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Pathogenesis, Computation, and Sequel of Hyperkyphosis on Lung Function - A Literature Review

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Abstract

Kyphosis may affect the human body in various ways, causing falls, fractures, pain, decreasing performance, and affecting lifestyle quality. However, the primary goal of this literature review is more towards an overview of various causes, measurement methods of kyphotic angle, and the effect on the lungs of reducing respiratory effort, resulting in decreased FEV1 and FVC. Possible preventive measures are also discussed. Even though there is a lack of an established hyperkyphosis threshold, we stick to an angle of more than 40° in young adults and beyond 60° in the elderly group over 60 years. A search was done through popular databases such as PubMed, ScienceOpen, and Embase, and 41 relevant articles were selected. With a thorough reading and analysis, up-to-date information regarding kyphosis is listed in this article.

Keywords: Kyphosis; hyperkyphosis; FEV1; FEV; vital capacity

Introduction

The spine's natural forward curve is called kyphosis. Hyperkyphosis, regarded as abnormal, is used when the forward curvature is more significant than 40°, though the Scoliosis Research Society suggests a range of 20° to 60°. Hyperkyphosis is increasing its prevalence and incidence for various reasons; it affects up to 20 to 40 % of the older population of more than 60 years in both men and women. However, a more rapid development of kyphosis is observed in women due to menopause. In the USA, the prevalence of Scheuermann's kyphosis ranges from 0.4% to 8%, affecting males twice as much as females [1, 2]. Kyphosis under normal limits is a primary curve developed in the thoracic and sacral regions. Primary curvature develops during the fetal period, whereas secondary curvature results from various problems such as posture, vertebral fracture, aging, degenerative joint disease, muscle weakness resulting from various reasons, limited physical activity, accidents, Etc. This article mainly reviews the impact of thoracic hyperkyphosis on lung function and its implications if left untreated. We will discuss the reasons for hyperkyphosis and how they affect lung volumes, capacities, etc [3].

Anatomy of the Spine

The Vertical column, comprising 33 vertebrae, plays an essential role in keeping one's posture upright, acting as a shock absorber, and protecting the spinal cord. Cervical vertebrae, C1-C7, connect the skull through the atlantooccipital joint. T1-T12 of the "thoracic vertebrae" make up the chest level of the spine and are connected to ribs on either side, forming a solid rib cage to lodge the lungs and heart and protect them. During breathing, gliding motion of the ribs on vertebrae is permitted through costovertebral joints, allowing the lungs to expand fully to their capacity. The lumbar L1-L5 region serves weight bearing. Sacrum, S1-S5, and Coccyx Cx1-Cx4 form the base of the vertebral column, whose vertebrae are fused without intervertebral discs [3].

Methods

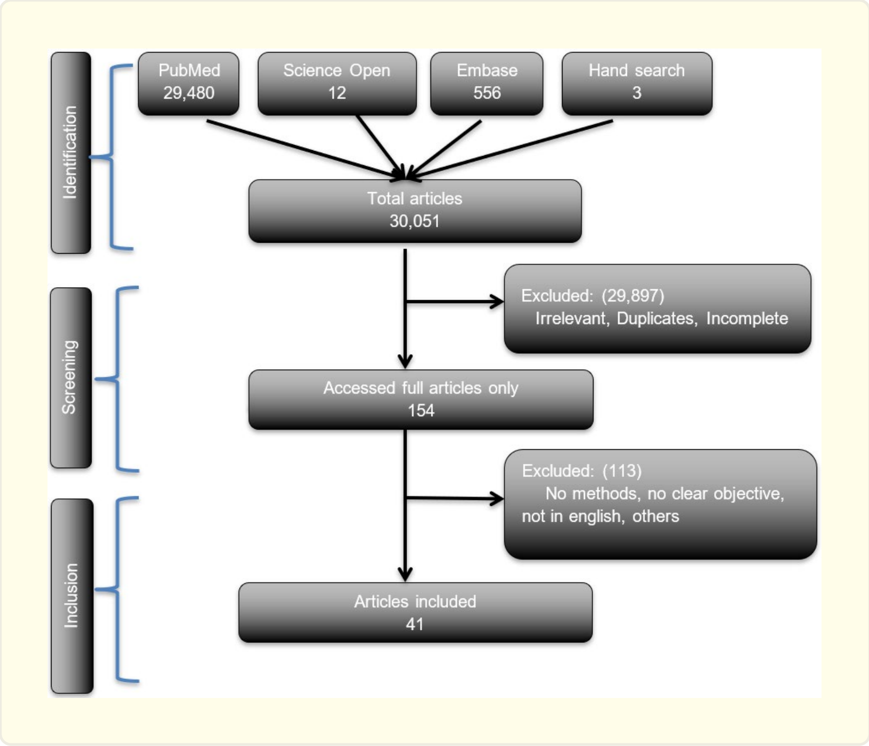
The literature search is conducted through a list of databases such as PubMed (29,480), ScienceOPen (12), and Embase (556) by filtering clinical trials, RCTs, and observational peer-reviewed primary data studies in the past 20 years that looked at the relationship between hyperkyphosis and lung function using searchable terms and derivatives as shown in Table 1. Search through the database yielded many articles, and additional articles were also found through the hand search (3) totaling 30,047, from which only 41 were taken for this review. The remaining articles were excluded as few were duplicates, few were irrelevant, and few were overlaps (PRISMA chart). The review includes articles only available in English.

Search criteria

Population	***Exposure/Physical Condition***	***Comparison/Normal***	***Outcome measures***
Adults	Kyphosis	No Kyphosis Population or Normal Values in healthy adults	Lung Functions measured by various parameters
No keywords needed, already implied within articles	Kyphosis Hyperkyphosis	No keywords needed	Lung, Volume Spirometry, Incentive spirometry Respiratory, Asthma FEV1, TLC, VC, IRV, ERV, RV, IC, FVC, Hypoxia, Hypercarbia, Clubbing, Spasm, Status Asthmaticus, Methacholine challenge test, Pulse Oximetry, Oxygen Saturation

Table 1

Prisma Flow Chart



Definition

Kyphosis: The posterior convexity of the spine is termed kyphosis. Most of us use kyphosis and hyperkyphosis interchangeably, as the minimum threshold to differentiate between terms is not stated [4, 5]. Increased posterior convexity to a degree higher than 35 to 38° falls under hyperkyphosis.

Pulmonary function tests: A series of functional tests to quantify lung volumes, bronchial blockage, gaseous exchange, lung compliance, and ventilatory capacity to decide the lung's functional status. They are often considered the foundation for clinical decision-making for a variety of individuals, including those who have dyspnea symptoms, need thoracic or abdominal surgery, or might need screening because they are at risk, in addition to patients with pulmonary disease [6, 7].

Etiology

Kyphosis can be classified into two subtypes: primary and secondary. The primary causes are due to congenital developmental anomalies. In contrast, the risk factors for secondary causes (degenerative disc disease, osteoporosis, inflammatory and infectious diseases, muscular and neuromuscular diseases, trauma, and other conditions) can all cause kyphosis, etc. Although there are several types of kyphosis, three main types commonly observed in practice are Congenital Deformities, Scheuermann disease, and Postural deformities.

Pathogenesis

Congenital kyphosis

Congenital kyphosis is a type of kyphotic spine deformity that tends to be a Deformity of the sagittal plane. A spine segment's aberrant posterior convex angulation is one of its defining features, usually seen more in girls than boys. Congenital kyphosis could partially develop the vertebrae, which impairs the sagittal plane's longitudinal expansion of the region anterior to or anterolateral to the transverse axis of vertebral rotation.

Three types of congenital kyphosis are classified based on their structural failures.

Failure of vertebral development results in Type I, especially centrum hypoplasia and aplasia, when kyphosis results from the failure of vertebral bodies to form and tends to worsen in curvature as the child grows. Within this type, five common subtypes are known to be centrum deficiencies. Wedge is associated with Deformity of the posterior hemivertebra or posterior hemicentrum. A unilateral absence of vascularization is related to the lateral hemicentrum. The posterior quadrant centrum, also known as the posterolateral quadrant vertebra, is where at least ¼ of the centrum of the spine leads to ossification in the posterior ¼ of the spine. Centrum, The most severe variant of the anterior region of the spinal malformation, is aplasia, a complete absence of the vertebral body. The contralateral production of neural arch elements in this subtype is either average or underdeveloped instead of absent. This results in very sharp angulated kyphoscoliosis.

Type II is due to failure of vertebral body segmentation, also known as Annulus Fibrosus Osseous Metaplasia, where vertebral bodies fail to separate, which is usually diagnosed and more commonly observed at the age of walking when the ossification of the defective annulus occurs. The outer layer of the annulus fibrosus starts to retain growth potential in the periosteum and perichondrium regions, respectively. As bone growth stops, the ossified annulus connects two or more central vertebrae, causing the vertebra to undergo osseous metaplasia [8].

The most frequent cause of spinal cord compression due to spinal cord abnormalities is tuberculosis, along with congenital kyphosis. Knowing the type of congenital kyphosis is more crucial than measuring Cobb's angle to determine the accurate prognosis of the disease. Type III is a combination of both Types I and II.

Scheuermann disease

Juvenile kyphosis, or Scheuermann disease, is a structural deformity that begins before puberty, affects the thoracic or thoracolumbar spine, and worsens with a growth spurt. After a Danish orthopedic surgeon, it was given the name Holger Scheuermann. Scheuermann's disease, or Scheuermann kyphosis, was described by the surgeon with his back with disabling pain caused by a juvenile spine kyphosis, which is meant to be the result of At least three neighboring vertebral bodies of end plates displaying disordered endochondral ossification, a decrease in collagen, and an increase in mucopolysaccharide. This rigid type of kyphosis can worsen with growth, giving vertebrae a wedge shape over at least three adjacent spine levels. Although a structural deformity causes kyphosis, it is usually a benign pathology. The two types of Scheuermann disease are known as typical and atypical. The more prevalent typical type meets Sorensen's criteria (more than three adjacent vertebrae wedged five or more), and the pinnacle of the deformity is typically in the mid-thoracic spine (T7-T9). When unusual, the thoracolumbar or lumbar spine is typically where the deformity's apex is located. Schmorl's nodes and other conventional radiography findings, such as disc space narrowing and end plate alterations, are still visible, but Sorensen's criteria are only occasionally met. Knowing Sorenson's criteria for the disease: at least three adjacent vertebral bodies, greater than Schmorl's nodes with end plate abnormalities, a 5° anterior wedging, and a shrinking disc. Scheuermann Kyphosis is thought to have a varied expressivity and complete penetrance of autosomal dominant inheritance. Although unknown, some studies suggest that identical monozygotic twins have three times higher chances of getting the disease than fraternal twins. Males tend to get affected more than females in the area of the upper or middle thoracic spine; even though we do not have definite evidence, we have some theories. One of the theories suggests that males with the disease are heavier and taller than healthier individuals. However, some studies show no correlation between height and the disease. Patients tend to suffer from chest pain and rarely from breathing difficulties due to decreased lung capacity when it is upper kyphosis [9-13].

Postural kyphosis

Postural hyperkyphosis is when the upper portion of the vertebrae is more significant than 60°, and the normal kyphosis is 20° - 45°. This type of kyphosis is seen in adolescent females more than males. Postural kyphosis is not a structural or developmental deformity. It occurs due to slouching posture. The extensor muscles in the back and the posterior spinal ligaments are stretched and weakened with time, ultimately increasing the forward curvature. Postural kyphosis is flexible with round shoulders, so there is no wedging, and the vertebral structures are typical, so it could be reversed by bending backward. Apart from postural kyphosis seen in adolescents, age-related effects also contribute to increased thoracic kyphosis, mainly affecting females. According to different studies, four different factors contribute to hyperkyphosis in aging. Asymmetric disk degeneration is likely the main contributing factor that causes changes in anterior disk height, leading to vertebral compressions, anterior wedge deformity, and degenerative disk changes. The changes seen in the disk are more anterior than posterior, which causes an increase in kyphosis. The second contributing factor is a decrease in thoracic extensor muscle tone. The spine's extensor muscle strength is reduced with increased age, leading to increased kyphosis. Aging also causes natural hypermobility, which is associated with exaggerated thoracic kyphosis.

Along with these three factors, postmenopausal hormonal changes are associated with the weakening of the spine ligament that decreases spinal support, including annulus, leading to an increase in the curvature of the spine because of a decline in estrogen in the postmenopausal state. There has been an association between collagen loss and a change in connective tissue integrity that impacts the body, including the spine. Therefore, asymmetric disk degeneration, weak muscle tone, natural hypermobility, and endocrine-associated collagen weakening may relate to hyperkyphosis in the elderly group with or without vertebral compression. In addition to that, elderly patients with increased thoracic kyphosis have an association with increased falls regardless of underlying causes such as vertebral fractures. Geriatric population with increased kyphosis tends to avoid engaging in daily activities, especially outdoors, due to falling risk [14-17].

Degenerative kyphosis

Osteoporosis is one of the typical progressive degenerative diseases due to loss of bone mineralization that leads to problems in the spine and disc disease of the spine. In this, patients lean forward at the angle of the neck, developing prominent posterior convexity leading to muscle overuse and eventually muscle strain around the spine.

Muscular and Neuromuscular kyphosis

Very common with children suffering from muscular and neuromuscular diseases such as cerebral palsy, ehlers danlos syndrome III, muscular dystrophy, spina bifida, etc.

Nutritional Kyphosis

This type of kyphosis is due to vitamin D deficiency leading to rickets constituting structural alteration of the curvature of the spine.

Infectious Kyphosis

This type of kyphosis is most commonly due to Tuberculosis, which causes spine compression and back deformity.

Measurements of Kyphosis Angle

Radiographic or clinical methods can be used to determine the degree of kyphosis and discussed as follows,

Radiographic method

This method is carried out by medical professionals using Cobb's angle, derived using radiographs for spinal deformities in patients. Radiographs In either a standing or lying position, the lateral spine is photographed. One calculates the angle by drawing a combination of the following lines: horizontal line (a) is drawn through the T3 superior endplate, and a third line (b) is drawn perpendicular to the first line (a). Line {c} is drawn from the inferior endplate of T12, and another line (d) is drawn perpendicular to line (c). The measured angle at the intersection of lines (b) and (d) is Cobb's angle, which measures kyphosis/hyperkyphosis (Figure 1).

Advantages include accuracy and reliability, so it is considered the "GOLD STANDARD".

Non-radiographic methods have evolved due to limitations such as X-ray as a prerequisite, expensive and time-consuming, radiation exposure, etc [18].

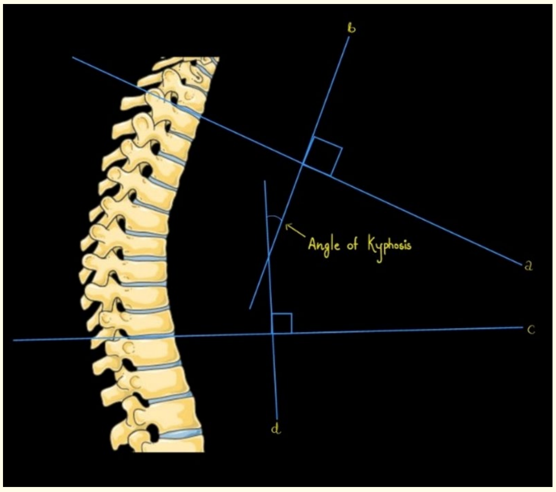


Figure 1: Showing angle of kyphosis.

Non-radiographic methods

The limitations of the radiographic methods led the professionals to think further, leading them to discover new methods to avoid patients' health at risk. A significant number of non-radiographic methods to measure kyphosis were developed, such as an arcometer, flexicurve rulerSpinal Mouse, Debrunner's kyphometer, goniometer, electrogoniometer, raster stereography, manual inclinometer, and digital inclinometer, block method, and occiput-to-wall distance (OWD). Debrunner's kyphometer, flexicurve ruler, block method, and OWD are the most popular, reliable, and clinically used methods.

Debrunner kyphometer

The kyphometer, popularized as a goniometer, measures the kyphosis angle with a protractor-like device with two arms attached. The kyphometer's top arm is between the T2 and T3 spinous processes over the interspace. The lower arm of the kyphometer, on the other hand, is positioned at the bottom above the gap between the T11 and T12 spinous processes. Then the patient is asked to exhale, the normal kyphosis is measured, and then, the patient is asked to stand as straight as possible to measure the best kyphotic angle. From the goniometer, Cobb's angle measurement is obtained [18].

Flexicurve ruler

As its name suggests, the flexicurve ruler is a plastic, bendable object positioned from the C7 spinous process to the L5-S1 interspace. It is shaped like a flexible ruler to follow the spine curve, and the lumbar and thoracic curves are measured. The thoracic curve's total width (TW) divided by its total length (TL) multiplied by 100 determines the kyphosis index. The study conducted in 2015 found no significant relation between abnormal kyphosis and interscapular pain. A kyphosis index value over thirteen (13) falls under the category of hyperkyphosis [18, 19]. Advantages are strong validity and reliability, Inexpensive, ease of use by entry-level staff, avoidance of high radiation risk, easy measurement of spinal curves and abnormalities.

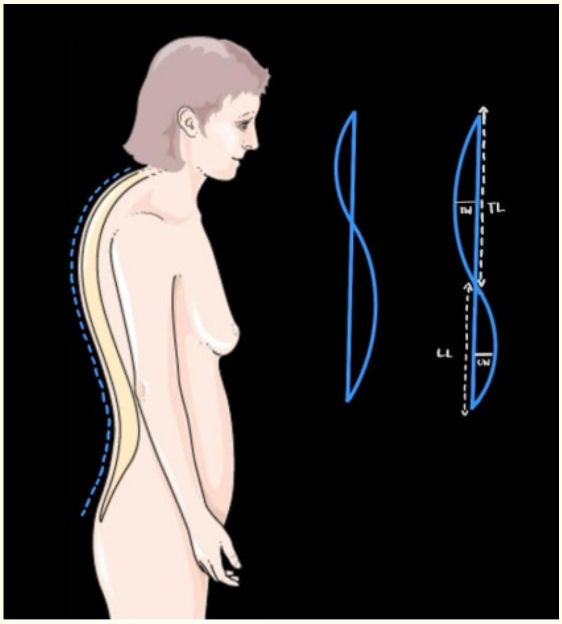


Figure 2: Showing Flexicurve ruler.

Occiput-wall distance measurement (OWD)

The examinee is asked to stand straight as feasible with one back to a wall. While ensuring that the head, shoulder, buttocks, calf, and heel are touching the wall and ensuring the neck is neutral. If the head is touching the wall, then it is considered normal, and if there is a gap between the head and the wall, then the occiput-wall distance is measured with a ruler; a value above 2 cm is abnormal, and the spine curvature is considered to be kyphotic [19].

Blocks method

Measures the participant's head with 1.7 cm-thick blocks while resting supine to measure the degree of kyphosis. Hyperkyphotic people cannot supinely lie in a neutral position without hyperextending their necks. Blocks support the head until it is in a neutral position, with the more significant number of blocks being directly proportional to the greater severity of kyphosis [20].

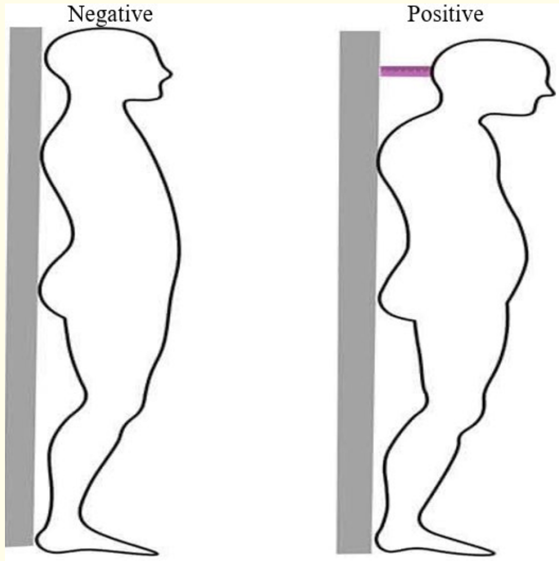


Figure 3: Wall Occiput Test (WOT).

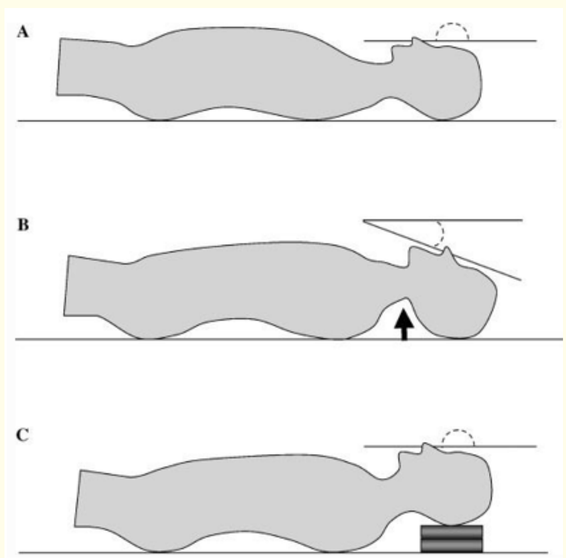


Figure 4: Showing blocks method.

Arcometer

Arcometer has three (3) bars, a single long bar, and two short, parallel bars. Millimeters are marked along each bar. The two perpendicular bars are positioned at T1 and T12, respectively, to produce calculates the thoracic kyphosis angle using the three lengths with a mathematical formula [21].

Spinal Mouse

Using accelerometers, a Spinal Mouse records intersegmental distance changes and the tilt of the spinous processes. The tool monitors the spine's spinous processes and sends data about them to a computer, which analyzes the data to calculate the kyphotic angle [21].

Digital inclinometer

An inclinometer reads directly from two sensor arms. One sensor arm is placed on the T1 spinal process and the other on the T12 spinal process. The inclinometer then measures the kyphotic angle [22].

3D ultrasound

A chest board and hip board are used in 3D ultrasound, which helps to reduce patient movements. The probe has sensors to monitor the probe's orientation and placement. Standing while performing the scan, the probe is raised from below L5 to above T1 [23].

Electrogoniometer

The protractor used in a goniometer is replaced with a potentiometer. The electrical output from the potentiometer records the angle present at the joint when motion happens there.

Spinal wheel

The spinal wheel is a 10 cm diameter plastic object with a reflective marking. It is rolled up from S1 to the endpoint of the occiput. An accurate trace of the spinal position provided by a 3D kinematic system detects the wheel's motion.

Raster stereography

This method automatically examines the patient in a standing position using a personal computer; a 3-dimensional spine model is reconstructed using parallel light lines called projected raster lines on the rear surface, and a digital camera is used to detect the raster lines' distorting. Various features, such as frontal, sagittal, and transverse profile parameters, can be determined using mathematical shape analysis.

Effects of Hyperkyphosis on Lung Function

Hyperkyphosis results in compromised lung functioning via the thoracic cavity shrinkage, decreased rib cage mobility, diaphragmatic mobility, and expansion of the lungs. Therefore, Thoracic hyperkyphosis patients usually show respiratory insufficiency. An early cross-sectional investigation on the connection between thoracic kyphosis and ventilatory dysfunction in older people found that there is a direct association between age and the prevalence of thoracic kyphosis, which means that dyspnea and ventilatory dysfunction are more common in older people. The extent of the kyphosis in the participant's OWD and DS were used to assess (Difference Stature) had a direct positive correlation to the severity of ventilatory dysfunction, having participants with kyphoses with significantly When compared to non-kyphotic patients, the spirometric evaluation revealed decreased FVC, FEV1, and FVC/FEV1. When accounting for age, the study found that kyphotic people had a greater than twice the high chance of developing dyspnea than non-kyphotic people. Unfortunately, underlying diseases like smoking, persistent bronchitis, or asthma could not be accounted for. Independent of co-morbid conditions, including COPD and asthma, hyperkyphosis in participants increased the risk for airway obstruction to more than three times what it would otherwise be, the mechanism mostly being the distortion of the larger airways following the increased kyphotic angle of the spine.

Similarly, thoracic kyphosis participants exhibited more than a doubling in risk for a restrictive ventilatory pattern of lung disease [24]. The study provides a gripping reason to consider thoracic kyphosis as a risk factor for dyspnea and decreased ventilatory function in the elderly. The burden of respiratory disease and mortality in old age could be reduced by avoiding the same.

To measure the effect of the severity of kyphosis on the loss of pulmonary function over 16 years in both men and women, another longitudinal study showed a strong positive correlation between how severe kyphosis is and worsening pulmonary function. Unlike the study conducted by Di Bari and colleagues, the change in lung function over 16 years was measured in this study using radiographic measurements of thoracic spine curvature and standardized pulmonary function testing; the mean FEV1 decreased from advancing age and time in both women and men and the decline in FEV1 with increasing severity of kyphosis was more apparent in women compared to men, mostly may be due to a smaller number of male participants compared to females but not draw the conclusion about the same. The study points to the restriction of ventilation because of a smaller chest capacity and thoracic muscle weakness to explain the declining pulmonary function in participants with the severity of kyphosis angle. Lorberg and colleagues, in another study, also concluded that suggested measures to stop and slow the development of kyphosis would aid in lowering the mortality and morbidity as a consequence of declined pulmonary function in older persons [25].

McMaster retrospectively studied the impact of Congenital kyphosis and kyphoscoliosis on lung function in 41 patients seeking corrective spinal surgery. The study found a strong positive correlation between the apex of kyphosis and respiratory impairment. The respiratory function worsens the higher the kyphotic deformity's apex within the thoracic cage. In contrast to the severity of kyphosis, which only had a more significant impact on FVC, it was discovered that the apex of kyphosis was the most significant noteworthy variable affecting both FVC and FEV1. A more cranial level of the apex of the kyphosis, notably above T10, was found to be associated with more severe impairment in lung function [26].

McMaster and colleagues also noted that rib cage deformity associated with the sharply angulated curvature of the spine in congenital kyphosis and kyphoscoliosis compressing ribs bilaterally and impeding diaphragmatic movement might also restrict normal lung biomechanics leading to alveolar atrophy in a developing lung, in turn leading to significant impairment in the lung functioning. The lungs are fully developed until linked with severe deformity. Therefore, the same does not apply to spinal curvature associated with rib cage deformity emerging in adolescence or respiratory muscle paralysis. The study concluded that surgical treatment for kyphosis or kyphoscoliosis is indicated early to prevent severe spinal deformity and iatrogenic adverse effects on lung development, leading to a progressive decline in lung function.

In two patient groups, two groups underwent kyphotic corrective operations, and Zeng and his team examined the changes in pulmonary function and thoracic volume after the procedures; FVC% was found to be worse in patients with a kyphosis angle greater than 60° and with a kyphosis apex above T10. Pulmonary function mainly improved in younger patients with more thoracic flexibility post-surgery compared to older/ankylosed patients with thoracic rigidity. Also, patients whose kyphosis apex is higher than T10 showed significant improvement in pulmonary function parameters post-surgery. PFT mostly dropped in patients post-surgery from pre-operative levels for a short term due to the pain caused by surgical trauma, interference with intercostal nerves, and changes to the thorax shape. The study noted that PFT was more likely to show improvement in patients with a follow-up of more than two years, indicating that the lung would adapt to the reconstructed thorax with time. The improved pulmonary function in younger patients post-surgery is most likely due to the continued development of the lung. The study did not find any statistically significant change in thoracic volume post-surgical correction in patients. However, it concluded that restoring the typical shape of the thoracic cavity is beneficial to improving pulmonary function [27].

Discussion

Various shortcomings drawn from this review include the basic standard threshold to differentiate kyphosis from hyperkyphosis because the spine typically has a fundamental curvature called kyphosis. In contrast, hyperkyphosis is an exaggeration of the kyphotic angle. A definition of hyperkyphosis can be analyzed using Cobb's angle as it is the gold standard. A normal kyphotic angle is 20 to 40°; anything more than that is called hyperkyphosis. However, normal kyphosis may stretch to 60° in the elderly group so that hyperkyphosis will be beyond that. Kyphosis measured using a Flexicurve ruler shows According to one of the online publications from Health

Line, which states that kyphosis puts pressure on the spine, there is no correlation between kyphosis and interscapular pain, which results in pain and then leads to breathing difficulties, reducing lung expansion [28]. Compared with Cobb's method of measuring kyphotic angle, the Flexicurve ruler has the advantage of reducing the high radiation risk along with proven reliability and validity.

As healthcare professionals, our main aim is patient safety, so using the Flexicurve ruler can be encouraged with more awareness [29]. Literature on the effects of Hyperkyphosis on lung function is minimal, and the literature shows that pulmonary function and the degree of kyphosis have a negative connection, with pulmonary function worsening to an increasing degree of kyphosis. Along with the degree of kyphosis, the level of the kyphosis apex, age of the patient, and pathologies affecting the flexibility of the thorax (Ankylosing spondylitis, Osteoporosis) also have a significant effect on pulmonary function. Spinal corrective surgeries have significantly improved PFTs in adolescent and juvenile kyphosis and young adults, improving the quality of life and lowering pulmonary insufficiency-related morbidity and mortality.

Conclusion

To conclude, some studies generated little hope with interventions such as Yoga and physical therapy training for back extensors and paraspinal muscles. Chest pectoralis muscle lengthening, along with self-mobilization techniques such as foam roller diaphragmatic breathing, improves the strengthening of the muscles and rib cage expansion, leading to improved lung capacities. Future studies should include the clinical relevance of hyperkyphosis using Cobb's angle in young adults as well as the elderly group due to their variance in etiology and also, as some studies point out that more significant respiratory impairment is with cranial kyphosis above the level of T10, which should be kept in mind while providing conservative treatments to patients. As one study quotes, an untreated hyperkyphotic patient of more than 128° died due to cor pulmonale; more concentration should be given to the prevention and treatment of hyperkyphosis to avoid respiratory complications [30].

Consent to Publish

We have used third-party images and cited them appropriately.

Conflict of Interest Statement

There is no conflict of interest between the authors and this review.

Tools Used

PubMed.
Medline.
Google Scholar.
Embase.
Science Open.
OpenMD.

Abbreviations

T1-12: Thoracic L1-5: Lumbar C1-7: Cervical.
S1-5: Sacral.
Cx1-4: Coccyx.
DS: Difference Stature.
OWD: (Occiput to wall distance).
TW: Total Width.
TL: Total Length.

WOT: Wall to Occiput Test.
COPD: Chronic Obstructive Pulmonary Disease.
PFT: Pulmonary Function Test.
FVC: Forced Vital Capacity.
FEV1: Forced Expiratory Volume in 1 second.
TLC: Total Lung Capacity.
VC: Vital Capacity.
IRV: Inspiratory Reserve Volume.
ERV: Expiratory Reserve Volume.
RV: Residual Volume.
IC: Inspiratory Capacity.

References

1. Zappalá M, Lightbourne S and Heneghan NR. "The relationship between thoracic kyphosis and age, and normative values across age groups: a systematic review of healthy adults". Journal of Orthopaedic Surgery and Research 16.1 (2021).
2. Lam JC and Mukhdomi T. "Kyphosis". StatPearls (2022).
3. Katzman WB., et al. "Physical Function in Older Men with Hyperkyphosis". The Journals of Gerontology Series A: Biological Sciences and Medical Sciences 70.5 (2014): 635-640.
4. Koelé MC, Lems WF and Willems HC. "The Clinical Relevance of Hyperkyphosis: A Narrative Review". Frontiers in Endocrinology 11 (2020).
5. Yaman O and Dalbayrak S. "Kyphosis and review of the literature". Turkish Neurosurgery (2013).
6. Murray and Nadel's Textbook of Respiratory Medicine. (n.d.). ScienceDirect (2016).
7. Ruppel GL and Enright PL. "Pulmonary Function Testing". Respiratory Care 57.1 (2012): 165-175.
8. Marks DS and Qaimkhani SA. "The Natural History of Congenital Scoliosis and Kyphosis". Spine 34.17 (2009): 1751-1755.
9. Sardar ZM, Ames RJ and Lenke L. "Scheuermann's Kyphosis: Diagnosis, Management, and Selecting Fusion Levels". Journal of the American Academy of Orthopaedic Surgeons 27.10 (2019): e462-e472.
10. Fotiadis E., et al. "Scheuermann's disease: focus on weight and height role". European Spine Journal 17.5 (2008): 673-678.
11. Takahashi T., et al. "Trunk deformity is associated with a reduction in outdoor activities of daily living and life satisfaction in community-dwelling older people". Osteoporosis International 16.3 (2004): 273-279.
12. Tribus CB. "Scheuermann's Kyphosis in Adolescents and Adults: Diagnosis and Management". Journal of the American Academy of Orthopaedic Surgeons 6.1 (1998): 36-43.
13. Lowe TG and Line BG. "Evidence based medicine: analysis of Scheuermann kyphosis". Spine 32 (2007): S115-S119.
14. Spencer L., et al. "Upper back pain in postmenopausal women and associated physical characteristics". PloS One 14.7 (2019): e0220452.
15. Bartynski WS., et al. "Severe thoracic kyphosis in the older patient in the absence of vertebral fracture: association of extreme curve with age". AJNR. American Journal of Neuroradiology 26.8 (2005): 2077-2085.
16. Mika A, Unnithan VB and Mika P. "Differences in Thoracic Kyphosis and in Back Muscle Strength in Women with Bone Loss due to Osteoporosis". Spine 30.2 (2005): 241-246.
17. van der Jagt-Willems HC., et al. "Associations between vertebral fractures, increased thoracic kyphosis, a flexed posture and falls in older adults: a prospective cohort study". BMC Geriatrics 15.1 (2015).
18. Katzman WB., et al. "Age-related hyperkyphosis: its causes, consequences, and management". The Journal of Orthopaedic and Sports Physical Therapy 40.6 (2010): 352-360.
19. Tominaga R., et al. "Relationship Betweefotin Kyphotic Posture and Falls in Community-Dwelling Men and Women". SPINE 41.15 (2016): 1232-1238.

20. Tran TH., et al. “Correlations among four measures of thoracic kyphosis in older adults”. Osteoporosis International 27.3 (2015): 1255-1259.
21. Jung S., et al. “Correlation among Non-radiological Measurements for Thoracic Kyphosis”. Journal of Musculoskeletal Science and Technology, 4(1), (2020): 1-5.
22. Azadinia F., et al. “The Validity and Reliability of Noninvasive Methods for Measuring Kyphosis”. Journal of Spinal Disorders and Techniques 27.6 (2014): E212-E218.
23. Lee TT-Y., et al. “3D ultrasound imaging provides reliable angle measurement with validity comparable to X-ray in patients with adolescent idiopathic scoliosis”. Journal of Orthopaedic Translation 29 (2021): 51-59.
24. Di Bari M., et al. “Thoracic Kyphosis and Ventilatory Dysfunction in Unselected Older Persons: An Epidemiological Study in Dicomano, Italy”. Journal of the American Geriatrics Society 52.6 (2004): 909-915.
25. Lorbergs AL., et al. “Severity of Kyphosis and Decline in Lung Function: The Framingham Study. The Journals of Gerontology”. Series A, Biological Sciences and Medical Sciences 72.5 (2017): 689-694.
26. McMaster MJ., et al. “Lung function in congenital kyphosis and kyphoscoliosis”. Journal of Spinal Disorders and Techniques 20.3 (2007): 203-208.
27. Zeng Y., et al. “The Influence of Kyphosis Correction Surgery on Pulmonary Function and Thoracic Volume”. Spine 39.21 (2014): 1777-1784.
28. Mirbagheri S-S., et al. “Evaluating Kyphosis and Lordosis in Students by Using a Flexible Ruler and Their Relationship with Severity and Frequency of Thoracic and Lumbar Pain”. Asian Spine Journal 9.3 (2015): 416-22.
29. Hinman M. “Comparison Of Thoracic Kyphosis And Postural Stiffness In Younger And Older Women”. The Spine Journal 4.4 (2004): 413-417.
30. McMaster MJ., et al. “Lung function in congenital kyphosis and kyphoscoliosis”. Journal of Spinal Disorders andamp; Techniques 20.3 (2007): 203-208.

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