

1 TITLE PAGE

2 Title:

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

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42 **ABSTRACT**

43 **OBJECTIVE:**

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

46 **METHODS:**

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

52 **RESULTS:**

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

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64 **CONCLUSION:**

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

69 **Contribution of paper**

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

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79 **Key Words:**

80 Physical Activity; Neck Pain; Systematic Review

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86 **MANUSCRIPT**

87 **INTRODUCTION**

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

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

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

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

116 The reasons why the general public or patients participate in PA are complex. It is reported that
117 there are multiple factors that can influence why patients choose to participate in PA in long-
118 term musculoskeletal conditions such as osteoarthritis, including social support, economic
119 costs, access to facilities, disease related and psychological factors (18). A previous literature
120 review investigating the association between levels of physical activity and neck pain reported
121 that there is conflicting evidence based on a low number of heterogeneous studies (19).

122 However, this review did not specifically investigate possible factors that may or may not
123 influence patients with neck pain participation in PA. There is some evidence supporting
124 favourable outcomes in patients with neck pain that participated in PA and demonstrated active
125 lifestyles (20-22). Identifying factors that influence participation in PA may assist in the
126 development of effective management strategies for not only localised neck pain but overall
127 '*illness*' management in regards to disability, physical function and psychological well-being.

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

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134 **METHODS**

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

137 Search Strategy

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

149 Eligibility Criteria

150 Studies were included if they met the following criteria:

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

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

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

161 Study Identification

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

166 Data Extraction

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

172 Quality Assessment

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

180 Data Analysis

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

190 **RESULTS**

191 Search Strategy

192 A total of 7 studies met the selection criteria (Figure 1). However, one study was excluded (27)
193 as on contacting the corresponding authors, they were unable to provide the cervical spine sub-
194 group data from their whole spine data set. One study was excluded as the authors did not
195 respond to our request for cervical spine data (28). A further study was excluded (29) as the
196 data utilised was in a poster presentation format and then the same data was subsequently
197 published in a peer reviewed journal (30). Accordingly, four papers were included in the final
198 review Cheung et al. 2013; Demirbuken et al. 2015; Hallman et al. 2014; Rasmussen-Barr et al.
199 2013.

200

201 Study Characteristics

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

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

208 Risk of Bias

209 Two reviewers (MM, TS) utilised a modified Downs and Black tool to appraise the quality of the
210 articles (Supplementary table 2). Item 8 was removed from assessment as our review question
211 and included studies did not assess the adverse effects of an intervention. Item 14 was
212 removed as the research question of the included studies did not require that the subjects were
213 blinded to the intervention. Items 17 and 21 were removed from the quality assessment of two
214 of the studies as the study designs did not need to adjust for length of follow ups or take into
215 account sampling from different populations (20, 30). Item 19 was removed from the
216 assessment of all included studies as compliance was not an objective of their research. Items
217 23 and 24 were removed from assessment of all studies as randomisation was not indicated in
218 the study designs.

219 The scoring between the two reviewers of the included studies had an agreement rate of 74%
220 (95/128). Disagreements were around items 5-7, 11-12, 15-18 and 21-22. All disagreements
221 were resolved during discussion and consensus was achieved. The mean risk of bias score
222 over the four included studies was 59% with a range of 53-65%.

223

224 Physical Activity Measurement

225 Cheung et al (31) measured self-reported PA participation with a Rapid Assessment of Physical
226 Activity (RAPA) tool and an accelerometry total activity count objective measurement tool.

227 Demirboken et al (30) used the International Physical Activity Questionnaire (IPAQ) tool. An

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

230 Evidence of Physical Activity Participation Factors

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

233 Pain

234 Cheung et al (31) and Demirbuken et al (30) assessed the relationship between pain and PA.
235 Cheung et al (31) found a relationship between increased pain measured by pressure pain
236 thresholds at the C2 paraspinal muscle and tibalis anterior sites and decreased PA measured
237 by accelerometry ($p=0.04$). Increased pain pressure threshold at the C2 paraspinal site and
238 decreased PA using RAPA assessment was significant in the neck pain group ($p=0.03$) only. In
239 addition, there was a negative association between pain tolerance at the C2 paraspinal muscle
240 site and RAPA assessment and between accelerometry and upper trapezius sites ($p=0.05$ and
241 0.02 respectively). Demirbuken et al (30) however, found no relationship between neck pain
242 intensity and PA participation ($p=0.432$)

243 Fear of Movement

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

247 Smoking Habits

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

251 Socioeconomic Status

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

255 Gender

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

259 Leisure Time and Work Time

260 One study assessed the relationship between leisure time and work time habits in relation to PA
261 participation. Hallman et al (32) demonstrated a statistically significant association between
262 neck pain and decreased leisure time PA measured by accelerometry (ANOVA Testing,
263 $p<0.05$). During working time there was a statistically significant association between neck
264 pain subjects and reduced PA measured by steps taken (ANOVA Testing, $p=0.009$), walking
265 time (ANOVA Testing, $p=0.026$) but not in time spent lying or sitting (ANOVA Testing, $p=0.069$).
266 Rasmussen-Barr et al (20) suggested that females with chronic neck pain who perceived they
267 had increased physical workloads took more sick leave and participated in less PA. The same
268 individuals also spent more time at a computer at work which also had a non-significant
269 association with reduced PA participation.

270 **DISCUSSION**

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

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

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

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

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

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

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

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

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

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343 **Conclusions**

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

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

350

351 **Ethical Approval:**

352 None required

353

354 **Funding:**

355 None

356

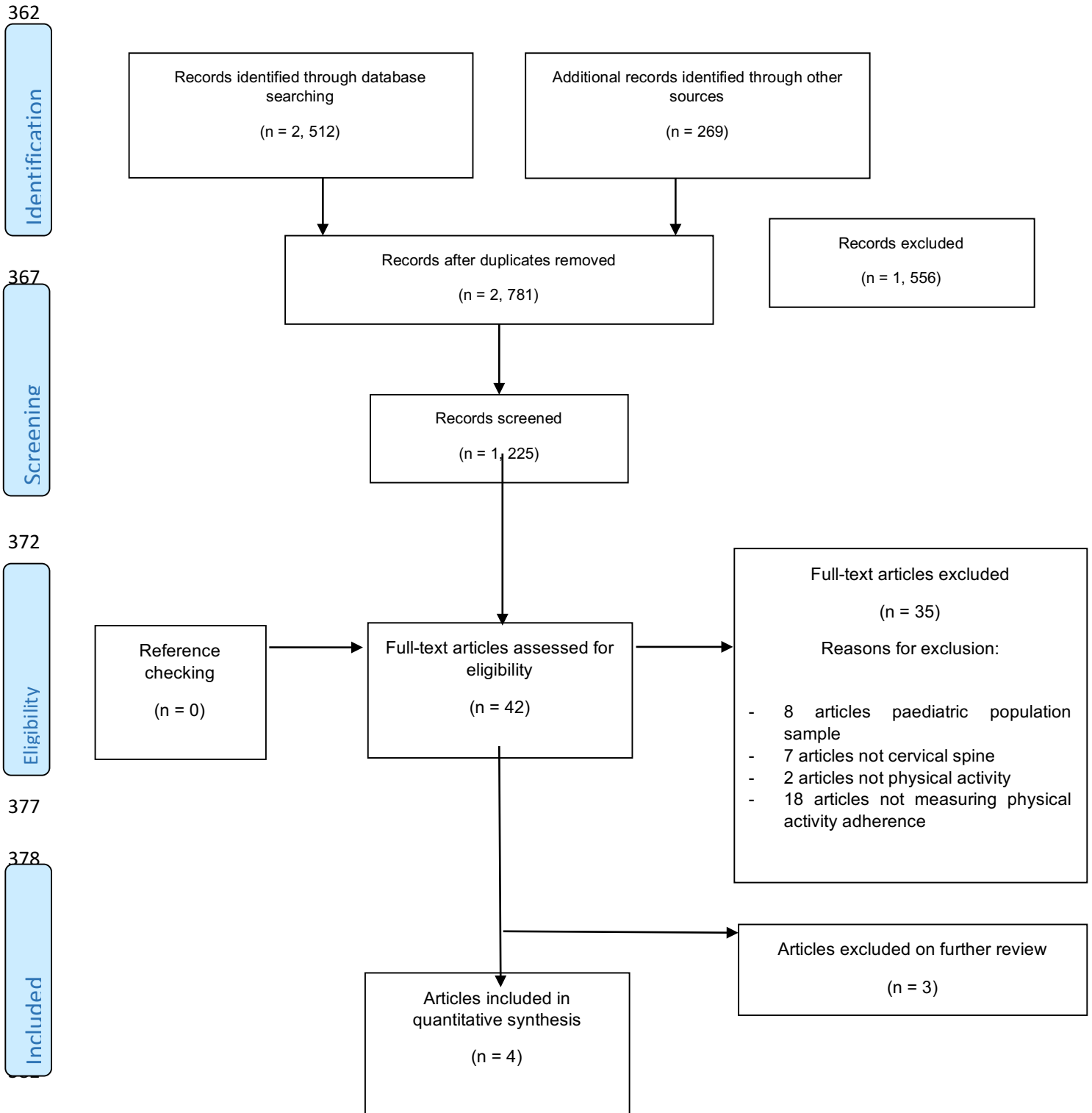
357 **Conflict of Interest:**

358 There are no conflicts of interest

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361 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)	<p>Neck pain: 14 female-5 male; mean age 28 years. Pain intensity score 3.55; disability score; 13.6 (NDI). Duration >3 months.</p> <p>Control: 17 female-14 male; mean age 23.7 years. Pain intensity score 0.05; disability score; 1.3 (NDI).</p>	Chronic or recurrent neck pain for greater 3 months and greater pain intensity 2/10. No data on specific cervical spine pathology.	<p>Neck pain: 14 female-5 male</p> <p>Control: 17 female-14 male</p>	<p>(B) Self-reported physical activity Rapid Assessment of Physical Activity (RAPA) tool.</p> <p>(C) Accelerometer total activity count physical activity intensity.</p>
Demirbukan 2015	Cohort	99	<p>Mean age: 43.6; BMI: 27.4; pain intensity: 6.47; kinesiophobia: 41.8; IPAQ:</p>	Chronic neck pain (pain for 6 months or longer)	34 males; 65 females	(B) International Physical Activity Questionnaire (IPAQ)

Physical Activity Participation Factors Cervical Spine

			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 – Physic Activity Level Assessment

Physical Activity Participation Factors Cervical Spine

			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. Completed 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

Physical Activity Participation Factors Cervical Spine

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.