International Journal of Research in Medical Sciences
Dalal AA et al. Int J Res Med Sci. 2023 Dec;11(12):4395-4402
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20233706

Original Research Article

Inter-relationship between altered thoracic- kyphosis angle and core stability and its effect on quality of life among female subjects with hyper-kyphosis

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Received: 10 May 2023
Revised: 11 June 2023
Accepted: 11 August 2023

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ABSTRACT

Background: The hyper-kyphotic posture may result in altered alignment of the shoulder and pelvic girdle which may develop compensatory changes in the spinal segments above and below. Thus, affecting the components which maintain the core stability. In this study two components namely strength and endurance were evaluated. The main objective was to determine if there was any correlation between the altered thoracic kyphosis and the core stability as well as to study the effect of hyper-kyphosis on quality of life in female subjects.
Methods: The study included 84 female subjects from various areas of Surat aged between 20-60 years with thoracic-kyphosis angle more than 50º and were able to read and write Gujarati language. The Thoracic-kyphosis angle was measured using inclinometer and to assess the core stability (1) Static Endurance tests (2) Dynamic Endurance test and (3) Trunk MMT for strength testing was used. The quality of life was assessed using WHOQOL-BREF Gujarati version.
Results: Statistically, moderate positive correlation was obtained between age and thoracic-kyphosis angle. There was strong positive correlation between thoracic-kyphosis angle and flexion: extension, thoracic-kyphosis angle and right-side bridge: left-side bridge, thoracic-kyphosis angle and right- side bridge: extension and thoracic-kyphosis angle and left-side bridge: extension. Out of four domains of WHOQOL-BREF the first two domains showed moderate negative correlation.
Conclusions: The core stability was hampered more in subjects with more thoracic-kyphosis angle. While only the physical and psychological component of quality of life was affected by the altered thoracic-kyphosis angle.

Keywords: Core stability, Quality of life, Thoracic-kyphosis, WHOQOL-BREF

INTRODUCTION

Thoracic kyphosis impairment is considered one of the most common postural anomalies.[1] Thoracic kyphosis is the sagittal plane curvature between the T1 and T12 vertebral bodies and indication for the treatment is based on kyphosis angular measurement.[1,2] Normal thoracic kyphosis ranges from 20^0 to 50^0 when assessed radiographically.[3] Some studies show that one in every three postmenopausal women have significant kyphotic posture; whereas 20% to 40% of both male and female older adults have impaired thoracic kyphosis.[4,5] According to some literature, 78% of physiotherapists encounter patients with hyper-kyphosis at least once a week.[6]

Many previous studies have shown that the thoracic kyphosis can be altered for various reasons such as vertebral fractures, mostly affecting the mid-thoracic spine, which is mainly characterized by a reduced vertebral height often affecting the middle and anterior parts of the vertebral bodies.[7,8] Although, nearly 50% of all patients having hyper-kyphosis with clinical complications do not suffer from vertebral fractures. The increased curvature may also be related to degenerative changes of the spine which include intervertebral disk space narrowing, deformities of the anterior part of the vertebrae, reduced spinal muscle strength.[9] In some people, kyphosis may also result due to weight gain and some degenerative changes.[10] Generally, after 40 years of age angle of thoracic kyphosis begins to increase rapidly.[5]

There is no consistency in the results of previous studies regarding the impact of impaired thoracic kyphosis on the functional performance. Some studies have found hyper-kyphosis to be associated with worse physical function, balance, or mortality.[11] However, some studies concluded there is no relationship between increased kyphosis and balance.[12] An individual with kyphosis can easily get fatigue and may have considerable difficulty in performing activities requiring an upright posture or exercise tolerance such as walking, climbing stairs, housework, and reaching overhead.[13] So, considering the above factors some studies show that the basic activities of daily living, leisure, and emotions are negatively affected by spinal-deformity.[14]

The hyper-kyphotic posture may result in many musculoskeletal alterations mainly in the sagittal plane. It may alter the alignment of the shoulder and pelvic girdle and it can also develop compensatory changes in the spinal segments above and below.[5] The common changes associated with the kyphotic posture are Forward head posture, scapular protraction, reduced lumbar lordosis and decreased standing height in the patients with hyper-kyphosis.[15] Such changes can lead to unequal loading on the joints. Bahmanbeglou et al concluded in their study that thoracic kyphosis can be prevented by the strong back extensor even if bone mass density is decreased.[16] Thus, strong core plays an important role in maintaining body mechanics.

The two concepts core stability and core strength which are fundamentally very different from each other were not differentiated by many studies. Faries and Greenwood have provided a clear difference between core stability and core strength for the rehabilitation sector by suggesting that core stability refers to the ability to stabilize the spine which is provided by the muscle activity, whereas core strength refers to the ability of the musculature to then produce force through contractile forces and intra-abdominal pressure.[17] The term “core”, known as the lumbopelvic-hip complex, can also be described as a muscular box. It has abdominal muscles in the front, the back portion contains para-spinal muscles and gluteal muscles, the diaphragm makes the roof, and the pelvic floor and hip girdle musculature together make the bottom.[18]

Universally the measurement of Cobb’s angle using the radiographs is considered as the gold standard for the assessment of thoracic-kyphosis.[19] Consequently, a wide range of non-invasive instruments has been developed for the clinical measurement of thoracic kyphosis when radiographs are not available. These methods include the arcometer, 3D ultra-sound, Debrunner’s kyphometer, spinal mouse, photogrammetry, goniometry, and electro-goniometry. The Flexi-curve and the inclinometer are the most used hand-held instruments for measuring the thoracic curvature during clinical practice.[20,21]

Core stability can be defined as the capacity for motor control and muscular endurance within the core muscles, which are responsible for sustaining stability in different body positions and when subjected to external forces. Core instability occurs when there is a failure to develop or rectify disorders related to this crucial aspect of physical stability. There are various components of Core Stability including strength, endurance, flexibility, motor control, and function. Although, Acar et al evaluated the core stability using its two components namely endurance and strength.[22] For static endurance testing Trunk Flexor endurance test, the Trunk Extensor endurance test, and bilateral side bridge test are the tests included in the protocol formed by McGill et al.[23] Whereas the Sit-up test measures the dynamic component of the endurance.[24] For the assessment of the strength component of the core stability the trunk flexors, trunk extensors and hip strength can be measured using manual muscle testing. Some previous studies show that by improving these components of the core stability the quality of life in patients had a positive influence.[25]

The definition of quality of life given by the World Health Organization Quality of Life (WHOQOL) Group is that it is the “individuals’ perceptions” about their position in life in the context of the culture and value systems in which they live and also in relation to their goals, expectations, standards, and concerns.[26] The WHOQOL-BREF mainly evaluates the four domains (i.e., 1- Physical health, 2- Psychological health, 3- Social relationship, and 4- Environment). Each domain is scored individually and then the scores are converted into scores out of 100.

Women with hyper-kyphosis report more physical difficulty, more adaptations to their lives, and greater generalized fears than women without hyper-kyphosis. Additionally, community-dwelling men and women aged 65 years and older with hyper-kyphosis report poorer satisfaction with subjective health, family relationships, economic conditions, and their lives in general.[27]

While core strengthening has not been extensively studied, it has gained recognition as a rehabilitative approach, a means of enhancing performance, and a

preventive measure against musculoskeletal and lumbar spine injuries. The main purpose of this study was to examine the core stability in subjects with altered thoracic kyphosis. Also, the impact of hyper-kyphosis on the subject's quality of life was evaluated.

METHODS

This was cross-sectional observational study conducted in female subjects with altered thoracic kyphosis having age between 20-60 years. The duration of study was 12 months (March 2021 to April 2022). Total 84 subjects from different areas (City-light, Udhna, Katargam, Adajan etc.) of Surat were taken.

Inclusion criteria

Females with age group 20-60 years, thoracic Kyphosis angle more than 50°, female subjects who can read and write Gujarati were included.[8,9,3]

Exclusion criteria

Subjects having other musculoskeletal problems in the spine or thoracic cage such as fracture, infection, trauma, etc, subjects with a history of spinal or lower limb surgery, cardiopulmonary disease, neuromuscular disorders, visual or auditory deficits, other medical conditions that can affect the subject's functional level or quality of life were excluded.

Ethical approval was taken from institutional ethical committee. The subjects were explained in detail about the purpose and the procedure of the research and a signed informed consent was obtained before starting with the further procedure.

Firstly, the participants were examined for altered thoracic kyphosis i.e., with the help of two inclinometers angle-□ (angle at T1-T2 level) and angle-□ (angle at T12-L1 level) were measured. Then, the subjects with altered thoracic kyphosis were evaluated for core stability which mainly had two parameters. They were endurance test (Trunk Flexor endurance test, Trunk extensor endurance test, Lateral side bridge test, Sit-up test (for dynamic endurance) and strength test (Manual Muscle Testing for Trunk flexors and Trunk extensors). Then the participants were then given a WHOQOL-BREF questionnaire Gujarati version for which the permission from the WHO had been taken for research purpose.

Statistical analysis

Statistical analysis was done using SPSS software (version 20). Descriptive analysis of patient's Age, Trunk Flexor MMT and Trunk Extensor MMT was done. Kolmogorov Smirnov test was used to check normality of distribution. Correlation of Thoracic-Kyphosis angle was analyzed using Spearman's Rank Correlation test with Age, Flexion: Extension ratio, Right-side bridge: Left-side bridge ratio, Right-side bridge: Extension ratio, Left-side bridge: Extension ratio and WHOQOL-BREF scores. For interpretation correlation coefficient ($\rho = 0$) no correlation, ($0 < |\rho| \leq 0.19$) very weak correlation, ($0.20 \leq |\rho| \leq 0.39$) weak correlation, ($0.40 \leq |\rho| \leq 0.59$) moderate correlation, ($0.60 \leq |\rho| \leq 0.79$) strong correlation, ($0.80 \leq |\rho| \leq 1.00$) very strong correlation.

RESULTS

Out of total 84 patients, 35 were of the age group 20 to 30 years, 8 were of the age group 31 to 40 years, 22 were of the age group 41 to 50 years and 19 were of the age 51 to 60. Descriptive analysis is shown in Table 1 and 2.

As seen in Figure 1 moderate positive correlation was found between the age and thoracic-kyphosis angle. Thus, the relevance was found between alterations in the thoracic-kyphosis angle with the age of the subject.

As seen in Figure 2 a very strong positive correlation was found between the thoracic-kyphosis angle and flexion: extension ratio. Thus, it implies that with increase in the angle of thoracic-kyphosis there will be increase in the ratio of flexion: extension.

As seen in Figure 3 a strong positive correlation was found between the thoracic-kyphosis angle and right-side bridge: left- side bridge ratio. Thus, it implies that with increase in the angle of thoracic- kyphosis there will be increase in the ratio of right-side bridge: left-side bridge.

Table 1: Descriptive analysis including frequency and percentage of subject's trunk flexor and extensor MMT.

Grades	Trunk flexor MMT frequency (n=84)	Percentage	Trunk extensor MMT frequency (n=84)	Percentage
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	66	78.6	52	61.9
4	18	21.4	32	38.1
5	0	0	0	0

Table 2: Descriptive characteristics of variables.

Outcome measures	Mean±SD
Age	37.55±12.851
Thoracic kyphosis angle	59.20±3.354
Flexion: extension	1.472619±0.5637399
Right side bridge: left side bridge	1.443095±0.4033563
Right side bridge: extension	0.973695±0.5637399
Left side bridge: extension	0.973695±0.5637399
Trunk Flexor MMT	3.21±0.413
Trunk Flexor MMT	3.38±0.489
WHOQOL-BREF Domain 1	44.51 ±14.858
WHOQOL-BREF Domain 2	50.06±14.372
WHOQOL-BREF Domain 3	71.20±20.087
WHOQOL-BREF Domain 4	65.07±12.523

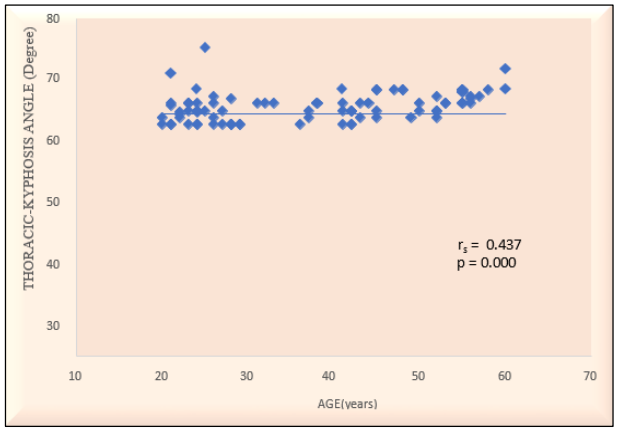

Figure 1: Linear relationship between thoracic-kyphosis angle and age.

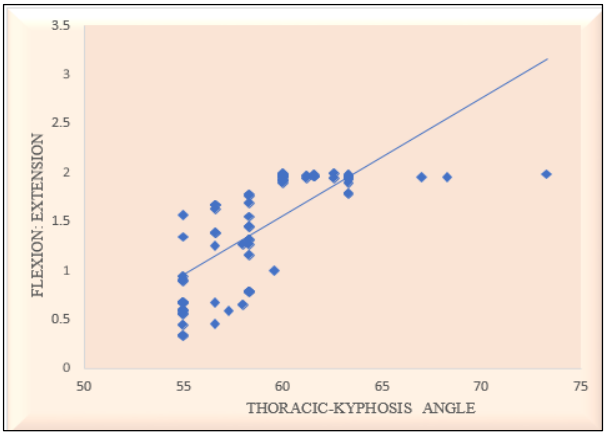

Figure 2: Linear relationship between thoracic-kyphosis angle and flexion: extension ratio.

As seen in Figure 4 a strong positive correlation was found between the thoracic-kyphosis angle and right-side bridge: extension ratio. Thus, it implies that with increase in the angle of thoracic- kyphosis there will be increase in the ratio of right-side bridge: extension.

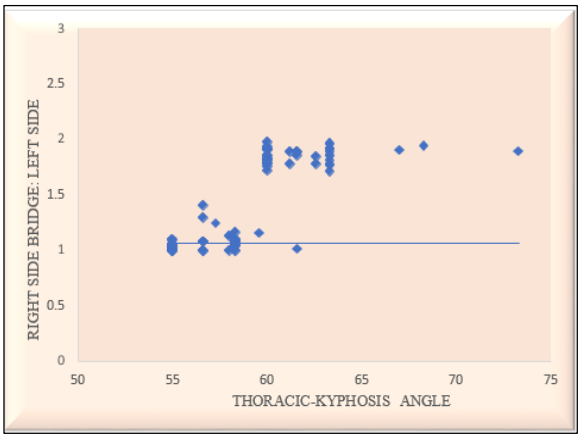

Figure 3: Linear relationship between thoracic-kyphosis angle and right-side bridge: left-side bridge ratio.

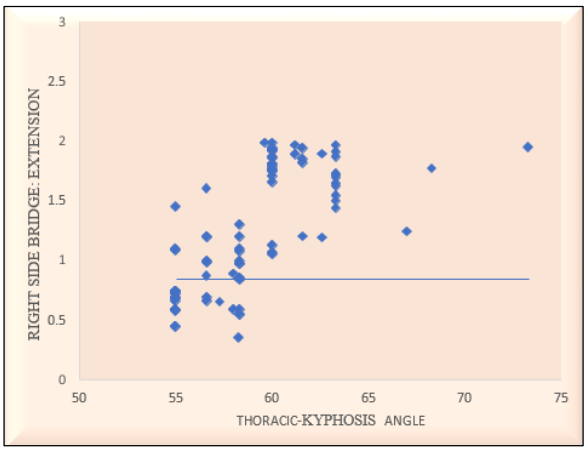

Figure 4: Linear relationship between thoracic-kyphosis angle and right-side bridge: extension ratio.

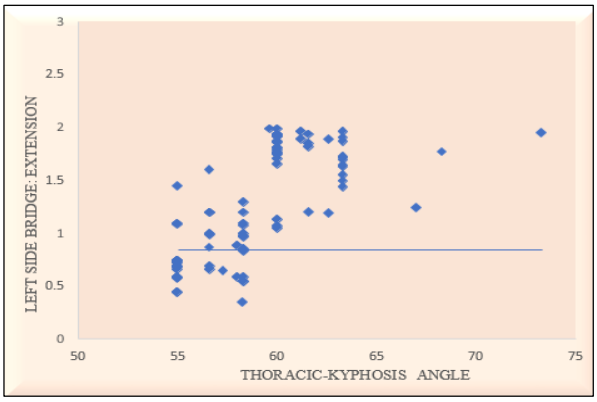

Figure 5: Linear relationship between thoracic-kyphosis angle and left side bridge: extension ratio.

As seen in Figure 5 a strong positive correlation was found between the thoracic-kyphosis angle and left-side bridge: extension ratio. Thus, it implies that with increase in the angle of thoracic-kyphosis there will be increase in the ratio of left-side bridge: extension.

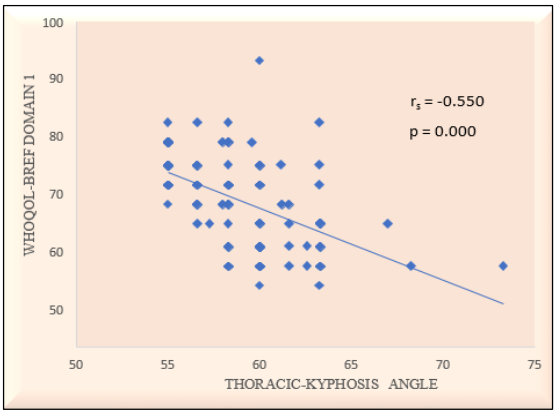

Figure 6: Linear relationship between thoracic-kyphosis angle and WHOQOL-BREF domain 1.

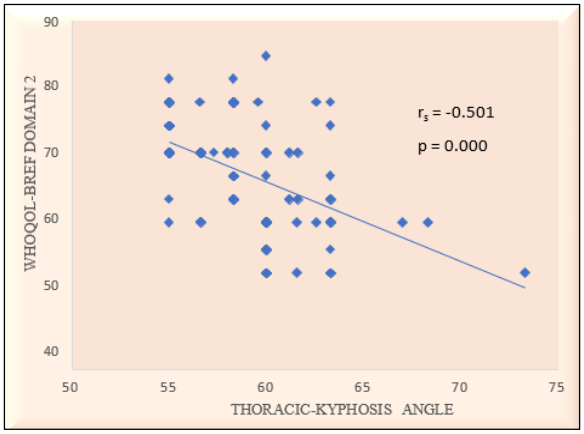

Figure 7: Linear relationship between thoracic-kyphosis angle and WHOQOL-BREF domain 2.

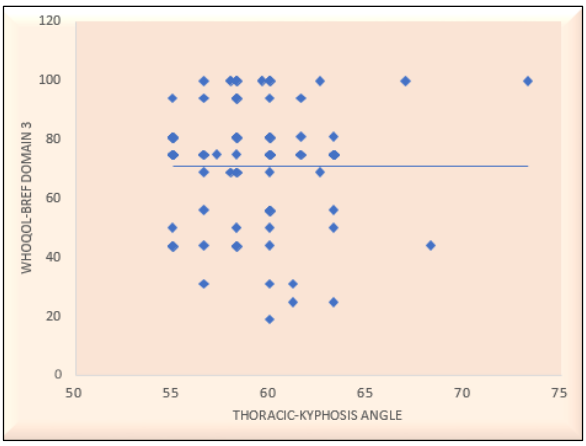

Figure 8: Linear relationship between thoracic-kyphosis angle and WHOQOL-BREF domain 3.

As seen in Figure 6 a moderate negative correlation was found between the thoracic-kyphosis angle and WHOQOL-BREF domain 1. Thus, it implies that with increase in the angle of thoracic-kyphosis there will be decrease in the score of WHOQOL-BREF domain 1.

As seen in Figure 7 a moderate negative correlation was found between the thoracic-kyphosis angle and WHOQOL-BREF domain 2. Thus, it implies that with increase in the angle of thoracic-kyphosis there will be decrease in the score of WHOQOL-BREF domain 2.

As seen in Figure 8 no statistically significant correlation was found between the thoracic-kyphosis angle and WHOQOL- BREF domain 3. Thus, it implies that there is no relevance between alterations in the score of WHOQOL-BREF domain 3 and the increase in thoracic-kyphosis angle.

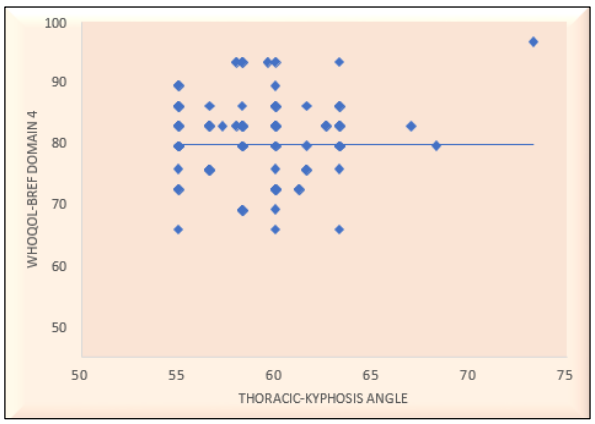

Figure 9: Linear relationship between thoracic-kyphosis angle and WHOQOL-BREF domain 4.

As seen in Figure 9 no statistically significant correlation was found between the thoracic-kyphosis angle and WHOQOL- BREF domain 4. Thus, it implies that there is no relevance between alterations in the score of WHOQOL-BREF domain 4 and the increase in thoracic-kyphosis angle.

DISCUSSION

Spinal curvatures change throughout the life span.[28] Changes in the spinal curve cause both physical and psychological distress due to the changes in posture, balance, and self-image.[29,30] Thoracic stabilization was reported to have a significant role in obtaining and maintaining vertical alignment.[31] It was reported that more neutral thoraco-lumbopelvic alignment was associated with less back pain.[32] The thoracic spine's natural bend, known as kyphosis, has been estimated to range from 20° to 50°. This deformity has been mostly associated with postural problems called round back posture or hunchback.

The results of this study demonstrated that hyperkyphotic subjects had poor static and dynamic endurance. Whereas domain 1 (physical health) and domain 2 (psychological) of WHOQOL-BREF had lower scores as compared to domain 3 (social relationships) and domain 4 (environment).

In this study 84 females with age between 20-60 years were included with mean age 37.55±12.851. The frequency of females with age group 20-30 years was more as compared to other age groups but the Thoracic-kyphosis angle was more in age group 51-60 years. Thus, it can be said that more the age greater was the Thoracic-kyphosis angle but hyper-kyphosis was not age dependent as it can be prevalent in any age group. This was also supported by the findings of other authors in their previous studies as Cutler et al in his study named "Prevalence of Kyphosis in healthy sample of pre and post-menopausal women" also found that hyper-kyphosis was not age dependent as it was prevalent in any age group. Our findings from this study indicate that there is a moderate positive correlation (rs=0.437 at level of significance 0.05) of age with thoracic-kyphosis angle.

Likewise, Zappalá et al in his study "The relationship between thoracic kyphosis and age, and normative values across age groups: a systematic review of healthy adults" concluded that there a moderate positive correlation between age and thoracic-kyphosis angle with Spearman's Rank Correlation Coefficient rs=0.52.

According to the previous studies it was found that muscle strength, vertebral body shape and intervertebral disc morphology can affect kyphosis angle.[6] But 86-93% of the thoracic spine's curvature can be attributed to intervertebral disc morphology and vertebral body form. More negatively correlated with aging than vertebral morphology is disc morphology. Therefore, the increase in thoracic kyphosis observed with ageing may be related to the changes occurring in intervertebral discs.

Other findings from this study indicate that statistically there is a strong positive correlation between the Thoracic-kyphosis and Flexion: Extension ratio (rs = 0.810), Right-side bridge: Left-side bridge ratio (rs = 0.788), Right-side bridge: Extension ratio (rs = 0.712) and Left-side bridge: Extension ratio (rs = 0.712).The frequency distribution for Trunk MMT shows that no subjects were having grade 0, grade 1, grade 2, and grade 5 of MMT whereas 78.6% were having grade 3 and 21.4% were having grade 4 for trunk flexors and 61.9% were having grade 3 and 38.1% were having grade 4 for trunk extensors. Thus, it was concluded that with increasing alterations in normal thoracic-kyphosis angle there was increase in the ratio and also the strength of trunk muscles was affected. This increase in ratios and lower grades of MMT indicate poor core stability. The term "core", known as the lumbopelvic-hip complex, can also be described as a muscular box. It has abdominal muscles in the front, the back portion contains para-spinal muscles and gluteal muscles, the diaphragm makes the roof, and the pelvic floor and hip girdle musculature together make the bottom.[18] Core stability can be defined as motor control and muscular endurance in the core, which has a role of maintaining the stability of this core in various posture and external forces applied to it.[32] Because of this abnormal flexion posture the abdominal muscles and para-spinal muscles will have impaired biomechanics as there will be change in the angle of pull and there will be altered load distribution leading to altered motor control and endurance of these muscles.

The present study also indicated that the subjects with altered thoracic-kyphosis angle had physically and psychologically poor quality of life where as there was no significant correlation found with the social-relationship and environmental component of the quality of life. Altered thoracic-kyphosis angle had negative effects on the physical well-being and psychological health of the subjects.

The definition of quality of life given by the World Health Organization Quality of Life (WHOQOL) Group is that it is the "individuals' perceptions" about their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. The physical domain of WHOQOL-BREF mainly evaluated pain, discomfort, energy, fatigue, Physical health, Sleep and rest, dependence on medication, aids, work capacity and mobility.[33] So as the subject assumes kyphotic posture the efficiency and biomechanics of the muscles gets hampered leading to discomfort, fatigue and reduced work capacity in such subjects. Hence, there was a moderate negative correlation between Thoracic-kyphosis angle and domain 1 of WHOQOL-BREF. The psychological domain of WHOQOL-BREF mainly evaluated positive feelings, learning and concentration, self-esteem, body image and appearance, negative feelings, spirituality, and personal beliefs.[37] The subjects in this study mainly scored lower in questions evaluating body image and appearance as well as negative feelings and self-esteem due to postural impairments. Hence, there was moderate negative correlation between thoracic-kyphosis angle and psychological domain of WHOQOL-BREF.

Study had small sample size and the study was conducted on normal subjects and no specificity of population was there.

CONCLUSION

It can be concluded that, younger the subjects less were the Thoracic-kyphosis angle and older the subject comparatively more was the thoracic-kyphosis angle. Also, the core stability was hampered more in subjects with more thoracic-kyphosis angle. While only the physical and psychological component of quality of life were affected by the altered thoracic-kyphosis angle.

Recommendations

In future, study can be done with condition specific population and with large sample size including male subjects.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Dalal AA, Modi NA. Inter-relationship between altered thoracic- kyphosis angle and core stability and its effect on quality of life among female subjects with hyper-kyphosis. Int J Res Med Sci 2023;11:4395-402.