Research Article

Are Thoracic Kyphosis and its Mobility Different between Community-Dwelling Older Men and Women?

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Abstarct

Background and Objective: It is believed that the amount of thoracic kyphosis and its mobility may be affected by gender in older adults. The aim of this study was to investigate gender difference of thoracic kyphosis and thoracic spine mobility in healthy older adults.

Method: In this cross-sectional study, 36 participants among which 21 were female and 15 male with an age range of 65-80 years participated. The amount of thoracic spine kyphosis was measured in a relaxed standing position and in the position of maximum correction of thoracic

kyphosis using a flexible ruler between the spinous processes of T12 and C7. The difference between the thoracic kyphosis of the relaxed state and the condition of the maximum correction used to determine the degree of the thoracic spine mobility. Finally, men and women were compared in terms of thoracic kyphosis and thoracic spine mobility. Student t-test to compare kyphosis and spinal mobility between men and women, Paired student t-test to compare kyphosis angle in relaxed posture and maximum kyphosis correction status, and Pearson test to evaluate the relationship between variables were used.

Results: Although there was no statistically significant difference in the mean thoracic kyphosis of relaxation (P=0.13) and maximal correction (P=0.18) status of healthy old men and women, There was a significant positive relationship between the rate of kyphosis angle and the amount of mobility of thoracic kyphosis (P=0.003, r=0.48).

Conclusion: The study's findings revealed that there is no difference in the degree of kyphosis and thoracic spine mobility in older men and women. In addition, people with more thoracic kyphosis had more spinal mobility.

Keywords: Aging, Thoracic Kyphosis, Males, Females, Mobility of Kyphosis, sex difference.

Introduction

In a standing position, kyphosis is a curvature of the spine caused by the form of the vertebrae, intervertebral discs, and paraspinal muscles [1]. The normal values of kyphosis is in the range of 20 to 40 degrees and rises above 40 degrees after the fourth decade of life [2]. This frequent age-related postural alteration is known as hyperkyphosis and in a large cohort study, the prevalence of hyperkyphosis in men and women aged 60 to 70 years were 14 percent compared to 28 percent respectively [3].

It has negative effect on physical function [4,5], respiratory function [6] postural control,[7] independence [8], general health [9], quality of life [10], balance and performance [11] and may interfere with spinal mobility (12,13,14).

Degenerative disc disease and family variables, aging, vertebral fractures, low bone density and muscle weakness are substantial risk factors for hyperkyphosis in elderly men and women. [13, 14, 15, 16, 17, 18]. On the other hand, evidence suggests that a growing kyphosis angle is connected with a decline in mobility and physical function in community-dwelling seniors, especially in women [1, 11, 19]. Mika et al 2009 suggested that spinal range of motion in active women was greater than sedentary ones [20].

Women may be at higher risk of hyperkyphosis due to hormone changes with menopause and other sex-related factors such as poor spinal extensor muscle quality, low spinal muscle strength and endurance, low bone mineral density, vertebral fractures, and the weight of hanging breasts [21,22,23], but there is a contradiction in the results of research literature.

Fon et al 1980 among participants aged 2-77 years, reported that the rate of increase in kyphosis by age in women is higher than in men [24], but in the study by Katzman et al ۲۰17, men had more kyphosis than women although this difference was not statistically significant [25]. Zappala et al 2021 in a systematic review reported that ethnicity could affect the degree of kyphosis, but not gender [26].

According to the Hinman 2004, healthy older women show more kyphosis and less mobility in their thoracic spine compared to younger women, which shows that increasing the thoracic kyphosis increases the spinal stiffness and reduces the spinal mobility. [12]

Despite the factors that predispose women to a greater increase in thoracic kyphosis [23] as seen in the research literature, there is a contradiction regarding the effect of gender on the amount of kyphosis such that Fon et al believe that kyphosis is more in woman [24], Katzman et al believe that kyphosis is less in women [25], and Zappala et al believe that gender has not effect on the amount of kyphosis [26]. In addition, no published study were available to the researchers of the

present study that compared the mobility of the thoracic spine between elderly men and women. The aim of this study was to assess and compare the amount and mobility of thoracic kyphosis in male and female community dwelling older adults.

Method

The participants in this analytical-descriptive study were 36 healthy older persons (21 females and 15 males) aged 65-80 years. The sample size of 15 for each group was calculated using G power based on the result of our pilot study (α=0.05 and β=0.2).

Individuals were recruited using simple sampling method from the people referring to the elderly Cultural Center in Tehran. The inclusion criteria were age between 65 -80 and being community dwelling .The exclusion criteria were having a history of spinal tuberculosis, spinal surgery, radiation, tumor, neuromuscular disease, history of spinal fracture or bone disease, back pain, osteoporosis or obvious hyperkyphosis. First, the subjects signed an informed consent. The height and weight were measured and the Body Mass Index (BMI) was calculated using weight in kilograms (kg) divided by the square of height in meters (m2) .Then the kyphosis arc was measured by a 60 cm long flexible ruler [27, 28], between the spinous processes of C7 and T12 vertebrae.

The greatest fixed spinous process in the neck was determined as the C7 spinous process. The examiner placed a finger on the C7 spinous process, while the other finger was placed on the easily palpable C6 spinous process.[10,19,29] Moreover, the location of T12 spinous process was identified by connecting the lower side of the two posterior superior iliac spines to each other, the midpoint of the two was identified as the S2 vertebral spine. After that, the participant was requested to stand up straight while the examiner's finger was on the T12 spinous process and the location of the spinous process was marked in this posture to reduce the inaccuracy caused by skin movement [30, 31]. The Hoppenfeld's method was used to ensure the correct location of the spinous process (to reach the T12 spinous process, the inferior border of twelfth rib in two sides were touched by the thumb and then the two thumbs were moved up and down simultaneously on both sides until the rib disappeared under the soft tissue), the midpoint of the distance between the two thumbs was considered to be the T12 spinous process [32]. To ensure the accuracy of the landmarks, both examiners in each individual identified them. In the next step, the person stood barefoot while each arm hanging on either side of the body, while feet were 15 cm apart. The person was asked to be in a comfortable position while distributing their weight evenly on both feet and looking at a fixed point on the opposite wall and remain in this position for 3 minutes to reach his/her normal state. The stabilizer was placed on the sternum to keep the person from swinging freely on the sagittal plate while the measurement was being taken. The thoracic arch was modeled on the flexible ruler, which was put on the spinous processes between C7 and T12 (Figure 1). Finally, the shape was transferred to paper. The length and width of the arc were computed first on the arcs recorded by the flexible ruler, and then the amount of angle of kyphosis or θ was estimated using the following formula: $\theta = 4 [\arctan (2h / l)]$. [33]

Fig. 1. Modeling of thoracic kyphosis arch with flexible ruler.

Khalkhali et al 2003 reported that the validity of measuring dorsal kyphosis using flexible ruler by this formula compared to dorsal radiographs is 89%. [28] To measure the mobility of the thoracic spine, the person was asked to straighten his or her spine as much as he or she could while standing, without raising the shoulders or lifting the legs off the ground. In this case, the flexible ruler was again placed between the spinous processes C7 and T12 and the arc shape was drawn. The difference between kyphosis angle in relaxed posture and maximal correction status shows the degree of thoracic spine mobility, which higher numerical value, indicates more mobility of the thoracic spine.[12] Findings were analyzed using SPSS16 software. The Shapiro-Wilk test used to assess the normality of the distribution of data, Student t-test to compare kyphosis and spinal mobility between men and women, Paired student t-test to compare kyphosis angle in relaxed posture and maximum kyphosis correction status, and Pearson test to evaluate the relationship between variables.

Results

Due to the normality of the distribution of variables, parametric tests were used to analyze the data.

As can be seen in Table 1, the two groups of men and women were not significantly different in terms of demographic profile (age and weight).

Table 1. Comparing the demographic profile of participants

Variable	Male(n=15) Mean±SD	Female(n=21) Mean±SD	P value
Age(year)	70.9±4.4	68.5±4.7	0.16
Weight(kg)	63.6±9.3	69±11.3	0.33
Height	172±12	165±7	0.08
BMI	21.75±9	25.8±2.1	0.23

Table 2. Comparison of the thoracic kyphosis and spinal mobility in two standing positions between men and women.

Variable	Male(n=15) Mean±SD	Female(n=21) Mean±SD	P value
Kyphosis angle in relaxed posture (degree)	54.1±10.5	47.3±14.5	0.13
Kyphosis angle in Maximum correction of kyphosis status (degree)	46.7±12.1	41.5±11	0.18
Thoracic mobility (degree)	7.3±6.3	5.8±5.1	0.45

Table 2 illustrates that, the degree of thoracic kyphosis as well as the amount of thoracic spine mobility between the two sexes were not significantly different by student t-test ($p > 0.05$). The mean values of kyphosis both in relaxed and maximal correction position were higher in men compared to women, but this difference was not statistically significant ($p = 0.13$ and $p = 0.18$).
According to Pearson test results, there was a significant positive relationship between the rate of kyphosis angle and the amount of mobility of thoracic kyphosis ($P = 0.003$ and $r = 0.48$). In other words, the more kyphosis angle in relaxed position, the more mobility of the thoracic spine.
The amount of kyphosis in relaxed standing position and the amount of kyphosis in standing position with maximum correction of thoracic kyphosis showed a significant difference ($P = 0.001$). On average, individuals reduced their kyphosis angle 6.4 ± 5.6 degrees by maximal correction of thoracic kyphosis.
In addition, there was a weak negative and statistically significant relationship between the mobility of thoracic spine and BMI ($P = 0.05$ and $r = -0.31$), which means, the higher the BMI, the less mobility of the thoracic spine.

Discussion

In this study, the amount of thoracic kyphosis in healthy elderly men and women was measured and compared. Moreover, the degree of thoracic spine mobility in men and women was compared. According to the results, contrary to the researchers' hypothesis that women may have more thoracic kyphosis due to the expected changes after menopause in older women.[21,22,23] the kyphosis was even slightly higher in older men than in older women, but this difference was not statistically significant. Our results is in line with Giglio et al 2007 who found that the thoracic kyphosis angle of 718 men and women aged 5-20 years had no difference between the sexes, but reported a linear increase in kyphosis with age, of course the age range of the two study is different [34]. In addition, Milne & Williamson 1983 in their cross-sectional study, although observed a greater increase in kyphosis angle by age in women than men, their longitudinal study over 5 years did not confirm it [35]. Our result is comparable with the findings of Katzman et al 2017 who reported that men had grater kyphosis than women at baseline and before strengthening exercise but this difference was not significant [25]. Our finding also is comparable to suggestion by Zappala et al 2021 that gender has no effect on degree of kyphosis [26].
The findings of our study were inconsistent with the findings of Milne & Lauder 1974 and Fon et al 1980 who showed a higher rate of kyphosis in women [36, 24]. On the other hand, Mellien et al 1992 suggested that girls have less thoracic kyphosis than boys [37]. In addition, age-related reductions in thoracic kyphosis were seen in a longitudinal study of females. [38] However, in

these studies, given the age range of participants in the study were wider, this difference in the results can be justified.

Our finding is also inconsistent with suggestion of Boyle et al 2002 who in their experiences as spinal surgeons reported that among older men and women with spinal hyperkyphosis, women had a greater kyphosis angle than men [39]. This difference can be explained by the fact that the observations of these surgeons were on hyperkyphotic individuals [40]. Moreover, Urrutia et al 2021 found that the depth of the back arch is greater in women than in men, however, the angle of the arch was not computed; just the depth of the arch was measured. The length and depth of the back arch are both utilized to determine the kyphosis angle. [41]Pan 2019 in a systematic review and meta-analysis suggested that heterogeneity might partly explain that why heterogeneous sizes and different mean ages produced contradictory results. [42]

Our study suggested that there is not any difference in the thoracic spine mobility between women and men. Although there was no similar study available to compare the results of our study with it but Pan 2019 showed that in each decade of age range, sex had a variable impact on spinal mobility, and it varied depending on the different spinal regions and anatomical directions. [42] .Our finding also showed that those with more kyphosis were able to adjust the amount of thoracic spine kyphosis, implying that they had more spinal mobility. Our results are contrary to the results of Hinman who showed that healthy older women have more kyphosis and less mobility in their thoracic spine compared to younger women and concluded that increasing the thoracic kyphosis increases the spinal stiffness and reduces the spinal mobility. Their study was only on women, while our study shows the results both on women and on men. The difference between the two groups in the study by Hinman may not be because of more kyphosis, but because of the age difference and the changes caused by it. One possible explanation for the observed results in our study may be that the more kyphosis is more away from the erect posture so there is more available range and it is reasonable to allow for more adjustment and movement.

Based on our findings, the quantity of thoracic spine mobility could reduce when the body mass index (BMI) rises considered as an effective factor, although weak , in increasing stiffness and reducing spinal mobility.

Conclusion

The study's findings revealed that there is no difference in the degree of thoracic kyphosis and thoracic spine mobility in healthy aged men and women. In addition, persons with more thoracic kyphosis had more spinal mobility and less stiffness, and the rate of the mobility of thoracic spine decreased as the BMI increased.

Limitations and suggestions

The small number of samples was the main limitation of this study. It is recommended repeating this study in a larger population of healthy older people and in hyperkyphotic people. In addition, in the present study, the bone density of the participants we not examined and measured. However due to the importance of bone changes in spinal health and vertebral shape, a similar study would be valuable considering this variable.

Clinical Relevance

The results of this study can be used to determine how gender affects the prevalence of dorsal kyphosis in the elderly.

Ethical Approval

The Ethics Committee of Shahid Beheshti University of Medical Sciences (IR. approved this study SBMU. RETECH.REC.1398.410).

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Author's contributions
Supervision: Minoo Khalkhali Zavieh; Conceptualization: Tayebeh Roghani , Somayeh Mahmoodiaghdam , Maryam Nodehi; Data collection: Somayeh Mahmoodiaghdam, Maryam Nodehi; Methodology: All authors; Writing the original draft and data analysis: Somayeh Mahmoodiaghdam, Maryam Nodehi, Himan Aryanfar ; Alireza Akbarzadeh Baghban; Investigation: Somayeh Mahmoodiaghdam, Maryam Nodehi; Review & editing: Minoo Khalkhali Zavieh .

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Conflict of Interests statement
The authors reported no conflict of interest.

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