Effects of 20 sessions of Pilates method on postural alignment and flexibility of young women: pilot study

Efeitos de 20 sessões do método Pilates no alinhamento postural e flexibilidade de mulheres jovens: estudo piloto

Efectos de 20 sesiones del método Pilates en el alineamiento postural y flexibilidad de mujeres jóvenes: estudio piloto

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ABSTRACT | The aim of this study was to evaluate the effects of the Pilates method on the postural alignment and joint flexibility in healthy young females. Thirty-three women aged between 18 and 30 years (56.8±8.5 kg, 1.60±0.06 m, and 22.1±2.7 kg/m^2) having no prior knowledge of Pilates participated in this study. They were randomly allocated into two groups: control group (without intervention) and Pilates group (PG; mat Pilates, 20 sessions, twice a week). Pre and post-program evaluation procedures were performed by a blinded investigator and were characterized by photogrammetric postural analysis (Postural Assessment Software) and assessment of joint flexibility (Wells sit and reach test). A 2×2 Analysis of Variance was used for repeated measures in order to verify differences between pre- and post-measurements for both control group and PG. No significant differences were found between the groups, for all variables. The PG presented no differences in postural alignment after the program ($p>0.05$). However, the PG demonstrated a significant increase of 19.1% in flexibility ($p=0.036$). This study showed that a program of mat Pilates produces significant effects on joint flexibility. However, 20 sessions were not sufficient to cause static postural adaptations in healthy young women.

Keywords | physical therapy specialty; posture; joint motion range; exercise therapy.

RESUMO | O objetivo do estudo foi avaliar os efeitos do método Pilates em solo no alinhamento postural e flexibilidade articular de indivíduos sadios jovens do sexo feminino. Participaram 33 mulheres, com idade entre 18 e 30 anos (56,8±8,5 kg; 1,60±0,06 m e 22,1±2,7 kg/m^2), sem conhecimento prévio de Pilates. Todas deram entrada sequencial e foram alocadas aleatoriamente em dois grupos: grupo controle (GC; sem intervenção) e grupo Pilates (GP; Pilates em solo, 20 sessões, 2 vezes por semana). O processo de avaliação pré e pós-programa foi realizado por avaliador mascarado e caracterizado por avaliação postural fotogramétrica (programa SAPO) e avaliação da flexibilidade articular (teste de sentar e alcançar no banco de Wells). Utilizou-se uma Análise de Variância (ANOVA) 2X2 para medidas repetidas para se verificar diferenças entre momentos pré e pós-programa, para o GC e GP. Não foram encontradas diferenças significantes entre o GC e GP para todas as variáveis. O GP não apresentou diferenças na postura, após o programa ($p>0,05$). Entretanto, o grupo GP apresentou um ganho significante de 19,1% na flexibilidade ($p=0,036$) no momento pós. O estudo demonstrou que um programa de Pilates aplicado em solo gera efeitos significantes na flexibilidade articular. Entretanto, vinte sessões parecem não ser suficientes para causar adaptações posturais estáticas em mulheres jovens sadias.

Descritores | fisioterapia; postura; amplitude de movimento articular; terapia por exercício..

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RESUMEN | El objetivo del estudio fue evaluar los efectos del método Pilates en el alineamiento postural y flexibilidad articular de individuos sanos jóvenes de sexo femenino. Participaron 33 mujeres, con edad entre 18 y 30 años (56,8±8,5 kg; 1,60±0,06 m y 22,1±2,7 kg/m²), sin conocimiento previo de Pilates. Todas fueron ingresadas de forma secuencial y fueron asignadas al azar en dos grupos: grupo control (GC; sin intervención) y grupo Pilates (GP; Pilates en el suelo, 20 sesiones, 2x/semana). El proceso de evaluación pre y post-programa fue realizado por un evaluador ciego y caracterizado por evaluación postural fotogramétrica (programa SAPO) y evaluación de la flexibilidad articular (banco de Wells). Se utilizó un Análisis de Variancia (ANOVA) 2X2 para medidas repetidas para verificar diferencias entre los momentos pre y post-programa para el GC y GP. No fueron encontradas diferencias significativas entre el GC y GP para todas las variables. El GP no presentó diferencias en la postura, después del programa (p>0,05). Por el contrario, el GP presentó una ganancia significativa de un 19,1% en la flexibilidad (p=0,036) en el momento post. El estudio demostró que un programa de Pilates realizado en el suelo genera efectos significativos en la flexibilidad articular. Sin embargo, veinte sesiones parecen no ser suficientes para causar adaptaciones posturales estáticas en mujeres jóvenes sanas.

Palabras clave | fisioterapia; postura; amplitud de movimiento articular; terapia por ejercicio.

INTRODUCTION

The Pilates method was originally developed by Joseph Pilates, who was arrested during the First World War in England as a foreign enemy. In a camp, he refined his ideas about health and muscle development, in addition to encouraging his colleagues to participate in his conditioning program, which was based on a series of exercises performed on the ground[1]. The concept integrated elements from gymnastics, martial arts, and dance, focusing on the relationship between the body and mental discipline[1,2]. The exercises are characterized by progressive movements, and are founded on conscious control of muscle actions and spine stabilization, knowledge of the body's functioning mechanisms, and understanding of balance and gravity principles[3,4].

Pilates is characterized by exercises that involve concentric, eccentric, and especially isometric contractions, with emphasis on the *power house* compound (formed by abdominal, transverse abdominal, and multifidus muscles, and pelvic floor), responsible for the body's static and dynamic stabilization[5]. According to the method's updated concepts, a great influence over the body's postural alignment is attributed to postural muscles[2]. In this sense, the precepts of concentration, motor control, and exercise precision[6] seem to stimulate perception and body alignment based on proprioceptive responses[2].

It is presupposed that the Pilates method is capable of improving the body's general flexibility, postural alignment, and motor coordination, in addition to providing an increase in muscular strength, which demonstrates direct relation to a process of postural re-education[3,6], improvement of motor control, and muscle recruiting[7]. In this context, it is worth highlighting that muscle functioning is intimately related to postural alignment[7], as shown by studies that verified improvement in postural alignment and in the movement range of individuals submitted to methods of postural re-education performed on the ground, indicating that the effects of exercises performed while lying down may be transferred to the standing posture[8,9].

It was indeed verified that Pilates generated gain in the flexibility and muscle strength of ballet dancers[10]. However, a systematic review[11] demonstrated the scarcity of evidence on the effectiveness of Pilates over muscle resistance, flexibility, and strength. In regards to postural alignment, Cruz-Ferreira et al.[11], presented contradictory results and no evidence of the effects of the Pilates method.

According to Bispo Júnior[12], the incidence of postural deviations and related problems (such as back pain, for instance) has gradually increased over the years. According to Kendall et al.[13], an individual's posture refers to a state of joint balance determined by the relationship between body parts and the necessary strength to stabilize joints and favor symmetrical movements. Postural stability is related to the notion of position and movement in relation to the gravitational field and the environment. In this case, stability is generated from the sensorial information sent by different sources (visual, vestibular, and somatosensory systems)[14]. Therefore, a good posture control can protect the individual from traumas besides safeguarding other structures of the body and favoring functionality, comfort, and low energy consumption[15].

One way of minimizing postural side effects is the adoption of training programs. According to Zapater et al.[16], training must focus on the systematic development of a model of behavioral ability necessary to promote changes in the knowledge and behavior of the individuals in relation to their habits and health. Thus, the effects presupposed by the Pilates method could be applied to the process of postural re-education by physiotherapists, considering the improvement in physical fitness, flexibility, and postural alignment. Nevertheless, literature still lacks clinical essays that present evidence about its effects[11].

Therefore, the aim of this study was to evaluate the effects of 20 mat Pilates sessions on the postural alignment and joint flexibility in healthy female individuals. In this sense, we raise the question about the effects of a mat Pilates program on postural alignment (symmetry of angular measurements), and on joint flexibility in healthy young women.

METHODOLOGY

Study type

Controlled and random testing, characterized by an intervention program using exercises of the mat Pilates method, during 10 weeks, twice a week. Pre and post-intervention program evaluations were performed, shown in Figure 1.

Participants

Sample calculation was performed with the software G*Power version 3.1.2 (University of Trier – Trier, Germany), considering type 1 error (α=0.05) and type 2 error (β=0.20) in order to detect moderate effect (f^2>0.5). The calculations indicated a sample of 30 individuals.

Thirty-three young women, university students, ranging from 18 to 25 years of age (56.8±8.5 kg, 1.60±0.06 m, and 22.1±2.7 kg/m^2) participated in this study. They were recruited through posters distributed throughout the university campus. The inclusion criteria were (1) age between 18 and 30 years; (2) no previous knowledge of Pilates; (3) availability to participate in the study; (4) no conduction or participation in workout programs in the last 6 months; (5) living in Campo Grande or nearby region. The participants were excluded if they presented: (1) back pain that lasted longer than 7 days over the past year; (2) musculoskeletal impairment of upper and lower limbs; (3) previous surgeries in the lumbar or abdominal area.

Women who met the criteria were invited to participate in the study and signed a free and informed consent form. The study was approved by the Research Ethics Committee of the Mato Grosso do Sul Federal University (UFMS, protocol number 2032/2011).

All procedures were performed at UFMS's Laboratório de Ensino e Pesquisa em Fisioterapia (Laboratory of Physiotherapy Teaching and Research), in a conditioned environment. The individuals selected were allocated randomly by a table of random numbers generated by the program *Statistical Package for the Social Sciences*, and were divided in two groups: control group (CG), and Pilates group (PG). We used sealed matted envelopes that contained several cards with the names of the interventions (the names "CONTROL" and "PILATES" were used), in order to guarantee the secrecy of the allocation of the participants. This procedure was performed by a researcher who had no knowledge of the study's objectives and purposes.

The participants allocated in the CG did not receive any type of intervention, while the PG was subjected

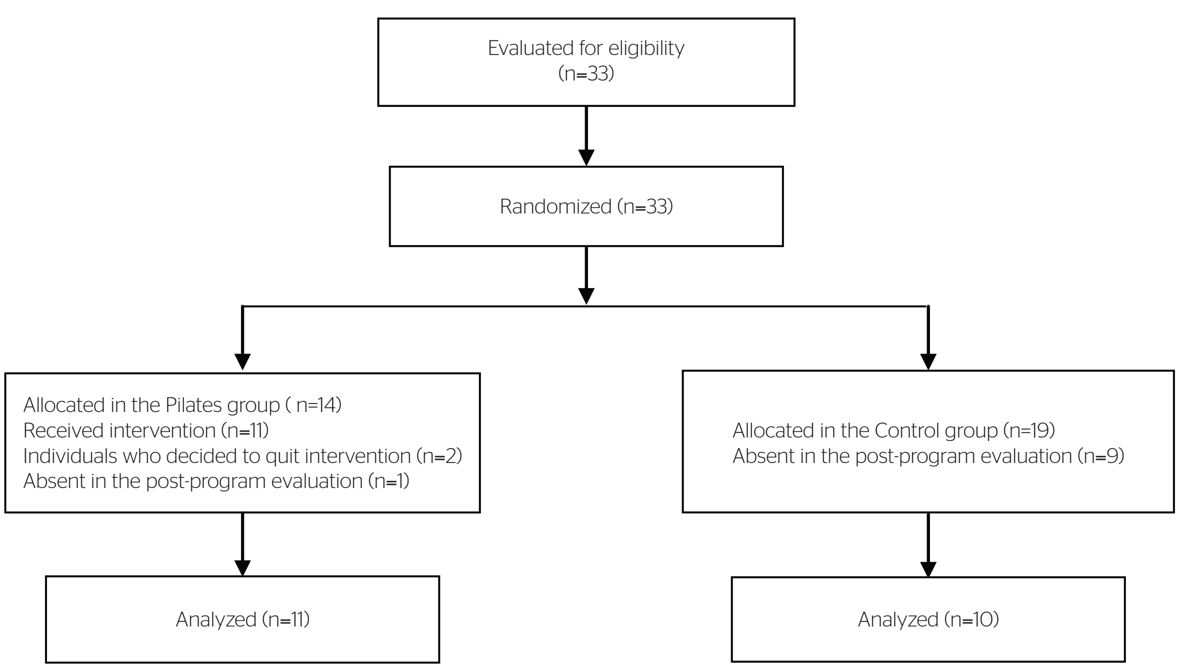

Figure 1. Diagram of the study and flow of participants

to an exercise program based on the mat Pilates method. The program conducted by a previously trained physiotherapist had 20 sessions, twice a week, totaling 10 weeks of intervention under the supervision of a physiotherapist specialized in Pilates.

Evaluation procedures

The evaluation process was conducted by a researcher who was trained in the method and had no knowledge of the research's objectives. The pre and post-exercise program moments were characterized by a postural evaluation through computerized photogrammetry, and evaluation of joint flexibility in the CG and PG groups.

Postural evaluation

Postural evaluation was performed by means of photographic registers, and analysis using the *Postural Assessment Software* (PAS)[17,18]. Spherical markers with 15 mm of diameter were attached to the skin on reference anatomic spots. The photos were taken with the participants minimally dressed in order to detect the following spots[19]: ear tragus; seventh cervical vertebrae; third thoracic vertebrae (T3); acromion midpoint; anterior superior iliac spine; posterior superior iliac spine; femur trochanter; patellar medial facet; tibial tuberosity; knee lateral epicondyle; scapular lower angle; knee joint line; medial gastrocnemius line; calcaneal tendon and calcaneal base; lateral and medial malleolus. All were placed bilaterally, except seventh cervical vertebrae and T3.

The participants were instructed to stand up, with parallel feet. A digital photographic camera (Sony DSC-P9, 4 megapixels) placed on a tripod, 2.5 m away from the participants, was used (Figure 2). A plumb line was positioned on the same plane as the individuals' bodies, with a well-known measurement (50 cm), for the purpose of calibrating the digitalized images. Four images were captured: anterior, posterior, right, and left view.

Based on the spots, the following bodily alignments were calculated[18]: (1) Horizontal Head Alignment; (2) Horizontal Acromion Alignment; (3) Horizontal Anterior Superior Iliac Spine Alignment; (4) Left Lower Limb Frontal Angle; (5) Right Lower Limb Frontal Angle; (6) Q Angle; (7) Scapula Horizontal Asymmetry in Relation to T3; (8) Body Vertical Alignment; (9) Pelvis Horizontal Alignment; (10) Knee Angle; (11) Gravity center asymmetry on the frontal plane; (12) Gravity center asymmetry on the sagittal plane.

Assessment of joint flexibility

We used Wells sit and reach test, an instrument that evaluates the shortening of posterior thigh muscles and its influence on the flexibility of the lumbar spine lower region, and hips. During the test, the participants were instructed to keep their legs straight and attempt to perform a reaching movement three times, which was then measured in centimeters. The highest value of the three attempts was considered for analysis.

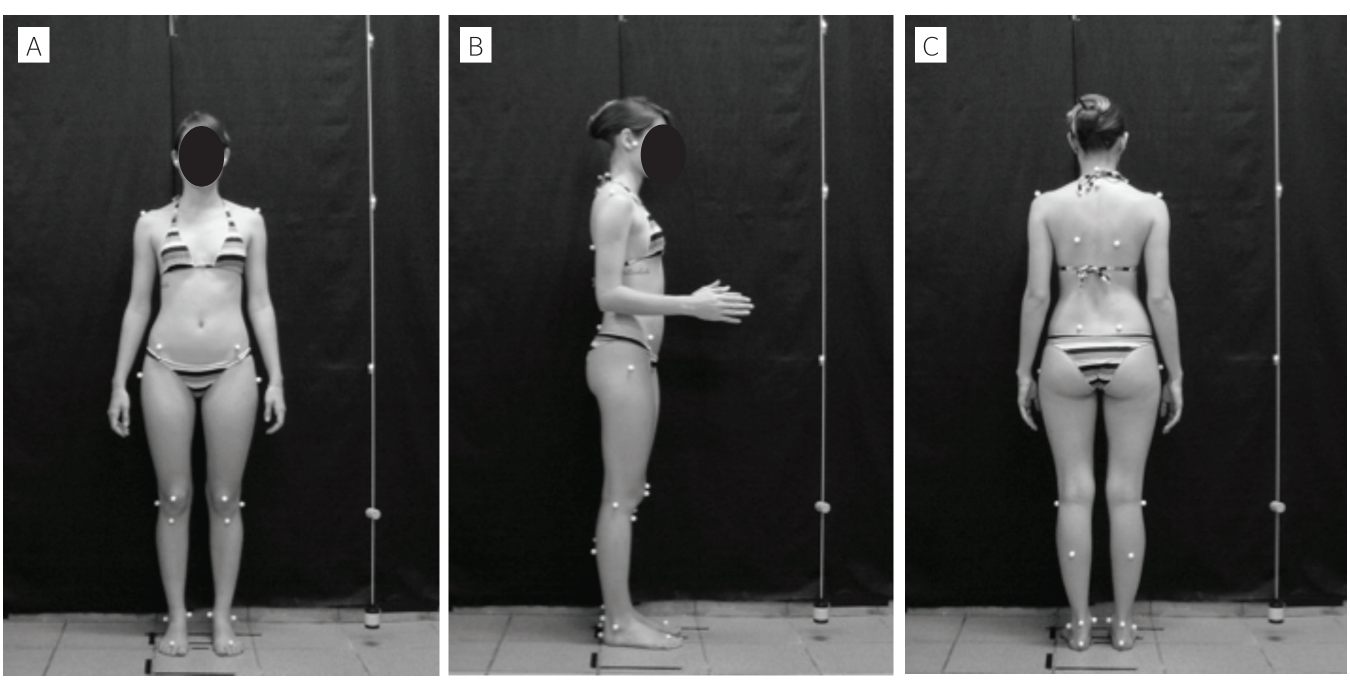

Figure 2. Illustration of the photographic register, and PAS protocol bone markers; anterior view (A), lateral view (B), and posterior view (C)

Pilates exercises

The protocol was characterized by 12 exercises performed on a mat. Each exercise was repeated six times. Each session lasted approximately 60 minutes, and was composed of basic, intermediate, and advanced exercises. A familiarization process took place during the first meeting, in which the participants were instructed about how to breathe during the exercises (inhaling in preparation for the movement, and breathing out during its execution, thus approximating the costal arches). In this first meeting, all participants tried to execute the postures in order to perceive the "strength core" when contracting abdominal muscles, gluteus, and muscles of the adductor and perineum.

The exercises adopted were: (1) *Spine Stretch Forward* – stretching of the posterior chain and spine mobilization; (2) *Rolling like a ball* – strengthening of abdominal rectus, external oblique muscle, and spine mobilization; (3) *Swan* – stretching of the anterior thoracic cage and spine mobilization, strengthening of major chest muscles, brachial triceps, anconeus, and anterior deltoid muscles; (4) *Saw* – stretching of torso rotators, ischiotibial muscles, lumbar region, strengthening of abdominal rectus, external and internal oblique muscles; (5) *Single Leg Stretch* – strengthening of abdominal muscles, stretching of gluteus and lumbar spine; (6) *Teaser* – strengthening of the abdominal rectus, and external oblique muscles; (7) *Criss Cross* – strengthening of the abdominal rectus, external and internal oblique muscles; (8) *Leg Pull Front* – strengthening of major chest muscles, brachial triceps, anconeus, anterior deltoid, gluteus maximus, femoral biceps, semitendinosus tendon, and paravertebral muscles; (9) *Roll-over* – strengthening of the external oblique muscle, and femoral rectus; (10) *Swimming* – strengthening of paravertebral, posterior, and medial deltoid muscles, gluteus maximus, femoral biceps, semitendinosus and semimembranosus tendons; (11) *Side Plank* – strengthening of spine stabilizer muscles; (12) *Shoulder Bridge* – strengthening of quadriceps, gluteus, and posterior leg muscles.

Protocol progression was based on the increase in difficulty through variations of intermediate and advanced positions for each exercise.

Data analysis

Statistical analysis was performed using the program Statistical Package for the Social Sciences version 17.0. The data were presented in relation to the average±standard deviation. We verified data normality through Shapiro-Wilk's test. We used 2×2 Analysis of Variance with repeated measures in order to verify the effects of Pilates before and after the program, considering the independent variables: group (PG and CG) and moment (pre and post). The size effect was calculated through Cohen's $\overline{d}$ for both groups (PG and CG), classified as high, moderate, and low[20,21]. The dependent variables were joint flexibility and postural alignment. In regards to lateral deviation, we used data from the right side, given that there was no significant difference in comparison to the left side. We adopted a significance of 5% ($p<0.05$).

Table 1. Values of postural deviations of the control and Pilates groups; anterior, posterior, and right lateral view (in degrees), and gravity center asymmetry (in percentage), analyzed through PAS before and after evaluation

	Pre-evaluation			Post-evaluation		
Group	Variable	Average	Standard deviation	Variable	Average	Standard deviation
PG	HHA	1.5	2.8	HHA	1.0	2.9
CG		0.4	2.2		0.9	1.5
PG	HAA	0.5	1.7	HAA	0.9	1.2
CG		0.7	1.6		0.8	1.5
PG	HASISA	-0.7	1.7	HASISA	-0.4	1.4
CG		-0.4	1.4		-0.4	2.3
PG	RLLFA	-1.4	2.9	RLLFA	-1.4	2.3
CG		-1.4	3.6		-0.9	3.4
PG	Q	18.2	9.0	Q	16.3	6.4
CG		19.8	7.8		20.4	8.9
PG	SHAT3	4.9	10.4	SHAT3	2.9	14.7
CG		-3.7	9.1		4.1	6.4
PG	BVA	2.0	1.4	BVA	1.5	1.2
CG		2.5	1.3		1.5	2.2
PG	PHA	-13.4	4.2	PHA	-14.7	4.9
CG		-16.1	4.1		-17.1	4.5
PG	KA	-5.8	4.3	KA	-6.0	4.0
CG		-8.6	4.6		-5.8	5.4
PG	Frontal CG	-2.1	6.3	Frontal CG	-2.4	3.7
CG		-3.9	5.1		-2.9	6.9
PG	Sagittal CG	35.0	11.3	Sagittal CG	39.8	18.8
CG		39.2	9.3		34.8	11.8

CG: control group; G: Pilates group; HHA: Horizontal Head Alignment; HAA: Horizontal Acromion Alignment; HASISA: Horizontal Anterior Superior Iliac Spine Alignment; RLLFA: Right Lower Limb Frontal Angle; Q: Q angle; SHAT3: Scapula Horizontal Asymmetry in Relation to T3; BVA: Body Vertical Alignment; PHA: Pelvis Horizontal Alignment; KA: Knee Angle; frontal CG: Gravity center asymmetry on the frontal plane; sagittal CG: Gravity center asymmetry on the sagittal plane

Table 2. Flexibility values measured by Wells (in cm) at the pre and postprogram moments, for the control and Pilates groups. Values presented in average±standard deviation

Group	Pre-evaluation	Post-evaluation	Δ%	ES
CG	26.1±5.8	24.9±6.4	-4.5%	-0.21
PG	25.1±11.2	29.9±8.5	19.1%*	0.43

CG: control group; PG: Pilates group; Δ%: percentual variation between pre and post-program moments; ES: Effect size; Significant difference between pre and post-program evaluation: *p=0.034

RESULTS

The data related to postural deviations as seen through anterior, lateral, and posterior views are presented in Table 1. Significant differences were not found between the CG and the PG. Concerning the moments before and after the program, we did not find significant differences between the groups, in relation to all variables ($p>0.05$).

The values referring to joint flexibility, measured by the test of Wells, are presented in Table 2. We did not find significant differences between the groups PG and CG ($p>0.05$). However, the comparison of the pre and post-program moments demonstrated that the group subjected to Pilates sessions presented a significant gain of 19.1% in flexibility, with moderate size effect ($p=0.036$, Cohen's $\bar{d}=0.43$).

DISCUSSION

This study demonstrated a flexibility gain of 19.1% in individuals subjected to 10 weeks of Pilates exercises, and it confirms Kloubec's recommendations[22] in regard to the use of the method with the purpose of gaining flexibility. Our findings also corroborate the study by Amorim et al.[10], who reported significant flexibility gain in ballet dancers after an 11-week Pilates program. Likewise, Bertolla et al.[23], evaluated the effects of a Pilates program on the flexibility of an indoor soccer team (youth category), aged between 17 and 20 years. The program lasted 4 weeks, during which evaluations using the test of Wells and a fleximeter were performed. The authors also found significant increased flexibility immediately after the program. In the study by Sekendiz et al.[24], the flexibility gain of young sedentary women (measured by Wells' test) were followed by increased abdominal strength. In this case, it is possible to suppose that the gaining of joint flexibility results from the characteristics of Pilates exercises, which mix strengthening and stretching, performed in dynamic conditions[2].

In relation to the measurements of postural alignment, the present study did not find significant differences incurred by the Pilates method after a 10-week program, corroborating the studies by Segal, Hein and Basford[25], and Donahoe-Fillmore et al.[26] In Segal, Hein and Basford study[25], a Pilates protocol was applied once a week, during 1 hour, over a period of 2 months, and joint flexibility gain was verified, but with no alterations to bodily composition (weight and posture). On the other hand, the study by Nunes Junior et al.[27], reported a significant improvement in the postural alignment of healthy individuals after 36 Pilates sessions that lasted 1 hour each, three times a week. The postural effects of Pilates could be attributed to an increase in resistance and muscle strength, as verified by Ferreira et al.[28]. In this study[28], the authors analyzed the influence of Pilates on the resistance and flex strength during abdominal exercises performed by women. The program lasted 9 weeks and generated significant increase in strength and resistance of abdominal muscles. These findings show that the strengthening level provided by Pilates can improve postural alignment due to a better relationship between agonist and antagonist muscles, which are connected to postural and joint balance[2,28].

In this study, however, the 20 mat Pilates sessions do not seem to have been enough to elicit adaptations that could change static postural alignment. Apparently, the effects of the exercises that focus on postural reeducation are time-dependent[29] and involve the adaptation of structures and postural awareness. On the other hand, Johnson et al.[30], verified significant effects on the dynamic balance (functional reach test) of healthy individuals submitted to only 10 Pilates sessions, twice a week. The exercises were performed on *Reformer* equipment, and were characterized by the strengthening of upper limbs, torso, and abdomen. Based on Ferreira et al.'s study[28], it is possible to speculate that the individuals of the present study gained muscle strength. Considering that we did not evaluate this variable; however, this was a limitation that prevents us from inferring the cause–effect relation concerning postural alignment.

According to Johnson et al.[30], Pilates exercises defy the sensorial systems responsible for balance and dynamic postural control, and the effects might be elicited by the strengthening of core muscles. These findings point to the fact that dynamic measures of postural control are perhaps more responsive to effects incurred by a 20-session mat Pilates program, contrary to the static measurements adopted in the present study. This hypothesis coincides with Sayenko et al.[31], who verified that proprioceptive muscle training had the potential to increase only dynamic postural responses. In this case, we suggest that further studies measure, besides the static postural alignment, functional variables related to dynamic postural balance, and also compare the effects of mat Pilates to Pilates performed with equipment for this purpose.

Another aspect that could explain the absence of postural alterations was the sample of the present study. Contrary to Nunes Junior et al.[27], who recruited participants between 50 and 66 years of age, our study was composed of healthy young women. In this case, it is possible that these young women need longer exposure time in order to benefit from the postural effects brought by the Pilates method. This affirmation is based on the concepts used in resistance exercises, which postulate that effects depend on several variables, such as age, the amount of training (for instance, weight, weekly frequency, number of repetitions), and the period of time of exposure to the exercises[32]. This inference is also reinforced by the moderate effect of flexibility gain in the Pilates group. In this sense, new studies are necessary in order to figure out the ideal number of sessions and weekly frequency, considering the objective of physiotherapy interventions aimed at improving women's postural alignment. In addition, we highlight the importance of comparing the effects of Pilates among different age groups with the purpose of verifying the time of exposure necessary to benefit in flexibility and posture, taking into consideration the peculiarities of different life cycles.

It is worth mentioning that we did not find differences between the control and Pilates groups in the present study. These findings might reinforce the idea that the delimitation of 20 sessions, attended twice a week, were not enough to generate statistically significant differences between the groups. Therefore, the findings of this study must be interpreted with caution, given that the limitation of the sample size might have produced type 2 errors. We suggest that authors carrying out further studies on the benefits of Pilates must be mindful of sample sizes.

CONCLUSION

This study demonstrated that a mat Pilates program attended twice a week generated significant joint flexibility gain. Nevertheless, the findings show that 20 sessions were not enough to elicit postural adaptations in healthy women between 18 and 30 years of age.

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