

The association between neck pain, the Neck Disability Index and cervical ranges of motion: a narrative review

Emily R. Howell, BPHE (Hons), DC*

Background: *The Neck Disability Index (NDI) and Cervical Ranges of Motion (CROM) are measurement tools that are used for neck pain patients.*

Objective: *To review the literature to determine how the NDI is associated with neck pain and CROM outcomes.*

Methods: *Computer based searches of 5 databases were performed and supplemented by internet and hand searching of article references and “related citations.”*

Results: *The search yielded 23 studies that met the inclusion and exclusion criteria and these were summarized into four categories: NDI, NDI and other questionnaires, whiplash and NDI and cervical range of motion and NDI. The NDI was shown to be a well validated and reliable self-reported questionnaire, especially when compared to other questionnaires, in both neck pain and whiplash (WAD) patients. There are very few studies that discuss the NDI and cervical range of motion.*

Conclusion: *This review outlines the strength of the NDI as a self-reported neck disability questionnaire, but also demonstrates a need for further research to explore the association between the NDI, neck pain and cervical ranges of motion.*

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KEY WORDS: neck pain, neck disability index, range of motion, whiplash

Historique : *l'indice d'invalidité du cou (NDI) et la portée du mouvement cervical (CROM) sont des outils servant à mesurer la douleur au cou des patients.*

Objectif : *lire la documentation afin de déterminer le lien entre le NDI et la douleur au cou et les résultats de CROM.*

Méthodes : *recherche par ordinateur de 5 banques de données, à laquelle s'ajoute une recherche sur Internet et une recherche à la main de références et de « citations connexes ».*

Résultats : *la recherche a permis de consulter 23 études répondant aux critères d'inclusion et d'exclusion, et ces études furent résumées en quatre catégories : NDI, NDI et autres questionnaires, coup de fouet cervical et NDI, et portée du mouvement cervical et NDI. Le NDI s'avéra un questionnaire fiable et bien documenté par rapport aux autres questionnaires, autant chez les patients souffrant de douleur au cou que chez ceux qui souffrent de coup de fouet cervical. Il existe peu d'études traitant du NDI et de la portée du mouvement cervical.*

Conclusion : *cette analyse résume les points forts du NDI en tant que questionnaire rempli directement par les patients souffrant de douleur au cou, mais aussi à des fins de recherche visant à déterminer le lien entre le NDI, la douleur au cou et la portée du mouvement cervical.*

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MOTS CLÉS : douleur au cou, indice d'invalidité du cou, portée du mouvement cervical, coup de fouet cervical

* Emily R. Howell, BPHE(Hons), DC, Ashbridge's Health Centre, 1522 Queen St. East, Toronto, ON M4L 1E3.

Contact info: dremilyhowell@hotmail.com. Tel: 416-465-5575.

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Introduction

Self-reported disability and other outcome measures are an important part of patient assessment and provide important clinical information to the clinician. Neck pain related disability and function need to be measured in order to assess pre and post treatment patient outcomes, as well as provide valuable information to other stakeholders.

The Neck Disability Index (NDI) is a 10-item questionnaire that measures a patient's self-reported neck pain related disability. It was the first of its kind when it was published in 1991 in JMPT and was based on the Oswestry Low Back Pain Disability Questionnaire. The NDI was reviewed in 2008 by the same author. The NDI is the most widely used, translated and oldest questionnaire for neck pain. It has been shown to have high "test-retest" reliability. The NDI has also been shown to be valid when comparing it to other pain and disability measures. Questions include activities of daily living, such as: personal care, lifting, reading, work, driving, sleeping, recreational activities, pain intensity, concentration and headache. Each question is measured on a scale from 0 (no disability) to 5, and an overall score out of 100 is calculated by adding each item score together and multiplying it by two. A higher NDI score means the greater a patient's perceived disability due to neck pain. The "minimally clinically important change" by patients has been found to be 5 or 10%. The NDI has been translated into over 20 languages, cited by over 350 articles in the scientific literature, used in over 100 treatment studies and has been endorsed by many guidelines.^{1,2}

Cervical ranges of motion are frequently used in clinical practice as a functional outcome measure, but is usually performed visually and not with a CROM device. How CROM relates with a neck pain patient's self-reported disability still needs to be investigated. In a recent cross-sectional survey of chiropractors, the majority reported that they do not use psychosocial questionnaires or condition-specific disability indices to document health status. Most rely on history taking and pain drawings, as well as neurological and visual testing for patient visits. The NDI and CROM device were reported to be underused in clinical practice, but are important tools to give practitioners clinical baselines and treatment outcome measures.³

The association between neck pain (including WAD), the Neck Disability Index, and cervical ranges of motion was investigated in the literature. The aims of this litera-

ture review are to investigate any association between the three; describe any lack of information; and to suggest areas for further research.

Methods

MEDLINE (via EBSCO and PubMed), CINAHL, Index to Chiropractic Literature, SPORTDiscus and the Cochrane Database of Systematic Reviews were searched for the earliest possible dates of inclusion through to September 2010. Search terms included MeSH terms: "neck pain," "disability evaluation," "severity of illness index," "health status indicators," "pain measurement" "range of motion - articular" and "whiplash," as well as "neck disability index/NDI." All searches met the inclusion criteria: human, adult (18 years of age or older) and English-language studies. Types of studies included were systematic and narrative reviews, randomized controlled trials, cohort studies and case series. Exclusion criteria included: non-NDI data, non-English language, not adult subjects, unpublished data, as well as those that were not from peer-reviewed publications and did not use methodologies (such as editorials, commentaries, case studies, etc). Additional references were later identified from references of relevant articles, as well as "related citations" (in PubMed's MEDLINE feature) were also assessed for the review. One rebuttal was included, as it applied specifically to a particular study and was written by the NDI's original author.

Results

A literature search of the five databases resulted in 54 articles, including the following: MEDLINE (n = 26), CINAHL (n = 27), ICL (n = 6), SPORTDiscus (n = 15), and Cochrane (n = 6). The total located citations that met the inclusion and exclusion criteria and were also found by references from the original articles (n = 23) were reviewed.

Discussion

The association between NDI, CROM, and neck pain (including whiplash) has not been well studied. There were many articles that measured each individual factor, but the association between them has not been reviewed in depth. Since there is a general lack of information on these topics, this review attempts to summarize the small parts found in the few articles that discuss these topics. The review has been structured into four parts, including:

NDI, NDI and other questionnaires, NDI and WAD, and NDI and cervical ranges of motion (CROM). A recommendation for future research would include further studies with respect to the correlation between neck pain, NDI and cervical ranges of motion.

I. The Neck Disability Index (NDI) (see table 1 for summary)

In a cross sectional study of 237 neck pain patients, Hains et al. evaluated the responses in the original NDI and 7 other modified versions of the NDI. They determined that there was a lack of response set bias, concluding that patients were responding to the questionnaire content and not the format of the items. They also reported a high internal consistency. The authors concluded that each item of the NDI contributes equal weight, relates positively to the VAS measured pain, and that overall the NDI possesses stable psychometric characteristics to assess disability and treatment response over time for neck pain patients.⁴

Another more recent study of the psychosocial, physical and workplace features of female office workers found that those with neck pain and disability can be differentiated from those with no disability (using the NDI). Low supervisor support was reported to be associated with a higher NDI score. As well, they observed a linear relationship between the frequency of mouse use and NDI score.⁵

In 2007, Pool et al. reported a prospective, single-cohort study to assess the minimally clinically important change (MCIC) on the NDI and the Numerical Rating Scale for neck pain patients. They summarized that the NDI is frequently used, has good validity and test-retest reliability. They stated that MCIC was investigated as a measure of the change in health status within patients, as opposed to minimally clinically important difference (which they state is different between patients). In the 183 neck pain patients they studied, they found that MCIC can be used to detect clinically important change. They used the method of the optimal cutoff point of the receiver operator characteristic curve (ROC) curve, which helps to improve the interpretability of change scores since it is expressed in scale points and is a diagnostic test to discriminate between important and non-important improvement in disability and index scales. For example, when they used the ROC curve optimal cutoff point, they found the MCIC or change score of 3.5 on the NDI could best distinguish patients who are clinically improved from those who are not.⁶

In 2009, Young et al. studied 91 neck pain subjects in a cohort study that looked at the test-retest reliability, construct validity minimally clinically important difference (MCID) and the minimal detectable change (MDC) for the NDI. They found that the NDI appeared to show moderate test-retest reliability, adequate responsiveness and that a 10-point change out of 50 points (the MDC) should be used as the MCID for patients with and without concurrent upper extremity symptoms.⁷

In 2008, Cleland et al. undertook a single-group repeated measure cohort study of 137 neck pain patients. They studied the test-retest reliability, construct validity and minimal levels of detectable and clinically important change for the NDI and the numeric rating scale (NRS). They found both the NDI and the NRS have fair to moderate test-retest reliability and adequate responsiveness. They also reported that the MCID was twice what was previously reported for the NDI (19 points).⁸ Vernon rebutted the findings in this study a few months later in a letter to the editor, stating that 6 studies were published in 2007 reporting good test-retest reliability. Also, that Cleland used a “stable group” after a single treatment, which violates the test-retest assumption that the two testing occasions are similar (leaving subjects to be selected based on clinical status after the fact). It was also stated that the variance in subjects with minimal change in their NDI scores may have been a factor why Cleland obtained a low reliability. NDI values were only obtained with one rating, as opposed to the numeric rating scale for pain (which they did 3 ratings), therefore reducing the reliability of one and increasing the other. Vernon also noted another limitation to the study was that the time interval used to assess the true responsiveness of the NDI was too short, since the investigators obtained information from patients over up to 2 intervals of 2–4 days. Finally, the year prior to Cleland’s article being published, Vernon stated that 11 publications reported responsiveness of the NDI, but that Cleland only mentioned 2 references to report MDIC values. None of these studies had treatment intervals of less than two weeks. Vernon concluded that disability and pain are different constructs and that each will have different responsiveness. The short time-line used in Cleland et al.’s study was stated to be too short and was never advocated by the NDI developer, Vernon himself.⁹

In 2009, MacDermid et al. systematically reviewed the measurement properties of the NDI. They found that most

Table 1 *The Neck Disability Index (NDI)*

Study	Design Strength	Design limit	Measure	Results
Hains, et al 1998	N = 237 Cross-sectional study	Patients recruited from chiropractic college clinic who were already seeking treatment	7 modified versions + original NDI	NDI has stable psychometric properties and is an objective measure
Johnston et al 2009	N = 52 neck pain subjects and 22 controls Laboratory based cross-sectional design	Non-disabled subjects still reported occasional symptoms	NDI, surveys, Thermotest unit, PPT, skin blood flow, active neck ROM, sEMG, heart rate	Low supervisor support and higher mouse use correlate with higher NDI score
Pool et al 2007	N = 183 Prospective single-cohort study	Explanation confusing at times of the MDC and ROC curve cutoff point	NDI, NRS pain scale, global perceived effect with 6-point Likert scale	MDC for the NDI is 10.5 & a change score of 3.5 distinguishes disabled from not
Young et al 2009	N = 91 Cohort study	Short 3 week follow up (after 6 treatments); recall bias with GRC; 60% patients had upper extremity symptoms;	NDI, Global Rating of Change (GRC) scale	NDI demonstrates adequate responsiveness & 10-point change out of 50 (the MDC) should be used as the MCID
Cleland et al 2008	N = 137 Single-group repeated measures design	Other studies report good test-retest reliability; use of stable group after one treatment; NDI values obtained with only one rating (unlike pain scale used three ratings); short time-line used; did not reference other numerous MDIC value studies	NDI, NRS, GRC	NDI and NRS fair to moderate test-retest reliability & adequate responsiveness; MCID twice previously reported
MacDermaid et al 2009	N = 37 primary studies, 3 reviews and 1 in-press paper; Systematic literature review	A large number of authors could lead to reviewing inconsistencies.	NDI	Acceptable reliability, validity and responsiveness; culturally valid; MDC 5-10/50; NDI strongly correlates with other similar indices

studies suggested that the NDI has acceptable reliability (and that longer test intervals and defining stable helped to influence their findings), validity and responsiveness. The MDC is around 5/50 for uncomplicated neck pain and up to 10/50 for cervical radiculopathy. They also found many cultural validation studies for multiple languages. They found inconsistency for the reported clinically important difference from 5/50 to 19/50. They stated that the NDI is strongly correlated to many other similar indices and moderately related to physical and mental aspects of general health.¹⁰

II. NDI and other questionnaires (see table 2 for summary)

The NDI and the Neck Bournemouth Questionnaire (NBQ) were compared in a prospective longitudinal study of 23 chronic uncomplicated neck pain patients by Gay et al. in 2007. They found that both questionnaires had similar sensitivity to change (better than pain VAS) and similar responsiveness, acceptable internal consistency, and low respondent burden. They reported a lack of strong correlation between pain VAS change and both questionnaires and suggested that this meant that clinical improvements may be more complex than pain severity rating alone. They also found that the NBQ had good convergent validity with the NDI, with a strong correlation between them for pre and post treatment scores.¹¹

Hoving et al. assessed the validity of the NDI and the Northwick Park neck pain questionnaire (NPCP) in 71 whiplash patients. They found that the NDI and NPCP questionnaire correlated highly with each other. They also found that only the NDI included work driving and sleep factors, while commonly problematic emotional and social items are absent.¹²

In her narrative review, Resnick observed that the NDI was the first outcome measurement to assess the impact of neck pain on activities of daily living (ADLs). This review revealed a high degree of reliability, internal consistency, construct validity and a moderate correlation between NDI, VAS and MPQ. She also found the NDI did not assess emotional function, but it had more correlation with SF-36 scores than with cervical ROM. Resnick concluded that developing a gold standard subjective outcome measure for neck pain would be difficult, since the wide range of bio psychosocial influences acting on each patient are so individual. She

suggested instead that a standard set of outcome measures would allow for treatment effect comparison across studies.¹³

McCarthy et al. compared the NDI with the short form-36 health survey questionnaire in a prospective cohort study of 150 completed questionnaires. They found that the NDI and SF-36 both had good internal consistency, the NDI had high test-retest reliability and the NDI had good reliability and validity and compares well to the SF36 in the spinal surgery out patient setting (which they stated has been shown in physiotherapy settings or whiplash injured patients in previous studies). They also reported that the minimum clinically important difference for the NDI is around ten points.¹⁴

Most recently, Ferreira et al. did a systematic review in 2010 that compared neck pain scales and questionnaires to see if they are compatible with the international classification of functioning, disability and health (ICF). They found that the NDI alone has shown excellent reliability, including internal consistency and test-retest reliability, and convergent correlation with the pain visual analog scale. They also stated that the NDI had four items categorized as body functions, six sections as activity and participation and two sections that were linked to two ICF categories (personal care and reading). Overall, they found that the neck Bournemouth questionnaire (NBQ), NDI and neck pain and disability scale (NPDS) all showed a well-balanced item distribution in terms of body function and activity and participation components. They also concluded that these three have the best fit to the bio-psycho-social framework that the World Health Organization promotes with a good distribution of items across the components and ICF categories. All three were reported to have excellent reliability and validity, excellent to adequate consistency, but that their sensitivity to change needs further investigation.¹⁵

III. Whiplash and the NDI (see table 3 for summary)

When correlating the NDI to whiplash, Vernon reported in his review in 2008 that the NDI has been used in 41 WAD studies. Several of these studies reported that the NDI score was the best predictor of outcome, meaning that a low initial NDI score predicted recovery and a high initial NDI score predicted chronicity. It was shown that the NDI is very useful in patients with WAD injury alone or with multivariable models when it came to prognos-

Table 2 NDI and other questionnaires

Study	Design Strength	Design limit	Measure	Results
Gay et al 2007	N = 23 Prospective longitudinal study	Small sample size; short 4 week treatment timeline follow-up; no minimum pain level required for study entry	NDI, NBQ	Both had similar sensitivity to change and responsiveness; acceptable internal consistency; good convergent validity with each other and strong correlation for pre and post treatment scores
Hoving et al 2003	N = 71 WAD patients Cross-sectional study	More women in study; mean scores low on some items and doesn't allow for detection of improvement; only cross-sectional data collected and therefore did not look at change over time	NDI, NPQ	Correlate highly with each other; NDI only includes certain factors measured; emotional and social items are absent in both.
Resnick 2005	N = 11 Narrative review	Did not include all neck pain measures because some unavailable; did not include non-organic signs tools	BNQ, CNFDS, DRI, ABPS, FRI, NDI, NPAD, NPNPQ, PSFS, WDQ, VAS	NDI first outcomes measure for neck pain and ADLs; high reliability, internal consistency, construct validity and moderate correlation between NDI, VAS and MPQ; NDI more correlation with SF-36 than with CROM.
McCarthy et al 2007	N = 150 questionnaires; Prospective single cohort study	Did not do with specific defined neck pain populations; hospital setting; did not investigate responsiveness to change of the NDI or floor or ceiling effects of NDI.	NDI & short form-36 health survey	Both have good internal consistency; NDI high test-retest reliability, good reliability and validity; NDI compares well with SF-36; MDID for NDI around 10 points.
Ferreira et al 2010	74 Systematic review	Not all questionnaires include all ICF categories, therefore all will fall short of fulfilling the requirements; some items could not be classified; not all descriptions fit into ICF framework.	NDI, PDI, NPQ, CNFDS, NPDS, NBQ, FRI; all compared with the ICF	NDI had excellent reliability and convergent correlation with VAS; NBQ, NDI and NPDS all have well-balanced distribution of items for body function, activity and participation components (and are best fit to ICF bio-psycho-social framework)

Table 3 *NDI and whiplash*

Study	Design strength	Design limit	Measure	Results
Vernon 2008	41 NDI and WAD studies Review	Review done by NDI author himself (could have some bias)	NDI	NDI most widely used and strongly validated self-rated disability measure for neck pain; best outcome predictor (especially of longer term physiological dysfunction and physical impairment)
Kaale et al 2005	N = 92 chronic grade 2 WAD patients & 30 controls	Controls were being treated by physical therapist for other conditions (not specified); controls slightly older than WAD patients.	MRI , NDI	Transverse ligament and posterior atlanto-occipital membrane lesions relate to NDI scores.
Pereira et al 2008	N= 30 WAD and 30 controls Case control study	WAD patients older, had more driving experience, had higher composite driving tasks scores and used more assistance with driving than controls; measures were taken in laboratory and not in real driving context;	NDI, GHQ-28, IES-R, TSK, DHQ, CROM (with Fastrak), cervical joint position sense, smoother pursuit neck torsion test	WAD had CROM deficits (more so in flexion, extension and rotation); moderate correlation between driving task scores and pain and disability levels
Stewart et al 2007	N = 132 chronic WAD patients Cohort study	Baseline and 6 weeks follow-up measurement (after 12 session of exercise program); used diary (not supervised exercise).	NDI, pain intensity, bothersomeness, SF-36, PSFS, FRS, Copenhagen Scale, SF-36 physical summary	NDI and other region-specific measures no more responsive than other general disability measures; region-specific measures are easy to administer and score and are relevant to neck pain population
Vernon et al 2009	N = 107 chronic WAD Cross-sectional correlation design	Pain and disability status of sample higher than previous studies; referral bias of obtaining subjects; no-fault insurance system jurisdiction;	NDI, TSK, pain VAS, pain diagram.	Fear avoidance beliefs and pain amplification have some moderate influence on self-reported disability (and NDI scores) in WAD subjects; Pain diagram correlates with NDI scores

sis of outcome. It was determined that it was better than “pain level” and that high levels of NDI 3–36 months post accident were strongly correlated with key physiologic dysfunction and physical impairment measure. Vernon stated that this demonstrated that attention must be paid to pathophysiologic factors as a cause of high self-rated disability and not just psychosocial and accident-related findings in chronic whiplash patients.²

Kaale et al. observed MRI findings in 92 whiplash patients and 30 controls and found that lesions in the transverse ligament and the posterior atlanto-occipital membrane were related to NDI score (and less so for the alar ligament). They also found that whiplash patients scored higher on NDI scores than the controls, especially for questions related to neck pain, reading, headache, concentration, driving and overall activity level. They concluded that whiplash patients’ symptoms can be linked to structural abnormalities in upper cervical ligaments and membranes observed in high resolution MRI.¹⁶

In 2008, Pereira et al. reported in their case-control study that chronically injured whiplash subjects had deficits in range of motion, significantly so in flexion, extension and rotation. They also found a moderate correlation ($r = 0.5$) between driving task scores and reported levels of pain and disability (NDI). However, they did not find a correlation between neck ROM and driving habits scores or degree of difficulty with reversing or reverse parking. They concluded that chronic whiplash patients present with physical performance deficits as well as ongoing psychologic features and that driving difficulties are associated with ongoing psychologic distress.¹⁷

In 2007, Stewart et al. compared several pain and disability measures in 132 chronic whiplash patients in their cohort study, including the NDI. They included many measurement tools, including: pain intensity, SF-36 bodily pain score, Patient Specific Functional Scale, NDI, Functional Rating Scale, Copenhagen Scale and the SF-36 physical summary. They found that the NDI and other region-specific disability scales were not better than others, which they extrapolated to suggest that any could be used for whiplash patients. They also reported no difference between external responsiveness of these measures and the generic disability measure. They did state that the region-specific measures are easy to administer and score and are relevant to the neck pain population. Overall, they recommended the Patient Specific Func-

tional Scale as the most responsive measure for this patient group.¹⁸

Most recently in 2009, Vernon et al. published a cross-sectional clinical study on 107 chronic whiplash patients. They found that important psychological factors, including fear avoidance beliefs and pain amplification, have some moderate influence on self-reported disability in this patient population and that this effect plateaus fairly early in post-injury time period. They also reported that duration of symptoms, age and gender did not seem to have a significant association with NDI scores. They discussed that fear avoidance beliefs and pain amplification ratings correlated with NDI scores and added approximately 30% of score variance for an average 13.4 months post whiplash but the NDI is an accurate reflection of self-rated disability. They also reported that the Pain Diagram correlated with NDI scores and pain severity and may provide insights into nonorganic pain behaviours. They concluded that generally, the NDI does provide an accurate picture of chronic whiplash sufferers, with psychological factors only moderately influencing NDI scores (including pain VAS and fear avoidance, as measured by the Tampa Scale for Kinesiophobia).¹⁹

IV. Cervical Range of motion (CROM) and the NDI (see table 4 for summary)

In 2005, Kumbhare et al. reported that cervical flexor endurance (CFE) had more between subject variability than NDI or range of motion scores, but that overall CFE, CROM in each plane and NDI had similar effect sizes. They quoted Vernon in 1997, stating that ROM seems consistent with weak correlations between NDI and CROM in chronic neck pain patients. Also, that side flexion only correlated with NDI unilaterally and that there were no correlations between NDI and flexion, extension and rotation. They also stated they found that CFE is relevant to disability and that CROM measures different aspects of neck function.²⁰

Ylinen et al. studied 175 female office workers in 2004, using VAS, NDI, passive ROM and maximal isometric neck muscle strength testing. They stated that several studies have shown significantly reduced CROM in flexion and extension in patients with disabling neck pain. They found a considerable variability in their subjects in the amount of neck pain and disability due to chronic neck pain. They also found a great variation in passive

Table 4 *NDI and range of motion*

Study	Design Strength	Design limit	Measure	Results
Kumbhare et al 2005	N = 81 WAD grade II patients & 160 controls	Controls had no more than 3/10 VAS for neck pain (true controls?); pain increased by 50% during CFE testing; CFE measurement variability;	VAS, CROM, NDI, grip strength, CFE using a stopwatch	CROM and NDI have similar effect sizes; CROM consistent with weak correlations to NDI; side flexion correlates with NDI unilaterally; CFE relevant to disability
Ylinen et al 2004	N = 175 female office workers	Female subjects only included; most subjects right-handed;	VAS, NDI, passive CROM (with 3D motion-testing device), Maximal isometric neck muscle strength	Studies showed reduced CROM in flexion and extension in disabled neck pain patients; found considerable variability; weak correlation between pain and CROM;
Piva et al 2006	N = 30 neck pain patients	Only included subjects with NDI of less than 60%; reliability of PIM/palpation as a measure?	NDI, active CROM (gravity goniometer), PIM (palpation)	Active CROM in sagittal and transverse planes were significantly associated with disability scores
Jordan et al 1997	N = 119 chronic neck pain patients & 80 age-matched controls	Patients were seeking neck pain treatment;	VAS, ADL Standardized Nordic Questionnaire, Maximum isometric muscle strength (strain gauge dynamometer), Active ROM (goniometer)	Active CROM had good within-day and day-to-day reproducibility, was significantly reduced in women and not in all males; physical measurements are of clinical value and demonstrate weak correlations to patient reported pain and disability.

CROM. They did find that neck pain was felt by subjects more often and more intensely in right rotation compared to the left, which they concluded may be related to handedness. They expected that more severe pain would lead to greater disability, decreased muscle strength and restricted CROM. They did find several patients who did have restricted CROM, but that there was no significant correlation between pain and ROM. They also stated that that passive ROM has been suggested to be more reliable than active motion. The only significant correlations were

found to be weak between ROM and pain were in extension and left rotation, leading them to conclude that pain is not the reason for reduced ROM in most directions.²¹

Piva et al. measured passive intervertebral and active cervical spine movements in neck pain patients using a gravity goniometer. They included patients with an NDI score of less than 60%, since above this point patients have a high level of disability whereby repeating the examination procedures would exacerbate the patient's symptoms.

They reported that establishing the validity of active ROM and its association to disability helps practitioners interpret clinical meanings of the measurements they take. They found that measures of active ROM in the sagittal (flexion/extension) and transverse (rotation) planes were significantly associated with disability scores. Therefore, they suggested that practitioners should pay attention to total changes in these planes of movement when assessing patients with neck pain. They stated that improvements in active ROM will most likely be clinically relevant to patients overall functional improvement and correlated to their overall prognosis.²²

Jordan et al. found significant reductions in active ROM during extension in 119 neck pain patients when compared with 80 age-matched controls. Using an electronic goniometer, they found that active ROM had good within-day and day-to-day reproducibility and was significantly reduced in women, but not in all male age groups. They also reported that physical measurements do have clinical value, but demonstrate weak correlations to patients' self-reported pain and disability.²³

Conclusion

Overall, the literature agrees that the NDI is a valid, reliable, responsive and internally consistent clinical tool to measure self-reported disability as it relates to patients with neck pain. It objectifies the self-rated experience of the patient. The NDI provides us with a starting point, off of which to springboard further research possibilities. When compared to other questionnaires, the NDI correlates well with other measures and has similar sensitivity to change and responsiveness, good convergent validity and correlates with pre and post treatment scores. The NDI was shown to not assess emotional function and that its sensitivity to change needs further investigation. Specifically in whiplash patients, studies showed that the NDI was a good predictor of long term outcomes and that patient's symptoms can be linked to structural abnormalities on MRI and NDI scores. Correlations were found with pain, disability and driving task scores in WAD patients but duration of symptoms, age and gender did not have a significant association with NDI scores in WAD patients. Pain diagrams were found to correlate with NDI scores. Overall, there has been more research in the WAD population and the NDI seems to be appropriately used.

Cervical range of motion also provides us with another

commonly used and important clinical outcome measure that measures neck function. CROM can relate to clinical prognosis, but in the four studies reviewed it was shown in only one paper to have a weak correlation to the NDI and CROM was found to be reduced in disabled neck patients in another study. There is a real lack of information in this area and a therefore a great need for more studies that look at the association between CROM and NDI.

The articles in this review represent the current state of the literature. The association between neck pain (including whiplash), the NDI and cervical ranges of motion is not well documented and therefore, it is appropriate to recommend further studies in this area.

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