

**Investigating inter-relationships
between pain, mobility, and posture
following osteopathic treatment in
patients with chronic neck pain**

Kathryn Frith

A research project submitted in partial fulfilment of requirement for
the degree of Master of Osteopathy,

Unitec Institute of Technology, 2013



Declaration

Name of candidate: Kathryn Frith

This Thesis/Dissertation/Research Project entitled **Investigating inter-relationships between pain, mobility, and posture in patients with chronic neck pain, following osteopathic treatment**, is submitted in partial fulfilment for the requirements for the Unitec degree of **Master of Osteopathy**

Candidate's declaration

I confirm that:

- This Thesis/Dissertation/Research Project represents my own work;
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec Research Ethics Committee.

Research Ethics Committee Approval Number: **2011-1196**

Candidate Signature:Date:

Student number: 1262374

Acknowledgements

Firstly I would like to thank and acknowledge the work of Monique Gasson, thank you for all of the work you put into this project, organising participants and being a great sounding board for me.

I would like to thank my supervisors Catherine Bacon and Rob Moran for all of their hard work. Without your support and endless meetings this project would still be a stage of infancy.

To Amy and GJ, my measurers, thank you for being available when I needed you and for doing a great job with your help with this study.

Lastly, I would like to thank my family in particular my long suffering husband Derek, without all of your emotional support I would never completed this project...even though it took me little longer than it should have. To my beautiful daughter Emma, although I was a week from completing this when I gave birth to you, it is now done, thank you for being my inspiration to get this far, both when I was pregnant and now. Love you both

Contents

Introduction to Thesis	6
Section One: Literature Review	8
1. Introduction.....	9
2. Anatomy	10
3. Regional Interdependence	11
4. Types of Pain	13
5. Causes of Chronic Neck Pain	14
6. Neck pain prevalence	15
7. Effectiveness of single technique interventions in the treatment of neck pain.....	17
8. Combination Treatments.	23
9. Neck pain and disability.	26
10. Posture and Pain.....	29
11. Conclusions.....	33
12. References.....	35
Section Two: Manuscript	46
Abstract	48
Introduction	49
Methods.....	51
Results	56
Discussion.....	70
Conclusion.....	74
References	75

Section Three: Appendices	81
Appendix A: Ethical Approval	82
Appendix B: Case history Form	84
Appendix C: Neck Disability Index Questionnaire	87
Appendix D: Protocols for Craniovertebral Angle and Cervical Range of Motion	91
Appendix E: Individual Analysis.....	94
Table Six: Participant effect size for change in NDI	96
Table Seven: Participant change in effect size for VAS	97
Appendix F: Instructions for authors International Journal for Osteopathic Medicine ..	98

Introduction to Thesis

Neck pain is a common condition. It is estimated that between 20% and 70% of people will experience neck pain at some point during any 1-year period (Borghouts, Koes, Vondeling, & Bouter, 1999; Carpenter, Mintken, & Cleland, 2009; Côté, Cassidy, & Carroll, 1998) with 4.6% of people reporting significant disability due to the pain experienced (Côté, et al., 1998).

Many studies have investigated stand-alone manipulation, mobilisation or other techniques to either the neck or thoracic spine to gauge the effect on neck pain. Some of these reviews and studies have concluded that manipulation and mobilisation are both effective in treating neck pain (J. Cleland, Childs, Fritz, Whitman, & Eberhart, 2007; J. Cleland, Flynn, Childs, & Eberhart, 2007; González-Iglesias et al., 2009; H. Lau, Wing Chiu, & Lam, 2010; Sharples, 2010). While these reviews and studies have investigated the effectiveness of the use of single different manual therapy techniques on neck pain, only one study exists which researched the effects of an osteopathic treatment on neck pain, showing a decrease in neck pain and disability measures following treatment (Fryer, Alvizatos, & Lamaro, 2005).

Other studies have examined the correlations between measures of neck pain and disability or between these measures and posture (Chiu, Lam, & Hedley, 2005; K. T. Lau et al., 2010; Yip, Chiu, & Poon, 2008). Chui et al. (2005) found a moderate correlation between disability and pain (r range = 0.55 to 0.63) and only a weak relationship between pain and physical impairment (r range = -0.08 to - 0.25). Lau et al. (2010) found a negative correlation between neck posture and pain ($r = -0.56$) and Yip et al. (2008) found negative correlation between posture and disability using the Northwick Park Questionnaire ($r = -0.380$).

However to date, no study has been published which explored correlates of change in pain or disability following an intervention.

The aims of the study reported in the second part of this thesis are to investigate baseline relationships between posture, pain, disability and cervical range of motion; to examine whether posture and mobility are associated with degree of change in pain and disability following osteopathic treatment; and to explore whether correlations exist between the changes in posture and mobility and the changes in pain and disability that occur following osteopathic treatment.

This 90-credit thesis consists of three sections: Section One is the Literature Review, which explores literature surrounding neck pain, its origin, prevalence and management, with a focus on the inter-relationships between posture, mobility and pain. Section Two is a Manuscript set out in the style prescribed for the International Journal of Osteopathic Medicine, which reports the results of the study investigating whether correlations exist between initial posture and mobility, and their change, and change of pain and disability following osteopathic treatment. Section Three comprises the Appendices which include protocols used in the study, ethics approval and samples of the various questionnaires utilised.

A comparison of the direct effects of osteopathic treatment on chronic neck pain, perceived disability post-treatment and after a 3-week follow-up, along with an analysis of a quasi-randomised control trial allowed by the study design are the research domain of another Master of Osteopathy student thesis (Gasson, 2013).

Section One: Literature Review

1. Introduction

Chronic neck pain is a common condition affecting many people worldwide. There is some evidence supporting the use of manual therapy techniques and/or treatment to treat chronic and acute neck pain (Gross, et al. 2010; Bronfort, Haas, Evans, & Bouter, 2004; Carpenter, et al., 2009; J. A. Cleland, Childs, McRae, Palmer, & Stowell, 2005; D'Sylva et al., 2010; Escortell-Mayor et al., 2011; Fryer, et al., 2005; González-Iglesias, et al., 2009; 2010; Leaver et al., 2007; Miller et al., 2010; Murphy, Taylor, & Marshall, 2009; Sharples, 2010).

Several recent studies have shown that correlations of varying strength exist between neck disability, intensity of pain, posture, and cervical range of motion measures (Chiu, et al., 2005; H. M. C. Lau, Chiu, & Lam, 2010; K. T. Lau, et al., 2010; Yip, et al., 2008). Despite limited evidence for correlations between these measures, there is currently no longitudinal evidence available investigating correlates of change between posture and mobility and pain and disability in people with chronic neck pain. Furthermore, no study has investigated correlates of change after a programme of manual therapy treatments.

If a relationship between two variables is established then it can be tentatively used to make predictions. For example, the stronger the correlation is, the stronger the ability to predict the other variable with more certainty. Although a causative relationship is not implied, a strong ability to predict changes in neck pain, or disability from range of motion, posture, or their changes, may give researchers the ability to forecast the outcome of treatment. Correlational data is also important in understanding the nature of relationships between variables, and may thus provide investigators with knowledge about neck pain, disability, mobility, and posture that may be important to examination, assessment and management of those suffering from neck pain (Chiu, et al., 2005; K. T. Lau, et al., 2010).

This literature review aims to review existing evidence on prevalence and causes of chronic neck pain, the use of manual therapy techniques, combination treatments for neck pain and correlations found by authors between different neck pain measures.

2. Anatomy

2.1 Cervical spine

The anatomical boundaries of the cervical spine are defined as the region between the anatomical landmarks of the superior nuchal line, the tip of the first thoracic spinous process inferiorly, and laterally between the left and right borders of the neck (Sinnatamby & Last, 2006). The cervical spine is composed of seven vertebrae (C₁-C₇), various soft tissues, ligaments, musculature and nerves, which control and link the neck with the thoracic spine, upper back, shoulders and head (Sinnatamby & Last, 2006; Snell, 2004; Ward, Hruby, & Jerome, 2002).

The vertebrae of the neck are classified anatomically as *atypical* or *typical* segments. The atypical cervical segments are deemed to be C₁, C₂ and C₃ due to their unique morphology, whilst the remainder (C₄₋₇) are typical segments. These first two vertebrae may be thought of as the Cradle (C₁) (Bogduk & Mercer, 2000), which sits directly under the head and allows for nodding movements, and the Axis (C₂). The majority of movement of the cervical spine occur within the first three segments of the cervical spine, especially rotation where approximately half of cervical rotation occurs between C₁ and C₂ (Bogduk & Mercer, 2000; Ward, et al., 2002). The Root (C₃) (Bogduk & Mercer, 2000), which with its junction with C₂ provides stability for superior structures, along with the Column (C₄₋₇), which is less mobile than the upper neck (Bogduk & Mercer, 2000).

2.2 Thoracic Spine

Situated between the cervical and lumbar spines is the thoracic spine (Gray, 2008; Sinnatamby & Last, 2006; Snell, 2004). The thoracic spine is comprised of 12 vertebrae and, as a whole, is less flexible than the cervical spine. Due to the biomechanics of the upper thoracic spine (T₁₋₄), this area works with the lower neck to provide a stable functional base for the upper neck and head (Bogduk & Mercer, 2000; Hoppenfield, 1976; Sharples, 2010; Ward, et al., 2002). It has been proposed that if the upper thoracic spine is impaired by movement restriction then dysfunction and pain in the cervical spine is more likely (Sharples, 2010). This is because many of the muscles of the cervical spine have their origin in the thoracic spine and there is a functional similarity between the vertebrae of the upper thoracic spine and those of the lower cervical spine (Jull, Sterling, & Falla, 2008; Sharples, 2010; Sinnatamby & Last, 2006; Snell, 2004; Ward, et al., 2002). The functional and anatomical interdependence of the cervical and thoracic spines also means that it is possible that treating the thoracic spine may decrease pain, increase range of motion and decrease disability in patients with neck pain (J. Cleland et al., 2007; González-Iglesias, et al., 2009; Sharples, 2010; Ward, et al., 2002).

3. Regional Interdependence

Due to the theory of interdependence of the cervical and thoracic spines, there has been an emerging shift in research and clinical practice, from viewing the body as a set of separate parts, towards a more integrated view. The emerging recognition that one part of the body is connected to, and may be influenced by, another adjacent area of the body suggests that disorders of the musculoskeletal system may benefit and respond well to regional

examination, diagnosis and treatment (Daniel, 2008; Reiman, Weisbach, & Glynn, 2009; Slaven & Mathers, 2010; Strunce, Walker, Boyles, & Young, 2009). A regional approach to examination and treatment of neck pain, for example, would include several adjacent areas of the body. These areas would include thoracic spine, shoulder and ribs, as these areas may have an effect on, or be affected by, a problem in the neck. One study on regional interdependence found that 21 participants with acute (pain lasting for less than six weeks) and chronic shoulder pain (pain lasting for more than 12 weeks) had decreased shoulder range of motion (ROM) and responded well to a treatment. The treatment included both thoracic spine and rib manipulation (Strunce, et al., 2009). Participants exhibited an improved shoulder ROM (an increase of 30-38° min – max) and an average of 51% decrease in reported pain levels. The study methodology was limited by lack of a control group. Since all participants were aware that they were receiving treatment, positive expectancy effects might have played a part in the clinical improvement.

Similarly, chronic and acute pain sufferers were not separated in the analysis, which might have meant that a positive response in those suffering from acute pain might have masked a much smaller response in those with chronic pain. Although more thorough research is needed, this study supports the idea of regional interdependence through its results of decreasing pain and increasing ROM of the shoulder (Strunce, et al., 2009).

Fryer et al. (2005) investigated the use of osteopathic treatment to the cervical and thoracic spine for sufferers of sub-chronic or sub-acute (pain of between 6 and 12 weeks duration) and chronic neck pain using the Neck Disability Index (NDI), a well known and validated measure of perceived disability due to neck pain, and Visual Analogue Scale (VAS), a well-used and validated pain score. Disability showed a decrease from an NDI score (mean \pm SD) of 23 ± 13 to 9 ± 7 and a decrease in reported pain from a VAS score of 6.5 ± 3 cm to $1.4 \pm$

2cm. Limitations in this study were similar to those seen in Strunce et al. (2009), notably the absence of a control group, and combined analysis of participants with sub-chronic and chronic pain. The omission of a control group in the Fryer et al. (2005) article does not allow the reader to ascertain treatment effect. Group comparison of results is impossible as ultimately participants results can only be compared with their own pre-treatment measurements. Therefore, the research cannot report how effective osteopathic treatment is, because effectiveness requires other comparison of results, which, in this case can only be the pre- and post treatment measures. This lack of sub-group analysis prevents insight into the influence of pain duration on treatment effect. Although Fryer et al. (2005) was not investigating regional interdependence, the results of this study provide some support for the existence of regional interdependence between the cervical and upper thoracic spine, as treatment was applied to both the thoracic and cervical spines. When the findings of Fryer et al. are combined with those reported by Strunce et al. they suggest that regional interdependence may extend to the thoracic spine, shoulder girdle and cervical spine, and these areas of the body should be viewed together as a single unit in an examination and treatment context. There is currently no research which investigates direct versus interdependent models of viewing, examining and treating the human body.

4. Types of Pain

The International Association for the Study of Pain, defines pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage” (McCarberg, Stanos, & D'Arcy, 2010). Whilst various measures assess the quality and intensity of pain, the two main classifications of pain, relate only to its duration. As previously stated, *acute* pain resolves in less than 6 weeks and is often

accompanied by tissue injury and inflammation, whilst *chronic* pain last for longer than 12 weeks and is characterised by intermittent or recurrent pain (Fryer, et al., 2005). Pain which lasts between 6 and 12 weeks before recovery is classed as sub-chronic (or sub-acute pain) pain (Fryer, et al., 2005). While most sufferers of neck pain will fully recover from their initial acute episode of pain, some will continue to feel pain long after the initial six-week period and hence are at risk of developing chronic pain (Fryer, et al., 2005; Goodman & Snyder, 2007; Murphy, et al., 2009). Pain, particularly chronic pain, can be highly debilitating for sufferers. It can affect their social lives, mood, relationships, exercise routines, and workplace engagement (Goodman & Snyder, 2007). Each person has a unique response to pain and a unique set of behaviours resulting from pain (Goodman & Snyder, 2007). Sufferers of chronic pain may experience biopsychosocial problems and withdraw from social situations, have negative thoughts or feelings and/or believe that they are highly disabled, sometimes much more disabled than the level and intensity of pain they are suffering would indicate (Goodman & Snyder, 2007).

5. Causes of Chronic Neck Pain

Just as the behaviours associated with chronic neck pain vary from person to person, so too do the causes and clinical presentation. Neck pain can originate from a multitude of factors. Sprains, strains and injuries to the muscles, ligaments, nerves or vertebra of the neck may cause acute neck pain in the first instance or neck pain may be due to the more gradual effects of arthritis, joint disorders, gradual process injuries and spinal problems of the neck and adjacent areas of the spine and shoulder complex (Goodman & Snyder, 2007; Slaven & Mathers, 2010).

Resulting symptoms may occur in the neck, head (headaches) or upper extremity depending on the tissues affected (Cote, Cassidy, & Carroll, 2000; Fryer, et al., 2005; Sharples, 2010). Acute neck pain can usually be attributed to a specific event with a definitive area of injury and localised inflammation. In contrast, chronic neck pain may originate from a trauma, but may come about gradually and can be caused or exacerbated by poor work-place ergonomics, notably of computer/workstation, or other overuse from repetitive movements or inappropriate posture, (Accident Compensation Corporation, 2010; Bogduk & Yoganandan, 2001; Goodman & Snyder, 2007; Korhonen et al., 2003). Despite the myriad of causes of chronic neck pain resulting from combinations of effects of injury, poor posture, misuse and/or aging, in a majority of cases a specific cause cannot be identified and many people will suffer from neck pain at some point of their lives (Murtagh, 2009).

6. Neck Pain Prevalence

A review of 56 studies by Fejer, Kyvik and Hartvigsen (2006), investigated research articles internationally published prior to 2006 on neck pain prevalence. It reported an average point prevalence (prevalence at any given time-point) of neck pain of 7.6% (range of 5.9% – 22%, across 8 studies); an average 1-year prevalence of 37.2% (with a large range of findings 16.1% – 75.1%, reviewing 22 studies); and an average lifetime prevalence of 48.5% (range of 14.2% – 71% across 8 studies) (Fejer, Kyvik, & Hartvigsen, 2006).

There are no prevalence studies investigating New Zealanders with neck pain. The most recent document available from the New Zealand Ministry of Health was printed in 2008 for the period 2006 to 2007. In this report, back and neck pain statistics are combined with no separation of the two evident in the document. The document states that between October

2006 and November 2007, there was a 1-year prevalence of 18.2% of people suffering from neck or lower back pain (Ministry of Health, 2008). Considering Fejer et al. (2006) reported a 1-year prevalence of 37.2% in people suffering neck pain, the New Zealand neck pain statistics appear surprisingly low, especially when combined with low back pain.

Fejer et al. (2006) states that one possible reason for the large difference in the ranges of prevalence statistics could be that the studies reviewed did not ask the same questions pertaining to neck pain. In addition, geographic location may have played a part, as might gender of participants and year of publication. Wording varied, for example 'Pain, ache or stiffness in the neck during the past 12 months, leading to medical consultation or treatment' (Fredriksson et al., 1999) compared to, 'Have you ever had any of these problems in the last 12 months?... [neck pain]' (Holmen, Barrett-Connor, Holmen, & Bjermer, 2000) and 'Have you had pain or ache during the last year in the following regions?...[neck and occiput]' (Rauhala, Oikarinen, Marjo-Riitta, & Raustia, 2000), with 1-year prevalence reported as 17% and 22% and 75.1% respectively (Fejer, et al. 2006). It appears that while all three of these studies took place in Scandinavia, prevalence results by Fredriksson et al. and Holmen et al. differ greatly to those reported by Rauhala et al. Geographical location might also affect observed prevalence. The review shows that those studies conducted in Scandinavia had higher prevalence statistics (one year prevalence of 36%) than those studies conducted in Asia (1-year prevalence of 13%), although the number of Asian studies are small with only 6 of the 55 reviewed studies located in continental Asia, compared to 23 which investigated prevalence in Scandinavian populations (Fejer, et al. 2006).

Fejer et al. also noted that in 25 out of 30 studies women reported more pain prevalence than men. There might have been several reasons for this finding, including the fact that women may be more at risk of developing pain conditions, that women may have greater pain sensitivity than men (Fillingim, King, Ribeiro-Dasilva, Rahim-Williams, & Riley, 2009), women might participate or return surveys with greater frequency than men or, perhaps, more women with pain attend the places where participants were recruited from. It is unclear from this review whether there has been a change in neck pain prevalence over time as large ranges of statistics are reported for all time periods. An analysis of 1-year prevalence of neck pain shows ranges of between 7 and 17 % in studies published in the 1980s (2 studies), 9% and 43% in studies published during the 1990s (12 studies) and ranges of 2% and 75 % in 5 studies published in the 2000s (Fejer, et al. 2006). Therefore, year of publication of the reviewed studies does not appear to have influenced annual prevalence statistics. Although the population estimates for neck pain are highly spread, it can be seen that neck pain is a major health concern in the countries from which the data is drawn, both on a point, 1-year and lifetime prevalence basis.

7. Effectiveness of Single Technique Interventions in the Treatment of Neck Pain

There have been several reviews of studies investigating the effectiveness of single treatment techniques (manipulation and mobilisation) or a range of manual therapy techniques for effectiveness in treating both acute and chronic neck pain (Bronfort, et al., 2004; D'Sylva, et al., 2010; Escortell-Mayor, et al., 2011; Miller, et al., 2010). Many individual research studies have also investigated different treatments for both acute and chronic neck pain; these studies have researched one technique (pre- and post- measure analysis) or compared techniques (Carpenter, et al., 2009; J. Cleland, Flynn, et al., 2007; J. Cleland, Glynn, et al.,

2007; J. A. Cleland, et al., 2005; D'Sylva, et al., 2010; Escortell-Mayor, et al., 2011; A Gross, et al., 2010; Miller, et al., 2010; Murphy, et al., 2009; Sharples, 2010; Walser, Meserve, & Boucher, 2009). There is tentative evidence supporting the use of some single techniques in treating neck pain. The most commonly researched techniques are high velocity, low amplitude (HVLA) manipulation to the cervical or thoracic spine, mobilisation of the cervical spine, exercise programmes and the use of transcutaneous electrical nerve stimulation (Carpenter, et al., 2009; J. Cleland, Glynn, et al., 2007; J. A. Cleland, et al., 2005; A Gross, et al., 2010; Miller, et al., 2010; Sharples, 2010; Walser, et al., 2009).

7.1 Manipulation and Mobilisation

Manipulation (HVLA) is a technique used by practitioners trained in the musculoskeletal field. It involves a single force directed at a specific spinal segment. HVLA can occur at any spinal segment of the spine (Gross et al., 2010; Hartman, 1997; Ward, et al., 2002).

Mobilisation is a passive technique where repetitive motion is employed, by the practitioner on the patient, in a spinal segment or area of the spine within the patient's normal range of function (Gross et al., 2010; Hartman, 1997). A recent Cochrane review explored the question of whether manipulation or mobilisation of the neck and/or thoracic spine were effective treatments for neck pain (Gross et al., 2010). Authors investigated randomised controlled trials (total sample $N=27$) and quasi-randomised control trials (RCTs) either fully published or published in abstract form, which met the criteria for inclusion (Gross et al., 2010). Outcomes from the review were equivocal. Those studies with a primary aim of investigating effectiveness of cervical spine manipulation on neck pain ($n= 16$) found that manipulation was not superior to other pain reduction technologies (medication and TENS). This means that whilst neck manipulation may have been an effective treatment for neck

pain, it is effective but no more effective than existing and already well-used pain relief options (Gross et al., 2010).

The same review noted eight RCTs addressing the effectiveness of mobilisation applied to the cervical spine with Egwu (2008) finding that anterior-posterior mobilisations exhibit greater effectiveness compared to rotational mobilisation for the treatment of neck pain.

Overall the Cochrane review by Gross et al. (2010) suggests some relief of neck pain with use of manipulation to the neck and/or thoracic spine and mobilisation to the neck, although supporting evidence is somewhat limited by a lack of high quality trials (according to Cochrane criteria). The reasons that some of the evidence was deemed to be of ‘low quality’ by the authors using Cochrane procedures, is that some of the RCTs did not report how they allocated participants to different groups, and some RCTs either did not report blinding procedures or had ineffective blinding techniques (Gross et al., 2010). It is evident that higher quality studies are required into the use of manipulation and mobilisations in the treatment of neck pain, including more cautious and inclusive use of CONSORT criteria.

7.2 Thoracic Manipulation

The Cochrane review by Gross et al. (2010) and a meta-analysis by Walser et al. (2009) also evaluated the effectiveness of thoracic manipulation on neck pain, and concluded that there is insufficient but encouraging evidence linked to thoracic spine manipulation. One of the studies included in this section of the review, was reported by Gross et al. (2010) as having a low risk of bias. This low risk of bias is considered important because bias at any stage of the planning or reporting process may make the results less generalisable or credible. This study, by Cleland et al. (2005), demonstrated the benefit of a single session of manipulation to the

thoracic spine in the treatment of neck pain, revealing a decrease in VAS (mean \pm SD) (42mm \pm 18 at baseline to 26mm \pm 17), compared to the control group (48mm at baseline to 44mm) (J. A. Cleland, et al., 2005).

The Walser review (2009) investigated nine studies reporting on the effectiveness of thoracic manipulation on neck pain. Results ranged from improvement in range of movement and function of the neck, to significant improvement in pain-related disability (Fernández-de-las-Peñas, Alonso-Blanco, Cleland, Rodríguez-Blanco, & Alburquerque-Sendín, 2008; González-Iglesias, et al., 2009). The generalisability of the results in the Walser review are limited, as it compared studies that were not investigating the same type of neck pain (chronic and acute pain cases were included, as were asymptomatic participants). The repercussions of this are that the use of all these studies may hide divergent results, as those with acute neck pain may have fundamentally different scores on questionnaires and asymptomatic participants would have scored nil, or very low, on the questionnaires used in the studies. Included in this review were studies that did not report how long the participants have been experiencing neck pain. This is a fundamental flaw in reporting results, as it is difficult to interpret the changes that have taken place if the reader is unsure how long the participants have been experiencing neck pain.

Several individual studies further support the use of thoracic spine manipulation in people suffering with neck pain, (Carpenter, et al., 2009; J. Cleland, Glynn, et al., 2007; J. Cleland 2005; Escortell-Mayor, et al., 2011; González-Iglesias, et al., 2009; Sharples, 2010).

Sharples (2010) and Gonzalez-Iglesias et al. (2009) and H Lau et al. (2010) both used experimental and control groups; the participants were blinded to group allocation and following the intervention participants could not tell which group (experimental or control) they were allocated to. All three studies show some limited effectiveness of thoracic

manipulation on neck pain using different approaches to thoracic manipulation. Sharples used a supine technique and Gonzalez-Inglesias et al. used a seated distraction technique. Results showed an increase in the range of motion in the cervical spine by a mean increase of $7^\circ \pm 6$ ($p = 0.01$) in right rotation, and flexion $4^\circ \pm 3$, which did not attain statistical significance ($p = 0.1$) following HVLA to the upper thoracic spine (T1 – 4) in asymptomatic people (Sharples, 2010); and mean increase of 9° in all planes of motion by H Lau et al. (2010). One reason given for the lack of any increase in rotation left by Sharples (2010), was that the measurer was seated to the immediate left of the participant and this may have been off-putting to the participants. This study also lacked any longer-term follow up, which would be necessary to show any persisting effects of thoracic manipulation on cervical ROM and could add weight to the results. In addition to this shortcoming, the use of asymptomatic subjects is another weakness of this study. Although, if thoracic spine manipulation improves ROM in asymptomatic participants, then there is a good chance that manipulation in those with neck pain will be advantageous to function, when you apply the principles of regional interdependence (Sharples, 2010). Gonzalez-Inglesias, et al. (2009) followed a three-week programme of seated thoracic manipulation and noted a beneficial effect on pain and disability in a treatment group, but not in a control group. This study observed 45 participants who had acute neck pain, divided into an experimental group who each received thoracic manipulation and an electrotherapy programme, thermo-therapy and soft-tissue massage, and a control group that received all of the previously mentioned techniques except thoracic manipulation. The authors used well known measures of range of motion, Numeric Pain rating scale (NPRS), and the Northwick Pain Questionnaire (NPQ) and found that participants who received thoracic manipulation reported reductions in mean neck pain of 3.30 ($p < 0.001$) (pre- 5.6 ± 0.9 – post-treatment 2.3 ± 1) and disability 12.6 ($p < 0.001$) (pre- 27.8 ± 3.1 – post treatment 15.2 ± 12.6), as well as increases in range of motion of between

8.5° to 11° ($p < 0.001$). The control group, who did not receive thoracic manipulation, reported mean neck pain reduction of 1.07 ($p < 0.001$), disability reductions of 4.2 ($p < 0.001$) and mean range of motion reduction of between 0.2° and 1.6° ($p < 0.01$) for extension, left side bending, ($p < 0.001$ for right side bending, and non-significant similar trends for flexion and bilateral rotation). It is unclear whether the between group differences gained statistical significance as *p-values* are not reported. The age group of the participants, the use of only one clinic to source participants and the number of treatment sessions, all represent limitations of this study. Since ages of patients in this study were quite low, ranging between 23 – 45 years (mean 34 ± 4 years), the findings are only generalisable to the younger population. The use of one physiotherapy clinic also puts to question the generalisability to a wider range of manual therapy clinics, and the study may lack external validity because of this. Six treatment sessions over three weeks were employed by Gonzalez-Iglesias, et al. (2009) in the control group and, in addition to this, the treatment group received 3 thoracic manipulation sessions during the same period. It would have been interesting to see whether or not the participants had experienced greater changes in pain and disability with a longer duration. Despite the limited generalisability of these studies, the results suggest that thoracic manipulation could be effective in treating neck pain, disability and range of motion. More research using more symptomatic participants, at more manual therapy clinics would be necessary in this area to give studies more validity and to provide a body of background evidence into the use of thoracic manipulation in cases of neck pain.

8. Combination Treatments.

The effectiveness of combination treatments on neck pain has been reviewed by Miller et al. (2010), and D'Sylva et al. (2010). Miller et al reviewed 17 research reports, investigating acute, sub-acute and chronic neck pain, with and without additional symptoms suggested that a combination of manual therapy, manipulation, mobilisation, and exercise, may produce better outcomes for patients in terms of pain, disability and satisfaction than exercise alone. Mirroring these findings is another review, which investigated the effects of manual therapy and/or physical medicine modalities on neck pain (acute, sub-acute and chronic pain types), (D'Sylva, et al., 2010). The D'Sylva et al. review researched 19 randomised control trials and found that there was evidence of benefit to participants for a combination of mobilisation, manipulation and soft tissue massage, when these were used in conjunction with exercise. The authors noted a lack of statistically significant change in outcomes, and concluded that manipulation, mobilisation and soft tissue work might be beneficial in treating neck pain, although more research would be required into the effectiveness of combination treatments on neck pain (D'Sylva et al. (2010). In addition, they suggested that studies with longer-term follow-ups would be of benefit so the persistence of any beneficial effects could be established (D'Sylva, et al., 2010). On this basis Miller et al. (2010) argues that the use of combined manual therapy techniques may be of benefit to the patient; the benefits may be greater when combined with exercise and this may produce longer term advantages to the participant. Both D'Sylva et al. (2010) and Miller et al. (2010) noted the low quality of many of the RCTs reviewed, due to lack of participant blinding and of allocation concealment. This point reiterates earlier appeals for improved quality of methods in RCTs in the manual therapy field (Bronfort, et al., 2004).

8.1 Osteopathic treatment

Osteopathy is a highly skilled form of musculoskeletal manual medicine that applies combinations of treatment approaches and could therefore be considered in the context of the literature reviewed by D'Sylva et al. (2010) and Miller et al. (2010). Those who train for the role are educated in all forms of musculoskeletal management, referral, manual techniques and treatment plans. Osteopaths use learnt knowledge together with patient case history, palpation, movement analysis, and special orthopaedic tests, to diagnose the area of the body and tissue that is causing pain and/or dysfunction. An osteopathic treatment consists of a series of techniques chosen by the practitioner; it is the combination of techniques that constitute a treatment. Treatments commonly applied in osteopathy include HVLA, counter-strain, soft tissue manipulation, mobilisation, cranial and functional, muscle energy and myofascial release techniques, however they are not specific to osteopathy and may be used by physiotherapist, chiropractors, and musculoskeletal trained doctors (Fryer, et al., 2005; Hartman, 1997; Ward, et al., 2002). The techniques chosen for use on a patient depend on patient age, health status, health of the tissues (bone, muscle, skin etc.), medications, and any other musculoskeletal dysfunctions the patient might have which may be affecting them. This is because some techniques may not suit a particular patient or the root cause of their particular musculoskeletal issues may differ. For this reason, strict treatment protocols for musculoskeletal conditions do not exist within osteopathy, as a distinctive set of circumstances surrounding each patient's conditions or problems is present.

8.2 Osteopathic treatment for neck pain

Only one published report has studied the effectiveness of osteopathic therapy on neck pain (sub-chronic and chronic) using a semi-standardised treatment strategy in a single cohort (Fryer, et al., 2005). The osteopath selected techniques from those on an extensive list (Fryer, et al., 2005). Results showed a decrease in the neck pain suffered by participants ($n=17$), with an average 5 mm decrease in VAS from pre-treatment to immediately after 4 weeks of treatment ($6.5 \pm 3.1 - 1.4 \pm 2$, $p = 0.001$). There was a similar improvement in MPQ and NDI over the same period, from a mean score of 15 ± 8 to 4 ± 5 ($p = 0.001$) and from 23 ± 12.6 to 9 ± 7 ($p = 0.001$), respectively. The experimental approach and treatment protocol used in this research paper allow for some moulding of the treatment around the patient, thus providing a compromise between true clinical osteopathy, where the osteopath can choose from a larger number of techniques (a more externally valid approach), and strict adherence to a more prescriptive treatment protocol (a more internally valid approach).

Another threat to the internal validity of the study is that because the patients knew that they were receiving treatment to the neck and thoracic spine, positive expectancy effects may have been induced. This study was a single system cohort design; the use of a control group was omitted. Had it been included, a comparison between the pre- and post-treatment change between treatment and control groups could have been made, allowing greater certainty about the cause of the improvements in neck pain and disability, and hence greater internal validity. Because of the lack of other studies that replicate these findings and limitations in the design of the study by Fryer, it is still not clear whether osteopathy is effective in treating sub-chronic and chronic neck pain.

9. Neck pain and disability.

Pain is felt as a result of noxious stimuli, and is a protective mechanism; it informs the body of the threat of damage (Vlaeyan & Linton, 2012). However, when acute pain becomes chronic it can be accompanied by the psychosocial concepts of fear-avoidance, catastrophisation, anxiety, depression, and coping strategies. Fear-avoidance is an important psycho-social behavioural construct where sufferers of chronic pain stop completing, taking part in or attempting particular tasks and activities because it might cause or increase the pain (Vlayaen & Linton, 2000; Vlaeyen & Linton, 2012). Disuse of the affected body part, and hyper-vigilance can occur with sufferers seemingly unable to use the painful body part and they become increasingly unable to turn their attention away from the pain (Vlaeyen & Linton, 2000). There is evidence that suggests fear may be more disabling than the pain, and the fear experienced may influence pain and pain intensity reporting (Crombez, Vlaeyen, Heuts, & Lysens, 1999; Fejer & Hartvigsen, 2008; Leeuw et al., 2007; Parr et al., 2012; Vlaeyen & Linton, 2000; Vlaeyen & Linton, 2012).

Pain catastrophisation concerns negative pain-related thoughts in those who suffer from pain which may be related to higher levels of pain intensity, disability and psychological distress (Börsbo, Gerdle, & Peolsson, 2010; Severeijns, Vlaeyen, van den Hout, & Weber, 2001; Thompson, Oldham, Urmston, & Woby, 2010; Thompson, Urmston, Oldham, & Woby, 2010). Therefore, those who exhibit either catastrophisation or fear-avoidance may report a higher level of disability than the level of pain indicates (Meyer, Tschopp, Spratt, & Mannion, 2009).

9.1 Correlations between pain and disability

Despite the additional mechanisms of disability that can be independent from pain, correlations between pain and disability have been reported in the literature. Chui et al. (2005), in an intervention study ($n=254$), and Lau et al (2010), in a cross-sectional analysis ($n=30$), both reported moderate sized cross-sectional correlations of $r = 0.4$. In the Chiu study participants received strengthening exercises for the cervical spine, infrared irradiation and transcutaneous electric nerve stimulation, twice weekly for 6 weeks. Participants were measured three times using the NPQ and ROM, strength indicators and the VNPS. One measurement occurred before treatment (baseline), another at 6-weeks and a final measurement 6 months after the treatment had ended. Correlations between VNPS and NPQ increased from $r = 0.37$ at baseline to $r = 0.55$ at 6 weeks (following treatment), and $r = 0.63$ at 6 months follow-up, (Chiu, et al., 2005). Lau et al. (2010) recorded a cross-sectional correlation of $r = 0.41$ between the NPQ and the NPRS. Despite the differences in sample size and neck pain and disability measures used, the results of these studies at baseline are very consistent with each other. The increase that occurred over time in the correlation strength reported by Chiu et al. (2005) may have been firstly, because the treatment protocols used targeted the pain the participants suffered, and by decreasing the amount of pain the participant had, the perceived disability may have also decreased. Secondly, because the treatments or time that had passed since receiving treatment, may have resulted in increased matching of perceived disability and pain by participants.

The range of participant ages was also quite different in both studies, Lau et al. (2005) studied participants between the ages of 20 and 50 years with a mean age of 37 ± 10 years, while Chiu's participants were aged between 20 and 64 years, with a mean age of 44 ± 10 years. This is an important difference to note as participants in the over 50s age group may

be more likely to report higher pain and disability due to normal degenerative changes and possibly more time with the pain present in their cervical spines, an increase in these degenerative changes could lead to the correlations having more strength. However, despite this difference between these two studies, the correlation between pain and disability remained consistent.

9.2 Correlations between neck mobility and disability

Chiu et al. (2005) reported a weak correlation between scores on the NPQ and cervical mobility (range of motion) at baseline ($r = -0.20$) and a slightly higher correlation ($r = -0.30$) at 6 weeks post-treatment. Hermann and Reese (2001) ($n = 146$) reported a correlation $r = -0.30$ between mobility and the NDI, while Riddle and Stratford (1998) reported correlations of between $r = 0.27$ and 0.40 between the NDI and active neck range of motion. Only one of these studies concurs with the findings of Chiu et al. that a small to moderate correlation exists between the two measures. While results reported by Riddle and Stratford ($n = 80$) negate those of Chiu et al. and Herman and Reese. Both Riddle and Stratford, and Hermann and Reese used the same procedures and methods to measure the ROM of the neck (Youdas, Carey, & Garrett, 1991). While both Riddle and Stratford and, Hermann and Reese, used similar population sizes, there may have been discrepancies of population age between the two studies. The latter study had a range of 20 – 80 years (mean 45.7 ± 15.9) and was limited to one hospital physiotherapy unit (the number of therapists used is not reported), while the age range and mean of participants in the former study are unreported and 4 physiotherapy clinics were used, accounting for the use of 17 therapists. Because correlations are particular to the population they are calculated for, this, and the number of therapists used, may account for the differences between the two studies. Similar to pain and disability associations, Chiu

et al.'s (2005) correlations show an increase over time, again suggesting matching of mobility and disability with treatment that targeted both. This possibility is difficult to clarify because pre- and post-intervention measurements were not reported.

10. Posture and Pain

The longstanding 'vicious cycle' theory of pain assumes that within a painful muscle, activity increases in a stereotypical fashion, no matter the task being accomplished, and continued pain is the end product of ischaemia, spasm and accumulation of muscle waste products and metabolites (Hodges & Moseley, 2003; Lund, Donga, Widmer, & Stohler, 1991; Peck, Murray, & Gerzina, 2008). This theory has since been superseded by a more recent and plausible model of pain adaptation (Lund, et al., 1991). Lund's theory states that the activity of the painful muscle is decreased during voluntary effort, when the muscle is being used as a prime mover (agonist muscle), while the activity of the opposing muscles (antagonist) increases, thus the velocity, force and range of the movements are reduced (Hodges & Tucker, 2011; Lund, et al., 1991). Lund et al. believed that these changes in muscle tone and activity occur in several chronic pain conditions, and these findings are underpinned by experimental pain studies on the jaw, erector spinae and muscles of the shoulder (Hodges, Moseley, Gabrielsson, & Gandevia, 2003; Sandsjö, Melin, Rissén, Dohms, & Lundberg, 2000; Zedka, Prochazka, Knight, Gillard, & Gauthier, 1999). Within experimental neck pain studies, findings of a decreased ability to relax particular muscles (Falla, Bilenkji, & Jull, 2004), and an inability to relax the trapezius between and after arm movements (Falla, Bilenkji, & Jull, 2004), may explain the effect chronic neck pain has on the cervical spine and muscles of the neck. Although Lund's model of how pain effects the movement and

muscular control of the body is by no means complete, it helps us understand the adaptations and compensation that the human body must and does undergo in response to pain.

Neck pain has been found to increase the activation of superficial neck muscles, (Falla, et al. 2004) while muscles which are not usually responsible for moving the neck are recruited to assist. During the Zedka et al. (1999) investigation, participants were injected with hypertonic saline to induce muscular pain in the right erector spinae muscles, results showed a higher electro-myographic activity (lack of relaxation in full forward flexion) of the muscles on both the left and right sides of the erector spinae. It is thought that while the lack of relaxation of bilateral muscles in full flexion was a protective response, it was also preventing normal relaxation. Zedka et al. hypothesised that this protective splinting of the spine could lead to chronic pain. This hypothesis might help to explain why chronic pain can spread to surrounding muscles over time, and also why range of motion and disability are both affected (Zedka, et al., 1999). Increased muscular fatigue may then lead to chronic pain or the spread of the pain, from the original site to surrounding tissues and muscles (Falla, & Farina, 2008; Lund, et al., 1991; Sandsjö, et al., 2000). These adaptations may be protective and designed to stop the body from performing movements, which may cause further tissue damage. While this is of benefit to the human body initially, in the longer term it can be debilitating to the sufferer of chronic pain.

10.1 Posture in participants with and without Neck Pain

K. T. Lau (2010), Cheung Lau, et al. (2009) and Yip et al. (2005) have all investigated craniovertebral angle (CVA) measurements in those with and without neck pain. All three studies used participants of a similar age (mean age range of 35 – 42 years in sub-groups). Clinically a larger CVA angle equates to more upright head posture (less forward head

posture), which is generally regarded to be desirable. All three studies report differences in the CVA of those with neck pain compared to those without neck pain. K. T Lau et al. report a difference of 8° in CVA, with better posture in the control group ($48^\circ \pm 5$) compared to the neck pain group ($40^\circ \pm 7$; $p < 0.01$). Similarly, Cheung Lau et al. reported a 7° higher CVA in non-patient controls ($51^\circ \pm 2$) compared to patients with neck pain ($44^\circ \pm 4$; $p < 0.001$), and Yip et al. recorded CVAs which were 5° higher in those without neck pain ($55^\circ \pm 3$) compared to those with neck pain ($50^\circ \pm 6$; $p < 0.001$). Despite these findings, it does not necessarily follow that those with higher CVA measurements will be pain free, or that there will be a linear relationship between CVA and pain intensity in the general population.

10.2 Relationships between Posture and Pain

In the literature, to date, there have been several examples of investigations of the interrelationships between pain, disability and CVA (H. M. C. Lau, et al., 2010; K. T. Lau, et al., 2010; Yip, et al., 2008). In these three studies, the authors investigated correlations using the CVA, NPQ and the NPRS.

A validity study by H. M. C Lau et al. (2010) studied participants with neck pain ($n = 30$) with an average age of 47 ± 10 years and reported correlation coefficients of $r = -0.70$ between both the CVA and NPQ, and the CVA and NPRS. K. T. Lau et al.'s (2010) study investigated cross-sectional correlations and reported $r = -0.40$ and $r = -0.36$ between the CVA and NPQ, and CVA and NPRS respectively for 60 participants. Like the latter study (H. M. C. Lau, et al., 2010), correlations from a earlier study by Yip et al. (2005) are moderate in strength with findings of $r = -0.40$ and $r = -0.30$ between the CVA and NPQ, and CVA and NPRS respectively ($n = 114$, age 35 ± 10 years). There are large differences in the

correlation strengths and this may be attributed to differences between the studies in sample size, and consequently in sample spread, in age of participants and in duration of neck pain experienced by the participants. In the validity study, with the fewest participants (H. M. C. Lau, et al., 2010), correlations between the measures were considerably higher than those in the two cross-sectional studies (K. T. Lau, et al., 2010) and Yip et al (2005) research. An important aspect of the research by H. M. C Lau (2010) is that they only used one group of participants, those with chronic neck pain. Although the omission of participants without neck pain would not have affected the correlation, it does make it more difficult to see what the correlation scores of a control group might have been. The cross sectional study (K. T. Lau, et al., 2010) and Yip et al (2005), split participants into two groups; those who had an absence of neck pain for 6 months and those who had neck pain (although no definition is given as to how long they had been suffering from neck pain). This may have affected results due to the fact that those suffering acute neck pain may have had less pain to begin with or felt they were less disabled by their neck pain.

The mean age of participants were slightly older (10 years) (H. M. C. Lau, et al., 2010) than those used in the other two articles (K. T. Lau, et al., 2010; Yip, et al., 2008). The implications for this may have been that after 50 years of age, normal degenerative processes impact on the bones and muscles of the neck. These normal aging processes may leave people more vulnerable to pain and disability and a potentially smaller CVA measurement, thus a stronger inverse correlation was reported for the population, due to changes in muscle strength and bone density (H. M. C. Lau, et al., 2010; K. T. Lau, et al., 2010; Yip, et al., 2008).

An understanding of Lund's theory may help to explain why those with chronic neck pain, experience decreases in mobility, and altered posture of the head and neck due to the increased activation of muscles (Lund et al. 1991). The increased activity of antagonist

muscles with a decrease in activity of the painful muscle is the main stay of this theory, and may help to explain why correlations of varying strength may exist between the measures of pain, mobility and posture.

11. Conclusions

Neck pain is a very common condition and many studies consistently show some effectiveness after manual therapy techniques are applied (Bronfort, et al., 2004; D'Sylva, et al., 2010; AR Gross et al., 2004; Miller, et al., 2010). Only a single study of the effect of osteopathy on neck pain has been published (Fryer, et al., 2005). Despite some methodological limitations, such as lack of a control group, small sample size and no long-term follow-up, the results show promising efficacy of this treatment approach (Fryer, et al., 2005). Results of other studies have researched the effectiveness of a single technique or a combination of treatments including cervical and thoracic manipulation to assess the value of manual techniques in treating neck pain (J. Cleland, Glynn, et al., 2007; González-Iglesias, et al., 2009; H. Lau, et al., 2010; Sharples, 2010). Data from these studies that show some effectiveness in using manual therapy techniques applied to the neck and thoracic spine in the treatment of neck pain. These findings add some weight to the notion, believed by many manual practitioners, that in order to treat neck pain, one must also treat the thoracic spine, particularly the upper thoracic spine. Studies investigating correlations between neck pain, disability, range of motion and neck posture measures have also given support to the idea that anatomical structures in the area are functionally inter-related. Nonetheless, no research has yet been undertaken as to whether initial measures of mobility and posture are associated with changes in pain and disability that arise following any manual therapy treatment. This is

an important question in a clinical setting as these data may allow practitioners to predict which patients would be likely to have better pain and disability outcomes following treatment.

12. References

- Accident Compensation Corporation. (2010). *Guidelines for Using Computers*.
- Bogduk, N., & Mercer, S. (2000). Biomechanics of the cervical spine. I: Normal kinematics. *Clinical Biomechanics*, 15(9), 633-648.
- Bogduk, N., & Yoganandan, N. (2001). Biomechanics of the cervical spine Part 3: minor injuries. *Clinical Biomechanics*, 16(4), 267-275.
- Borghouts, J. A. J., Koes, B. W., Vondeling, H., & Bouter, L. M. (1999). Cost-of-illness of neck pain in The Netherlands in 1996. *Pain*, 80(3), 629-636.
- Börsbo, B., Gerdle, B., & Peolsson, M. (2010). Impact of the interaction between self-efficacy, symptoms and catastrophising on disability, quality of life and health in with chronic pain patients. *Disability & Rehabilitation*, 32(17), 1387-1396.
- Bronfort, G., Haas, M., Evans, R., & Bouter, L. (2004). Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. *Spine Journal*, 4(3), 335 - 356.
- Carpenter, K. J., Mintken, P. E., & Cleland, J. A. (2009). Evaluation of outcomes in patients with neck pain treated with thoracic spine manipulation and exercise: a case series. *NZ Journal of Physiotherapy*, 37(2), 76.
- Cheung Lau, H. M., Wing Chiu, T. T., & Lam, T. H. (2009). Clinical measurement of craniovertebral angle by electronic head posture instrument: A test of reliability and validity. *Manual Therapy*, 14(4), 363-368.

- Chiu, T. T., Lam, T. H., & Hedley, A. J. (2005). Correlation among physical impairments, pain, disability, and patient satisfaction in patients with chronic neck pain. *Archives of physical medicine and rehabilitation*, 86(3), 534-540.
- Cleland, J., Childs, J., Fritz, J., Whitman, J., & Eberhart, S. (2007). 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. *Physical Therapy*, 87(1), 9.
- Cleland, J., Flynn, T., Childs, J., & Eberhart, S. (2007). The audible pop from thoracic spine thrust manipulation and its relation to short-term outcomes in patients with neck pain. *The Journal of Manual & Manipulative Therapy*, 15(3), 143.
- Cleland, J., Glynn, P., Whitman, J., Eberhart, S., MacDonald, C., & Childs, J. (2007). Short-term effects of thrust versus nonthrust mobilization/manipulation directed at the thoracic spine in patients with neck pain: a randomized clinical trial. *Physical Therapy*, 87(4), 431.
- Cleland, J. A., Childs, M. J. D., McRae, M., Palmer, J. A., & Stowell, T. (2005). Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. *Manual Therapy*, 10, 127-135.
- Cote, P., Cassidy, D., & Carroll, L. (2000). The factors associated with neck pain and its related disability in the Saskatchewan population. *Spine*, 25(9), 1109.

- Côté, P., Cassidy, J. D., & Carroll, L. (1998). The Saskatchewan health and back pain survey: the prevalence of neck pain and related disability in Saskatchewan adults. *Spine*, 23(15), 1689.
- Crombez, G., Vlaeyen, J. W. S., Heuts, P. H. T. G., & Lysens, R. (1999). Pain-related fear is more disabling than pain itself: evidence on the role of pain-related fear in chronic back pain disability. *Pain*, 80(1–2), 329-339.
- D'Sylva, J., Miller, J., Gross, A., Burnie, S. J., Goldsmith, C. H., Graham, N., et al. (2010). Manual therapy with or without physical medicine modalities for neck pain: a systematic review. *Manual Therapy*, 15(5), 415-433.
- Daniel, W. V. (2008). Isolated Knee Pain: A Case Report Highlighting Regional Interdependence. *Journal of Orthopaedic and Sports Physical Therapy*, 38(10), 616-623.
- Emily Joan, S., & Jessie, M. (2010). Differential diagnosis of shoulder and cervical pain: a case report. *Journal of Manual & Manipulative Therapy*, 18(4), 191-196.
- Escortell-Mayor, E., Riesgo-Fuertes, R., Garrido-Elustondo, S., Asúnsolo-del Barco, A., Díaz-Pulido, B., Blanco-Díaz, M., et al. (2011). Primary care randomized clinical trial: Manual therapy effectiveness in comparison with TENS in patients with neck pain. *Manual Therapy*, 16(1), 66-73.
- Falla, D., Bilenkij, G., & Jull, G. (2004). Patients with chronic neck pain demonstrate altered patterns of muscle activation during performance of a functional upper limb task. *Spine*, 29(13), 1436-1440.

Falla, D., & Farina, D. (2008). Neuromuscular adaptation in experimental and clinical neck pain. *Journal of Electromyography and Kinesiology*, 18(2), 255-261.

Falla, D. L., Jull, G. A., & Hodges, P. W. (2004). Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. *Spine*, 29(19), 2108-2114.

Fejer, R., & Hartvigsen, J. (2008). Neck pain and disability due to neck pain: what is the relation? *European spine journal*, 17(1), 80-88.

Fejer, R., Kyvik, K. O., & Hartvigsen, J. (2006). The prevalence of neck pain in the world population: a systematic critical review of the literature. *European spine journal*, 15(6), 834-848.

Fernández-de-las-Peñas, C., Alonso-Blanco, C., Cleland, J. A., Rodríguez-Blanco, C., & Albuquerque-Sendín, F. (2008). Changes in Pressure Pain Thresholds Over C5-C6 Zygapophyseal Joint After a Cervicothoracic Junction Manipulation in Healthy Subjects. *Journal of manipulative and physiological therapeutics*, 31(5), 332-337.

Fillangim, R. B., King, C. D., Ribeiro-Dasilva, M. C., Rahim-Williams, B., & Riley, J. L. (2009). Sex, gender, and pain: a review of recent clinical and experimental findings. *The Journal of Pain*, 10(5), 447-485.

Fredriksson, K., Alfredsson, L., Koster, M., Thorbjornsson, C., Toomingas, A., Torgen, M., et al. (1999). Risk factors for neck and upper limb disorders: Results from 24 years of follow up. *Occupational and environmental medicine*, 56(59-66).

- Fryer, G., Alvizatos, J., & Lamaro, J. (2005). The effect of osteopathic treatment on people with chronic and sub-chronic neck pain: A pilot study. *International Journal of Osteopathic Medicine*, 8(2), 41-48.
- Gasson, M. (2013). Effectiveness of Osteopathic Treatment on Chronic Neck Pain. Unpublished Thesis. UNITEC New Zealand.
- González-Iglesias, J., Fernández-de-las-Peñas, C., Cleland, J., Albuquerque-Sendín, F., Palomeque-del-Cerro, L., & Méndez-Sánchez, R. (2009). Inclusion of thoracic spine thrust manipulation into an electro-therapy/thermal program for the management of patients with acute mechanical neck pain: A randomized clinical trial. *Manual Therapy*, 14(3), 306-313.
- Goodman, C., & Snyder, T. (2007). *Differential Diagnosis for Physical Therapists: Screening for Referral*. St Louis, Missouri: Saunders Elsevier.
- Gray, H. (2008). *Grays Anatomy*. London: Arcturus Publishing Limited.
- Gross, A., Hoving, J., Haines, T., Goldsmith, C., Kay, T., Aker, P., et al. (2004). A Cochrane review of manipulation and mobilization for mechanical neck disorders. *Spine*, 29(14), 1541 - 1548.
- Gross, A., Miller, J., D'Sylva, J., Burnie, S. J., Goldsmith, C. H., Graham, N., et al. (2010). Manipulation or mobilisation for neck pain: A Cochrane Review. *Manual Therapy*, 15(4), 315-333.

- Hagen, K. B., Harms-Ringdahl, K., Enger, N. O., Hedenstad, R., & Morten, H. (1997). Relationship between subjective neck disorders and cervical spine mobility and motion-related pain in male machine operators. *Spine*, 22(13), 1501-1507.
- Hartman, L. S. (1997). *Handbook of osteopathic technique*: Chapman & Hall Thomson Publ. Serv.
- Hermann, K. M., & Reese, C. S. (2001). Relationships among selected measures of impairment, functional limitation, and disability in patients with cervical spine disorders. *Physical Therapy*, 81(3), 903-912.
- Hodges, P. W., & Moseley, G. L. (2003). Pain and motor control of the lumbopelvic region: effect and possible mechanisms. *Journal of Electromyography and Kinesiology*, 13(4), 361-370.
- Hodges, P. W., Moseley, G. L., Gabrielsson, A., & Gandevia, S. C. (2003). Experimental muscle pain changes feedforward postural responses of the trunk muscles. *Experimental Brain Research*, 151(2), 262-271.
- Hodges, P. W., & Tucker, K. (2011). Moving differently in pain: a new theory to explain the adaptation to pain. *Pain*, 152(3 Suppl), S90-S98.
- Holmen, T. L., Barrett-Connor, E., Holmen, J., & Bjermer, L. (2000). Health Problems in Teenage Daily Smokers versus Nonsmokers, Norway, 1995–1997 The Nord-Trøndelag Health Study. *American Journal of Epidemiology*, 151(2), 148-155.
- Hoppenfield, S. (1976). *Physical Examination of the Spine and Extremities*. New Jersey: Prentice Hall.

- Jull, G., Sterling, M., & Falla, D. (2008). *Whiplash, headache, and neck pain: research-based directions for physical therapies*: Elsevier Health Sciences.
- Korhonen, T., Ketola, R., Toivonen, R., Luukkonen, R., Häkkänen, M., & Viikari-Juntura, E. (2003). Work related and individual predictors for incident neck pain among office employees working with video display units. *Occupational and environmental medicine*, 60(7), 475-482.
- Lau, H., Wing Chiu, T., & Lam, T. (2010). The effectiveness of thoracic manipulation on patients with chronic mechanical neck pain—A randomized controlled trial. *Manual Therapy*.
- Lau, H. M. C., Chiu, T. T. W., & Lam, T. H. (2010). Measurement of craniovertebral angle with Electronic Head Posture Instrument: Criterion validity. *Journal of rehabilitation research and development*, 47(9), 911.
- Lau, K. T., Cheung, K. Y., Chan, k. B., Chan, M. H., Lo, K. Y., & Wing Chiu, T. T. (2010). Relationships between sagittal postures of thoracic and cervical spine, presence of neck pain, neck pain severity and disability. *Manual Therapy*, 15(5), 457-462.
- Leaver, A., Refshauge, K., Maher, C., Latimer, J., Herbert, R., Jull, G., et al. (2007). Efficacy of manipulation for non-specific neck pain of recent onset: design of a randomised controlled trial. *BMC Musculoskeletal Disorders*, 8(1), 18.
- Leeuw, M., Goossens, M. E., Linton, S. J., Crombez, G., Boersma, K., & Vlaeyen, J. W. (2007). The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *Journal of behavioral medicine*, 30(1), 77-94.

- Lund, J. P., Donga, R., Widmer, C. G., & Stohler, C. S. (1991). The pain-adaptation model: a discussion of the relationship between chronic musculoskeletal pain and motor activity. *Canadian journal of physiology and pharmacology*, 69(5), 683-694.
- McCarberg, B., Stanos, S., & D'Arcy, Y. (2010). *Back and Neck Pain*: Oxford University Press.
- Meyer, K., Tschopp, A., Sprott, H., & Mannion, A. F. (2009). Association between catastrophizing and self-rated pain and disability in patients with chronic low back pain. *Journal of Rehabilitation Medicine*, 41(8), 620-625.
- Miller, J., Gross, A., D'Sylva, J., Burnie, S. J., Goldsmith, C. H., Graham, N., et al. (2010). Manual therapy and exercise for neck pain: A systematic review. *Manual Therapy*, 15(4), 334-354.
- Ministry of Health. (2008). *A Portrait of Health. key results of the 2006/2007 New Zealand Health Survey*. Wellington: Ministry of Health.
- Murphy, B., Taylor, H. H., & Marshall, P. (2009). The Effect of Spinal Manipulation on the Efficacy of a Rehabilitation Protocol for Patients With Chronic Neck Pain: A Pilot Study. *Journal of manipulative and physiological therapeutics*, 33(3), 168-177.
- Murtagh, J. (2009). *General Practice* (4th ed.). North Ryde, NSW: McGraw-Hill Australia Pty Ltd.
- Parr, J. J., Borsa, P. A., Fillingim, R. B., Tillman, M. D., Manini, T. M., Gregory, C. M., et al. (2012). Pain-related fear and catastrophizing predict pain intensity and disability

- independently using an induced muscle injury model. *The Journal of Pain*, 13(4), 370-378.
- Peck, C., Murray, G., & Gerzina, T. (2008). How does pain affect jaw muscle activity? The Integrated Pain Adaptation Model. *Australian dental journal*, 53(3), 201-207.
- Rauhala, K., Oikarinen, K. S., Marjo-Riitta, J., & Raustia, A. (2000). Facial pain and temporomandibular disorders: An epidemiological study of the Northern Finland 1966 Birth Cohort. *Cranio-chattanooga tn-*, 18(1), 40-46.
- Reiman, M. P., Weisbach, P. C., & Glynn, P. E. (2009). The Hip's Influence on Low Back Pain: A Distal Link to a Proximal Problem. *Journal of Sport Rehabilitation*, 18(1), 24-32.
- Riddle, D. L., & Stratford, P. W. (1998). Use of generic versus region-specific functional status measures on patients with cervical spine disorders. *Physical Therapy*, 78(9), 951-963.
- Sandsjö, L., Melin, B., Rissén, D., Dohns, I., & Lundberg, U. (2000). Trapezius muscle activity, neck and shoulder pain, and subjective experiences during monotonous work in women. *European journal of applied physiology*, 83(2), 235-238.
- Severeijns, R., Vlaeyen, J. W. S., van den Hout, M. A., & Weber, W. E. J. (2001). Pain Catastrophizing Predicts Pain Intensity, Disability, and Psychological Distress Independent of the Level of Physical Impairment. *The Clinical Journal of Pain*, 17(2), 165-172.

Sharples, L. (2010). Does a single thrust manipulation of the upper thoracic spine increase neck range of motion? A research project submitted in partial requirement for the degree of Master of Osteopathy, Unitec Institute of Technology, Auckland. Unitec New Zealand.

Sinnatamby, C., & Last, R. (2006). *Last's anatomy: regional and applied*: Churchill Livingstone.

Slaven, E. J., & Mathers, J. (2010). Differential diagnosis of shoulder and cervical pain: a case report. *The Journal of Manual & Manipulative Therapy*, 18(4), 191.

Snell, R. S. (2004). *Clinical Anatomy* (7th ed.). Baltimore: Lippincott Williams & Wilkins.

Strunce, J. B., Walker, M. J., Boyles, R. E., & Young, B. A. (2009). The immediate effects of thoracic spine and rib manipulation on subjects with primary complaints of shoulder pain. *The Journal of Manual & Manipulative Therapy*, 17(4), 230.

Thompson, D. P., Oldham, J. A., Urmston, M., & Woby, S. R. (2010). Cognitive determinants of pain and disability in patients with chronic whiplash-associated disorder: a cross-sectional observational study. *Physiotherapy*, 96(2), 151-159.

Thompson, D. P., Urmston, M., Oldham, J. A., & Woby, S. R. (2010). The association between cognitive factors, pain and disability in patients with idiopathic chronic neck pain. *Disability & Rehabilitation*, 32(21), 1758-1767.

Vlaeyen, J., & Linton, S. J. (2000). Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain*, 85(3), 317-332.

- Vlaeyen, J. W. S., & Linton, S. J. (2012). Fear-avoidance model of chronic musculoskeletal pain: 12 years on. *Pain, 153*(6), 1144-1147.
- Walser, R., Meserve, B., & Boucher, T. (2009). The effectiveness of thoracic spine manipulation for the management of musculoskeletal conditions: a systematic review and meta-analysis of randomized clinical trials. *The Journal of Manual & Manipulative Therapy, 17*(4), 237.
- Ward, R. C., Hruby, R. J., & Jerome, J. A. (2002). *Foundations for osteopathic medicine*: Lippincott Williams & Wilkins.
- Yip, C. H. T., Chiu, T. T. W., & Poon, A. T. K. (2008). The relationship between head posture and severity and disability of patients with neck pain. *Manual Therapy, 13*(2), 148-154.
- Youdas, J. W., Carey, J. R., & Garrett, T. R. (1991). Reliability of measurements of cervical spine range of motion—comparison of three methods. *Physical Therapy, 71*(2), 98-104.
- Zedka, M., Prochazka, A., Knight, B., Gillard, D., & Gauthier, M. (1999). Voluntary and reflex control of human back muscles during induced pain. *The Journal of physiology, 520*(2), 591-604.

Section Two: Manuscript

With the exception of embedded figures and tables, this manuscript has been prepared in accordance with the instructions for authors for the International Journal of Osteopathic Medicine (Appendix F).

Investigating Inter-Relationships Between Pain, Mobility, and Posture Following Osteopathic Treatment In Patients With Chronic Neck Pain.

Author: Kathryn Frith

Affiliation: Department of Osteopathy

Unitec New Zealand

Private Bag 92025

Auckland

New Zealand

Contact: katt.frith@gmail.com

Abstract

Background: Previous studies have investigated the benefits of osteopathic treatment on pain and disability associated with neck pain but variables associated with treatment efficacy are unclear. This study aimed to investigate whether posture or mobility is associated with changes in pain and disability following osteopathic treatment.

Methods: Twenty-one participants (15 female and 6 male) with chronic neck pain received two osteopathic treatments per week for 3 weeks. and were randomised to start treatment immediately or after a 3-week delay. Neck Disability Index (NDI), pain via Visual Analogue Scale (VAS), cervical range of motion (in two planes and about its rotational axis), and posture via craniovertebral angle (CVA) were measured.

Results: A large inverse correlation was seen between initial NDI and change in VAS (from initial to post treatment) following osteopathic treatment ($r = -0.62, p = 0.004$). Non-significant trends towards inverse correlations of moderate effect size were observed between initial CVA and change in NDI from initial to follow-up ($r = -0.41, p = 0.07$), and between initial rotation left and change in NDI (initial to follow up) ($r = -0.44, p = 0.28$). Changes in pain and disability were not associated with any other posture or mobility variables or their change.

Conclusions: This study shows little evidence that neck posture or mobility, or their changes, are associated with neck disability or pain changes following osteopathic treatment. Posture and mobility measures do not seem useful for predicting clinical outcomes of manual therapy.

Key words: manipulation, manual therapy, mobilisation, movement, musculoskeletal, osteopathy, spine, soft tissue treatment.

Introduction

Neck pain is common and afflicts 20 – 70% of people at least once during any one year⁽¹⁻⁴⁾. The ramifications of neck pain are many and varied but may include work absenteeism, chronic pain, and disruptions or disability in completing daily tasks^(5, 6). Neck pain can reduce range of motion, cause headaches and arm pain^(6, 7), and is often associated with disability^(8, 9). Many published studies and reviews have compared the effectiveness of single manual therapy techniques with another treatment on neck pain^(2, 9-18), but there is very little research available on cross-sectional relationships between these measures reported in neck pain studies either before, during, after or in the absence of an intervention.

Correlations of varying strength have been found between pain and disability^(8, 19). Relationships have also been reported between neck posture and neck pain^(8, 20, 21), and correlations have been investigated between cervical range of motion and pain⁽²²⁾ and range of motion and disability⁽²³⁾. Lund et al.⁽²⁴⁾ states that those in pain may have adaptive changes in their posture and range of motion due to changes in activation of the muscles. These protective mechanisms may mean that when one region is painful, surrounding muscles help provide a biological splint, redistributing some of the workload from muscles within the painful region. Thus the pain can spread and the range and velocity of movement from the surrounding muscles is reduced⁽²⁴⁻²⁶⁾. In these instances those suffering neck pain may have more forward head posture, less range of motion and more widespread pain.

Correlational relationships have been shown between mobility, pain and disability^(19, 23, 27). In everyday life, sufferers often find that mobility restricts daily activities, for example they may find the neck pain they experience makes reversing a vehicle out of a

driveway increasingly difficult. Posture and disability caused by neck pain have also been shown to be related ^(8, 20, 21). The more forward the head posture, the greater the pain and the more disability the person may perceive they have, ^(8, 20, 21) citation.

Perceived disability is also linked to difficulty completing everyday tasks and reduced mobility, with small to moderate relationships reported ^(19, 23, 27).

Despite the cross-sectional evidence, there are a lack of reported longitudinal inter-relationships involving changes in neck pain and disability, and posture and range of motion following manual therapy treatment. This is important information in a clinical context. If a manual therapist can predict who might respond better to treatments in terms of pain and disability from the initial measurements of posture and mobility, this provides them with more predictive power in terms of treatment outcomes.

Osteopathy is a type of manual therapy treatment in which practitioners utilise a selection of techniques on a patient that vary according to individual history, age and body type of the individual as well as findings from clinical examination ^(28, 29). It is important to investigate relationships between pain, disability, mobility and posture following osteopathic treatment because the techniques used address pain, range of motion and/or posture of a person, and as a result the relationships between these variables may be linked.

The aims of this research are primarily to investigate whether posture and/or mobility are associated with changes in pain or disability and, secondarily to investigate if changes in posture and mobility correlate with changes in pain and disability following osteopathic treatment.

Methods

Study Design

A modified randomised-controlled design was employed in which participants were randomised to either immediate-start or delayed-start groups. As all participants received treatment, both groups were considered as a single cohort. The Unitec Research Ethics Council approved the study (approval number 2011-1196) and data were collected between August 2011 and May 2012 (Appendix A). Two reports arise from this study. Research investigating the effectiveness of the intervention was carried out by a colleague.

Sample Size

Using G*Power 3⁽³⁰⁾, a sample size of 12 participants per group was calculated for the intervention study, based on the ability to detect an effect size in the Visual Analogue Scale(VAS) of 1, equivalent to a change in Visual Analogue Scale (VAS) of 2.7⁽⁶⁾, assuming a two-tailed test, an alpha-level of 0.05, a power of 0.8, and allowing for an additional two participants per group in case of withdrawals from the study.

Participants

Adults sought for the study were required to be between 25 and 65 years of age with a primary complaint of musculoskeletal pain between the base of the skull and the first thoracic vertebra (neck pain) of more than 12 weeks duration, and which attained a VAS intensity of 3 cm out of 10 cm, at some time each day, on most days of the week.

The study was advertised via notices and local newspaper articles within Western and Central Auckland. In addition, study details were listed in an advertisement on an internet-based research participant database ResearchStudies.co.nz. Participants with pain caused by skeletal and neurovascular conditions such as recent whiplash, inflammatory disorders and/or neurological disorders were excluded from the study, as were those who had undergone recent neck surgery, and those who exhibited contraindications (absolute or relative) to the use of osteopathic techniques. An osteopathic physical examination, which may have included orthopaedic or neurological testing, took place and only those participants with a diagnosis of pain from a musculoskeletal origin continued into the study. Osteopathic students were also excluded from the study due to their exposure to osteopathic treatment.

Randomisation

Participants were randomised using block randomisation (www.random.org) into either the immediate-start group or the delayed-start group and scheduled for their examination and first treatment. Those who were allocated to the delayed-start group were instructed to continue with life as normal, and a pre-treatment measurement session was scheduled three weeks later (see fig 1).

Measurements

Pain and Disability

Dependent variables measuring neck disability and pain intensity were Neck Disability Index (NDI) and VAS, respectively. The Neck Disability Index is a ten-item questionnaire that reports patient disability as a result of neck pain ⁽³⁶⁾. The NDI has been previously shown to be reliable and correlated with the Neck and Pain Disability Scale ($r = 0.86$ $p = 0.01$) ⁽³¹⁾ and the Northwick Park Pain Questionnaire ($r = 0.88$) ⁽³²⁾. Both of these measures have been shown to correlate well with other similar pain measures and have high reliability in recent studies ⁽³³⁻³⁵⁾.

The Visual Analogue Scale for pain has been shown to give consistent results when compared to other pain intensity scales including the Numeric Rating scale, and the Verbal Descriptor Scale for Pain.

Posture and Range of Motion

Sagittal posture of the neck, measured via cranio-vertebral angle (CVA), and cervical range of motion (CROM) in three planes were assessed as potential explanatory variables. The CVA was measured using a lateral photograph. Participants were seated upright in a chair and asked to look directly forwards. A digital camera was positioned 0.8 m from their spinous process of C7 vertebra, and then markers were then placed on the tragus of the ear and on the spinous process of C7 and a series of three digital photographs were taken. A line was drawn from the spinous process of C7 and the tragus of the ear and a second line from the spinous process of C7 projected

horizontally and the angle between these two lines was recorded ⁽⁸⁾. (see Appendix D for protocols and scripts).

Cervical ROM was measured using an electrogoniometer attached to the top of the participants head, and a software programme was used to measure the ROM.

Participants were seated and instructed to look straight ahead and then instructions were given by the measurers on how to perform all of the movements. The angles of movement from neutral to maximal, unassisted flexion extension, side-bending left and right and rotation left and right were measured and recorded.

Timing of Measurements

Outcome measures, NDI, , CROM and CVA, were measured three weeks apart. Those randomised to the immediate start had measures made directly before treatment, as well as three weeks later. Those randomised to delayed start had two measurements prior to treatment (Initial and Pre-Treatment) which were averaged for the purposes of these analyses, as there was no significant change between them. VAS measurements were completed before each treatment appointment. Measurers were employed for the assessment of CVA and CROM and they remained blinded to the treatments which took place.

Osteopathic Treatment

Treatments were performed by two final-year Master of Osteopathy students and took place under the supervision of registered clinic tutors at the Unitec osteopathic clinic.

Case history and treatment notes were made in accordance with normal procedures at the clinic. Participants received 2 treatments a week for 3 weeks.

The osteopathic treatment protocol used in this study was semi-standardised and identical to a treatment protocol described by Fryer et al (2005). It included a selection of soft tissue techniques: cross-fibre kneading (inhibition) to trapezius, cervical, thoracic erector spinae, levator scapulae, and sub occipital muscles; articulation (passive joint mobilisation) to the cervical and thoracic spine; muscle energy technique to the scalenes, levator scapulae, trapezius, sternocleidomastoid muscles; counterstrain technique and high velocity, low amplitude thrusts. Verbal consent was sought before any treatment or technique was applied.

Non-standardised post-treatment advice may have been given to the participants. The advice given was dependant on what the practitioner deemed to be right for the participants. It may have included exercises or postural advice, stretches or guidance on possible treatment reactions. Further information on advice given to participants is available in Appendix E.

Statistical Analysis

All relationships were investigated using Pearson's correlational analysis. Following analysis of the distribution, key variables were checked and assumptions of normality were adhered to⁽³⁷⁾. The level of statistical significance was set at $p < 0.05$ and correlations were evaluated using Hopkins descriptors of effect magnitude⁽³⁸⁾.

Statistical calculations were performed using SPSS v.18 (SPSS Inc). Unless specified otherwise, data are reported as mean (standard deviation).

Results

Participants

From 28 applicants, 4 were recruited online and 24 from newspaper articles, 7 in total withdrew from the study due to 'lack of time'. Thus, a total of 21 participants were enrolled (6 males and 15 females, aged 50.8 (10.8) years [mean (SD)], and with a pain duration of 412 (501) weeks, (median 248 weeks, range 17 – 1565 weeks). One participant withdrew after completion of the treatment sessions and post-treatment data collection, but prior to the 3-week follow-up, because of commencement of full-time work. All participants attended at least 4 sessions. Gender distribution into the Delayed- and Immediate-start Groups was equal. Limited data ($n = 8 - 9$) were available for pre-treatment ROM measurement points (right side-bending and left and right rotation) due to a data collection error.

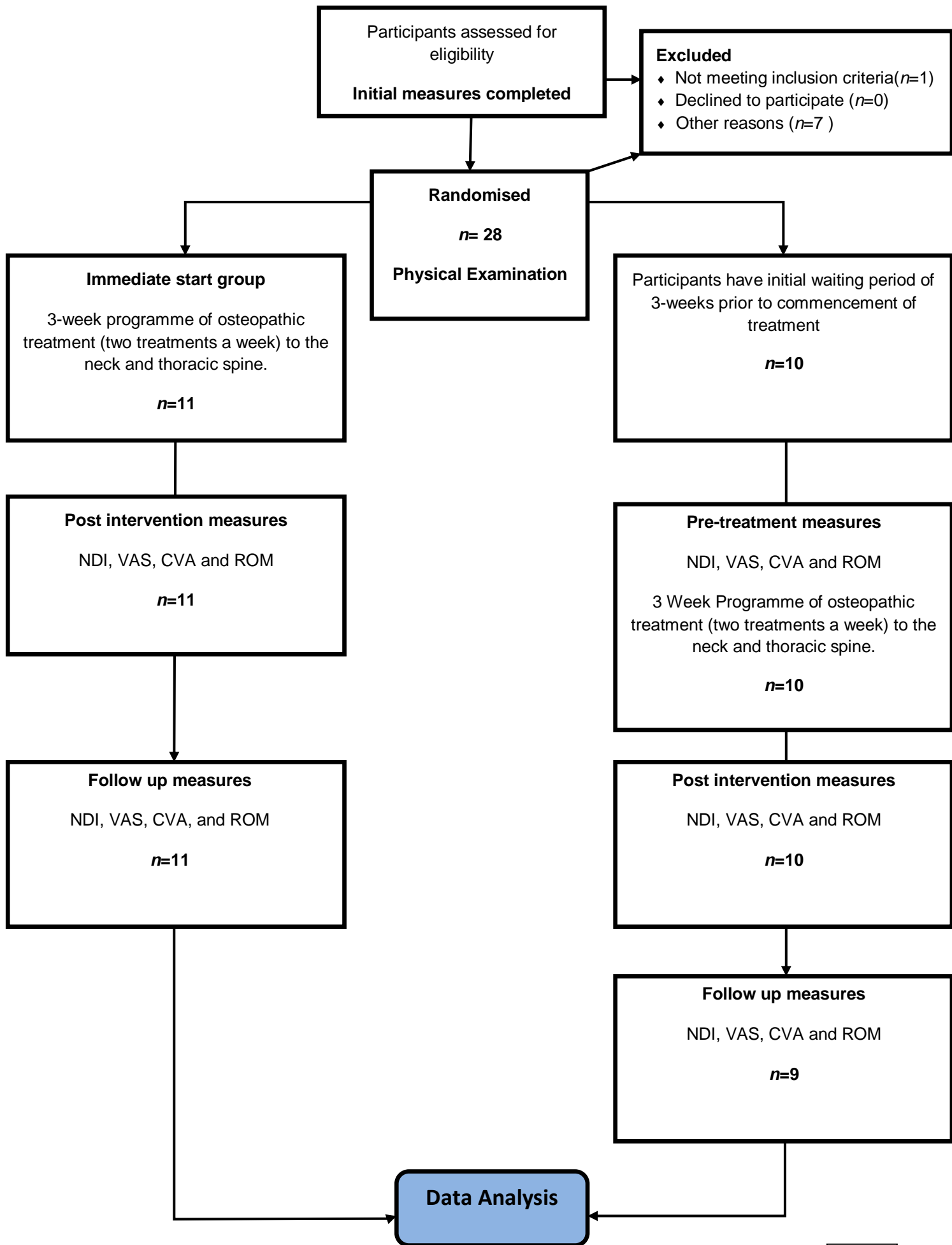


Fig. 1

Initial Participant Characteristics (Table 1)

At baseline, participants mean NDI score and VAS were 15.2 % (males) – 27.9 % (females) and 2.3cm (males) – 3.9cm (females) respectively. When variables were viewed by gender, males, compared to females, reported lower NDI and VAS ($p < 0.05$ for both), (Table 1). Left side bending was also greater in males than females ($p = 0.04$). There was less variability between genders in neck mobility and posture measures (Table 1).

Pre-Treatment Relationships (Table 2)

NDI and VAS exhibited a correlation of large effect size ($r = 0.57$; $p = 0.007$) (see fig 2.). NDI correlated moderately and inversely with extension ($r = -0.47$; $p = 0.03$) (see fig 3.). Though inverse correlations of moderate effect size were observed between NDI and left and right side-bending, these did not reach statistical significance ($p = 0.1$). The stronger of these, right side-bending, was due to a smaller sample size ($n = 9$).

Pain, Disability, Posture and ROM at Pre-Treatment, Immediately Post-Treatment and Follow-Up (Table 3).

NDI decreased by 8.7 percentage points (pre- to post-treatment) and again by 1 percentage point (from post-treatment to follow-up) and was different from before treatment at both post-treatment time-points ($p < 0.001$ for ANOVA) . VAS also decreased by 20 mm from pre-treatment to post-treatment ($p = 0.001$ for ANOVA), and all follow-up measurements were different from pre-treatment. Flexion increased from 45° pre-treatment to 50° at follow up ($p = 0.04$ for ANOVA), while CVA and other

cervical range of motion changes over the six week treatment and follow-up period were minimal and non-significant.

Table 1. Initial Participant Characteristics

	Males (<i>n</i> =6)		Females (<i>n</i> =15)		Difference	Combined	
	mean	SD	mean	SD	p value*	mean	SD
Pain and Disability							
NDI (%)	15.2	(10.2)	27.9	(8.4)	0.008	24.3	(10.5)
VAS (cm)	2.3	(1.2)	3.9	(2.1)	0.048	3.5	(2.0)
Posture							
CVA (degrees)	51.2	(7.9)	50.7	(6.6)	0.9	50.8	(6.8)
Neck Mobility							
Flexion (degrees)	46.2	(7.1)	44.6	(10.0)	0.7	45.1	(9.1)
Extension (degrees)	55.7	(14.0)	42.0	(8.7)	0.01	45.9	(11.9)
Side bending Right (degrees)	44.3	(6.6)	30.0	(8.4)	0.04	34.8	(10.3)
Side bending Left (degrees)	41.9	(5.9)	33.9	(7.9)	0.04	36.2	(8.1)
Rotation Right (degrees)	85.0	(10.7)	76.2	(16.3)	0.4	79.1	(14.7)
Rotation Left (degrees)	99.0	(4.5)	82.0	(23.1)	0.1	87.6	(20.3)

Note: *difference between genders

Table 2: Pre-treatment postural and mobility correlations with VAS, NDI and CVA

	NDI	VAS	CVA
Cranio vertebral Angle	-0.11	-0.17	1.00
Flexion	-0.03	0.19	0.32
Extension	* -0.47	0.20	0.25
Side bending right	^ -0.55	-0.25	0.30
Side bending left	-0.37	-0.03	0.04
Rotation Right	-0.13	0.15	^0.56
Rotation Left	-0.04	0.18	^0.59

* Correlation is significant at the $p < .05$ level, ^ Not significant due to lack of data points (n = 9).

0.0-0.1	trivial, very small, insubstantial, tiny, practically zero
0.1-0.3	small, low, minor
0.3-0.5	moderate, medium
0.5-0.7	large, high, major
0.7-0.9	very large, very high, huge
0.9-1	nearly, practically, or almost: perfect, distinct, infinite

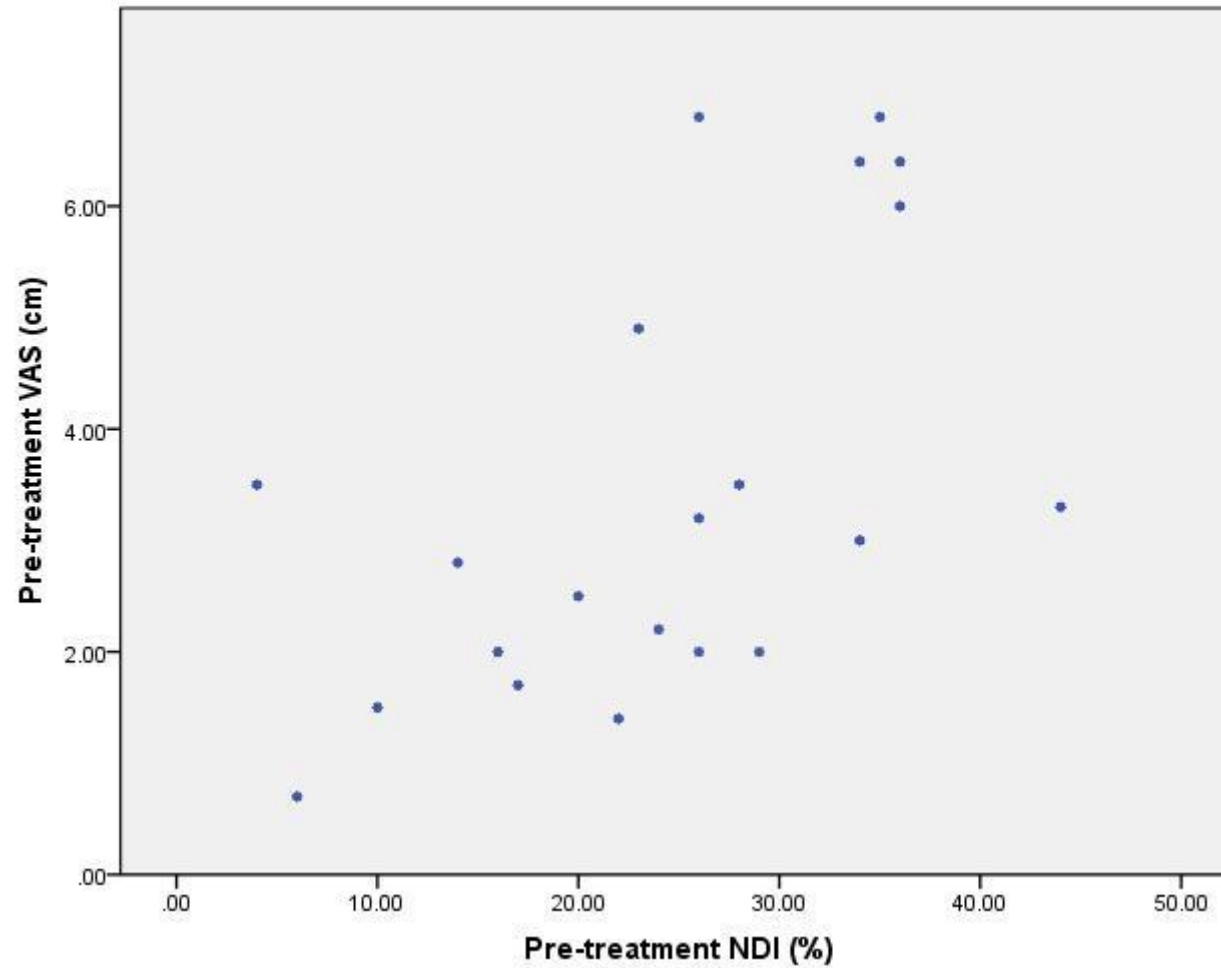


Fig 2. Scatter plot of correlations between pre-treatment VAS and pre-treatment NDI, $r = 0.57$ $p = 0.007$

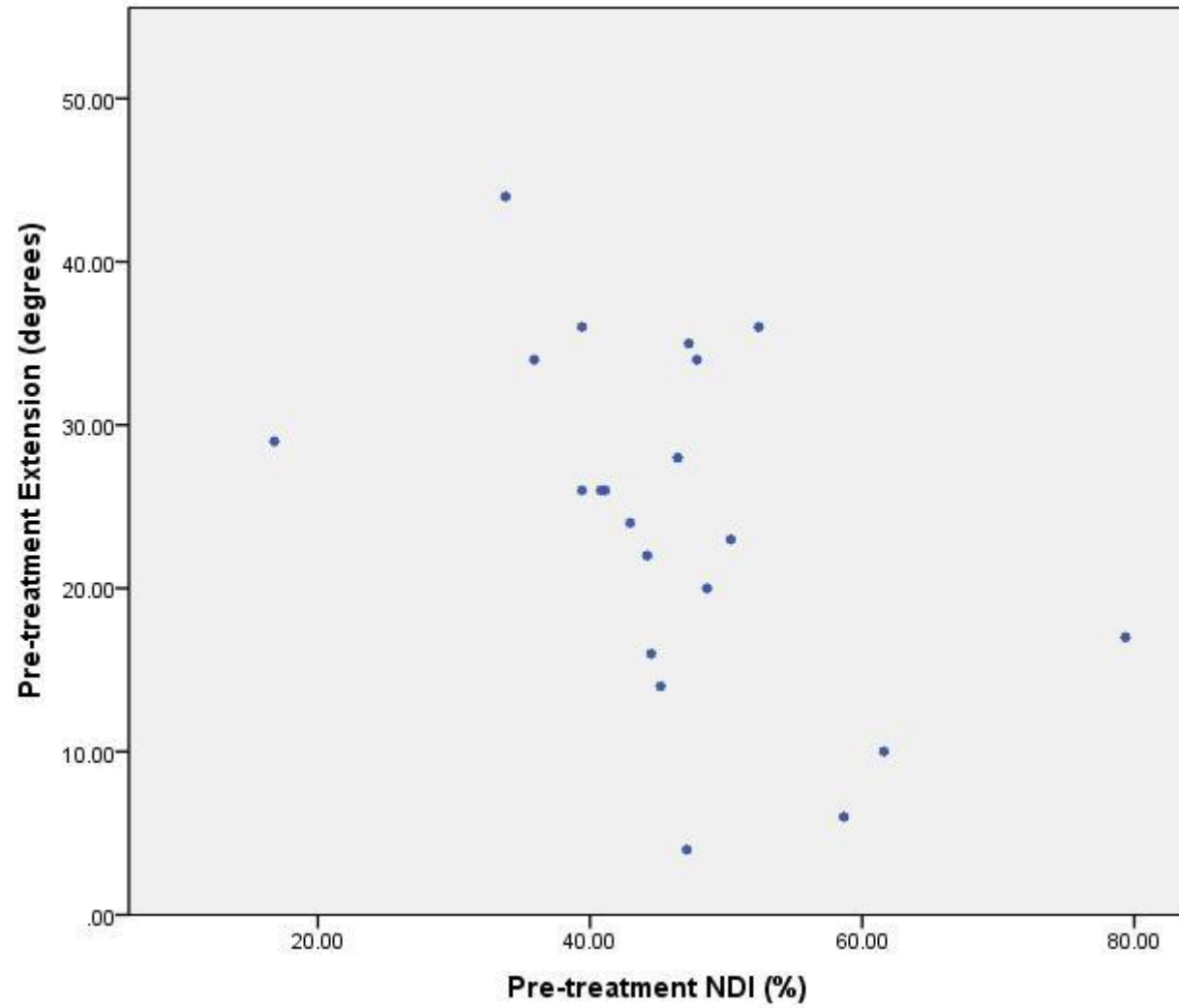


Fig 3. Scatter plot of correlations between pre-treatment extension and pre-treatment NDI, $r = -0.47$ $p = 0.03$

Table 3: Mean measurements in initial disability, pain, posture and mobility, Immediately post treatment and at three weeks follow-up

	Pre-treatment				Post Treatment			Follow Up		
	n	Mean	CI (95%)		Mean	CI (95%)		Mean	CI (95%)	
			lower	upper		Lower	Upper		Lower	Upper
NDI (%)	20	24.3	19.2	29.4	*15.6	10.7	20.3	*14.6	10.3	18.9
VAS (cm)	21	3.5	2.6	4.3	*1.5	0.8	2.1	n/a	n/a	n/a
CVA (°)	20	50.8	48.5	54.4	49.0	46.2	53.0	47.3	41.3	53.3
Flexion (°)	20	45.1	41.1	49.7	48.4	45.7	51.3	*49.9	45.6	54.3
Extension (°)	20	45.9	40.3	51.8	48.6	42.7	54.9	48.7	43.4	53.9
Side bending Right (°)	8	34.8	25.3	43.7	34.3	30.8	44.5	40.9	29.5	53.7
Side bending Left (°)	20	36.2	32.0	39.8	37.7	33.6	41.2	37.8	33.2	42.3
Rotation Right (°)	8	79.1	65.8	92.0	74.0	75.3	90.2	78.7	79.2	99.4
Rotations Left (°)	8	87.6	68.9	104.9	84.9	80.6	109.6	85.2	79.6	108.7

NOTE: * indicates a significant difference from baseline at the $p < 0.05$ level (two-tailed)

Correlates of Change in Disability and Pain

To determine whether the change in disability and pain scores was related to the magnitude of pain, disability, posture or range of motion measures, correlates of change from pre-treatment to post-treatment and, post-treatment to follow-up were explored (Table 4). For relationships between changes in NDI and VAS and their own magnitudes, change scores were correlated with average scores from the same time-points⁽³⁹⁾. A large inverse relationship was shown between initial NDI and change in VAS (pre- to post-treatment) ($r = -0.62$; $p = 0.004$) (Figure 4). Moderate inverse correlations ($r = -0.4$) that failed to attain statistical significance were noted between NDI (change from pre-treatment to follow-up) and initial CVA ($p = 0.07$; $n = 20$; Table 4), and rotation left ($p = 0.3$; $n = 8$; Table 4). Removing outliers reduced the effect.

Relationships between changes in disability and pain, and changes in other variables over the same time period were also determined (shown in Table 5). A large-sized relationship ($r = 0.68$) was found between pre- to post-treatment change in NDI and change in VAS ($p < 0.001$; Figure 4 and 5). Correlations with moderate effect sizes were noted between pre- to post-treatment changes in NDI and in CVA; and right and left side-bending; and between pre-treatment to follow-up changes in NDI and left rotation, although none attained statistical significance (p range 0.1 – 0.4) and some were affected by missing data ($n = 8 - 9$).

[Individual analyses are included in the appendices (see appendix E)]

Table 4: Correlations of change in VAS and NDI Immediately post treatment and at three-weeks follow-up versus initial measurements in CROM, CVA, NDI and VAS

	VAS (change from initial to post-Tx)	NDI (change from initial to post-Tx)	NDI (change from pre-treatment to follow-up)
VAS	~-0.28	-0.26	-0.14
NDI	*-0.62	~-0.06	~-0.24
Craniovertebral Angle	-0.10	-0.07	-0.41
Flexion	-0.21	0.02	0.06
Extension	0.12	0.10	0.07
Side bending Right	0.24	0.04	-0.05
Side bending Left	0.19	0.15	0.01
Rotation Right	-0.07	0.21	-0.13
Rotation Left	-0.20	0.02	-0.44 [^]

0.0-0.1	trivial, very small, insubstantial, tiny, practically zero
0.1-0.3	small, low, minor
0.3-0.5	moderate, medium
0.5-0.7	large, high, major
0.7-0.9	very large, very high, huge
0.9-1	nearly, practically, or almost: perfect, distinct, infinite

* Correlation is significant at the 0.05 level

[^] Not significant due to lack of data points (n = 8)

~ Averages for NDI and VAS at same data points as change used as suggested by Gill et al, 1985 ⁽³⁵⁾

Tx - treatment

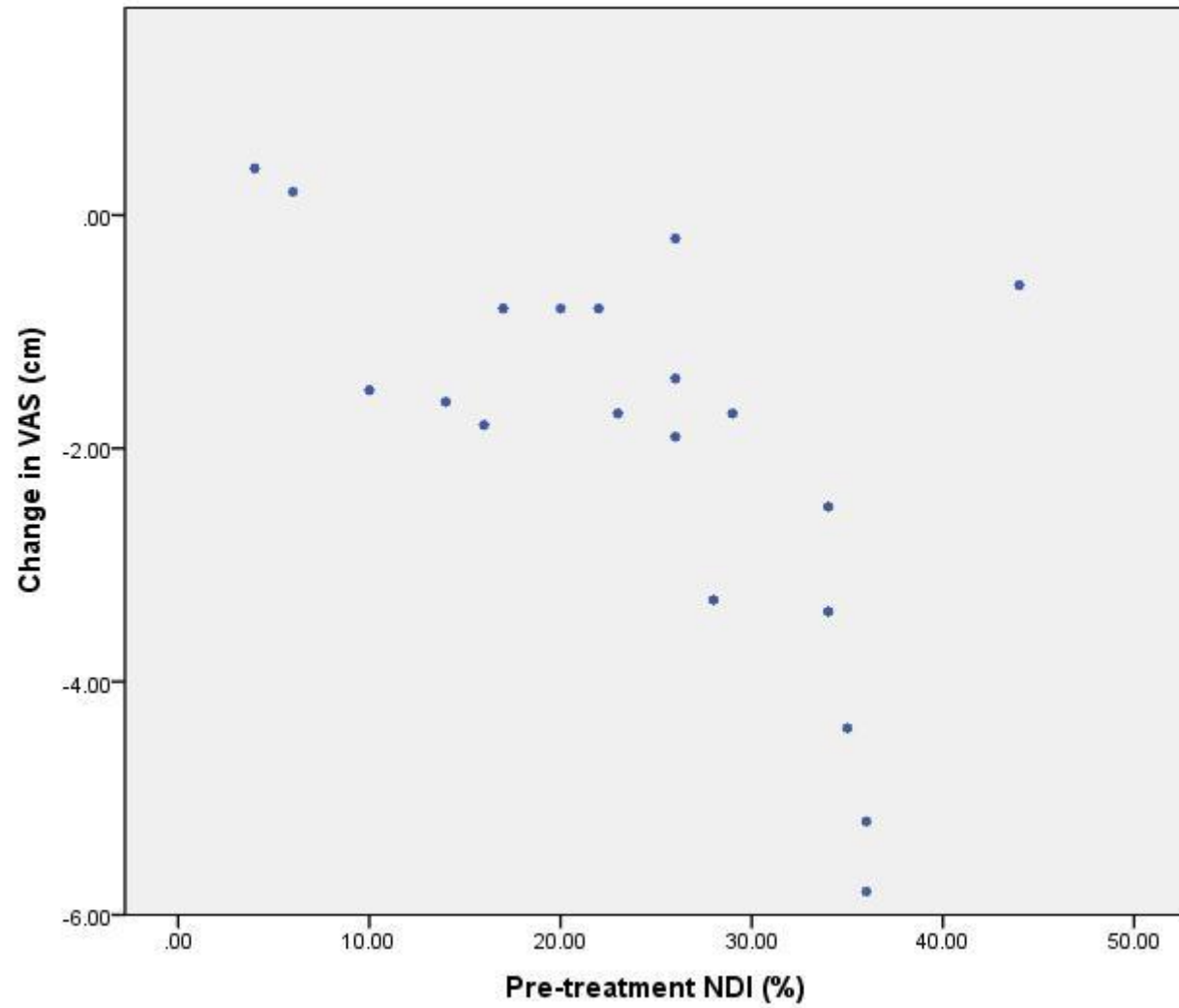


Fig 4. Scatter plot showing correlation between change in VAS (pre- to post-treatment) and pre-treatment NDI, $r = -0.62$ $p = 0.004$

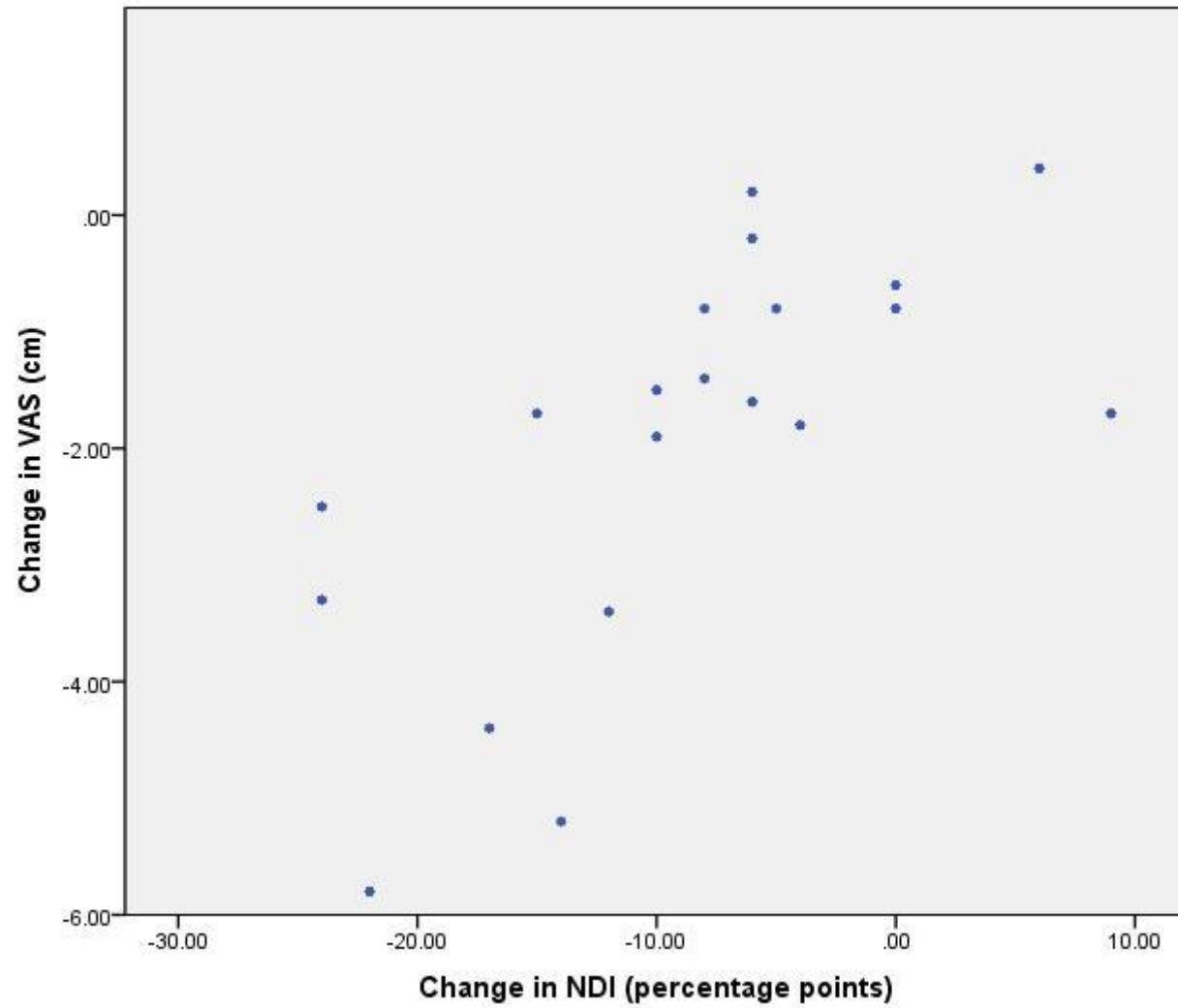


FIG 5. Scatter plot showing correlation between change in VAS (pre- to post-treatment) and NDI(pre- to post-treatment), $r = 0.68$ $p = 0.001$

Table Five: Correlations of change in Pain and Disability versus changes in Range of Motion and Posture at the same time points

	Change in NDI pre- to post-treatment	Change in NDI Pre-treatment to follow up	Change in VAS pre- to post- treatment
Change in Craniovertebral Angle	0.34	0.27	0.21
Change in Flexion	-0.21	-0.02	0.24
Change in Extension	-0.08	-0.10	0.15
Change in Side bending Right	-0.39	-0.16	-0.26
Change in Side bending Left	-0.34	-0.07	-0.27
Change in Rotation right	0.21	-0.07	0.14
Change in Rotation Left	-0.14	0.34	-0.06

0.0-0.1	trivial, very small, insubstantial, tiny, practically zero
0.1-0.3	small, low, minor
0.3-0.5	moderate, medium
0.5-0.7	large, high, major
0.7-0.9	very large, very high, huge
0.9-1	nearly, practically, or almost: perfect, distinct, infinite

Discussion

This study primarily examined the relationships between neck posture and mobility measurements and changes in both neck pain and disability following a semi-standardised osteopathic treatment protocol in people with chronic neck pain. There was no evidence that initial levels of mobility and posture correlated with changes in pain or disability following osteopathic treatment. Furthermore, there was no tendency for change in posture and mobility to be related to clinical outcomes of pain and disability.

The inverse cross-sectional correlation between NDI and neck extension result concurs with the results of two other studies investigating baseline correlations^(19,27). Chiu, Lam and Hedley (2005)⁽¹⁹⁾ reported a small inverse correlation between Northwick Pain Questionnaire and overall neck ROM ($r = -0.20$) and results of another research study showed moderate inverse correlation ($r = -0.54$) between NDI and ROM⁽²⁷⁾, while reported results by Riddle & Stafford⁽²³⁾ show positive correlations (0.28 – 0.40). These studies varied in equipment used, age range and sample size.

Equipment varied between these three studies and the current research. An electrogoniometer was used here, while Chiu et al. (2005)⁽¹⁹⁾ used a potentiometer and Riddle et al. (1998)⁽²³⁾ and Hermann et al. (2001)⁽²⁷⁾ both used a different ROM devices. Though all three authors used a similar procedure to those employed in the current study, the variability in the equipment and set up employed may have caused a variation in results. Nonetheless, this does not seem to explain all differences since the equipment and protocols used by Hermann & Reese⁽²⁷⁾ and Riddle et al.⁽²³⁾ were the same as those used by Youdas, Carey & Garnett (1991)⁽⁴⁰⁾ and yet the results of these

two studies are very different. Further study on correlations between the range of motion of the neck and disability caused by neck pain are required to gain further insight into whether relationships between the two are robust. First, standard equipment and methods of measuring mobility of the neck must be agreed upon by researchers in order to ascertain whether correlations of similar strength can be found.

Ages also varied between the three studies. Chiu et al. (2005)⁽¹⁹⁾ study participants' age was 44 ± 10 years (mean \pm SD), participants in Riddle et al. ⁽²³⁾ were aged 18 – 70 years, and for Hermann et al. ⁽²⁷⁾ study, participants aged 18 – 70⁺ years, while the current study's participants were younger and with a smaller age variability (aged 51 ± 11 years). Therefore Chiu et al. (2005)⁽¹⁹⁾ along with the current research had the smallest age range of any of the four studies, and this may have meant a smaller range of mobility was recorded. Because Riddle et al ⁽²³⁾ had very different results it is difficult to say if age played a role, as the age variability is reported as range not a mean.

Chiu et al⁽¹⁹⁾ had the largest sample size, ($n = 218$), followed by Riddle et al⁽²³⁾ with 159, Hermann et al. ⁽²⁷⁾ ($n = 80$) whilst the current study had 21 participants take part. A large inverse correlation between NDI and both bilateral side bending and rotation reported in the current study attained a large effect size but did not demonstrate statistical significance. The lack of statistical significance is possibly due to missing data for side-bending and rotation at the pre-treatment data collection stage, which was due to an recording error. Had more participant data points been available for analysis this correlation may have possibly gained a *p value* of <0.05 .

Although not a focus of this investigation, this study showed moderate to strong associations between the disability and pain measures used. The relationships between

pain and disability seem to continue over time, and in response to osteopathic intervention. The large correlation between change in disability and change in pain intensity (from pre- to post-treatment) show a trend for the two measures to change in parallel with each other. This trend may potentially suggest links between the two measures in the mechanisms of treatment response. It may be that when pain is addressed by treatment, the disability also changes, perhaps in part due to patient perception. When the participant perceives they have less pain, their disability is also decreased. This may be linked to changes in the participants fear-avoidance behaviour, they may have experienced as a result of suffering from chronic pain. They may think they cannot complete everyday tasks because of the pain, which leads to heightened levels of perceived disability ⁽⁴¹⁻⁴⁴⁾.

Here the inverse association between pre-treatment NDI and change in VAS (pre-treatment to post-treatment) in this study shows that beneficial changes in pain scores could possibly be predicted by high initial disability scores. What this may mean for the practitioner is in those patients who experience neck pain and disability their outcomes might be able to be predicted by their NDI scores, thus giving the practitioner the opportunity to predict who will make in biggest gains in terms of changes to pain scores. Interestingly neither NDI nor VAS appear to be related to improvement in disability. Correlations reported here must be treated with caution. There are no other studies which investigate change correlates so this study adds new information.

While the inclusion criterion for participant age in the current study was 25 – 65 years, it attracted mainly those in the older demographic, with only one participant in this study under the age of 40 years. This may have been because these participants had the time and motivation to take part or that they are in the demographic that reads local papers or enrolls online with ResearchStudies.co.nz. Conclusions from relationships

observed here are therefore limited to middle-aged adults and less generalisable to the whole adult population. Another limitation was the sample size. The study was underpowered for correlation analysis as it was powered for the intervention part of the study⁽⁴⁵⁾. In future studies of this nature a larger number of participants would lend some weight to the presence or lack of correlations present in the data. Due to the small number of participants the results of this study are not generalisable to the general population suffering chronic neck pain.

Measurers used and measurement of VAS are also identified as a limitation in the current study. Three different people completed the measures of craniovertebral angle and range of motion in the current study using pre-prepared protocols and scripts. This may have introduced some inter-measurer variability but different measurers were used due to individual time limitations, when ideally one person would have been employed.

VAS was measured as part of a standard pre-treatment protocol for osteopathic therapy. As a result of this, the inclusion of three week follow-up measures for VAS was consequently overlooked, and consequently the longer term relationship between pain and other variables is unknown.

Conclusion

This study shows no evidence of a relationship between initial posture and mobility and changes in pain and disability following osteopathic treatment. A secondary finding is of no evidence of a meaningful correlation between change in posture and mobility and change in pain and disability. Therefore, both initial values and changes in posture and mobility were found to not be predictive of changes in pain and disability following osteopathic treatment.

References

1. Borghouts JAJ, Koes BW, Vondeling H, Bouter LM. Cost-of-illness of neck pain in The Netherlands in 1996. *Pain*. 1999;80(3):629-36.
2. Carpenter KJ, Mintken PE, Cleland JA. Evaluation of outcomes in patients with neck pain treated with thoracic spine manipulation and exercise: a case series. *NZ Journal of Physiotherapy*. 2009;37(2):76.
3. Côté P, Cassidy JD, Carroll L. The Saskatchewan health and back pain survey: the prevalence of neck pain and related disability in Saskatchewan adults. *Spine*. 1998;23(15):1689.
4. Fejer R, Kyvik KO, Hartvigsen J. The prevalence of neck pain in the world population: a systematic critical review of the literature. *European spine journal*. 2006;15(6):834-48.
5. Goodman C, Snyder T. *Differential Diagnosis for Physical Therapists: Screening for Referral*. St Louis, Missouri: Saunders Elsevier; 2007.
6. Fryer G, Alvizatos J, Lamaro J. The effect of osteopathic treatment on people with chronic and sub-chronic neck pain: A pilot study. *International Journal of Osteopathic Medicine*. 2005;8(2):41-8.
7. Brukner P, Khan K. *Clinical sports medicine*: McGraw Hill; 2010.

8. Lau KT, Cheung KY, Chan kB, Chan MH, Lo KY, Wing Chiu TT. Relationships between sagittal postures of thoracic and cervical spine, presence of neck pain, neck pain severity and disability. *Manual Therapy*. 2010;15(5):457-62.
9. Miller J, Gross A, D'Sylva J, Burnie SJ, Goldsmith CH, Graham N, et al. Manual therapy and exercise for neck pain: A systematic review. *Manual Therapy*. 2010;15(4):334-54.
10. Cleland J, Flynn T, Childs J, Eberhart S. The audible pop from thoracic spine thrust manipulation and its relation to short-term outcomes in patients with neck pain. *The Journal of Manual & Manipulative Therapy*. 2007;15(3):143.
11. Cleland J, Glynn P, Whitman J, Eberhart S, MacDonald C, Childs J. Short-term effects of thrust versus nonthrust mobilization/manipulation directed at the thoracic spine in patients with neck pain: a randomized clinical trial. *Physical Therapy*. 2007;87(4):431.
12. Cleland JA, Childs MJD, McRae M, Palmer JA, Stowell T. Immediate effects of thoracic manipulation in patients with neck pain: a randomized clinical trial. *Manual Therapy*. 2005;10:127-35.
13. Sharples L. Does a single thrust manipulation of the upper thoracic spine increase neck range of motion? A research project submitted in partial requirement for the degree of Master of Osteopathy, Unitec Institute of Technology, Auckland. 2010.
14. Murphy B, Taylor HH, Marshall P. The Effect of Spinal Manipulation on the Efficacy of a Rehabilitation Protocol for Patients With Chronic Neck Pain: A Pilot Study. *Journal of manipulative and physiological therapeutics*. 2009;33(3):168-77.

15. Gross A, Miller J, D'Sylva J, Burnie SJ, Goldsmith CH, Graham N, et al. Manipulation or mobilisation for neck pain: A Cochrane Review. *Manual Therapy*. 2010;15(4):315-33.
16. Escortell-Mayor E, Riesgo-Fuertes R, Garrido-Elustondo S, Asúnsolo-del Barco A, Díaz-Pulido B, Blanco-Díaz M, et al. Primary care randomized clinical trial: Manual therapy effectiveness in comparison with TENS in patients with neck pain. *Manual Therapy*. 2011;16(1):66-73.
17. D'Sylva J, Miller J, Gross A, Burnie SJ, Goldsmith CH, Graham N, et al. Manual therapy with or without physical medicine modalities for neck pain: a systematic review. *Manual Therapy*. 2010;15(5):415-33.
18. Walser R, Meserve B, Boucher T. The effectiveness of thoracic spine manipulation for the management of musculoskeletal conditions: a systematic review and meta-analysis of randomized clinical trials. *The Journal of Manual & Manipulative Therapy*. 2009;17(4):237.
19. Chiu TT, Lam TH, Hedley AJ. Correlation among physical impairments, pain, disability, and patient satisfaction in patients with chronic neck pain. *Archives of physical medicine and rehabilitation*. 2005;86(3):534-40.
20. Yip CHT, Chiu TTW, Poon ATK. The relationship between head posture and severity and disability of patients with neck pain. *Manual Therapy*. 2008;13(2):148-54.
21. Lau HMC, Chiu TTW, Lam TH. Measurement of craniovertebral angle with Electronic Head Posture Instrument: Criterion validity. *Journal of rehabilitation research and development*. 2010;47(9):911.

22. Hagen KB, Harms-Ringdahl K, Enger NO, Hedenstad R, Morten H. Relationship between subjective neck disorders and cervical spine mobility and motion-related pain in male machine operators. *Spine*. 1997;22(13):1501-7.
23. Riddle DL, Stratford PW. Use of generic versus region-specific functional status measures on patients with cervical spine disorders. *Physical Therapy*. 1998;78(9):951-63.
24. Lund JP, Donga R, Widmer CG, Stohler CS. The pain-adaptation model: a discussion of the relationship between chronic musculoskeletal pain and motor activity. *Canadian journal of physiology and pharmacology*. 1991;69(5):683-94.
25. Zedka M, Prochazka A, Knight B, Gillard D, Gauthier M. Voluntary and reflex control of human back muscles during induced pain. *The Journal of physiology*. 1999;520(2):591-604.
26. Hodges PW, Tucker K. Moving differently in pain: a new theory to explain the adaptation to pain. *Pain*. 2011;152(3 Suppl):S90-S8.
27. Hermann KM, Reese CS. Relationships among selected measures of impairment, functional limitation, and disability in patients with cervical spine disorders. *Physical Therapy*. 2001;81(3):903-12.
28. Ward RC, Hruby RJ, Jerome JA. *Foundations for osteopathic medicine*: Lippincott Williams & Wilkins; 2002.
29. Hartman LS. *Handbook of osteopathic technique*: Chapman & Hall Thomson Publ. Serv.; 1997.

30. Faul F, Erdfelder E, Lang AG, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*. 2007;39(2):175-91.
31. Chan Ci En M, Clair DA, Edmondston SJ. Validity of the Neck Disability Index and Neck Pain and Disability Scale for measuring disability associated with chronic, non-traumatic neck pain. *Manual Therapy*. 2009;14(4):433-8.
32. Hoving JL, O'Leary EF, Niere KR, Green S, Buchbinder R. Validity of the neck disability index, Northwick Park neck pain questionnaire, and problem elicitation technique for measuring disability associated with whiplash-associated disorders. *Pain*. 2003;102(3):273-81.
33. Chanques G, Viel E, Constantin J-M, Jung B, Lattre Sd, Carr J, et al. The measurement of pain in intensive care unit: Comparison of 5 self-report intensity scales. *Pain*. 2010;151(3):711-21.
34. Ferreira-Valente MA, Pais-Ribeiro JL, Jensen MP. Validity of four pain intensity rating scales. *Pain*. 2011;152(10):2399-404.
35. Hjerstad MJ, Fayers PM, Haugen DF, Caraceni A, Hanks GW, Loge JH, et al. Studies Comparing Numerical Rating Scales, Verbal Rating Scales, and Visual Analogue Scales for Assessment of Pain Intensity in Adults: A Systematic Literature Review. *Journal of Pain and Symptom Management*. 2011;41(6):1073-93.
36. Vernon H, Mior S. The neck disability index: A study of reliability and validity. *Journal of Manipulative Physiological Therapeutics*. 1991;14(7):409 - 15.

37. Field A. *Discovering statistics using SPSS*: Sage Publications Limited; 2009.
38. Hopkins WG. *A new view of statistics*. Internet Society for Sport Science. 2000; Available from: <http://www.sportsci.org/resource/stats/>.
39. Gill J, Beevers D, Zezulka A, Davies P. Relation between initial blood pressure and its fall with treatment. *The Lancet*. 1985;325(8428):567-9.
40. Youdas JW, Carey JR, Garrett TR. Reliability of measurements of cervical spine range of motion—comparison of three methods. *Physical Therapy*. 1991;71(2):98-104.
41. Leeuw M, Goossens ME, Linton SJ, Crombez G, Boersma K, Vlaeyen JW. The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. *Journal of behavioral medicine*. 2007;30(1):77-94.
42. Vlaeyen J, Linton SJ. Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. *Pain*. 2000;85(3):317-32.
43. Vlaeyen JWS, Linton SJ. Fear-avoidance model of chronic musculoskeletal pain: 12 years on. *Pain*. 2012;153(6):1144-7.
44. Thompson DP, Urmston M, Oldham JA, Woby SR. The association between cognitive factors, pain and disability in patients with idiopathic chronic neck pain. *Disability & Rehabilitation*. 2010;32(21):1758-67.
45. Gasson M. *Effectiveness of Osteopathic Treatment on Chronic Neck Pain*. Unpublished Thesis. 2013.

Section Three: Appendices

Appendix A: Ethical Approval

Kathryn Marr
4/7 Turama Rd
Royal Oak
Auckland 1023

24.8.2011

Dear Kathryn,

Your file number for this application: 2011-1196

Title: The effect of osteopathic therapy on chronic neck pain and disability: Associations with neck posture and mobility.



Your application for ethics approval has been reviewed by the Unitec Research Ethics Committee (UREC) and has been approved for the following period:

Start date: 28.7.2011

Finish date: 28.7.2012

Please note that:

1. The above dates must be referred to on the information AND consent forms given to all participants.
2. You must inform UREC, in advance, of any ethically-relevant deviation in the project. This may require additional approval.

You may now commence your research according to the protocols approved by UREC. We wish you every success with your project.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'P.S. Scott Wilson'.

Scott Wilson
Deputy Chair, UREC

cc: Catherine Bacon
Cynthia Almeida

study@unitec.ac.nz
Tel +64 9 849 4180
Fax +64 9 815 2901

Postal address
Private Bag 92025
Victoria St West
Auckland 1142
New Zealand

Mt Albert campus
139 Carrington Rd
Mt Albert
Auckland 1025
New Zealand

Newmarket campus
277 Broadway
Newmarket
Auckland 1023
New Zealand

Northern campus
10 Rothwell Ave
North Harbour
Auckland 0632
New Zealand

Waitakere campus
5-7 Ratanui St
Henderson
Auckland 0612
New Zealand

Appendix B: Case History Form

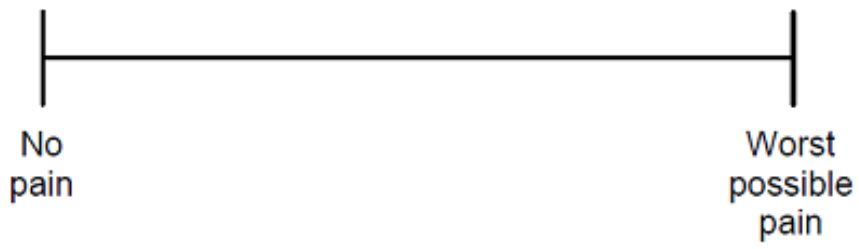
History of Neck Pain

<p>Presenting complaint</p> <p>Where is the pain exactly?</p> <p>Quality of pain?</p> <p>Associated symptoms</p>	
<p>Mode of Onset</p> <p>When did it start? How?</p>	
<p>Frequency</p> <p>How has it progressed?</p>	
<p>Duration of symptoms</p>	
<p>Daily Pattern</p>	
<p>Aggravating Factors</p>	
<p>Relieving Factors</p>	

Physical Examination

<p><u>Active tests:</u></p>	<p><u>Working Diagnosis:</u></p>
-----------------------------	----------------------------------

<p><u>Passive tests:</u></p> <p><u>Special tests/other findings:</u></p>	<p><u>Treatment:</u></p>
---	--------------------------



Appendix C: Neck Disability Index Questionnaire

Patient name: _____ **Date:** _____

Score: _____ **[50]**

This questionnaire has been designed to give your healthcare professional information as to how your neck pain has affected your ability to manage everyday life activities. Please mark in each section **ONE** box that applies to you. We realize that you may consider that two of the statements in any one section relate to you, but please just mark the box that **most closely** describes your **present day situation**.

Pain Intensity

- I have no pain at the moment
- The pain is very mild at the moment
- The pain is moderate at the moment
- The pain is fairly severe at the moment
- The pain is very severe at the moment
- The pain is the worst imaginable at the moment

Lifting

- I can lift heavy weights without extra pain
- I can lift heavy weights but it gives extra pain
- Pain prevents me from lifting heavy weights off the floor, but I can manage if they are conveniently positioned, for example on a table
- Pain prevents me from lifting heavy weights, but I can manage light to medium weights if they are conveniently positioned
- I can lift very light weights
- I cannot lift or carry anything at all

Headaches

- I have no headaches at all
- I have slight headaches which come infrequently
- I have moderate headaches which come infrequently
- I have moderate headaches which come frequently
- I have severe headaches which come frequently
- I have headaches almost all the time

Personal Care

- I can look after myself without causing extra pain
- I can look after myself normally but it causes extra pain
- It is painful to look after myself, I am slow and careful
- I need some help but manage most of my personal care
- I need help everyday in most aspects of self-care
- I do not get dressed, I wash with difficulty and stay in bed

Reading

- I can read as much as I want to with no pain in my neck
- I can read as much as I want to with slight pain in my neck
- I can read as much as I want with moderate pain in my neck
- I can't read as much as I want, because of moderate neck pain
- I can hardly read at all because of severe pain in my neck
- I cannot read at all

Concentration

- I can concentrate fully when I want to with no difficulty
- I can concentrate fully when I want to with slight difficulty
- I have a fair degree of difficulty concentrating when I want to
- I have a lot of difficulty concentrating when I want to
- I have a great deal of difficulty concentrating when I want to
- I cannot concentrate at all

Work

- I can do as much work as I want to
- I can do my usual work
- I can do my usual work, but no more
- I can do most of my usual work, but no more
- I can hardly do any work at all
- I can't do any work at all

Sleeping

- I have no trouble sleeping
- My sleep is slightly disturbed (< 1 hr sleepless)
- My sleep is mildly disturbed (1-2 hrs sleepless)
- My sleep is moderately disturbed (2-3 hrs sleepless)
- My sleep is greatly disturbed (3-5 hrs sleepless)
- My sleep is completely disturbed (5-7 hrs sleepless)

Driving

- I can drive my car without any neck pain
- I can drive my car as long as I want with slight pain in my neck
- I can drive my car as long as I want with moderate pain in my neck
- I can't drive my car as long as I want because of moderate pain in my neck
- I can hardly drive at all because of severe pain in my neck
- I can't drive my car at all

Recreation

- I am able to engage in all my recreation activities with no neck pain at all
- I am able to engage in all my recreation activities, with some pain in my neck
- I am able to engage in most, but not all my usual recreation activities, because of some pain in my neck
- I am able to engage in a few of my usual recreation activities because of pain in my neck
- I can hardly do any recreation activities because of pain in my neck
- I can't do any recreation activities at all

(McLean, 2011) – derived from Vernon, H., & Mior, S. (1991). The Neck Disability Index: A study of reliability and validity. *Journal of Manipulative and Physiological Therapeutics*, 14, 409-415

Appendix D: Protocols for Craniovertebral Angle and Cervical Range of Motion

Protocol for Cranio-vertebral Angle Photograph

1. Participant is seated in the chair with their bottom at the back of the seat and sitting on their ischial tuberosities.
2. Participants heels are in contact with the board positioned on the front of the legs of the chair. Feet are resting on the floor.
3. Participant sits with hands positioned comfortably in lap.
4. Place markers on participants C₇ (approx the middle of the spinous process) and on the tragus of the left ear.
5. Camera is placed directly opposite C₇ and at the same height as C₇, ensure that the cross hairs on camera is on the base of the C₇ marker and camera lens is 80cms from the participants seventh cervical vertebra.
6. Participant flexes their neck towards their chest, and up towards the ceiling three times before coming back to a comfortable position.
7. Have the participant to keep their eyes open and stare into the distance.
8. Take photo.

Repeat the photo twice more, Steps 7 to 11 making sure that the patient resets head position, using flexion extension three times before returning the head to a comfortable position.

ROM Protocol

1. Participant is seated in the chair with their bottom at the back of the seat and sitting on their ischial tuberosities.
2. Participants heels are in contact with the board (supplied, placed in front of the chairs front legs) and their feet are resting on the floor.
3. Strap participant to the chair with supplied strap across their hips.
4. Get participant to put on hat and attach electrogoniometer to the top of the hat ensuring that the cord of electrogoniometer is on the left hand side.
5. Participant should sit with their hands on opposite shoulders looking forward.
6. Measurer ensures that participants have practiced the moves they are to make, by moving the head through all ranges of motion to make certain they know what to do.
7. Measurer writes date and participant identification number on sheet.
8. Using randomised head movements sheet, participant is instructed through all of the ranges of motion on the sheet in the order that they are written.
 - Eg.
 - i) F1 = flexion, first measure.
 - ii) Measurer presses the acquire rotation data button
 - iii) Participant is instructed to flex their neck as far as they can, and back up to looking straight ahead.
 - iv) Measurer presses the acquire rotation data button again, and the maximum flexion number is displayed. This displayed number is written in the F1 box.
 - v) Measurer presses the reset button, and moves to the next box down which will hold another movement, eg. RotR1

Appendix E: Individual Analysis

Individual participant NDI and VAS scores

Data were inspected at an individual level to seek other factors that might have influenced response to treatment. Those participants who scored over 30% in the NDI (Table 6) exhibited improvements of more than 10 percentage points (Participants 17, 2, 12, 16, 6). In contrast, participants 5, 18, 15, 7 and 4, had low NDI scores (17 - 4) and showed minimal improvement (6-4 percentage points).

Participants who had higher VAS scores at baseline tended to exhibit greater improvements following treatment (Table 7). Five participants, 6, 21, 7, 3, 18 were given advice (exercise or postural) with little effect on the change in VAS reported (range of -3.4 – 0.2). Compared to those who did not receive advice (change in VAS range of -5.8 – 0.4). It appears participant compliance had little effect on VAS changes seen. Women exhibited more pain and disability at the initial measures than men. (Table 1). Within Table 7, four women show greater effect size than the first man, with initial VAS measures of 6.4 – 6 cm, while the first male shows an effect size of -1.93.

Table Six: Participant effect size for change in NDI

ID	Gender	NDI (%) Baseline	NDI (%) Post TTT	NDI (%) Post TTT-BL	Effect Size*	Advice Given	Compliance	TTTs attended
17	F	34	10	-24	-2.73	-	-	5
14	M	28	4	-24	-2.73	-	-	6
2	F	36	14	-22	-2.50	-	-	6
12	F	35	18	-17	-1.94	-	-	6
19	F	29	14	-15	-1.71	-	-	4
16	F	36	22	-14	-1.59	-	-	6
6	F	34	22	-12	-1.37	shoulder rolls	yes	5
3	M	10	0	-10	-1.14	daily rotations left and right x 5each	yes	6
21	F	26	16	-10	-1.14	thoracic and cervical alphabets	yes	5
1	F	20	12	-8	-0.91	-	-	4
8	F	26	18	-8	-0.91	chin tucks	no	6
5	F	14	8	-6	-0.68	-	-	6
9	M	26	20	-6	-0.68	-	-	5
13	F	24	18	-6	-0.68	-	-	6
18	M	6	0	-6	-0.68	heat pack on rhomboids	no	5
15	M	17	12	-5	-0.57	-	-	6
7	F	16	12	-4	-0.46	shoulder rolls, side bending left and right	yes	6
10	F	44	44	0	0.00	-	-	6
11	F	22	22	0	0.00	-	-	5
4	M	4	10	6	0.68	-	-	5
20	F	23	32	9	1.02	-	-	5

*Effect size calculated by using the participant NDI change (pre-post) divided by the group SD for post TTT-pre TTT

Table Seven: Participant change in effect size for VAS

ID	GENDER	VAS (cm) Baseline	VAS (cm) post TTT	VAS (cm) post TTT- BL	Effect size*	Advice Given	Compliance	TTTs Attended
2	F	6.4	0.6	-5.8	-3.40	-	-	6
16	F	6	0.8	-5.2	-3.05	-	-	6
12	F	6.8	2.4	-4.4	-2.58	-	-	6
6	F	6.4		-3.4	-1.99	shoulder rolls	yes	5
14	M	3.5	0.2	-3.3	-1.93	-	-	6
17	F	3	0.5	-2.5	-1.46	-	-	5
21	F	2	0.1	-1.9	-1.11	thoracic and cervical alphabets	yes	5
7	F	2	0.2	-1.8	-1.05	shoulder rolls, side bending left and right	yes	6
19	F	2	0.3	-1.7	-1.00	-	-	4
20	F	4.9	3.2	-1.7	-1.00	-	-	5
5	F	2.8	1.2	-1.6	-0.94	-	-	6
3	M	1.5	0	-1.5	-0.88	daily rotations left and right x 5each	yes	6
8	F	6.8	5.4	-1.4	-0.82	chin tucks	no	6
1	F	2.5	1.7	-0.8	-0.47	-	n/a	4
11	F	1.4	0.6	-0.8	-0.47	-	-	5
15	M	1.7	0.9	-0.8	-0.47	-	-	6
10	F	3.3	2.7	-0.6	-0.35	-	-	6
9	M	3.2	3	-0.2	-0.12	-	-	5
13	F	2.2	2.2	0	0.00	-	-	6
18	M	0.7	0.9	0.2	0.12	heat pack on rhomboids	no	5
4	M	3.5	3.9	0.4	0.23	-	-	5

*Effect size calculated by using the participant NDI change (pre-post) divided by the group SD for post TTT-preTTT

Appendix F: Instructions for authors International Journal for Osteopathic Medicine

The Editors of the Journal welcome contributions for publication from the following categories: Letters to the Editor and Editorials, Reviews and Original Research articles, Commentaries, Clinical Practice articles (Case Studies) with educational value and Protocols.

The Guidelines are separated into the following sections:

- A Online Submission
- B Types of Contributions
- C General Guidance
- D Preparation of the Manuscript
- E Specific Guidance for Original Research Articles
- F Specific Guidance for Protocols
- G Post Acceptance

(A) ONLINE SUBMISSION

Submission to this journal proceeds totally online at (<http://ees.elsevier.com/ijom>). You will be guided stepwise through the creation and uploading of the various files. The system automatically converts source files to a single Adobe Acrobat PDF version of the article, which is used in the peer-review process. Please note that even though manuscript source files are converted to PDF at submission for the review process, these source files are needed for further processing after acceptance. All correspondence, including notification of the Editor's decision and requests for revision, takes place by e-mail and via the Author's homepage, removing the need for a hard-copy paper trail.

The above represents a very brief outline of this form of submission. It can be advantageous to print this "Guide for Authors" section from the site for reference in the subsequent stages of article preparation.

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the Publisher.

(B) TYPES OF CONTRIBUTIONS - word limits exclude tables, figures and reference list.

Letters to the Editor (up to 1,000 words)

As is common in biomedical journals the Editorial Board welcomes critical responses to any aspect of the journal. In particular, letters that point out deficiencies and that add to, or further clarify points made in a recently published work, are welcomed. The Editorial Board reserves the right to offer authors of papers the right of rebuttal, which may be published alongside the letter.

Reviews and Original Articles (2,000 - 5,000 words)

These should be either **(i)** reports of new findings related to osteopathic medicine that are supported by research evidence. These should be original, previously unpublished works; or **(ii)** a critical or systematic review that seeks to summarise or

draw conclusions from the established literature on a topic relevant to osteopathic medicine.

Short review (1,500-3,000 words)

The drawing together of present knowledge in a subject area, in order to provide a background for the reader not currently versed in the literature of a particular topic. Shorter in length than and not intended to be as comprehensive as that of the critical or systematic review paper. These papers typically place more emphasis on outlining areas of deficit in the current literature that warrant further investigation.

Research Note (up to 1,500 words)

Findings of interest arising from a larger study but not the primary aim of the research endeavour, for example short experiments aimed at establishing the reliability of new equipment used in the primary experiment or other incidental findings of interest, arising from, but not the topic of the primary research. Includes further clarification of an experimental protocol after addition of further controls, or statistical reassessment of raw data.

Preliminary Findings (1,500-2,500 words)

Presentation of results from pilot studies which may establish a solid basis for further investigations. Format similar to original research report but with more emphasis in discussion of future studies and hypotheses arising from pilot study.

Commentaries (up to 2,000 words)

Includes articles that do not fit into the above criteria as original research. Includes commentaries and essays especially in regards to history, philosophy, professional, educational, clinical, ethical, political and legal aspects of osteopathic medicine.

Clinical Practice

Authors are encouraged to submit papers in one of the following formats: **Case Report**, **Case Problem**, and **Evidence in Practice**.

- i. **Case Reports** - usually document the management of one patient, with an emphasis on presentations that are unusual, rare or where there was an unexpected response to treatment (e.g. an unexpected side effect or adverse reaction). Authors may also wish to present a case series where multiple occurrences of a similar phenomenon are documented. Preference will be given to reports that are prospective in their planning and utilise Single System Designs, including objective measures.
- ii. The aim of the **Case Problem** is to provide a more thorough discussion of the differential diagnosis of a clinical problem. The emphasis is on the clinical reasoning and logic employed in the diagnostic process.
- iii. The purpose of the **Evidence in Practice** report is to provide an account of the application of the recognised Evidence Based Medicine process to a real clinical problem. The paper should be written with reference to each of the following five steps: 1. Developing an answerable clinical question. 2. The processes employed in searching the literature for evidence. 3. The appraisal of evidence for usefulness and applicability. 4. Integrating the critical appraisal with existing clinical expertise and with the patient's unique biology, values, and circumstances. 5. Reflect on the process (steps 1-4), evaluating effectiveness, and identifying deficiencies.

Protocols (1,500 - 2,000 words)

The IJOM accepts the submission of protocols of randomised interventions, systematic reviews and meta-analyses, observational studies, and selected phase I and II studies (novel intervention for a novel indication; a strong or unexpected beneficial or adverse response; or a novel mechanism of action), with the overall aim to encourage good principles in clinical research design.

The editors are looking for studies that will appeal to a wide general readership. The question being addressed and the planned design and analysis will need to be as original as possible, topical, and valid. All protocols will be subject to the journal's usual peer review process.

(C) GENERAL GUIDANCE

Submission Declaration

Submission of an article implies that the work described has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, without the written consent of the copyright-holder.

Ethical considerations

Human subjects. Work on human beings that is submitted to *The International Journal of Osteopathic Medicine* should comply with the principles laid down in the declaration of Helsinki; Recommendations guiding physicians in biomedical research involving human subjects. Adopted by the 18th World Medical Assembly, Helsinki, Finland, June 1964, amended by the 29th World Medical Assembly, Tokyo, Japan, October 1975, the 35th World Medical Assembly, Venice, Italy, October 1983, and the 41st World Medical Assembly, Hong Kong, September 1989. The manuscript should contain a statement that the research has been approved by the appropriate ethical committees related to the institution(s) in which it was performed and that subjects gave informed consent to the work. Studies involving experiments with animals must state that their care was in accordance with institution guidelines. Patients' and volunteers' names, initials, and hospital numbers should not be used. In a case report, the subject's written consent should be provided. It is the author's responsibility to ensure all appropriate consents have been obtained.

Patient anonymity. Studies on patients or volunteers require ethics committee approval and informed consent which should be documented in the manuscript.

Patients have a right to privacy. Therefore identifying information, including patients' images, names, initials, or hospital numbers, should not be included in videos, recordings, written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and you have obtained written informed consent for publication in print and electronic form from the patient (or parent, guardian or next of kin where applicable). If such consent is made subject to any conditions, Elsevier must be aware of all such conditions. Evidence of written consent must be provided to Elsevier on request.

Even where consent has been given, identifying details should be omitted if they are not essential. If identifying characteristics are altered to protect anonymity, such as in

genetic pedigrees, authors should provide assurance that alterations do not distort scientific meaning and editors should so note.

Authors submitting manuscripts as Case Reports, Case Problems, and Evidence in Practice should ensure that they have received consent from patients who are the subject of such reports. A statement to this effect should be included in the manuscript.

If such consent has not been obtained, personal details of patients included in any part of the paper and in any supplementary materials (including all illustrations and videos) must be removed before submission.

Role of the funding source

You are requested to identify who provided financial support for the conduct of the research and/or preparation of the article and to briefly describe the role of the sponsor(s), if any, in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the paper for publication. If the funding source(s) had no such involvement then this should be stated. Please see <http://www.elsevier.com/funding> .

Funding Body Agreements and Policies

Elsevier has established agreements and developed policies to allow authors whose articles appear in journals published by Elsevier, to comply with potential manuscript archiving requirements as specified as conditions of their grant awards. To learn more about existing agreements and policies please visit <http://www.elsevier.com/fundingbodies>.

Conflict of interest

At the end of the text, under a subheading "Conflict of interest statement" all authors must disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) their work. Examples of potential conflicts of interest include employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

Acknowledgments

In the appendix one or more statements should specify (a) contributions that need acknowledging, but do not justify authorship (b) acknowledgments of technical support (c) acknowledgments of financial and material support, specifying the nature of the support. Persons named in this section must have given their permission to be named. Authors are responsible for obtaining written permission from those acknowledged by name since readers may infer their endorsement of the data and conclusions.

Sponsored Articles

The IJOM now offers authors the option to sponsor non-subscriber access to individual articles. The access sponsorship contribution fee per article is \$3,000. This contribution is necessary to offset publishing costs - from managing article submission and peer review, to typesetting, tagging and indexing of articles, hosting articles on dedicated servers, supporting sales and marketing costs to ensure global dissemination via ScienceDirect, and permanently preserving the published journal article. The sponsorship fee excludes taxes and other potential author fees such as colour charges which are additional.

Authors can specify that they would like to select this option after receiving notification that their article has been accepted for publication, but not before. This eliminates a potential conflict of interest by ensuring that the journal does not have a financial incentive to accept an article for publication.

English Language Service

Please write your text in good English. Authors who require information about language editing and copyediting services pre- and post-submission please visit <http://www.elsevier.com/languagepolishing> or our customer support site at <http://epsupport.elsevier.com> for more information. Please note Elsevier neither endorses nor takes responsibility for any products, goods or services offered by outside vendors through our services or in any advertising. For more information please refer to our Terms & Conditions: <http://www.elsevier.com/termsandconditions>.

Review Process

The decision to publish a paper is based on an editorial assessment and peer review. Initially all papers are assessed by an editor of the journal. The prime purpose is to decide whether to send a paper for peer review and to give a rapid decision on those that are not.

Manuscripts going forward to the review process are reviewed by members of an international expert panel. All such papers will undergo a double blind peer review by two or more reviewers. All papers are subject to peer review and the Journal takes every reasonable step to ensure author identity is concealed during the review process. The Editors reserve the right to the final decision regarding acceptance.

Author Enquiries

For enquiries relating to the submission of articles (including electronic submission where available) please visit this journal's homepage at <http://www.elsevier.com/ijosm>. You can track accepted articles at <http://www.elsevier.com/trackarticle> and set up e-mail alerts to inform you of when an article's status has changed. Also accessible from here is information on copyright, frequently asked questions and more.

Contact details for questions arising after acceptance of an article, especially those relating to proofs, will be provided by the publisher.

(D) PREPARATION OF THE MANUSCRIPT

Submitted papers should be relevant to an international audience and authors should not assume knowledge of national practices, policies, law, etc. Authors should consult a recent issue of the journal for style if possible. Since the journal is distributed all over the world, and as English is a second language for many readers, authors are requested to write in plain English and use terminology which is internationally acceptable.

Abbreviations - Avoid the use of abbreviations unless they are likely to be widely recognised. In particular you should avoid abbreviating key concepts in your paper where readers might not already be familiar with the abbreviation. Any abbreviations which the authors intend to use should be written out in full and followed by the letters in brackets the first time they appear, thereafter only the letters without brackets should be used.

Statistics - Standard methods of presenting statistical material should be used. Where methods used are not widely recognised explanation and full reference to widely accessible sources must be given.

Manuscript Layout

The manuscript with a font size of 12 or 10 pt double-spaced with wide margins (2.5 cm at least) and number pages consecutively beginning with the Title Page. Depending on the *paper type* (see above) this should include the title, abstract, key words, text, references, tables, figure legends, figures, appendix. Microsoft Word or similar programme should be used.

Please check your typescript carefully before you send it off, both for correct content and typographic errors. It is not possible to change the content of accepted typescripts during production.

To facilitate anonymity, the author's names and any reference to their addresses should only appear on the title page. Please check your typescript carefully before you send it off, both for correct content and typographic errors. It is not possible to change the content of accepted typescripts during production.

Papers should be set out as follows, with each section beginning on a separate page:

Title page

To facilitate the blinded peer-review process, **two** title pages are required. The first should carry just the title of the paper and no information that might identify the author or institution. The second should contain the following information: title of paper; full name(s) and address(es) of author(s) clearly indicating who is the corresponding author; you should give a maximum of four degrees/qualifications for each author and the current relevant appointment only; institutional affiliation; name, address, telephone, fax and e-mail of the corresponding author; source(s) of support in the form of funding and/or equipment.

Keywords

Include four to ten keywords in alphabetical order, which accurately identify the paper's subject, purpose, method and focus. These should be indexing terms that may be published with the abstract with the aim of increasing the likely accessibility of your paper to potential readers searching the literature. Therefore, ensure keywords are descriptive of the study. Use the Medical Subject Headings (MeSH®) thesaurus or Cumulative Index to Nursing and Allied Health (CINAHL) headings where possible (see <http://www.nlm.nih.gov/mesh/meshhome.html>).

Abstract

Both qualitative and quantitative research approaches should be accompanied by a structured abstract of no more than 250 words. Commentaries and Essays may continue to use text based abstracts of no more than 150 words. All original articles should include the following headings in the abstract as appropriate: *Background, Objective, Design, Setting, Methods, Participants, Results, and Conclusions*. As an absolute minimum: *Objectives, Methods, Results, and Conclusions* must be provided for all original articles. Abstracts for reviews of the literature (in particular systematic reviews and meta-analysis) should include the following headings as appropriate: *Objectives, Data Sources, Study Selection, Data Extraction, Data Synthesis, Conclusions*. Abstracts for Case Studies should include the following

headings as appropriate: *Background, Objectives, Clinical Features, Intervention and Outcomes, Conclusions.*

Text

The text of observational and experimental articles is usually, but not necessarily, divided into sections with the headings; introduction, methods, results, results and discussion. In longer articles, headings should be used only to enhance the readability. Three categories of headings should be used:

- major headings should be typed in capital letter in the centre of the page and underlined (i.e. INTRODUCTION)
- secondary ones should be typed in lower case (with an initial capital letter) in the left hand margin and underlined (i.e. Participants).
- minor ones typed in lower case and italicised (i.e. *questionnaire*).

Do not use 'he', 'his' etc. where the sex of the person is unknown; say 'the patient' etc. Avoid inelegant alternatives such as 'he/she'.

Statement of Competing Interests

When submitting a manuscript you will need to consider if you, or any of your co-authors, are an Editor or Editorial Board member of the International Journal of Osteopathic Medicine. If this is the case you will need to include a section, at the end of your manuscript immediately before the reference section, called "Statement of Competing Interests". Example statement, which may require editing, is as follows: {Name of author} is an Editor of the Int J Osteopath Med; {Name of author} is a member of the Editorial Board of the Int J Osteopath Med but was not involved in review or editorial decisions regarding this manuscript.

References

Responsibility for the accuracy of bibliographic citations lies entirely with the authors.

Citations in the text: Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Avoid using references in the abstract. Avoid citation of personal communications or unpublished material. Citations to material "in press" is acceptable and implies that the item has been accepted for publication.. Citation of material currently under consideration elsewhere (e.g. "under review" or "submitted") is not.

Text: Indicate references by superscript numbers in the text. The actual authors can be referred to, but the reference number(s) must always be given.

List: Number the references in the list in the order in which they appear in the text.

Examples:

Reference to a journal publication:

1. Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *J Sci Commun* 2000;**163**:51-9.

Reference to a book:

2. Strunk Jr W, White EB. *The elements of style*. 3rd ed. New York: Macmillan; 1979.

Reference to a chapter in an edited book:

3. Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, editors. *Introduction to the electronic age*. New York: E-Publishing Inc; 1999, p. 281-304

For journal articles, the abbreviated title of the journal should be used. Authors should refer to the National Library of Medicine database for journal abbreviations (<http://www.ncbi.nlm.nih.gov/nlmcatalog/journals>).

Note shortened form for last page number. (e.g., 51-9), and that for more than 6 authors the first 6 should be listed followed by "et al." For further details you are referred to "Uniform Requirements for Manuscripts submitted to Biomedical Journals" (J Am Med Assoc 1997;277:927-934) (see also <http://www.nejm.org/general/text/requirements/1.htm>).

Web references - As a minimum, the full URL and access date should be given. Any further information, if known (DOI, author names, dates, reference to a source publication, etc.), should also be provided. Web references should be included in the reference list.

Tables, Illustrations and Figures

Tables, illustrations and figures should be placed on separate pages as separate electronic files and not placed within the manuscript. Each table, illustration or figure should be accompanied by a number (e.g. Table 1) and a brief description of the content of the table, figure or illustration, below the table, illustration or figure. All tables, illustrations or figures should be referred to in the manuscript.

File Formatting for Artwork & Illustrations - General points

- Make sure you use uniform lettering and sizing of your original artwork.
- Save text in illustrations as "graphics" or enclose the font.
- Only use the following fonts in your illustrations: Arial, Courier, Times, Symbol.
- Number the illustrations according to their sequence in the text.
- Use a logical naming convention for your artwork files.
- Provide captions to illustrations separately.
- Produce images near to the desired size of the printed version.
- Submit each figure as a separate file.

A detailed guide on electronic artwork is available on our website: <http://www.elsevier.com/artworkinstructions>

Please do not:

- Supply embedded graphics in your word processor (spreadsheet, presentation) document.
- Supply files that are optimised for screen use (like GIF, BMP, PICT, WPG); the resolution is too low.
- Supply files that are too low in resolution.
- Submit graphics that are disproportionately large for the content.

Appendices - Ordinarily there should be no appendices although in the case of papers reporting tool development or the use of novel questionnaires authors must include a copy of the tool as an appendix unless all items appear in a table in the text. Appendices may be published as online supplementary files to which a reference should be made in the printed article.

Illustrations and tables that have appeared elsewhere must be accompanied by written permission to reproduce them from the original publishers. This is necessary even if you are an author of the borrowed material. Borrowed material should be acknowledged in the captions in the exact wording required by the copyright holder. If not specified, use this style: 'Reproduced by kind permission of . . . (publishers) from . . . (reference).' **Identifiable clinical photographs must be accompanied by written permission from the patient.**

Implications for Clinical Practice

At submission stage, authors of reviews and original research articles are required to provide three to four bullet points outlining the manuscript implications for clinical practice.

(E) SPECIFIC GUIDANCE FOR ORIGINAL RESEARCH ARTICLES

The text of **original research** for a quantitative or qualitative study is typically subdivided into the following sections:

Introduction

State the purpose of the article. Summarise the rationale for the study or observation. Give only strictly pertinent references and do not review the subject extensively. Do not include data or conclusions from the work being reported.

Materials and Methods

Describe your selection of observational or experimental participants (including controls). Identify the methods, apparatus (manufacturer's name and address in parenthesis) and procedures in sufficient detail to allow workers to reproduce the results. Give references and brief descriptions for methods that have been published but are not well known; describe new methods and evaluate limitations.

Indicate whether procedures followed were in accordance with the ethical standards of the institution or regional committee responsible for ethical standards. Do not use patient names or initials. Take care to mask the identity of any participants in illustrative material.

Results

Present results in a logical sequence in the text, tables and illustrations. Do not repeat in the text all the data in the tables or illustrations. Emphasise or summarise only important observations.

Discussion

Emphasise the new and important aspects of the study and the conclusions that follow from them. Do not repeat in detail data or other material given in the introduction or the results section. Include implications of the findings and their limitations, and include implications for future research. Relate the observations to other relevant studies. Link the conclusion with the goals of the study, but avoid unqualified statements and conclusions not completely supported by your data. State new hypothesis when warranted, but clearly label them as such. Recommendations, when appropriate, may be included.

Conclusion

A summary of the pertinent findings and, relevance of the study and implications of the study for future research.

CONSIDERATIONS SPECIFIC TO TYPES OF RESEARCH DESIGNS

Manuscripts are required to adhere to recognized reporting guidelines relevant to the research design used. These identify matters that should be addressed in your paper. These are not quality assessment frameworks and your study need not meet all the criteria implied in the reporting guideline to be worthy of publication in the journal.

You are encouraged (but not required) to provide a brief description of the reporting tool employed in your manuscript to guide the editors and reviewers.

Reporting guidelines endorsed by the journal are listed below:

Observational cohort, case control and cross sectional studies - STROBE - Strengthening the Reporting of Observational Studies in Epidemiology <http://www.equator-network.org/index.aspx?o=1032>

Quasi-experimental/non-randomised evaluations - TREND - Transparent Reporting of Evaluations with Non-randomized Designs <http://www.equator-network.org/index.aspx?o=1032>

Randomised (and quasi-randomised) controlled trial - CONSORT - Consolidated Standards of Reporting Trials <http://www.equator-network.org/index.aspx?o=1032>

Study of Diagnostic accuracy/assessment scale - STARD - Standards for the Reporting of Diagnostic Accuracy Studies <http://www.equator-network.org/index.aspx?o=1032>

Systematic Review of Controlled Trials - PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses <http://www.equator-network.org/index.aspx?o=1032>

Systematic Review of Observational Studies - MOOSE - Meta-analysis of Observational Studies in Epidemiology <http://www.equator-network.org/index.aspx?o=1032>

Qualitative researchers might wish to consult the guideline listed below:

Qualitative studies - COREQ - Consolidated criteria for reporting qualitative research. Tong, A., Sainsbury, P., Craig, J., 2007. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care* 19 (6), 349-357. <http://www.emgo.nl/kc/Analysis/statements/COREQ.pdf>

IJOM Author Contribution Statement

All manuscripts submitted to the journal should be accompanied by an Author Contribution Statement. The purpose of the Statement is to give appropriate credit to each author for their role in the study. All persons listed as authors should have made substantive intellectual contributions to the research. To qualify for authorship each person listed should have made contributions in each of the following;

- 1) Contributions to conception and design; data acquisition; data analysis and interpretation;
- 2) Drafting of manuscript, or critical revision for important intellectual content;
- 3) All authors must have given approval to the final version of the manuscript submitted for consideration to publish.

Acquisition of funding; provision of resources; data collection; or general supervision, alone, is not sufficient justification for authorship. Contributors who do not meet the criteria for authorship as outlined above should be listed in the Acknowledgements section. Acknowledgements may include contributions of technical assistance, proof reading and editing, or assistance with resources and funding. The statement may be published in the paper as appropriate.

Example of suggested format (note the use of author initials).

AB conceived the idea for the study. AB and CD contributed to the design and planning of the research. All authors were involved in data collection. AB and EF analysed the data. AB and CD wrote the first draft of the manuscript. EF coordinated funding for the project. All authors edited and approved the final version of the manuscript.

(F) SPECIFIC GUIDANCE FOR PROTOCOLS

Organisation of a Protocol - the following need to be adequately addressed.

- Title
- Abstract/Summary - this should provide a concise description of the purpose of the Protocol and should not exceed 200 words.
- Background, including rationale and any previous systematic review(s).
- Keywords - provide 4-10 keywords.
- Principal investigator(s); contact details.
- Aim(s).
- Design (randomised, double-blind) - including inclusion and exclusion criteria; intervention(s)/method; primary and secondary endpoint(s); side-effects reporting and quantification
- Statistical analysis - including sample size and power calculations; type of analysis; statistical testing.
- Ethical issues - including ethics committee approval; informed consent form and information sheet.
- Publication plan.
- Time required - an estimation of the time required to run the protocol should be given per separate step and for the whole protocol, including reporting.
- Funding source(s).
- References.

(G) POST ACCEPTANCE

Changes to authorship

This policy concerns the addition, deletion, or rearrangement of author names in the authorship of accepted manuscripts:

Before the accepted manuscript is published in an online issue: Requests to add or remove an author, or to rearrange the author names, must be sent to the Journal Manager from the corresponding author of the accepted manuscript and must include: (a) the reason the name should be added or removed, or the author names rearranged and (b) written confirmation (e-mail, fax, letter) from all authors that they agree with the addition, removal or rearrangement. In the case of addition or removal of authors, this includes confirmation from the author being added or removed. Requests that are not sent by the corresponding author will be forwarded by the Journal Manager to the corresponding author, who must follow the procedure as described above. Note that: (1) Journal Managers will inform the Journal Editors of

any such requests and (2) publication of the accepted manuscript in an online issue is suspended until authorship has been agreed.

After the accepted manuscript is published in an online issue: Any requests to add, delete, or rearrange author names in an article published in an online issue will follow the same policies as noted above and result in a corrigendum.

Proofs

One set of page proofs (as PDF files) will be sent by e-mail to the corresponding author (if we do not have an e-mail address then paper proofs will be sent by post) or, a link will be provided in the e-mail so that authors can download the files themselves. Elsevier now provides authors with PDF proofs which can be annotated; for this you will need to download Adobe Reader version 7 (or higher) available free from <http://www.adobe.com/products/acrobat/readstep2.html>. Instructions on how to annotate PDF files will accompany the proofs (also given online). The exact system requirements are given at the Adobe site: <http://www.adobe.com/products/acrobat/acrrsystemreqs.html#70win>.

If you do not wish to use the PDF annotations function, you may list the corrections (including replies to the Query Form) and return them to Elsevier in an e-mail. Please list your corrections quoting line number. If, for any reason, this is not possible, then mark the corrections and any other comments (including replies to the Query Form) on a printout of your proof and return by fax, or scan the pages and e-mail, or by post. Please use this proof only for checking the typesetting, editing, completeness and correctness of the text, tables and figures. Significant changes to the article as accepted for publication will only be considered at this stage with permission from the Editor. We will do everything possible to get your article published quickly and accurately. Therefore, it is important to ensure that all of your corrections are sent back to us in one communication: please check carefully before replying, as inclusion of any subsequent corrections cannot be guaranteed. Proofreading is solely your responsibility. Note that Elsevier may proceed with the publication of your article if no response is received.

Offprints

The corresponding author, at no cost, will be provided with a PDF file of the article via e-mail. The PDF file is a watermarked version of the published article and includes a cover sheet with the journal cover image and a disclaimer outlining the terms and conditions of use. Additional paper offprints can be ordered by the authors. An order form with prices will be sent to the corresponding author.

Copyright

Upon acceptance of an article, authors will be asked to complete a 'Journal Publishing Agreement' (for more information on this and copyright see <http://www.elsevier.com/copyright>). Acceptance of the agreement will ensure the widest possible dissemination of information. An e-mail will be sent to the corresponding author confirming receipt of the manuscript together with a 'Journal Publishing Agreement' form or a link to the online version of this agreement.

Subscribers may reproduce tables of contents or prepare lists of articles including abstracts for internal circulation within their institutions. Permission of the Publisher is required for resale or distribution outside the institution and for all other derivative works, including compilations and translations (please consult <http://www.elsevier.com/permissions>). If excerpts from other copyrighted

works are included, the author(s) must obtain written permission from the copyright owners and credit the source(s) in the article. Elsevier has pre-printed forms for use by authors in these cases: please consult <http://www.elsevier.com/permissions>.

Submission Checklist

Please check the manuscript carefully before it is sent off to the Editorial Office, both for correct content and typographical errors, as it is not possible to change the content of accepted typescripts during the production process. As a guide, please ensure the following had been included:

- One copy of manuscript and;
- Tables, figures and illustrations, uploaded separately and correctly labelled;
- Reference list in correct style and correct in-text referencing;
- Written permission from original publishers and authors to reproduce any borrowed any borrowed material (where relevant).