

Approach of a Patient with Multiple Sclerosis and Urinary Incontinence with the Clinical Pilates Method: A Narrative Review and Case Study

Paraskevi / Evi Stavrianou

Department of Physiotherapy, University of West Attica, Athens, Attica, Greece

***Correspondence to:** Paraskevi / Evi Stavrianou, Department of Physiotherapy, University of West Attica, Athens, Attica, Greece. Email: evi.st.par@hotmail.com, Tel: +306980828002.

Copyright

© 2022 Paraskevi / Evi Stavrianou. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Received: 26 January 2022

Published: 31 January 2022

Keywords: *Urinary Incontinence; LUTS; Multiple Sclerosis; Clinical Pilates; Pilates*

Abstract

Introduction

Urinary Incontinence (UI) can occur in many patients with Multiple Sclerosis (MS) creating adverse conditions. In this paper, the focus is on the treating of UI in MS patients with the Clinical Pilates method, which is a modification of the classic Pilates.

Materials and Methods

Review: The literature from 1st January of 2010 to 30th September of 2021 was reviewed.

Case Study: Clinical Pilates sessions were performed in a female patient, 57 years old, diagnosed with bilateral Cerebellar - Ataxic impairment in the spectrum of MS, with UI symptoms. The intervention program lasted 4 weeks.

Results

Review: A total of 19 articles were collected. No review or study has been found to examine the effect of Clinical Pilates, or even of classic Pilates method, on a patient with MS and UI, simultaneously.

Case Study: The score of the “Australian Pelvic Floor Questionnaire” and the score of the “ICQ-SF”, after the Clinical Pilates program completed, decreased showing a slight improvement of symptoms.

Conclusions

The Clinical Pilates method seems to be a satisfactory tool in the physiotherapist’s “quiver”. However, further studies are needed with a complete methodology, which will focus on patients with MS and UI as parameters in the same research.

Introduction

Along with its socio-economic impact, the influence of Multiple Sclerosis (MS) is growing globally, ending up the most common autoimmune and non-traumatic disability disease of the Central Nervous System (CNS) that affects young adults.¹ Resulting from an autoimmune inflammatory demyelinating lesion in the white matter, is affecting more than 2 million people internationally [1,2].

Although it prevails that there are no clear etiological factors, most agree that low levels of vitamin D, overexposure to ultraviolet B (UVB) radiation, smoking, obesity and, especially, childhood obesity, infection with Epstein-Barr virus, as well as the genetic background, increase the chances of developing MS [1-4].

The first appearance of MS is depending on the location of the lesion and its form. Patients may present a wide range of symptoms, depending on the area of the lesion, including Urinary Incontinence (UI) [3,5,6], which is included in Lower Urinary Tract Symptoms (LUTS). The regions of CNS that appear to be associated with such symptoms are the brainstem, the frontal lobe, the parafibular helix, and the spinal cord above the sacrum of the spine [7,8].

LUTS report to 50% to 90% of cases of MS patients [8,9], with an average indication of the onset 8 years after the appearance of the disease [7]. They can be divided into storage symptoms and voiding symptoms [9-11].

Storage symptoms include UI, which can be distinguished into the Urge Incontinence, where the patient reports often and urgent urination, and also nocturia, because of the hyperactivity of the detrusor muscle, the Stress Incontinence, where occurs due to relaxation of the urethral sphincter, the Mixed Incontinence, where there is a mix of urge and stress incontinence, the Overflow Incontinence, with the bladder not emptying normally resulting in some involuntary leak, and Functional Incontinence, where there is no pathology of

the urinary tract, but rather some cognitive or motor dysfunction that does not allow the patient to go to the toilet on time or not at all [12].

Treatment methods can be divided into pharmaceutical and non-pharmaceutical interventions [13]. Non-pharmaceutical interventions include Pelvic Floor Muscle Training (PFMT) exercises [7-11] followed by Neuromuscular Electrical Stimulation (NMES), Percutaneous Tibial Nerve Stimulation (PTNS) [7,9,11,13], and catheterization [7,12]. In some cases, surgery is indicated [7]. In this paper, the focus is on the treating of UI in MS patients with the Clinical Pilates method, which is a modification of the classic Pilates method, restoring the health of patients with various pathologies. While the basic concepts, as first introduced by Joseph Pilates, remaining the same, the goal and the audience, to which it is addressed, are changing. Its use as a method of exercise has a therapeutic character, constituting a therapeutic exercise, and is addressed to a population with pathologies, including patients with MS. The principles of the method are based on the basic concepts, as well as the evaluation, the clinical reasoning and the therapeutic goal and intervention [14,15].

Materials and Methods

Literature Review

In the first phase the literature was reviewed via the databases of PubMed, Google Scholar, Cochrane Library and Research Gate, using keywords "Pilates" or "Clinical Pilates" and "Multiple Sclerosis", or/and "Urinary Incontinence", or/and "LUTS", or/and "Pelvic Floor". The included reviews and studies were published from 1st January of 2010 to 30th September of 2021. Studies comparing patients with healthy population were excluded.

Case Study

Case Presentation

In the second phase Clinical Pilates sessions were performed in a female patient, 57 years old, diagnosed with bilateral Cerebellar - Ataxic impairment in the spectrum of MS, with UI symptoms. The diagnosis was made in 2004.

The patient's height is 1.62 and weighs approximately 110 kg. In the early stages of the disease there was, according to the patient, increasing instability, increasing fatigue and numbness in the upper extremities. Based on the clinical picture, the UI, which has appeared in recent years, can be classified in the category of Urge Incontinence. The patient has frequent urination and nocturia, making it necessary for her to use diapers. Walking requires the use of a walker. She is able to go to the toilet, but she is not independent in the dressing and bathing process. More parameters were evaluated regarding the clinical pilates level, balance, muscle strength etc. (Table 1).

Table 1: Patient's evaluated parameters

Variables	Level / Score
Clinical Pilates Level	1
Berg Balance Scale (BBS)	22
Oxford Scale	4-
SF-36	
Vitality (Energy and Fatigue)	Moderate
Physical Functioning	Low
General Health Perceptions	Low
Physical Role Functioning	High Limitations
Emotional Role Functioning	Low Limitations
Social Role Functioning	Moderate Limitations
Mental Health	High
Bodily Pain	Low to Moderate
Modified Asworth Scale	1

Intervention

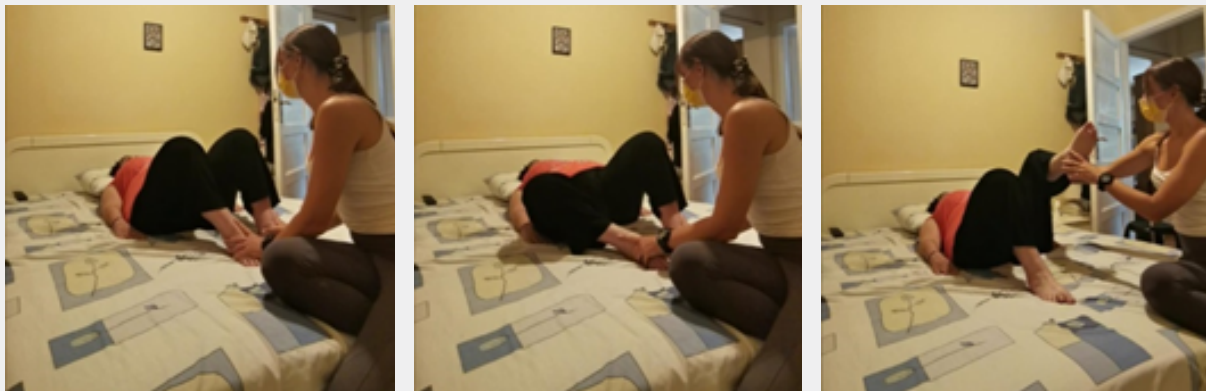
The intervention program lasted 4 weeks. The frequency was 3 sessions of 60 minutes each per week. Each session included a 40'-45' Clinical Pilates Mat exercise program with PFMT (Table 2), and 10'-15' balance and strength training, as well as walking.

Table 2: Clinical Pilates Mat exercise program

	1 st Week	2 nd Week	3 rd Week	4 th Week
EXERCISES	Breathing 1x10	Breathing 2x10	Breathing 2x10	Breathing 2x10
	PFM Activation 1x10	PFM Activation 2x10	PFM Activation 2x10	PFM Activation 2x10
	Hip Twist 1x10	Hip Twist 2x10	Hip Twist 2x10	Hip Twist 2x10
	Hip Twist + PFM Actv. 1x10	Hip Twist + PFM Actv. 2x10	Hip Twist + PFM Actv. 2x10	Hip Twist + PFM Actv. 2x10
	Single Leg Stretch 1x10	Single Leg Stretch 2x10	Single Leg Stretch 2x10	

Single Leg Stretch + PFM Actv. 1x10	Single Leg Stretch + PFM Actv. 2x10	Single Leg Stretch + PFM Actv. 2x10	
Scissors 1x10	Scissors 2x10		Scissors 2x10
Scissors + PFM Actv. 1x10	Scissors + PFM Actv. 2x10		Scissors + PFM Actv. 2x10
Shoulder Bridge 1x10	Shoulder Bridge 2x10		Shoulder Bridge 2x10
Shoulder Bridge + PFM Actv. 1x10	Shoulder Bridge + PFM Actv. 2x10		Shoulder Bridge + PFM Actv. 2x10
Double Leg Stretch 1x10	Double Leg Stretch 2x10	Double Leg Stretch 2x10 With the addition of two small bottles of water in the hands	Double Leg Stretch 2x10 With the addition of two small bottles of water in the hands
Double Leg Stretch + PFM Actv. 1x10	Double Leg Stretch + PFM Actv. 2x10	Double Leg Stretch + PFM Actv. 2x10 +0.5 kg hand weights	Double Leg Stretch + PFM Actv. 2x10 +0.5 kg hand weights
			Arm Opening 1x10
			Arm Opening + PFM Actv. 1x10
			Clam 1x10
			Clam + PFM Actv. 1x10
PFM Activation 1x10 1x1 (continuously)	PFM Activation 2x10 1x2 (continuously)	PFM Activation 2x10 1x3 (continuously)	PFM Activation 2x10 1x4 (continuously)
Breathing 1x10	Breathing 2x10	Breathing 2x10	Breathing 2x10
Note: all exercises were performed in level 1			

Furthermore, before starting the program, the pelvic anatomy was presented to the patient, with the online tool “Anatomy 3D Atlas”, and the philosophy, goals and basic concepts around PFMT and the Clinical Pilates method was explained. On days when no session would take place, the patient had to perform some PFMT exercises and some simple strengthening and balance exercises. An exception is the 3rd week where no sessions were performed at all and the patient had to perform some exercises on her own, even on the days when there would be, under normal circumstances, a supervised session. The sessions were performed at patient’s home. But, due to the patient’s inability to lie on an exercise mat on the ground, the program was performed on bed for supine and lateral position exercises (Figure 1, 2, 3).



Pelvic floor and urinary tract function and severity of symptoms were assessed before and after the intervention program. The Australian Pelvic Floor Questionnaire [16] and the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICQ-SF) [17] were used. A quality evaluation was also performed after the completion of the program, in the form of an interview, for the patient to describe her experience with the Clinical Pilates method.

Results

Literature Review

A total of 19 articles were collected. However, no review or study has been found to examine the effect of Clinical Pilates, or even of classic Pilates method, on a patient with MS and UI. From the 20 articles, the 12 were examine the influence of Clinical Pilates and classic Pilates on patients with MS, but not with UI symptoms, and the rest 7 the influence on patients with UI, but without MS.

Clinical Pilates/Pilates on Multiple Sclerosis: Systematic Reviews

The results of 3 systematic reviews, using the term “Pilates” rather than “Clinical Pilates”, have shown that this therapeutic approach appears to have a positive effect on MS patients. In particular, the Pilates method is a safe therapeutic method to improve balance, strength, QoL, cognitive function, physical condition, posture and gait parameters, pain and fatigue. Nevertheless, opinions differ as to whether the Pilates method is superior to conventional physiotherapy [18-20].

Clinical Pilates/Pilates on Multiple Sclerosis: Clinical Trials

During the research for clinical trials, 4 studies using the term of “Clinical Pilates” and 5 studies using the term of “Pilates” were found. Almost all had the participation and guidance of physiotherapists, specially trained in the methods.

Küçük *et al.* [21] correlated an 8-week Clinical Pilates program with a traditional exercise program and found that there was a statistically significant improvement in cognitive function, balance, sitting, walking, fatigue, depression, QoL and physical condition in patients who participated in a Clinical Pilates program. The same year, improvement after a 10-week Clinical Pilates program in MS patients also appeared on sensory interaction, postural control and fatigue of these patients, from the study of Tomruk *et al.* [22] In the study of Abasiyanik *et al.* [23] statistically significant difference was found in gait, strength, balance and trunk stabilization, as well as in respiratory and cognitive function, of patients with MS, with the Clinical Pilates method overrunning a home exercise program. Abasiyanik *et al.* [24], also, compared the Clinical Pilates with the Hatha Yoga method. After the participation of 8 weeks for both methods, the results showed an improvement in the strength of the respiratory muscles and a reduction in gait difficulties for both groups. However, in the group that followed the Clinical Pilates program, there was also an increase in gait speed, improvement on mobility, cognitive function, QoL and self-confidence in balance.

Van der Linden *et al.* [25] wanted to examine the impact of the Pilates method on 15 MS patients using a wheelchair. First, the results showed that Pilates is a suitable method for people with MS who use a wheelchair. Then there was a statistically significant improvement in sitting balance, function, standing posture, pain and QoL of patients. The quality results, from the interviews they made, showed that the method is a beneficial and enjoyable way of intervention for patients, which also comes from social interaction and teamwork during the courses. In the study of Guclu-Gunduz *et al.* [26], while there were no adverse effects in either group, in the case of the Pilates group, balance, mobility, and upper and lower extremities strength were improved by a statistically significant difference compared to the control group, where participants performed upper and lower extremities strengthening exercises and diaphragmatic breathing exercises. In another study, balance, function, trunk stabilization, fatigue and quality of life in MS patients were investigated before and after Pilates Mat and Pilates Reformer, by Bulguroglu *et al.* [27]. Eventually all parameters were improved with a statistically significant difference in the Pilates Mat and Pilates Reformer group compared to the control group. Between the two Pilates groups, however, there was no superiority of one method over the other, except in the case of abdominal muscle strength, where there was a greater improvement in the Pilates Reformer group. Another comparison of the results that the Pilates method can bring to patients with MS, was made in relation to therapeutic massage, by Duff *et al.* [28]. Walking ability and function improved by a statistically significant difference in the Pilates group. Finally, Gheitashi *et al.* [29] investigated the effect of Pilates on the dynamic balance of 30 male MS patients. The results showed an improvement in the Pilates group, compared to the control group, which can lead to the prevention of possible falls.

Clinical Pilates/Pilates on Urinary Incontinence: Systematic Reviews

In the two systematic reviews found, it is argued that strengthening the PFM is not possible with the Pilates method, unless the session is accompanied by specialized PFMT exercises. According to the researchers, a

Pilates exercise program promotes proper movement, intense activation of the abdominal muscles and to a certain extent the activation of the PFM, things that make pelvic floor exercises compatible with Pilates [30,31].

Clinical Pilates/Pilates on Urinary Incontinence: Clinical Trials

Using the term “Clinical Pilates”, only 1 study was found that was investigate the impact of the method on patients with UI, but using the term “Pilates” 4 studies were found. Patients with pathologies of the Nervous System were excluded from all the studies.

The study related to the Clinical Pilates method was found specifically with the term “Modified Pilates”. The study involved 73 women suffering from UI, who were referred for physical therapy. The results showed that in the intervention group there was a greater improvement in self-esteem, reduced impact on daily activities and a reduction in the social embarrassment of women with a low score on the SSI (Symptom Severity Index), i.e. with milder symptoms, and an improvement in women’s personal relationships, with a higher score, i.e. more severe symptoms. Qualitative analysis supported these findings and also stated that the Modified Pilates exercise program could positively influence exercise, diet, and well-being beliefs [32].

Gomes *et al.* [33] compared the Pilates method with the classic PFMT and the Anal Electrical Stimulation (AES) method, in male patients with UI after prostatectomy. The results showed that 10 Pilates sessions can increase PFM strength, speed up restraint and improve QoL. Pilates method showed similar effects to those in the PFMT group in combination with AES. Although there was an improvement in the parameters, there was no complete recovery of UI. In a similar way, there is a second study, with 85 participants after prostatectomy, which was done by the same group of researchers before the above, but without follow-up after 4 months. The parameters and methodology were similar and the results led to similar conclusions [34]. Chmielewska *et al.* [35], through their research, concluded that the use of Oov tool can be an effective method of intervention in combination with Pilates to improve abdominal thickness, PFM function, and QoL of women with LUTS. Finally, another thing that has been studied by researchers in women with UI, is whether Pilates affects not only the function of the pelvic floor but also the metabolic profile. The results showed an improvement in PFM function, as well as an increase in L-Glutamine, L-Cystathionine, L-Arginine, and L-1-Pyrroline Carboxylic Acid. -3-hydroxy-5-carboxylate) of the patients [36].

Case Study

The score of the “Australian Pelvic Floor Questionnaire” and the score of the “ICQ-SF” showed a slight decrease after the intervention program (Table 3). In both questionnaires the highest score reveals greater difficulties and pathologies.

In the quality assessment through interview, the patient stated briefly that the method is a way out of these difficult days with the pandemic, and also a pleasant, low intensity and easy intervention, which she is willing to continue, as she felt she had more control over her incontinence, as well as greater flexibility.

Table 3: Score results before and after the program

	Before the Program	After the Program
Australian Pelvic Floor Questionnaire	25.29	23,14
ICQ-SF	16	13
Note: the highest score reveals greater difficulties and pathologies		

Discussion

In the present paper, it was investigated whether the Clinical Pilates method is able to help patients with MS and UI, through the review of the literature and through a case study.

No article was found from the literature review referring to a patient with MS and UI. The two parameters have been studied and investigated separately from researchers on whether the Clinical Pilates / Pilates method can have a positive effect, with most referring to the classic Pilates.

The improvement of the scores in the patient's questionnaires, although with a small difference, gives positive signs around the treatment of incontinence in patients with MS via Clinical Pilates. Especially in the case of a program with a longer duration, since in most studies the duration of the Clinical Pilates/Pilates program was 6 weeks or more.

The positive response of the patient during the qualitative evaluation, towards the Clinical Pilates method, is in line with the response of the patients with MS in other studies. In the research of Van der Linden *et al.* [25] the MS patients that were using a wheelchair, despite the difficulties, showed in their qualitative results that the method is a beneficial and enjoyable way of intervention, which also stems from social interaction and teamwork during the sessions, although there should be greater and more accessible facilities. Correspondingly, in the research of Lausen *et al.* [32] qualitative analysis argued that a 6-week program of Clinical/Modified Pilates can improve self-esteem, reduce social embarrassment, improve social relationships, and positively affect attitudes toward in exercise, diet and wellness in women with UI.

The effect of Clinical Pilates and Pilates on MS patients has been investigated by several researchers with a variety of evaluation parameters and in relation to various methods, with the vast majority agreeing that Clinical Pilates and Pilates have a positive impact on patients with MS and its characteristics [21-29].

Regarding the parameter of UI, the existing studies rejected the participants with neurological pathologies, as a result of which MS is not included anywhere at the same time with UI as a parameter and with the intervention method of Pilates or Clinical Pilates [32-36].

When it comes to the mechanism of Pilates exercises to improve incontinence, many researchers have formulated the theory that by strongly activating the abdominals, the pelvic floor is get carried away, making all this muscles act as a whole [30-36]. Specifically, the activation of the transverse abdomen presses down the pelvic floor or, respectively, pushes the levator ani upwards, trapping the pelvic sluice [30]. Moreover, the

principles of Pilates in relation to maintaining the correct posture and motor control could positively affect the correct activation of the PFM and enhance restraint. On the other hand, one more basic principle of Pilates is also breathing. According to the researchers, for that reason, we have intense movement of the thoracic cage and activation of the diaphragm, with which the PFM is also connected. It could be considered that by influencing the movement in one area you can influence correspondingly the other, considering that there is a direct connection and cooperation between them [30,33,34].

In all existing studies, a positive effect of Pilates and Clinical Pilates has been found in the symptoms of LUTS and UI, but it should be borne in mind that they're effective, mainly in combination with PFMT, because activation it doesn't mean necessarily strengthening too, something that has been noted by Jacomo *et al.* [31], as well as by Bo & Herbert [30].

It is important that patients in general, and patients with MS in particular, to not stop collaborating with physiotherapists to receive their therapeutic exercise, as the ideal approach exists through the Clinical Pilates method [27]. To achieve this more effectively it will be needed to be facilitated, both at the kinetic and socio-economic level [25].

Conclusions

The Clinical Pilates method seems to be a satisfactory tool in the physiotherapist's "quiver", for the treatment of adverse conditions that patients with MS experiencing, including UI, especially when applied for a few weeks. However, further studies are needed with a complete methodology, which will focus on people with MS and UI as parameters in the same research.

Acknowledgments

Special thanks to the patient who trusted me and agreed to participate in this effort to highlight the research gap that exists in the field of MS and the treatment of urinary tract symptoms. Also, I thank the UNIWA Lifelong Learning and Training Center and its professors, through which I received the specialized knowledge of the Clinical Pilates Method.

Disclosure

The article is free from any such conflicts with others in any aspect.

Bibliography

1. Dobson, P. & Giovannoni, G. (2019). Multiple sclerosis - a review. *Eur J Neurol.*, 26(1), 27-40.
2. Cotsapas, C., Mitrovic, M. & Hafler, D. (2018). Multiple sclerosis. *Handb Clin Neurol.*, 148, 723-730.
3. Doshi, A. & Chataway, J. (2017). Multiple sclerosis, a treatable disease. *Clin Med.*, 17(6), 530-536.

4. Oh, J., Vidal-Jordana, A. & Montalban, X. (2018). Multiple sclerosis: clinical aspects. *Curr Opin Neurol.*, 31(6), 752-759.
5. Brownlee, W. J., Hardy, T. A., Fazekas, F. & Miller, D. H. (2017). Diagnosis of multiple sclerosis: progress and challenges. *Lancet*, 389(10076), 1336-1346.
6. Sand, I. K. (2015). Classification, diagnosis, and differential diagnosis of multiple sclerosis. *Curr Opin Neurol.*, 28(3), 193-205.
7. Tornic, J. & Panicker, J. N. (2018). The management of lower urinary tract dysfunction in multiple sclerosis. *Curr Neurol Neurosci.*, 18(8), 54.
8. Fröhlich, K., Wang, R., Bobinger, T., Schmidt, M., Dörfler, A., Nickel, F. T., *et al.* (2020). Voxel-wise lesion mapping of self-reported urinary incontinence in multiple sclerosis. *Neurourol Urodyn.*, 39(1), 295-302.
9. Lúcio, A., D'ancona, C. A. L., Perissinotto, M. C., McLean, L., Damasceno, B. P. & Baena de Moraes Lopes, M. H. (2016). Pelvic floor muscle training with and without electrical stimulation in the treatment of lower urinary tract symptoms in women with multiple sclerosis. *J Wound Ostomy Continence Nurs.*, 43(4), 414-419.
10. Al Dandan, H. B., Coote, S. & McClurg, D. (2020). Prevalence of lower urinary tract symptoms in people with multiple sclerosis: a systematic review and meta-analysis. *Int J MS Care.*, 22(2), 91-99.
11. Pérez, D. C., Chao, C. W., Jiménez, L. L., Fernández, I. M. & Rincón, A. I. L. (2020). Pelvic floor muscle training adapted for urinary incontinence in multiple sclerosis: a randomized clinical trial. *Int Urogynecol J.*, 31(2), 267-275.
12. Irwin, G. I. (2019). Urinary incontinence. *Prim Care.*, 46(2), 233-242.
13. Al Dandan, H. B., Galvin, R., McClurg, D. & Coote, S. (2019). Management strategies for lower urinary tract symptoms (LUTS) among people with multiple sclerosis (MS): a qualitative study of the perspectives of people with MS and healthcare professionals. *HRB Open Res.*, 2, 31.
14. Laws, A., Williams, S. & Wilson, C. (2017). The effect of clinical pilates on functional movement in recreational runners. *Int J Sports Med.*, 38(10), 776-780.
15. Wajswelner, H., Metcalf, B. & Bennell, K. (2012). Clinical pilates versus general exercise for chronic low back pain: randomized trial. *Med Sci Sports Exerc.*, 44(7), 1197-205.
16. Baessler, K., O'Neill, S. M., Maher, C. F. & Battistutta, D. (2009). Australian pelvic floor questionnaire: a validated interviewer-administered pelvic floor questionnaire for routine clinic and research. *Int Urogynecol J Pelvic Floor Dysfunct.*, 20(2), 149-158.

17. Athanasiou, S., Grigoriadis, T., Kyriakidou, N., Giannoulis, G. & Antsaklis, A. (2012). The validation of international consultation on incontinence questionnaires in the Greek language. *Neurourol Urodyn.*, *31*(7), 1141-1144.
18. Byrnes, K., Wu, P.J. & Whillier, S. (2018). Is Pilates an effective rehabilitation tool? A systematic review. *J Bodyw Mov Ther.*, *22*(1), 192-202.
19. Marques, K. A. P., Trindade, C. B. B., Almeida M. C. V. & Bento-Torres, N. V. O. (2020). Pilates for rehabilitation in patients with multiple sclerosis: a systematic review of effects on cognition, health-related physical fitness, general symptoms and quality of life. *J Bodyw Mov Ther.*, *24*(2), 26-36.
20. Sánchez-Lastra, M. A., Martínez-Aldao, D. & Molina, A. J. (2019). Pilates for people with multiple sclerosis: a systematic review and meta-analysis. *Mult Scler Relat Disord.*, *28*, 199-212.
21. Küçük, F., Kara, B., Poyraz, E. C. & Idiman, E. (2016). Improvements in cognition, quality of life, and physical performance with clinical Pilates in multiple sclerosis: a randomized controlled trial. *J Phys Ther Sci.*, *28*(3), 761-768.
22. Tomruk, M. S., Uz, M. Z., Kara, B. & Idiman, E. (2016). Effects of Pilates exercises on sensory interaction, postural control and fatigue in patients with multiple sclerosis. *Mult Scler Relat Disord.*, 70-73.
23. Abasıyanık, Z., Ertekin, O., Kahraman, T., Yigit, P. & Özakbaş, S. (2020). The effects of clinical pilates training on walking, balance, fall risk, respiratory, and cognitive functions in persons with multiple sclerosis: a randomized controlled trial. *Explore (NY)*, *16*(1), 12-20.
24. Abasıyanık, Z., Yiğit, P., Özdoğar, A. T., Kahraman, T., Ertekin, O. & Özakbaş, S. (2021). A comparative study of the effects of yoga and clinical Pilates training on walking, cognition, respiratory functions, and quality of life in persons with multiple sclerosis: a quasi-experimental study. *Explore (NY)*, *17*(5), 424-429.
25. Van der Linden, M. L., Bulley, C., Geneen, L. J., Hooper, J. E., Cowan, P. & Mercer, T. H. (2014). Pilates for people with multiple sclerosis who use a wheelchair: feasibility, efficacy and participant experiences. *Disabil Rehabil.*, *36*(11), 932-939.
26. Guclu-Gunduz, A., Citaker, S., Irkeç, C., Nazliel, B. & Batur-Caglayan, H.Z. (2014). The effects of pilates on balance, mobility and strength in patients with multiple sclerosis. *Neuro Rehabilitation.*, *34*(2), 337-342.
27. Bulguroglu, I., Guclu-Gunduz, A., Yazici, G., Ozkul, C., Irkeç, C., Nazliel, B., *et al.* (2017). The effects of mat pilates and reformer pilates in patients with multiple sclerosis: a randomized controlled study. *Neuro Rehabilitation.*, *41*(2), 413-422.
28. Duff, W. R. D., Andrushko, J. W., Renshaw, D. W., Chilibeck, P. D., Farthing, P. J., Danielson, J., *et al.* (2018). Impact of pilates exercise in multiple sclerosis: a randomized controlled trial. *Int J MS Care.*, *20*(2), 92-100.

29. Gheitasi, M., Bayattork, M., Andersen, L. L., Imani, S. & Daneshfar, A. (2021). Effect of twelve weeks pilates training on functional balance of male patients with multiple sclerosis: randomized controlled trial. *J Bodyw Mov Ther.*, 25, 41-45.
30. Bø, K. & Herbert, R. D. (2013). There is not yet strong evidence that exercise regimens other than pelvic floor muscle training can reduce stress urinary incontinence in women: a systematic review. *J Physiother.*, 59(3), 159-168.
31. Jacomo, R. H., Nascimento, T. R., Lucena da Siva, M., Salata, M. C., Alves, A. T., Cintra da Cruzet, P. R., *et al.* (2020). Exercise regimens other than pelvic floor muscle training cannot increase pelvic muscle strength—a systematic review. *J Bodyw Mov Ther.*, 24(4), 568-574.
32. Lausen, A., Marsland, L., Head, S., Jackson, J. & Lausen, B. (2018). Modified pilates as an adjunct to standard physiotherapy care for urinary incontinence: a mixed methods pilot for a randomised controlled trial. *BMC Womens Health.*, 18(1), 16.
33. Gomes, C. S., Pedriali, F. R., Urbano, M. R., Moreira, E. H., Averbeck, M. A. & Almeida, S. H. M. (2018). The effects of pilates method on pelvic floor muscle strength in patients with post-prostatectomy urinary incontinence: a randomized clinical trial. *Neurourol Urodyn.*, 37(1), 346-353.
34. Pedriali, F. R., Gomes, C. S., Soares, L., Urbano, M. R., Moreira, E. C. H., Averbeck, M. A., *et al.* (2016). Is pilates as effective as conventional pelvic floor muscle exercises in the conservative treatment of post-prostatectomy urinary incontinence? A randomised controlled trial. *Neurourol Urodyn.*, 35(5), 615-621.
35. Chmielewska, D., Stania, M., Kucab-Klich, K., Błaszczak, E., Kwaśna, K., Smyklaet, A., *et al.* (2019). Electromyographic characteristics of pelvic floor muscles in women with stress urinary incontinence following sEMG-assisted biofeedback training and pilates exercises. *PLoS One.*, 14(12), e0225647.
36. Kang, G., Lee, H., Shin, M., Kim, J., Lee, S. & Park, Y. (2021). The efficacy of pilates on urinary incontinence in Korean women: a metabolomics approach. *Metabolites.*, 11(12), 118.