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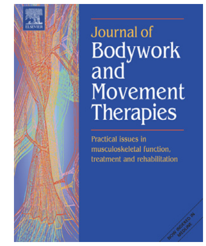


FUNCTIONAL ANATOMY

# Changes in sitting posture affect shoulder range of motion

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**KEYWORDS**
Thoracic kyphosis;
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**Summary** *Objective:* To assess the effect of slouched sitting on shoulder range of motion (ROM).
*Method:* 30 asymptomatic males aged between 18 and 35 years with no history of shoulder problems within the last 6 months. Shoulder ROMs in flexion and abduction as well as external rotation and internal rotation in 90° of shoulder abduction were measured while the subjects sat in 3 different sitting postures.
*Results:* There were statistically significant mean differences among the 3 sitting postures regarding thoracic kyphosis and shoulder ROMs ($p < 0.001$). *Post hoc* analyzes demonstrated significant differences in all comparisons ($p < 0.001$).
*Conclusion:* Changes in sitting posture affect shoulder ROMs in all directions tested. Greater changes in shoulder ROMs were associated with greater increase in thoracic kyphosis. These findings suggest that even subtle changes in thoracic kyphosis need to be considered during shoulder evaluation.


## Background

Shoulder problems are commonly found among the general population. It was found to be the second most frequently reported pain site among adults (Picavet and Schouten, 2003). The 12-month prevalence of shoulder complaints ranges from 4.7% to 46.7% (Choi et al., 2013; Luime et al., 2004; Picavet and Schouten, 2003). The lifetime prevalence varies from 6.7% to 66.7% (Luime et al., 2004). Many risk factors including work-related physical, psychosocial, and ergonomic factors are considered to contribute to the development of shoulder complaints. Poor posture, sustained muscle activity, and highly repetitive work at or

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above shoulder level have also been found to be associated with shoulder disorders (Bodin et al., 2012; Choi et al., 2013; Herin et al., 2012; van Rijn et al., 2010). Spinal alignment, especially thoracic curvature, is proposed to be critical for determining the scapular position which influences overall shoulder function.

With excessive thoracic kyphosis, the orientation of the scapula on the thorax is altered. A more anterior shoulder position and an increased forward head are also evident (Ludewig and Reynolds, 2009). In the elderly, it was found that subjects with severe thoracic kyphosis at rest had a narrower acromiohumeral distance (subacromial space) than those with less thoracic kyphosis (Gumina et al., 2008). However, the difference in acromiohumeral distance between the impinged and healthy shoulders tends to be obvious during shoulder movement. Significant difference in acromiohumeral distance is observed when the shoulders are flexed or abducted more than 80° (Hebert et al., 2003). These findings possibly affect shoulder ROMs above shoulder level.

It was found that excessive thoracic kyphosis could alter scapular kinematics which affected shoulder ROMs. With increased thoracic kyphosis, the scapula is in less posterior tilt and less external rotation during shoulder abduction along the scapular plane (Finley and Lee, 2003; Kebaetse et al., 1999). Active shoulder abduction ROM becomes less in the slouched posture (mean difference = 15°–24°) (Kebaetse et al., 1999; Lewis et al., 2005). The decreased ROM is more significant in symptomatic subjects with subacromial impingement syndrome. The shoulder flexion ROM in the sagittal plane between the erect and maximum slouched postures is found to decrease with a mean difference of 16°–18° (Bullock et al., 2005; Lewis et al., 2005). As a result, several studies often recommend interventions that correct the alignment of thoracic kyphosis for treatment of shoulder pain.

The majority of previous studies investigated the maximum slouched posture or maximal thoracic kyphosis. In general, it is unlikely an individual will continuously assume extreme thoracic kyphosis while performing normal daily activities. In fact, poor posture in moderate thoracic kyphosis is more common. However, the effects of moderate thoracic kyphosis associated with a comfortable slouched posture on shoulder ROMs have not been fully examined. Therefore, the aims of this study were to investigate the effects of the comfortable slouched sitting on shoulder ROMs and to ascertain whether the shoulder ROMs in the comfortable slouched sitting differ from those in the erect and maximum slouched sittings.

## Method

### Design

A same-subject repeated measures design was used to examine whether different sitting postures influence shoulder ROMs. This study was approved by the Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University. Informed consent was obtained from all subjects prior to testing.

### Participants

Thirty asymptomatic males aged between 18 and 35 years were recruited by convenience sampling. This sample size allowed for a 5% chance in incorrectly and an 80% chance in correctly accepting the nonsignificant differences in shoulder ROMs among the 3 sitting postures. The minimum clinically significant difference in shoulder ROMs between sitting postures was set at 20° (estimated from Bullock et al., 2005; Kebaetse et al., 1999). Subjects had no history of shoulder problems within the last 6 months and were excluded on the basis of the clinical examination. Subjects with positive signs on the Neer and Hawkins–Kennedy tests as well as pain on palpation of the rotator cuff tendons were excluded.

Four researchers involved in the measurement. The first researcher conducted the moulding of the flexible ruler on the subject's thoracic spine. The second researcher transferred the thoracic curve onto paper and calculated the thoracic kyphosis. The third researcher performed the goniometric measurement for shoulder ROMs. The fourth researcher who stood outside the testing area behind a curtain during the test read the number on the panel of the goniometer. This procedure aimed to blind the fourth researcher to the shoulder movements being tested.

The subjects were asked to take their shirts off and sit on a stool without backrest. Three sitting postures were tested sequentially, i.e. erect, comfortable slouched, and maximum slouched postures. Postures were achieved by using standardized verbal commands. Once the subjects acquired the posture, a controller which could be adjusted in horizontal and vertical directions was adjusted so that it lightly touched the subject's sternum (Fig. 1). This was to prevent the subjects from changing their postures during testing. Next, a flexible ruler was moulded onto the subjects' thoracic spine from the spinous processes of C7 to T12 in order to determine the amount of thoracic kyphosis of each sitting posture.

In each sitting posture, the subjects were asked to maximally move their right shoulder in 4 directions: flexion, abduction, external rotation, and internal rotation in 90° of shoulder abduction. The sequence of shoulder movement was randomly assigned using the balanced Latin square (Portney and Watkins, 2000). In order to avoid fatigue, a 10-second rest was incorporated between shoulder movements while a 1-minute interval was allowed between sitting postures.

### Outcome measures

The degrees of thoracic kyphosis were determined by the flexicurve method (Teixeira and Carvalho, 2007). This method was selected as it was practical and low cost with acceptable validity and reliability for clinical use. A flexible ruler was moulded onto the subject's thoracic spine from the spinous processes of C7 to T12. Then, it was removed from the subject's back while its shape was being maintained so that its contour could be immediately drawn on a piece of paper. With a specific formula, the distances of C7 and T12 spinous processes were measured and calculated in order to obtain the value of thoracic kyphosis. This