A COMPARATIVE STUDY OF THORACIC KYPHOSIS ANGLES AND RESPIRATORY MUSCLE STRENGTH OF ELDERLY WOMEN

Vanessa das Graças de Assis Bastos, Erika Baptista Gomes, Renato Valduga, Otávio de Toledo Nóbbrega, Gustavo de Azevedo Carvalho

OBJECTIVE: The increase in thoracic kyphosis and the decrease in respiratory muscle strength are among the most frequently observed physiological changes in the elderly. The aim of this study was to compare thoracic kyphosis angle and respiratory muscle strength measurements among women who do physical activity with those who do not. METHOD: We evaluated 54 elderly women aged between 60 and 80 years old, and distributed them into two groups: Group 1, with 27 physically active elderly women (71.3 ± 5.1 years old); and Group 2, with 27 elderly women who do not do physical activity (70.2 ± 4.8 years old). Respiratory muscle strength was assessed by maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP), and the angle degree of the thoracic kyphosis was measured using the Flexicurva method. For data analysis, we used Pearson’s correlation test and Student’s t-test, with a significance level set at p < 0.05. RESULTS: Group 1 participants showed higher values of MIP and MEP when compared to those in Group 2. A possible reason for this result could be the effects of regular physical activity and, specifically, the sport practiced. CONCLUSION: Results suggest that regular participation in physical activity contributes to the maintenance of respiratory muscle strength and delays the increase of the thoracic kyphosis angle in physically active elderly women.

KEYWORDS: elderly; kyphosis; respiratory muscles; physical activity.

ABSTRACT

ORIGINAL ARTICLE

Estudo comparativo do ângulo da cifose torácica e da força dos músculos respiratórios de mulheres idosas

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OBJETIVO: O aumento da cifose torácica e a diminuição da força dos músculos respiratórios estão entre as alterações fisiológicas mais observadas em idosos. O objetivo deste estudo foi comparar medidas do ângulo da cifose torácica e da força dos músculos respiratórios entre idosas praticantes e não praticantes de atividade física. MÉTODO: Foram avaliadas 54 idosas entre 60 e 80 anos, distribuídas em dois grupos: Grupo 1, com 27 idosas praticantes de atividade física (71,3 ± 5,1 anos), e Grupo 2, com 27 idosas não praticantes de atividade física (70,2 ± 4,8 anos). A força dos músculos respiratórios foi avaliada por meio da pressão inspiratória máxima (Pimáx) e da pressão expiratória máxima (Pemáx); e o grau de cifose torácica, por meio do método Flexicurva. Para a análise dos dados, foram utilizados correlação de Pearson e teste t de Student, com nível de significância p < 0,05. RESULTADOS: As idosas do Grupo 1 exibiram valores maiores na Pimáx e na Pemáx quando comparadas com as idosas do Grupo 2. Esse resultado poderia ser explicado pelos efeitos do tempo da prática de atividade física regular e da especificidade do esporte. CONCLUSÃO: Os resultados sugerem que a prática regular de atividade física contribui para a manutenção da força dos músculos respiratórios e para retardar o aumento do ângulo da cifose torácica em idosas fisicamente ativas.

PALAVRAS-CHAVE: idoso; cifose; músculos respiratórios; atividade física.

RESUMO

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Received on: 09/05/2017. Accepted on: 09/05/2017
DOI: 10.5327/Z2447-211520171700065

Geriatr Gerontol Aging.
INTRODUCTION

An increase in life expectancy and the consequent growth in the number of elderly people are representative of population phenomena that have been happening for some time. In 2025, estimates show that Brazil will have 34 million people that are older than 60 years old, with a higher prevalence of women.1

Aging is a natural and irreversible process of the human body that is marked by important physiological, structural, and functional alterations that progressively limit the human organism in a different rhythm for each person.2

Among the many changes that happen due to aging, postural changes are most responsible for increasing the thoracic curvature in the sagittal plane. This may result in a decrease in trunk movements used for respiration and motor responses.3

The Flexicurva method is an important instrument to measure and quantify the degree of the thoracic kyphosis angle in a reliable and fast way.4

In addition to musculoskeletal changes, the mechanics of the respiratory system may suffer changes from aging, thus causing alterations in the amount of air ones lungs can hold and a decrease in respiratory muscle strength.5 Weakness in the respiratory muscles harms the expansibility of the thoracic cage, increases respiratory work, and decreases the effectiveness of coughing, which may result in the development of respiratory problems that might limit functional autonomy and elderly people’s independence.6–7 Studies have showed that elderly people who participate regularly in physical activities have lower physical limitations and higher functional capacity in comparison with elderly who do not do physical activity.8 Regular physical activity practice may provide several advantages to the elderly, such as a delay in thoracic kyphosis progression and an increase in respiratory muscle strength.9,10

Based on the clinical implications and the harm done to functional capacity, it is extremely relevant to investigate the progression and an increase in respiratory muscle strength. In doing so, we should support health professionals in directing treatment programs to include rehabilitative and preventive focuses, with the goal of minimizing possible respiratory dysfunctions and providing a better quality of life.

In this regard, the present study aimed to compare the thoracic kyphosis angle and respiratory muscle strength measurements in elderly women who participate in physical activities and those who do not.

METHODS

After approval from the Research Ethics Committee Involving Human Beings, we developed a cross-sectional analytical study from July to September of 2009 at the Cardiopulmonary Rehabilitation Laboratory of the Universidade Católica de Brasília (UCB). The sample included 54 elderly women aged 60 and 80 years old, who were distributed into 2 groups: Group 1, with 27 elderly women who participated in physical activities (test); and Group 2, with 27 elderly women who did not participate in physical activities (control). We compared measurements after the interventions.

Inclusion criteria were: voluntarily enrolled in an educational and recreational program conducted at UCB; participating in a resistance training discipline; not a practitioner of regular physical activity; and has no respiratory problems. Exclusion criteria, on the other hand, included: having diseases or impairments that prevent the elderly person from remaining in orthostatic and sitting positions; having an early diagnosed pulmonary disease; having a neuropsychomotor control deficit that could interfere in the postural pattern or in the lung function throughout collection; having difficulties in understanding and performing the proposed tests; and refusing to take part in the study. The volunteers signed the Free Informed Consent (TCLE, acronym in Portuguese).

We began collecting data after the participants completed the evaluation form that was mainly comprised of personal data, existing diseases, medication use, participation or not in a physical activity, and time spent doing a physical activity. Before beginning the tests, the volunteers received individual instructions on how to perform the evaluation.

The resistance training circuit was performed in 3 stages: 40 seconds of performance at each station; 20 seconds of rest between each station; and 1 minute of rest between each stage. During each rest period, a hydrating station was set up for the participants. In total, there was around 30 minutes of exercise. We monitored the participants’ heart rate continuously during the intervention. It is important to highlight that a trained professional remained at each station to ensure the safety of volunteers.

The adopted exercises for each station consisted in: “rowing”, which was done with a Theraband (Cari, São Paulo, Brazil) that had super strong tension and a support attached to a fixed structure; “sitting on a chair and standing up”, adapted by Rikli and Jones,11 “vertical chest press”, performed with a Theraband (same specifications adopted at the “rowing” station); “deadlift”; “bicep curl”, performed with 2–kg dumbbells (Polimet, Curitiba, Brazil); “squat with gym ball” (Mercur, Santa Cruz do Sul, Brazil); “tricep dumbbells” (same weight and specifications adopted at the “bicep curl” station); and “free squat” (exercise with many knee movements and support from a stick).
We evaluated the volunteers’ maximal inspiratory (MaxIP) and expiratory (MaxEP) pressures according to Black and Hyatt’s method to measure respiratory muscle strength. We used a properly calibrated Suporte® analogical manovacuometer with an operational interval of ± 300 cm H\textsubscript{2}O, which was connected to the patient through a rigid plastic buccal — which was firmly held by the volunteer against her lips in such a way as to prevent perioral air from escaping. The patients sat comfortably and performed all of the movements in chairs with backrests. Their heads were kept in a neutral position, their hips and knees were bent at a 90° angle; and their feet rested on the floor.

In order to measure the MaxIP, the volunteer, with her nose occluded by a nasal clip, had to exhale to her fullest extent through her mouth until she reached her residual volume. Then, she was encouraged to breathe in completely until she reached her limit. Concurrently, the MaxEP was measured closely to the global respiratory capacity. With her nostrils sealed using a nasal clip, the volunteer received guidance to breathe in as far as she could and then exhale strongly through her mouth until reaching her limit.

Each volunteer repeated each movement three times, with a 1-minute pause between each one, and with maximal pressures maintained for at least two seconds. The chosen value for the statistical analysis consisted in the highest value found among the three performed measurements.

The angle measurement of the thoracic kyphosis was assessed through the Flexicurva’ method by using a flexible 60cm-long Trident® ruler. During the measurement of the thoracic kyphosis, the volunteer was required to remain in an orthostatic position with her head in a neutral position, her arms extended along her body, barefoot, and wearing a bathing suit. First, we performed a palpitation of the reference points (spinal processes from C7 and T12) by means of the methods proposed by Hoppenfeld. Then, the flexible ruler was placed on the volunteer’s back beginning at the C7 spinal process and then it was molded up until the T12 spinal process. Next, we traced along the side of the ruler that touched the participant’s back on graph paper with a ballpoint pen. Then, we used the third-degree polynomial to calculate the thoracic kyphosis angle as proposed by Teixeira and Carvalho.

For the statistical analysis, we used the descriptive analysis, Student’s t-test for independent samples, and Pearson's correlation test to assess respiratory muscle strength and the angle of the thoracic kyphosis, which were calculated in the Statistical Package for Social Sciences (SPSS), version 10, for Windows. We adopted a significance level of \( p \leq 0.05 \).

### RESULTS

Table 1 shows the mean values and standard deviation (SD) of the main anthropometric characteristics of Groups 1 (test) and 2 (control). There was no difference between groups regarding age, weight, height, and body mass index (BMI).

Table 2 presents the mean values and respective SD of the MaxIP and MaxEP and the degree of the thoracic kyphosis angle of the groups. The analysis of the respiratory muscle strength showed that the difference regarding the MaxIP (\( p = 0.010 \)) and MaxEP (\( p = 0.002 \)) between the groups was very significant. On the other hand, the MaxIP of Group 2 was lower than the reference values for their age.

The degree of the thoracic kyphosis angle was not different between the groups. Both groups showed a thoracic kyphosis angle degree at an interval (20 to 56°) that is compatible within the expected values.

### Table 1 A profile of the sample including mean and standard deviation according to the experimental group.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1 (n = 27)</th>
<th>Group 2 (n = 27)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>71.30 ± 5.10</td>
<td>70.20 ± 4.80</td>
<td>0.80</td>
<td>0.43</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.90 ± 10.70</td>
<td>61.10 ± 8.00</td>
<td>1.46</td>
<td>0.15</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.54 ± 0.07</td>
<td>1.51 ± 0.05</td>
<td>1.70</td>
<td>0.10</td>
</tr>
<tr>
<td>BMI (kg/m\textsuperscript{2})</td>
<td>27.40 ± 3.80</td>
<td>26.70 ± 3.30</td>
<td>0.65</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Group 1: physical activity participants; Group 2: non-active participants; BMI: body mass index. Statistical associations obtained through Student’s t-test.

### Table 2 Comparative analysis of maximal inspiratory pressure, minimal inspiratory pressure, and thoracic kyphosis angle degree in each group of elderly women.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1 (n = 27)</th>
<th>Group 2 (n = 27)</th>
<th>Reference</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MaxIP (cm H\textsubscript{2}O)</td>
<td>79.4 ± 16.7</td>
<td>66.7 ± 19.9</td>
<td>72.7 ± 3.9</td>
<td>0.010*</td>
</tr>
<tr>
<td>MaxEP (cm H\textsubscript{2}O)</td>
<td>95.2 ± 20.6</td>
<td>77.8 ± 18.4</td>
<td>69.6 ± 6.7</td>
<td>0.002*</td>
</tr>
<tr>
<td>Thoracic kyphosis (degrees)</td>
<td>52.7 ± 16.3</td>
<td>54.1 ± 12.1</td>
<td>56</td>
<td>0.710</td>
</tr>
</tbody>
</table>

MaxIP: maximal inspiratory pressure; MaxEP: maximal expiratory pressure; Group 1: physical activity participants; Group 2: non-active participants.

Source: MaxIP and MaxEP\textsuperscript{14} thoracic kyphosis. Statistical associations obtained through Student’s t-test.
DISCUSSION

The increase in thoracic kyphosis and the decrease in respiratory muscle strength are some of the most observed physiological alterations in aging, and are considered to be of great importance for physical and functional decline in elderly people. Undeniably, regular participation in physical activities prevents or increases the adverse effects of aging, thus improving the elderly person’s quality of life.

The results of this study showed that elderly women who participate in physical activities present higher MaxIP and MaxEP than non-practitioners. Gonçalves et al. compared the respiratory muscle strength of elderly women who participate with those that do not participate in physical activities, and they found that the first group had higher respiratory muscle strength than the second group.

Cader et al. found a similar result when comparing MaxIP and quality of life of non-active elderly women who live in retirement homes and participate in water gymnastics. The authors observed that elderly women who took water gymnastics classes had a higher MaxIP than non-active elderly women.

Rendas et al. analyzed the effects of a physical exercise program geared toward the respiratory muscles and the lungs of 52 women aged 60 to 76 years, and found that the group who participated in physical activities presented higher MaxIP results than the group of non-active elderly women. In addition, Frandin et al. also observed that healthy non-active individuals that began participating in physical activities had their maximal respiratory pressures raised and, therefore, the strength of their respiratory muscles increased considerably.

We observed a significant decrease of the MaxIP in Group 2 in this study. It is known that a decrease in inspiratory muscle strength may result in a decrease of the ventilatory capacity and in respiratory impairment. Black and Hyatt studied the normal values for maximal respiratory pressures according to sex and gender in 120 individuals aged between 20 and 70 years. The results show that the MaxIP starts to decrease significantly among women aged 55 or older.

A study carried out by Teramoto et al. with 300 healthy individuals aged between 20 and 94 years old showed a decrease in lung volume and a decrease in MaxIP among elderly people, which the authors attribute to hyper kyphosis. Even though our study has a different sample, which is comprised of elderly women with a clinically important thoracic kyphosis that prominent, but also within normality patterns (between 20 and 56º), we did not find a significant decrease of the MaxIP among volunteers that do not participate in physical activities.

Fon et al. evaluated the thoracic kyphosis angle degree of 316 subjects considered normal, who are aged between 2 and 77 years, and found that aging determines an increase in the thoracic kyphosis angle degree, which is considered to be a hyper kyphosis above 56º. When Hinman compared the thoracic kyphosis of young and old healthy women through the Flexicurva method, they found that the degree of the thoracic kyphosis angle is higher in the elderly women’s group.

The results obtained in this study did not show a significant difference in the degree of the thoracic kyphosis angle among the groups. However, Cutler, after analyzing the occurrence of the same damage in the habitual posture of postmenopausal women, found that women who exercise have lower levels of thoracic kyphosis.

According to Wilmore and Costill, the principle of specificity is essential to an exercise program, and training should be focused towards working on the physiological valences that one expects to be developed in accordance with their purpose. The low specificity of the sports practiced for correction, maintenance or attenuation of the thoracic kyphosis angle degree by the volunteers in this study might have influenced the aforementioned results.

In the group of elderly women who participated in physical activities, we found that most of them had been exercising on average for less than ten years. We cannot affirm that ten years of physical activities are enough to revert or delay the progression of aging-related thoracic kyphosis. Another limitation of this study consists in the fact that it was based on a convenience sampling, in which adherence to exercise and the consumption of drugs that affect the respiratory system could not be properly measured.

CONCLUSION

We found that the respiratory muscle strength in the group of elderly women who participated in physical activities was significantly higher in comparison with the group of non-practitioners. This demonstrates, therefore, that physical exercises may prevent and minimize the deleterious effects of aging, such as a decrease in thoracic cage expansibility, respiratory impairment, and decrease in cough efficiency.

With regards to thoracic kyphosis, the majority of the elderly women from both groups had a significant angle degree, which is within the normality values (20 to 56º). There was no significant difference in the angle degree of thoracic kyphosis between the groups.

These data suggest that new studies should be performed with the aim of investigating a protocol of physical activities that is able to modify the phenotype of aging-related thoracic kyphosis.

CONFLICT OF INTEREST

The authors report no conflict of interest.
REFERENCES


