TITLE PAGE

Title:

Factors Associated With Physical Activity Participation In Adults With Chronic Cervical Spine Pain. A Systematic Review.

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ABSTRACT

OBJECTIVE:

To determine the factors associated with physical activity participation in adults with chronic cervical spine pain.

METHODS:

A systematic review was conducted including searches of PubMed (MEDLINE), EMBASE and CINAHL from inception to June 12th 2016. Grey literature and reference checking was also undertaken. Quantitative studies including factors related to physical activity participation in adults with chronic cervical spine pain were included. Two independent authors conducted the searches, extracted data and completed methodological quality assessment.

RESULTS:

A total of 7 studies met the selection criteria, however, four papers were finally included in the final review. A modified Downs and Black criteria was used to assess methodological quality, each study included was classed as moderate quality. A total of 6 factors were assessed against physical activity participation for people with chronic neck pain. These included; pain, fear of movement, smoking habits, socioeconomic status, gender, leisure and work time habits. A significant relationship was demonstrated between pain, leisure and work time habits and physical activity. Subjects were less likely to participate in physical activity if they were in pain. Subjects with neck pain were less likely to participate in physical activity in their leisure and work time.

CONCLUSION:

This review, based on a small number of heterogeneous studies demonstrated key factors that are likely to affect physical activity in people with chronic neck pain, most notably, pain levels, leisure and work habits. This review suggests that more in-depth, high quality studies are required to fully understand the impact of chronic pain on physical activity.

Contribution of paper

- No systematic literature review to date has determined what factors are associated with physical activity participation in adults with chronic cervical spine pain
- Whilst pain, fear of movement, smoking habits, socioeconomic status, gender and leisure and work time are factors associated with engagement with physical activity, only pain and leisure and work habits were shown to have significant impact on physical activity participation for patients with chronic cervical spine pain.
- There were a small number of heterogeneous studies and further research will be necessary to add further support to these findings.

Key Words:

Physical Activity; Neck Pain; Systematic Review

MANUSCRIPT

INTRODUCTION

Neck pain is a common musculoskeletal condition with a point prevalence ranging from 20.6% to 22.2% (1, 2). Up to 50% of people with neck pain are categorised as "chronic" with pain and subsequent disability lasting more than three months (3). Importantly, patients with chronic musculoskeletal conditions demonstrate poorer mental health status (4) and a reduction in functional activity and social participation (5), which have been shown to negatively impact on health status and overall management of their condition and prognosis. Patients with chronic neck pain often report difficulties in relation to performance of daily activities (6) and present with psychological factors such as stress and anxiety, which are strongly associated with increased pain and disability (7). Therefore management strategies aiming to address overall '*illness'* management, disability and health status of this group of patients may have greater effectiveness than local treatment addressing the underlying cervical pathology alone.

Conservative management for neck pain may include uni-modal or multi-modal strategies such as advice, education, manual therapy and exercise prescription (8, 9). Therapeutic exercise prescription may be in the form of specific stretching, 'postural' or strengthening programmes targeted locally at the cervical spine, which can provide short term improvements in pain and function (10, 11). However, a world-wide neck pain task force suggests that physical activity may provide greater efficacy and effectiveness in restoring physical function and managing the psychological components of chronic neck pain such as anxiety and depression (1, 12).

Physical activity (PA) is defined as any bodily movement that requires energy expenditure (13). It is suggested that PA may be sub-grouped into three categories including active transport (for example, walking from home to work), active living (for example, gardening, housework) and sports and exercise (13-15). Public Health England (PHE) reports that if primary healthcare practitioners, society and individuals can improve the adherence to PA guidelines (14) then important health benefits can be achieved for sufferers of chronic conditions such as

cardiovascular disease, mental health and osteoporosis (14-16). Moreover, physical inactivity has been strongly associated with the development and exacerbation of chronic health problems, including diabetes mellitus, ischemic heart disease, stroke, breast cancer, colon/rectal cancer and chronic musculoskeletal complaints (15, 17).

The reasons why the general public or patients participate in PA are complex. It is reported that there are multiple factors that can influence why patients choose to participate in PA in long-term musculoskeletal conditions such as osteoarthritis, including social support, economic costs, access to facilities, disease related and psychological factors (18). A previous literature review investigating the association between levels of physical activity and neck pain reported that there is conflicting evidence based on a low number of heterogeneous studies (19). However, this review did not specifically investigate possible factors that may or may not influence patients with neck pain participation in PA. There is some evidence supporting favourable outcomes in patients with neck pain that participated in PA and demonstrated active lifestyles (20-22). Identifying factors that influence participation in PA may assist in the development of effective management strategies for not only localised neck pain but overall '*illness'* management in regards to disability, physical function and psychological well-being.

To date no systematic reviews been undertaken to determine what factors are associated with PA participation in adults with chronic cervical spine pain. The aim of this study is to undertake a systematic review to establish factors that influence participation in PA in patients with chronic neck pain.

METHODS

The systematic review was registered with PROSPERO review database (Ref: CRD42015027970), and completed following the PRISMA guidelines of reporting (23).

Search Strategy

One reviewer (MM) conducted the systematic search of electronic databases PubMed (MEDLINE), EMBASE and CINAHL from inception to June 12th 2016. An example of the MEDLINE search strategy can be found in Appendix 1. An unpublished (grey) literature search and trial registry search was also completed (Appendix 2). A hand search was completed of the reference lists of the records screened for potential inclusion. Finally, the corresponding authors from all included studies were contacted to determine if there were any pending article publications in this area or unpublished work. Two reviewers (MM, TS) conducted the inclusion and exclusion of studies; at the eligibility stage of selection an inter-rater reliability assessment of the eligibility criteria using a weighted Kappa statistic (Supplementary Table 1) was performed and substantial agreement (0.85) occurred between the two reviewers was established.

Eligibility Criteria

Studies were included if they met the following criteria:

a) Any quantitative study type
b) Adult subjects (over 18 years) with cervical spine pain lasting more than 3 months, including non-specific cervical spine pain or whiplash associated disorders (Modified Quebec task force grade equal or less than IIc) (24).
c) The dependent variable being physical activity participation

Any outcome measure capturing PA was considered for inclusion. No limitation of publication date was applied. All considered articles had to be in the English language. Articles were excluded if PA adherence was not measured or if the participants' cervical spine pain was

related to systemic pathology, fracture, radiculopathy, myelopathy or upper motor neurone pathology.

Study Identification

Using the eligibility criteria, the titles and abstracts of all search results were independently reviewed by two reviewers (MM, TS). From this, full text articles from potentially eligible articles were retrieved and independent assessments were made by the two reviewers. Final eligibility was decided based on full-text assessment.

Data Extraction

Data were extracted onto a pre-defined data extraction table independently by two reviewers (MM, TS). Data extracted included: study characteristics, study type (setting and design), subjects (number, age, gender, duration of symptoms) and details of cervical spine diagnosis. Corresponding authors were contacted to seek clarification or to request additional information on the data sets.

Quality Assessment

Two authors (MM, TS) independently assessed the quality of each included study using a modified Downs and Black (26) (Appendix 3). This tool was used as it has been reported to be a valid and reliable critical appraisal tool to assess methodological quality of non-randomised control studies, which was the predominant study design amongst our eligible papers (25). Any disagreement between reviewers in respect of study eligibility, data extraction or critical appraisal was firstly discussed between the two reviewers (MM, TS). If a consensus could not be reached a third reviewer (MT) acted as adjudicator.

Data Analysis

The heterogeneity of the included studies was assessed by the two reviewers (MM, TS) through examination of the data extraction table. This demonstrated significant heterogeneity in respect of subject characteristics (definition of neck pain), co-interventions, environmental exposure (i.e. work-place/social circumstance) as well as the method of assessing PA participation. Based on these factors, it was inappropriate to conduct a meta-analysis of the data to identify factors associated with PA in subjects with chronic neck pain for several reasons; a meta-analysis was not possible for most factors since only two studies actually measured the same factor (pain) associated with PA; for the other five factors, only one of the eligible studies assessed them. A narrative analysis approach was therefore adopted to answer this question.

RESULTS

Search Strategy

A total of 7 studies met the selection criteria (Figure 1). However, one study was excluded (27) as on contacting the corresponding authors, they were unable to provide the cervical spine sub-group data from their whole spine data set. One study was excluded as the authors did not respond to our request for cervical spine data (28). A further study was excluded (29) as the data utilised was in a poster presentation format and then the same data was subsequently published in a peer reviewed journal (30). Accordingly, four papers were included in the final review Cheung et al. 2013; Demirbuken et al. 2015; Hallman et al. 2014; Rasmussen-Barr et al. 2013.

Study Characteristics

The characteristics of the included studies are presented in Table 1. All four papers were cohort studies. Of these two were non-matched cohort studies (20, 30), whilst two studies (31, 32) were age and gender-matched cohort studies. One study also attempted to closely match the

type of occupation (32). All studies sampled from the general population and no Whiplash Associated Disorders (WAD) populations were identified. A total of 1,925 subjects were sampled across the four studies.

Risk of Bias

Two reviewers (MM, TS) utilised a modified Downs and Black tool to appraise the quality of the articles (Supplementary table 2). Item 8 was removed from assessment as our review question and included studies did not assess the adverse effects of an intervention. Item 14 was removed as the research question of the included studies did not require that the subjects were blinded to the intervention. Items 17 and 21 were removed from the quality assessment of two of the studies as the study designs did not need to adjust for length of follow ups or take into account sampling from different populations (20, 30). Item 19 was removed from the assessment of all included studies as compliance was not an objective of their research. Items 23 and 24 were removed from assessment of all studies as randomisation was not indicated in the study designs.

The scoring between the two reviewers of the included studies had an agreement rate of 74% (95/128). Disagreements were around items 5-7, 11-12, 15-18 and 21-22. All disagreements were resolved during discussion and consensus was achieved. The mean risk of bias score over the four included studies was 59% with a range of 53-65%.

Physical Activity Measurement

Cheung et al (31) measured self-reported PA participation with a Rapid Assessment of Physical Activity (RAPA) tool and an accelerometry total activity count objective measurement tool. Demirbuken et al (30) used the International Physical Activity Questionnaire (IPAQ) tool. An

accelerometry objective measurement device was used by Hallman et al (32). Rasmussen-Barr et al (20) utilised The Physical Activity Level (PAL) assessment tool.

Evidence of Physical Activity Participation Factors

A total of 6 factors were assessed against PA pursuits for subjects with neck pain. Of these, 2 factors demonstrated a statistical relationship whilst 4 did not. These factors are outlined below.

Pain

Cheung et al (31) and Demirbuken et al (30) assessed the relationship between pain and PA. Cheung et al (31) found a relationship between increased pain measured by pressure pain thresholds at the C2 paraspinal muscle and tibalis anterior sites and decreased PA measured by accelerometry ($p=0.04$). Increased pain pressure threshold at the C2 paraspinal site and decreased PA using RAPA assessment was significant in the neck pain group ($p=0.03$) only. In addition, there was a negative association between pain tolerance at the C2 paraspinal muscle site and RAPA assessment and between accelerometry and upper trapezius sites ($p=0.05$ and 0.02 respectively). Demirbuken et al (30) however, found no relationship between neck pain intensity and PA participation ($p=0.432$)

Fear of Movement

Demirbuken et al (30) was the only study to assess fear of movement (kinesiophobia) and PA participation. The study concluded that kinesiophobia was not a statistically significant factor in PA participation (Pearson Correlation, $p=0.148$, $r= - 0.153$).

Smoking Habits

One study examined the relationship between smoking and PA participation in subjects with neck pain. Rasmussen-Barr et al (20) reported a non-significant association in male smokers with neck pain and decreased PA.

Socioeconomic Status

Rasmussen-Barr et al (20) assessed the relationship between socioeconomic status and PA participation in people with neck pain. The authors reported a non-significant association in males with neck pain who were of 'lower' socioeconomic class and PA.

Gender

The relationship between gender and PA participation was assessed by Demirbuken et al (30) who were unable to identify any significant relationship between gender and PA participation (Pearson Correlation p=0.07, r= - 0.043).

Leisure Time and Work Time

One study assessed the relationship between leisure time and work time habits in relation to PA participation. Hallman et al (32) demonstrated a statistically significant association between neck pain and decreased leisure time PA measured by accelerometry (ANOVA Testing, p=<0.05). During working time there was a statistically significant association between neck pain subjects and reduced PA measured by steps taken (ANOVA Testing, p=0.009), walking time (ANOVA Testing, p=0.026) but not in time spent lying or sitting (ANOVA Testing, p=0.069). Rasmussen-Barr et al (20) suggested that females with chronic neck pain who perceived they had increased physical workloads took more sick leave and participated in less PA. The same individuals also spent more time at a computer at work which also had a non-significant association with reduced PA participation.

DISCUSSION

This is the first systematic review undertaken to investigate possible factors related to PA participation in adults with chronic cervical spine pain. From the four studies that met the selection criteria, six factors were identified: Pain, fear of movement, smoking habits,

socioeconomic status, gender and leisure and work time. Based on moderate quality evidence, there was a statistically significant relationship between subjects with neck pain and decreased PA participation. Furthermore, subjects with neck pain were less likely to participate in PA in work and leisure time, which was also based on moderate quality evidence. All four studies utilised different objective methods of assessing PA levels.

Stubbs et al (18) completed a systematic review investigating PA participation factors in people with knee osteoarthritis (OA), the study reported a reduction in PA was related to increasing age, female gender, non-white ethnicity and severity of symptoms (18). Stubbs et al (18) and this review identified the severity of symptoms was a significant factor associated with reduced PA participation. Pain severity, identified by lowered pain thresholds and lowered pain tolerance in chronic cervical spine pain subjects, had a significant negative impact on PA participation. In both Stubbs et al (18) and this review's analysis, reducing subjects' pain is suggested to be an important primary aim of treatment for chronic musculoskeletal conditions in order to help maintain physical functioning and activities of daily living.

Interestingly, our review failed to identify any studies demonstrating factors that are associated with increased engagement with physical activity, whereas Stubbs et al (18) suggested lower limb function, balance and social participation have a positive impact on PA participation in joint specific and mixed lower limb OA.

Relating PA participation factors in chronic cervical spine patient populations to other populations with chronic musculoskeletal spinal pain are challenging due to the dearth of evidence in this area. Hendrick et al (33) systematic review suggested that PA levels in subjects with non-specific low back pain are neither associated nor predictive of pain levels and disability. Conversely, another systematic review suggested a moderate correlation between PA levels and disability in chronic low back pain (34). These differences may be attributed to differing inclusion criteria of each review, Lin (34) examined the relationship between PA levels

and low back pain including studies using any validated measures of disability and PA objective measurements, whereas Hendrick et al (33) examined the outcomes, recovery and reoccurrence rates of low back pain in relation to PA levels. Moreover, Hendrick et al (33), only included longitudinal studies if there was already statistically significant relationship between PA participation and a low back pain outcome measure. Furthermore, both studies did not explore the factors associated with PA participation in low back pain populations.

Due to the limited evidence-base, further research is warranted to identify factors that are associated in PA participation in chronic cervical spine populations. Conducting more research in primary, secondary and tertiary healthcare settings and across varied ethnic and socioeconomic groups may provide greater insight into the factors associated with participation in PA. This review has focused on quantitative research investigating factors affecting PA participation. Future qualitative studies are warranted to investigate the underlying contextual factors from a first person perspective of why PA participation is undertaken, or not, in subjects with chronic cervical spine pain. Furthermore, qualitative investigations may help inform future prospective study designs. In addition, validating objective measurements of PA in chronic cervical spine population will be essential for consistency in future study designs.

Chronic pain is a complex biopsychosocial phenomenon that is challenging to assess and treat. Pain was identified as a significant negative factor in PA participation in cervical spine pain subjects. A future research priority will be to explore the prognosis, outcomes, recovery and reoccurrence rates of subjects with cervical spine pain and how this relates to PA participation. Furthermore, emerging work in pain sciences on the classification and phenotyping of underlying pain mechanisms in musculoskeletal pain may aid in refining the diagnosis of chronic cervical spine pain and direct more optimal treatment strategies. The relationship of PA participation to pain mechanisms-based diagnostic classification will need to be further explored in future research to assist optimal treatment strategies.

It is recognised that there are a number of potential limitations to our review. Firstly, only four highly heterogeneous studies being included. Therefore, the strength of our narrative analysis and how generalisable our findings are to clinical practice is open to question. We did identify two further studies that could have been included for review but unfortunately no response was received from one author and the other author was unable to provide the cervical spine data from their whole spine dataset. We acknowledge that a negative association between the factors identified and physical activity participation cannot, of itself, assume causation. In addition, three of the studies included had a total sample size of less than 50, which may mean their results being underpowered. As further research is undertaken, it is hope that we will be able to better understand potential factors to PA engagement for this population when we update the review. Lastly, each included study had different methods of assessing PA participation. Although these were all validated measures of PA including accelerometry, these tools have not been evaluated in chronic cervical spine population and the adoption of validated outcomes universally used within the literature will facilitate future meta-analyses.

Conclusions

Our review reports a significant association between pain, work and leisure time and decreased participation in PA in adults with chronic cervical spine pain. However, our conclusions should be viewed with caution as the current evidence-base is limited in size and quality. Further

prospective studies in primary, secondary and tertiary healthcare settings are required to develop understanding of why patients may or may not participate in PA with this disabling musculoskeletal condition.

Ethical Approval:

None required

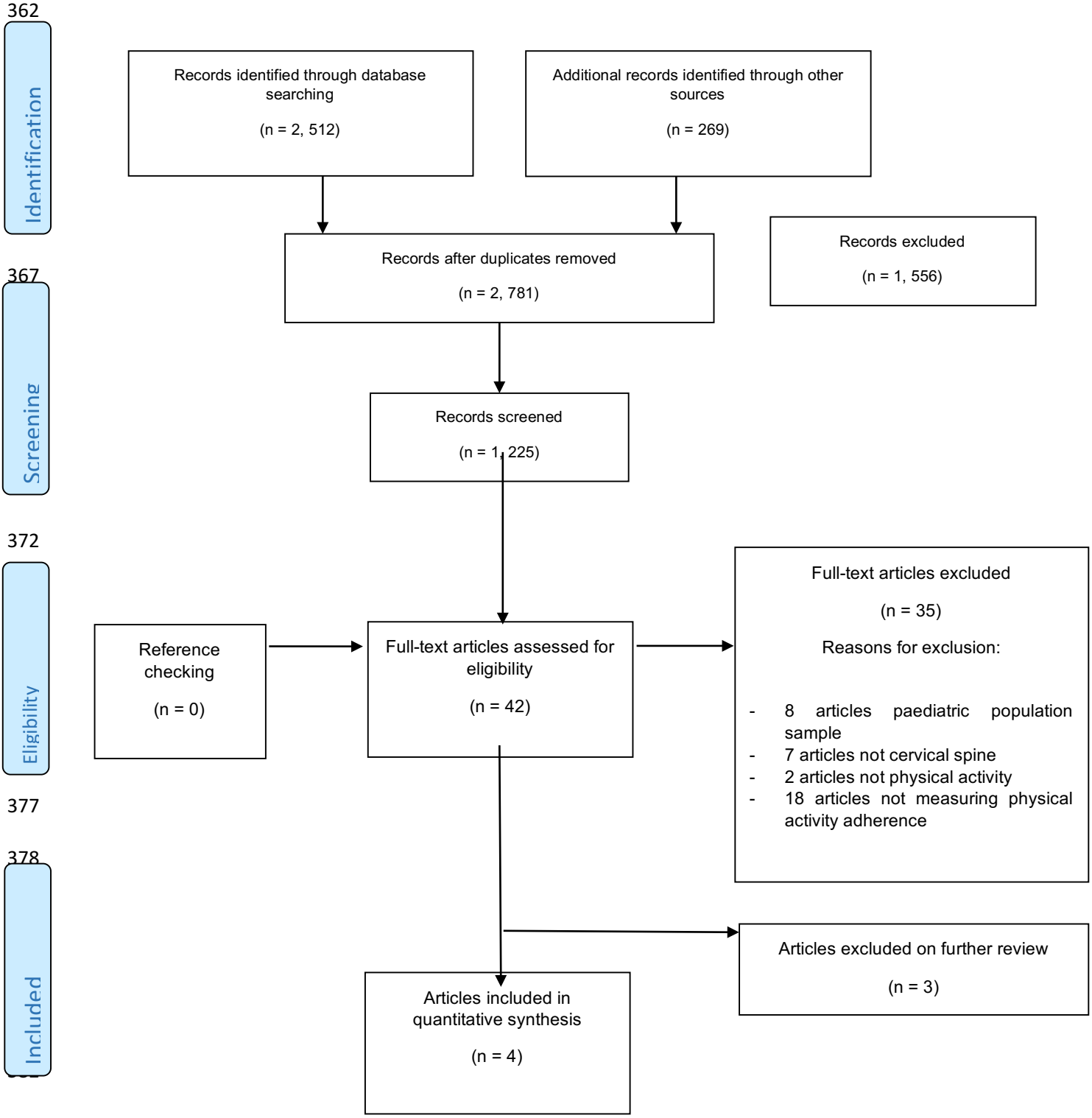
Funding:

None

Conflict of Interest:

There are no conflicts of interest

Figure 1. Study Selection - Flow Diagram



383 Table 1- Study Characteristics

Study	Design	Sample Size	Study Demographics	Cervical Pathology / Clinical Impression	Gender (Male %: Female %)	PA measure
Cheung 2013	Matched-cohort (age and gender)	40 (19/21)	Neck pain: 14 female-5 male; mean age 28 years. Pain intensity score 3.55; disability score; 13.6 (NDI). Duration >3 months. Control: 17 female-14 male; mean age 23.7 years. Pain intensity score 0.05; disability score; 1.3 (NDI).	Chronic or recurrent neck pain for greater 3 months and greater pain intensity 2/10. No data on specific cervical spine pathology.	Neck pain: 14 female-5 male Control: 17 female-14 male	(B) Self-reported physical activity Rapid Assessme of Physical Activ (RAPA) tool. (C) Acceleromet total activity cou physical activity intensity.
Demirbuken 2015	Cohort	99	Mean age: 43.6; BMI: 27.4; pain intensity: 6.47; kinesiophobia: 41.8; IPAQ:	Chronic neck pain (pain for 6 months or longer)	34 males; 65 females	(B) International Physical Activity Questionnaire (IPAQ)

			3749.2. Duration of pain not documented.			
Hallman 2014	Matched-cohort (age and gender; closely matched for type of work and production)	56	Neck-shoulder pain cohort: n=29; mean age 41; BMI: 24.6; duration of pain: 10 years; Control healthy cohort: n=27; mean age 41; BMI: 23.9; duration of pain: 0 years;	Chronic neck and shoulder pain (>6 months). Pain primary neck and/or trapezius muscle.	Neck-shoulder pain cohort: 13 women; 16 males; Healthy cohort: 12 females; 15 males	(C) Acceleromet worn over a 7 da period
Rasmussen – Barr 2013	Cohort	1730	495 males; 1235 females; characteristics of age but ranged from 18-65, BMI and other characteristics are not presented as a cohort.	Persistent neck pain defined as pain daily during the past 6 months.	495 males; 1235 females	(B) PAL – Physi Activity Level Assessment

			Duration of symptoms not explicitly stated.			

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386 *(Notes: PA Measurement*

387 *A: Self-report with unknown/not reported reliability/validity in cervical spine pathology*

388 *B: Self-report with acceptable reliability/validity in cervical spine pathology (if known/any)*

389 *C: Objective measurements)*

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Appendix 1 – MEDLINE Search Strategy. Completed on 17th November 2015

Population: spine OR cervical OR neck pain

AND

Intervention: physical activity OR physical inactivity OR exercise

Appendix 2 – Grey literature and trial database searches. Competed 17th November 2015.

Database	Search Terms	Total Studies	Included
WHO Registry	neck pain AND physical activity	8	0
clinicaltrials.gov	neck pain AND physical activity	261	0
ZETOC	neck pain AND physical activity	16	0

Study / Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
								N/A						N/A					N/A				N/A	N/A			

Reporting: "Yes=1," "No=0"

1. Is the hypothesis /aim /objective of the study clearly described?

2. Are the main outcomes to be measured clearly described in the Introduction or Methods section?

3. Are the characteristics of the patients / samples included in the study clearly described?

4. Are the interventions of interest clearly described?

5. Are the distributions of principal confounders in each group of subjects to be compared clearly described?

"Yes=2," "Partially=1," "No=0"

6. Are the main findings of the study clearly described?

7. Does the study provide estimates of the random variability in the data for the main outcomes?

8. Have all important adverse events that may be a consequence of the intervention been reported?

9. Have the characteristics of patients lost to follow-up been described?

10. Have actual probability values been reported (e.g., 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?

External validity: "Yes=1," "No=0," "Unable to determine=0"

11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?

12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?

13. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?

Internal validity - bias: "Yes=1," "No=0," "Unable to determine=0"

14. Was an attempt made to blind study subjects to the intervention they have received?

15. Was an attempt made to blind those measuring the main outcomes of the intervention?

16. If any of the results of the study were based on “data dredging” was this made clear?

17. In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?

18. Were the statistical tests used to assess the main outcomes appropriate?

19. Was compliance with the intervention/s reliable?

20.Were the main outcome measures used accurate (valid and reliable)?

Internal validity - confounding (selection bias): “Yes=1,” “No=0,” “Unable to determine=0”

21. Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?

22. Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?

23.Were study subjects randomized to intervention groups?

24.Was the randomized intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?

25. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?

26. Were losses of patients to follow-up taken into account?

27. Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?

Appendix 4 – Reliability of inclusion and exclusion between MM and TS

Table 1: Reliability assessment of the eligibility criteria as assessed using the weighted Kappa statistic.

Eligibility criteria	Kappa	Kappa interpretation*
Not adult	1.00	Perfect Agreement
Non-English language	1.00	Perfect Agreement
Not cervical Spine	0.91	Almost Perfect Agreement
Not physical activity	1.00	Perfect Agreement
Not assessing physical activity adherence	0.90	Almost Perfect Agreement
Overall agreement	**0.85**	**Almost Perfect Agreement**

** Landis, J.R.; Koch, G.G. (1977). "The measurement of observer agreement for categorical data". Biometrics **33** (1): 159–174.*