

Effect of pilates method on inspiratory and expiratory muscle strength in the elderly

Efeito do método pilates na força dos músculos inspiratórios e expiratórios em idosos

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Abstract – With aging, the respiratory muscle strength decreases and the Pilates method is a technique that uses respiration as one of its principles. The present study has the aim of analyzing the influence of the Pilates method on respiratory muscle strength in older women. For the evaluation of respiratory muscle strength (inspiratory and expiratory), manovacuometer was used. Thirty-one older women were divided into two groups: 14 participated in the Pilates group and 17 in the control group. Participants of the Pilates group performed 16 sessions of Pilates method with an hour of training, twice a week for eight weeks. The control group participated in four educational lectures for eight weeks. For statistical analysis, Shapiro-Wilk, ANOVA for repeated measures ($p < 0.05$) and Cohen's D index were performed. The results showed significant difference and the mean effect for the Cohen's D index expiratory muscle strength of the Pilates group when comparing before (69.71 ± 25.48) and after (85.23 ± 22.21) training ($p < 0.05$) with an increase of 23%. The results of inspiratory muscle strength were not significant but presented an average effect for the Cohen's D index for the Pilates group before (69.71 ± 35.46) and after (88.00 ± 34.87) training, with an increase of 27%. The control group did not present significant differences for the variables evaluated. It could be concluded that the Pilates method is effective in improving expiratory muscle strength and provides positive effects on the increase in inspiratory muscle strength.

Key words: Muscle strength; Physical therapy modalities; Respiratory function tests.

Resumo – Com o envelhecimento, a força muscular respiratória diminui e o método Pilates é uma técnica que utiliza da respiração como um de seus princípios. Com isso, o presente estudo tem como objetivo analisar a influência do método Pilates na força muscular respiratória em idosos. Para a avaliação da força dos músculos respiratórios (inspiratórios e expiratórios) foi utilizado o manovacuômetro. Participaram da pesquisa 31 idosas que foram divididas em dois grupos, 14 idosas participaram do grupo Pilates e 17 do grupo controle. As idosas participantes do grupo Pilates realizaram 16 sessões com uma hora de treinamento, duas vezes na semana, durante oito semanas. Quanto ao grupo controle, as idosas participaram de quatro palestras educativas durante oito semanas. Para a análise estatística foi realizado o teste de Shapiro-Wilk, ANOVA para medidas repetidas e o D de Cohen. Os resultados mostraram diferença significativa e efeito médio para o índice de D de Cohen da força dos músculos expiratórios do grupo Pilates, ao comparar antes ($69,71 \pm 25,48$) e após ($85,23 \pm 22,21$) o treinamento ($p < 0,05$), com aumento de 23%. Os resultados da força muscular inspiratória não apresentaram diferença significativa, mas apresentou efeito médio para o índice de D de Cohen para o grupo Pilates comparando antes ($69,71 \pm 35,46$) e após ($88,00 \pm 34,87$) o treinamento, com um aumento de 27%. O grupo controle não apresentou diferença significativa para as variáveis avaliadas. Pode-se concluir que o método Pilates é eficaz na melhora da força muscular expiratória e apresenta efeito positivo sobre o aumento da força muscular inspiratória.

Palavras-chave: Força muscular; Modalidades de fisioterapia; Testes de função respiratória.

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INTRODUCTION

Aging is increasing in Brazil and it is known that in 1920, the elderly population represented 4% with life expectancy of 35.2 years¹. After 90 years, in 2010, this reality is different, 10.8% of the population is considered elderly, presenting life expectancy of approximately 74 years, which shows a significant increase in Brazilian population aging, showing an increase in social and economic demands¹.

With the increased life expectancy, the elderly population presents changes in the respiratory system², presenting among them changes in lung complacency and parenchyma^{2,3} and respiratory muscle strength⁴. The performance of respiratory muscles is related to modifications of the chest cavity caused by aging², which causes malfunction of the diaphragm because, the principle of muscle length and tension will not occur in an adequate way⁵. The diaphragm length and tension are related to the aging process, muscle weakness and/or postural changes⁵, reducing force.

The decrease in respiratory muscle strength⁴ is also related to sarcopenia⁶. Sarcopenia of respiratory muscles causes a decrease in functionality⁷, which leads to a decline in activities of the daily living⁴. For the optimal respiratory muscle strength to occur, activities that improve it⁴ are necessary, so there is a need for the inclusion of respiratory exercises in training programs for the elderly population⁷. The performance of resistance physical exercise improves respiratory muscle strength⁸ and a modality that performs this type of training is the Pilates method^{9,10}.

The Pilates method plays a role in the improvement of the trunk alignment (decrease of thoracic kyphosis)¹¹, from strengthening and stretching exercises¹². It is based on six principles: Centralization, Control, Accuracy, Concentration, Breathing, and Flow¹³. As one can be observed, breathing is one of the principles, which for the creator of the method, it is important due to the better synchronism between respiratory muscles and trunk stabilizers, leading to greater muscle control¹⁴.

The study by Cancellero-Gaiad et al.¹⁵ compared the diaphragmatic breathing and that performed by Pilates method in patients with chronic obstructive pulmonary disease (COPD), observing that diaphragmatic breathing presents increased pulmonary volumes, respiratory movement, oxygen saturation and reduction of respiratory rate in COPD patients, while in healthy individuals, no improvements were observed. During breathing using the Pilates method, the COPD group presented increased oxygenation and healthy volunteers showed better results for oxygenation and volumes¹⁵, showing the importance of this modality in healthy individuals.

As there is a need to perform exercises that work breathing for the elderly population without respiratory problems⁷, it is necessary to identify the importance of the Pilates Method in healthy older women, because according to literature, the Pilates method is effective in increasing volumes and oxygenation in healthy individuals¹⁵. This research intends to evaluate if the Pilates method and all its principles improves respiratory muscle

strength efficacy in the elderly.

Therefore, the present study aims to analyze the influence of the Pilates method on the effectiveness of respiratory muscle strength in the elderly. As hypothesis, the Pilates method will show improved inspiratory and expiratory muscle strength.

METHODOLOGICAL PROCEDURES

This article is a randomized study approved by the Research Ethics Committee of the Faculty of Philosophy and Sciences of UNESP/Marília (No. 1.591.884). Data were collected at the Faculty of Philosophy and Sciences of UNESP/Marília between June and October 2016. All participants were clarified about the research and signed the informed consent form. Participants were recruited from the project's advertisement in specialized places in the care of the elderly, in pharmacies and churches.

Subjects

A total of 39 older women were randomly divided into two groups: Control Group (CG), $n = 22$; $65.4 (\pm 4.03)$ years and Pilates Group (PG), $n = 17$; $67.71 (\pm 3.24)$ years.

The inclusion criteria were: women aged 60-75 years, who agreed to participate in the study. Exclusion criteria were the presence of neurological symptoms, orthopedic problems that would not allow them to perform exercises, cardiopulmonary or cognitive impairment and dropouts during the intervention period; presence in training sessions and lectures should be more than 75%.

The sample was calculated during a pilot study with 4 volunteers in each group for variable expiratory muscle power, with power of 95%, α error of 0.05 and main effect of 1.67, showing the need of 11 volunteers in each group.

Procedures

Groups participated in an initial assessment and after 8 weeks of training with the Pilates Method (PG) or Lectures (CG), reevaluations were performed. Evaluation and reevaluation were composed of a personal data sheet and general information about health care, in addition to the specific tests of respiratory muscle strength. At the end of the reassessment, CG participated in the training previously offered to the PG. Both groups were asked to maintain their previous exercise routine.

The predicted respiratory muscle strength value for women was calculated according to Neder et al.¹⁶, which states that the formula used to calculate inspiratory muscle strength is $-0.49 (\text{age}) + 110.4$ with standard error of 9.1 and for expiratory muscle strength is $-0.61 (\text{age}) + 115.6$, with standard error of 11.2.

Respiratory Muscle Strength

The inspiratory muscle strength was verified by means of the maximum

inspiratory pressure (Pimax) and the expiratory muscular strength by means of maximum expiratory pressure (Pemax). For the measurement of these variables, the Portable Aneroid Manovacuumeter (Comercial Medica®) was used.

Tests were performed on the volunteer so that she could have the chest perpendicular to the seat of the chair, feet resting on the floor, nostrils occluded and the buccal of the equipment in the mouth. Pimax was measured from a deep expiration (close to residual volume) and after maximal inspiration was performed. Pemax was measured from a deep inspiration (close to total lung capacity) and after maximum expiration was performed¹⁷. Two replicates were performed with submaximal force for familiarization and three with maximum force with one minute rest between tests. The highest value was used¹⁷.

Pilates Method Training (PM)

Training with Pilates Method was performed according to protocol proposed by Tozim et al.¹⁸, who performed 16 sessions twice weekly for eight weeks, and exercises were performed in groups of up to 8 volunteers. Training consisted of exercises using the Pilates Solo Method, progressively inserted and for this the protocol was divided into 4 stages:

- Exercises for stabilization and strengthening of trunk and hip: Hundred level 1, One leg Stretch and One Leg Circles (2 x 5 minutes, with interval of 2 minutes)¹⁸.
- Exercises for stabilization, strengthening and stretching of trunk and hip, balance training: Hundred level 2, One Leg Stretch (ball), Saw (ball), Neck Pull, Single Leg Lifting (ball) (2 X 4 minutes, 1 minute interval)¹⁸.
- Exercises for stabilization, strengthening and stretching of trunk and hip, balance training: Rollup (theraband), leg stretching (theraband), Scissors, Swan, Side Twist, Hundred in Stading (ball), Table (2 X 2.5 minutes, with an interval of 1 minutes)¹⁸.
- Exercising for stabilization, strengthening and stretching of trunk and hip, balance training: Stretching leg making opposition (theraband), Breast Stroke, Double leg stretch (ball, theraband), Spine Stretch forward, Shell Stretch, Standing Scissors (ball), Standing Star series (theraband), Standing knee flexion and extension series (theraband), Slices (ball, theraband) (2 x 2 minutes, with 1-minute interval).

Each stage lasted two weeks and at the end of each stage, one the volunteers presented the same evolution. Training was carried out with the supervision of two physiotherapists trained in soloPM.

Lectures

The Control Group participated in four lectures during eight weeks, with each lecture presenting a maximum of 8 volunteers. The topics covered in lectures were changes due to aging, physical exercise and quality of life.

Data analysis

Data obtained through the evaluation and the applied tests were analyzed through exploratory statistical techniques. After verification of normality and homogeneity by the Shapiro-Wilk test, data were analyzed by repeated measures two-way analysis of variance (ANOVA), considering factors group and evaluation, group and predicted value. In the case of significant difference, the post-hoc Bonferroni was used, considering $p < 0.05$.

The Cohen's d index representing the effect size for dependent variables in CG and PG groups was calculated using the G * Power software. Calculation is performed from the following formula: (Mean of evaluation - Mean of reevaluation) / Standard deviation of combined¹⁹. The results in this formula can be classified into 3 levels: low (0.20-0.50), medium (0.50-0.80) and high (greater than 0.80)^{19,20}.

RESULTS

During training and lectures, 8 volunteers gave up, five of which from the CG and three from the PG. Groups were homogeneous according to age ($p = 0.097$), height ($p = 0.604$), body mass ($p = 0.328$), and body mass index ($p = 0.181$).

Table 1. Characterization of Pilates Group and Control Group

	PG (n=14)		CG (n=17)	
	Mean	95% CI	Mean	95% CI
Age (years)	67.00	65.38-68.62	64.88	62.80-66.96
Height (m)	1.58	1.54-1.62	1.60	1.55-1.64
Body Mass (Kg)	76.66	69.83-83.47	72.40	66.28-78.50
BMI (Kg/m ²)	30.68	27.82-33.54	28.38	26.21-30.54
Predicted Inspiratory Strength (cmH ₂ O)	74.73	73.74-75.71	76.02	74.75-77.29
Predicted Expiratory Strength (cmH ₂ O)	77.57	76.77-78.36	78.61	77.58-79.62

95% CI = 95% confidence interval; PG = Pilates group; CG = control group; BMI = body mass index.

The comparison between predicted muscle strength and that of the initial assessment of patients did not show significant difference, both for the inspiratory strength in the following comparisons: group ($p = 0.306$ and $F = 1.087$), predicted value ($p = 0.981$ and $F = 0.001$) and predicted value versus groups ($p = 0.434$ and $F = 0.630$). The same occurred for the expiratory strength in the following comparisons: group ($p = 0.367$ and $F = 0.840$), predicted value ($p = 1.591$ and $F = 0.217$) and predicted value versus groups ($p = 0.532$ and $F = 0.400$).

The results of respiratory muscle strength (Table 2) showed significant difference for the comparison evaluation ($p = 0.007$ and $F = 5.970$) and evaluation versus group ($p = 0.012$ and $F = 5.235$), but for group, it was not significant ($p = 0.949$ and $F = 0.052$). The evaluation interaction showed significant difference when comparing the maximum expiratory strength

($p = 0.002$), showing that the reevaluation presented higher values for inspiratory muscle strength, which was not significant ($p = 0.151$).

In the Evaluation versus Group interaction, significant difference was observed in the PG group when comparing before and after training with PM for the maximum expiratory strength ($p < 0.001$), giving Cohen's d index with mean effect for this result (Cohen = 0.649), while for maximal inspiratory muscle strength, it was not significant ($p = 0.057$), but Cohen's d expressed a mean effect (Cohen = 0.520).

For the CG group, the Evaluation versus Group interaction was not significant for the expiratory muscle strength ($p = 0.864$, Cohen = 0.001), and inspiratory muscle strength ($p = 0.995$, Cohen = 0.025).

Table 2. Results of inspiratory and expiratory muscle strength

		Inspiratory Muscle Strength			Expiratory Muscle Strength		
			Variation		Variation		
PG	Evaluation	69.71	±35.46	27%	69.71	±25.48	23%
	Reevaluation	88.00	±34.87		85.23	±22.21*	
CG	Evaluation	80.75	±31.47	0.1%	76.00	±19.75	0.7%
	Reevaluation	80.80	±32.69		76.53	±21.95	

* Significant difference ($p < 0.01$); PG = Pilates Group; CG = Control Group.

DISCUSSION

The effect size calculated by the Cohen's d index reports the magnitude of the treatment, that is, how much it is effective²⁰, thus showing that even if not significant, the PG group showed mean effect for variable inspiratory muscle strength, indicating that the PM has a positive effect on this population. The same effect was observed for the expiratory muscle strength in the PG group.

As observed, the respiratory muscles are influenced by the length-tension of the musculature and its modification may be due to the lack of postural alignment, muscle weakness and aging²¹. For this effect to not be maintained, it is necessary to perform exercises²¹. These characteristics can be reversed by Pilates exercises, as they strengthen muscles^{12,22} and improve the trunk alignment¹¹, reducing the deleterious effects of aging.

The Pilates method presents 6 principles, among them breathing, which is responsible for the best synchronization of the respiratory and stabilizing muscles¹⁴ and centralization that refers to the center of the body, and this region is called powerhouse^{12,22}. It is formed by the abdominal, paravertebral, diaphragm and pelvic floor muscles^{12,22} and a good recruitment of these muscles leads to better respiratory functioning due to the improvement of trunk flexibility²³ and abdominal strength^{12,22}, leading to an increase in the strength of expiratory muscles^{23,24}.

Some of the muscles responsible for expiration are the internal and external oblique, rectus sheath and transversus abdominis²³, and during exercises, they present greater activation so that they have the improvement in the movement of the diaphragm with the improvement of inspiratory

and expiratory muscle strength²⁵.

In a study that evaluated the respiratory muscle strength and the thickness of the transverse abdominals, internal and external oblique muscles before and after training with the Pilates method, it was observed that it was effective in hypertrophy and in the increase of inspiratory and expiratory muscle strength, and this improvement in abdominal musculature is important in respiratory mechanics²⁶.

The improvement in respiratory mechanics that the Pilates method provides²⁶ is reported to be the best of cardiorespiratory parameters, since it improves gas exchange and heart rate in individuals practicing the method²⁷.

In addition, a study has reported that the Pilates method in young population shows an improvement in inspiratory muscle strength of 24.7% and expiratory of 25%²⁸. In the present study, this proportion is similar, showing that training is important for respiratory muscle strength.

Thus, further studies should be carried out evaluate the action of the Pilates method in older women with decreased respiratory muscle strength to verify if it is effective in these variables. Most articles found on respiratory muscle strength and Pilates method were carried out with young volunteers^{26,28}, chronic kidney patients²⁹ and cystic fibrosis³⁰.

In an article reporting the effect of the Pilates method on the respiratory muscle strength in the elderly, a group of 7 older women participated in an 11-week training protocol, each week presenting 2 sessions and each session lasting 40 minutes¹⁴. The results indicated that the proposed exercises improved the strength of expiratory muscles, but this study described that they cannot affirm the findings due to the low number of participants¹⁴, differing from the present study, whose sample is satisfactory and presents two groups (intervention and control).

Based on the above, it was concluded that the Pilates method is effective in improving the strength of the expiratory muscles and provides a positive effect on the inspiratory strength determined by the Cohen's d index for improving recruitment, chest cavity dynamics²⁵ and abdominal strength, thus reducing the appearance of diseases²⁶ and improving the functionality and activities of the daily life of older women.

The limitations of the present study are that evaluation during de-training to verify if this effect would be maintained over time was not performed. Therefore, further studies with the elderly population should be conducted to evaluate if these results would be maintained after training with the Pilates method.

CONCLUSION

It could be concluded that the Pilates method is effective in improving the expiratory muscle strength of older women. As for the inspiratory muscle strength, training with Pilates method is a technique that brings positive effects. Thus, the Pilates method is an alternative training in the elderly,

because it works breathing together with the performance of exercises, reducing the effects of aging on the respiratory system.

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