Scand J Work Environ Health 2005;31(5):387-393

<https://doi.org/10.5271/sjweh.922>

Issue date: Oct 2005

Utility of restricted neck movement as a diagnostic criterion in case definition for neck disorders

by [Reading I](#), [Walker-Bone K](#), [Palmer KT](#), [Cooper C](#), [Coggon D](#)

Affiliation: Medical Research Council (MRC) Epidemiology Resource Centre, University of Southampton, Southampton, United Kingdom.

Key terms: [case definition](#); [diagnosis](#); [diagnostic criterion](#); [neck disorder](#); [physical activity](#); [psychosocial risk factor](#); [restricted neck movement](#); [risk factor](#)

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/16273965

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

Utility of restricted neck movement as a diagnostic criterion in case definition for neck disorders

by Isabel Reading, PhD,¹ Karen Walker-Bone, MRCP,^{1,2} Keith T Palmer, DM,¹ Cyrus Cooper, FMedSci,¹ David Coggon, FMedSc¹

Reading I, Walker-Bone K, Palmer KT, Cooper C, Coggon D. Utility of restricted neck movement as a diagnostic criterion in case definition for neck disorders. *Scand J Work Environ Health* 2005;31(5):387–393.

Objectives This study explored the utility of restricted neck movement in epidemiologic case definition for neck disorders.

Methods Data on neck pain, sensory symptoms in the arm, psychosocial and physical risk factors for neck disorders, and the range of active neck movements were obtained through a self-administered questionnaire, interview, and physical examination for a community-based sample of 2145 adults aged 25–64 years. The prevalence of neck pain and sensory symptoms was examined according to the extent of neck movements. Logistic regression was used to assess the relation of risk factors to neck disorders, defined by various combinations of pain and restricted movement, and the associations were compared.

Results The ranges of different categories of neck movement were correlated within persons, and their sum (“total neck movement”) was unimodally distributed across persons. The prevalence of neck pain and sensory symptoms was elevated when total neck movement was below the 30th centile, and particularly below the 10th centile. Associations between neck pain and low vitality and poor support at work were stronger when there was also restricted neck movement, but the extent of neck movement did not materially modify the relation of neck pain to physical risk factors.

Conclusions The restriction of total neck movement may serve as a marker of severity in community-based studies of neck disorders, but no indication was found that it distinguishes a subset of cases with a distinct etiology.

Key terms case definition; diagnosis; neck disorder; physical activity; psychosocial risk factor.

Neck pain is one of the most common work-related musculoskeletal complaints in the adult populations of developed countries, contributing importantly to the demand for medical services and the economic burden of sickness absence from work (1–8). The epidemiologic investigation of its causes would be enhanced if subsets of cases could be distinguished that differ importantly in their etiology and pathogenesis. Often the symptom is associated with cervical spondylosis, and, although the correlation with radiological abnormalities of the spine is far from perfect (9), the presence of such changes may be one basis for a useful subclassification of cases. However, in large community-based epidemiologic surveys, radiological examination of the neck may be neither practical nor ethically acceptable.

Another clinical feature that is more easily elicited, and may be indicative of distinct underlying disease processes, is limitation of neck movement. Using data from a cross-sectional survey of adults in the general population, we have previously shown that neck pain is more likely to be associated with numbness or tingling in the hands when there is also a reduction in the range of neck movement (10). In that analysis, neck movement was defined as abnormal if the sum of the ranges of flexion, extension, lateral flexion, and rotation fell more than two standard deviations below the age- and gender-adjusted mean for the population studied. However, it is unclear whether this is the optimal method of classification and whether the restriction of neck movement distinguishes illness that has clearly distinct causes or it is simply a marker for severity.

¹ Medical Research Council (MRC) Epidemiology Resource Centre, University of Southampton, Southampton, United Kingdom.

² Brighton and Sussex Medical School, Mayfield House, Village Way, Falmer, Brighton, United Kingdom.

Correspondence to: Professor D Coggon, MRC Epidemiology Resource Centre, Southampton General Hospital, Southampton, SO16 6YD, UK. [E-mail: dnc@mrc.soton.ac.uk]

To explore these questions, we carried out a more-detailed analysis of patterns of neck movement and their relation to symptoms and risk factors, using data from the same survey.

Study population and methods

The study sample comprised men and women aged 25–64 years who were registered with two general practices in Southampton. In Great Britain, almost everyone is registered with a general practitioner, and practice lists effectively provide a sampling frame for the general population. After 156 persons were excluded on the advice of their general practitioner (eg, because of terminal illness or recent bereavement), all of the 9696 men and women who remained were sent a postal questionnaire, followed if necessary by a reminder. Among other things, the questionnaire asked about psychological symptoms [questions on vitality and mental health taken from the SF-36 questionnaire (11)], and about occupational risk factors for musculoskeletal symptoms, including measures of demand, support, and control, based on the Karasek model (12), work with the neck bent forward or twisted, use of a computer keyboard, repetitive use of the upper limb, carrying or lifting, use of hand-held vibratory tools, and work with the hands above shoulder height. It also asked whether, during the past 7 days, the person had experienced pain in the neck or arm lasting a day or longer, or numbness or tingling in the hand or arm that had lasted at least 3 minutes. Usable replies were received from 6038 persons (62% of those receiving mail).

Subsequently, all of the respondents who reported pain or sensory symptoms in the arm or neck ($N=3152$) were invited to take part in an interview and clinical examination, together with a random sample ($N=489$) of those without these symptoms. A total of 2145 (59%) agreed (1960 of those with symptoms and 185 of those without). The interviews and examinations were carried out by four trained research nurses and a research physiotherapist at an interval of 0–398 days (median 37 days, 80% within 65 days) from the return of the questionnaire. As part of the assessment, the respondents were asked again about symptoms in their arm and neck over the past 7 days, and the maximal extent of unassisted active neck movement without discomfort from a neutral position was determined for rotation to the right and left (using a neck goniometer) and for flexion, extension, and right and left lateral flexion, using a plurimeter (Plurimeter-V inclinometer: Dr Rippstein, Zurich, Switzerland). Neck pain was defined by a positive answer to the question “During the past 7 days have you had pain lasting a day or longer in your neck?”, and

numbness or tingling in the hand or arm as the occurrence of either or both of these symptoms lasting for at least 3 minutes during the past 7 days in at least one of “your fingers or thumbs”, “other parts of your hands” or “other parts of your arm”. Neck movements were defined according to Greene & Heckman (13), and their measurement was carried out after the interview about symptoms (duration approximately 10 minutes) and before other elements of the physical examination. Care was taken to ensure as far as possible that the participant was relaxed and comfortable in a sitting position. One measurement was performed for each movement, in the described order, and without prior training of the participant.

In our analysis, we examined the frequency distributions for each of the six categories of neck movement, their interrelation, and their relation to gender, age, neck pain, and numbness and tingling in the fingers and hand. We then used a logistic regression analysis to compare the associations between reduced neck movement and psychosocial and physical risk factors according to the presence or absence of neck pain. Information about the psychosocial and physical risk factors was derived from the results of the initial postal questionnaire. The occurrence of pain and sensory symptoms was determined from the interviews at the time of the physical examination (in some cases there had been a change in symptoms between the completion of the postal questionnaire and the subsequent interview).

Results

Complete measurements of neck movement were obtained for 2145 participants (855 men and 1290 women) with a mean age at the time of examination of 48 years. Figure 1 shows the frequency distributions for each of the six measures recorded. Four of the movements (flexion, extension, and right and left lateral flexion) were distributed more or less symmetrically about a modal value. The distributions of maximal right and left rotation were also unimodal, but were slightly skewed to the left. The dispersions of the six measures were similar (standard deviations from 11.6 to 15.5 degrees).

All of the movements were interrelated, the pairwise correlation coefficients ranging from 0.42 (flexion versus extension) to 0.77 (right versus left rotation) (table 1). Adjustment for age and gender reduced all of the correlation coefficients, but only somewhat (reductions of 0.03 to 0.06).

Figure 2 shows the distribution of total neck movement (calculated by adding the six measures for each participant) according to gender and age. The distributions were again unimodal and were broadly similar for

Figure 1. Distributions of maximum neck movement for 2145 men and women. (° = degrees)

Table 1. Pairwise correlations between maximum neck movement in different planes. The correlations were summarized by Pearson correlation coefficients.

	Rotation (right)		Rotation (left)		Flexion		Extension		Lateral flexion (right)		Lateral flexion (left)	
	Adjust-ed ^a	Unad-justed	Adjust-ed ^a	Unad-justed	Adjust-ed ^a	Unad-justed	Adjust-ed ^a	Unad-justed	Adjust-ed ^a	Unad-justed	Adjust-ed ^a	Unad-justed
Rotation (right)	1											
Rotation (left)	0.74	0.77	1									
Flexion	0.43	0.47	0.44	0.48	1							
Extension	0.48	0.52	0.49	0.53	0.39	0.42	1					
Lateral flexion (right)	0.48	0.54	0.47	0.53	0.42	0.46	0.55	0.59	1			
Lateral flexion (left)	0.46	0.52	0.48	0.54	0.45	0.48	0.55	0.60	0.59	0.65	1	

^a Adjusted for gender and age (in 10-year strata).

Figure 2. Distribution of total neck movement according to gender and age. (° = degrees)

the men and women. The modal and maximal values varied little with age, but there was a tendency for the distribution to become more skewed at older ages, with a small, but increasing proportion of participants with an unusually low range of movement (<245 degrees).

Altogether, 581 participants (27%) reported neck pain, and 681 (32%) had numbness or tingling in the hand or arm. The relation of total neck movement to neck pain and numbness or tingling in the hand and arm is summarized in figure 3, which shows that the prevalence of both symptoms declined as total neck movement increased. There is no clear point of inflexion in either of the graphs in figure 3, but the maximum rate of decline in symptom prevalence occurred between the 10th and 30th centiles of the distribution of total neck movement. The prevalence of neck pain was some 8% higher for the women than for the men, and numbness and tingling was approximately 8% less frequent below the age of 35 years than at older ages. However, these differences appeared to be largely independent of neck movement. Thus, for example, among the men and women with total neck movement of <295 degrees, the prevalence of neck pain was 37% and 48%, respectively, while, for neck movement of <245 degrees, the corresponding rates were 55% and 63%.

Table 2 shows the relation of neck pain and total neck movement to psychosocial and physical risk factors. The risk factors presented are those that showed statistically significant associations ($P < 0.05$) with at least one of the five combinations of pain and movement when the risk estimates were mutually adjusted. Low vitality was associated with neck pain whether or not neck movement was limited, but associations were stronger when the pain was accompanied by restriction

of movement. Thus, for the combination of neck pain and total movement of <245 degrees in comparison with no neck pain and total movement of ≥ 295 degrees, low vitality carried an odds ratio of 6.7 (95% confidence interval 3.0–15.1). Furthermore, reduced neck movement was more common for those who reported low vitality, even in the absence of neck pain. A report of poor support from colleagues and managers at work was associated with a higher risk of neck pain when the latter was accompanied by reduced neck movement, but was not related to neck movement among the participants who did not have neck pain. Working with the neck bent or twisted carried an increased risk of neck pain, but was not additionally related to impaired neck movement.

Discussion

Our findings indicate that the neck mobility of a person can be summarized conveniently by summing the range of flexion, extension, right and left lateral flexion, and right and left rotation. This measure, which we have termed "total neck movement", was distributed unimodally in the general population of young and middle-aged adults. Lower levels of total neck movement were associated with a higher prevalence of neck pain and of numbness or tingling in the hand or arm. Within the distribution of total neck movements, there was no clear threshold below which the prevalence of symptoms was markedly higher, but, in the population studied, most of the excess of symptoms occurred below the 30th centile (295 degrees). The associations of neck pain with low vitality and poor support at work were stronger

Figure 3. Prevalence of neck pain and numbness or tingling in the hand or arm according to total neck movement. Each point on a graph represents the prevalence of pain or numbness-tingling among men and women whose total neck movement was below the value indicated on the horizontal axis. Also indicated on the horizontal axis are the corresponding centile points of the distribution of total neck movement. (° = degrees)

Table 2. Associations of neck pain and restricted neck movement with psychosocial and physical risk factors. The odds ratios (OR) were derived from five logistic regression models, one for each combination of neck pain and total neck movement, and were calculated relative to the participants with no neck pain and total neck movement of ≥ 295 degrees. Each model incorporated all of the risk factors shown as independent variables, together with gender and age (in four 10-year strata). (95% CI = 95% confidence interval)

Risk factor	No neck pain							Neck pain								
	Movement ≥295 degrees (N)	Movement 245–294 degrees			Movement <245 degrees			Movement ≥295 degrees			Movement 245–294 degrees			Movement <245 degrees		
		N	OR	95% CI	N	OR	95% CI	N	OR	95% CI	N	OR	95% CI	N	OR	95% CI
Vitality																
High	342	49	1	.	8	1	.	53	1	.	20	1	.	9	1	.
Medium	326	58	1.5	1.0–2.4	19	3.5	1.4–8.4	81	1.5	1.0–2.2	29	1.6	0.9–3.0	13	2.0	0.8–4.9
Low	267	57	1.9	1.2–3.0	16	3.9	1.6–9.6	113	2.4	1.7–3.5	58	4.1	2.3–7.2	34	6.7	3.0–15.1
Support at work from colleagues or boss																
Often or sometimes	735	125	1	.	31	1	.	184	1	.	73	1	.	28	1	.
Seldom or never	108	23	1.0	0.6–1.7	6	0.9	0.4–2.4	37	1.3	0.9–2.0	22	1.7	1.0–2.9	16	2.9	1.5–5.7
Not applicable	92	16	0.9	0.5–1.6	6	1.4	0.5–3.5	26	1.3	0.8–2.1	12	1.1	0.5–2.2	12	3.1	1.4–6.7
Work with neck bent forward >2 hours/day																
No	497	84	1	.	27	1	.	102	1	.	42	1	.	26	1	.
Yes	438	80	1.1	0.8–1.6	16	0.7	0.4–1.4	145	1.4	1.0–1.9	65	1.7	1.1–2.6	30	1.4	0.8–2.6
Work with neck twisted >0.5 hours/day																
No	670	110	1	.	31	1	.	150	1	.	67	1	.	36	1	.
Yes	265	54	1.2	0.8–1.8	12	1.1	0.5–2.4	97	1.5	1.1–2.1	40	1.4	0.9–2.3	20	1.2	0.6–2.3

when the symptom was accompanied by a restriction of total neck movement to <295 degrees, and particularly when it was <245 degrees. Moreover, low vitality was associated with restricted neck movement even in the absence of neck pain. However, the extent of neck movement did not materially modify the relation between neck pain and the physical risk factors examined.

Although our study population was geographically localized, it included a broad representation of occupational and socioeconomic groups, and we have no reason to suspect that it was atypical in relation to the questions that our investigation addressed. Furthermore, although the incomplete response to the two phases of data collection may have led to an overrepresentation of people with a higher level of education, more available free time, or a greater personal interest in musculoskeletal disorders, any overrepresentation is unlikely to have had biased associations with different levels of neck movement. The six measurements of neck movement that we recorded were quick and easy to perform, and we have previously found that they show good repeatability within and between observers (14). Their validity is further supported by the clear relation that we found with neck pain and numbness or tingling in the hand or arm (figure 3).

The intercorrelation of the six measurements of neck movement (table 1) could reflect a general effect on neck mobility from disease processes in the cervical spine. However, it is also possible that people with a lower pain threshold or greater awareness of musculoskeletal symptoms are more inclined to limit all neck movements at their extremes. Whatever the explanation,

the pattern of mutual correlation suggests that it is reasonable to combine the six measures to form a single summary index of neck mobility.

The distribution of total neck movement within the study sample was continuous and unimodal, and therefore there was no obvious cutpoint by which to distinguish abnormality. However, the thresholds that we adopted for case definitions (245 and 295 degrees) corresponded to extremes of the range over which the prevalence of neck pain and sensory symptoms in the arm increased the most steeply. Moreover, one feature of the relation of total neck movement to age was a tendency towards a more skewed distribution at older ages because of an increased proportion of participants with values of <245 degrees, a finding suggesting that this extreme 10% of the distribution may contain a high proportion of people with abnormal movement. For these reasons, if the extent of neck movement contributes usefully to case definition, we would expect it to have been apparent with the cutpoints chosen.

Ultimately, the value of any case definition lies in its utility in the prevention or management of illness. It must distinguish a category of illness or disease that differs importantly from others, either in its causation or in its clinical course and response to treatment. When an illness results from a well-established pathological process, the demonstration of such pathology may constitute a gold standard against which other diagnostic criteria can be assessed. If, however, the pathogenesis is uncertain, as is the case with most neck pain, then the evaluation of possible case definitions requires empirical evidence of their potential to distinguish categories of

illness with importantly different risk factors, prognoses, or responses to treatment.

In this investigation, we explored the discriminatory value of case definitions for neck pain in relation to various possible risk factors. The risk factors examined were psychosocial variables and occupational physical activities that are known or suspected causes of neck complaints. Several prospective studies have highlighted the association between incident neck pain and poor psychological status (15, 16), low decision latitude (17, 18), high quantitative job demands (18), low co-worker support (18), and sustained neck flexion (19); while recent reviews (20, 21) have focused on neck posture, repetitive arm movements, hand-arm vibration, and forceful work with the arms. From the set of 13 risk factors with which we started (five psychosocial and eight physical), our final analysis was based on the four which were statistically significant in at least one of the models presented (table 2).

A comparison of different possible case definitions revealed that the association between low vitality and neck pain was present at all levels of neck movement, but it was stronger if, in addition to the pain, neck movement was restricted. A similar pattern was observed for poor support at work, although the association with neck pain in the absence of restricted movement fell just short of statistical significance. For the two physical risk factors examined, a concomitant restriction of neck movement appeared to make no difference to associations with neck pain. This pattern of results suggests that restricted neck movements may distinguish more severe cases of neck pain, but it gives no indication that it serves as a marker for a distinct subset of cases with different causes and pathogeneses. In particular, we found no evidence that, in the general population, restricted neck movement is a useful sign of pathology resulting from repeated physical stress to the cervical spine.

On the contrary, restricted neck movement appeared to be more relevant to psychosocial than physical risk factors. It may be that people suffer reduced vitality and perceive more stresses in their work as a consequence of neck disorders, particularly if the disorder is sufficiently severe to limit neck movements. However, the fact that reduced neck movement was associated with low vitality even when no pain was reported suggests that this is not the full explanation for its relation to psychosocial variables. An alternative possibility is that people who complain of low vitality are more prone to perceive or report pain in the neck, and also to resist extreme neck movements. This possibility would be consistent with the observation that depressive symptoms have been found to predict the subsequent incidence of musculoskeletal symptoms at other anatomical sites, such as the back (22, 23) and forearm (24).

On the basis of our findings, we conclude that reduced total neck movement, particularly to <245 degrees, may serve as a marker of severity in community-based studies of neck disorders, but we have found no indication that it distinguishes a subset of cases with a distinct etiology.

Acknowledgments

This study was supported by a grant from the Health and Safety Executive and a project grant (P0552) from the Arthritis Research Campaign (ARC). Karen Walker-Bone was supported by an ARC Clinical Research Fellowship and Isabel Reading by a grant from the Colt Foundation.

We are grateful to Dr Cathy Linaker, Mrs Trish Byng, Mrs Angie Shipp, Mrs Claire Ryall, and Mrs Karen Collins, who helped conduct the interviews and examinations, to Vanessa Cox and Ken Cox for their computer support, and to the staff at the MRC Environmental Epidemiology Unit, Southampton, who assisted with the data handling and the typing of this report. We wish to thank the Southampton general practitioners who participated in this study for their enthusiastic support of the project.

References

1. Mäkelä M, Heliövaara M, Sievers K, Impivaara O, Knekt P, Aromaa A. Prevalence, determinants, and consequences of chronic neck pain in Finland. *Am J Epidemiol* 1991; 134:1356–67.
2. Brattberg G, Thorslund M, Wikman A. The prevalence of pain in a general population: the results of a postal survey in a county of Sweden. *Pain* 1989;37:215–22.
3. Côté P, Cassidy JD, Carroll L. The Saskatchewan Health and Back Pain Survey. *Spine* 1997;23:1689–98.
4. Lau EMC, Sham A, Wong KC. The prevalence of and risk factors for neck pain in Hong Kong Chinese. *J Public Health Med* 1996;18:396–9.
5. Takala J, Sievers K, Klaukka T. Rheumatic symptoms in the middle-aged population in southwestern Finland. *Scand J Rheumatol* 1982;47:15–29.
6. Westerling D, Jonsson BG. Pain from the neck-shoulder region and sick leave. *Scand J Soc Med* 1980;8:131–6.
7. Bovim G, Schrader H, Sand T. Neck pain in the general population. *Spine* 1994;19:1307–9.
8. Cunningham I, Kelsey J. Epidemiology of musculoskeletal impairments and associated disability. *Am J Public Health* 1984;74:574–9.
9. Lawrence JS. Disc degeneration: prevalence and relationship to symptoms. *Ann Rheum Dis* 1969;28:121–38.
10. Reading I, Walker-Bone K, Palmer KT, Cooper C, Coggon D. Anatomic distribution of sensory symptoms in the hand and their relation to neck pain, psychosocial variables and occupa-

- tional activities. *Am J Epidemiol* 2003;157:524–30.
11. Jenkinson C, Coulter A, Wright L. Short form 36 (SF 36) health survey questionnaire: normative data for adults of working age. *BMJ* 1993;306:1437–40.
 12. Karasek RA. Job demands, job decision latitude, and mental strain: implications for job redesign. *Adm Sci Q* 1979;24:285–307.
 13. Greene WB, Heckman JD. The clinical measurement of joint motion. Rosemont (IL): American Academy of Orthopaedic Surgeons; 1994.
 14. Palmer K, Walker-Bone K, Linaker C, Reading I, Kellingray S, Coggon D, et al. The Southampton examination schedule for the diagnosis of musculoskeletal disorders of the upper limb. *Ann Rheum Dis* 2000;59:5–11.
 15. Croft PR, Lewis M, Papageorgiou AC, Thomas E, Jayson MI, Macfarlane GJ, et al. Risk factors for neck pain: a longitudinal study in the general population. *Pain* 2001;93:317–25.
 16. Viikari-Juntura E, Martikainen R, Luukkonen R, Mutanen P, Takala EP, Riihimäki H. Longitudinal study on work related and individual risk factors affecting radiating neck pain. *Occup Environ Med* 2001;58:345–52.
 17. Eriksen W, Natvig B, Knardahl S, Bruusgaard D. Job characteristics as predictors of neck pain: a 4-year prospective study. *Occup Environ Med* 1999;41:893–902.
 18. Ariëns GA, Bongers PM, Hoogendoorn WE, Houtman IL, van der Wal G, van Mechelen W. High quantitative job demands and low coworker support as risk factors for neck pain: results of a prospective cohort study. *Spine* 2001;26:1896–901.
 19. Ariëns GA, Bongers PM, Douwes M, Miedema MC, Hoogendoorn WE, van der Wal G, et al. Are neck flexion, neck rotation, and sitting at work risk factors for neck pain? results of a prospective cohort study. *Occup Environ Med* 2001;58:200–7.
 20. Ariëns GA, van Mechelen WV, Bongers PM, Bouter LM, van der Wal G. Physical risk factors for neck pain. *Scand J Work Environ Health* 2000;26:7–19.
 21. Bernard B. Musculoskeletal disorders and workplace factors. a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. Cincinnati (OH): US Department of Health and Human Sciences/ National Institute for Occupational Safety and Health; 1997. p 2.1–2.90.
 22. Pincus T, Burton AK, Vogel S, Field AP. A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine* 2002;27:E109–120.
 23. Power C, Frank J, Hertzman C, Schierhout G, Li L. Predictors of low back pain onset in a prospective British study. *Am J Public Health* 2001;91:1671–8.
 24. Macfarlane GJ, Hunt IM, Silman A. Role of mechanical and psychosocial factors in the onset of forearm pain: prospective population based study. *BMJ* 2000;321:676–9.

Received for publication: 16 February 2005