RBCDH Revista Brasileira de CINEANTROPOMETRIA e Desempenho Humano

DOI: http://dx.doi.org/10.5007/1980-0037.2014v16n6p648

original article

Influence of pilates exercises on soil stabilization in lumbar muscles in older adults

Influência de exercícios de pilates no solo nos músculos estabilizadores lombares em idosas

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Abstract – The practice of regular physical activity is recognized as a strong ally of active aging, healthy, or successful, whose hallmark is the independent and effective performance of activities of daily living. The Pilates Method (MP) has emerged as a good alternative physical activity in older adults with the main objective of strengthening and stretching the muscles simultaneously, raising body awareness. The aim of this study was to analyze the effects of MP on the strength and conductivity of the electrical stimulation of the lumbar paraspinal muscles as well as muscle contraction transversus abdominis (TrA) in older women before and after performing Pilates exercises on the ground. The instruments used were surface electromyography, force transducer and pressure biofeedback unit. Participants were aged 13, who underwent 12 sessions of Pilates exercises on the ground with an average duration of 50 minutes, are reviewed at the end of the intervention protocol. The participants had increased strength and electrical activation of the lumbar paraspinal muscles, as well as increased ability to contract the transversus abdominis muscle. Based on the results obtained we can conclude that there was a significant improvement of strength and electrical conductivity of the stabilizing muscles of the lumbar voluntary and therefore training with MP positively influenced this musculature.

Key words: Life; Health; Physical.

Resumo – *A prática regular de exercícios físicos é reconhecida como forte aliada do envelhecimento ativo, saudável, ou bem-sucedido, cuja marca distintiva é o desempenho independente e eficaz de atividades de vida diária. O Método Pilates (MP) vem surgindo como uma boa alternativa na prática de atividade física em idosos tendo como objetivo principal o fortalecimento e alongamento simultâneo da musculatura, despertando a consciência corporal. O objetivo foi analisar a influência do MP sobre a força e condutibilidade do estímulo elétrico dos músculos paravertebrais lombares, bem como a contração do músculo transverso do abdômen (TrA) em idosas antes e após a realização de exercícios de Pilates no solo. Os instrumentos utilizados foram eletromiógrafo de superfície, transdutor de força e a unidade de Biofeedback Pressórico. Participaram do estudo 13 idosas, que foram submetidas a 12 sessões de exercícios de Pilates no solo com duração média de 50 minutos, sendo reavaliadas no término do protocolo de intervenção. As participantes obtiveram aumento da força e da ativação elétrica dos músculos paravertebrais lombares, bem como aumento na capacidade de contração do músculo transverso do abdômen. Com base nos resultados observou-se uma melhora significativa da força e da condutibilidade elétrica dos músculos estabilizadores lombares das voluntárias e, portanto, o treinamento com o MP influenciou positivamente essa musculatura.*

Palavras-chave: *Exercício físico; Força muscular; Idoso; Região lombar.*

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Received: 17 July 2013
Accepted: 23 January 2014

INTRODUCTION

With increased longevity, the number of older adults has grown substantially. Brazil is assuming a demographic profile of ageing population, indicating changes in the population age structure[1].

One indicator that shows this process is the ageing index. Between 2035 and 2040, the number of elderly people (aged 65 and over) may reach 18% more than the number of children (0 to 14 years old) and, in 2050, it may represent 22.71% of total population[2].

By definition, aging is the sum of all processes (alterations and adaptation) that occur along the years in the human body[3]. The main alterations include reduced muscle strength, which limits daily activities and reduces the functional interdependence of the elderly people[1]. This fact is particularly relevant for women, who have longer life expectancy than men, reduced functional reserve and greater reduction of muscle strength[4].

The maintenance of interdependence for activities of daily living (ADL) is a predictive factor for successful ageing[5]. Thus, the therapy of physical exercises for the elderly people has been proposed to prevent and treat disabling events, chronic diseases and risk factors[6].Pilates is a physical fitness system that combines strength and flexibility and, with the benefits proposed for better muscle control, it may be an effective method for the elderly people[7].

The purpose of the Pilates method is to strengthen muscles located in the center of the body (abdominal and paravertebral muscles), referred to by Joseph Pilates (who developed the method) as the powerhouse. He combined improvements in motor activity, body stability and movement with better flexibility of these muscles[8].

Then, the Pilates method can have a new focus, acting as a therapy tool to prevent and treat geriatric disorders, which, associated with the restricted number of studies in the area, justify studies that evaluate the Pilates method effect on elderly people. The purpose of this study was to analyze the influence of the Pilates method on the strength and conductibility of electrical stimulation of paravertebral muscles and the contraction of transverse abdominal (TVA)musclein elderly women before and after performing Pilates exercises on the ground.

METHODOLOGICAL PROCEDURES

Study design

This is a quantitative, comparative descriptive study. Data were collected at the primary care clinic of the sector of Physiotherapy at the Hospital Getúlio Vargas, in the city of Teresina-Piauí, from April to June 2013. All participants were informed of the study procedures and signed an Informed Consent Term before they were submitted to the intervention protocol, which was approved by the Research Ethics Committee of the State University of Piauí/ Via Plataforma Brasil (CAAE 12 86613.7.0000.5209) recorded under Nº 248.105 on April 17, 2013.

Sampling

The participants were submitted to an interview to collect data about their practice of physical activity, diseases, use of medication and family history. The sample had 13 elderly women. The inclusion criteria were: women between 60 and 80 years of age, who agreed to participate spontaneously in the study, by signing an Informed Consent Term and that practiced physical activity regularly(three or more times a week, for at least 30 minutes). The exclusion criteria were: presence of any restriction to practice the proposed activities, comprehension deficit and more than two absences in the scheduled visits.

Evaluation protocol

An initial evaluation was conducted, and personal data were collected from the participants; then, the electrical strength and stimulation of paravertebral muscles was evaluated and the TVA muscle contraction was indirectly measured.

A force transducer (0-200 kg range) produced by EMG System do Brazil LTDA evaluated the paravertebral muscle strength evaluation, connected to the electromyography system.

The electromyographic analysis of paravertebral muscles used an 8-channel surface electromyograph produced by EMG System do Brazil (São José dos Campos, SP, Brazil) with signal acquisition and processing software, calibrated before this study was conducted. The sampling frequency was 2000 Hz, expansion of 1,000 times, high-pass 20Hz filter and low-pass 500Hz filter and 12-bit analog converter. The bipolar technique used Kendall surface electrodes (Meditrace – 100; Ag/AgCl; 2.2cm diameter) for signal capture, and all procedures in the protocol of SENIAM (Surface Electromyography for Non-Invasive Assessment of Muscles)[9] project were rigorously observed. The electromyographic signal was statically collected.

The electrodes were bilaterally placed at level L5 and aligned in parallel between the line of posterior superior iliac spines and the interspinous space of L1 and L2, placed on the muscular venter, in parallel with the muscular fibers, keeping 2cm between them. For comparison, the EMG signals were normalized, based on the maximum isometric voluntary contraction (MIVC).

The participants remained in the sitting position, at 90º hip flexion. In this position, they were instructed to stretch the trunk against the load cell resistance for ten seconds when they heard the sound stimulation, when the signals were captured.

The indirect measurement of the TVA muscle contraction was conducted using a Stabilizer Pressure Biofeedback unit. During the tests, with participants in ventral decubitus (VD), the inflatable bag was placed in the space immediately above the anterior superior iliac spines, under the umbilical scar.

Before starting the contraction, the pressure bag was insufflated to 70mmHg with closed valve. The participants were instructed to breathe in

and out some times especially using the abdominal region. The bag pressure was then again adjusted to 70mmHg. Three contractions of the TVA muscle were requested with the following command: "Force the abdomen upwards and inside, without moving the spinal column and pelvis". These contractions were made for at least ten seconds, with 1-minute interval between every contraction, measured with a timer. After that, the average of three values was calculated.

The classification adopted for the evaluation of the values found with the Stabilizer Pressure Biofeedback unit was that proposed by Richardson et al[10]: 70mmHg corresponding to 0mmHg –no alteration; 70-66mmHg: 0 to -4mmHg –insufficient contraction of the TVA muscle; 66-60mmHg: -4 to -10mmHg –excellent performance; above 70mmHg means full muscle contraction.

The protocol comprised Pilates exercises on the ground; stretching and exercises were performed for the Upper Limbs (UL), trunk and Lower Limbs (LL), with repetitions and strength increasing along the exercise weeks, using a Swiss ball, thera-band and flex ring. Twelve sessions of the Pilates method were performed, three times a week; each session lasted 50 minutes on average. After the protocol was concluded, the participants were revaluated.

Box 1. Protocol comprised of basic exercises adopted in the study.

FIRST WEEK		SECOND WEEK	
Exercise	Repetitions	Exercise	Repetitions
Shoulders: raise the ball in DD	5	Shoulders: raise the ball in DD	5
Hip: move the ball sideways	5	Hip: move the ball sideways	5
Belly dance	5	Quadruped	5
Bridging	5	Bridging	5
THIRD WEEK		FORTH WEEK	
Exercise	Repetitions	Exercise	Repetitions
Single leg circles: laying down with thera-band	8	Single leg circles: laying down with thera-band	10
Training with the flex ring	10	Training with the flex ring	10
Elevator	10	Elevator	10
Ball-supported quadruped, release hand/foot, alternating the side	5	Ball-supported quadruped, release hand/foot, alternating the side	10
Bridging, releasing one foot at a time	5	Bridging, releasing one foot at a time	10

Statistical Analysis

Data were evaluated first through the Shapiro-Wilk test to assess normality, and then, using the Student's t-test for parametric data and the Wilcoxon t-test for non-parametric data. The level of statistical significance considered in this study was 95% ($p<0.05$) using Bioestat 5.0 (application).

RESULTS

Table 1 shows the anthropometric data of the participants.

Table 1. Characteristics of participants. Teresina, Piauí, 2013.

Variables	Mean ± Standard Deviation
Age (years)	68.63 ± 6.81
Body mass (kg)	59.68 ± 9.86
Height (m)	1.52 ± 0.05
BMI (kg/m²)	24.91 ± 3.73

kg = kilogram; m= meter; BMI = Body Mass Index; m^2 = square meter

Figure 1 shows the values of paravertebral muscle strength obtained before (18.20± 4.67) and after (27.18 ± 8.37) the Pilates protocol application.

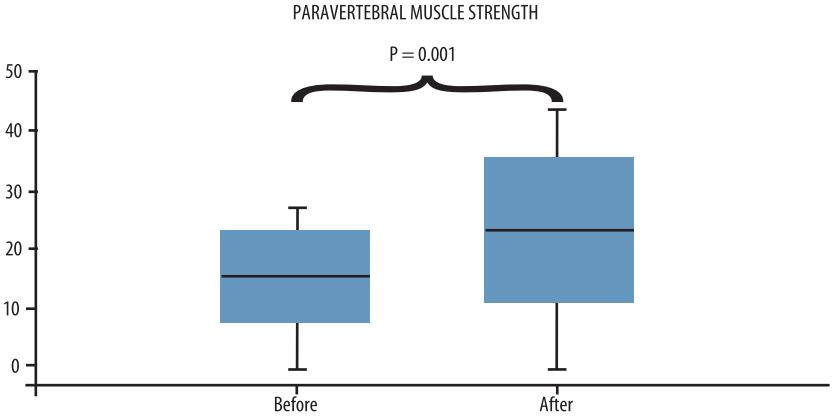

Figure 1. Comparison of paravertebral muscle strength before and after Pilates exercises on the ground. Teresina, Piauí, 2013.

Figure 2 shows the EMG variables in the electrical activation of paravertebral muscles from both the left (before: 35.06 ±20.22; after: 49.18±23.86) and right (before: 32.55±15.10; after: 45.92 ±19.37) sides.

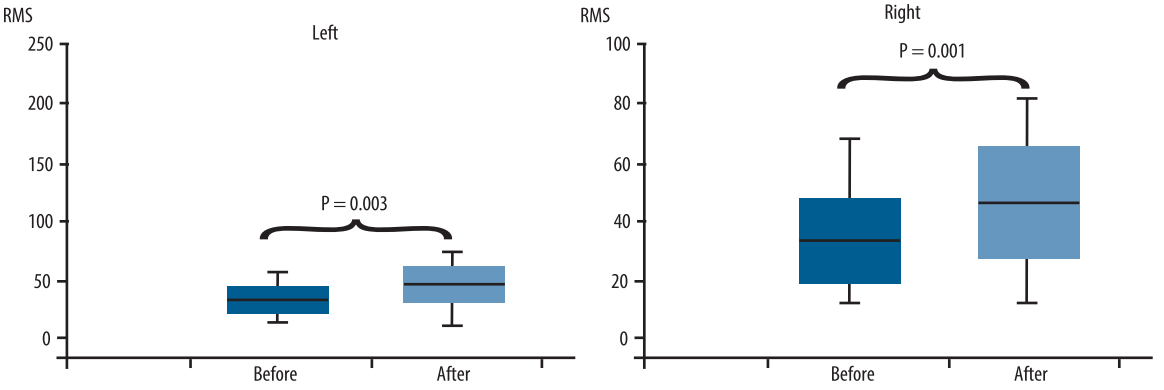

Figure 2. Comparison of the electrical activity of left and right paravertebral muscles before and after the Pilates exercises on the ground. Teresina, Piauí, 2013.

In terms of laterality, the comparison of left and right muscles of the vertebral column did not show any statistically significant difference.

Table 2 show the mean values of the TVA muscle activation, before and after the intervention.

Table 2. Ability of TVA muscle activation. Teresina, Piauí, 2013.

TVA muscle activation (mmHg)	Before (Mean ± SD)	After (Mean ± SD)	p
	-1.66 ± 1.72	-7.92 ± 5.78	< 0.003

TVA = transverse abdominal (muscle); mmHg= millimeter of mercury; SD = standard deviation; p = level of significance.

DISCUSSION

This study analyzed a homogeneous population, following the pre-established criteria, and which remaining the same until the end of the study, allowing to compare pre- and post-intervention moments.

Sarcopenia, defined as a slow, progressive and apparently inevitable process of loss of muscle mass and strength, is one of the most important physiological changes associated with ageing[11]. This strength is estimated to reduce, on average, 15% every decade after the age of 50 and 30% after the age of 70[12].

Specifically in women, one of the factors that contribute to sarcopenia development and progression is the reduction of estrogens associated with menopause. The female sex steroids possibly have anabolic effects on muscle through tissue conversion in testosterone[13].

Inactivity, common in this population, favors physical dependence, leading to inability to perform ADL[14]. Evidences suggest that an exercise program prevents and/or minimizes the deleterious effects of ageing[15].

One of the purposes of prescribing physical exercises to elderly people is to increase and/or keep muscle strength, acting against sarcopenia[16]. Resistance exercises and innovative methods, like Pilates, which emphasizes principles such as strengthening of abdominal and paravertebral muscles while keeping good posture, body alignment and breathing, are today in perspective in exercise programs[17].

Pilates is characterized by efficient movements of abdominal, gluteal and paravertebral muscles[18], which explains the considerable improvement in the participants' ability to contract these muscles, as the protocol adopted in this study comprised mainly basic exercises of a program to strengthen these muscles.

One of the results observed was increased paravertebral muscle strength. The mechanisms involved in such increase, in elderly people, are still not fully explained, but can be attributed to neural adaptations and/or muscle hypertrophy. Thus, a possible explanation for increased strength might have been the increased neuromuscular activation, also observed in the study.

Considering that, to perform muscle strength activities, the neuromuscular activation should occur first, the results are considered consistent, as with the increased number of muscular fibers activated, due to increased electrical activity, the consequence is increased muscle strength observed in the study.

Other studies conducted with the Pilates method presented similar results. Sekendiz et al[19] analyzed the effects of Pilates exercises on the ground on trunk muscle strength and flexibility of21 sedentary adult women, whose mean age was 30 years. The authors presented significant improvement in both variables (strength and flexibility). Kolyniak et al[20]evaluated the effects of Pilates exercises on the function of trunk extensors in 20 people (16 woman, mean age: 34.06 years; four men, mean age: 33.5 years). The study presented significant result: 25% increase in strength peak of the extensor muscles. Another study that confirmed these results was the one conducted by Kawanishi et al[17], which presented positive effects of Pilates training on the reduction of pain symptoms and improvement of lumbar flexibility and strength in 12 individuals with chronic low back pain (6 women and 6 men, mean age: 33 years).

The increased strength in paravertebral muscles is very relevant, as these muscles ensure the correct position of upright trunk and act as synergists for the movements of body segments. When the performance of these muscles is poor, the spinal column shows instability. That leads to loose ligaments, alteration to muscle control, pain and muscle fatigue[21].

Low resistance to fatigue of paravertebral muscles, defined as reduced ability of the neuromuscular system to produce strength, is common in patients with chronic low back pain and such fatigue results in abnormal movements of the trunk and loss of muscle control that can lead to micro lesion of ligaments and intervertebral discs[21]; thus, justifying the importance of strengthening these muscles.

In terms of laterality, the comparison of left and right muscles of the lumbar spine did not show any statistically significant difference, in agreement with the study conducted by Gonçalves & Barbosa[22].

Regarding the TVA muscle, its activation was obtained by using a Stabilizer Pressure Biofeedback unit, an instrument commonly used in clinical practice and studies that evaluate the TVA muscle activation ability, with good level of reliability and accuracy. This instrument has already been associated with imaging exams and electromyography, considered gold standards in the analysis of TVA behavior[23].

Richardson et al[10]state that the usual answer to the records of Stabilizer Pressure Biofeedback unit is pressure reduction between -4 and -10mmHg, that is, in actual values of 66 to 60mmHg. Hodges et al[24]report that the ideal depression of the abdominal wall should be -5.82mmHg or above.

Table 2 shows a significant increase was observed in the TVA muscle contraction ($p< 0.001$). According to the classification proposed by Richardson et al[10], the participants that had insufficient contraction (-1.66mmHg) before, present now excellent performance (-9.33mmHg), after practicing the proposed exercises.

The increase in TVA muscle contraction ability can be explained by the type of breathing adopted in the Pilates method. The Pilates exercises use inhaling as relaxation and preparation for the movement, while exhaling is used for abdominal practice, by activating the accessory muscles

of inspiration, such as: rectus abdominis muscle, transverse abdominal muscle and oblique muscles[20].

Kloubec[25], in his study with 25 patients, reported that the Pilates method promoted statistically significant increases in the abdominal muscle strength of participants, in agreement with the results obtained in this study.

The increased ability of the TVA muscle contraction observed in this study is very relevant, due to the importance of these muscles to keep the lumbar spine integrity. Studies show that individuals with chronic low back pain present deep abdominal muscle mal function, especially the TVA muscle.

Ramos et al[23]evaluated the TVA muscle activation ability of individuals with and without unspecific chronic low back pain. The results showed that individuals with chronic low back pain presented insufficient TVA muscle activation (-0.3mmHg), while individuals without chronic low back pain presented almost excellent contraction values (-3.6mmHg), indicating more efficient activation in healthy individuals.

The Pilates method involves muscle exercise of low-impact contraction, intensely strengthening lumbar stabilization muscles[26], in agreement with the results found, as it increased the strength of abdominal muscle and trunk extensor.

The practice of this method, by strengthening the powerhouse muscles, especially the deep stabilization muscles (transverse abdominal muscle), improves the dynamic balance of elderly people, providing stability. On the other hand, the inefficiency of these muscles, associated with weakening, leads to unstable trunk, which may increase the stress of intervertebral articulations, favoring degeneration in this segments and, consequently, the development of pathologies[6].

CONCLUSION

Based on the results of this study, after twelve sessions with the Pilates method, a significant improvement of lumbar stabilization muscle strength was observed in the participants and, therefore, the training brought positive effects to these muscles. Although the results are positive, they are consistent with the small group studied. Thus, new random studies are required with larger sample sizes, longer intervention period, and including male elderly people, investigating the effects of this activity on elderly population. The Pilates exercises can be practiced by elderly people between 60 and 80 years old, and, besides involving low cost of implementation, the Pilates method can be consolidated as a new therapy strategy for a group that tends to keep growing in the near future.

REFERENCES

1. Lacourt MX, Marini LL. Decréscimo da função muscular decorrente do envelhecimento e a influência na qualidade de vida do idoso: uma revisão de literatura. Rev Bras Cien Envelh Hum 2006;3(1):114-21.

2. IBGE, Censo Demográfico 1940/2000 e Projeção da População do Brasil por Sexo e Idade para o Período 1980-2050 – Revisão 2008. Dados extraídos do Atlas Nacional Do Brasil Milton Santos, IBGE,2008:121. Disponível em URL: <http://seriesestatisticas.ibge.gov.br> [2013 mai 27]
3. Zago AS. Exercício físico e o processo saúde-doença no envelhecimento. Rev Bras Geriatr Gerontol 2010;13(1):153-8.
4. Gurjão ALD, Carneiro NH. Efeito agudo do alongamento estático na força muscular de mulheres idosas. Rev Bras Cineantropom Desempenho Hum 2010;12(3):195-201.
5. Moraes JFD, Souza VBA. Factors associated whit the sucessful aging of the socially-active elderly in the metropolitan region of Porto Alegre. Rev Bras Psiquiatr 2005;27(4):302-8.
6. Pestana VS, Pestana AMS. Efeitos do Pilates solo e exercício resistido sobre a obesidade central e o índice de massa corpórea em idosos. Rev Cienc Med Biol 2012;11(2):218-23
7. Bird ML, Hill KD, Fell JW. A randomized controlled study investigating static and dynamic balance in older adults after training with Pilates. Arch Phys Med Rehabil 2012;93(1):43-9.
8. Rodrigues BGS, Cader SA. Autonomia funcional de idosas praticantes de Pilates. Fisioter Pesqui 2010;17(4):300-5.
9. SENIAM. Surface Electromyography for the Non-Invasive Assessment of Muscles. Disponivel em URL: < http://www.seniam.org/>[2013 jun10.]
10. Richardson CHP, Hides J. Therapeutic exercise for lumbo pelvic stabilization. A motor control approach for the treatment and prevention of low back pain. 2 ed. Churchill Livingstone 2004.
11. Garcia PA, Dias JMD, Dias RC, Santos P, Zamp CC. Estudo da relação entre função muscular, mobilidade funcional e nível de atividade física em idosos comunitários. Rev Bras Fisioter 2011;15(1):15-22.
12. Rocha AC, Fernandes MC, Gudes Júnior DP. Analise comparativa da força muscular entres idosas praticantes de musculação, ginástica localizada e institucionalizada. Fit Perf J 2009;8(1):16-20.
13. Gallon D, Gomes ARS. Idosos institucionalizados e os efeitos do exercício no processo de envelhecimento musculoesquelético: uma revisão. Rev Bras Cienc Envelh Hum 2011;8(1):136-47.
14. Aveiro MC, Navega MT, Granito RN, Rennó ACM, Oishi J. Efeitos de um programa de atividade física no equilíbrio e na força muscular do quadríceps em mulheres osteoporóticas visando uma melhoria na qualidade de vida. Rev Bras Cienc Mov 2004;12(3):33-8.
15. Almeida APPV, Veras RP, Doimo LA. Avaliação do equilíbrio estático e dinâmico de idosas praticantes de hidroginástica e ginástica. Rev Bras Cineantropom Desempenho Hum 2010;12(1):55-61.
16. Jarek C, Oliveira MH. Comparação antropométrica, força muscular e equilíbrio entre idosos praticantes e não praticantes de musculação. Rev Bras Cienc Envelh Hum 2010;7(2):173-180.
17. Kawanishi CY, Oliveira MR, Coelho VS, Parreira RB, Oliveira RF, Santos CF, et al. Efeitos dos exercícios pilates na função do tronco e na dor de pacientes com lombalgia. Ter Man 2011; 9(44):410-4.
18. Marés G, Oliveira KB. A importância da estabilização central no método Pilates: uma revisão sistemática. Fisioter Mov 2012;25(2):445-45.
19. Sekendiz B, Altun O. Effects of Pilates exercise on trunk strength, endurance and flexibility in sedentary adult females. J Bodyw Mov Ther 2007;11(4): 318-26.
20. Kolyniak IEG, Cavalcanti SMB, Aoki MS. Avaliação isocinética da musculatura envolvida na flexão e extensão do tronco; efeito do método Pilates. Rev Bras Med Esporte 2004;10 (6):487-490.
21. Kawano M, Souza RB, Oliveira BIR, Menacho MO, Cardoso APRG, Nakamura FY, et al. Comparação da fadiga eletromiográfica dos músculos paraespinhais e da cinemática angular da coluna entre indivíduos com e sem dor lombar. Rev Bras Med Esporte 2008;14(3):209-14.

22. Gonçalves M, Barbosa FSS. Análise de parâmetros de força e resistência dos músculos eretores da espinha lombar durante a realização de exercício isométrico em diferentes níveis de esforço. Rev Bras Med Esporte 2005;11(2):109-14.
23. Ramos LAV, França FJR. Ativação do músculo transverso do abdome em indivíduos com e sem lombalgia crônica inespecífica. Rev Ter Man 2011;9(46):695-9.
24. Hodges P, Richardson C. Evaluation of the relationship between laboratory and clinical tests of transverses abdominis function. Physiother Res Int 1996; 1(1):30-40.
25. Kloubec JA. Pilates for improvement of muscle endurance, flexibility, balance, and posture. J Strength Cond Res. 2010;24(3):661-7.
26. Conceição JS, Mergener CR. Eficácia do método Pilates no solo em pacientes com lombalgia crônica. Relato de casos. Rev Dor 2012;13(4):385-8.

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