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EFFECTIVENESS OF STRETCHING AND STRENGTHENING EXERCISES ON STOOPED POSTURE IN GERIATRIC PATIENTS.

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Abstract
Purpose of the study- This study aims to assess the effectiveness of a combined stretching and strengthening exercise program in addressing hyperkyphotic posture among geriatric patients. Hyperkyphosis, prevalent in older adults, adversely affects health and mobility. The purpose is to determine whether a multifaceted exercise approach yields superior outcomes compared to stretching alone.
Methods-The study was conducted in Karad, Maharashtra. It included 30 participants aged above 60 with hyperkyphosis and a kyphotic index greater than 13. Participants were randomly assigned to Group A (stretching only) or Group B (stretching and strengthening). A 6-week exercise protocol was implemented, and outcomes were measured using kyphotic index, thoracolumbar flexion range of motion, and the tragus-to-wall test.
Results- Kyphotic Index: Group B, receiving both stretching and strengthening exercises, showed a significantly greater reduction in kyphotic index compared to Group A ($p < 0.0001$). This implies that the combined approach is more effective in treating hyperkyphosis.**Thoracolumbar Flexion Range of Motion:**Both groups exhibited extremely significant improvements ($p < 0.0001$) in thoracolumbar flexion range of motion. However, Group B displayed a more substantial increase, indicating that incorporating strengthening exercises contributed to enhanced flexibility.**Tragus to Wall Test:**Group B demonstrated a more pronounced reduction in the tragus-to-wall distance compared to Group A ($p < 0.0001$), suggesting that the combined stretching and strengthening approach was more effective in improving posture.
Conclusion: The study concludes that a combined stretching and strengthening exercise program is superior in addressing hyperkyphotic posture in geriatric patients compared to stretching alone. This comprehensive approach leads to a significantly greater reduction in kyphotic index, improved flexibility, and more pronounced posture improvement. The findings emphasize the importance of incorporating both elements into rehabilitation protocols for optimal outcomes in managing hyperkyphosis in the elderly.
Keywords- Hyperkyphosis, Geriatric Patients, Stretching Exercises, Strengthening Exercises, Posture Improvement

1. Introduction

The term "kyphosis" usually means the normal curve of the upper back. But when someone is called "kyphotic," it means their back is curved too much. To avoid confusion, we use "hyperkyphosis" to describe an overly curved upper back. Hyperkyphosis is common among older people, affecting between 20% and 40% of them[1].

Osteopenia and osteoporosis are conditions where bones become less dense. This usually starts in women when they reach menopause and in men around age 65. The loss of bone density happens because the body loses calcium, making bones weaker. This can cause the spine bones to become smaller and less dense, which might affect posture[2].A significant factor in spinal curvature is the change in intervertebral discs, which harden and lose flexibility with age. This leads to a compressed spine length and a forward tilt known as kyphosis. These age-related changes collectively form senile kyphosis, considered a normal part of aging.[3]

As we age, our muscles shrink and weaken, a process known as sarcopenia, leading to increased spinal curvature[4,5]. Around age 30, both men and women start transitioning from lean bodies to ones with more fat, which tends to gather at the waist, causing weight gain until about age 55 in men and 65 in women. This weight shift contributes to spinal changes[6]. Additionally, aging can bring about bone fractures and arthritis, making bones and discs stiffer, more curved, and painful[7].In people with hyperkyphotic posture, the chest and front neck muscles are tight. The upper back muscles and the ones at the back of the neck are often weak. Additionally, the hip flexors may be tight, and the core muscles might be weak.[8]

Muscles exhibit viscoelastic properties meaning they undergo alterations when subjected to stretching, in contrast to elastic materials like rubber that stretch under stress and return to their original shape once the external force is removed.When we stretch a muscle, we also extend the tendons that attach the muscle to the bone and also the endomysium which is protective covering that surrounds the muscle fiber. Because these tissues are made of elastic proteins like collagen and elastin, they can somewhat elongate during the stretching process[9].

At a microscopic level, skeletal muscle fibers consist of sarcomeres, which are the fundamental units responsible for muscle contraction. These sarcomeres contain elongated fibrous proteins that can either relax, allowing the muscle fibers to lengthen, or contract, resulting in their shortening and the exertion of force on tendons and surrounding tissues. Unlike a rubber band, which tends to resist stretching consistently, a muscle's resistance to stretching decreases gradually with each 30-second stretch. This characteristic enables a continuous elongation of the muscle over time.[10]

For sustainable increase in flexibility muscles add more sarcomeres, which help maintain strength even when stretched further. The number of sarcomeres in muscles can increase or decrease based on how often they're used, highlighting the importance of a regular stretching routine for overall flexibility enhancement[11]. Mechanical tension is produced when muscles are subjected to resistance, as in weightlifting or resistance training. The force that muscles use to overcome resistance is what causes this tension. Satellite cells that are essential for muscle growth and repair are activated by mechanical strain, which initiate cellular signaling pathways.

The activated satellite cells help form sarcomeres, which are the basic units that make muscles contract. Actin and myosin, two important contractile proteins, are produced as a result of an increase in protein synthesis during the process[12].These proteins are synthesized, and as a result, new sarcomeres are formed along preexisting muscle fibers, causing hypertrophy, or the enlargement of muscle fibers. Sarcomere hypertrophy is the result of both new sarcomere formation and sarcomere enlargement in response to increased demands during resistance training. To build muscle effectively, sticking to a regular routine of challenging resistance training is essential. Consistent and progressively challenging resistance training programs significantly impact the process of adding sarcomeres and increasing muscle size. The factors like intensity, frequency and duration play crucial roles in achieving these adaptations[13,14].It is believed that if back strengthening exercises are given to healthy women of age group between 49 years to 65 years, it helps to improve their posture.Therefore, back strengthening exercises are included in this interventional study along with stretching exercises for different muscle groups. The extent of a stooped posture in elderly females correlates with the severity of vertebral pain, emotional well-being, muscular limitations, and motor issues[15].Increased thoracic kyphotic curve beyond the normal range results in various health impacts, including heightened levels of depression and diminished motivation in individuals[16]. Diminished capacity to carry out mobility tasks is linked to kyphosis, underscoring the importance of addressing hyperkyphosis in the elderly[17].

2. Materials and Methods

This comparative study has been carried out in Krishna College of Physiotherapy, Krishna Vishwa Vidyapeeth, Karad, Maharashtra after receiving approval from the Institutional Ethical Committee.Participants were selected according to inclusion and exclusion criteria. The study includes people who have a stooped posture, are aged 60 or older, and can be male or female. But it excludes anyone with other injuries to their trunk.

Total 120 subjects fulfilled the inclusion criteria. Participants were explained about the procedure of the study and written consent was taken.Spinal kyphosis was measured in each subject using the flexicurve ruler[18,19], which is a malleable band of metal covered with plastic and of 50cm in length.The participant was asked to stand upright and as tall as they could. A flexible ruler, capable of bending in only one direction and maintaining its shape, was then positioned along the natural curves of the spine from the base of the neck (C7) to the lower thoracic region (T12). Afterward, the ruler was laid flat on a piece of paper, and its shape was outlined by tracing along its edges. A straight line was then drawn from the ruler position of C7 to T12 that corresponded to the length of thoracic kyphosis (l) and was measured in cm. The height of the thoracic kyphosis (h) in cm was determined by drawing a perpendicular line from the highest point in the thoracic curve to the line from C7 to T12. Kyphotic index of the participantwas calculated using the formula (h/l) *100. Individuals with kyphotic index greater than 13 were assessed further for thoracolumbar spine ROM and tragus to wall test.

To measure thoracolumbar flexion ROM, participant was asked to stand upright in relaxed and neutral position. Anatomical landmarks T1 and S2 were marked using a pen.To avoid confusion, T1, which is located below C7, was identified as an anatomical landmark. The participant was asked to perform cervical flexion, during which C7 moves while T1 remains stationary.This allowed for accurate palpation and marking of T1.To palpate S2, first, the iliac crest was traced, followed by locating the PSIS and then identifying S2.Distance between these two landmarks was measured with the help of measuring tape in centimeter.Then participant was asked to bend forward as much as possible and again the distance between landmarks was measured.The measurement taken when the participant was flexed was then subtracted from the measurement taken in the neutral position. This difference provided the thoracolumbar flexion range of motion.

The tragus-to-wall test was used to measure cervical and thoracic mobility. The patient was positioned standing against the wall, with their heels touching the wall and feet hip-width apart. Then, the participant was instructed to flatten the back of their neck towards the wall by tucking their chin. The distance between the tragus and the wall was then measured.

Out of 120 participants, 37 participants had kyphotic index greater than 13. Out of 37, 2 subjects did not agree to participate while other 5 terminated the treatment. The remaining 30 individuals participated actively in the study. the 30 participants were randomly allocated in two groups, namely Group A and Group B by simple random sampling. Stretching protocolwas given to group A for 6 weeks. Following exercise protocol which included stretching and strengthening exercises were given to group B for the same time period. The outcome measures were again measured post intervention[1,20,21,22,23].

Table 1. shows exercise protocol given to group A (only stretching)

Week	Exercise	Repetitions
Week 1 and 2	Pectorals,Biceps,triceps,Quadriceps,HamstringStretch	Sustained for 10 sec * 3
Week 3 and 4	Pectorals,Biceps,triceps,Quadriceps,HamstringStretch	Sustained for 20 sec * 3
Week 5 and 6	Pectorals,Biceps,triceps,Quadriceps,HamstringStretch	Sustained for 30 sec * 3

Table 2.shows exercise protocol given to group B (stretching and strengthening)

Week	**Exercise**	**Repetitions**
Week 1 and 2	Pectorals,Biceps,triceps,Quadriceps,HamstringStretch	Sustained for 10 sec * 3
	IsometricsofBiceps,triceps,Quadriceps,Hamstring	Sustained for 10 sec * 3
	Wallangels	5 * 1
	ExtensionRegime	1 set
	Blackburnexercises	10 * 1
Week 3 and 4	Pectorals,Biceps,triceps,Quadriceps,HamstringStretch	Sustained for 20 sec * 3
	IsometricsofBiceps,triceps,Quadriceps,Hamstring	Sustained for 10 sec * 3
	Wallangels	5 * 2
	ExtensionRegime	2 sets
	Blackburnexercises	10 * 2
Week 5 and 6	Pectorals,Biceps,triceps,Quadriceps,HamstringStretch	Sustained for 30 sec * 3
	IsometricsofBiceps,triceps,Quadriceps,Hamstring	Sustained for 10 sec * 3
	Wallangels	5 * 3
	ExtensionRegime	3 sets
	Blackburnexercises	10 * 3

3. Results

Table 3. Shows the Mean and SD values of kyphotic index of group A and B, pre and post intervention

Group	**Pre-intervention**		**Post intervention**		**P value**	**Results**
	Mean	**SD**	**Mean**	**SD**		
Group A	15.53	1.11	12	0.86	<0.0001	Extremely significant
Group B	16.06	1.08	12	1	<0.0001	Extremely significant

Interpretation- Group A participants were given only the stretching protocol for 6 weeks. Kyphotic index in group A before the intervention was 15.53±1.11 which was reduced to 12±0.86. Group B participants were given stretching as well as strengthening exercises. Kyphotic index in group B before the intervention was 16.06±1.08 which was reduced to 12±1. Participants in Group B, receiving both stretching and strengthening exercises, demonstrated a significantly greater reduction in kyphotic index compared to Group A, suggesting the combined approach yielded superior results.

Table 4. Shows the Mean and SD values of thoracolumbar flexion range of motion in centimetre group A and B, pre and post intervention

Group	Pre-intervention		Post intervention		P value	Results
	Mean	SD	Mean	SD		
Group A	4.61	1.10	10.84	0.68	<0.0001	Extremely significant
Group B	5.26	1.44	10.88	0.43	<0.0001	Extremely significant

Interpretation- Thoracolumbar flexion range of motion in group A prior to the intervention was 4.61±1.10 which was increased to 10.84±0.68 after the 6 weeks of exercise protocol. Thoracolumbar flexion range of motion in group B prior to the intervention was 5.26±1.44 which was increased to 10.88±0.43 after the intervention. Group B exhibited a more substantial increase in thoracolumbar flexion ROM compared to Group A, indicating that the addition of strengthening exercises contributed to enhanced flexibility.

Table 5. Shows the Mean and SD values of tragus to wall test in centimetre of group A and B, pre and post intervention

Group	Pre-intervention		Post-intervention		P value	Results
	Mean	SD	Mean	SD		
Group A	14.24	0.88	9.66	0.31	<0.0001	Extremely significant
Group B	15.04	0.68	9.9	0.33	<0.0001	Extremely significant

Interpretation- Tragus to wall test result in group A before the intervention was 14.24±0.88 which was reduced to 9.66±0.31 after the intervention. - Tragus to wall test result in group B before the intervention was 15.04±0.68 which was reduced to 9.9±0.33 after the intervention. Group B demonstrated a more pronounced reduction in the tragus-to-wall distance compared to Group A, indicating that the combined stretching and strengthening approach was more effective in improving posture.

The results consistently indicate that participants in Group B, receiving both stretching and strengthening exercises, achieved superior outcomes in terms of kyphotic index reduction, increased thoracolumbar flexion ROM, and greater improvement in the tragus-to-wall test compared to those in Group A. This suggests that the combined approach is more effective in addressing hyperkyphotic posture in the elderly.

4. Discussion-

This study looked at whether a combination of exercises, including stretching and strengthening, could help older people with their stooped posture.This study demonstrates that participants who received both stretching and strengthening exercises (Group B) showed significantly greater reductions in kyphotic index, increased thoracolumbar flexion range of motion, and more pronounced improvement in the tragus-to-wall test outcome compared to those who received stretching exercises alone (Group A). This aligns with previous research emphasizing the importance of back extensor strength in managing hyperkyphotic posture[24,25,26]. Exercises for trunk control have been shown to be effective in diseased people like stroke[37].

The combined stretching and strengthening exercises engaged a wider range of muscles. Stretching exercises improved flexibility, while strengthening exercises targeted muscles in the back and other supporting areas. This dual approach seemed to work together to address both the structural and muscular aspects of stooped posture[27].Understanding the biomechanics of stretching and strengthening exercises helps explain the improvements observed. Stretching elongated muscle fibers, enhancing flexibility, while strengthening exercises increased muscle size and strength. This adaptation in muscles, especially through strengthening, is consistent with previous studies on muscle growth and exercise. It stresses the need to tailor exercises to target specific changes in posture-related muscles[28,29,30].The study by Katzman and others demonstrated the efficacy of targeted multimodal spine-strengthening exercises in improving hyperkyphosis and overall well-being in older adults[31]. In his other study Katzman and others demonstrated a 6-degree improvement in usual kyphosis angle and also significant gains in thoracolumbar flexion range of motionfollowing a 12-week multidimensional group exercise intervention for elderly women with kyphosis >50 degrees. This improvement suggests that targeted exercise interventions can effectively reduce kyphosis angle in this population[32]. Core stability exercises improves muscle strength after spinal cord injury[38].

Similarly, the Adapted Physical Activity (APA) program implemented by researchers for flexed posture showed promising results, with participants demonstrating a decrease in occiput-to-wall distance following a 3-month intervention. These findings highlight the potential of specific exercise protocols in reducing hyperkyphosis-related postural abnormalities[21].Furthermore, the study involving back extensor strengthening exercises among women in their 50s suggested that regular exercise could potentially slow down the progression of kyphosis[22]. This supports the concept that targeted strengthening exercises may have long-term benefits in reducing the advancement of hyperkyphosis, especially when initiated early.Renno and others reported a 5% improvement in kyphosis following an eight-week exercise program for older women. This improvement indicates that exercise interventions can enhance spinal flexibility and contribute to the reduction of hyperkyphotic posture[20].

Additionally, the temporary decrease in thoracic kyphosis observed following a 10-week Pilates-based intervention highlights the transient yet statistically significant improvements achievable through structured exercise programs[33]. While the effect may be modest in duration, such evidences support the efficacy of exercise in managing hyperkyphosis.Although the modified Hatha yoga poses did not lead to significant changes in kyphosis measured by the Debrunner kyphometer, they did result in improvements when measured by the flexicurve[34]. This highlights the importance of considering different measurement techniques and outcomes when evaluating the effectiveness of exercise interventions for hyperkyphosis.Finally, research by Tudini and others demonstrated a significant correlation between kyphotic posture and reduced tragus-to-wall distance in elderly individuals. This association suggests that interventions aimed at correcting kyphosis can lead to improvements in tragus-to-wall distance as observed in our study[35].These findings suggest important considerations for designing exercise programs for elderly individuals with stooped posture. Including both stretching and strengthening exercises in rehabilitation plans may offer more benefits than focusing on just one. Engaging various muscle groups, particularly those in the back, can lead to a more balanced musculoskeletal system and sustained improvements in flexibility[27].

Despite these positive results, the study has limitations. The short duration of the intervention and the specific exercises used may limit how broadly the findings can be applied. Future research should explore longer interventions and different exercise variations to better personalized programs based on individual needs and conditions.

When people have a stooped posture, they adjust by bending their knees and flexing their ankles more to maintain balance[21]. It's crucial to consider each person's unique challenges and tailor exercise plans accordingly. Ongoing research is vital for improving exercise dosage and intensity to ensure sustained improvements over time.Keeping muscles strong and flexible is key, as stopping exercise can undo progress[36].This study's insights contribute to developing sustainable exercise programs for the elderly, specifically aimed at managing and preventing stooped posture in the long term.

5. Conclusion –

The collective findings from these studies reinforce the potential of exercise-based interventions in addressing hyperkyphosis among older individuals. By incorporating targeted exercises into rehabilitation protocols, clinicians can help improve posture, enhance physical function, and potentially delay the progression of kyphotic deformities, thereby improving the quality of life for affected individuals.

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Conflict of Interest

Authors declare no conflict of interest.

Ethics Statement

The interventional study was acceptedby Institutional Human Ethics Committee of Krishna Institute of Medical Sciences, "Deemed to be University," Karad (Protocol number 058/2023-2024).

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