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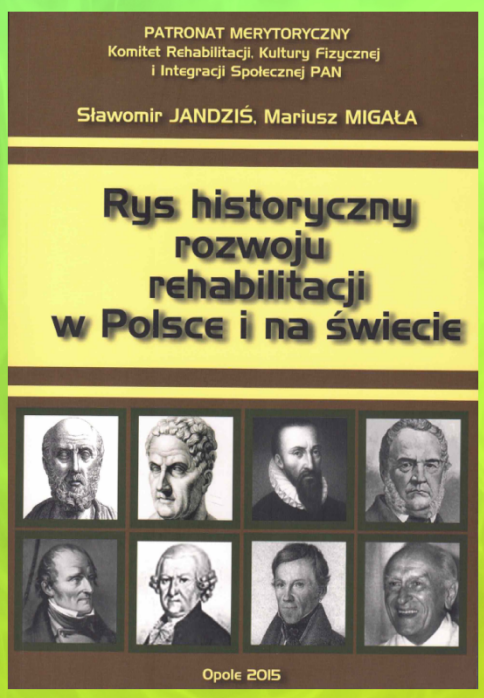

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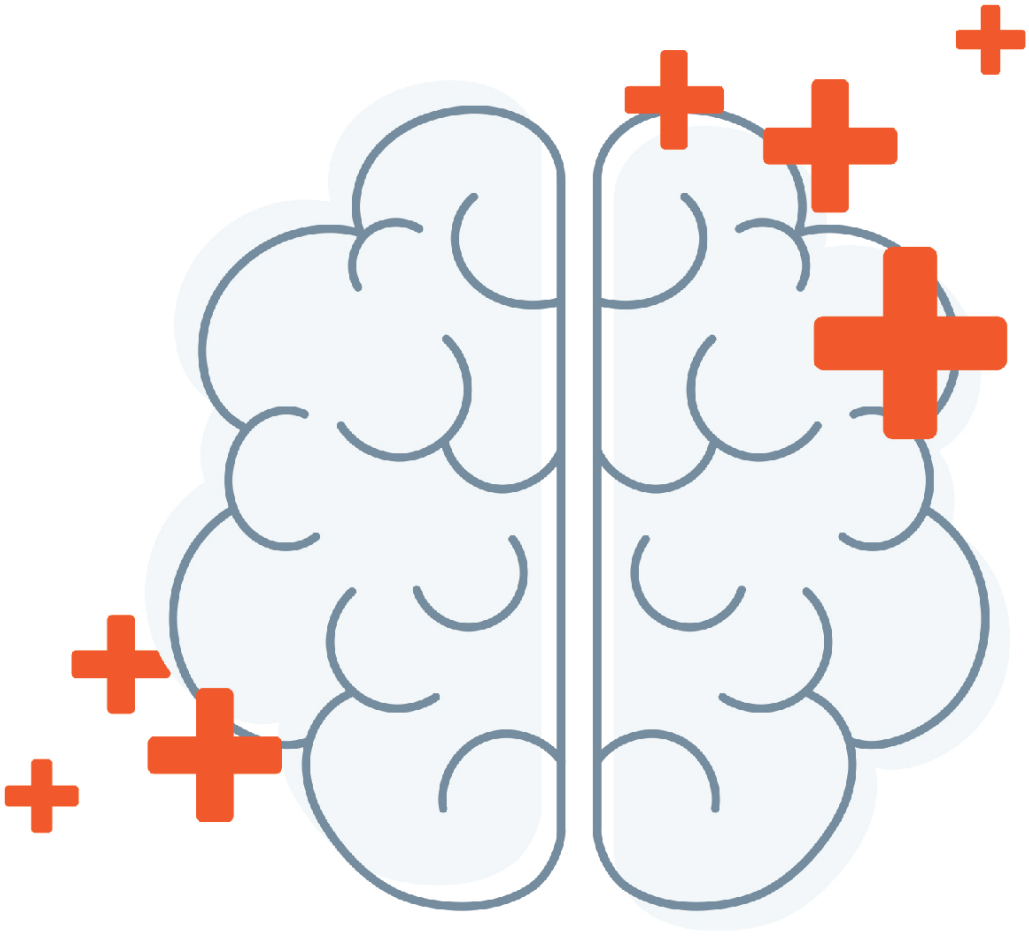

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Effect of pilates training on cognitive functions in patients with stroke: A randomized controlled trial

Wpływ treningu pilates na funkcje poznawcze u pacjentów po udarze mózgu: randomizowana kontrolowana próba

Raghda Nasr Nassar[1(A,B,C,D,E,F)], Nawal Abou Shady[2(A,C,D,E,F)], Mohamed Nabil El- Bahrawy[2(A,B,D,E,F)], Ahmed Abdelalim[3(A,B,D,E,F)]

[1]Physical Therapy for Neuromuscular Disorders and its Surgery Department, Faculty of Physical Therapy, Benha University, Egypt
[2]Physical Therapy for Neuromuscular Disorders and its Surgery Department, Faculty of Physical Therapy, Cairo University, Egypt
[3]Neurology Department, Faculty of Medicine, Cairo University, Egypt

Abstract

Purpose. To investigate the effect of pilates training on cognitive functions in patients with stroke. Materials and Methods. Forty Right stroke patients (Left hemiparesis) of both genders with age ranged from 50–65 years old were recruited randomly and divided into two equal groups; Study group (I) received pilates training therapy and selected physical therapy program for 6 weeks, Control group (II) received the same selected physical therapy program only for 6 weeks. Pre- and post-treatment assessment using RehaCom System, Montreal Cognitive Assessment (MoCA) and Mini-Mental State Examination (MMSE) were done for all patients. Results. Cognitive disorders (Attention, Memory, Reaction behavior and logical reasoning) were significantly improved in study group (pilates training therapy) more than control group (selected physical therapy program). cognitive disorders were improved in both groups with the best improvement results of group (I) more than group (II). Conclusion. Pilates Training program considered an effective physical therapy method for improving cognitive disorders in patients with stroke.

Keywords

stroke, pilates training, cognitive disorders

Streszczenie

Cel. Zbadanie wpływu treningu pilates na funkcje poznawcze u pacjentów po udarze mózgu. Materiał i metody. Czterdziestu pacjentów po udarze mózgu po prawej stronie (niedowład połowiczy lewostronny) obu płci w wieku od 50 do 65 lat zrekrutowano losowo i podzielono na dwie równe grupy; Grupa badana (I) wykonywała trening pilates i wybrany program fizjoterapeutyczny przez 6 tygodni, grupa kontrolna (II) realizowała ten sam wybrany program fizjoterapeutyczny przez 6 tygodni. U wszystkich pacjentów przeprowadzono ocenę przed i po leczeniu za pomocą systemu RehaCom, Montreal Cognitive Assessment (ocena funkcji poznawczych MoCA) i Mini-Mental State Examination (badanie stanu umysłowego MMSE). Wyniki. Zaburzenia poznawcze (uwaga, pamięć, reakcje i logiczne rozumowanie) uległy znacznej poprawie w grupie badanej (trening pilates) bardziej niż w grupie kontrolnej (wybrany program fizjoterapeutyczny). Zaburzenia poznawcze uległy poprawie w obu grupach z najlepszymi wynikami poprawy w grupie (I) wyższymi niż w grupie (II). Wniosek. Program treningowy pilates uważa się za skuteczną metodę fizjoterapeutyczną poprawiającą zaburzenia poznawcze u pacjentów po udarze mózgu.

Słowa kluczowe

udar, trening pilates, zaburzenia poznawcze

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Introduction

Cognitive impairment was defined as deficits in four or more domains of attention, memory, orientation, language, visuospatial ability, and abstract reasoning. It occurs in up to 64% of people who have had a stroke and has been associated with a 3-fold increase in risk for mortality, institutionalization and decreased instrumental activities of daily living function [1]. Cognitive impairment was found in the vast majority of late middle-aged and older patients six months after ischaemic stroke, and it was very frequent even in patients with seemingly successful clinical recovery and no functional disability. Typically, complex cognitive abilities, including long-term memory encoding and retrieval, focused attention and executive functions as well as visuo-constructional abilities, were compromised [2].

Patients with right hemisphere brain damage most commonly have difficulties with attention, perception, learning, memory, recognition and expression of emotion, neglect and deficits include reasoning and problem solving, awareness, and orientation [3]. Pilates is a training program that has become very popular in recent years and it has beneficial effects on both core stabilization and the whole body stability. It is different from other exercise programs, as it includes respiratory component. Pilates provides complete coordination of body, mind and spirit. It based on six principles; breathing, control, concentration, precision, fluidity and centralization which enable to increase attention, motivation and enhance cognitive functions while minimizing stress [4]. The method combines principles of exercises from the Eastern cultures (control of motion by the mind, precision, body centre as the main energy point, proper breathing and relaxation) and the Western cultures (endurance training, stabilization) [5]. The lack of primary related studies and research on the role of pilates training on cognitive functions in patients with stroke. Unfortunately, there is a divergence of opinion regarding the best physical therapy strategy for cognitive functions in patients with stroke. As a result, the current study attempted to investigate the effect of pilates training on cognitive functions in patients with stroke.

Materials and methods

Design

A randomized controlled trial (RCT) was conducted to investigate the effect of pilates training on cognitive functions in patients with stroke. Data were collected pre and post treatment from (Septemper 2020 to June 2021). Research Ethics Committee before study commencement [P.T.REC/012/002572] at date of: 1/12/2019. Clinical trial registration number: NCT04157582.

Participants

Forty left (Lt) hemiparetic patients were recruited by a specialized neurologist from the Outpatient Clinics of Neurology, Internal Medicine, in Kasr Al- Aini Hospitals, and Outpatient Clinic of Neurology, Faculty of Physical Therapy, Cairo University. All patients from both genders evaluated and diagnosed by neurologist and confirmed by CT and/or MRI of the brain as right (Rt) ischemic stroke in the domain of the carotid system, with muscle power at least grade 3 according to manual muscle testing scale [6]., Duration of illness not less than six months and not more than 18 months [7]. In addition, all patients have mild cognitive deficits in the domains of (attention and concentration, memory, reaction behavior and logical reasoning) with score < 25 according to Montreal Cognitive Assessment scale (MOCA) [8]. and from (18–23) according to Mini-Mental State Examination (MMSE) [9]. Spasticity grade (1,1+) according to the Modified aschworth scale (MAS) [10]. Patients were excluded if they had Hemiparesis due to any cause other than cerebral infarction, cardiovascular problems, dementia, depression, epilepsy, Musculoskeletal problems and Age over 65 years to minimize the effect of aging on cognitive function. All patients written informed consent before the study.

Randomization

A randomized controlled trial and double blinded (all patients were assessed by the same physician before and after treatment. Neither the investigator nor the patients informed of the treatment assignments). Patients divided randomly using a secure system of opaque closed envelopes that was assigned either Study group or Control group. As shown in (Figure1).

Interventions

Study group (I) included 20 participants who received Pilates training in addition to Selected physical therapy program for 6 weeks. Control group (II) included 20 participants who received selected physical therapy program only the same as the study group for 6 weeks.

Pilates training therapy

Each participant in group (I) received Pilates training for 18 sessions every other day for one and half month, 3 sessions / week, each session for 1hour (30 minutes for pilates then 30 minutes Selected physical therapy program). The Pilates key elements were taught to the patients before the clinical Pilates training sessions. These key elements were breathing, focus, and placement of the rib cage, shoulder, head, and neck. Pilates training (30 minutes) in form of Pilates warm-up (5 minutes) consisted of (Breathing, Chest stretch, roll down and the Toy soldier) (Repeat each exercise 10 times) then Pilates Mat Training (20 minutes) was performed in 5 different positions (supine, side-lying, prone, sitting and kneeling position). (Repeat each exercise 10 times) with Rest between Set of Exercise 10 Seconds, starting with supine position (One leg stretch, Hundreds, the Double leg stretch, the Shoulder bridge, and the Hip twist), side-lying position (The Side kick, Arm openings and Leg lifts), prone position (Swan dive, the One leg kick and the Breast stroke), sitting position (Half roll back, Oblique roll up) and Swimming performing in the kneeling position. Ending with Pilates cool down (5 minutes) were (The Saw, Chest stretch and Spine stretch) [11].

Selected physical therapy program

All participants in both groups (I & II) received 18 sessions every other day for one and half month, 3 sessions /week of Selected physical therapy program which was comprised of gentle

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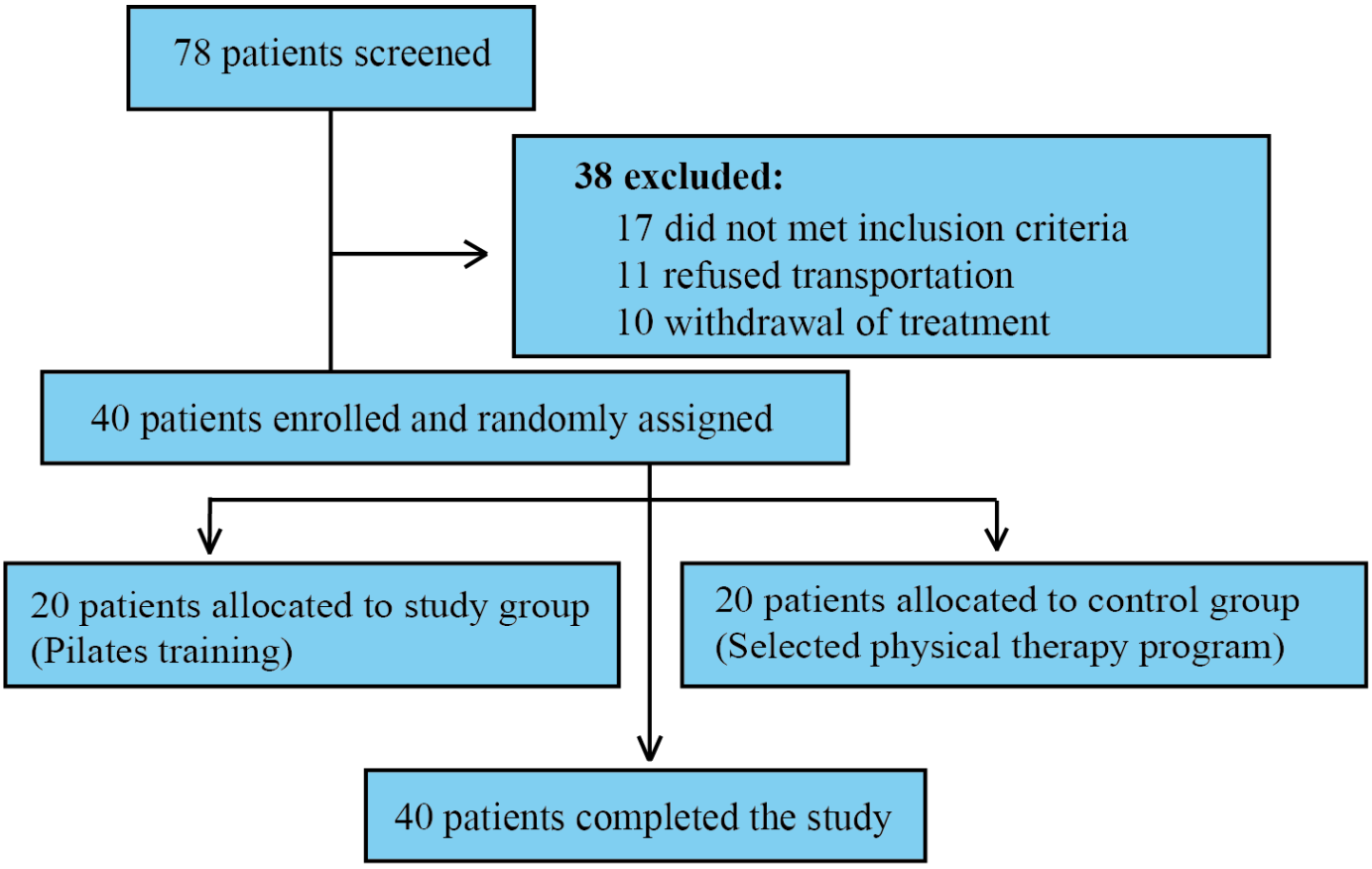

Figure 1. Flow chart of the patients

passive stretching for (elbow flexors, wrist flexors, hamstring and calf muscle), mobility training, Strengthening Exercises for (elbow extensors, wrist extensors and foot dorsiflexors) and Balance training inform of (Wobble board training) [12].

Outcome measures

Computer-based cognitive device RehaCom

It was used to evaluate cognitive disorders pre- and post-treatment for both groups (I & II). RehaCom is a software program that has been developed in collaboration with experts and therapists. It is a screening, scientifically based and clinically tested part that help to identify suspected cognitive impairments. It contains different modules for assess the cognitive impairments of patients with neurological and/or psychiatric diseases that affect specific domains of (attention, orientation, memory, perception and executive skills) pre and post treatment. Each module Starting at a low level of difficulty, the patient was able to solve increasingly complex tasks [13].

Montreal Cognitive Assessment (MoCA)

It was used to evaluate mild cognitive disorders pre- and post-treatment for both groups (I & II). It is a widely used screening assessment for detecting cognitive impairment. It takes approximately 10 minutes to complete. 30-point cognitive screening instrument designed to assess mild cognitive impairment. It purports to assess different cognitive domains [short-term memory, visuospatial abilities, executive function, attention, concentration, working memory, language and orientation to time and place]. MoCA scores range between 0 and 30, A score of 26 or over is considered to be normal [8].

Mini-Mental State Examination (MMSE) or Folstein test

It measures early and middle stages of cognitive decline pre- and post-treatment for both groups (I & II). The most commonly used cognitive screening tool is the Folstein Mini-Mental State Examination (MMSE). With administration taking about 15 minutes and has a maximum score of 30. It is a 30-point questionnaire includes assessment of attention, orientation, registration, recall, short-term memory, language, and visuospatial construction. When the resulting MMSE is 24 points or less, this means that the patient may suffer from some degree of cognitive impairment [9].

Statistical analysis

Results were recorded in regards of the mean ± standard deviation (SD) of measured variables. According to the normality test, comparison the cognitive functions parameters, MOCA and MMSE between and within groups was performed using 2x2 mixed designs MANOVA. Data analysis was performed using the Statistical Package for Social Sciences (SPSS) computer program (version 23 windows). Significance was considered significant at p-value ≤ 0.05 and highly significant at $P < 0.01$.

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Results

Of the 78 patients screened for the study, 38 patients were excluded due to some of them did not met inclusion criteria and others denied. The remaining 40 cases randomly to Study group (n = 20) or Control group (n = 20). Demographic data and The primary criteria and patients' characteristics showed that, there were insignificant difference between both groups as shown in Table (1).

Table 1. Baseline characteristics of participants in both groups

	Group A, n = 20 Mean ± SD	Group B, n = 20 Mean ± SD	P-value
Age [years]	58.9 ± 4.48	58.4 ± 4.52	0.72^{NS}
Weight [kg]	70.2 ± 7.09	73.1 ± 5.35	0.15^{NS}
Height [cm]	164.45 ± 5.21	164.5 ± 3.31	0.97^{NS}
BMI [kg/m²]	26.02 ± 3.03	27.03 ± 2.07	0.23^{NS}

^{NS} P > 0.05 = non-significant, P = Probability, BMI: Body mass index.

Mixed MANOVA revealed that there was a significant interaction of treatment and time (F = 240.33, p = 0.0001*). There was a significant main effect of time (F = 440.18, p = 0.0001*). There was significant main effect of treatment (F = 28.61, p = 0.0001*). Table 2 showed descriptive statistics of Cognitive functions parameters, MOCA and MMSE and the significant level of comparison between groups as well as significant level of comparison between pre and post treatment in each group.

There was no statistical significant difference between both study and control groups in all measuring variables pre-treatment (p > 0.05). Post treatment there was a significant increase in Cognitive functions parameters, MOCA and MMSE of the study group compared with that of control group post treatment (p < 0.05). Comparison between pre and post treatment in each group revealed that there was a significant increase (p < 0.05) in Attention & concentration level, Memory level, MoCA and MMSE (p < 0.05) post treatment compared with pre treatment in study and control groups (p < 0.05). As well as, there was a significant increase (p < 0.05) in Reaction behavior level and Logical reasoning level post treatment compared with pre treatment in study group only.

Table 2. Comparison of Cognitive functions parameters, MOCA and MMSE between both groups

		Group (A), (n = 20)	Group (B), (n = 20)	P-value*
Attention & concentration level	Pre training	2.65 ± 0.67	2.3 ± 0.73	0.12^{NS}
	Post training	5.55 ± 1.31	2.8 ± 1.05	0.001^{S}
	% of change	109.43 ↑↑	21.47↑	
	P value**	0.001^{S}	0.009^{S}	
Memory level	Pre training	2.2 ± 0.69	2.1 ± 0.64	0.63^{NS}
	Post training	4.6 ± 1.04	2.4 ± 1.05	0.001^{S}
	% of change	109.09 ↑↑	14.29 ↑	
	P value**	0.001^{S}	0.009^{S}	
Reaction behavior level	Pre training	1.65 ± 0.67	1.8 ± 0.76	0.51^{NS}
	Post training	3.15 ± 0.93	2 ± 1.12	0.001^{S}
	% of change	90.91 ↑↑	11.11↑	
	P value**	0.007^{S}	0.09^{NS}	
Logical reasoning level	Pre training	1.8 ± 0.52	1.9 ± 0.55	0.56^{NS}
	Post training	4.2 ± 0.83	2.1 ± 0.78	0.001^{S}
	% of change	133.33 ↑↑	10.53 ↑	
	P value**	0.001^{S}	0.17^{NS}	
MoCA	Pre training	18 ± 1.07	18.25 ± 1.16	0.48^{NS}
	Post training	22.6 ± 0.82	18.95 ± 1.05	0.001^{S}
	% of change	25.56 ↑↑	3.84 ↑	
	P value**	0.001^{S}	0.001^{S}	
MMSE	Pre training	18.5 ± 0.68	18.65 ± 0.67	0.48^{NS}
	Post training	21.7 ± 0.57	19.15 ± 0.81	0.001^{S}
	% of change	17.3 ↑↑	2.68 ↑	
	P value**	0.001^{S}	0.001^{S}	

** Inter-group comparison; ** intra-group comparison of the results pre and post training.*

^{NS} P > 0.05 = non-significant, ^{S} P < 0.05 = significant, P = Probability, MRT: Minimum reaction time, MoCA: Montreal Cognitive Assessment and MMSE: Mini-Mental State Examination

doi.org/10.56984/8ZG20ASbq

Discussion

Cognitive skills are mental skills required for memory, learning, problem solving, and other functions relating to processing information. The mindfulness found in yoga and pilates is a key reason for fundamental improvements in cognitive function [14].

Pilates training exercise improves neurogenesis , creation of new brain cells ,as well as protects existing cells by prompting in increase in BDNF production , a nerve protecting compound that some scientists call “Miracle-Gro” for the brain. The changes are mostly noticeable in the hippocampus, the region responsible for memories and learning [15]. Pilates training Method is an effective preventive strategy to maintain and improve health status, concentration demonstrating direct and indirect beneficial effects on several aspects and contributing to the prevention of diseases and other comorbidities associated with changes caused stroke [16].

The current study showed that treatment with Pilates training for 6 weeks improves cognitive functions in post stroke cognitive impairment. Furthermore, both groups showed improvement with superiority of pilates training group. Cognitive impairment following stroke also impact negatively on the stroke patients ‘ability to participate fully in their rehabilitation and reach their full rehabilitation potential due to an inability to concentrate efficiently, encode/recall information, or plan and sequence their behaviour, there are relationships between physical and cognitive functions. Pilates training have an obvious effect on cognitive integrity in the brain [17]. Pilates training is one of the most promising strategies in the fight against cognitive disorders, dementia and physical fitness. The improvement in physical fitness also brings cognitive benefits in post stroke rehabilitation. In addition, it is perceived that a greater frequency of stimuli leads to better results [18].

The mindfulness attribute of pilates training tremendously deepens awareness of self. The body responds by boosting the level of feel-good hormones known as endorphins while also suppressing cortisol, a stress hormone. Large amounts of cortisol are associated with mental disorders which range from mild to serious. Pilates are extremely vital for creating hormonal balance necessary for optimum mental well-being [19].

The main limitation of the current study is the lack of a follow-up of the pilates training between the examined groups following the end of interventions by several months to assess the long-term impact.

Conclusion

Pilates training confirmed to be an effective and safety treatment modality for improving cognitive functions in patients with stroke. It determines positive biological and psychological effects that affect the brain and the cognitive functioning and promote a condition of wellbeing.

Adres do korespondencji / Corresponding author

Raghda Nasr Nassar

E-mail: raghda.nassar@fpt.bu.edu.eg

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