

Lumbar spine angular measures in older people: comparison between two radiographic analysis strategies

Medidas angulares da coluna lombar em idosos: comparação entre duas estratégias de análise radiográfica

Medidas angulares de la columna lumbar en adultos mayores: comparación entre dos estrategias de análisis radiográfico

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ABSTRACT | The literature about posture in older adults includes studies that measure spine angles through several strategies. This may interfere with postural diagnosis and impact on the resolution of comorbidities affecting the spine in older people. The objective of this study was to compare two lumbar spine measurement methods commonly used in research. The association between these measures and the angle of kyphosis was used as the basis for comparison. One hundred-sixty older adults were submitted to anterior-posterior lumbar spine x-ray. Two Cobb measures were used for each image (L1-L5 and L1-S1) and the conventional measure for hyperkyphosis. Only the measure based on L1-L5 was associated with the kyphosis angle. The study suggests that lumbar spine x-rays should be analyzed through the L1-L5 Cobb strategy in older people.

Keywords | Aging; Lordosis/Radiography; Posture.

RESUMO | A literatura sobre postura em idosos tem apresentado artigos que medem os ângulos da coluna por diferentes estratégias. Isso pode interferir no diagnóstico postural e impactar na resolução das comorbidades que afetam a coluna desses indivíduos. O objetivo deste estudo foi comparar dois métodos de medida da coluna lombar comumente utilizados em pesquisa. A associação dessas medidas com o ângulo da cifose foi utilizada como base para comparação. Participaram da pesquisa 160 idosos, submetidos a raio-X anteroposterior da coluna lombar. Foram realizadas duas medidas de Cobb para cada radiografia: uma com base em T12-S1 e outra em

L1-L5. Somente a medida com base em L1-L5 apresentou associação significativa com o ângulo da cifose. Não houve associação da medida T12-S1 com o ângulo da curva torácica. Nossos achados indicam que o método de Cobb mais adequado para analisar radiografias de coluna lombar em idosos é o do traçado de linhas entre L1-L5.

Descritores | Envelhecimento; Lordose/Radiografia, Postura.

RESUMEN | La literatura sobre la postura de adultos mayores está compuesta de textos que estudian la medida angular de la columna a través de distintas estrategias. Esto puede producir interferencias en el diagnóstico postural e impactar en comorbidades que les afectan la columna de los adultos mayores. El propósito de este estudio es comparar dos métodos de medición de la columna lumbar empleados frecuentemente en los estudios. Se empleó como base de comparación la asociación de las medidas con el ángulo de cifosis. A los 160 adultos mayores participantes del estudio se les sometieron al rayo X anteroposterior de la columna lumbar. Se llevó a cabo dos medidas Cobb para cada radiografía: una con base en T12-S1 y la otra en L1-L5. La medida con base en L1-L5 fue la única que presentó la asociación significativa con el ángulo de cifosis. No presentó asociación la medida T12-S1 con el ángulo de la curvatura torácica. Los resultados encontrados en este estudio muestran que del método Cobb para analizar radiografías de la columna lumbar de adultos mayores el más adecuado es el de trazado de líneas entre L1-L5.

Palabras clave | Envejecimiento; Lordosis/Radiografía; Postura.

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INTRODUCTION

Studies on human aging are defined under biological, behavioral and social aspects. One of the lines of investigation has been changes in body structure, such as spinal posture and its modifications during the aging process¹⁻⁵. The study of posture involves measuring the angles of the spine. However, the diversity of strategies for measuring causes divergences of results and hinders standardization⁶⁻⁸.

In the sagittal plane the lordotic and kyphotic curves of the spine are evaluated, in the anterior-posterior direction. The spine (thoracic region) is susceptible to deformities as structural changes which are characteristic of human aging occur, what causes changes in the lumbar angle⁹⁻¹². Due to this, researches on the influence of different postures on the social and physical condition of the elderly stand out. However, these analyses have differences regarding their different measuring strategies, among them of the lumbar spine⁷⁻⁹.

The study by Bruno et al.¹⁰ points out that when the elderly show increase in the kyphotic angle, one of the ways to keep the body balance is the posterior rotation of the iliac crest in the pelvis. Other adjustments such as hip extension, knee flexion and ankle dorsiflexion make up the structural adjustments for keeping stable the center of mass.

The radiographic evaluation, considered the gold standard for angular measurements of the spine, can be analyzed through different strategies. The Cobb method advocates the drawing of parallel lines over the vertebral surfaces of each point that defines the curves and, through them, perpendicular lines are crossed with each other for the identification of the angle. However, measurements of the lumbar spine can be made from different points of these lines^{9,11-15}.

One of the methods for the measuring of the lumbar spine uses as its starting point the lines parallel to the superior surface of the vertebral body of L1 and to the inferior surface of L5. Another method analyzes the lines starting from the inferior surface of T12 and the superior surface of S1. It is unclear whether the use of either corresponds to the same clinical outcome. The places indicated as starting points of the lines (such as the superior surface of the sacrum, for example), have biomechanical peculiarities that change the direction of the lines^{11,13,15-17}. The use of the line starting from T12 and S1 considers the position of the sacrum as decisive in the lordosis curve. It is known that the sacrum has

varying positions from one individual to another, and can be in either horizontal or vertical inclination. Therefore, it is possible that the use of the method which adopts the position of S1 does not accurately determine the lumbar curvature in elderly people^{13,16,18}. In addition, there are studies that show that there are differences between men and women regarding the curvature of the lumbar and thoracic spine.

Therefore, this work aims to identify the lumbar spine angle, determined through two measures (L1-L5 and T12-S1) and evaluate which one is best associated with the angulation of the thoracic region in the elderly. The primary objective is to investigate possible divergences between measures, caused by the different markings and that can influence the postural diagnosis. The secondary objective is to compare the curvatures of elderly men and women.

METHODOLOGY

The research has a descriptive and transversal character and used a probabilistic sample of a population of elders at a primary health care unit in the city of Amparo-SP.

Of the 820 active elders, 420 were randomly chosen and invited to participate in a follow-up survey with the conducting of the radiographic examination. Of these, 160 attended the examination and were positioned for the recording of the sagittal plane, in its anterior-posterior view. The inclusion criterion was to be more than 65 years old, not having gone through a spine surgery nor having a restrictive disease that would hinder walking or maintaining a standing up position.

The posture was analyzed through the Cobb method, using the two aforementioned lines strategies for the lumbar spine (T12-S1 and L1-L5, Fig. 1). The thoracic spine was also evaluated through the Cobb method based on the line on the superior surface of the vertebral body which had a more evident superior curve and another line on the inferior surface of the vertebral body of T12 (Fig. 2).

The study obtained approval of the Research Ethics Committee under number 387,026, with the signing of the Informed Consent Form by all participants.

The normality of the data was verified using the Kolgomorov-Smirnov test. The description of the continuous variables was performed through means and standard deviation and the proportion of individuals

with hyperkyphosis and hyperlordosis was described by frequency distribution, with a 95% confidence interval. The Pearson correlation coefficient was used to verify the relationship between the kyphosis angle and the two different measures of the lordosis angle. The association of the proportion of individuals with hyperkyphosis and hyperlordosis evaluated through two measuring strategies was tested through the Chi-square test. The odds ratio of individuals with hyperlordosis having hyperkyphosis was verified through binary logistic regression adjusted according to gender. All analyses were performed using the SPSS 18.0 software and the established significance level was $p < 0.05$.

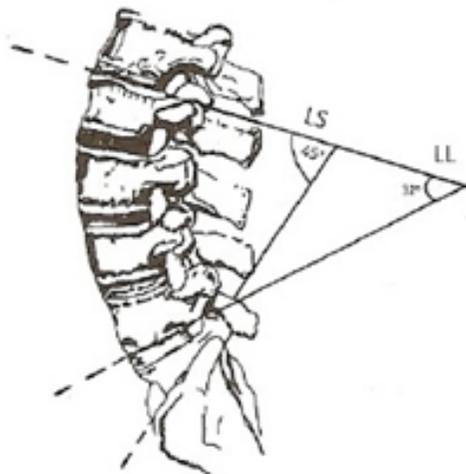


Figure 1 - Measurements of lumbar lordosis (T12/S1 and L1/L5)

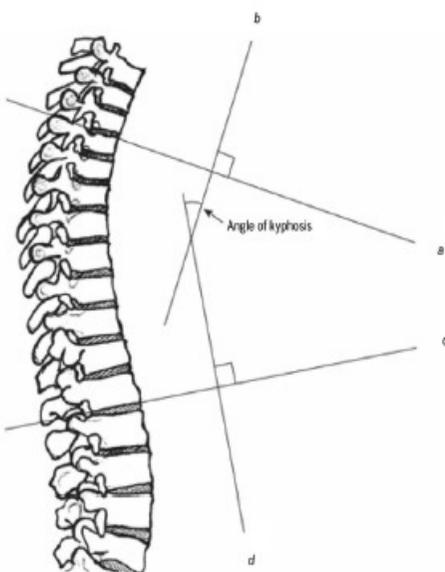


Figure 2 - Measurement of thoracic kyphosis

RESULTS

Correlation was observed between the kyphosis angle and both measures of the lordosis angles (L1-L5 and T12-S1). However, the measuring of lordosis performed through L1-L5 had a more expressive correlation. The correlation between the measures of the kyphosis and lordosis angles is described in Table 1.

Table 1. Correlation between the kyphosis angle and the lordosis angle with the two measuring strategies

	Lordosis L1-L5	Lordosis T12-S1	P
Kyphosis	0.475	0.382	<0.001*

* $p < 0.05$

The association between the proportion of individuals with hyperkyphosis and hyperlordosis was identified only through the measurement performed with L1-L5. The analysis of the association between the proportion of hyperkyphosis with hyperlordosis measured through the two strategies is described in Table 2.

Table 2. Association between hyperkyphosis and hyperlordosis (evaluated through two measuring strategies)

Variables	With Hyperkyphosis % (CI95%)	Without Hyperkyphosis % (CI95%)	p
Male			
Hyperlordosis (L1-L5)	92.6 (81.8 - 99.5)	53.7 (36.6 - 68.8)	0.01*
Hyperlordosis (T12-S1)	96.3 (87.5 - 99.8)	92.7 (83.3 - 99.9)	0.98
Female			
Hyperlordosis (L1-L5)	97.6 (92.5 - 98.6)	67.8 (56.5 - 79.4)	<0.01*
Hyperlordosis (T12-S1)	95.2 (88.4 - 98.3)	96.6 (91.2 - 99.1)	0.55

CI: Confidence interval; $p < 0.01$

The adjusted logistic regression showed that hyperkyphosis was associated with hyperlordosis only when measured through L1-L5, regardless of gender. The odds ratio of individuals with hyperlordosis having hyperkyphosis is presented in Table 3 and shows that, through the L1-L5 measure for lordosis, there is an 81% chance of that same individual having hyperkyphosis.

The average angle of kyphosis was superior in women. A high proportion of individuals with hyperlordosis was identified, both for the measures performed through the L1-L5 and the T12-S1 vertebrae. The description of the sample, with means and standard deviation of the continuous variables, as well as the proportion of hyperkyphosis and hyperlordosis calculated through the two evaluation measures are presented in Table 4.

Table 3. Adjusted odds ratio of hyperlordosis (evaluated through the two measuring strategies) associated with hyperkyphosis

Variables	Odds Ratio (95%CI)	p
Hyperlordosis (L1-L5)	1.81 (1.09 – 3.04)	0.02*
Hyperlordosis (T12-S1)	0.66 (0.41 – 1.08)	0.11

CI: Confidence interval; p* < 0.05

Table 4. Descriptive analysis of the average age and kyphosis and lordosis angles evaluated through two measuring strategies and proportion of individuals with hyperkyphosis and hyperlordosis calculated through the two measuring strategies

Variables	Female (n=106)	Male (n=69)	p
	Mean (SD)	Mean (SD)	
Age	72.8 (±5.6)	74.4 (±6.5)	0.09
Kyphosis angle	43.1 (±13.6)	39.3 (±10.6)	0.02*
Lordosis Angle (L1-L5)	41.7 (±11.9)	39.3 (±10.6)	0.42
Lordosis Angle (T12-S1)	53.3 (±15.3)	56.1 (±16.2)	0.26
	% (CI95%)	% (CI95%)	
Hyperkyphosis	41.6 (31.7 – 51.5)	39.7 (28.1 – 51.5)	0.75
Hyperlordosis (L1-L5)	80.2 (72.3 – 88.1)	69.1 (58.8 – 79.4)	0.11
Hyperlordosis (T12-S1)	96.0 (91.1 – 98.9)	94.1 (88.2 – 98.5)	0.71

p* < 0.05

SD: Standard Deviation; CI: Confidence interval

DISCUSSION

The changes in the curvature of the spine during the process of human aging are widely discussed, however, there is still disagreement among researchers concerning its measuring. The diversity of methods observed in the literature seems to demonstrate a free choice of the researcher, independently of the relationship with the assessed structure^{1,2,6,9,10,14,16,17}. In the analyses in the sagittal plane, the position of the joints of the pelvic girdle interferes in the measures. Thus, the measures that consider the angle of the lumbar region with influence of the sacral position are frequent, such as the T12-S1 measure, also called lumbosacral angle^{12,14,17,19-22}. The present study was based on two measures which are widely seen in researches with the elderly which are the lines on L1-L5 and T12-S1. Although the Cobb method is considered to be the standard, there is variability of the starting point of the lines^{23,24}.

Wang et al.⁶ discuss the measures of the thoracic and lumbar spine in the Chinese population. The authors report the difficulty in identifying the best relationship between the thoracic and lumbar region, in the sagittal plane. They highlight that there is influence of one curvature over the other. Similarly, the works of Erkan et al.³ and Quek⁴, which focus on the cervical spine, also reveal uncertainty about the measures, pointing

to the need for standardization of the measures in the sagittal plane.

The use of measure L5-S1 is associated with changes in the position of the sacrum. Recent studies indicate that the pelvic position is important in the definition of sagittal alignment, since it participates in the compensations in the lumbar region, as well as in the thoracic and cervical regions. The study by Russouly & Pinheiro-Franco¹² shows that the pelvis undergoes retroversion as the reduction of lumbar lordosis occurs. This retroversion is increased when there is thoracic hyperkyphosis and generates other compensations, such as hip extension and knee flexion.

On the other hand, increased lumbar lordosis is also evidenced in studies. The work by Abreu et al.²⁴ found an important percentage of hyperlordosis after radiographic analysis in elderly people (using measures L1-L5). According to the researchers, the reduction of the muscular strength of the muscles that support the lumbar region, such as the rectus abdominis and abdominal oblique and the glutes, explain this angle change in the aging process.

Smith et al.¹⁸ discuss the radiographic measures and mention the T12-S1 measure as the most common way to analyze the lumbar curve. However, they also report that, in the correlation of this line with the other curve of the sagittal plane (kyphosis), there was no significance. The same findings were observed in this study (Table 1), even with the separation by gender for obtaining greater homogeneity.

The study by Miyasaki et al.²¹ evaluated the lumbar angle of elderly men and identified associations with walking skills and the strength of the lower limbs. In their work, the defined measure was L1-L5. In the present study, there was a significant association of this measurement strategy with the thoracic curve (Tables 1 and 2). There was significance both for the group of elderly males as for the females (p=0.01 for men and p<0.01 for women).

The thoracic spine was used as a basis for comparison with the lumbar region. The angle of the thoracic spine also showed differences concerning the cutoff point for the elderly. Although recent studies use degrees between 40° and 50°, as shown in the research by Burke et al.⁵, the studies by Katzman et al.⁷ have identified that the angle which adapted better to the changes related to the aging process was the one with 44° degrees (5.7). In this study this was thus the angle used for the cutoff point of hyperkyphosis.

The measuring of hyperkyphosis was carried out for comparison with the changes in the lumbar spine because they share the same plane of movement, the sagittal plane. When testing the correlations between the values of the lumbar angles measured through L1-L5 and L1-S1, it was observed that only the first was related to the thoracic curve. An odds ratio of 1.81 ($p=0.02$) was verified for the L1-L5 measure with hyperkyphosis (Table 3). These data indicate that the L1-L5 measure is most appropriate to assess lumbar lordosis.

CONCLUSION

The results of this research suggest a reassessment of the best strategy of measurement of the lumbar angle using the Cobb method. In this research, the line starting from L1-L5 was identified as having a greater relationship with the thoracic curve. The other model analyzed, T12-S1, showed no relationship with the thoracic curve. It is important that further research is carried out with the same goal, to deepen the discussion on methods of measurement for defining the strategy that best represents the lumbar curve.

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