computed.

Randomization to receive core stability training plus traditional balance exercises or IMT training plus traditional balance exercises or only traditional balance exercises was performed by closed envelope. Each participant had an equal probability of being assigned to either group. A researcher who was unaware of the details of the experiment saw the envelope and allocated the patients to their respective groups.

Outcome Measures:

The Timed Up and Go Test (TUGT): TUGT is advised for this purpose since it has been confirmed to be a valid method for determining an elderly person's fall risk [10].

During the TUG test, participants sat on a 46-centimeter-high armchair with their backs touching the back support. They were told to stand up, go as quickly and carefully as they could for three meters, turn around, and go back to their seats. They were given the option of utilizing a walking cane or walker. At "go," the timer started, and at "stop," the participants were instructed to sit with their backs against the back support. Twice, once for practice and once for real, they performed the TUG. For this metric, excellent test-retest reliability has been reported [11].

The Sit to Stand Test (STS): The STS test was conducted on a chair without armrests and with a typical height of 46 cm (1.8 feet). The patient was positioned on the chair with its back to the wall in an upright position. The patient was seated with their hands resting on their hips, their knees bent to a 90-degree angle, and their feet level on the floor and hip-width apart. The cycle of sit, stand, and sit was confirmed following each and every rise from a seated position [12].

Interventions:

The Core Stability Training for Group (A): they performed pelvic floor muscle exercises and co-contractions of the transverse abdominis and multifidus

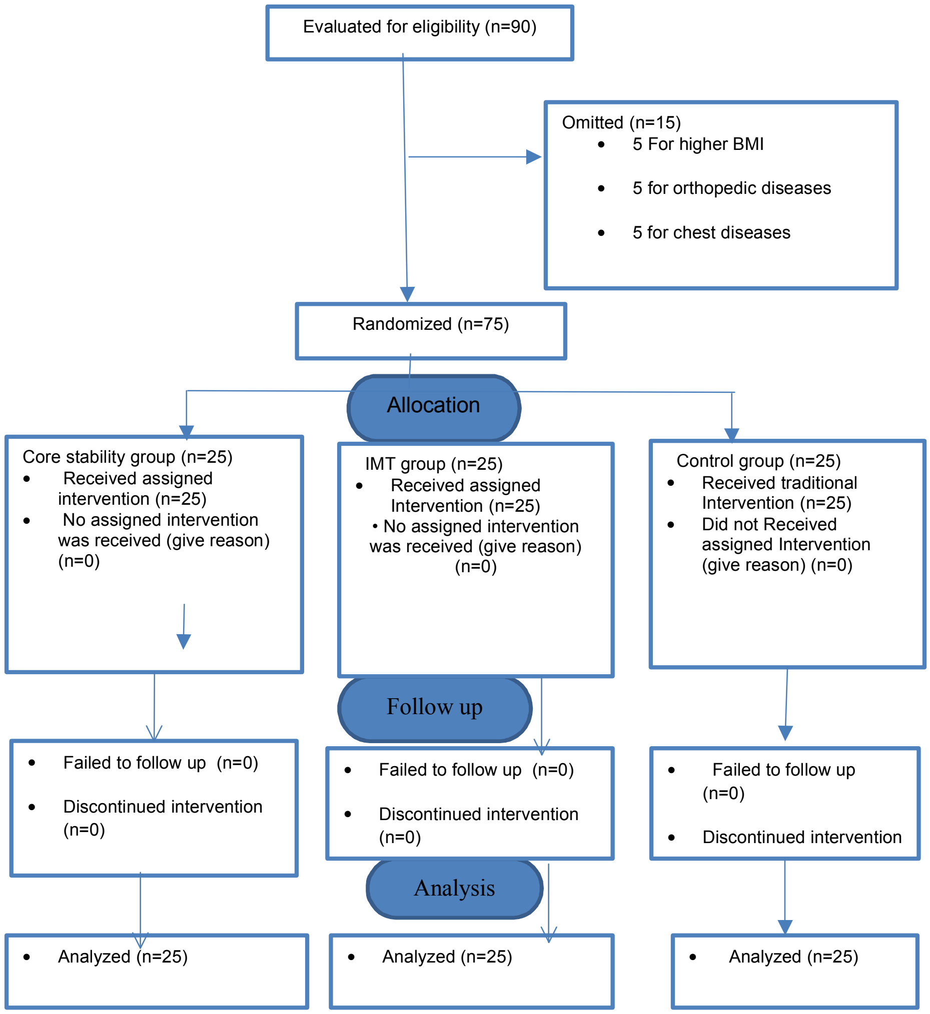

Figure 1: Study flow chart.

to create a bridging position. The knee joint was kept in a cross-extended position. After that, they were instructed to co-contract their pelvic floor, multifidus, and transverse abdominis muscles while lying face down and maintaining a crawling posture. They were then instructed to repeat this exercise with the other arm and leg after stretching one arm and the other. Three sets of five minutes each were dedicated to practicing each position. The intervention lasted for eight weeks, with a total of thirty minutes of activity five times a week [5].

The IMT Training for Group (B): They underwent diaphragmatic strengthening utilizing the green power lung device three times weekly, with each session lasting 10 minutes. The breathing cycle involved the following steps: (a) correctly placing the mouthpiece in the mouth before starting to inhale and making sure to finish the breath before removing the mouthpiece for exhaling normally; (b) inhaling through a power lung device for 3 seconds, filling the lungs as much as possible during this time, and listening for a smooth and full sound of air passing through the device. Allow your respiratory muscles to adapt for duration of two seconds prior to exhaling. (c) Exhale for a duration of three seconds, completely releasing the breath from your lungs, and pay attention to the presence of a complete and uninterrupted sound of air passing through the device. (d) Nasal clips were used during IMT training to obstruct the subject's nasal passage. Each session had three sets of ten repetitions. Each set had duration of roughly 2 minutes, and there was a 2-minute pause with regular breathing between each set. (e) After completing ten repetitions without encountering respiratory muscle exhaustion, dizziness, or lightheadedness, the patients were directed to raise the inspiratory and/or expiratory dial, which controls the airflow resistance, by one [13] **.**

The Conventional Program Was Done for the Three Groups (A, B, and C) and it Consisted of Khot and Hande [14]:

1. **Flexibility Exercise Phase:** The calves, hamstrings, quadriceps, and adductors may all be worked in 10 minutes (15 sec hold and 3 repetitions).

2. **Strengthening Exercise for about 10 Minutes:** All exercises were performed 10 times (abdominal and spinal extensors, hip abductors, hip extensors, hamstrings, and quadriceps).

3. **Postural Control Exercise about 10 Minutes:**

- stepping in all directions
- Exploring the boundaries of stability in various postures
- step up and down
- Sessions are broken up into 2 sets with breaks in between.

Statistical Analysis: All statistical analyses were performed employing version 22 of SPSS. The demographic features of all participants in the three groups were analyzed utilizing one-way ANOVA; however, the Kurskal-Wallis test was employed for comparing the sex between groups. Furthermore, MANOVA was employed to determine the differences between the three groups prior to and following the intervention, pairwise test was performed to detect the effect of the intervention within every group, and multiple comparisons were performed to identify the significant variations between every group and the other. The significance level for all statistical tests was set at $P<0.05$.

RESULTS

Typically, 75 participants were assigned to this investigation and distributed in three groups (25 patients per group) at random. Demographic data analysis was performed and exhibited that no significant variations between the three groups in terms of their age, weight, height, BMI, and sex were found, as the P-values were (0.476, 0.292. 0.967, 0.146, and 0.504, respectively) (Table 1).

Regarding sit-to-stand test results, there was no statistical variation between groups A, B, and C before the intervention, while significant variation was identified post-intervention between all groups (P=0.006) (Table 2). Multiple comparisons were conducted and indicated that no statistical variation was observed between groups A and B as well as groups B and C; however, there was statistical variation between groups A and C (P=0.009). The outcomes indicated there were significant effects of the intervention in both groups A and B, with a percentage of change of 27.1% and 14.1%, respectively; however, no statistical variation was detected in group C (Table 2).

Furthermore, the findings exhibited that a significant variation between all groups post-treatment was observed regarding the Timed up-and-go test, but no significant difference was detected pre-intervention (Table 2). The multiple comparisons revealed that no significant variation was detected between groups A and B as well as between groups B and C; however, a significant disparity was seen between groups A and C, with a P-value of 0.049. Moreover, there was a significant impact of the intervention in group A, with a proportion of alteration of 19%. However, no significant effect was observed in groups B and C (Table 2).

Table 1: Comparison of characteristics between groups A, B, and C.

		Group A N=25 $\bar{X} \pm SD$	Group B N=25 $\bar{X} \pm SD$	Group C N=25 $\bar{X} \pm SD$	F-value	P-value
Age (years)		69.7±3.3	69.7±3.5	70±3.4	0.749	0.476
Weight (kg)		86.5±19.7	79.1±17.1	81.4±13.7	1.251	0.292
Height (cm)		171.4±12.7	170.4±14.3	171.2±12.3	0.034	0.967
BMI (kg/m²)		29.3±5.6	26.9±4.9	27.3±2.9	1.976	0.146
		N (%)	N (%)	N (%)		
Sex	Male	18(72%)	16(64%)	14(56%)		0.504
	Female	7(28%)	9(36%)	11(44%)		

$\bar{X}$: Mean, SD: Standard deviation, p-value: Probability value, *: significance, N: number of participants

Table 2: Sit-to-stand and Timed up-and-go tests comparison within and between groups A, B, and C.

Variables		Group A $\bar{X} \pm SD$	Group B $\bar{X} \pm SD$	Group C $\bar{X} \pm SD$	Comparison between Groups F-value	P-value
Sit-to-stand (rep/30 sec)	Pre-Treatment	5.9±1.3	6.4±1.5	6.7±1.4	2.115	0.128
	Post-Treatment	7.5±1.4	7.2±1.3	6.4±1.2	5.470	0.006*
	Change %	27.1%	14.1%	5.4%		
	Comparison within Group	P<0.05*	P=0.002*	P=0.142		
Timed up and go test	Pre-Treatment	14.2±3	12.4±2.8	12.7±3.4	2.357	0.102
	Post-Treatment	11.4±3.1	11.9±2.9	13.4±2.3	3.431	0.038*
	Change %	19%	4.5%	5.7%		
	Comparison within Group	P<0.05*	P=0.166	P=0.265		

Multiple Comparisons (post-treatment)	Sit-to-stand MD	Sit-to-stand P-value	Timed up and go test MD	Timed up and go test P-value
Group A vs. Group B	0.28	0.747	-0.44	0.885
Group A vs. Group C	1.16	0.009*	-1.96	0.049*
Group B vs. Group C	0.88	0.062	-1.52	0.161

$\bar{X}$: Mean, SD: Standard deviation, MD: mean difference, p-value: Probability value, *: significance, change %: percentage of change

DISCUSSION

We propose to compare the effect of Inspiratory muscle training (Green Powerlung device) versus core stability training on balance problems using the time up and go test and 30 sec sit to stand the test in older adults.

The current study revealed a significant improvement in STS in groups (A and B) with a percentage increase of (27.1 and 14.1%, respectively, and in TUG only in group A, with a percentage increase of 19%. There was no significant improvement in STS in group C, with percentage of increase 5.4%, and in TUG in groups (B and C) with a percentage of increase 4.5 and 5.7%, respectively.

The outcomes of the current investigation agreed with Kang [5], who found that the ability to balance was statistically significantly improved in the senior participants who performed core strengthening exercises.

Exercises for the core stability muscles improve brain adaptations, such as faster nervous system activation, more effective neural patterns, and improved motor and neuronal unit coordination [15].

In another RCT, Sadeghi *et al*. [16] assessed the implications of core stability exercise training on balance (TUG) in a group of 15 older individuals with a previous history of falls. The study revealed that central stability training had a noteworthy and statistically significant influence on TUG (P = 0.001).

On the other hand, the outcomes of the current investigation considering the STS score were not consistent with Arnold *et al*. [17], who demonstrated a pilot study contrasted standard balance (SB) exercises with core stability exercises to improve balance and postural control (EB) in older individuals undergoing a nine-week training program. In 23 older people with at least one fall risk factor, kinematic performance and repetitions in 30 seconds (STSreps) were measured before and following the intervention, and there was no significant improvement in STSreps.

The findings of this research contradicted the results reported by Ferraro *et al.* [9], who observed that the IMT (Powerbreath device) group showed a considerable improvement in completing the TUG test following 8 weeks, with a hindrance of 5.3% compared to their initial performance. Balance gains may be attributed to enhancements in inspiratory muscle strength, leading to beneficial alterations in diaphragmatic phasic contractions and the capacity to elevate intra-abdominal pressure.

Furthermore, the outcomes lined up with Ferraro *et al*. [18], who observed a noteworthy 15% enhancement in the performance of the IMT group in the 30sSTS tests following 8 weeks.

In this study, the control group did not manifest a significant increase in TUG scores. This outcome contradicts the conclusion of Surbala *et al.* [19] , who found that a conventional balance training program resulted in a significant improvement in functional balance, as evidenced by a significant elevation in TUG score from 16.6±1.0 to 15.2±1.0 (p-value <0.05).

Ultimately, we suggest that the efficacy of diaphragmatic training in elderly people with balance problems should be evaluated in subsequent research, also using an objective method for the evaluation.

CONCLUSIONS

Herein, we concluded that training with core stability exercise combined with conventional balance exercise improves balance problems in the elderly more than IMT when combined with conventional balance exercise or conventional balance exercise alone. It appears that keeping balance in the elderly during daily activities is correlated with strengthening the muscles in the central region of the body. Since independence is crucial for those who have experienced falls in the past, completing these exercises as easy, affordable, and suitable at-home workouts can increase their independence and active engagement.

Limitations: In the current study, because the participants were unavailable, there was no post-training evaluation of the training's impact. Additionally, the lack of an objective evaluation method concedes a research restriction.

Disclosure: The authors affirm that there are no evident or possible conflicts of interest associated with the publication of this work.

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Ethics Approval: The authors affirm that the methodologies used in this work adhere to the ethical guidelines set by the organizations overseeing the study and align with the principles outlined in the 2013 Declaration of Helsinki. The research received approval from the Local Ethics Committee of the faculty of physical therapy at Cairo University, Egypt, under Protocol No. (NO: P.T.REC/012/003092).

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