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Correlation between Thoracic Kyphosis and Shoulder Joint Position Sense among Health Care Workers

Eman Saad Nabih*, Enas Fawzy Youssef, Dina S. Abd Allah
Department of Physical Therapy for Musculoskeletal Disorders and its Surgery,
Faculty of Physical Therapy, Cairo University, Egypt
***Corresponding author:** Eman Saad Nabih, **Mobile:** (+20) 01019262991, **Email:** emansaad1228@gmail.com

ABSTRACT

Background: Healthcare workers especially those dealing with the patient and involved in physical demanding, intense and repetitive tasks in their practice are more predisposed to work-related musculoskeletal disorders (WMSDs). These WMSDs lead to prolonged postural abnormality and pain, which negatively affect productivity and quality of life.

Objectives: This study aimed to identify the correlation between thoracic kyphosis and shoulder joint position sense among healthcare workers.

Patients and methods: A cross-sectional observational study include forty-five participants of both gender with thoracic kyphosis detected by screening measurements at the start. Their ages ranged from 30-49 years old and their thoracic kyphotic angle (TKA) ranged according to age into 2 groups: (Group A) their ages ranged from 30 to 39 years old and (group B) their ages ranged from 40 to 49 years old. All subjects were right-handed. A bubble inclinometer is used to measure both TKA and joint position sense (JPS) of dominant arm among healthcare workers.

Results: There was a moderate correlation between thoracic kyphosis angle and shoulder flexion and abduction joint position error (JPE) at $r = 0.469$ & $p = 0.001$ and $r = 0.462$ & $p = 0.001$ respectively.

Conclusion: Thoracic kyphosis directly affects shoulder joint proprioception. Therefore, dorsal spine assessment should be considered during evaluation of shoulder joint and vice versa. So better control of the symptoms and better plan of treatment for preventing the potential disabling condition.

Keywords: Thoracic kyphosis, Thoracic mobility, Shoulder proprioception, Shoulder stability.

INTRODUCTION

Work related musculoskeletal disorders (WMSDs) have become common between healthcare workers especially those with high intensity work load [(1)], and those who adapting improper posture during the day such as physiotherapist, dentist, surgeon and nurses which increase the likelihood postural deformities and dysfunction [(2, 3, 4)]. One of these postural disorders is thoracic hyper kyphosis, which is an excessive posterior curve of the thoracic spine [(4)]. There is an anatomical relation between scapula and thoracic spine as scapula is resting on rib cage posteriorly. Therefore, any change of the thoracic curve beyond its normal ranges alters the scapular kinematics, the scapula will be in protraction, anterior tilting and downward rotation causing shoulder problems like subacromial impingement syndrome, which affects shoulder mobility and stability causing activity limitation and impede the quality of life [(5, 6)].

Most activities of daily living and recreational activities rely on joint position sense (JPS) to complete the task as it gives the majority of shoulder mobility. Proprioceptive deficit can lead to instability, pain and furthermore injury to the joint so it is important to assess JPS of shoulder joint as it affects quality of movement which hinders the working tasks and activity of daily livings [(7)]. As JPS has a substantial role in the maintenance of shoulder joint stability and upper extremity function. Numerous studies reported that there is a strong relationship between shoulder dysfunction and JPS as in case of shoulder instability and shoulder disorders (e.g. frozen shoulder, sub-acromial impingement syndrome) it was found that JPS markedly diminished [(8, 9)].

Many previous studies investigated the association between increasing thoracic kyphosis and shoulder range of movements, muscular strength, sub-acromial distance, and upper extremity function, and reported that there is an inverse relationship between thoracic hyper kyphosis and shoulder disorders [(5, 10-12)].

Regardless of the strong relationship between increased thoracic kyphosis and the shoulder complex, there are few high-quality studies required to fully explore the relation between thoracic kyphosis and shoulder joint position sense as it has vital importance in daily activities.

SUBJECTS AND METHODS

This study was a cross-sectional observational study. Participants were collected from El Andalusia Hospital in Alexandria, Egypt. The research was held between February 2023 to September 2023.

Subjects: forty-five participants of both genders with thoracic kyphosis detected by screening measurements at the start. The calculation of the sample size was done by G*Power statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany).

The minimum required sample size for this study is N=45. Calculation was made using $\alpha = 0.05$, power= 890%, and moderate effect size = 0.5 [(21)]. Participants were divided according to age into two groups as their thoracic kyphotic angle varies according to age [(13, 14)]: Group A ranged from 30 to 39 years old, and group B

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ranged from 40 to 49 years old. All participants were right-handed and from healthcare workers. Enrolment of the participants was only done if they matched the inclusion criteria.

Inclusion criteria: Age between 30 to 49 years, body mass index from 18.5 kg/m^2 to 29.9 kg/m^2 and TKA according to age, group A (30-39) years old, their TKA were more than 29.04 degree in males and 28.42 degree in females while group B (40-49) years old, their TKA were more than 29.75 degree in males and 32.66 degree in female [12, 13].

Exclusion criteria: Participants with neurologic disease, previous history of trauma of the dorsal spine or shoulder joint [22], previous history of balance or vestibular disorders, previous history of inflammatory disease or infectious disease or malignancy, previous surgery to the dorsal spine or shoulder joint, Participants with ankylosing spondylitis, thoracic spine fracture and with cervical or lumber disorders [23].

Measurement of TKA:

TKA was measured using two gravity-dependent bubble inclinometers (Baseline bubble inclinometer, Fabrication Enterprises Inc., White Plains, New York, USA) [15, 16]. The participants were measured in a relaxed standing position. One inclinometer was placed over the region of the 1st and 2nd thoracic spinous processes. The second inclinometer, over the region of the 12th thoracic and 1st lumbar spinous processes. To avoid errors, the therapist takes the measurements by each inclinometer 3 times and averaged the result. TKA is calculated by taking the total scores measured by the inclinometer placed across T1 and T2 (angle a) and the other one placed across T12 and L1 (angle b) [17].

Measurement of shoulder JPS:

This assessment was done to assess shoulder flexion and abduction JPS. Before the test session started, the participant's active range of motion (ROM) for shoulder flexion and abduction should be determined [18]. The therapist positioned the inclinometer on the dorsal side of the wrist joint for flexion JPS testing and on the volar aspect of the wrist joint for abduction JPS testing, and secured it with a Velcro strap. During measurements, participants were requested to maintain an upright posture with no back arching, simply a calm standing position. If there was any deviation or compensation from the participants' trunk during JPS measurements, the trial was repeated [18]. We also told participants to hold their forearms in a single plane during the JPS assessments. Immediately following these measurements, the participants were blindfolded and the JPS testing started [18, 22].

Proprioception testing: Remove 10% of the whole range of motion (flexion + extension or abduction + adduction) from the ROM being examined to calculate the target angle. We utilized a fraction of the whole range of motion so that each participant had the same relative target angle. The target angle was then considered as a reference point during the repositioning of the JPS testing [22]. The therapist moved the participant's arm to the target angle and held it for three seconds. The participants were then requested to relax and to restore the arm in its neutral posture at his or her side. Each participant was then instructed to deliberately return her/his arm to the target angle and notify the therapist when they believed she had replicated the initial target angle. The angle was then measured by holding the arm still. The repositioning was repeated three times for each movement (flexion and abduction), and the average scores were calculated. The discrepancy between the repositioning trial angle and the original target angle was known as joint position sense error (JPE) [18].

Ethical approval: The Institutional Review Board of Cairo University's Faculty of Physical Therapy gave ethical approval to this study (P.T.REC/012/004360). Written informed consents were taken from all participants. The study followed the guidelines outlined in the Declaration of Helsinki.

Statistical analysis

SPSS version 25.0 for Windows was used to perform all statistical measurements. Frequencies and relative percentages were used to depict qualitative data. To compare qualitative characteristics between groups, we used the χ^2-test. Quantitative data were presented as mean ± SD. For independent samples, t-test was performed to compare two independent groups of normally distributed variables. To compare subject characteristics as well as TKA and shoulder JPE between groups, an unpaired t test was used. To establish the relationship between TKA and shoulder JPE, the Pearson Correlation Coefficient was used. Statistical tests were set at $p \leq 0.05$ to indicate significance.

RESULTS

Subject characteristics:

Forty- five health care workers with thoracic kyphosis and age between 30 to 49 years participated in this study. Participant' characteristics were demonstrated in table (1). There was a significant increase in age of group B compared to age of group A ($p < 0.001$) while there was no significance difference in BMI and gender distribution between both groups ($p > 0.05$).

Table (1): Basic characteristics of participants

	Group A	Group B		
	Mean ± SD	**Mean ± SD**	**t-value**	**p-value**
Age (years)	33.94 ± 3.51	45.83 ± 2.90	-12.20	0.001
BMI (kg/m²)	29.05 ± 1.18	28.77 ± 1.71	0.57	0.57
Gender, n (%)				
Females	11(69%)	24 (83%)	(χ^2 = 1.17)	0.28
Males	5 (31%)	5 (17%)		

SD, standard deviation; χ^2, Chi squared value, p-value, probability value.

Comparison of TKA and shoulder JPE between group A and B: There was a significant increase in flexion and abduction JPE of group B compared to that of group A (P<0.001) (Table 2).

Table (2): Comparison of TKA and shoulder JPE between group A and B

	Group A	Group B			
	Mean ± SD	**Mean ± SD**	**Mean difference**	**t-value**	**p value**
TKA (degrees)	34.02 ± 3.36	37.72 ± 4.04	-3.7	-3.11	0.003
Shoulder JPE (degrees)					
Flexion JPE	3.38 ± 1.97	8.07 ± 2.35	-4.69	-6.74	0.001
Abduction JPE	2.80 ± 2.23	5.49 ± 1.85	-2.69	-4.34	0.001

Correlation of TKA and shoulder JPE of both groups: In total sample, there was a moderate positive significant correlation with flexion JPE (r = 0.469, p = 0.001) and abduction JPE (r = 0.462, p = 0.001) (Table 3).

Table (3): Correlation between TKA and shoulder JPE of both groups

		r value	p value	Sig
TKA (degrees)	**Flexion JPE (degrees)**	0.469	0.001	**S**
	Abduction JPE (degrees)	0.462	0.001	**S**

r value: Pearson correlation coefficient, P-value: Probability value, S: Significant.

DISCUSSION

The results of the current study revealed that there was a significant increase in TKA of group B compared to that of group A (p < 0.01). Besides, there was a significant increase in flexion and abduction JPE of group B compared to that of group A (p < 0.001). Thoracic kyphosis accompanied by structural postural changes, which appeared with progression of age result in alternation of scapular position and shoulder and scapular kinematics. Therefore, joint position sense is affected as a result of changes of muscle force, ligaments and joints. Accordingly, the more the thoracic kyphosis angle, the more the shoulder JPS error [14, 17]. This is supported by **Hinman** [19] who concluded that younger women have a greater active reduction of their kyphosis than older women. On the other hand, **Granito *et al.*** [10] proved that there was an inverse relationship between kyphotic angle and back extensor muscle strength and joint position sense in older women with osteoporosis than healthy individuals. This came in agreement with **Sinaki *et al.*** [11] **and Karimizzadeh *et al.*** [12] who reported a negative association between thoracic kyphosis angle and back muscle extensors strength, which in turn causes joint position sense error. They explained that joint position sense was affected by posture (signals come from muscles, joints and ligaments) and in case of thoracic hyper-kyphosis there is an impairment of the biomechanical alignment of the spine and muscle recruitment deficit of the trunk muscle supporting spine so improper signals coming from muscle and joints and so impaired proprioception [10, 11, 12].

Moreover, there was a moderate positive significant correlation with flexion and abduction joint position error in both groups. This significant result is supported by **Moustafa *et al.*** [20] who concluded that increased flexion of thoracic spine was correlated with discrepancies of many sensorimotor control measures like proprioception and postural control when he assessed the degree of dorsal kyphosis in relation to cervical sensorimotor control in patient with chronic non-specific neck pain.

From the result of the current study, it seems that subjects who had thoracic kyphosis higher than normal ranges, their shoulder joint position sense were affected. So, it is advisable for therapist to assess the dorsal spine mobility in case of shoulder problems. Also, it is advisable to put into the plan of treatment exercises to increase thoracic extension mobility and proprioceptive exercises to the shoulder joint. As, proprioception was considered an important component of stability of shoulder joint in many occupations especially healthcare workers including dentists, physiotherapists, surgeons and nurses.

CONCLUSION

It was concluded that thoracic kyphosis directly affects shoulder joint proprioception. Therefore, dorsal spine assessment should be considered during evaluation of shoulder joint and vice versa. So, better control of the symptoms and better plan of treatment for preventing the potential disabling condition.

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