



Confirmatory Factor Analysis and Multiple Linear Regression of the Neck Disability Index: Assessment If Subscales Are Equally Relevant in Whiplash and Nonspecific Neck Pain

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Abstract

Objective: Because of previously published recommendations to modify the Neck Disability Index (NDI), we evaluated the responsiveness and dimensionality of the NDI within a population of adult whiplash-injured subjects. The purpose of the present study was to evaluate the responsiveness and dimensionality of the NDI within a population of adult whiplash-injured subjects.

Methods: Subjects who had sustained whiplash injuries of grade 2 or higher completed an NDI questionnaire. There were 123 subjects (55% female, of which 36% had recovered and 64% had chronic symptoms). NDI subscales were analyzed using confirmatory factor analysis, considering only the subscales and, secondly, using sex as an 11th variable. The subscales were also tested with multiple linear regression modeling using the total score as a target variable.

Results: When considering only the 10 NDI subscales, only a single factor emerged, with an eigenvalue of 5.4, explaining 53.7% of the total variance. Strong correlation ($>.55$) ($P < .0001$) between all variables was found. Multiple linear regression modeling revealed high internal consistency with all coefficients reaching significance ($P < .0001$). The 4 NDI subscales exerting the greatest effect were, in decreasing order, Sleeping, Lifting, Headaches, and Pain Intensity.

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Conclusion: A 2-factor model of the NDI is not justified based on our results, and in this population of whiplash subjects, the NDI was unidimensional, demonstrating high internal consistency and supporting the original validation study of Vernon and Mior.
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Introduction

In the 1980s, Fairbank et al¹ developed a questionnaire for the assessment of disability related to low back pain. Known today as the *Revised Oswestry Disability Index*, it is widely used both in the clinical setting and in research.² It is a self-assessment questionnaire that subjects can quickly complete in a few minutes, and it can be easily scored by therapists or physicians. The format is categorical, but each category is ordinal. Accordingly, the scale is not arithmetically isomorphic, and the scores cannot be considered linearly correlated with disablement. This also raises some questions concerning derivative calculations or the use of parametric statistical methods that are sometimes applied to Neck Disability Index (NDI) scores.³

In 1991, Vernon and Mior³ modified the Revised Oswestry Disability Questionnaire so that it would be responsive to disability related to neck pain and named it the *Neck Disability Index*. The NDI was initially validated in a whiplash patient population and achieved a high degree of internal consistency, reliability, and responsiveness, and has been revalidated in several studies since then.^{3,4} In subsequent years, a number of other questionnaires have been introduced. These include the Whiplash Disability Questionnaire,^{5–7} the Functional Rating Index,⁸ the Northwick Park Neck Pain Questionnaire,^{6,7} the Neck Pain and Disability Scale,⁶ the Copenhagen Neck Functional Disability Index,^{6,9,10} and the EQ-5D.¹¹ But to date, the NDI has been the most extensively used questionnaire in clinical trials and outcome studies.^{6,10,12–40}

The general format of the NDI follows that of the Revised Oswestry Disability Index, with a 10-item subscale design. The subscales include Pain Intensity, Personal Care, Lifting, Reading, Headaches, Concentration, Work, Driving, Sleeping, and Recreation. Each has a 6-level response, with the first representing the normal, nonimpaired or nonsymptomatic state and carrying a score of 0, and the last representing the greatest degree of symptoms or impairment and carrying a score of 5. The 10 subscales are then summed and multiplied by 2, thereby providing a potential range of 0–100, to which the phrase *percent disability* is appended.

The NDI has been used in a wide variety of clinical conditions affecting the cervical spine, and it is assumed by most that it is a nonspecific measure of neck-related conditions.⁴¹ van der Velde et al⁴² studied the threshold ordering of NDI subscale items and tested the assumption of unidimensionality. They reported that Headaches and Recreation subscales showed statistically significant misfit or deviation from model expectations. They concluded that it is not a unidimensional scale and optimized it by eliminating 2 subscales: Headaches and Lifting. Their pooled data source comprised persons with primarily mechanical (ie, nonspecific) neck pain.

Gabel et al⁴¹ used confirmatory factor analysis in their study of 1278 pooled subjects which were obtained from 6 separate published studies. They assumed that the NDI is not a condition-specific measure of neck function and considered problematic neck pain subjects as a homogeneous group. They reported that the NDI conformed to a 1-factor structure, although a 2-factor structure approached a level of significance ($P < .07$) based on slight differences between the sexes, as they dichotomized over mental function and physical function constructs.

Headaches are generally reported with high frequency and risk relevance among whiplash subjects,^{43–46} as is lower back pain,^{47–49} which would likely correlate with the Lifting subscale. Among a more general population of persons with mechanical neck pain, lower back pain is not expected to be as common. A question of the relative responsiveness of the NDI across divergent clinical conditions thus arises. Is the NDI a better measure of disability, impairment, or function in whiplash subjects as compared with a population of general mechanical neck pain? Because of previously published recommendations to modify the NDI based upon groups of subjects with mechanical neck pain, the purpose of the present study was to evaluate the responsiveness and dimensionality of the NDI within a population of adult whiplash-injured subjects.

Methods

This investigation included 123 volunteers (55 men, 68 women) who had suffered a whiplash injury for

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