

THORACIC HYPERKYPHOSIS DOES NOT INFLUENCE THE BALANCE IN SEDENTARY ELDERLY

HIPERCIFOSE TORÁCICA NÃO GERA INFLUÊNCIA NO EQUILÍBRIO EM IDOSOS SEDENTÁRIOS

LA HIPERCIFOSIS TORÁCICA NO INFLUYE EN EL EQUILIBRIO DE LOS ANCIANOS SEDENTARIOS

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ABSTRACT

Objective: Evaluate and correlate balance and thoracic hyperkyphosis in sedentary elderly people. **Methods:** 61 elderly, 14 men and 47 women, mean age of 78.03 ± 9.34 , mean weight of $67.80 \text{ kg} \pm 12.82$, and mean height of $1.58 \text{ m} \pm 0.09$. Balance assessment was performed using the Berg Balance Scale, Romberg Test, and Functional Reach Test, and the Flexicurve method was used to detect thoracic hyperkyphosis. The correlation between the variables was performed using the Bivariate correlation test. **Results:** The values obtained in the tests were: Flexicurve ($65.73^\circ \pm 10.57$), Berg Balance Scale (44.05 points ± 7.58), Functional Reach Test ($16.29 \text{ cm} \pm 6.36$), and Romberg Test (89% positive, 11% negative). There was no correlation between the Flexicurve method and the Berg Balance Scale ($r = -0.22$, $p = 0.08$); with the Romberg Test ($r = -0.08$, $p = 0.52$); and the Functional Range Test ($r = 0.13$, $p = 0.31$). **Conclusion:** Thoracic hyperkyphosis did not influence the balance variables in the elderly sample studied. **Level of evidence I; Diagnostic studies - Investigation of a diagnostic test - Test of previously developed diagnostic criteria in consecutive patients (with "gold" reference standard applied).**

Keywords: Postural Balance; Aging; kyphosis; Sedentary Behavior.

RESUMO

Objetivo: Avaliar e correlacionar o equilíbrio e a hiper cifose torácica de idosos sedentários. **Métodos:** 61 idosos, 14 homens e 47 mulheres, média de idade de $78,03 \pm 9,34$, peso médio de $67,80 \text{ kg} \pm 12,82$ e altura média de $1,58 \text{ m} \pm 0,09$. A avaliação do equilíbrio foi realizada pela Escala de Equilíbrio de Berg, Teste de Romberg e Teste de Alcance Funcional e para a detecção de hiper cifose torácica foi utilizado o método Flexicurva. A correlação entre as variáveis se deu pelo teste de correlação Bivariada. **Resultados:** Os valores obtidos nos testes foram: Flexicurva ($65,73^\circ \pm 10,57$), Escala de Equilíbrio de Berg (44,14 pontos $\pm 7,72$), Teste de Alcance Funcional ($16,29 \text{ cm} \pm 6,36$) e Teste de Romberg (89% positivo, 11% negativo). Não houve correlação do método Flexicurva com a Escala de Equilíbrio de Berg ($r = -0,22$, $p = 0,08$); com o Teste de Romberg ($r = -0,08$, $p = 0,52$); e com o Teste de Alcance Funcional ($r = 0,13$, $p = 0,31$). **Conclusão:** A hiper cifose torácica não gerou influência sobre as variáveis de equilíbrio na amostra de idosos estudada. **Nível de evidência I; Estudos diagnósticos - Investigação de um exame para diagnóstico - Teste de critérios diagnósticos desenvolvidos anteriormente em pacientes consecutivos (com padrão de referência "ouro" aplicado).**

Descritores: Equilíbrio Postural; Envelhecimento; Cifose; Sedentarismo.

RESUMEN

Objetivo: Evaluar y correlacionar el equilibrio y la hiper cifosis torácica en ancianos sedentarios. **Métodos:** 61 ancianos, 14 hombres y 47 mujeres, edad media $78,03 \pm 9,34$, peso medio $67,80 \text{ kg} \pm 12,82$ y altura media $1,58 \text{ m} \pm 0,09$. La evaluación del equilibrio se realizó mediante la Escala de Equilibrio de Berg, el Test de Romberg y el Test de Alcance Funcional, y para la detección de hiper cifosis torácica se utilizó el método Flexicurvo. La correlación entre las variables se realizó mediante la prueba de correlación Bivariada. **Resultados:** Los valores obtenidos en las pruebas fueron: Flexicurvo ($65,73^\circ \pm 10,57$), Escala de Equilibrio de Berg (44,05 puntos $\pm 7,58$), Test de Alcance Funcional ($16,29 \text{ cm} \pm 6,36$) y Test de Romberg (89% positivo, 11% negativo). No hubo correlación entre el método Flexicurvo y la Escala de Equilibrio de Berg ($r = -0,22$, $p = 0,08$); con el Test de Romberg ($r = -0,08$, $p = 0,52$); y con el Test de Alcance Funcional ($r = 0,13$, $p = 0,31$). **Conclusión:** La hiper cifosis torácica no influyó en las variables del equilibrio en la muestra de ancianos estudiada. **Nivel de evidencia: I; Estudios diagnósticos - Investigación de una prueba diagnóstica - Prueba de criterios diagnósticos previamente desarrollados en pacientes consecutivos (con la aplicación del estándar "oro").**

Descriptores: Equilibrio Postural; Envejecimiento; Cifosis; Conducta Sedentaria.

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INTRODUCTION

With aging, the body configuration undergoes some changes, and thoracic hyperkyphosis is one of the most observed postural changes. Several studies have demonstrated the relationship between increased thoracic kyphosis and aging.¹

Thoracic hyperkyphosis is the increase in thoracic curvature in the sagittal plane,² when the concavity of the spine exceeds 50°.³

The most used way to assess the degree of thoracic kyphosis is the measurement of the *Cobb* angle using the radiographic method. Still, because it is a higher-cost assessment and exposes individuals to radiation, it is rarely used in patient follow-up. Other methods, such as the Flexicurve, can be used, allowing a quick, inexpensive, and non-invasive assessment of hyperkyphosis.¹ The Flexicurve method has already been compared with chest radiography, which is the gold standard for assessing the degree of thoracic kyphosis. Both do not have significant differences in treatment progress.⁴

It is important to emphasize that the increase in the thoracic curvature causes a shift in the center of gravity, an increase in postural instability, and greater susceptibility to falls.⁵ And in elderly men, impairment of the physical function of the lower limbs is associated.⁶

The center of gravity shifts forward and changes the direction imposed by body weight on structures such as vertebrae and intervertebral discs. This process can later result in disc compressions, nerve pinching, and joint friction.³

Changes in balance control are common among the elderly, with serious effects on their quality of life and presenting a high social cost to society.⁷

In elderly women, an increase in postural sway in the medial-lateral direction was observed compared to younger women.⁸

Association between thoracic hyperkyphosis, impaired lung function; muscle weakness; poor physical function ability, and falls can lead to an increased death rate in older people.⁹

The prevalence of thoracic hyperkyphosis in the elderly is about 20% to 40%.¹⁰ There are other postural deviations also resulting from aging, such as cervical hyperlordosis; cervical straightening; thoracic straightening; lumbar hyperlordosis, and lumbar rectification that lead to functional changes in daily activities.¹¹

Among the factors proposed in the literature that may contribute to hyperkyphosis are: degenerative disc disease, weakness of trunk flexor and extensor muscles, genetic predisposition¹² and osteoporosis.¹³

Given that thoracic hyperkyphosis can lead to imbalances and falls, it was justified to carry out this study to investigate these changes clinically.

This study aimed to evaluate and correlate balance and thoracic hyperkyphosis in sedentary elderly people.

METHOD

This is a cross-sectional observational study.

It was submitted to the Research Ethics Committee of Universidade Paulista - UNIP, approved by CAAE: 61399916.7.0000.5512; and performed in the kinesiotherapy laboratory of Universidade Paulista, North Campus, São Paulo - SP, Brazil.

The research included elderly people who did not practice regular physical activity, aged over 60 years, of both sexes, with thoracic hyperkyphosis (greater than 50 degrees), who could stand independently.

Individuals with pathologies associated with balance deficit, gait aids (canes, crutches, and walkers), wheelchairs, thoracic scoliosis, sedative, and hypnotic medications, or any physical-cognitive impairment were excluded. Hinder the performance of one or more steps of data collection.

All research participants signed an informed consent form, agreeing to participate.

Patients' personal and clinical data were collected using an evaluation form. The following were applied: the *Berg* Balance Scale (BSE);¹⁴ Romberg test;⁸ and functional range test (TAF).¹⁵ The angle of the thoracic curvature was evaluated using the Flexicurve method.²

The thoracic curvature angle evaluation, through the *Flexicurve* method, was performed according to the procedures adopted by

Teixeira and Carvalho.² The ruler (Trident®) used was a 60-centimeter and paper (Spiral®) 70g/m², A2, 420x594 mm. The elderly was in the orthostatic position, barefoot, arms along the body, with the alignment of lower limbs in their usual posture, being oriented to unload the body weight equally on both feet. The evaluator was positioned behind the volunteers to locate and mark the spinous processes of C7 and T12 with an adhesive label. The ruler was transferred to graph paper, and its values were converted from centimeters to degrees using a formula developed by Teixeira and Carvalho, calculated in the Excel program.²

The *Berg* Balance Scale (BSE) was used to assess balance, composed of 14 items with common activities of daily living with a progressive degree of difficulty. Each item is graded from 0-4 points, with a maximum total of 56 points. The tasks are qualified through the evaluator's observation; points will be subtracted if time and distance are not reached or if you need supervision in executing a task or assistance. The application lasts an average of 15 minutes; it only requires a ruler and a watch.¹⁴ Each point less on the scale corresponds to an increase in the risk of falls; between scores 56 to 54, each point less is associated with a 3 to 4% increase in the risk of falls; between 54 and 46, an increase of 6 to 8% of chances, and below 36 points the risk of falls is almost 100%.¹⁶

In the Romberg test, the patient was placed in an orthostatic position, with heels and toes apart at 45°, head aligned, arms along the body in the anatomical position, eyes closed (to inhibit vision), for one minute. The test evaluates whether the individual presents anteroposterior and/or medial-lateral body displacement; the test is considered positive if the individual presents one or more body oscillations.⁸

The functional range test (TAF) determines how much the elderly person can move within the anterior stability limit. The measuring tape was attached to the wall, parallel to the floor, and positioned at the height of the volunteer's acromion. The individual barefoot, positioned with comfortable feet and parallel to each other, perpendicular to the wall, and close to the beginning of the tape measure. With wrists in a neutral position, elbows extended, and shoulders flexed at 90°, the volunteer was instructed to bend forward without touching the tape. After three attempts, the test result was represented by the average difference between the measurement in the initial and final positions recorded on the ruler. Displacements smaller than 15 cm indicate patient fragility and risk of falls.¹⁵

The sample size calculation to estimate a 20% reduction in balance in patients with hyperkyphosis, with an absolute precision of the estimate of 10%, at a significance level of 5%, was determined in 61 volunteers. Qualitative and quantitative data analysis was performed. To quantitatively evaluate, initially, its normal distribution was verified by the Shapiro-Wilk test, where all outlier values were treated by the Winsorize method; The correlation between the variables was performed using the Bivariate correlation test.

Data were analyzed using the SPSS Statistics v.21 software (IBM Company, Chicago, IL) with a confidence level of 95% ($p \leq 0.05$) and using the Microsoft Excel 2010® program.

RESULTS

79 volunteers were recruited, but three were excluded because they had scoliosis, 13 because the thoracic kyphosis angle was less than 50°, and two because they did not attend the evaluation.

The sample of the present study consisted of 61 volunteers, 14 (22.95%) male and 47 (77.04%) female with a mean age of 78.03 years \pm 9.34, mean weight of 67.80 kg \pm 12.82, and an average height of 1.58 m \pm 0.09.

Table 1 shows the values obtained in the tests, Flexicurve (Kyphosis angle), Berg balance scale (BSE), and functional range test (TAF).

Table 2 shows the distribution of the Romberg test in quantity and percentage.

Table 3 refers to the correlation of the Flexicurve method with the Berg balance scale (BSE), Romberg test and functional range test (FAT). It is noted that there was no correlation between the variables studied with thoracic hyperkyphosis.

Table 1. Values of Flexicurve, Berg and TAF tests.

	Mean SD
Flexicurve (°)	65.73 ± 10.58
Berg (points)	44.05 ± 7.58
TAF (cm)	16.30 ± 6.36

Note: All data were expressed as mean ± standard deviation. BERG: Berg balance scale; TAF: functional range test; cm: centimeters; pts: points.

Table 2. Distribution of the Romberg test, between positive and negative values and percentage.

Romberg	Volunteers (total)	Percent (%)
Positive	54	89
Negative	7	11

Table 3. Correlation between the Flexicurve method and Berg, Romberg and TAF.

	Flexicurve (°)
Berg (points)	
r	-0.22
p	0.08
Romberg	
r	-0.08
p	0.52
TAF (cm)	
r	0.13
p	0.31

BERG: Berg balance scale; TAF: functional range test; cm: centimeters; pts: points; Romberg: balance test.

DISCUSSION

As a result of aging, the tissues surrounding the joints undergo changes that decrease their elasticity and flexibility, particularly in the spine joints; there are also changes in the postural control system, musculoskeletal, neuromuscular, and sensory systems that influence functional mobility and the deficit of energy. Balance in the elderly,¹⁷ and these alterations are considered justifications for the presence of thoracic hyperkyphosis, which can cause displacement of the center of gravity, increase in postural instability, and greater susceptibility to falls.⁵

According to Teixeira and Carvalho,² the Flexicurve method was used to assess thoracic kyphosis. This method was chosen because it is validated, does not expose individuals to radiation, being practical and accessible.

The present study's mean thoracic hyperkyphosis was 65.73 ± 10.57° (Table 1). According to Barrett et al.,⁵ it is considered physiological kyphosis between 20° and 50°, and from 50°, it is considered thoracic hyperkyphosis. Thus, it can be considered that the studied sample presented thoracic hyperkyphosis.

In this study, no correlation was observed between the variables studied.

The mechanisms involved in balance control are required in simple activities, such as walking, getting up, changing direction, and climbing stairs, which are present in everyday situations; for this and other reasons, the present study used the Berg balance scale.¹⁴

The sample evaluated presented a mean score of 44.14 ± 7.72 points on the Berg Scale (Table 1). According to Miyamoto,¹⁴ a score between 54 and 46 increases the risk of falls from 6 to 8%.

However, there was no correlation between Berg and thoracic hyperkyphosis (Table 3). Therefore, thoracic hyperkyphosis cannot be associated with a higher risk of falls in this group of elderly people. No studies were found correlating hyperkyphotic elderly with the Berg balance scale.

To assess static balance, we used the *Romberg* test⁸ because it is fast, practical, and requires only a stopwatch. In this study, it is observed that 89% (Table 2) of the elderly were positive in the test; that is, they presented static imbalance with anteroposterior and/or medial-lateral body displacement. The values obtained are consistent with the literature, which describes the loss in the balance control process in this population. However, in this study, there was no correlation between thoracic hyperkyphosis and the *Romberg* test (Table 3), so it cannot be said that thoracic hyperkyphosis would impair the maintenance of balance in this sample.

In a study by Regolin et al.¹ The force platform was used to assess and correlate bone mass and dorsal kyphosis in elderly women. Elderly women with low bone mineral density associated with increased dorsal kyphosis had greater body sway in the anteroposterior direction on the force platform. They used the hip strategy more to maintain postural control. These body oscillations were also observed in the *present study's Romberg test of the elderly*.

The functional reach test (TAF) was used to assess postural control in reaching activities, as it is easy, fast, and low cost. The population of this study had a mean of 16.29 ± 6.36 cm (Table 1). According to Karuka et al.,¹⁵ displacements smaller than 15 cm indicate patient fragility and risk of falls, contradicting the results of the present study. However, in this study, no correlation was found between the functional reach test and thoracic hyperkyphosis, which means that thoracic hyperkyphosis did not influence the test result (Table 3). No previous studies were found that have made this correlation. There was expected to be a correlation since the literature describes that aging causes a gradual decrease in functional capacity, which is progressive and increases with age,¹⁸ and in individuals with postural deviation, the center of gravity shifts.⁵

Concerning postural control in aging, research indicates that posture stability is linked to the adjustment between sensory information and motor action. In this environment, decision-making would be included in the best motor strategy to maintain or seek postural stability.³

The study by Gasparotto et al.,³ describes that individuals with deviation in posture do not necessarily reproduce a body imbalance; balance control is mediated and compensated by several systems, anticipatory and compensatory adjustments, and body strategies, which can justify the lack of correlation between thoracic hyperkyphosis and the results obtained in the tests used in this study.

CONCLUSION

Thoracic hyperkyphosis did not influence the balance variables in the sample of elderly people studied. It may be interesting to investigate whether individuals with thoracic hyperkyphosis use other strategies to compensate for this postural change.

All authors declare no potential conflict of interest related to this article.

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