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### Understanding why the thoracic region is the 'Cinderella' region of the spine

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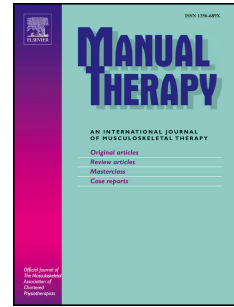
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# Accepted Manuscript

Understanding why the thoracic region is the 'Cinderella' region of the spine

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**Title**

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**Abstract**

The thoracic spine has for a long time been the 'Cinderella' region of the spine. There has been a lesser research focus to the thoracic region compared with the cervical and lumbar spine, and there continues to be a limited understanding of the aetiology and epidemiology of a range of neuromusculoskeletal presentations which have an anatomical connection to the thoracic spine. This paper firstly, provides a critical evaluation of the available evidence to provide some understanding for this under-exploration of the thoracic spine. Secondly the paper provides an evaluation of an emerging interest in this spinal region, with a body of evidence supporting the use of thoracic spine manipulation in the management of upper quadrant presentations. This has been linked to the theory of regional interdependence with the thoracic spine being viewed as a silent contributor to clinical presentations where a pain source lies elsewhere. Finally, a case for further research is made. Identified gaps in the current evidence base include, aetiology and epidemiology of thoracic spine pain and thoracic spine dysfunction, and to investigate mechanisms of action of currently used interventions.

## Introduction

The thoracic spine has for a long time been the 'Cinderella' region of the spine. Since the introduction of the *Manual Therapy* journal in 1995, there have been only 132 articles with 'thoracic spine' in the title and abstract, compared with 409 and 263 for the 'cervical' and 'lumbar' spines respectively. This paucity of evidence parallels a limited understanding of the aetiology and epidemiology of a range of neuromusculoskeletal presentations which have an anatomical connection to the thoracic spine (Briggs et al., 2009). This paper provides a critical evaluation of the under-exploration of the thoracic region, evaluates an emerging area of interest and makes a case for further research.

An under-explored region

Clinically, thoracic spine pain occurs between the levels of C7-T1 and T12-L1 and is often, but not exclusively, associated with pathologies such as osteoporosis, osteoarthritis, Scheurmann's disease and ankylosing spondylitis (Briggs et al., 2009). Managing these pathologies accounts for some of the 5% of patients presenting in outpatient physiotherapy with thoracic spine pain (van Kleef, 2010). Epidemiological data for thoracic spine pain in the general population is extremely limited. One study of a Norwegian population, found a one year estimate of thoracic spine pain prevalence of 13% compared with 43% and 44% for low back and neck pain respectively (Leboeuf-Yde et al., 2009). In a further study, lifetime prevalence data for thoracic spine pain ranged from 3.7 to 77% (Briggs et al., 2009), with the range reflecting a population of predominantly teenagers and older female adults. Recent research investigating a working population in France reported an incidence of isolated thoracic spine pain of 5.2 (95% CI 3.9 to 6.6) per 100 men and 10.0 (95% CI 7.8 to 12.1) per 100 women (Roquelaure et al., 2014). The

researchers also explored the co-existence of thoracic spine pain with neck and/or low back pain, reporting an association of 40.7% in men and 36% in women. This compares with isolated thoracic spine pain which was 18.7% in men and 16% in women (Roquelaure et al., 2014).

Whilst clinical practice focuses on identifying and managing the source of a patient's symptoms, the biopsychosocial model of practice promotes an evaluation of factors which extend beyond a symptom source. Whilst current data regarding thoracic spine pain (Briggs et al., 2009; Leboeuf-Yde et al., 2009; van Kleef, 2010; Roquelaure et al., 2014) does not in itself suggest that the thoracic spine impacts significantly on healthcare resources, the region may add to the economic burden as a 'silent' contributor (Sueki et al., 2013). Given its anatomical relationship to the shoulder, neck and low back, the term 'regional interdependence' has been adopted to describe how functional movement in one region depends on movement in a seemingly unrelated region (Sueki et al., 2013). Clinically, movement dysfunction in one region may underlie a primary complaint of symptoms in another, for example, shoulder pain secondary to a mechanical restriction in the thoracic spine where thoracic spine extension is required for full shoulder elevation (Edmondston et al., 2012). The contribution that the thoracic spine makes to functional movement in the upper and lower quadrants has not yet been widely investigated, perhaps attributable to a lack of perceived need and funding, where the economic and social burden of managing musculoskeletal problems such as 'nonspecific low back pain' and 'whiplash associated disorder' have fuelled research into the lumbar and cervical regions respectively.

The anatomical design of the thorax (vertebral bodies, ribs, clavicle and manubrium sternum) provides support and structural protection to vital internal organs (Edmondston and Singer, 1997), yet offers little mobility in the sagittal (flexion 32.00-degrees, extension 25.80-degrees)

and frontal planes (lateral flexion 26.50-degrees) Willems et al., (1996). The largest range of movement is that of axial rotation with a mean (SD) total range (full right and left rotation) of  $85.15 \pm 14.8$  degrees (Heneghan et al., 2009). Being the longest and most anatomically complex spinal region has likely hampered the development of measurement tools to assess thoracic movement (Heneghan et al., 2009). Unlike movement analysis in the cervical and lumbar region, where the cervical range of movement device (Audette et al., 2010) and modified-Schober test (Tousignant et al., 2005) respectively provide reliable and valid non-invasive and clinically useful tools, movement analysis of the thoracic region has relied on gross measures of thoracolumbar movement (Johnson et al., 2012), expensive equipment (Willems et al, 1996; Theodordis and Ruston, 2002; Edmondston et al., 2007), and/or imaging technologies (Cagnie et al, 1999; Kouwenhoven et al, 2006; Heneghan et al., 2009).

An emerging area of interest

Clinical interest in the thoracic spine has grown despite a lack of evidence supporting interventions targeting a primary symptom source in the thoracic spine. With many systematic reviews concluding at best, weak evidence to support many physiotherapy interventions targeting a primary pain source in an adjacent region e.g. exercise for neck pain (Kay et al., 2015), physiotherapy for adhesive capsulitis (Page et al., 2014), perhaps it is time to further consider and investigate the aetiology of common musculoskeletal presentations, and possibility that sub-clinical movement dysfunction in one region contributes to persistent or chronic pain in another. In support of this, Berglund et al., (2008) reported that 70% of patients presenting with lateral elbow pain had coexisting thoracic pain, compared with 16% ( $p < 0.001$ ) in a control group comprising healthy individuals. Based on this, the authors concluded that

examination of the cervical and thoracic spine should be included in patients presenting with lateral elbow pain.

Thoracic spine manipulation is considered a management option for patients with symptomatic neck and shoulder complaints (Walser et al., 2009). Partly driven by lower perceived risks associated with thoracic spine manipulation compared with cervical manipulation, studies have reported favourable and promising results. In a systematic review of trials, where 7/13 were rated fair or high risk of bias, thoracic spine manipulation was found beneficial for neck pain with a pooled effect size of 1.33, (95% Confidence interval: 1.14, 1.52) (Walser et al., 2009). These findings were also replicated in recent studies (Muth et al., 2012; Huisman et al., 2013; Casanova-Mendez et al., 2014; Haik et al., 2014; Salom- Moreno, et al, 2014). Whilst the underlying mechanisms of clinical effect are not well understood, it could be hypothesised that given the target tissue for the thrust techniques was predominantly the upper thoracic spine at levels T1-4 (Cleland et al., 2007), T4 (Casanova-Mendez et al., 2014), and T3-6 (Salom- Moreno, et al, 2014), improvements are partly attributable to improved biomechanics. This lends some support for the theory of regional interdependence (Sueki et al., 2013). With functional movement comprising movement from more than one region, interventions targeting asymptomatic, but possibly dysfunctional structures may result in a reduction in symptoms in the region of the primary complaint of pain. Thus in deriving clinical hypotheses during examination, the thoracic spine may be considered a contributing factor within a clinical presentation of shoulder or neck pain. A plausible explanation for this effect is that tissue stress in the symptomatic region is relieved through optimising movement throughout a functional movement chain. For example, movement at T1, T6 and T12 has been recorded as occurring during all cervical movements (Tsang et al., 2013), and excursion from



full cervical protraction to retraction has been recorded to involve a 30% and 10% contribution from levels C7-T4 and T5-12 respectively (Persson et al., 2007).

#### The case for further research

The gaps in the evidence base necessitate a better understanding of the aetiology and epidemiology of thoracic spine dysfunction, the social and economic burden of thoracic spine pain and dysfunction, and the mechanisms of action of manipulation. With limited prevalence data and information concerning risk factors for the development of thoracic spine pain (Briggs et al., 2009), further research is required to understand the contribution that thoracic spine dysfunction may have on functional movement. Interestingly, whilst significantly different levels of pain prevalence exist in the thoracic spine, disability has been reported to be comparable with that of other spinal regions (Occhipinti et al., 1993). A large Canadian cohort study identified thoracic spine pain as a significant predictor of failure to return to work for men presenting with low back pain in primary care, with an odds ratio of 7.00 (95% confidence interval 1.19-41.21) (Dionne et al., 2007).

Prolonged sitting or physical inactivity, an epidemic of the western world, has been identified as a risk factor for the development of work related neck symptoms (Cagnie et al., 2007) and thoracic spine pain in men (Briggs et al., 2009). Whilst authors propose an array of risk factors for the development of pain beyond simply sustained postures, such as the repetitive nature of task, psychological stress, etc. (Cagnie et al., 2007) further research is required to understand the effect of prolonged sitting on the thoracic spine. Prolonged periods of relative immobility and sustained loading may result in adaptive soft tissues changes and altered disc biomechanics, although evidence to support this is currently lacking. With the widespread use

of mobile phones, game consoles, home PCs, and the scope of television entertainment, it is possible that there will be many more complaints of neck and/or shoulder pain in the future. Clinicians need to consider that these presentations may be secondary to reduced thoracic mobility, with a resultant increase in tissue stress in the shoulder and neck regions resulting in local symptoms.

With the theory of regional interdependence gaining recognition as a rationale to support intervention studies targeting the thoracic spine for patients with neck and shoulder complaints (Sueki et al., 2013), and recent reviews of clinical trials reporting favourable results for such interventions (Walser et al., 2009), there is a need to understand the underlying mechanisms for the effects beyond a broad, but as yet unsupported, biomechanical effect (Sueki et al., 2013). Some evidence for a neurophysiological effect exists (Bialosky et al., 2009; Walser et al., 2009). However, in the absence of evidence of a biomechanical effect, beyond the existence of cavitation occurring during spinal manipulation (Ross et al., 2004) conclusions cannot be drawn as to the biomechanical contribution. To investigate evidence of a biomechanical effect measurement tools are required to evaluate range of movement. In turn, movement analysis is dependent on having measurement tools that can accurately measure *in vivo* thoracic spine movement, which is yet to be established for use in clinical practice. Until recently many of the measurement techniques have relied on skin sensors, although skin tissue artefact undermines the validity of such approaches (Heneghan et al., 2010). Recently, measurement has progressed in the research environment as Heneghan et al., (2009) used ultrasound imaging in conjunction with movement analysis to quantify thoracic axial rotation. The ability to image the underlying bony tissue gives confidence that the measurements are of the bony tissue, providing a useful technique to advance our understanding of movement analysis and effectiveness of interventions used in this region.

To conclude, this paper has analysed why the thoracic spine has justifiably been known as the 'Cinderella' of the spine. However, it is hoped that through an exploration of the issues contributing to this, clinicians and researchers alike will be energised to further consider the thoracic spine as a silent contributor to clinical presentations where a pain source lies elsewhere. For researchers, there are an infinite number of research projects waiting, which will in due course provide a better understanding of this spinal region in terms of aetiology, epidemiology, and mechanisms of action of currently used interventions.

Word count 1886

**Reference list**

- Audette I, Dumas JP, Côté JN, De Serres SJ. Validity and between-day reliability of the cervical range of motion (CROM) device. *J Orthop Sports Phys Ther.* 2010; 40 (5):318-23.
- Berglund KM, Persson BH, Denison E. Prevalence of pain and dysfunction in the cervical and thoracic spine in persons with and without lateral elbow pain. *Manual Therapy.* 2008; 13(4): 295-299
- Bialosky JE, Bishop MD, Price DD, Robinson ME, George SZ. The mechanisms of manual therapy in the treatment of musculoskeletal pain: a comprehensive model. *Manual Therapy.* 2009;14(5):531-8
- Briggs AM, Bragge P, Smith AJ, Govil D, Straker LM. Prevalence and associated factors for thoracic spine pain in the adult working population: a literature review. *J Occup Health.* 2009; 51(3):177-92
- Burwell R, Kirby A, Aujla R et al. Evaluation of Vertebral Rotation by Ultrasound for the Early Detection of Adolescent Idiopathic Scoliosis. In: *Research into Spinal Deformities 2.* 1999. Health Tech. & Inform. 59:Amsterdam, IOS Press
- Cagnie B, Danneels L, Van Tiggelen D, De Loose V, Cambier D. Individual and work related risk factors for neck pain among office workers: a cross sectional study. *Eur Spine J.* 2007; 16(5):679-86
- Casanova-Méndez A, Oliva-Pascual-Vaca A, Rodriguez-Blanco C, Heredia-Rizo AM, Gogorza-Arroitaonandia K, Almazán-Campos G. Comparative short-term effects of two thoracic spinal manipulation techniques in subjects with chronic mechanical neck pain: A randomized controlled trial. *Manual Therapy.* 2014; 19(4):331-7
- Cleland JA, Childs JD, Fritz JM, Whitman JM, Eberhart SL. Development of a clinical prediction rule for guiding treatment of a subgroup of patients with neck pain: use of thoracic spine manipulation, exercise, and patient education. *Phys Ther.* 2007; 87:9-23
- Dionne CE, Bourbonnais R, Frémont P, Rossignol M, Stock SR, Nouwen A, Larocque I, Demers E. Determinants of "return to work in good health" among workers with back pain who consult in primary care settings: a 2-year prospective study. *Eur Spine J.* 2007; 16(5):641-55.
- Edmondston S, Ferguson A, Ippersiel P, Ronningen L, Sodeland S, Barclay L Clinical and Radiological Investigation of Thoracic Spine Extension Motion During Bilateral Arm Elevation. *Journal of Orthopaedic & Sports Physical Therapy.* 2012; 42(10): 861-869
- Edmondston SJ, Aggerholm M, Elfving S, Flores N, Ng C, Smith R, Netto K. Influence of posture on the range of axial rotation and coupled lateral flexion of the thoracic spine *J Manipulative Physiol Ther.* 2007; 30(3):193-9.
- Kay TM, Gross A, Goldsmith CH, Rutherford S, Voth S, Hoving JL, Brønfort G, Santaguida PL. Exercises for mechanical neck disorders. *Cochrane Database Syst Rev.* 2015;1:CD004250.
- Haik MN, Alburquerque-Sendín F, Silva CZ, Siqueira-Junior AL, Ribeiro IL, Camargo PR. Scapular Kinematics Pre and Post Thoracic Thrust Manipulation in Individuals With and Without Shoulder Impingement Symptoms: A Randomized Controlled Study. *J Orthop Sports Phys Ther.* 2014; 44(7):475-87

Heneghan NR, Hall A, Hollands M, Balanos GM. Stability and intra-tester reliability of an in vivo measurement of thoracic axial rotation using an innovative methodology. *Manual Therapy*. 2009; 14(4):452-455

Heneghan NR, Balanos GM. Soft tissue artefact in the thoracic spine during axial rotation and arm elevation using ultrasound imaging: a descriptive study. *Manual Therapy*. 2010;15(6):599-602

Huisman PA, Speksnijder CM, de Wijer A. The effect of thoracic spine manipulation on pain and disability in patients with non-specific neck pain: a systematic review. *Disabil Rehabil*. 2013;35(20):1677-85

Leboeuf-Yde C, Nielsen J, Kyvik KO, Fejer R, Hartvigsen J. Pain in the lumbar, thoracic or cervical regions: Do age or gender matter? A population-based study of 34,902 Danish twins 20–71 years of age. *BMC Musculoskeletal Disorders* 2009; 10:39.

Johnson KD, Kim KM, Yu BK, Saliba SA, Grindstaff TL. Reliability of thoracic spine rotation range-of-motion measurements in healthy adults. *J Athl Train*. 2012; 47(1):52-60.

Kouwenhoven JW, Vincken K, Bartels L, Castelein R. Analysis of Pre-existent Vertebral Rotation in the Normal Spine. *Spine*. 2006; 31(13): 1467-1472

Muth S, Barbe MF, Lauer R, McClure PW The effects of thoracic spine manipulation in subjects with signs of rotator cuff tendinopathy. *J Orthop Sports Phys Ther*. 2012;42(12):1005-16.

Occhipinti E, Colombini D, Grieco A. Study of distribution and characteristics of spinal disorders using a validated questionnaire in a group of male subjects not exposed to occupational spinal risk factors. *Spine* 1993; 18:1150- 1159.

Page MJ, Green S, Kramer S, Johnston RV, McBain B, Chau M, Buchbinder R. Manual therapy and exercise for adhesive capsulitis (frozen shoulder). *Cochrane Database of Systematic Reviews* 2014, Issue 8. Art. No.: CD011275. DOI: 10.1002/14651858.CD011275.

Persson PR, Hirschfeld H, Nilsson-Wikmar L. Associated sagittal spinal movements in performance of head pro- and retraction in healthy women: a kinematic analysis *Manual Therapy*. 2007. 12(2):119-25.

Roquelaure Y, Bodin J, Ha C, Le Marec F, Fouquet N, Ramond-Roquin A, Goldberg M, Descatha A, Petit A, Imbernon E. Incidence and risk factors for thoracic spine pain in the working population: the French Pays de la Loire study. *Arthritis Care Res (Hoboken)*. 2014;66(11):1695-702.

Ross JK, Bereznick DE, McGill SM. Determining cavitation location during lumbar and thoracic spinal manipulation: is spinal manipulation accurate and specific? *Spine*. 2004; 29(13): 1452-7

Salom-Moreno J, Ortega-Santiago R, Cleland JA, Palacios-Ceña M, Truyols-Domínguez S, Fernández-de-Las-Peñas C. Immediate Changes in Neck Pain Intensity and Widespread Pressure Pain Sensitivity in Patients With Bilateral Chronic Mechanical Neck Pain: A Randomized Controlled Trial of Thoracic Thrust Manipulation vs Non-Thrust Mobilization. *J Manipulative Physiol Ther*. 2014; 37(5):312-9.

Sueki DG, Cleland JA, Wainner RS. A regional interdependence model of musculoskeletal dysfunction: research, mechanisms, and clinical implications. *Journal of Manual and Manipulative Therapy* 2013; 21 (2); 90-102

Tousignant M, Poulin L, Marchand S, Viau A, Place C The Modified-Modified Schober Test for range of motion assessment of lumbar flexion in patients with low back pain: a study of criterion validity, intra- and inter-rater reliability and minimum metrically detectable change. *Disabil Rehabil.* 2005; 20 ;27(10):553-9.

Tsang SM, Szeto GP, Lee RY. Normal kinematics of the neck: the interplay between the cervical and thoracic spines. *Manual Therapy.* 2013;18(5):431-7

van Kleef M, Stolker RJ, Lataster A, Geurts J, Benzon HT, Mekhail N. Thoracic Pain. *Pain Pract.* 2010; 10 (4): 327-38

Walser RF, Meserve BB, Boucher TR. The effectiveness of thoracic spine manipulation for the management of musculoskeletal conditions: a systematic review and meta-analysis of randomized clinical trials. *J Man Manip Ther.* 2009; 17 (4):237-46.

Willems JM, Jull GA, Ng JF-K An in vivo study of the Primary & coupled rotations of the thoracic spine. *Clinical Biomechanics.* 1996; 11(6): 311-316.

**Research highlights**

- Limited research of the thoracic spine, 'Cinderella' region
- Reasons for under-exploration of thoracic dysfunction are presented.
- Thoracic spine manipulation is beneficial for managing neck and shoulder pain
- The thoracic spine maybe viewed as a 'silent contributor' to clinical presentations
- Further research of thoracic spine pain and dysfunction is needed