RESEARCH PAPER

Validity and reliability of a thoracic kyphotic assessment tool measuring distance of the seventh cervical vertebra from the wall

Pipatana Amatachaya, PhD [a,b], Sawitree Wongsa, MSc [a,c],
Thanat Sooknuan, M. Eng. [a,d],
Thiwabhorn Thaweewannakij, PhD [a,c],
Maneepan Laophosri, MSc [a,e],
Nuttaset Manimanakorn, MD, PhD [a,e],
Sugalya Amatachaya, PhD [a,c,*]

[a] Improvements of Physical Performance and Quality of Life (IPQ) Research Group, Khon Kaen University, Khon Kaen, Thailand
[b] Department of Mechanical Engineering, Faculty of Engineering and Architecture, Rajamangala University of Technology Isan, Nakhonratchasima, Thailand
[c] School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, Thailand
[d] Department of Electronics Engineering, Faculty of Engineering and Architecture, Rajamangala University of Technology Isan, Nakhonratchasima, Thailand
[e] Department of Rehabilitation Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

Abstract *Background*: In primary healthcare (PHC) service, community residents, village health volunteers (VHVs), and healthcare professionals need to work in partnership to facilitate universal and equitable healthcare services. However, these partnerships may need an appropriate tool helping them to execute an effective health-related activity.
Objectives: To investigate the reliability and validity of a simple kyphosis measure using a perpendicular distance from the seventh cervical vertebra (C7) to the wall (C_7WD).
Methods: Elderly people with different degrees of kyphosis ($n = 179$) were cross-sectionally investigated for the intra- and interrater reliability of the measurement by a physical therapist (PT), VHV, and caregiver. The validity was assessed in terms of concurrent validity as compared with the Flexicurve, and discriminative validity for functional deterioration in participants with mild, moderate, and severe kyphosis.

* Corresponding author. School of Physical Therapy, Faculty of Associated Medical Sciences, Khon Kaen University, Khon Kaen, 40002, Thailand.
E-mail address: samata@kku.ac.th (S. Amatachaya).

Results: The method showed excellent reliability among PT, VHV, and caregivers (ICC > 0.90, $p < 0.001$), and excellent correlation to the data from the Flexicurve. Results of the assessment were greater than a level of minimal detectable change and could clearly discriminate functional deterioration in participants with different severity of kyphosis ($p < 0.001$).

Conclusion: C_7WD is valid and reliable, thus it can be used to promote the standardisation of kyphosis measures among PHC members.

Introduction

Structural kyphosis, a condition with rigidity and functional stiffness of the spinal curvature, is commonly found at a thoracic region and in older people (20—40%) [1,2]. It is characterised by a sagittal or backward deviation of the thoracic spine exceeding 50° [3]. The abnormality can affect adjacent structures such as restricted pulmonary functions; induced back pain, digestive problems, and risk of spinal fracture; and reduced ability of balance control due to the forward shift of the body centre of mass [3—5]. Thus it superimposes negative impacts on levels of functioning of older individuals, their quality of life and mortality rate [6,7]. Therefore, apart from treatments, an effective and practical measure is important to early detect the abnormality and minimize the harmful consequences, indicate effectiveness of the treatments, and improve standardisation of a monitoring and referring method of the kyphosis [8,9].

Presently, kyphosis can be measured using invasive and noninvasive methods, in which most of them are executed by a health-professional. Among the noninvasive methods, the Flexicurve has been suggested as a practical and valuable tool to monitor the changes of spinal curvature over time, due to the consequences of age and deterioration process [3,4,10—13]. Outcomes of the measurement are accurate and reliable compared with the findings derived from the DeBrunner's kyphometer and Cobb's method ($r = 0.98$) [13,14]. However, a landmark for the measurement, in particular the 12th thoracic vertebra (T12), may be difficult to identify, and the malleable band of the Flexicurve can change its shape once removed from the spine. Thus the method is susceptible to error, and should be used by a well-trained health professional [3,4].

In a community, primary healthcare (PHC) is an important strategy for universal access to healthcare services, in which community residents, community health workers [or village health volunteers (VHVs) in Thailand], and healthcare professionals need to work in partnership to achieve universal and equitable access to the healthcare system in their communities [15]. However, this partnership may need an appropriate technology or equipment helping them to execute an effective health-related activity.

In epidemiologic studies, severity of kyphosis can be easily quantified using a perpendicular distance from the bony prominence of the seventh cervical vertebra (C7) or occiput to a wall while standing against the wall as the so-called occiput—wall distance (OWD) [7,16]. However, there was no clear evidence to support its validity and reliability. Thus this study investigated: (1) the intra- and interrater reliability of the kyphosis measure using a perpendicular distance from C7 to the wall (C_7WD) when assessed by a healthcare professional, VHV, and caregiver; (2) the concurrent validity of the method using the Flexicurve as a standard method; and (3) discriminative validity of the results to determine functional deterioration in older people with various degrees of kyphosis. Findings of the study may promote the standardisation of kyphosis assessment and monitoring among PHC members.

Methods

Study design and participants

Older people, age ≥ 60 years, with a body mass index (BMI) between 18.5 kg/m² and 29.9 kg/m² were cross-sectionally recruited from several communities in the northeast areas of Thailand, during January—December 2014. The individuals were recruited if they had various degrees of structural kyphosis in the thoracic area without any signs and symptoms that might affect participation in the study such as using a walking device, and having pain or inflammation in the muscles or joints, other spinal or limb deformities (i.e., scoliosis and leg length discrepancy), and abnormal fat distribution, mass, or tumour in the upper back area. The research protocol was approved by the Office of the Khon Kaen University ethics committee in human research (HE 542111). The participants provided a written informed consent prior to participation in the study. Figure 1 illustrates patients' participation flowchart.

Reliability assessments

Walter et al [18] have provided estimates for sample size requirements for reliability studies using intraclass correlation coefficients (ICC). For a true p_0 of 0.4 (minimally acceptable level for 3 raters) against an alternative p_1 of 0.7, based on a 5% significance level and a power of 80% (β = 0.20), the study required 21 participants [17,18]. Details of the reliability assessments are as follows.

Kyphosis measured using the distance from the wall
The intra- and interrater reliability of the C_7WD was investigated using three raters, including a PT (a master degree student), VHV (51 years old who had 3 years working