

Does Pilates Exercise Change the Memory, Attention and Balance in Women with Lymphedema after Modified Mastectomy?

Arezoo Kazemi¹, MA;  Robabeh Rostami^{1*}, PhD;  Maryam Kooshaki Jahromi¹, PhD; Sedigheh Tahmasebi², PhD

¹Department of Sport Sciences, School of Education and Psychology, Shiraz University, Shiraz, Iran

²Department of Surgery, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran

*Corresponding author: Robabeh Rostami, PhD; Shiraz State University, Eram St, Postal code: 71946-84759, Shiraz, Iran. Tel: +98 71 36134625; Fax: +98 71 36286441; Email: Rostami@shirazu.ac.ir

Received August 6, 2020; Revised November 7, 2020; Accepted December 1, 2020

Abstract

Background: Breast cancer as the most common cancer and deadliest malignancy among women is one of the most important health concerns in the world. Therefore, the present study was conducted in response to the question of whether the Pilates training method affects the memory, attention, and balance of women with lymphedema after modified mastectomy.

Methods: In this quasi-experimental clinical trial, we studied 20 women with an average and standard deviation in (age, 43.03±5.61 year), height (163.85±4.63 cm) and weight (67±3.95 kg). Our subjects referred to Shahid Motahari clinic, Shiraz, Iran in 2019 with lymphedema after modified mastectomy. They were randomly divided into two groups: Pilates and control. The experimental group performed Pilate's exercises for 2 weeks, 3 days a week with 60 minutes long each session. Memory, attention, and balance before and after the training program were assessed using one-way analysis of covariance and paired t-test at a significance level of 0.05.

Results: Statistical analysis of age, height, and weight showed no differences between the two groups. Statistical analysis of paired t-test indicated a significant difference in pre-test and post-test scores of the training group, yet this difference was not significant in the control group.

Moreover, one-way analysis of covariance revealed a significant difference between the two groups in pre to post-tests in the tests of Stroop test [exercise (pre): 449.70±45, (post): 421.30±58.13; Control (pre): 461.30±23.17, (post): 457.10±22.20, P=0.014], n-back [Exercise (pre): 69.50±19.69; (post): 88.00±13.23; Control (pre): 79.40±17.48, (post): 82.00±10.74 P=0.016], and Flamingo [Exercise (pre): 18.49±18.92; (post): 51.57±43.02; Control (pre): 10.85±4.36, (post): 10.83±3.91, P=0.001]. Attention: (431.30±33.59), (461±11.12), memory: (72.50±17.34), (90±8.27), and static balance: (9.96±4.23), (29.39±7.00). In control group, the mean and standard deviation of the scores were as follows: attention: (465.90±10.56), (462.60±6.99), memory: (79.40±17.48), (85.90±4.45), and static balance: (10.85±4.36), (10.83±3.91).

Conclusion: According to our findings, it could be concluded that women with breast cancer can use the benefits of Pilates along with other treatments.

Keywords: Pilates Exercises, Memory, Attention, Balance, Breast Cancer

How to Cite: Kazemi A, Rostami R, Kooshaki Jahromi M, Tahmasebi S. Does Pilates Exercise Change the Memory, Attention and Balance in Women with Lymphedema after Modified Mastectomy? Women. Health. Bull. 2021;8(1):56-62. doi: 10.30476/whb.2021.88043.1083.

Introduction

Cancer is a chronic and non-communicable disease that covers a wide range of diseases. This disease, like other chronic diseases, occurs in any person, regardless of their age group and race; therefore, it is considered as a health problem affecting the health of society (1). Among various types of cancer breast cancer, which accounts for 23% of all cancers in women, is the most common cancer and deadliest malignancy among women. It is one of the most important health concerns in the world (2-4).

Breast cancer as one of the important cancers, which causes several disabilities and death, affects 1.2 million new cases each year (5). This disease is characterized with changes in uncontrolled growth of cells in the

breast tissue that occurs abnormally in the mammary glands (lobules) or in the ducts that connect the lobules to the nipple (duct) (6). The prognosis of cancer and the choice of treatment depends on several factors. Among the most important factors, we could name smoking, obesity, taking oral contraceptives, diabetes, hyperlipidemia, axillary lymph node involvement and the presence of estrogen and progesterone receptors (7, 8). Despite the increase in survival and improvement in treatment methods, numerous side effects are observed in these cases, including upper extremity disorders, lymphedema, fatigue, depression, weight gain and dysfunction of the immune system (9). Furthermore, advances achieved in diagnosis and improvement of treatment have created a favorable survival rate of 89.2% five years after diagnosis (10). The high costs of healthcare for patients of breast cancer usually

dramatically affects the treatment of breast cancer (11). Furthermore, treatment is followed by many side effects. One of them includes decreased upper extremity range of motion, pain, and secondary lymphedema of the affected arm, seroma formation, impaired self-concept, and feelings of sadness.

Concerning their social life, women may feel isolated, since breast is a symbol of femininity, sexuality and maternity (12-15). Evidence has indicated that some of breast cancer patients suffer from cognitive impairment. Among the cognitive functions attention is an essential component of cognitive function efficiency. Therefore, understanding attention-associated problems is an important key in treating cancer patients (16). Another factor in cognitive function is memory, which has a complex system and affects all human behaviors. In addition, balance is one of the basic needs for daily activities, which plays an important role in static and dynamic activities (17).

Pilates largely avoids high impact, high power output, and heavy muscular and skeletal loading. The present training method aimed to help the subjects primarily tack control in a purposeful way through the control method and then to achieve normal neuromuscular coordination by repeating its movements in a gradual but progressive way (18). It seems that in women with breast cancer exercise, some of the recurrent risk factors (pain, swelling, depression, etc.) could be modified, these risk factors may recur following the treatment. Thus, physical activity can be important involvement to be used during or following the breast cancer treatment. Ghorbani and colleagues investigated the effect of yoga and Pilates exercises on the range of motion, edema, and upper extremity pain of women after mastectomy immediately following the surgery. They concluded that the rate of flexion, extension, internal, and external rotation of the shoulder, elbow flexion and extension, arm and forearm edema and pain, get better (13). Sekendiz and colleagues reported that exercise had positive effects on balance, flexibility, and muscle strength. In light of the above mentioned evidence, the present study seeks to examine the effects of Pilate's exercises on memory, attention, and balance in women with breast cancer (19). Exercise improves the physical and mental health of people with breast cancer and improves circulatory system function, increases muscle strength, reduces fatigue, anxiety and depression, improves mood and creates a better feeling for the person. The results of a previous study showed that patients are able to improve their physical function during the rehabilitation period, particularly

with physical exercise (20, 21). Pilates largely avoids high impact, high power output, and heavy muscular and skeletal loading (22). Given the beneficial effects of Pilates and the low use of this exercise on people with breast cancer, this study is looking for the answer to this question "Does Pilates exercise effect of the memory, attention, and balance of women with breast cancer?"

Patients and Methods

In this quasi-experimental clinical trial, among the patients referred to Shahid Motahari Clinic in Shiraz during 6 months, 20 patients who had undergone mastectomy were selected as the subjects and were randomly divided into two groups: Pilates and control.

The following formula (23) was used for the sample size calculation:

$$n_A = \kappa n_B \text{ and } n_B = \left(1 + \frac{1}{\kappa}\right) \left(\sigma \frac{z_{1-\alpha/2} + z_{1-\beta}}{\mu_A - \mu_B}\right)^2$$

$$1 - \beta = \Phi(z - z_{1-\alpha/2}) + \Phi(-z - z_{1-\alpha/2}) \quad , \quad z = \frac{\mu_A - \mu_B}{\sigma \sqrt{\frac{1}{n_A} + \frac{1}{n_B}}}$$

$\kappa = n_A/n_B$ is the matching ratio

σ is standard deviation

Φ is the standard Normal distribution function

Φ^{-1} is the standard Normal quantile function

α is Type I error

β is Type II error, meaning $1 - \beta$ is power

The balance test mean and standard deviation (control: 15.81 ± 15.41 and exercise: 12.60 ± 11.10) from similar population (24) were used for estimating the number of samples. The inclusion criteria included the willingness to participate in the study, the ability to communicate verbally to cooperate, women with upper limb secondary lymphedema following a mastectomy whose definitive diagnosis was confirmed by a clinician, the ability to move independent and without the need for assistive equipment, a time interval of at least one year following the mastectomy (18, 25), those in the age range of between 35 and 50 years and patients who were in stage two in terms of lymphedema. The exclusion criteria were: unwillingness to cooperate, creating any situation that aggravates the disease or hospitalization

of the patient, history of congestive heart failure or chronic obstructive pulmonary disease, patients undergoing chemotherapy or radiation therapy, or any heart problems, which could affect their participation in the exercises. After getting the code of ethics committee under the number IR.SUMS.REHAB. REC.1398.015, all the subjects signed the consent form to participate in the study. Subsequently, the two experimental and control groups participated in the balance, attention, and memory tests as a pre-test. After two weeks of Pilate's exercises by the experimental group, attention, memory, and balance were tested again as a post test.

Technical Information

Primarily, before starting the training program, during a session held with the presence of the subjects, the conditions for conducting the research, conducting the pre-test and the exercise program for intervention were fully explained to the subjects. Afterwards, one week before the start of the training protocol, the two groups of flamingo static balance test were used to measure balance, Stroop test was carried out to measure attention and N-back test to measure memory as a pre-test. During the study, the experimental group performed Pilate's exercises for 60 minutes three times a week for 2 weeks. Following the exercises, the tests of attention, memory, and balance of the two groups were repeated as the same post-test and compared to each other.

Data Collection

In order to analyze the obtained information, descriptive statistics indicators were used to describe demographic variables and draw graphs and tables. After examining the normality of the distribution of scores with Kolmogorov-Smirnov test, paired t- test and one-way analysis of covariance were utilized for analyzing the data of research questions for comparison between the two groups. Statistical operations were performed with SPSS software version 21 and the level of significance of the tests ($P=0.05$) and 95% confidence level were considered.

Research Tools and Validity and Reliability

The tools employed in the present study included the followings:

- Stopwatch to record the Static one leg test
- Wall caliper with an accuracy of 1 cm to measure the height of the subjects

- Digital scales to measure the weight of the subjects
- Stroop test to measure attention
- N-back test to measure memory
- Flamingo static balance test to measure balance
- **Flamingo Static Balance Test**

This test was used to evaluate the ability to maintain balance on one leg. Validity (0.64-0.79) and reliability (0.93-0.99) of this test have been confirmed in previous studies (26).

Stroop Test

The validity of this test in measuring the inhibition of adults and children is 5 and 6, respectively, and its reliability has been reported to range from 0.80 to 0.91. The subject's task is to base the answer only on the appearance of the words, regardless of the meaning of the words (27).

N-back

There are several tests to evaluate memory function, the most famous of which is n-back. In this test the subject is shown a set of sequences of stimuli. The task is to decide whether the stimulus displayed is the same as its previous N sequence (for example, 2 backs means two previous sequences) (28).

Procedure

Initially, before starting the training program, during a session held with the presence of the subjects, the conditions of the research, pre-test and exercise program for intervention were fully explained to the subjects. After completing the informed consent form by the subjects, the height and weight- related measurements were performed. Subsequently, one week before the start of the training protocol the control group and the stork test were taken to measure balance, the Stroop test to measure attention and the n-back test to measure memory as a pre-test. During the study, the experimental group performed Pilate's exercises for 60 minutes three sessions per week, for week's even days. After the exercises, the tests of the two groups were repeated as a post-test. The results were compared to each other (Table 1 and 2).

Table 1: Block 1 Pilates Training Protocol

Train	Pilates practice	Focus on practice	Rep
1	Publishing stands in front	Strengthen shoulder muscles	5
2	Standing sideways with open legs	Sides	5
3	Foot forward pause for 3seconds	keeping balance	5
4	Crunch half pause 3 seconds	Strengthen the abdominal muscles	5
5	Starfish pause for 2 seconds	Hand-foot coordination and alignment	5
6	Move the leg for 3 seconds	Strengthen the muscles of the back of the leg	5

Table 2: Block 2 Pilates Training Protocol

Train	Pilates practice	Focus on practice	Rep
1	standing cat	Lumbar vertebrae	5
2	T balance	Balance	5
3	Raise the leg from the side Pause for 3 seconds	keeping balance	5
4	Nut to nut to leg	Lumbar vertebrae	5
5	Bend the leg bent 90 degrees single leg up	Strengthen the abdominal muscles	5
6	dart	Strengthen the muscles of the lumbar fillet, flanks	5

Experimental Group Training Protocol

Between training sets, the subjects had 20- seconds. The resting time between the movements depended on the extent of the change of position and being in the new position and also on how to increase the training load. The training load increased in two ways: Increasing the movement maintenance time: (for example, in the first days the movement maintenance time was 5 seconds and in the last days it reached 8 seconds), and adding limb movement to the previous movements.

Statistical Method

In this study, first Kolmogorov-Smirnov test was utilized to normalize the dispersion of the findings. After confirming the naturalness of the dispersion of the findings and homogeneity of variances using Levene's test, we employed analysis of covariance. This study was based on a model involving Pilate's exercises as an independent variable and n-back test, and Stroop test and pre-test Flamingo static balance test as a dependent variable. Additionally, the results of Shapiro-Wilk test showed that the scores in pre-test and post-test had good homogeneity and normality, accordingly parametric analysis was used. Paired-sample t test was used for within group comparison, and One- way analysis of covariance was used for the comparison between the groups. The statistical calculations were performed with SPSS software Version 23 and the significance level was $P < 0.05$.

Results

Twenty women with lymphedema after modified

mastectomy from Shahid Motahari clinic were purposefully selected according to the criteria in the study. The mean and standard deviation of age, height, and weight of the subjects in the experimental group were (43.20 ± 4.63) , (165 ± 4.80) and (67.80 ± 2.39) those in the control group were (42.63 ± 4.84) , (162.7 ± 4.39) and (67.20 ± 5.20) , respectively. No significant differences were found between age, height, and weight of the subjects.

In the experimental group, the mean and standard deviation of the scores in pre-and post-tests were respectively as follows: attention: (431.30 ± 33.59) , (461 ± 11.12) , memory: (72.50 ± 17.34) , and (90 ± 8.27) , and static balance: (9.96 ± 4.23) , and (29.39 ± 7.00) . In the control group, the mean and standard deviation of the scores were respectively as follows: attention: (465.90 ± 10.56) , and (462.60 ± 6.99) , memory: (79.40 ± 17.48) , (85.90 ± 4.45) , and static balance: (10.85 ± 4.36) , and (10.83 ± 3.91) . According to ANCOVA findings, there was significant difference between the exercise and control groups regarding Strop ($P = 0.014$), N-back ($P = 0.016$), and Flamingo ($P = 0.001$) testing findings (Table 3).

In the within-group comparisons, the results implied a significant difference concerning scores of strop ($t = -3.23$, $P = 0.008$), N-back ($t = -3.60$, $P = 0.003$) and Flamingo ($t = -4.20$, $P = 0.002$); however, these results were not significantly different in the control group (Table 3).

Discussion

The current research aimed to investigate the effect of Pilates exercise on memory, attention, and balance

Table 3: Within group comparison for the two groups (within group with t test and between group with ANCOVA)

Variables	Group	Tests	M	SD	P value (within groups)	P value (between groups)
Strop	Ex	Pre	421.30	58.13	0.008*	0.014*
		Post	449.70	45.70		
	Co	Pre	461.30	23.17	0.132	
		Post	457.10	22.20		
N-back	Ex	Pre	69.50	19.69	0.003*	0.016*
		Post	88.00	13.23		
	Co	Pre	79.40	17.48	0.461	
		Post	82.00	10.74		
Flamingo	Ex	Pre	18.49	18.92	0.002*	0.001*
		Post	51.57	43.02		
	Co	Pre	10.85	4.36	0.96	
		Post	10.83	3.91		

*Significant difference (P<0.05)

among women with moderate lymphedema following mastectomy. The obtained results revealed that memory function and balance improved in the subjects, yet this effect was not significant on their attention. Based on the theoretical foundations of the design, certain intervention methods improved their memory. The results of the present study showed that Pilates training significantly improved memory. In fact, the findings of the present study confirmed the effect of Pilates exercise on memory. In addition, several studies have shown that cognitive function improves after physical exercise (29). This result contradicts the findings of Blumenthal and Madden (30). Unlike these studies, other studies are consistent with the results of the present study on the significant effects of physical activity on memory, including studies by Cooper and colleagues (31). Therefore, according to the results of the present study Pilates exercises could be introduced as one of the effective intervention methods in improving memory. Our results revealed that Pilates training did not cause a significant change in attention. However, there are numerous therapeutic approaches to occupational therapy and physiotherapy, medicine, nutrition, and education to improve attention in different people, specifically those with disorders (32-34). Ultimately, regarding the performance of static balance and the effect of Pilate's exercises, the findings demonstrated that Pilates training significantly improved the static balance of the stork. The results of the present study are in line with those of Clark and colleagues, Sadeghi and colleagues. Meanwhile, they were inconsistent with the research of Manini and colleagues (17, 35-37). Given that balance is one of the key components in the performance of individuals and its deficiency is one of the important risk factors for injury in individuals, it is recommended that trainers and rehabilitation specialists use these exercises to improve balance.

Research Limitations

Among the limitations of research, we could point out the followings:

The small number of subjects with breast cancer living in Shiraz and limited access to them.

The absence of subjects on certain days of the week, which made it difficult to perform the tests.

Conclusion

Based on the findings obtained here, patients with breast cancer could exploit the benefits of Pilate's exercises along with other treatments.

Acknowledgement

This article is part of a master thesis of Ms. Arezoo Kazemi. This study was performed in Shahid Motahari Clinic in Shiraz. We thank all the staff and patients who participated in this study.

The Ethics Review Board of Shiraz Faculty of Rehabilitation Sciences, approved the present study with the following number: IR.SUMS.REHAB.REC.1398.015

Funding: This study received no grant from any institution/company/university.

All researchers participated in the design, guidance, and writing of the article.

Conflicts of interest: The authors declared no conflict of interest.

References

1. Siegel R, Ward E, Brawley O, Jemal A. Cancer statistics, 2011: the impact of eliminating socioeconomic and racial disparities on premature cancer deaths. *CA Cancer J Clin.* 2011;61(4):212-36. doi: 10.3322/caac.20121. PubMed PMID: 21685461.
2. Banegas MP, Bird Y, Moraros J, King S, Prapsiri S, Thompson B. Breast cancer knowledge, attitudes, and early detection practices in United States-Mexico border Latinas. *J Womens Health.* 2012;21(1):101-7. doi: 10.1089/jwh.2010.2638. PubMed PMID: 21970564; PubMed Central PMCID: PMC3304252.
3. Colditz GA, Bohlke K, Berkey CS. Breast cancer risk accumulation starts early: prevention must also. *Breast Cancer Res Treat.* 2014;145(3):567-79. doi: 10.1007/s10549-014-2993-8. PubMed PMID: 24820413; PubMed Central PMCID: PMC4079839.
4. Nafissi N, Saghafinia M, Motamedi MHK, Akbari ME. A survey of breast cancer knowledge and attitude in Iranian women. *J Can Res Ther.* 2012;8(1):46-9.
5. Eyigor S, Karapolat H, Yesil H, Uslu R, Durmaz B. Effects of pilates exercises on functional capacity, flexibility, fatigue, depression and quality of life in female breast cancer patients: a randomized controlled study. *Eur J Phys Rehabil Med.* 2010;46(4):481-7. PubMed PMID: 21224783.
6. Allred DC. Ductal carcinoma in situ: terminology, classification, and natural history. *J Natl Cancer Inst Monogr.* 2010;2010(41):134-8. doi: 10.1093/jncimonographs/lgq035. PubMed PMID: 20956817; PubMed Central PMCID: PMC5161057.
7. Billiar T, Andersen D, Hunter J, Brunnicardi F, Dunn D, Pollock RE. *Schwartz's principles of surgery.* McGraw-Hill Professional; 2004.
8. Chae BJ, Bae JS, Lee A, Park WC, Seo YJ, Song BJ, et al. p53 as a specific prognostic factor in triple-negative breast cancer. *Jpn J Clin Oncol.* 2009;39(4):217-24. doi: 10.1093/jjco/hyp007. PubMed PMID: 19304743.
9. Rietman JS, Dijkstra PU, Debreczeni R, Geertzen JH, Robinson DPH, De Vries J. Impairments, disabilities and health related quality of life after treatment for breast cancer: a follow-up study 2.7 years after surgery. *Disabil Rehabil.* 2004;26(2):78-84. doi: 10.1080/09638280310001629642. PubMed PMID: 14668143.
10. Aebi S, Davidson T, Gruber G, Cardoso F, ESMO Guidelines Working Group. Primary breast cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. *Ann Oncol.* 2011;22:vi12-vi24. doi: 10.1093/annonc/mdr371. PubMed PMID: 21908498.
11. Santos WDND, Gentil P, de Moraes RF, Ferreira Júnior JB, Campos MH, de Lira CAB, et al. Chronic effects of resistance training in breast cancer survivors. *Biomed Res Int.* 2017;2017:8367803. doi: 10.1155/2017/8367803. PubMed PMID: 28835898; PubMed Central PMCID: PMC5557266.
12. Finestone S. Meeting the Changing Emotional and Educational Needs of Breast Cancer Patients. *Psycho-oncology.* 2011;1:1-2.
13. Ghorbani M, Sokhangouei Y, Sadeghi H. Effect of Pilates exercise on range of motion and edema of upper limb in mastectomy side. *J Ardabil Univ Med Sci.* 2013;13(3):297-304. Persian.
14. Schachter HM, Mamaladze V, Lewin G, Graham ID, Brouwers M, Sampson M, et al. Many quality measurements, but few quality measures assessing the quality of breast cancer care in women: a systematic review. *BMC Cancer.* 2006;6:291. doi: 10.1186/1471-2407-6-291. PubMed PMID: 17176480; PubMed Central PMCID: PMC1764760.
15. Stan DL, Collins NM, Olsen MM, Croghan I, Pruthi S. The evolution of mindfulness-based physical interventions in breast cancer survivors. *Evid Based Complement Alternat Med.* 2012;2012:758641. doi: 10.1155/2012/758641. PubMed PMID: 22997532; PubMed Central PMCID: PMC3446749.
16. Key TJ, Verkasalo PK, Banks E. Epidemiology of breast cancer. *Lancet Oncol.* 2001;2(3):133-40. doi: 10.1016/S1470-2045(00)00254-0. PubMed PMID: 11902563.
17. Sadeghi H, Norouzi H, Karimi Asl A, Montazer M. Functional training program effect on static and dynamic balance in male able-bodied elderly. *Salmand: Iranian Journal of Ageing.* 2008;3(2):565-71. Persian.
18. Banasik J, Haberman M. The effect of Iyengar yoga practice on psychosocial function and salivary cortisol secretion in breast cancer survivors. *CRJ.* 2008;21(1):77-81.
19. Sekendiz B, Altun Ö, Korkusuz F, Akın S. Effects of Pilates exercise on trunk strength, endurance and flexibility in sedentary adult females. *Journal of bodywork and movement therapies.* 2007;11(4):318-26.
20. Martins-Meneses DT, Antunes HKM, de Oliveira NRC, Medeiros A. Mat Pilates training reduced clinical and ambulatory blood pressure in hypertensive women using antihypertensive medications. *Int J Cardiol.* 2015;179:262-8. doi: 10.1016/j.ijcard.2014.11.064. PubMed PMID: 25464462.

21. Quaney BM, Boyd LA, McDowd JM, Zahner LH, He J, Mayo MS, et al. Aerobic exercise improves cognition and motor function poststroke. *Neurorehabil Neural Repair*. 2009;23(9):879-85. doi: 10.1177/1545968309338193. PubMed PMID: 19541916; PubMed Central PMCID: PMC3024242.
22. Latey P. The Pilates method: history and philosophy. *Journal of Bodywork and Movement Therapies*. 2001;5(4):275-82. doi: 10.1054/JBMT.2001.0237.
23. Chow S-C, Shao J, Wang H, Lokhnygina Y. Sample size calculations in clinical research. CRC press; 2017.
24. Mahmoodi A, Jahromi MK, Neamati J, Tahmasebi S, Zamirian M. Effect of 8 weeks Pilates training on physical fitness indices in breast cancer patients: a clinical trial study. *Journal of Gorgan University of Medical Sciences*. 2018;20(1):Pe1-Pe7.
25. Banasik J, Williams H, Haberman M, Blank SE, Bendel R. Effect of Iyengar yoga practice on fatigue and diurnal salivary cortisol concentration in breast cancer survivors. *J Am Acad Nurse Pract*. 2011;23(3):135-42. doi: 10.1111/j.1745-7599.2010.00573.x. PubMed PMID: 21355946.
26. Sember V, Grošelj J, Pajek M. Balance Tests in Pre-Adolescent Children: Retest Reliability, Construct Validity, and Relative Ability. *Int J Environ Res Public Health*. 2020;17(15):5474. doi: 10.3390/ijerph17155474. PubMed PMID: 32751279; PubMed Central PMCID: PMC7432309.
27. Kapoula Z, Lê T-T, Bonnet A, Bourtoire P, Demule E, Fauvel C, et al. Poor Stroop performances in 15-year-old dyslexic teenagers. *Exp Brain Res*. 2010;203(2):419-25. doi: 10.1007/s00221-010-2247-x. PubMed PMID: 20437170.
28. Kane MJ, Conway AR, Miura TK, Colflesh GJH. Working memory, attention control, and the N-back task: a question of construct validity. *J Exp Psychol Learn Mem Cogn*. 2007;33(3):615-622. doi: 10.1037/0278-7393.33.3.615. PubMed PMID: 17470009.
29. Smith AM, Spiegler KM, Sauce B, Wass CD, Sturzoiu T, Matzel LD. Voluntary aerobic exercise increases the cognitive enhancing effects of working memory training. *Behav Brain Res*. 2013;256:626-35. doi: 10.1016/j.bbr.2013.09.012. PubMed PMID: 24036169; PubMed Central PMCID: PMC3856556.
30. Blumenthal JA, Madden DJ. Effects of aerobic exercise training, age, and physical fitness on memory-search performance. *Psychol Aging*. 1988;3(3):280-5. doi: 10.1037//0882-7974.3.3.280. PubMed PMID: 3268270.
31. Cooper R, Kuh D, Cooper C, Gale CR, Lawlor DA, Matthews F, et al. Objective measures of physical capability and subsequent health: a systematic review. *Age Ageing*. 2011;40(1):14-23. doi: 10.1093/ageing/afq117. PubMed PMID: 20843964; PubMed Central PMCID: PMC3000177.
32. Eimer M, Van Velzen J, Gherri E, Press C. Manual response preparation and saccade programming are linked to attention shifts: ERP evidence for covert attentional orienting and spatially specific modulations of visual processing. *Brain Res*. 2006;1105(1):7-19. doi: 10.1016/j.brainres.2005.10.060. PubMed PMID: 16448629.
33. Norton DJ, McBain RK, Öngür D, Chen Y. Perceptual training strongly improves visual motion perception in schizophrenia. *Brain Cogn*. 2011;77(2):248-56. doi: 10.1016/j.bandc.2011.08.003. PubMed PMID: 21872380; PubMed Central PMCID: PMC3195882.
34. Velikonja O, Čurić K, Ožura A, Jazbec SŠ. Influence of sports climbing and yoga on spasticity, cognitive function, mood and fatigue in patients with multiple sclerosis. *Clin Neurol Neurosurg*. 2010;112(7):597-601. doi: 10.1016/j.clineuro.2010.03.006. PubMed PMID: 20371148.
35. Clark MA, Fater D, Reuteman P. Core (trunk) stabilization and its importance for closed kinetic chain rehabilitation. *Orthopaedic Physical Therapy Clinics of North America*. 2000;9(2):119-36.
36. Mahdavi S, Golpaygani M, Shavandi N, Farzane H, Sheqhoseni R. The effect of 6-week core stability training on falls in elderly women. *Salmand Iranian Journal of Ageing*. 2010;5(17):30-42.
37. Manini T, Marko M, VanArnam T, Cook S, Fernhall B, Burke J, et al. Efficacy of resistance and task-specific exercise in older adults who modify tasks of everyday life. *J Gerontol A Biol Sci Med Sci*. 2007;62(6):616-23. doi: 10.1093/gerona/62.6.616. PubMed PMID: 17595417.