

A narrative review on cervical interventions in adults with chronic whiplash-associated disorder

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ABSTRACT

Introduction Whiplash injuries are common in society, but clinical interventions are inconclusive on the most effective treatment. Research and reviews have been completed with the goal of determining clinical interventions that are effective for whiplash injuries and disorders, but literature has not recently been summarised on best practices for cervical spine interventions for adults with chronic whiplash.

Purpose The objective of this narrative review is to update and expand on previous works, to provide recommendations for clinical interventions and future research in the area of cervical spine rehabilitation for adults with chronic whiplash-associated disorder.

Method The Arskey and O'Malley methodology was used for this narrative review. CINHAL, EMBASE, Medline, PsychInfo, Scopus, Web of Science, as well as grey literature, were searched from 2003 to April 2017. Two reviewers screened titles and abstracts for relevance to the review, and content analysis summarised the study findings. A total of 14 citations were included in the final review.

Findings Exercise-based interventions targeted at the cervical spine appear most beneficial for adults with chronic whiplash-associated disorder (WAD). Invasive interventions still require more rigorous studies to deem their effectiveness for this population.

Conclusion Further research is required to investigate and determine clinically relevant results for cervical spine intervention in patients with chronic WAD.

INTRODUCTION

Whiplash injuries are estimated to affect 3.8/1000 people per year in the USA.¹ Sports, falls, automobile collisions and other physical trauma can cause a whiplash injury.² Whiplash injuries and associated disorders, if not treated and managed, can cause chronic pain, suffering, disability and healthcare utilisation.³ Whiplash injuries and the associated medical care, disability, sick leave and lost work productivity account for \$3.9 billion annually in the USA.^{4,5} It has been concluded that 14%–42% of patients with whiplash injury report symptoms 6 months postinjury, and 10% of those patients have constant severe pain.^{6,7}

What is already known?

- ▶ Whiplash injuries and associated disorders, if not treated and managed, can cause chronic pain, suffering, disability and healthcare utilisation.
- ▶ There is no standardised protocol for rehabilitation or treatment of patients with whiplash-associated disorder (WAD).
- ▶ The Quebec Task Force report remains the most ambitious and comprehensive review of the management of whiplash, to date. However, this report finds the available evidence to be sparse and of poor quality.

What are the new findings?

- ▶ Literature shows that cervical spine exercise, including strengthening, endurance and stretching, shows benefit to patients with chronic WAD.
- ▶ The benefit of invasive treatments, such as surgery or pharmaceuticals, is inconclusive in the current literature.
- ▶ There is a need for further studies directed towards the optimal type, protocol and duration of a cervical spine exercise programme for patients with WAD.

Whiplash injuries result from a forceful, rapid, back and forth movement of the neck. The Quebec Task Force (QTF) developed recommendations regarding the classification and treatment of whiplash, and defined whiplash as an acceleration-deceleration mechanism of energy transfer to the neck and head from indirect neck trauma.^{1,8} Whiplash symptoms can occur immediately postinjury, but can have delayed onset. The impact that causes whiplash may result in bony or soft tissue injuries, which in turn may lead to a variety of clinical presentations and manifestations.⁹

The term whiplash-associated disorder (WAD), is used to describe the clinical presentation of a whiplash injury, and to separate it from the injury mechanism.⁸ WADs represent a class of clinical complaints associated with a whiplash injury, and are characterised by



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multiple physical complaints after a flexion-extension trauma to the neck. Such complaints can include, but are not limited to, headache, dizziness, neck pain and cognitive symptoms.¹⁰ Neck or cervical spine pain is the leading symptom of WAD, and is addressed by almost all published studies examining the diagnosis and treatment associated with such an injury.¹¹ WAD symptoms likely result from cervical ligament sprain or cervical muscle strain. Fractures to the cervical vertebrae are not included in WAD, although they can occur as a result of whiplash. Typically, symptoms of WAD should resolve in the first 2–3 months postinjury.¹² However, recent research suggests that approximately 60% of patients with whiplash injury are still reporting symptoms 3 months postinjury.⁷ Patients remaining symptomatic for more than 3 months postinjury are considered to have chronic WAD, and present a challenging condition to treat for healthcare professionals.¹³

WAD is difficult to treat, and often requires an interdisciplinary approach, including medical professionals, rehabilitation professionals and psychology professionals.¹⁴ Interventions have to address physical complaints such as neck pain, and a cluster of physiological, cognitive and emotional symptoms that may result from WAD.³ Due to the complexity of WAD, and the need for different interventions, WAD greatly impacts an individual's quality of life. Current treatment guidelines and protocols for healthcare professionals working with individuals with WAD, are vague, and have little supporting evidence.

In 1995, QTF published its guidelines for the management of WADs that aimed to offer a recommendation to treatment and management for WADs.⁸ While determining and performing an in-depth analysis of clinical, public health and financial determinates of whiplash, QTF⁸ reviewed 10 000 publications to determine diagnosis, treatment and prognosis of WADs.¹⁵ Through this process, the available evidence was found to be sparse and of poor quality.¹⁶ QTF based their recommendations for WAD treatment on consensus and the expert knowledge of QTF members from various clinical fields. This report remains the most ambitious and comprehensive review of the management of whiplash, to date. However, the review by QTF (1995) does not include any studies investigating the effect of electrical stimulation, modalities, surgery, exercise, nerve blocks, psychological interventions or acupuncture.⁹ All of these possible interventions may have a role in WAD treatment, and have been further investigated post-QTF guidelines. Conlin *et al*¹⁶ published a systematic review of the whiplash intervention literature (included studies from 1993 to 2003), and noted that despite QTF's recommendations, 'remarkably little quality research' (Conlin, p39)¹⁶ had been published in the area of whiplash treatment and management. Conlin *et al*¹⁶ determined the need for further research in the area of chronic whiplash management. The finding in the QTF report, as well as the subsequent available literature on WAD treatment continues to be inconsistent and

inconclusive, and does not offer a specific treatment or rehabilitation model for WADs. Rather, the best available literature varies in scope, profession and approach to the management of WAD in adults. The literature requires further research exploration prior to implementation into evidence-based clinical practice guidelines (moving beyond clinical experience and consensus). The purpose of this narrative review is to examine the literature to determine the effect of different cervical spine interventions in adults with chronic WAD.

MATERIALS AND METHODS

This narrative review uses the Arksey and O'Malley¹⁷ methodological framework. A narrative review refers to a rapid gathering of literature in a given clinical area with the objective of gathering as much evidence as possible and mapping the results.¹⁷ Thus, a narrative review is appropriate for this topic, as the goal was to summarise the current state of the literature as it relates to the proposed research question. This narrative review aimed to address the research question: *What are current cervical spine treatment techniques for adults with chronic WAD.* The purpose of this narrative review was not to assess the quality of the intervention studies included (which would be more appropriate in a systematic review), but rather to encapsulate the current literature on cervical spine interventions for adults with a chronic WAD. Furthermore, if applicable, included studies were assessed for statistical significance and for clinical significance.²² Clinical significance answers the question, 'how effective is the intervention or treatment, or how much change does the treatment cause?'.^{18–20} Four of the 14 included studies, commented on clinical significance. The authors of each study reporting clinical significance determined these values for clinically important changes, and therefore there is some subjectivity.^{21–26} A narrative study typical unfolds in a five-step process.

Step 1: identify the research question

The aim of this narrative review was to answer the question: What is known in the existing literature regarding the best ways to approach the biological rehabilitation of the cervical spine in adults with chronic WAD?

Step 2: identification and study selection

A structured literature search was conducted from the following academic databases until April 2017 (with no publication data limitations): MEDLINE, MEDLINE non-indexed, PsychINFO, EMBASE, CINAHL, Web of Science and Scopus. For grey literature, ProQUEST dissertations and theses, wire feeds and trade journals were also searched. These databases were searched for articles published between 2003 and April 2017. The systematic review by Conlin *et al*¹⁶ included studies published until the year 2003, therefore the purpose of this review is to compile and review the literature published post Conlin *et al*'s review.

Step 3: select the studies for detailed analysis

All articles that had titles that conformed to the inclusion criteria (listed below) were evaluated for relevance by two reviewers (CA and TT). The inclusion criteria for this narrative review was: (1) the study focused on people older than 19 years of age, defined as adults by WHO²⁷; (2) the study focused on cervical spine treatment and intervention methods; (3) the study focused on rehabilitation postwhiplash with symptoms lasting longer than 3 months (chronic symptoms)²⁸ (4) the article was written in English and published after 2003, (5) the evaluation of the treatment effect must have included a measurable outcome. Citations were excluded from the review if they: (1) were case studies, non experimental or uncontrolled design²⁹; (2) were not written in English. The definition of adult was inconsistent across the multiple databases therefore, the WHO definition of adult²⁷ was used to satisfy the overlap in age ranges found within the various databases. Symptoms lasting longer than 3 months are considered chronic.⁷ For this reason, all included studies must have included symptoms lasting for longer than 3 months to be considered chronic, and thus to be included in the review. Abstracts were included to suit the broad and all-encompassing nature of narrative review methodology.

Step 4: data extraction

Consistent with the Arskey and O'Malley¹⁷ recommendations, a 'descriptive-analytical' data extraction tool was developed by the primary author (CA) based on common variables across studies as well as 'process' information (eg, how were whiplash symptoms measured) to contextualise the outcome of the studies. All 14 selected articles were charted according to the domains outlined in the data extraction tool.

Step 5: collate and summarise the findings of the selected studies

All articles included in the review were charted according to the data extraction tool as outlined in step 4. These conceptual dimensions provide the basis for the discussion of results in the next section. Numerical analysis was used to document the distribution of studies according to: study design, population characteristics, study purpose and neck pain measurement.¹⁷ Qualitative content analysis³⁰ was used to summarise cervical spine interventions for adults with chronic WAD, wherein codes were generated from the data through an iterative process.³¹ Studies were coded by the first author for whiplash severity; study procedure (eg, measurement of symptoms, diagnosis, intervention, time since injury) and outcome(s) measured (eg, neck disability and functional outcome). No attempt was made to represent these data in other terms (ie, through extant theory, themes) but rather to describe regularities as they appear in the data.

RESULTS

In total, 14 articles were included in the narrative review (see figure 1 for the article selection process). These

studies can be grouped into treatment categories: exercise programme, alternative techniques (including osteopathic therapy and other alternative therapies) and invasive interventions.

Treatment categories

Exercise intervention

Seven randomised controlled trials (RCTs) evaluated the effect of an exercise programme targeted at the cervical spine to address WAD symptoms in participants reporting symptoms for longer than 3 months. In an RCT, Stewart *et al*³² determined that exercise and advice (experimental group) produces better outcomes than advice alone (control group) for people who have sustained WAD beyond 3 months. Furthermore, the effect of exercise has greater benefit in people with high levels of pain and disability associated with WAD. However, these positive effects seen with exercise and advice compared with advice alone were small and only apparent in the short term (up to 6 weeks post-treatment, pain intensity $p=0.005$, pain bothersome $p=0.003$, patient-specific functional $p=0.006$), where no significant results were evident between the experimental and control groups on any of the included outcome measures at 12 months post-treatment. During the treatment period, 15% of participants in the exercise and advice groups and 23% in the advice group reported seeking additional treatment, such as massage therapy, further physiotherapy, chiropractic treatment, hydrotherapy and osteopathic treatment.

Similarly, in an RCT that included 170 participants, Michaelieff *et al*²³ concluded that a comprehensive exercise programme (including cervical spine strengthening, stretching and postural control exercises) did not provide statistically significant benefit over advice alone for the average reported pain intensity in the neck of patients with chronic WAD. A significant difference for self-reported recovery and functional ability was found for the exercise group at the conclusion of the study intervention. However, these results were not clinically significant, indicating that the differences found were not clinically meaningful.

Vikne *et al*³³ also investigated cervical spine exercise and proposed incorporating a ceiling-mounted sling to promote and enable cervical spine stabilising exercise. In this study, there was no benefit of adding a ceiling-mounted sling exercise programme (designed to promote neuromuscular control of the neck) to a traditional exercise programme prescribed by a physiotherapist.

In another RCT, Jull *et al*³⁴ discussed the effects of a supervised exercise and physiotherapy programme compared with a self-managing home exercise programme. Over a 10-week intervention, the multi-modal physiotherapy (exercise, strength training of the cervical spine and stretching of the cervical spine) group attained significantly greater reduction in neck pain and disability than the self-managing group ($p=0.04$). In

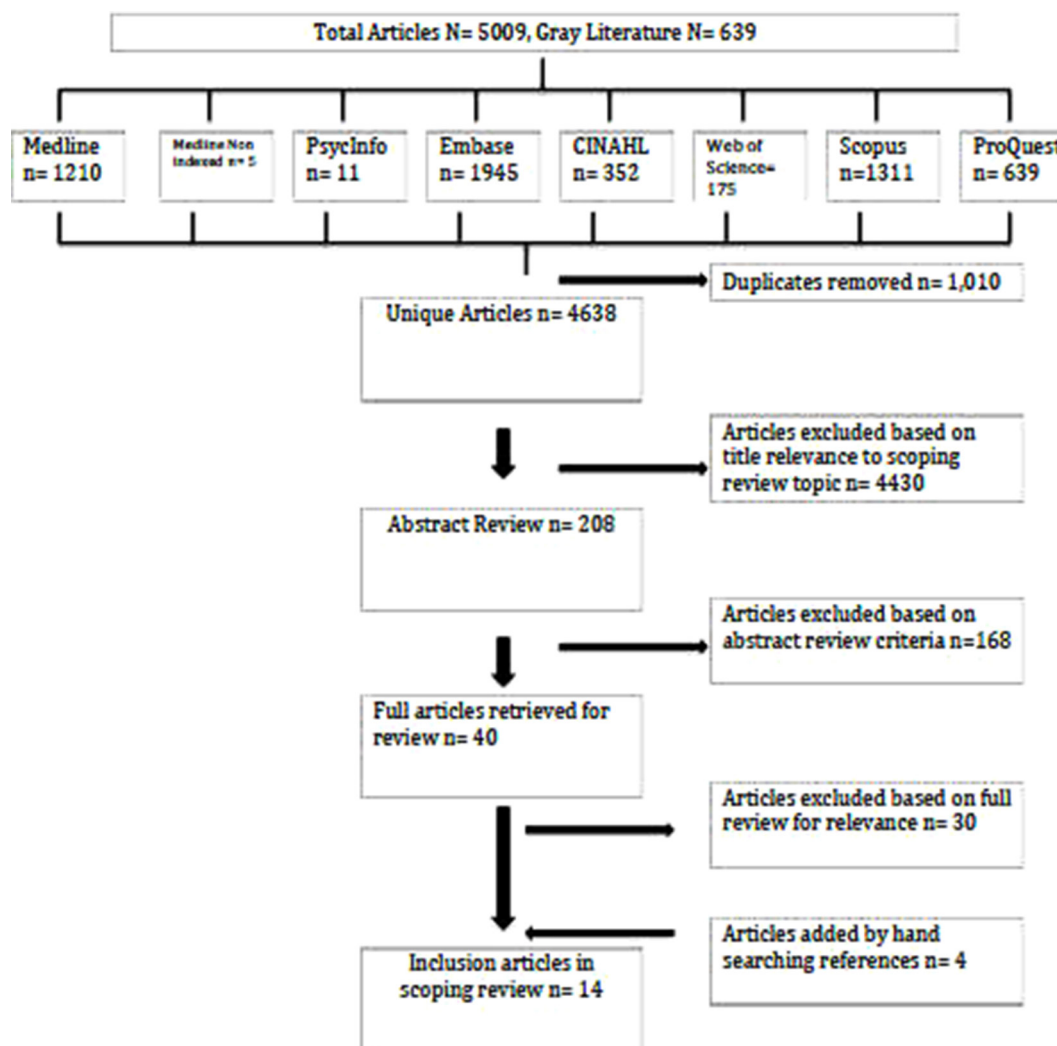


Figure 1 Narrative review article selection flow diagram.

this study, neither the treating physiotherapists nor the patients were blinded.

Ludvigsson *et al*³⁵ preformed a study to evaluate the effects of a cervical spine exercise programme with or without a behavioural approach on pain disability in patients with chronic WAD. They concluded that a physiotherapy-led exercise programme for the cervical spine resulted in superior outcomes ($p<0.01$) compared with a physical activity prescription (not supervised) in the WAD population after 3 months. Overall, neck-specific exercise interventions resulted in significantly greater changes in disability compared with the unsupervised group. It should be noted that compliance was lower in the unsupervised exercise group. Authors indicated that patients may have felt that this intervention was less direct and specific to their problem and have been less motivated.

In addition, a study by Treleven *et al*³⁶ also investigated the effect of exercise with or without a behavioural approach for this population. The results found that all groups showed significant improvement in reported neck pain over the course of treatment. Simple contract analysis revealed significant improvements from baseline

to 6 months ($p<0.001$) and the 12-month ($p=0.005$) follow-up. No significant differences between the groups for supervised, unsupervised or exercise with behavioural approach was concluded.

Finally, an RCT by Ryan *et al*²⁴ investigated strength training of the cervical spine with cervical spine endurance training. The results indicate statistically significant and clinically meaningful reductions in pain intensity over time in both the strength training and endurance training groups, but the strength training group experienced significantly greater reductions in functional limitations.

Conclusions regarding exercise interventions in chronic WAD

Exercise programmes targeting the cervical spine (strength, endurance, flexibility, postural control) appear to be effective in reducing pain and disability from chronic WAD. Further research is needed to conclude the clinical significance of exercise interventions, specific exercise protocols, longevity of results and duration of treatment for exercise programmes in reducing symptoms for patients with chronic WAD. There was a high volume of RCT study designs employed in the literature

assessing exercise interventions in chronic WAD, which suggests good methodological designs.

Alternative interventions

The effectiveness of alternative interventions on the cervical spine for patients with chronic WAD was assessed in four studies. These alternative interventions included osteopathic treatment, dry needling and acupuncture, as possible interventions for patients with chronic WAD.

In a clinical intervention study involving 42 participants, Schwerla *et al.*²⁵ conducted a study to evaluate the effects of osteopathic treatment on patients with chronic WAD. The osteopathic techniques included high velocity thrusts to the cervical spine, myofascial release, muscle energy practices, and indirect techniques such as balanced ligamentous tension and cranial techniques. A direct comparison between the untreated period and the treatment period revealed clinically relevant and statistically significant improvements in the osteopathic treatment period for the neck pain and disability outcome measurements. This study concluded that osteopathic treatments have a beneficial effect on the physical and mental components of WAD, and osteopathic treatment is a complimentary intervention for chronic WAD. It is important to note that because of the chosen study design (clinical intervention), the internal validity of the study is reduced and the results must be interpreted with caution. The results of the present study should be confirmed by RCTs.

Another study, which investigated the effects of dry needling for chronic WADs, was conducted by Sterling *et al.*²⁶ Dry needling is a technique where a needle is used to release myofascial trigger points. In this study the researchers compared dry needling and exercise with sham dry needling and exercise for a 6-week intervention. Dry needling and exercise produced statistically significant reductions in pain-related disability, and pain catastrophising at 6 months and 12 months follow-up, statistically significant reductions in post-traumatic stress symptoms at 6 months and small increases in pressure pain thresholds over the neck at 12 weeks. Aside from this latter measure, there was no difference between the interventions at short-term follow-ups conducted immediately after treatment and 12 weeks later. The data indicate that there was improvement in the primary outcome measures (approximate 10% decrease in average Neck Disability Index Score) from baseline to the immediate 6-week postintervention assessment. The study did not include an exercise only group, so results should be interpreted with caution and are not deemed clinically relevant.

Another similar study by Hyun *et al.*³⁷ investigated the effects of acupuncture three times per week (acupuncture points based on clinical assessment) for chronic WAD. This study found that a change in Visual Analogue Scale Scores in the acupuncture group was significant (−1.85 compared with −0.040 in the waiting-list group, 95% CI, $p=0.001$). No significant changes in secondary outcome

measures, such as quality of life, were concluded. However, it was concluded that acupuncture treatment is associated with a significant alleviation of pain. It should be noted that the treatment period in this study was short (six treatments), and there was a lack of additional follow-up with participants after treatment termination. This may have resulted in only a partial assessment of the effect of acupuncture on patients with WAD. Diagnosis of WAD, and subsequent recovery reports from patients, were self-reported and there was no imaging involved.

Conclusions regarding alternative interventions in chronic WAD

Based on the results from studies investigating alternative treatments for chronic WAD, there is limited evidence that such treatments provide relief to this population. Further research, with more rigorous methods, and RCTs are needed to produce clinically relevant results.

Invasive interventions

Three studies investigated invasive techniques for the treatment of chronic WADs. A study by Nyostrom *et al.*³⁸ explored treating patients suffering from WAD reporting cervical spine segmental pain through a fusion operation based on non-radiological segment localisation. At follow-up, 67% of the patients in the surgery group and 23% in the rehabilitation group demonstrated improvements in self-reported pain ($p=0.0007$). The researchers concluded that among patients with chronic neck pain postwhiplash, there are some in whom the neck pain emanates from a motion segment in the cervical spine, and may be suitable for fusion surgery.

Another invasive technique, botulinum toxin A, was investigated in an RCT by Padberg *et al.*³⁹ In this study, participants were randomly assigned to receive botulinum toxin A or a placebo (saline) injection in the cervical spine muscles presenting with increased tenderness. No significant difference (95% CI) was found between the group who received botulinum toxin A and the group that received saline injections.

Finally, a study by Lemming *et al.*⁴⁰ investigated the effect of intravenous administration of morphine, lidocaine and ketamine and their relations to duration of chronic neck pain after whiplash trauma. The response to the pharmacological intervention did not show any relationship with pain duration.

Conclusions regarding invasive interventions in chronic WAD

Results from the three studies investigating invasive interventions for symptoms related to chronic WAD concluded the need for further research to determine clinically relevant results. Further research and studies that employ the use of random allocation to experimental and control groups are needed to produce clinically relevant results.

DISCUSSION

The soft tissue and/or vertebrae of the cervical spine are damaged in a whiplash injury due to the acceleration and deceleration of the neck.⁹ For this reason, interventions

addressing the soft tissue and/or the vertebrae of the cervical spine target the specific structures at fault likely causing the symptoms associated with chronic WAD. Studies investigating treatments for chronic WADs are consistent in concluding that addressing the soft tissue and vertebrae of the cervical spine, including exercise, alternative treatment and invasive interventions, is beneficial. Specifically, the treatments involving exercise seem to have more consistent clinical effect and show statistical significance than other studied interventions.^{23 24 32–36} Up to 87% of patients with WAD have some degree of cervical spine muscle spasm.⁶ Specific and graded exercise targeting cervical spine muscles and postural control can help alleviate muscle spasm, thus contributing to decreased symptoms in patients with chronic WAD.

Research investigating alternative intervention techniques such as osteopathic treatment, acupuncture and dry needling, show benefit to patients with chronic WAD, but the results may not be clinically significant. Not all included studies in this review discussed the clinical significance of their results, and statistical significance cannot infer clinical significance. A calculation and discussion of clinical significance would contribute to this body of literature and the applicability of alternative interventions for the cervical spine post-WAD. Further studies, with improved methodological processes and RCTs must be published before clinical relevance can be deemed. Osteopathic treatment, acupuncture and dry needling pose very little risk or complications to a patient with WAD, and thus further research is required to support the use of these treatments as part of standard clinical care for adults with chronic WAD.

Recommendations for invasive techniques cannot be made based on the current literature. Findings from a study discussing the use of pharmaceutical interventions concluded there was no relationship with pain management, and thus further research was needed to contribute to clinical practice. Studies investigating cervical fusion suggested a relief in pain for patients with chronic WAD, however the study was of low quality (due to study design), and further research is needed to be conclusive. The need for high quality research, such as RCTs, and the inclusion of calculations required to determine clinical significance, is required for surgical and injection-based interventions to prove clinical relevance and benefit for chronic WAD, especially given the cost and risk associated with invasive procedures.²⁹ However, if less invasive interventions, such as exercise and complementary medicine produce clinically significant results, such interventions would be preferred due to risk, cost, administration and outcome.

A total of 14 studies was included in this narrative review, and although there are some statistically significant results, and results of clinical relevance (practical importance of a treatment effect), all studies concluded the need for further research to gain greater insight into cervical spine interventions for adults with chronic WAD.

CONCLUSION

In this review, all studies were RCTs, systematic reviews or clinical interventions. Exercise programmes focused on cervical spine strength and endurance appear to be the most effective treatment technique for this population. However, the optimal type, protocol and duration of these programmes remain unknown. Further research is required to inform the implementation of these interventions into the standard clinical care for adults with chronic WAD. Literature contributing to cervical spine interventions for this population would be beneficial to reduce disability, improve quality of life and lessen the burden on our healthcare system.

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REFERENCES

- Overmeer T, Peterson G, Ludvigsson M, *et al.* The effect of neck specific exercises with or without a behavioral approach on psychological factors in chronic whiplash associated disorders. A randomized controlled trial with a 2 year follow up. *Medicine* 2016;95:34.
- Hogg-Johnson S, van der Velde G, Carroll LJ. The Burden and determinants of neck pain in the general population: results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Spine* 2008;33:39–51.
- Côté P, Cassidy JD, Carrette S, *et al.* Protocol of a randomized controlled trial of the effectiveness of physician education and activation versus two rehabilitation programs for the treatment of Whiplash-associated Disorders: the University Health Network Whiplash Intervention Trial. *Trials* 2008;9:75.
- Freeman MD, Croft AC, Rossignol AM. “Whiplash associated disorders: redefining whiplash and its management” by the Quebec Task Force. A critical evaluation. *Spine* 1998;23:1043–9.
- Lord SM, Barnsley L, Wallis BJ, *et al.* Chronic cervical zygapophysial joint pain after whiplash. A placebo-controlled prevalence study. *Spine* 1996;21:1737–44.
- Sterling M. Whiplash associated disorders. *Neck and Arm Pain Syndromes* 2011;10:112–22.
- Carroll LJ, Holm LW, Hogg-Johnson S. Course and prognostic factors for neck pain in whiplash-associated disorders (WAD): results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Spine* 2011;33:S83–92.
- Spitzer WO, Skovron ML, Salmi LR, *et al.* Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: redefining “whiplash” and its management. *Spine* 1995;20(8 Suppl):1S–73.
- Barron SR, Ho K, Anton H. Re: the quebec task force on whiplash-associated disorders and the British Columbia whiplash initiative: a study of insurance industry initiatives. *Pain Res Manage* 1999;4:141–9.

10. Scholten-Peeters GG, Neeleman-van der Steen CW, van der Windt DA, *et al.* Education by general practitioners or education and exercises by physiotherapists for patients with whiplash-associated disorders? A randomized clinical trial. *Spine* 2006;31:723–31.
11. Hurwitz EL, Carragee EJ, van der Velde G, *et al.* Treatment of neck pain: noninvasive interventions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33(4 Suppl):S123–52.
12. Schwerla F, Kaiser AK, Gietz R, *et al.* Osteopathic treatment of patients with long-term sequelae of whiplash injury: effect on neck pain disability and quality of life. *J Altern Complement Med* 2013;19:543–9.
13. Holm LW, Carroll LJ, Cassidy JD. The burden and determinants of neck pain in whiplash-associated disorders after traffic collisions: results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. *Spine* 2008;33:52–9.
14. Schmid P, Schweizerische W. Whiplash associated disorders. *Europe PMC* 1999;129:1368–80.
15. Gurumoorthy D, Twomey L, Cassidy J. The quebec task force on whiplash-associated disorders. *Spine* 1996;21:5–10.
16. Conlin A, Bhogal S, Sequeira K, *et al.* Treatment of whiplash-associated disorders – part I: non-invasive interventions. *Pain Res Manag* 2005;10:21–32.
17. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8:19–32.
18. Shabbir SH, Sanders AE. Clinical significance in dementia research: a review of the literature. *Am J Alzheimers Dis Other Dement* 2014;29:492–7.
19. Jaeschke R, Singer J, Guyatt GH. Measurement of health status. Ascertaining the minimal clinically important difference. *Control Clin Trials* 1989;10:407–15.
20. Page P. Beyond statistical significance: clinical interpretation of rehabilitation research literature. *Int J Sports Phys Ther* 2014;9:726–36.
21. Copay AG, Subach BR, Glassman SD, *et al.* Understanding the minimum clinically important difference: a review of concepts and methods. *Spine J* 2007;7:541–6.
22. Guyatt GH, Osoba D, Wu AW. Clinical Significance Consensus Meeting G. Methods to explain the clinical significance of health status measures. *Mayo Clin Proc* 2002;77:371–83.
23. Michaleff ZA, Maher CG, Lin CW, *et al.* Comprehensive physiotherapy exercise programme or advice for chronic whiplash (PROMISE): a pragmatic randomised controlled trial. *Lancet* 2014;384:133–41.
24. Ryan JM, Ryan J. Reducing pain and disability for whiplash victims: a double blinded randomised controlled trial. *Cochrane Centrall Register of Controlled Trials* 2006;3.
25. Schwerla F, Kaiser AK, Gietz R, *et al.* Osteopathic treatment of patients with long-term sequelae of whiplash injury: effect on neck pain disability and quality of life. *J Altern Complement Med* 2013;19:543–9.
26. Sterling M, Vicenzino B, Souvlis T, *et al.* Dry-needling and exercise for chronic whiplash-associated disorders: a randomized single-blind placebo-controlled trial. *Pain* 2015;156:635–43.
27. World Health Organization. Young people's health – a challenge for society. 1986.
28. Merskey H, Bogduk N. *Classification of chronic pain: descriptions of chronic pain syndromes and definition of pain terms.* IASP Press, 1994;2:209–14.
29. Teasell RW, Ba J, Walton D. Noninvasive interventions for chronic WAD. *Pain Res Manage* 2010;15:313–22.
30. Morgan DL. Qualitative content analysis: a guide to paths not taken. *Qual Health Res* 1993;3:112–21.
31. Sandelowski M. Whatever happened to qualitative description? *Res Nurs Health* 2000;23:334–40.
32. Stewart MJ, Maher CG, Refshauge KM, *et al.* Randomized controlled trial of exercise for chronic whiplash-associated disorders. *Pain* 2007;128(1-2):59–68.
33. Vikne J, Oedegaard A, Laerum E, *et al.* A randomized study of new sling exercise treatment vs traditional physiotherapy for patients with chronic whiplash-associated disorders with unsettled compensation claims. *J Rehabil Med* 2007;39:252–9.
34. Jull G, Sterling M, Kenardy J, *et al.* Does the presence of sensory hypersensitivity influence outcomes of physical rehabilitation for chronic whiplash? – A preliminary RCT. *Pain* 2007;129(1-2):28–34.
35. Ludvigsson ML, Peterson G, O'Leary S, *et al.* The effect of neck-specific exercise with, or without a behavioral approach, on pain, disability, and self-efficacy in chronic whiplash-associated disorders: a randomized clinical trial. *Clin J Pain* 2015;31:294–303.
36. Treleaven J, Peterson G, Ludvigsson ML, *et al.* Balance, dizziness and proprioception in patients with chronic whiplash associated disorders complaining of dizziness: A prospective randomized study comparing three exercise programs. *Man Ther* 2016;22:122–30.
37. Kwak H-Y, Kim J-I, Park J-M, *et al.* Acupuncture for Whiplash-associated disorder: a randomized, waiting-list controlled, pilot trial. *Eur J Integr Med* 2012;4:e151–8.
38. Nyström B, Svensson E, Larsson S, *et al.* A small group Whiplash-Associated-Disorders (WAD) patients with central neck pain and movement induced stabbing pain, the painful segment determined by mechanical provocation: fusion surgery was superior to multimodal rehabilitation in a randomized trial. *Scand J Pain* 2016;12:33–42.
39. Padberg M, de Bruijn SF, Tavy DL. Neck pain in chronic whiplash syndrome treated with botulinum toxin. A double-blind, placebo-controlled clinical trial. *J Neurol* 2007;254:290–5.
40. Lemming D, Sörensen J, Graven-Nielsen T, *et al.* The responses to pharmacological challenges and experimental pain in patients with chronic whiplash-associated pain. *Clin J Pain* 2005;21:412–21.

Correction: *A narrative review on cervical interventions in adults with chronic whiplash-associated disorder*

Anderson C, Yeung E, Toong T, *et al.* A narrative review on cervical interventions in adults with chronic whiplash-associated disorder. *BMJ Open Sport Exerc Med* 2018;4:e000299. doi: 10.1136/bmjsem-2017-000299

The authors want to alert readers to the following error identified in the published version.

One of the co-authors' name was misspelled. The correct name should have been Tiffany Toong instead of Tiffany Tong.

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