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PILATES AS AN INSTRUMENT TO IMPROVE BALANCE IN ELDERLY WOMEN: A SYSTEMATIC REVIEW WITH META-ANALYSIS

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Abstract: Introduction: The use of Pilates to prevent falls has increased among physical education and physiotherapy professionals. The search for the method and the incidence of falls are higher among elderly women. Objective: To carry out a meta-analysis of randomized clinical trials that investigated the effect of the Pilates method on balance, assessed by the TUG, in elderly women. Methodology: A search was carried out using the terms "Pilates" AND "balance" AND "aged" until December 2023. 44 clinical trials were found and after selection based on the eligibility criteria, 4 articles were eligible for this research. Statistical analysis was performed using Comprehensive Meta-Analysis. Results: The comparison between the Pilates group and the Control group revealed an effect size = -2.093 (minimum= -2.455 and maximum= 1.731) and Q= 66.946, considering 95% of the confidence interval and p<0.0001. Conclusion: Current literature suggests that Pilates is effective in improving balance in elderly women. However, a greater number of randomized clinical studies of high methodological quality are needed to investigate this subject. Furthermore, the results of this meta-analysis suggest that TUG is useful for detecting improvements in dynamic balance and functional capacity in elderly women undergoing Pilates to improve balance.

Keywords: Aging, physical exercise, postural balance

INTRODUCTION

In 2022, the elderly population in Brazil was over 22 million, which represents an increase of 57.4% compared to 2010 (IBGE, 2022). Advancing years favors the progressive decrease in muscle mass and strength (LAURENTI; MELLO JORGE; GOTLIEB, 2005). Muscle weakness is decisive for postural control, requiring rapid neuromuscular responses in order to maintain and/or recover balance (HAMED et al., 2018; SCAGLIONI; NARICI; MARTIN, 2016; YEUNG et al., 2019). Poor balance has been cited as an important factor associated with physical decline with aging (HAMED et al., 2018; LESINSKI et al., 2015), being correlated with an increased risk of falls (KUKIDOME et al., 2017; OLIVEIRA et al., 2018). Between 2015 and 2020, 328,008 elderly people suffered a femur fracture and were treated by the SUS in Brazil (PINHEIRO, 2021).

Maintaining balance is essential since a fall is always preceded by loss of balance (BAUER et al., 2016). Maintaining postural control requires complex interaction between the sensory, nervous and musculoskeletal systems so that the body's center of mass remains within a support base between the limits of stability in order to minimize possible balance disturbances and prevent falls (ISHIZUKA, 2003; LIMA et al., 2001).

It has already been demonstrated that the most effective interventions for preventing falls are based on balance training and muscle strengthening of the lower limbs (GILLESPIE et al., 2012). The Pilates method has been investigated to improve balance in the elderly. It is based on six fundamental principles, concentration, control, centralization, fluidity in movements, precision and breathing (COSTA; ROTH; NORONHA, 2012; MCNEILL, 2011). A meta-analysis included randomized clinical trials and controlled clinical trials, with samples composed of elderly men and women who assessed static and/or dynamic balance using various tests. The authors concluded that there is evidence suggesting that Pilates can improve balance, and that this is an important risk factor for falls in the elderly. However, the authors emphasize that the effects may have been overestimated due to the low methodological quality of the studies (BARKER; BIRD; TALEVSKI, 2015).

These differences between studies make it difficult to compare results.

We know that the Pilates method is a technique frequently recommended for the elderly population, (SCHOENFELDER; RUBENSTEIN, 2004; SWANENBURG et al., 2010) and that the timed up and go is a widely used instrument for assessing dynamic balance and functional capacity. This test is indicated for its reliability in providing information on functional capacity, gait speed and balance in elderly patients. In addition to being recognized for being a simple test, which does not require sophisticated equipment, is fast and can be applied in any environment (PODSIADLO et al., 1991). In this sense, the objective of this meta-analysis is to systematically analyze the results of clinical trials that investigated the effect of the Pilates method on balance, assessed by timed up and go, in elderly women.

METHODS

A search was carried out in the databases, Pubmed, Scielo, PEDro, with the terms "Pilates" AND "balance" AND "aged" until December 2023. Clinical trials that used the Pilates method as an intervention to improve balance in women were included. elderly women over 60 years old. Studies that evaluated elderly men and that did not use the timed up and go as an assessment instrument were excluded.

Firstly, a total of 102 published articles were found. Of these, 44 were randomized clinical trials. 9 articles were excluded due to duplication, 21 that did not include elderly people in the sample. Four studies with individuals under 60 years of age were excluded, 3 that did not use the Timed up and go instrument and 3 that included men. Thus, a total of 4 articles were eligible for this study (Figure 1).

As all articles were randomized clinical trials, the mean, standard deviation, sample size and p-value values were used. For statistical analysis, Comprehensive Meta-Analysis (version 3.0) was used. The analyzes were performed by comparing the means using Hedges' g, adopting a 95% confidence interval and calculating the heterogeneity of the sample. The post-intervention means in the Pilates group (GP) and the control group (CG) were compared. Furthermore, the pre and post intervention means for the GP and pre and post intervention for the CG were compared.

Figure 1: Study selection flowchart

RESULTS

CHARACTERISTICS OF THE STUDIES

The data extracted from the 4 eligible studies were summarized in table 1, which describes the average age of the participants, sample size and types of intervention. Table 2 presents the level of evidence of the studies based on the scale classification: PEDro.

EFFECT OF PILATES ON BALANCE

Figure 1 shows the effect size of studies that compared the effect of the Pilates method, pre and post intervention, on the balance of elderly women. In this analysis, a mean difference less than 1.0 indicates that the Pilates method was effective in reducing the time to perform the timed up and go, being effective in improving dynamic balance. A mean difference of 1.0 indicates no effect. And, a mean difference greater than 1.0 indicates that the Pilates method did not improve dynamic balance.

In this study, the effect size value was -0.482, with maximum and minimum values, respectively, of -0.656 and -0.308 at the 95% confidence interval, and a p value < 0.0001, comparing the pre and post intervention results. from the Pilates group. Thus, there is moderate evidence that the Pilates method is

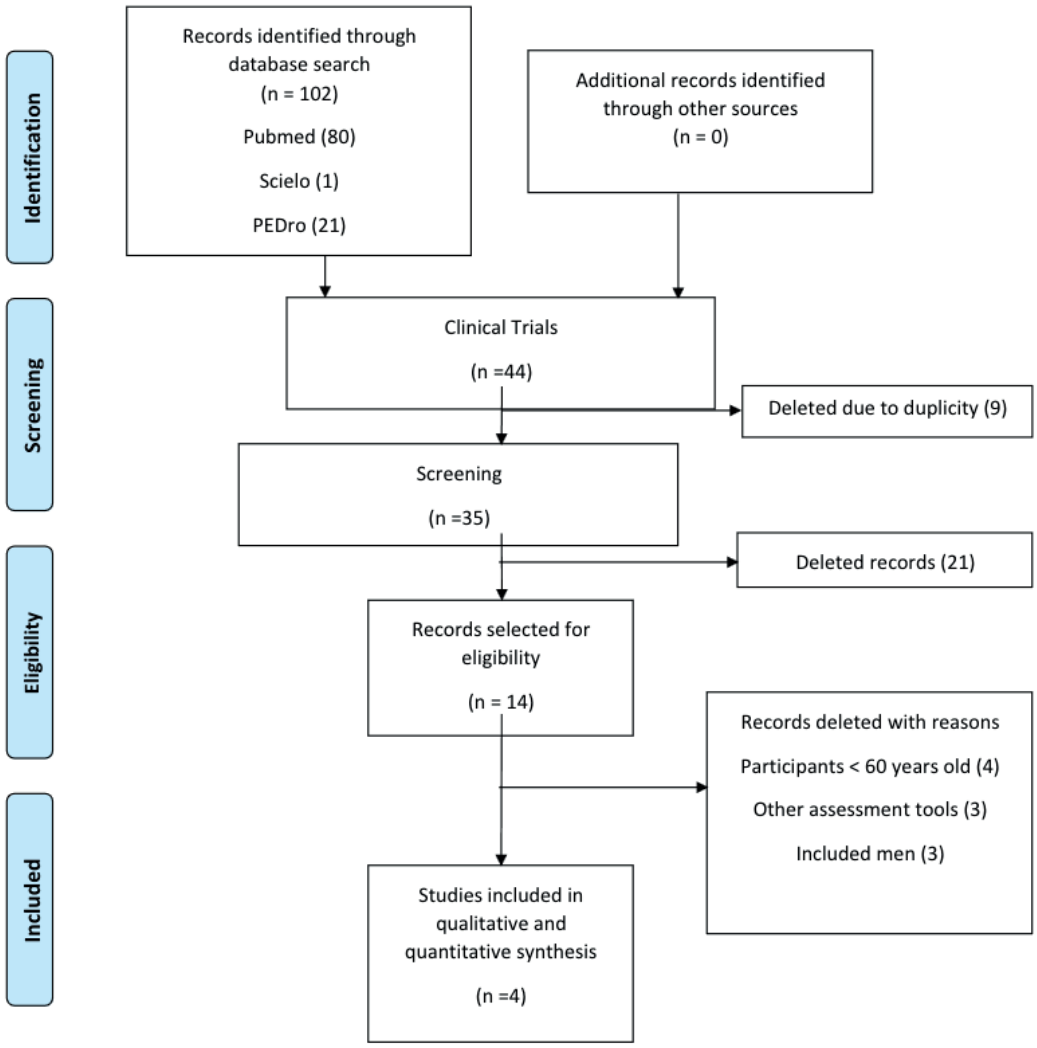

Figure 1: PRISMA Flow Diagram. The eligibility reasons for the excluded articles were associated with the sample selection (age, mixed samples with men and women or only men) and the non-use of the up and go imed to assess balance.

Study and year	N		Age (DP)		Intervention							
					Description of exercises		Frequency		Duration of intervention		Duration of session	
	GP	GC	GP	GC	GP	GC	GP	GC	GP	GC	GP	GC
Cruz-Diaz, D. et. al., 2015	47	50	72.81 (3.47)	69.58 (2.21)	Pilates/ Massagem/ Alongamento/ TENS/	Massagem/ Alongamento/ TENS	2x/ sem	2x/ sem	6 sem	6 sem	100 min	40 min
Mesquita, L. S. et al., 2015	20	18	67.3 (4.9)	71.5 (6.2)	Pilates	Sem intervenção	3x/ sem	-	4 sem	-	50 min	-
Vieira, N. D. et al., 2017	21	19	66.0 (1.35)	63.3 (0.91)	Pilates	Sem intervenção	2x/ sem	-	12 sem	-	60 min	-
Hyun, Y. et al., 2014	20	20	70.0 (2.2)	69.3 (2.6)	Pilates solo	Exercício em superfície instável	3x/ sem	3/ sem	12 sem	12 sem	40 min	40 min

Subtitle: N=number of participants; GP=Group Pilates; GC=Group Control; Sem=week; Min=minute;

Table 1. Characteristics of the studies

	PEDro Scale	Cruz-Diaz, D. et. al., 2015	Mesquita, L. S. et al., 2015	Vieira, N. D. et al., 2017	Hyun, Y. et al., 2014
1	Specified eligibility criteria	0	1	1	1
2	Random distribution	0	1	0	0
3	Secret allocation	0	0	1	0
4	Similar groups at the beginning	1	1	1	1
5	Blind people	0	0	0	0
6	Blind therapist	0	0	0	0
7	Blind assessor	1	1	0	0
8	Adequate follow-up	1	1	0	0
9	Intent-to-treat analysis	1	0	0	0
10	Statistical comparison between groups	1	1	1	1
11	Precision and variability measures	1	1	1	1
	Total score	**6**	**7**	**5**	**3**

Table 2. Classification of articles according to the PEDro scale

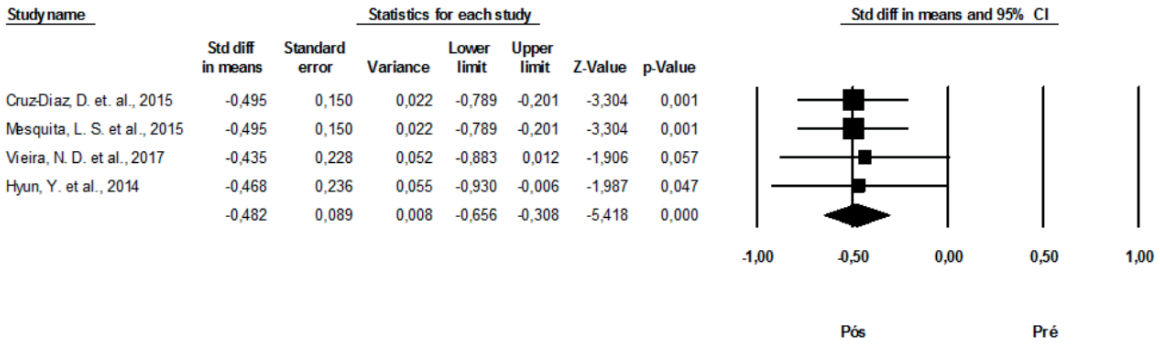

Figure 1: Comparison of pre and post intervention results of the Pilates group

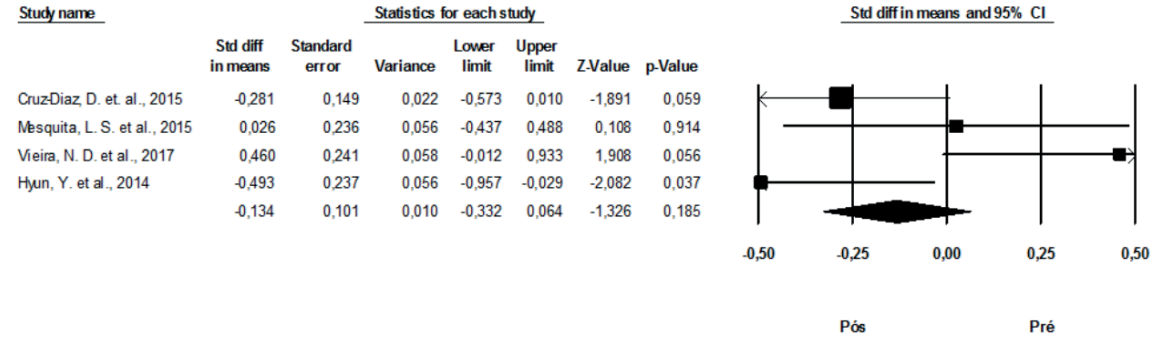

Figure 2: Comparison of pre and post intervention results of the control group

effective in improving the balance of elderly women when assessed using the timed up and go method (Figure 1).

Figure 2 shows the effect size of pre- and post-intervention comparisons in the control group, for the timed up and go results. Considering the comparison of pre- and post-intervention results in the Control Group, the effect size was -0.134, with a minimum value of -0.332 and a maximum of 0.064, with a 95% confidence interval (p= 0.185). Therefore, there is no evidence that the other interventions used in the studies evaluated were effective in improving the balance of elderly women.

Figure 3 shows the effect size of post-intervention comparisons between the Pilates and Control groups. There was a significant difference in balance assessed by timed up and go between the Pilates and Control groups. In this analysis, a mean difference less than 1.0 indicates that the study was favorable to the Pilates method. The effect size was -2.093, with minimum and maximum values of -2.455 and 1.731 respectively, considering 95% confidence interval and p-value<0.0001. All studies were favorable to the Pilates Group.

In table 3 we can observe homogeneity between the studies in the pre and post GP comparison. In the pre- and post-CG comparison, we found that the studies showed some variation in effect size, denoting heterogeneity. Finally, in the post-intervention comparison of the GP with the CG, we observed great heterogeneity between the studies.

The inclusion and exclusion criteria aimed to minimize differences between studies, making it easier to compare results. However, the Funnel graph shows that among the 4 studies analyzed, 3 were outside the slope of the graph, denoting possible publication bias (Figure 4).

DISCUSSION

The results of this meta-analysis showed that the Pilates method appears to be effective in improving balance in elderly women, over the age of 60, assessed using the Timed up and go instrument. The interventions carried out with the control groups did not prove to be effective in improving balance. When comparing the Pilates and Control groups, there was a significant difference between the groups, indicating that the GP obtained better results when compared to the CG.

In the pre- and post-intervention comparison of the Control Group, the p value was not significant and the effect size was 0.13. However, the variation in effect size between studies is equally important, represented by the Q value, which demonstrated that there is heterogeneity between the studies evaluated in this comparison. Therefore, it is imperative to understand why the intervention in the Control Group was effective in just one study, compared to other studies.

The study by Vieira et al. (VIEIRA et al., 2017) did not carry out any type of specific intervention in the Control Group, only the participants' usual activities were maintained. However, the authors do not describe what types of activities these were. The study by Mesquita et al. (SEPÚLVEDA DE ANDRADE MESQUITA et al., 2015), also did not use any type of intervention in the Control Group, maintaining only activities of daily living. In the study by Cruz Dias et al. (CRUZ-DÍAZ et al., 2015), the Control Group underwent physiotherapeutic treatment using TENS (Transcutaneous Electrical Neurostimulation), massage and stretching for 40 minutes. Finally, the study by Hyun et al. (HYUN; HWANGBO; LEE, 2014), which used balance training exercises using an unstable surface for 40 minutes, was the only one that showed a significant difference between pre and post intervention in the

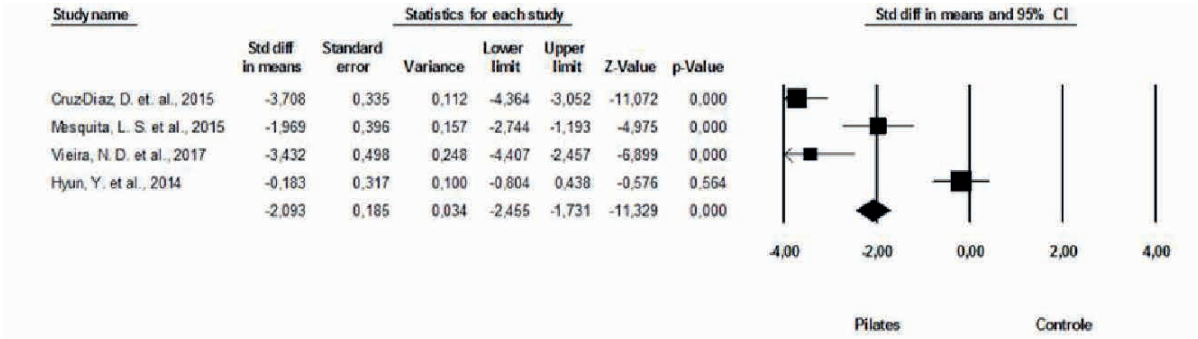

Figure 3: Comparison of pre and post intervention results between the Pilates and control group

		Effect size and 95% confidence interval					Test of null (2-Tail)		Heterogeneity				Tau-squared			
	Model	N Studies	PE	SE	V	Lower limit	Upper limit	Z-Value	P-Value	Q-Value	Df (Q)	P-Value	I-Squared	TS	SE	V	Tau
Pre and Post GP	Fixed	4	-0,482	0,089	0,008	-0,656	-0,308	-5,418	0,000	0,061	3	0,996	0,000	0	0,027	0,001	0
	Random	4	-0,482	0,089	0,008	-0,656	-0,308	-5,418	0,000								
Pre and Post GC	Fixed	4	-0,134	0,101	0,01	-0,332	0,064	-1,326	0,185	9,807	3	0,02	69,411	0,1	0,121	0,015	0,317
	Random	4	-0,087	0,191	0,037	-0,462	0,288	-0,456	0,648								
Post GP x GC	Fixed	4	-2,093	0,185	0,034	-2,455	-11,329	3,006	0,000	66,946	3	0,000	95,519	3,008	2,662	7,089	1,734
	Random	4	-2,31	0,889	0,79	-4,053	-2,599	3,006	0,009								

Legenda: GP=Grupo Pilates; GC=Grupo Controle; PE=point estimate; SE=standard error; V=variance; TS=T-squared.

Table 3. Effect Size and Heterogeneity of studies

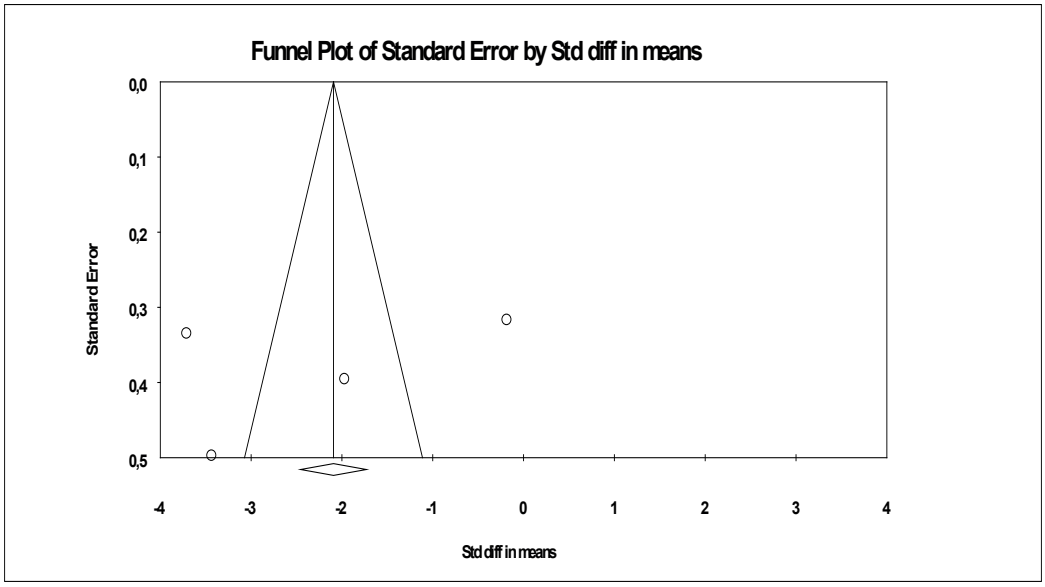

Figure 4. Funnel Plot

Control Group, which can be justified by the type of intervention used.

In the post-intervention comparison between GP and CG, the p value was very significant and the effect size was large, -2.093. However, the Q value was 66.946, demonstrating that there is great heterogeneity between the studies evaluated in this comparison. When we evaluate the p value individually, we only notice the study by Hyun et al. (2014) showed no significant difference between the Pilates and Control groups. This study was unique in that the control group performed an effective intervention to improve balance. This confirms the effectiveness of both interventions (Pilates and balance training on an unstable surface). And according to Gillespie et al. (2012), the most effective interventions for preventing falls are based on balance training and muscle strengthening of the lower limbs, which explains the results obtained by Hyun and collaborators. Already, the studies by Cruz Dias et al. (2015), Mesquita et al. (2015) and Vieira et al. (2017) showed a significant difference between the Pilates Group and the Control Group post intervention. Cruz Dias and collaborators did not use interventions to improve balance in the control group, while Mesquita et al. and Vieira et al. They did not apply any type of intervention to the control group, they just maintained the participants' usual activities. Thus, it is clear why there was a large difference observed between the Pilates group and the Control group. These methodological differences between studies make the great heterogeneity presented understandable.

Barker and collaborators (BARKER; BIRD; TALEVSKI, 2015), carried out a meta-analysis to investigate the effect of Pilates on balance and falls in elderly people (men and women) and used 6 randomized clinical trials that applied different instruments to assess balance, including the Timed up and go. The choice of studies that evaluated only women was based on the fact that women have a higher incidence of falls (SCHOENFELDER; RUBENSTEIN, 2004). The results of Barker and collaborators are in line with our findings, concluding that Pilates can improve balance, and that this is an important risk factor for falls in the elderly. However, the authors emphasize that the effects may have been overestimated due to the low methodological quality of the studies, which was also observed in our meta-analysis and could be confirmed by the PEDro scale.

When evaluating the included articles using the PEDro Scale, the ratings obtained were equal to or less than seven. The study by Hyun et al. (2014) was classified by the authors as having a low level of evidence, three points on the PEDro scale and was the only study that compared the Pilates method with a type of intervention focused on balance training.

The present meta-analysis presents a sample size bias, as it evaluated only 4 randomized clinical trials, which used the Timed up and go instrument to evaluate balance in elderly women before and after intervention with the Pilates method. This fact is due to the few published studies that evaluated balance using Timed up and go. As a result, the authors were aware that the number of studies found could be reduced. Furthermore, the large dispersion in the funnel plot constitutes another bias. Determining a single assessment instrument aimed to allow better comparisons between studies.

Conclusion

Current literature suggests that Pilates is effective in improving balance in older women. However, more high-quality randomized clinical studies on this topic are needed, especially for comparisons with other interventions. Furthermore, the results of this

meta-analysis suggest that Timed up and go is a useful instrument for detecting improvements in dynamic balance and functional capacity in elderly women undergoing the Pilates method.

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