

The effect of the Pilates method on the treatment of chronic low back pain: a clinical, randomized, controlled study

Efeito do método Pilates no tratamento da lombalgia crônica: estudo clínico, controlado e randomizado

Pedro Henrique Brito da Silva¹, Dayane Ferreira da Silva¹, Jéssyka Katrinny da Silva Oliveira¹, Franassis Barbosa de Oliveira¹

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ABSTRACT

BACKGROUND AND OBJECTIVES: Low back pain is defined as a painful disorder located between the first and the fifth lumbar vertebra, and it is considered to be an important public health problem. In Brazil, approximately 10 million people are disabled as a result of this condition. The objective this study was to assess the effects of the Pilates method on the treatment of chronic low back pain.

METHODS: The present study is based on a randomized, controlled clinical trial involving 16 individuals, aged 30-60 years, of both gender, with chronic low back pain, divided into control group and experimental group, with eight individuals each. Twelve sessions of 40 minutes were performed, in which nine positions of the Pilates method were applied within the experimental group. The control group performed kinesiotherapeutic conventional exercises. The visual analog scale and the Oswestry Disability Questionnaire were used before and after the study period in both groups.

RESULTS: The assessment of pain and disability in the pre- and post-evaluation periods showed no statistically significant difference. The control group also showed no statistical difference for the visual analog scale and Oswestry scores between the pre- and post-evaluation periods, whereas the experimental group showed a significant difference between the scores obtained in these two different periods for the Oswestry and visual analog scores.

CONCLUSION: It is suggested that the method was effective for the group studied and proved to be suitable for the treatment of low back pain, but it did not prove superior to conventional physical therapy.

Keywords: Low back pain, Pain, Spine.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A lombalgia crônica é definida como um distúrbio doloroso localizado entre a primeira e a quinta vértebra lombar, considerada um importante problema de saúde pública, sendo que no Brasil, aproximadamente 10 milhões de pessoas são incapacitadas em consequência desta afecção. O objetivo deste estudo foi avaliar o efeito do método Pilates no tratamento da lombalgia crônica.

MÉTODOS: Estudo clínico, controlado e randomizado, com participação de 16 indivíduos com lombalgia crônica, de ambos os sexos, com idade entre 30 e 60 anos, divididos aleatoriamente em grupo controle e grupo experimental, com oito indivíduos cada. Foram realizadas 12 sessões, de 40 minutos, em que foram aplicadas, no grupo experimental, nove posturas do método Pilates. O grupo controle realizou exercícios cinesioterapêuticos convencionais. Foram utilizados um questionário sociodemográfico, a escala analógica visual e o Questionário de Oswestry, pré e pós o período do estudo, em ambos os grupos.

RESULTADOS: A avaliação da dor e incapacidade no momento pré e pós entre os grupos não apresentou diferença estatística significativa. O grupo controle também não apresentou diferença estatística para os valores das escalas analógica visual e Oswestry entre os momentos pré e pós e o grupo experimental apresentou significância entre os valores obtidos nos dois momentos de coleta pré e pós para os escores de Oswestry e escala analógica visual.

CONCLUSÃO: Sugere-se que o método foi efetivo para o grupo estudado e adequado ao tratamento da dor lombar crônica, porém não se mostrou superior à fisioterapia convencional.

Descritores: Coluna vertebral, Dor, Lombalgia.

INTRODUCTION

Chronic back pain is a musculoskeletal problem with a prevalence of approximately 11.9% in the world population and high costs related to losses in productivity, leave of absence and expenses to the healthcare system in the economically advanced societies of the present time¹. Anatomically, it can be defined as a pain present from the last costal arch until the gluteal fold, persisting for more than 12 weeks and frequently not resulting from specific diseases but from of a set of causes, as sociodemographic factors (age, gender, income), behavior factors (smoking and lack of physical exercises), ergonomic exposure (stressful physical work, vicious working positions, repetitive movements), among others^{2,3}.

1. Universidade Estadual de Goiás, Curso de Fisioterapia, Goiânia, GO, Brasil.

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Correspondence to:

Avenida Anhangüera – Setor Vila Nova

74605-085 Goiânia GO, Brasil.

E-mail: pedrobryto@gmail.com

It was the first cause of disability retirement in Brazil, in 2007⁴. Therefore, there is a great amount of time and resources spent with patients with this type of musculoskeletal disease and about 50 billion dollars per year are directed to expenses related to low back pain around the world⁵.

Disability, when associated with chronic back pain, can be explained as the difficulty or impossibility to accomplish daily tasks and activities due to the painful picture. Self-care, household chores, work, social and leisure activities can be affected or even impaired, because of the pain. Other variables involved in defining disability are anxiety, stress, and fear^{6,7}.

There are many physiotherapeutic resources for the treatment of chronic back pain proposed in the literature. However, the one with better evidence is physical exercise⁸. Treatments based on exercises to improve trunk muscle strength and resistance are important to reduce the intensity of pain and the functional impairment⁹. Another treatment approach for chronic back pain is the Postural School, a multidisciplinary program based on health education aiming to facilitate the acquisition of healthier postural habits. The benefits of this technique are not limited to the musculoskeletal disorder, but also to the quality of life and psychosocial aspects³.

In this context, among the kinesiotherapy methods to patient's global approach is Pilates. This method reduces pain levels and, consequently, the damages caused by the painful picture in daily life activities (DLA) and practical life activities (PLA), since the exercises created by Josef Pilates in 1918, can be considered as the torso stabilization. The Pilates method requires contractions of the abdominal muscles (rectus abdominis, transverse abdominis, internal and external oblique), gluteus, perineal and lumbar paravertebral muscles, the so-called powerhouse, responsible for the static and dynamic core stabilization^{9,10}.

Moreover, resistance exercise and dynamic stretching, associated with breathing during the execution of the exercises promote a uniform strengthening the powerhouse, providing more core-stabilization, thus being effective in the elimination of the painful low back syndrome¹¹.

The Pilates method is based on a concept called "Contrology," which consists of the conscious control of all body muscle movements with the correct use and application of the most important principles of the forces acting on the musculoskeletal system, with the full knowledge of the functional body mechanisms. Pilates exercises are performed, in its great majority, in the lying position, resulting in less overload in the joints of the body support in orthostatism, enabling the recovery of muscle, joint, and ligament structures, particularly of the lumbar segment¹².

In addition, Pilates is characterized by a set of movements where the neutral position of the spine is always respected, aiming to improve the coordination of breath with the body movement, the general flexibility, muscle strength, and posture, which are important factors in the posture-re-education process. When performing these low-impact exercises, it is recommended to use six principles: concentration, control, precision, flow, breath, and centering¹³.

The prescription of Pilates exercises for patients with chronic back pain is justified by the fact that this method is based on exercises that emphasize body stretching and strengthening. Therefore, the method jointly works isometric strengthening, global stretching, breathing, and proper positioning of the spine promoting a broader body awareness and proprioception in the exerciser¹⁴.

The exercises proposed by the Pilates method are commonly used in the clinical practice of physiotherapists with satisfactory results. However, there is little evidence in the scientific literature on its effectiveness in patients with chronic low back pain¹⁵.

The objective of this study was to evaluate the effect of Pilates exercises in the treatment of the chronic back pain in individuals attending the Physiotherapy sector of the Medical Specialties Center of Senador Canedo (CEMSC), Goiás, GO.

METHODS

This is a clinical, controlled and randomized study. The sample was composed of patients with a clinical diagnosis of chronic back pain (with painful symptoms for more than three months) that were in the waiting line of the public physiotherapeutic service at CEMSC. The participants were referred to the study according to the inclusion and exclusion criteria, soon after an individualized clinical evaluation performed by the researchers.

The inclusion criteria of the study were a clinical diagnosis of chronic back pain by the physicians of the different Primary Care Units of Senator Canedo - Goiás; with age from 30 to 60 years; of both gender; voluntary participation in the study; be literate and able to communicate verbally. The exclusion criteria were: individuals with hypertension, severe neurologic, respiratory, cardiac, orthopedic diseases (fractures, instability, hernias, stenosis, and tumors), diagnosed by any clinical way and following a physiotherapeutic treatment in parallel to the present study.

The participants were duly informed by the researchers about the purpose of the study and its relevance to the society. Information was given in writing and orally and was detailed in the Free and Informed Consent Form (FICT). The subjects who agreed to participate in the study signed the FICT and then the 16 participants were referred to the physiotherapeutic treatment at CEMSC.

The size of the sample was calculated using 50% of the statistical power, 30% of improvement in the experimental group (visual analog scale - VAS), the Oswestry questionnaire, and a standard deviation of two points, giving the number of 15 participants in each group. It was used 5% of significance.

Thirty subjects were on the waiting list for physiotherapeutic treatment at CEMSC, and all of them were evaluated according to the eligibility criteria of the study. Of those, eight were excluded, and 22 participated in the study. The 22 subjects were randomly divided into two groups by means of a simple raffle, where the participants' names were in a dark envelope, and their names were taken one by one. The first 11 names

were allocated in the control group (CG) and the other 11 in the experimental group (EG). However, only 16 participants concluded the treatment, as illustrated in figure 1.

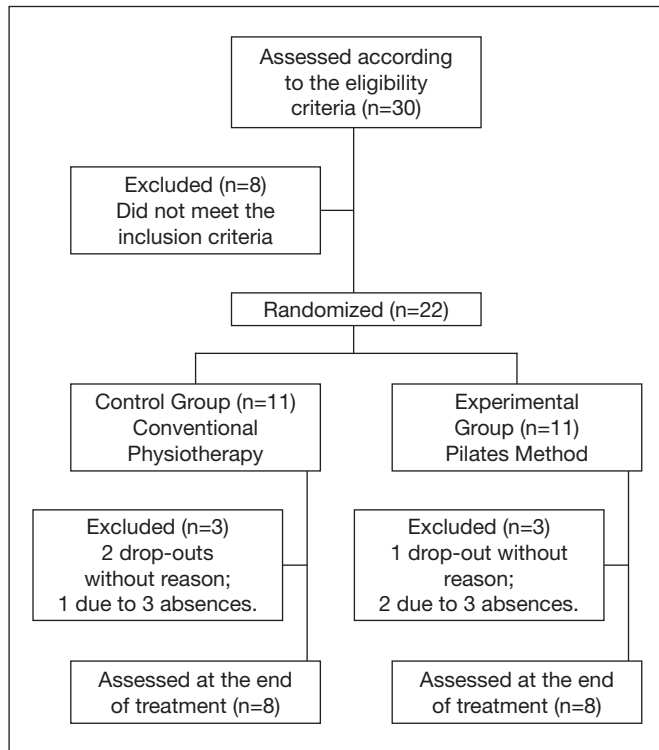


Figure 1. Representation of groups division
n = sample size.

It was used a sociodemographic questionnaire, structured by the researchers, with items related to personal data and some clinical information of the subjects of the study. The subjects informed their weight and height for the calculation of the body mass index (BMI). The VAS was also used to assess the subjects' pain intensity. And finally, the Oswestry Disability Questionnaire was applied to identify the impact of pain in participants' DLA and PLA.

The EG participated in the Pilates Method exercises. The CG performed conventional stretching and strengthening exercises for the spine and lower limbs. Both the CG and the EG had 12 sessions between April and May 2016, twice a week, with 40 minutes duration of individualized sessions. The place selected for the data collection was a large and ventilated room located in the CEMSC premises. The researcher conducted the treatment and evaluation sessions and also applied and analyzed the questionnaires and the VAS, before and after the intervention.

The exercises of the Pilates method selected for this study were: breathing with activation of transverse abdominis, in addition to the following postures: Spine Stretch, The Spine Twist, The Hundred, The one leg circle, The Plank, Leg Pull Front, Swimming, Rocking, Swan. (Annex 1).

The postures selected are described in the literature^{10,16} and followed these directions:

- 1) in the first session, to ensure a basic level of execution of movements before applying the Pilates method to the EG, the participants became familiar with the exercises;
- 2) nine exercises were adopted in each session, and each of them was repeated 10 times with an interval of one minute between each posture;
- 3) the postures adopted favored the respiratory chain, anterior, anterointernal hip, and the posterior chain, since it is observed a greater involvement due to muscle weakness and shortening in these chains in patients with chronic lower back pain¹⁴;
- 4) there was no posture progression, that is, the exercises did not change in terms of positioning. Moreover, the postures selected did not use balls or equipment, so that the intervention protocol could be applied in any situation;
- 5) The postures were maintained in accordance with the respiratory rhythm of each participant, determined by the time of forced and prolonged exhalation that should last about 10 seconds;
- 6) before the Pilates exercises, the volunteers received verbal instructions on how each exercise should be performed with a demonstration by the researcher;
- 7) during the postures, the researcher corrected the participants who were not doing the exercise correctly by tactile or verbal stimulation.

In the CG, resistance exercises were applied jointly with stretching exercises in a protocol of general exercises, with the purpose to simulate the common practice of exercises usually prescribed by physiotherapists in patients with low back pain¹⁶. The protocol consisted of stretching exercises with three repetitions, keeping the stretching stimulus for 30 seconds with a 30-second pause between each repetition. Strengthening exercises were performed in a series of 10 repetitions, using only the body load and handspikes to promote endurance, with a 30-second pause in each position¹⁷.

The protocol of the CG comprised of the following exercises, gluteus strengthening, abdominal strengthening, hamstrings strengthening, torso strengthening, anterior torso stretching, and torso extensor strengthening, hip adductors stretching, knee rocking, abdominal with a partial lift of the torso and rotation, piriformis stretching, knee to chest unilateral¹⁶⁻¹⁸.

The study was conducted in accordance with the Guidelines and Regulatory Standards for Research Involving Human Subjects (Resolution 466/2012, of the National Health Council). It was duly submitted, reviewed and approved by the Research Ethics Committee of the Faculdades Integradas de Santa Fé do Sul (FISA/FUNEC), with opinion number 1.772.749.

Statistical analysis

Descriptive analyses were performed using frequency and percentage measures, central tendency (average) and variability (standard deviation) of the VAS score and the questionnaires. The inferential statistical analysis was performed using the Bio Estat 5.0 software, and the distribution normality was performed using the Shapiro-Wilk test. The differences in the average of the variables of the levels of pain and disability intragroup were ana-

lyzed using the Student's t-test for paired samples, and the CG and EG intergroup variables were analyzed using the Student's t-test for independent samples. The significance level considered was $\alpha=0.05$.

RESULTS

The CG had an average age of 44.87 ± 11.07 years, with BMI of $25.49\pm 3.70\text{kg/cm}^2$, with seven female subjects and one male. In the group, five subjects (62.5%) of the sample were Caucasian and 3 were brown. Three subjects were married, three single and one divorced. Regarding the educational level of the CG, only one participant had a complete higher education (12.5%), two had complete elementary school, two had complete high school, two had incomplete elementary school and one had incomplete high school.

The average age of EG was 47 ± 8.48 years, average BMI of $25.96\pm 3.55\text{kg/cm}^2$, with seven female subjects and one male. In the group, four subjects were married, and four were single. The educational level of the group was characterized by three individuals (57.12%) with incomplete elementary education, three with complete elementary education, one with incomplete high school and one with complete high school.

The age and BMI values between the CG and EG groups had no statistically significant difference. The average values, standard deviation and p values for the Student's t-test are shown in table 1.

Table 1. Average values, standard deviation between the studied groups

Groups	Age (years)	BMI (kg/cm ²)
CG	44.87±11.07	25.49±3.70
EG	47.00±8.48	25.96±3.55
p value	0,6732	0,8000

CG = control group; EG = experimental group; BMI = body mass index. Source: the author (2016).

As for participants' working activity of the CG, six of them had paid employment jobs. In the EG, six participants did not have paid employment jobs. Both in the CG and the EG, participants reported having back pain for more than 24 months, with seven and six participants, respectively. It was observed that seven members of the CG and five individuals in the EG did not perform physical exercises.

Pain assessment by VAS, before and after between the groups showed no significant statistical difference. The CG also showed no statistical difference for the VAS values pre and post-assessment moments, and the EG presented significance between the values obtained in both pre and post moments of collection (table 2).

Table 2. Average values and standard deviation of the groups studied

Groups	Pre-VAS	Post-VAS	p value
CG	5.75 ± 2.81	3.25±3.37	0,1006
EG	5.00±2.00	2.00±2.56	0.0031*
p value	0.5489	0.4177	

* Significant difference between the averages; CG = control group; EG = experimental group; VAS = visual analog scale. Source: the author (2016).

With regard to the Oswestry questionnaire, the pre and post moments between the groups did not present significant statistical difference. The CG did not present statistical difference between the pre and post moments, while the EG showed a statistically significant difference between the pre and post moments, with a p-value of 0.0021 (Table 3).

Table 3. Average values and standard deviation, p values between intergroups and intragroup moments

Groups	Pre-Oswestry	Post-Oswestry	p value
CG	47.25 ± 17.13	37.75 ± 19.25	0,069
EG	36.75 ± 7.70	24.75 ± 11.56	0.0021*
p value	0.1362	0.1238	

* Significant difference between the averages; CG = control group; EG = experimental group. Source: the author (2016).

DISCUSSION

It was observed higher participation of women with low back pain in the present study. This can be attributed to women's greater awareness facing the signs and symptoms, who frequently seek more health services. In addition, household chores added to paid employment can lead to an overload on the lumbar segment due to repetitive work, in a non-ergonomic position and at high speed¹⁹. However, the meaning of pain for men can be influenced by social and cultural factors that allow the woman to express their pain while men are encouraged to ignore it, since insensitivity in the face of pain may be related to issues of manhood, which can justify the reduced number of male participants in the study^{20,21}.

In relation to age, in this study, there were individuals in the age group between 30 and 60 years, corroborating with similar results in the literature²². This is the age group of economically active individuals, which reduces their functional capacity to work and to perform their DLA with an impact on the quality of life of these individuals²³. Aging can result in progressive degenerative changes in the spine with the wear of musculoskeletal structures of the lumbar segment, bringing pain as a consequence²⁴.

The BMI results obtained for the CG and EG subjects point out an overweight of the studied sample. When there is an excessive load that the musculoskeletal structure is required to sustain, this can result in changes in the biomechanical balance of the lumbar spine²⁵.

The data indicate that in both groups there was a prevalence of individuals with low schooling, corroborating the studies conducted in the South and Southeast of the country^{26,27}. Individuals with lower levels of education have professions that have a higher physical demand, which may explain the relationship between the educational level and low back pain²⁴. Only the EG showed improvement of the VAS and Oswestry scores when comparing the pre and post-intervention results. In the comparison of the VAS and Oswestry results between the CG and the EG, there was no difference between before and after the kinesiotherapy and the Pilates exercises. A com-

parative study of the Pilates method and traditional exercises for the stabilization of the lumbar spine was conducted in the State of Tennessee, in the United States, in individuals with chronic lower back pain²⁸. The interventions occurred twice a week, totaling 12 sessions of 30 to 45 minutes, and the groups had six participants in each session. The pain was assessed by the VAS using Oswestry to analyze the functional impairment. The results showed a difference between the beginning and the conclusion of treatment only in the Pilates group. However, there was no difference between the groups, corroborating the results of this study

Therapeutic exercises focusing on the stabilization of the lumbar spine, involving muscle strengthening and stretching in order to rebalance the tension of the muscle chains of the lumbo-pelvic-hip complex may justify the positive results found in the EG in this study because the pain and the impairment faced by individuals with chronic lower back pain can be a result of muscle weakness, especially in the abdominal region and the low joint flexibility on the back and in the lower limbs²⁹.

In addition, Pilates is among the several physical therapy resources able to reduce back pain and provide a functional re-education of this dysfunction, which may promote physical, mental and social well-being, encouraging the return to DLA and PLA³⁰. Resistance exercise and dynamic stretching, associated with breathing during the execution of the exercises promote a uniform strengthening of the powerhouse muscles, providing more core-stabilization, thus being effective in the elimination of the painful low back syndrome³¹.

In a study conducted in Melbourne³², Australia, they compared an exercise program based on the Pilates method with a general exercise program in patients with chronic low back pain, between 18 and 70 years of age, for six weeks. They assessed the intensity of pain by the numeric scale and the functional impairment using the Quebec questionnaire. Eighty-three participants were randomized into two groups: The Pilates group with 41, and the exercise group with 42. The results showed a reduction in low back pain and improvements in the functional impairment in both groups, but with no statistical difference between them. Although the exercise is the physiotherapeutic resource with the best evidence^{15,16,28}, it is not established in the literature which is the best method to handle chronic low back pain. Therefore, the Pilates method was not considered superior to the other forms of exercise, corroborating the present research.

This can be explained by the relation between the chronic back pain, the lack of physical knowledge, and the reduction of the neuromotor control. The general physical fitness and endogenous factors, such as the release of endorphins, can be associated with the pain modulation central mechanisms, acting on its perception. Thus, the therapeutic exercise can reduce the painful disorder and the consequent functional limitations³³.

Other studies based on Pilates exercises directed to the treatment of chronic back pain were reported in the literature compared with control groups with none or minimum inter-

vention^{34,35}, or with a Back-School approach - an educational program which objective is to provide guidance on ergonomic posture to subjects with episodes of back pain³⁶. This can be exemplified by a controlled and randomized study³⁷ in which 39 subjects were divided into two groups, with ages between 20 and 55 years in Hong Kong, China. The experimental group worked with Pilates exercises for four weeks, in order to confirm its influence in reducing the pain of the participants, since low back pain may be related to a decreased joint mobility due to joint stiffening and changes in the ability of muscle recruitment. While the CG participants had only a medical follow-up in the same period. In this context, they noted a decrease in the level of pain in addition to a significant gain in muscle strength, stretching, and flexibility, determining the effectiveness of the Pilates exercises for the treatment of chronic low back pain when compared with the CG.

As to the application of postures, they recommended postures focusing on the muscle chains which were compromised in patients with low back pain. The postures applied to participants in some studies showed an improvement in the flexibility of the muscles that make up the respiratory chain, anterior, anterointernal hip chain, and the posterior chain^{14,16}. With the extensibility gain in these muscle chains, by maintaining the stretching position while performing the Pilates postures, there is an increase in the number of serial sarcomeres and connective tissue remodeling, providing a gain in ROM and decreased muscle tension, which can also justify the improvement of pain and disability scores in the EG^{38,39}.

The treatment with Pilates can vary in terms of frequency and duration of the sessions, with no consensus in the literature. This study was conducted during two sessions per week, for 40 minutes, totaling 12 sessions. Other studies followed the same frequency and duration with results similar to this study^{10,16}. General stretching techniques, such as Pilates, applied twice or three times during 10 to 12 sessions, provided benefits regarding flexibility, the range of motion, pain reduction and improvement in the quality of life⁴⁰.

The present study showed the importance of the Pilates exercises in the treatment of low back pain. Somehow, these exercises can improve the patient's painful picture, relieving pain and the functional limitations imposed on these individuals. However, limitations in the conduction of this research can be identified, such as the small sampling and loss of participants in both groups during the execution of the physiotherapeutic treatments.

CONCLUSION

This study showed that the Pilates method can be an effective tool for the physiotherapist in the management of patients with chronic low back pain to reduce pain and disability. However, when comparing with the CG subjects who had conventional physiotherapy activities in the same period, the Pilates method did not prove to be superior to the intensity of pain and functional impairment scores.

Annex 1. Description of the Pilates method postures

1. Breathing

For a correct execution of the Pilates exercises, proper breathing is paramount because with it comes the contraction of the deep muscles. When starting with the method, the patient was instructed to breathe properly, with deep and complete inhalation and exhalation. The directions on how to breathe properly were provided in the first treatment session. The transverse muscle contraction must be the result of forced exhalation, therefore favoring the stability of the entire lumbar spine and pelvis, favoring the relaxation of the inhalation muscles and cervical muscles. The proper breathing can be described by the synchronized motion in the following order: 1. Chest inhalation; 2. Upper chest exhalation; 3. Lower chest exhalation; 4. Abdominal exhalation. Those moments must occur together with the muscle action.

2. Spine Stretch

The patient sat on the sit bones, keeping the alignment of the physiological curves of the spine. With knees in extension and the hip in the maximum abduction. The hands were in front of the body, on the floor. The patient inhaled in this posture, followed by a forced exhalation taking the hands ahead of the body. At that moment, the movement started from the cervical vertebrae. The command given to the patient was to “roll up” the vertebrae and later to “roll down,” returning to initial posture.

3. The Spine Twist

In this exercise, the initial posture is similar to the one of the Spine Stretch. What differs is the positioning of the arms. The arms were in a 90° alignment of flexion and shoulder abduction with the extension of the elbows, keeping proper alignment in order to avoid bending the knees. In this posture, the patient inhaled. Followed by a forced exhalation while taking one of the hands towards the opposite foot, stretching the trunk rotators.

4. The Hundred

The patient remained in the supine position, with hip and knees bent, both at 90°; and plantarflexion. The arms were resting alongside the body, with the extension of elbows and palms on the supporting surface. Then, the patient inhaled. Exhalation occurred right after when the patient moved the arms in the air quickly and in sync with the breath, while remaining with a cervical flexion, lifting the scapulae off the floor.

5. The one-leg circle

The patient was in the supine position with the lower limbs extended, feet in plantarflexion, with the upper limbs resting alongside the torso and hands on the support surface. The patient performed rotation movements with one of the legs, with the iliac spines facing up all the time. Inhalation was made at the moment of the highest instability of the exercise, that is, during the rotation of one of the legs. 10 repetitions were performed for each side.

6. The Plank

This exercise consists of a lateral plank where the patient lies sideways putting the weight on the forearm at a 90° angle. The knees remained in a 90° flexion. The hip in a neutral position and lifted in the air, only supported by the forearm and knee. The opposite arm, the one that does not receive weight, rested alongside the body. The patient performed the isometric exercise for no more than 10 repetitions. Followed by a sequence on the opposite side.

7. Leg Pull Front (Cat or four-support)

In this exercise, the patient was positioned in four-supports: the hips in a 90° flexion to the thighs and the thighs in 90° with the legs. The shoulders, elbows and wrists remained similarly in the same direction. After positioning, and with the torso well stabilized, concomitantly, the patient performed the extension of one leg and the extension of the contralateral arm. The alignment of all structures was important to maintain a posture similar to the plank and always preserving the physiological curvature of the spine. The move was performed during exhalation.

8. Swimming

To perform this exercise, the patient lay on the stomach, with knees and shoulders extended (arms stretched overhead). Alternately, dissociating the upper and lower limbs, the patient performed a movement similar to swimming. The exercise activates the paravertebral. While raising one of the upper limbs, there was the hyperextension of the contralateral hip. The move was performed during exhalation. The return to the starting position was during inhalation.

9. Rocking

The patient was in the prone position, with knees in maximum flexion (stretching the quadriceps muscle). The hands held the feet, keeping elbows in flexion. The patient extended the elbows and the knees. At that time, the patient took a forced exhalation.

10. Swan

The patient was in the prone position, with the hands on the floor in the direction or above the shoulders. Then, the patient raised the chest off the supporting surface. The pelvis remained in contact with the floor during the performance. When pushing the floor with the hands, the patient took a forced exhalation.

Continue...

Annex 1. Description of the Pilates method postures – continuation

Description of conventional stretching and strengthening exercises

These postures were based on Kisner and Colby¹⁷ and selected according to studies by Macedo and Briganó¹⁸ and Franco¹⁶.

1. Strengthening glutes

The patient stayed in the supine position with the knees bent and feet in parallel on the floor. The exercise was done with the patient pressing the upper part of the spine against the floor, without lifting the heels.

2. Strengthening ABS

The patient stayed in the supine position with knees bent and feet on the floor with the lumbar spine rectified and supported on the same surface. It started with a posterior tilt of the pelvis, raising the head from the floor, which causes a stabilizing contraction of the abdominal muscles. Then, the chest was raised until the shoulder blades were out of the floor.

3. Stretching hamstrings

The patient stayed in the supine position with the hip and knee extended and the contralateral leg flexed supported on the floor. Then, the stretched leg was raised towards the chest.

4. Strengthening the torso

The patient was on all fours with the hands on the floor. The participant was instructed to perform a pelvic tilt before extending the lower limb. This limb would be stretched to align the hip, and the opposite arm extended overhead simultaneously with the leg extension. While the leg was stretched, the arm raised up to the shoulder.

5. Stretching the anterior torso and strengthening torso extensors

The patient was in the prone position, with the hands on the floor in the direction or above the shoulders. After that, the individual raised its chest, keeping the pelvis in contact with the floor. When pushing the floor with the hands, the patient also pushed the shoulder to depress the scapula.

6. Stretching hip adductors

With the patient in the supine position, with knees bent and tights in adduction and the feet with the posterior face one against the other. The subject stretched with the arms in shoulder flexion above of the head.

7. Rocking the knees

The patient, in the supine position, performed moves from one side to the other with the knees bent and thighs in adduction and bent.

8. Abdominal with partial torso lift and rotation

The patient stayed in the supine position with knees bent and feet on the floor with the lumbar spine rectified and supported on the same surface. It started with a posterior tilt of the pelvis, then raising the head off the floor. Then, the chest was raised until the ipsilateral scapula left the floor, rotating the torso towards the opposite knee.

9. Piriformis stretching

The patient, in the supine position, crossed one leg over the other with the ankle on the knee, bringing the opposite knee towards the chest to create the stretching.

10. Knee to chest unilateral

The patient was in the supine position, with the hip and knee bent unilaterally with the opposite leg extended took the bent limb towards the chest.

These postures were based on Franco¹⁶ and Pinheiro et al.¹⁰

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