



Title registration for a systematic review: **Back shape/posture is associated with balance, falling, and fear of falling in older adults with hyperkyphosis: a systematic review**

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Title of the review

The relationship between back shape/posture, balance, falling, and fear of falling in older adults with hyperkyphosis: a systematic review

Background

Age-related hyperkyphosis, an excessive anterior curvature of the thoracic spine, is the most common spinal deformity in older adults (Katzman, Wanek, Shepherd, & Sellmeyer, 2010). It is characterised by an increase in the anterior thoracic spinal curvature when the kyphosis angle reaches the critical angle of 40° as measured using the Cobb method (Fon et al., 1980; Roghani, Zavieh, Manshadi, King, & Katzman, 2017; Voutsinas & Macewen, 1986).

The estimated prevalence of hyperkyphosis has been reported to be 20% - 40% for the older adult population aged over 60 years (Kado, Huang, Karlamangla, Barrett-Connor, & Greendale, 2004; Ryan & Fried, 1997; Takahashi et al., 2005). This deformity affects both sexes, particularly women aged over 55 years (Huang, Barrett-Connor, Greendale, & Kado, 2006; Katzman et al., 2010), regardless of vertebral fractures, with the incidence increasing 6 - 11% for every 10 year increase in age (Huang et al., 2006).

Hyperkyphosis also has been associated with impaired pulmonary function, function limitations, decreased balance, falls, fractures, a decreased quality of life, increased premature death and mortality as well as is an indicator of the negative impact on health outcomes. (Ailon, Shaffrey, Lenke, Harrop, & Smith, 2015; Kado, 2009; Milne & Williamson, 1983, Kado, Prenovost, et al., 2007). Accentuated thoracic kyphosis had a significant effect on upright posture. That is attributed to a change in the centre of gravity of the body at levels close to the limits of stability that can lead to impaired balance and increased risk of falling (Hsu, Chen, Tsauo, & Yang, 2014; Lynn, Sinaki, & Westerlind, 1997). However, inconclusive results are available regarding the relationship between kyphosis, balance, falls and fear of falling.

Numerous studies have suggested an association between excessive thoracic kyphosis and balance (Lynn et al., 1997; Regolin & Carvalho, 2010; Sinaki, Brey, Hughes, Larson, & Kaufman, 2005). Lynn et al. (1997) reported that participants with osteoporosis that presents together with kyphosis have greater postural sway compared to either participants with osteoporosis on its own or normal participants. Sinaki et al., (2005) demonstrated that women with hyperkyphosis had significantly more body sway than healthy older women. Furthermore, Regolin & Carvalho, (2010) reported that whilst thoracic hyperkyphosis influenced postural

sway in the antero-posterior direction in 95 older adults women with mean aged 67.2 ± 5.01 years, they did not find an increase in sway in the medio-lateral direction.

In contrast to the aforementioned studies above, several studies (Eum et al., 2013; Greig, Bennell, Briggs, Wark, & Hodges, 2007; Ishikawa, Miyakoshi, Kasukawa, Hongo, & Shimada, 2009) have suggested that there was no relationship between kyphosis and balance. Eum et al. (2013) determined that the association with functional balance of having an increased kyphosis as evaluated by the flexicurve ruler among community-living older women and men. The results from this study demonstrated that there was no relationship between an increased kyphosis angle and the Berg balance score in the older adults. Further, Greig et al., (2007) conducted a study to examine the effects of having a vertebral fracture together with thoracic kyphosis on standing balance. The researchers found that having a vertebral fracture in the spine is associated with impaired balance in participants with osteoporosis but not thoracic kyphosis. Moreover, Ishikawa et al. (2009) investigated the influence of having thoracic spinal curvature as measured using the SpinalMouse® on postural balance in 93 patients with osteoporosis. The authors demonstrated that there was no significant correlation between postural balance and the kyphosis angle.

Hyperkyphosis also predisposes people to falls (Kado, Huang, et al. 2007; Sinaki, et al., 2005). There is a dearth of studies that have examined the correlation between kyphosis, falls and fear of falling (Arnold, Busch, Schachter, Harrison, & Olszynski, 2005; Kado, et al, 2007; Tominaga et al., 2016; Van der Jagt-Willems, de Groot, van Campen, Lamothe, & Lems, 2015). Tominaga et al. (2016) and Arnold et al. (2005) reported that there was a significant association between a severe kyphotic posture and falls in older adults. Nevertheless, then Kasukawa et al. (2010) and Ishikawa, Miyakoshi, Kasukawa, Hongo, & Shimada (2013) investigated the relationship between thoracic kyphosis, lumbar kyphosis and falls. Controversially, these researchers posited that elderly people who had a lumbar kyphosis but not a thoracic kyphosis were associated with falls.

Conversely, McDaniels-Davidson et al. (2018) reported that older adults with a greater kyphosis angle were likely to have a greater number of falls than older adults who had a less kyphotic spine. In brief, the current available evidence regarding the relationship between increased thoracic kyphosis, balance, falls and fear of falling in elderly people with hyperkyphosis is both controversial and inconclusive.

These controversial and inconclusive results observed within the above studies describing the association of an accentuated thoracic kyphosis with balance, falls, and fear of falling may be due to several reasons. A possible explanation for the difference in the results from the studies discussed above may be due to the different approaches used to measure of the

kyphosis angle and balance test, the heterogeneity of the study participants as well as the small sample sizes and small proportion of men participating in previous research papers.

Understanding of back shape/posture associated with balance, falls, and fear of falling would be helpful for screening patients at risk of fall and prevent falls associated with hyperkyphosis. The present review focused on evidence the available evidence on the relationship between back shape/posture, balance, falling and fear of falling in older adults with hyperkyphosis.

Policy relevance

In 2013 the National Institute for Health and Care Excellence (NICE) published clinical guidelines regarding the assessment of risk as well as the prevention of falls in older people for health care and other professionals. According to the guideline recommendations, the multifactorial screening for falls risk in older adults who present for medical attention includes cognitive impairment, continence problems, falls history (causes and consequences), gait abnormalities, balance problems, mobility problems, muscle weakness, osteoporosis risk, older person's perceived functional ability, fear relating to falling, visual impairment, cognitive impairment, neurological examination, urinary incontinence, home hazards, cardiovascular examination, and medication review.

However, the assessment of back shape/posture is not currently included in this guideline/or policy for multifactorial falls risk assessment. There is need for a systematic review to gather existing research evidence on the relationship between back shape/posture, balance and falls as well as fear of falling. The importance of these results lies in the fact that if there is a relationship between hyperkyphosis, balance and falls that is could potentially be included within this guideline/or policy.

Objectives

Is back shape/posture related to balance, falling and fear of falling in older adults with hyperkyphosis?

Existing reviews

A scoping literature review identified four narrative reviews that discussed the terminology, aetiology, adverse health consequences, as well as the treatment of hyperkyphosis in older adults (Ailon, Shaffrey, Lenke, Harrop, & Smith, 2015; Kado, Prenovost, et al., 2007;

Katzman et al., 2010; Roghani et al., 2017). Ailon et al. (2015) discussed the pathogenesis together with the evaluation, and treatment of thoracic hyperkyphosis in older adults. Kado and Prenovost, et al. (2007) reported the definition, potential causes, adverse health consequences, the measurement of thoracic kyphosis, as well as the management of thoracic hyperkyphosis. Katzman et al. (2010) reviewed the evidences with regards to the definition, prevalence, aetiology, assessment of thoracic kyphosis, clinical consequences, risk factors, as well as treatment of thoracic hyperkyphosis. In addition, Roghani et al. (2016) analysed the definition, contributing factors and health implication of age-related hyperkyphosis.

However, the reviews were not performed systematically and did not assess methodology quality of the research studies. Assessment of the study quality is important due to answer the question of whether the studies are robust enough to guide treatment, prevention, diagnostic or policy decisions. One systematic review by Fernandes, Ribeiro, Fernandes, & Menezes (2018) determined whether postural changes increase falls risk and/or balance in adults 60 years and older. The researchers concluded that postural changes (thoracic hyperkyphosis, loss of lumbar kyphosis, as well as decrease plantar arch) appear to contribute to the increase falls risk and/or balance in adults; however, that review do not include fear of falling outcome and had numerous of methods used to assess back posture and balance. In addition, to the authors' knowledge, no systematic review has evaluated the relationship between the back shape/posture (thoracic hyperkyphosis and lumbar lordosis), balance, falling, and fear of falling in older adults with hyperkyphosis. This review will contribute towards increasing understanding how back shape/posture affect balance, falling, and fear of falling in older adults. A systematic review in this topic is therefore, urgently needed.

Exposure

Exposure in this systematic review is hyperkyphosis. Hyperkyphosis also known as dowager's hump is defined as an excessive anterior curvature of thoracic spine, a kyphosis angle greater than 40° when measure with the Cobb method (Fon et al., 1980; Voutsinas & Macewen, 1986). Other spinal deformities such as scoliosis, kyphoscoliosis, Scheuermann's kyphosis and congenital kyphosis were excluded.

Population

Studies will be included if participants are male or female older adults who are 50 years or older. Studies will be excluded if participants are adults who are aged under 50 years, or children.

Outcomes

Back shape and back posture (such as cervical lordosis angle, thoracic kyphosis angle, lumbar lordosis angle, angle of trunk rotation etc.) are any sometimes used interchangeable, however the exactly meanings are slightly different. Bettany-Saltikov, Kandasamy, Czaprowski, & Stolinski (2017) defined back shape as the study of the back's surface shape, whereas back posture which a focused on the word "Posture" is provided by the American academy of orthopedic surgeons as "the state of muscular and skeletal balance which protects the supporting structures of the body against injury or progressive deformity irrespective of the attitude in which these structures are working or resting. Under such conditions, the muscles will function most efficiently and the optimum positions are afforded for the thoracic and abdominal organs" (Kendall Peterson, McCreary Kendall, Provance Geise, & McIntyre Rodgers, 2005). For, the assessment of back shape and posture three reference planes: sagittal, coronal, and transverse will be included.

Secondly, balance can be defined as the ability to maintain the body's centre of mass in relation to the base of support (Shumway-Cook & Woollacot, 2007). Balance in the standing position is divided into static balance and dynamic balance (Ragnarsdóttir, 1996). This study focused on postural sway (static balance) and the limits of stability (dynamic balance). Postural sway is defined as the movement of the centre of mass in quiet standing and can be measured as either an anteroposterior and mediolateral displacement (Horak, 2006). The limits of stability is defined as the maximum range in which the centre of gravity can move safely without moving the feet and without falling (Alexander, 1994).

Finally, risk of falls (i.e. fear of falling or history of falls or accidental falls) will be included in this review. Fear of falling is defined as older people lose confidence in participating in activities of daily living and functioning (Tinetti & Powell, 1993) while falls are defined as history of falls at least one fall in the past year.

Study designs

To qualify for this review. Research designs will include cross-sectional studies, longitudinal studies, case control studies, cohort studies and controlled trial studies. This review will use quantitative studies to examine the association between kyphosis angle, lumbar lordosis, history of falls, and fear of falling in older adults with hyperkyphosis.

Experimental studies; Randomized controlled trial studies (RCT), quasi experimental and qualitative studies will be excluded.

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Roles and responsibilities

Content and systematic review methodology: Mrs Roongtip Duangkaew, PhD student at Teesside University will be carrying out the research with the support of the rest of the team. She qualified as a physiotherapist and has been working as a lecturer of physiotherapy at the Department of Physical Therapy, Faculty of Allied Health Sciences, Thammasat University, Thailand for over seven years. She has also taught research methods and clinical physiotherapy work as well as student supervision.

Systematic review methods and content knowledge: Dr Josette Bettany-Saltikov will bring significant expertise of systematic review methods and content to this systematic review, both in terms of knowledge about back shape/ posture, balance, falling and fear of falling in older adults. She has taught systematic review methods to university students at all levels for over 15 years. She has also published a book on how to conduct a systematic review and has been involved in four Cochrane reviews one of which she led. She has authored a number of systematic reviews on diverse topics published in other journals and has significant experience of developing educational programmes from her teaching experience for 23 years as a university Senior lecturer. She also has further content expertise related to the management of back conditions. Josette originally qualified as a

physiotherapist and has been interested in the area of back shape/ posture and balance maintaining back health in and adolescents for over 25 years.

Statistical analysis: Prof. Paul van Schaik will contribute expertise in behavioral science in the context of education. He has extensive experience in advanced statistical data analysis in behavioral research and in behavioral measurement, including the analysis of psychometric questionnaires. His academic work has been recognized for international and national excellence. Paul will direct the analysis of literature with regard to instructional design of educational interventions. He has also been awarded the highly prestigious National Teaching Fellow award in the UK.

Content: Mr Gok Kandasamy will be bring both methodological as well as content expertise relating to back shape in clinical setting. He has over 15 years of experience in higher education, and has held a number of responsibilities which include: Clinical Consultancy, developing an international partnership, teaching and leading at BSc and MSc Physiotherapy and Sports Therapy Programmes. His area of expertise is around development and evaluation of low-cost 3D imaging, mobile, surface topography APP for measuring 3D back shape in a clinical settings.

Information retrieval: Mrs Julie Hogg brings Information retrieval expertise to the team. Julie is an Academic Librarian at Teesside University and will give advice in the search strategy.

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Potential conflicts of interest

None of the team members have any conflicts of interest in the review, nor have any team members been involved in any other systematic review focused on this topic.

Preliminary timeframe

- Date you plan to submit a draft protocol: June 2019
- Date you plan to submit a draft review: January 2020