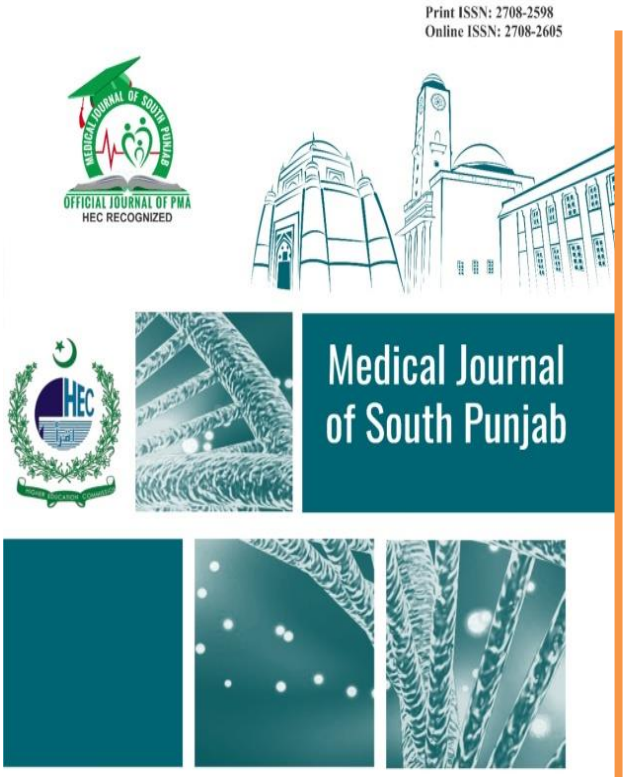
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Comparison between effects of pilate-based stabilization and lower limb strengthening for improving postural stability in post-concussion adults: Randomized Control Trail

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Original Article

Comparison between effects of pilate-based stabilization and lower limb strengthening for improving postural stability in post-concussion adults: Randomized Control Trail

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ABSTRACT

Objective: To compare the effects of Pilates-based stabilization and lower limb strengthening on postural stability in adults with post-concussion symptoms.

Methodology: Randomized controlled trial method was used. This study was conducted in Excel General Hospital, over a period of four months. Sixty-six adults aged between 25 and 45 years who met the following inclusion criteria; neurophysician diagnosed with a concussion and presenting with at least 2 weeks of symptoms were recruited using non-probability purposive sampling and randomly assigned to Group A (Pilates based stabilization, n=33) or Group B (lower limb strengthening to baseline, n=33). All learning and teaching consisted of supervised 20-minute sessions three times per week for 8 weeks, hot packs and posture and ergonomic education for both groups. Participants assessed the modified Balance Error Scoring System (mBESS) which is described below in detail, before and after week 8 to determine postural stability (where lower scores denote greater postural stability). Paired and Independent-samples t-test were used to analyse the data in SPSS version 27 with the significance level set at $p<0.05$.

Results: Six participants dropped out (four in Group A, two in Group B), leaving 60 for analysis (29 and 31). Total mBESS errors decreased from 16.00±3.01 to 8.00±2.45 in Group A and from 16.32±3.02 to 11.52±2.63 in Group B (both $p<0.001$). For Group A, there was a mean improvement of 8.00±1.60 points while Group B had a mean improvement of 4.81±2.07 points. The between-group difference of 3.19 points favoured Group A (95% CI 2.23-4.16; $t(58)=6.643$; $p<0.001$).

Conclusion: Static balance was enhanced with both programmes, but enhancement in post-concussion adults was greater with the Pilates-based stabilization programme than the lower limb strengthening programme.

Keywords: Concussion, Lower limb strengthening, mBESS, Pilates, Postural stability, Rehabilitation

1. INTRODUCTION

Concussion is a mild, traumatic brain injury that causes functional, not macroscopic structural damage, and postural instability is one of its most common and disabling consequences. The majority of patients recover in days or weeks, but for up to 30% of patients symptoms persist with negative impact on quality of life and return to normal activities[1]. The control of upright balance requires integration among the vestibular, visual, somatosensory and motor systems and disruptions of any of these information inputs following a concussion can impact postural control[2, 3]. In daily activities, dizziness and balance disturbances have been associated with falls and risk of consequent injury to the lower limbs, and there is a higher risk for lower limb injury following concussion[4, 5].

The approach to rehabilitation following concussion has shifted from days of inactivity to a slow and progressive approach to activity and aerobic activity is now widely accepted for symptom recovery[6]. There is limited evidence for exercises specifically targeted for postural stability. Pilates focuses on the core activation, controlled movement and proximal awareness, and has enhanced the balance of older adults[7, 8] and the core stability of other groups[9]. However, strengthening exercises of the lower limbs focus on strengthening peripheral muscles, and have been shown to increase balance in older adults[10]. These two approaches have not been compared head to head in the post-concussion adults, and access to structured post-concussion rehabilitation in Pakistan is limited. This type of study aimed at comparing the effects of the same was a study involving adults who have had a concussion and wanted to evaluate how post-concussion adults reacted to a lower limb strengthening vs. a Pilates-based stabilization program.

2. METHODOLOGY

Randomized controlled trial was conducted at Excel General Hospital over four months. G power analysis was performed and a sample size of 60 was indicated for sample size to yield an effect size of 0.5, as stated in the thesis (60%). 66 participants were enrolled (33 in each group) to make up for the allowable dropouts.

It was conducted using sampling technique (Non-probability purposive sampling). From then on, the participants were randomly divided into two groups.

Age 25-45 yrs, gender, diagnosed concussion by a neurophysician, symptoms > 2 wks, and walked without assistive devices.

If patient has severe traumatic brain injury, other vestibular problems (e.g., BPPV, chronic vestibular migraine, Meniere's disease) or neurological disorder (e.g., multiple sclerosis, Parkinson disease, cerebellar disorder, spinal cord injury) or significant visual impairment within the last 6-12 months.

Participants were screened for eligibility and gave informed consent. Baseline mBESS was completed at week 0 and the outcome was retaken at week 8. The groups were given 20 minutes, 3x a week for 8 weeks of supervised sessions under a physiotherapist, and instructions and education on hot packs used and the importance of posture and ergonomics in daily living under conventional care.

The exercises in Group A (Pilates based stabilization) include pelvic tilt/rocks to find a neutral spine, shoulder bridge (pelvic press) with knees at 90° and feet flat on the floor, and side-kick series while lying on your side, with a challenge to get lateral stabilization and strengthen hip stabilizers.

Group B (lower limb strengthening): stationary cycling, light resistance-band squats to neutral head position, body-weight squats to neutral head position, clam shells (hip abductors) and straight leg raises to about 45 degrees without dizziness.

The modified Balance Error Scoring System (mBESS) was used to measure postural stability: postural errors in double-leg, single-leg, and tandem stances on a firm surface with the hands on the hips and eyes closed[11]. Each stance is held for 20 seconds, with a maximum of 10 errors per stance (maximum total 30). The errors observed involved moving hands off hips, opening eyes, foot stumbles or falls, hip flexion or abduction > 30 degrees, lifting forefoot or heel, and out of testing position > 5 seconds. Lower scores mean greater balance.

Data were analysed by SPSS version 27.0. Descriptive data were provided as mean±SD and frequencies. The normality of data was tested using Shapiro-Wilk test. Intra-group differences were compared using paired-sample t tests, and between-group differences in change scores (baseline - week 8) by independent-samples t tests. p value < 0.05 was regarded as statistically significant.

3. RESULTS

There were 33 per group of sixty-six participants. There were six dropouts (four in Group A and 2 in Group B), which resulted in a final number of 60 participants (29 in Group A, 31 in Group B) for analysis. Among the enrolled participants, Group A comprised 13 females (39.4%) and 20 males (60.6%), and Group B comprised 16 females (48.5%) and 17 males (51.5%); overall there were 29 females (43.9%) and 37 males (56.1%). Mean age was 33.55±5.48 years in Group A and 36.06±6.47 years in Group B (overall 34.80±6.09 years). Additionally, Shapiro-Wilk tests revealed a lack of skewness at base, at week 8, and on change scores for both groups (p>0.05) and parametric tests were used.

Table 1: Within Group Comparison of Double-leg stance errors of Group A

Variables	Group A (n=29)			
	Baseline	8th week	Mean difference	P value
	Mean ± S.D	Mean ± S.D		
Double-leg stance errors	3.28 ± 1.07	1.69 ± 0.85	1.586	< .001
Single-leg stance errors	7.31 ± 1.63	3.38 ± 1.32	3.931	< .001
Tandem stance errors	5.41 ± 1.32	2.93 ± 1.28	2.483	< .001
mBESS total errors	16.00 ± 3.01	8.00 ± 2.45	8.000	< .001

The within group comparison of error in double leg stance in Group A (n = 29) between base and 8 week of intervention is shown in Table 4.5. The error score at baseline was 3.28 + 1.07 and decreased to 1.69 + 0.85 after 8 weeks with a mean overall decrease of errors as a result being 1.586. This difference was significant (p < .001), meaning number of balance errors made by the participants significantly decreased for 4th week evaluation compared with baseline. These results imply minimum impact on postural stability in double-leg standing position since lower scores in error in double-leg stance measure an enhanced performance on balance position.

Table 2: Within Group Comparison of Double-leg stance errors of Group B

Variables	Group B (n=31)			
	Baseline	8th week	Mean difference	P value
	Mean ± S.D	Mean ± S.D		
Double-leg stance errors	3.39 ± 0.88	2.13 ± 0.72	1.258	< .001
Single-leg stance errors	6.90 ± 1.42	4.97 ± 1.40	1.935	< .001
Tandem stance errors	6.03 ± 1.58	4.42 ± 1.50	1.613	< .001
mBESS total errors	16.32 ± 3.02	11.52 ± 2.63	4.806	< .001

At 8th week there was significant reduction in balance errors in Group B (Table 2). Double-leg stance errors decreased from 3.39 ± 0.88 to 2.13 ± 0.72, single-leg stance errors from 6.90 ± 1.42 to 4.97 ± 1.40, and tandem stance errors from 6.03 ± 1.58 to 4.42 ± 1.50. Similarly, total mBESS errors decreased from 16.32 ± 3.02 to 11.52 ± 2.63. All improvements were statistically significant ($p < .001$).

Table 3; Between-Group Comparison of CHANGE IN Scores

Variable	Group	Mean ± SD	p-value
CHANGE IN Scores	Group A	8.00 ± 1.60	< .001
	Group B	4.81 ± 2.07	

Table 3 shows that Group A achieved a greater mean change in scores (8.00 ± 1.60) than Group B (4.81 ± 2.07). The between group mean difference was 3.194, and was statistically significant ($p < .001$) with significantly better improvement in Group A.

4. DISCUSSION

This was a randomized controlled trial that compared the effectiveness of a Pilates based stabilization with strengthening of the lower limbs in adults post-concussion on postural stability. The two programmes led to significant decreases in mBESS errors, with a significantly greater reduction in scores for the Pilates-based stabilization programme (8.00 points to 4.81 points; between-group difference −3.19 points, 95% CI −2.23 to −4.16). The null hypothesis was thus rejected.

This improvement in the Pilates group corroborates the previous reviews that report benefits of Pilates for balance in older people[8] and people with multiple sclerosis[12] that, however, are different than those with post-concussion adults and one of the previous reviews was less specific than another on the comparison between Pilates and other exercise[11]. The current study provides first direct comparison evidence in a concussion population. Active, impairment-specific rehab after concussion is also supported by the preponderance of literature beyond that of Pilates[13, 14]. Volume of exercise is correlated to improved postural stability and symptom resolution symptoms[15] and aerobic exercise increases recovery in chronic symptoms agree with improvements for both arms[12].

In group A, where there are graded hip and pelvic movements, then there is an emphasis on linkages/coordination between the trunk and hips, transfer to trunk and hip stability in standing. Exercise to strengthen the leg muscles (like squats, leg raises and band exercises) can overwork muscles in the lower part of the body, and possibly not highlight good control of the trunk. This is an open interpretation as strength and trunk endurance and muscle activation were not measured. In addition to sensory and central mechanisms involved in post-concussion postural impairment (altered reliance on visual and vestibular input[16, 17, 18], gains in stance errors may be attributable to neural adaptation more than muscular effects alone.

This should not be decided that Group B failed the treatment, because group B improved greatly too. There is evidence to show that resistance training helps with balance and strength of the lower extremities in older adults[19] although these programmes in most cases last longer than 20 minutes. Both groups also were given hot packs and posture education, and improvement was not independent of natural recovery since there was no no-treatment control, and repeated testing and therapist contact.

One should also keep in mind that balance outcomes reflect balance function but do not necessarily reflect overall concussion outcome. Adding cervicovestibular rehab over and above aerobic exercise has not been shown to improve overall symptom outcomes for adults with persistent symptoms, but some

physical outcomes have improved in a randomized trial of adults with dizziness[20] and vestibular rehabilitation has been shown to be beneficial for the reduction of dizziness related disability[20]. Our results are limited to static balance and should be interpreted in a context of an impairment based rehabilitation.

The results of this study are subject to certain limitations. The sample size was small and purposive sampling was used to select from a single hospital; limited generalizability. The reliability of the mBESS in those with prolonged symptoms is limited[21, 22] and the test does not assess dual-task, gait or dynamic balance. For the double leg stance, the error post-treatment was found to be low, it is possible that a floor effect occurred. There was no description of blind-up of the outcome assessors, follow-up was limited to eight weeks and symptom burden, adherence and quality of life were not evaluated. There was a 9.1% dropout rate (6 of 66) and the analysis had to be limited to those who completed the study. Lastly, statistical significance does not imply clinical relevance, as there has been no determination of a "minimal clinically important difference" for mBESS in this population.

Future multicentre trials should ensure concealed allocation, blinded assessment, extended follow up, dynamic balance and patient-reported outcomes, direct assessment of trunk and lower limb strength to test proposed mechanisms. Next, implementation research is required with respect to the cost and feasibility of these programmes in resource constrained countries like Pakistan.

5. CONCLUSION

The lower limb strengthening and pilates-based stabilization exercises showed to effectively enhance the static postural stability in the post-concussion adult population, with a significantly greater reduction in the number of mBESS errors in the adults who were treated with stabilization. This could be a potential treatment for post-concussion dizziness and/or postural instability, pending further evidence from larger and longer-duration trials.

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