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Could Numeric Rating Scale Take the Place of Neck Disability Index, as a Self-Reported Instrument of the Neck/Arm Pain-Related Daily Living Disability, in Patients with Cervical Radiculopathy?

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Keywords

Cervical radiculopathy;
Neck Disability Index;
Neck/arm pain;
Numeric Rating Scale;
Pain-related disability.

Abstract

Background: Quantification of neck and upper extremity pain-related disability is crucial for treatment selection and, finally, for assessing clinical outcomes of the selected treatment in patients with cervical radiculopathy. The objective of this study was to investigate the correlation between the Neck Disability Index (NDI) and the properly adapted Numeric Rating Scale (NRS) in the context of a neck/arm pain-related daily living disability self-report instrument in patients with cervical radiculopathy. Methods: Data from 75 patients with neck/arm pain due to radiculopathy were collected. NRS was used to obtain the self-reported neck/arm pain severity. NDI and a proper adaptation of the NRS were used to obtain the self-reported daily living disability due to neck/arm pain. Results: There was "mild", statistically significant, positive correlation between NRS for neck/arm pain severity and NDI ($r = 0.351$, $P = 0.001$) as well as "mild", statistically significant, positive correlation between NRS for pain influence on daily living activities and NDI ($r = 0.417$, $P = 0.000$). Additionally, the NDI value could be predicted in a low percentage of 16% based on preoperative NRS for pain influence on daily living activities. Conclusion: Pain level exerts a significant impact on patient-reported functional capacity in patients with cervical radiculopathy. Moreover, because of the low prediction, the properly adapted NRS could not take the place of NDI as an easy-to-use and fast-reported instrument of daily living disability due to neck/arm pain, in such patients.

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Contents

1 Introduction

Cervical radiculopathy typically presents as neck pain radiating to the upper extremity and is most commonly due to the compression of a cervical nerve root that causes pain and disability (Jovicic et al., 2018). Daffner et al. (2003), reported that patients with upper arm pain are more disabled and have less improved quality of life compared to patients who have neck pain only. Quantification of neck and upper extremity pain-related disability is crucial for treatment selection and, finally, for assessing clinical outcomes of the selected treatment (Bicer et al., 2004).

Numeric Rating Scale (NRS) as well as the Neck Disability Index (NDI), pointed as Patient-Reported Outcome Measures (PROMs) firmly embedded in clinical research (Kyte et al., 2015), are two of the most commonly cited instruments for assessing self-reported neck/arm pain severity and self-reported disability in activities of daily living due to neck/arm pain, respectively (Spanos et al., 2018; MacDermid & Walton, 2022; Trouli et al., 2008; Cleland et al., 2006).

Among the strengths of NDI and NRS are their reported use in different populations and the fact that they have been validated against multiple measures of function, pain, and clinical signs/symptoms (Pietrobon et al., 2002; Young et al., 2010). There is a controversy in the literature regarding the responsiveness of NDI in patients with cervical radiculopathy. Young et al. (2010) reported adequate responsiveness of NDI in such patients. According to MacDermid et al. (2009), the NDI is responsive in cervical radiculopathy patients. However, they reported that patients who score in the range of either 40 to 50 or 0 to 10 should be considered as approaching a ceiling/floor effect (45/5, respectively), making it difficult to detect subsequent worsening or improvement. Contrary to Cleland et al. (2006), NDI was less responsive to change than other similar instruments in patients with cervical radiculopathy. More than that, Pietrobon et al. (2002) reported that NDI appears susceptible to missing data on activities associated with automobile driving among elderly populations and reading among patients of low educational status. It is indicated that the 10-item version of NDI was used in all of the above studies.

On the other hand, NRS as an instrument of self-reported pain severity, presents high reliability, construct validity, responsiveness, and applicability, in patients with cervical radiculopathy (Young et al., 2010; Lara-Munoz et al., 2004). Additionally, NRS is easy to administer and score since it takes < 1 minute to complete. More than that, minimal language translation difficulties support the use of NRS across cultures and languages.

In consequence, it was hypothesized that an instrument like NRS, if would undergo the proper adaptation to assess daily living disability due to neck/arm pain, could take the place of NDI, as a simple and easy-to-use instrument for the self-reported disability in activities of daily living due to neck/arm pain, in patients with cervical radiculopathy.

The current study aimed to investigate the extent of correlation between the 10-item NDI and the properly adapted NRS in the nature of a neck/arm pain-related daily living disability self-reported instrument, as well as whether the adapted NRS values could predict NDI values, in patients with cervical radiculopathy.

2 Materials and Methods

Design and setting

This study was a cross-sectional observational study. Sample size calculation was performed with the G*Power 3.1 software. The analysis showed that for a correlation of large effect size (r = 0.5), with α = 0.05 and statistical power of 80%, a sample size of at least 30 participants was required. The participants were recruited from the Department of Neurosurgery of our University Hospital.

Participants

Finally, the study group consisted of 75 participants who suffered cervical radiculopathy. The eligibility of the participants was assessed and determined by the same neurosurgeon according to the following inclusion criteria: (i) being adult patients (age ≥ 18), (ii) suffered neck and arm pain (radicular) and a functional deficit, (iii) being mentally, psychologically and physically able to comply this protocol. Participants were excluded if they had previous cervical operations/cervical injuries. Demographic and anthropometric variables such as age, sex, and BMI were recorded.

Ethical approval

The study protocol was carried out following the Code of Ethics of the World Medical Association (Declaration of Helsinki) and was approved by the Institutional Review Board of our University (approval date: 07-10-2015, project number: 795786-1). A signed informed consent was obtained from all participants before their enrolment in the study as well and the rights of subjects were protected.

Procedure

Every participant was asked to self-report current neck/arm pain severity as well as current daily living disability due to neck/arm pain. The Numeric Rating Scale (called “NRS for neck/arm pain severity”) was used to obtain self-reported neck/arm pain severity. The 10-item Neck Disability Index was used in order to obtain self-reported daily living disability due to neck/arm pain. A proper adaptation of the Numeric Rating Scale (called “NRS for pain influence on daily living activities”) was also used to obtain self-reported daily living disability due to neck/arm pain. Specifically, the properly adapted NRS like an instrument of self-reported daily living disability due to neck/arm pain was used as following: on the scale from 0 to 10, with 0 being “neck/arm pain does not produces any disability on daily living activities” and 10 being “neck/arm pain fully produces strong disability on daily living activities”, patient was asked to determine the point that was reflecting the influence of neck/arm pain on daily living activities. The above clinical outcome instruments were administered by the single-blinded research assistant.

Statistical analysis

The collected data were processed using the Statistical Package for the Social Sciences software (SPSS version 20, IBM Corporation, NY, USA). All results are presented as the mean value ± SD. The Kolmogorov-Smirnov normality test was used to ascertain the normal distribution of the variables. Pearson product-moment correlation coefficient methodology for parametric data was carried out to determine the correlation between “NDI” and “NRS for neck/arm pain severity” as well as the correlation between “NDI” and the proper adaptation of “NRS for pain influence on daily living activities”. Portney & Watkins' (2000) classification of "little or no correlation" (0.00 to 0.25), "mild" (0.25 to 0.50), "moderate to good" (0.50 to 0.75), and "excellent" correlations (> 0.75) was used to rank the *r* values. A P value of < 0.01 was considered to be significant in the above statistical tests. For those pairs of variables above that demonstrated statistically significant correlation, multiple linear regression analysis was carried out to determine the prediction of “NDI” value (like response variable) from “NRS for neck/arm pain severity” value as well as from “NRS for pain influence on daily living activities” value (both, like predictor variables).

3 Results and Discussions

3.1 Results

Participants' Demographics
75 volunteers with cervical radiculopathy were enrolled. A summary of the demographics is presented in **Table 1**.

Clinical Outcomes
NRS scores for neck/arm pain severity, NRS scores for pain influence on daily living activities, and NDI scores were available from all participants (**Table 2**).

Correlation
There was "mild" positive correlation between "NRS for neck/arm pain severity" and "NDI" (r = 0.351) that was statistically significant (P = 0.001) (**Figure 1**) as well as "mild" positive correlation between "NRS for pain influence on daily living activities" and "NDI" (r = 0.417) that was statistically significant, too (P = 0.000) (**Figure 2**).

Prediction
Multiple linear regression analysis was carried out to determine the prediction of "NDI" value (like response variable) from "NRS for neck/arm pain severity" value and also from "NRS for pain influence on daily living activities" value (both, in the nature of predictor variables). Due to multicollinearity of the "NRS for neck/arm pain severity" variable with the "NRS for pain influence on daily living activities" variable ($\Delta R^2 = 0.013$ and VIF = 8.167), the predictive impact of "NRS for neck/arm pain severity" variable was not statistically significant (P = 0.294) therefore, it was excluded from the final model of linear regression. Additionally, the Durbin-Watson statistic value was detected close enough to 2, confirming that there was independence of residuals and also verifying the accuracy of the model. Thereby, "NRS for pain influence on daily living activities" value was demonstrated significantly (F = 15.365, P = 0.000) to be a predictor variable in a percentage of 16% (R^2 = 0.163) for the "NDI" value (response variable). More than that, the slope of the regression line (B = 2.189 with confidence interval bounds 1.076 - 3.302) as well as the intercept (the fitted value of Y where the line crosses the Y axis) ($B_{constant}$ = 9.989) indicated the following mathematical equation:

$$NDI_{value} = B_{constant} + (B_{NRS} \bullet NRS_{value}).$$

As a result, for every unit increase of "NRS for pain influence on daily living activities" value, there would be an increase for "NDI" value of 1 • 2.189 units with starting value 9.989, and this is a statistically significant prediction.

3.2 Discussion

The purpose of the current study was to investigate whether the properly adapted NRS, as a self-reported instrument of daily living disability due to neck/arm pain, could take the place of the time-consuming and complex NDI in the assessment of daily living disability in patients with cervical radiculopathy.

Our results indicated that pain level exerts a significant impact on patient-reported functional capacity. Additionally, it is well known that NDI was designed to measure disability in activities of daily living due to neck/arm pain (MacDermid et al., 2009; Trouli et al., 2008). The above would be an explanation of our findings regarding the correlation between "NRS for neck/arm pain severity" mean scores and "NDI" mean scores. More specifically, there was a "mild" but statistically significant correlation between "NDI" and "NRS for neck/arm pain severity" in patients with cervical radiculopathy (**Figure 1**).

As we referred above, the NDI was designed to measure disability in activities of daily living due to neck/arm pain. Moreover, there is a controversy in the literature regarding the responsiveness of NDI (MacDermid et al., 2009; Cleland et al., 2006; Young et al., 2010; Pietrobon et al., 2002). On the other hand, the NRS presents advantages like easy administration and scoring since it takes <1 minute to complete, as well as

minimal language translation difficulties. Therefore, it could be hypothesized that an instrument like NRS, properly adapted in the nature of an instrument of self-reported daily living disability due to neck/arm pain, may be used as an easy-to-use instrument for patient-reported functional disability. Unfortunately, this hypothesis was not confirmed by the current study. More specifically, there was a "mild" positive correlation between these variables ("NDI" and "NRS for pain influence on daily living activities") in the obtained scores (**Figure 2**).

To our knowledge, there are no studies to evaluate patient-reported functional disability using the NRS instrument, like a self-reported instrument of daily living disability due to neck/arm pain. On the other hand, according to our current study results, the adapted NRS ("NRS for pain influence on daily living activities") could not take the place of NDI regarding the evaluation of daily living disability due to neck/arm pain, in patients with cervical radiculopathy because of the occurrence of "mild", although statistically significant, correlation between the two instruments as well as the low prediction of "NDI" value based on "NRS for pain influence on daily living activities" value (prediction in a percentage of 16% from "NRS for pain influence on daily living activities" value is extremely low, although statistically significant).

This study extends our current knowledge base on how pain intensity influences patient-reported outcomes in patients with cervical radiculopathy. In summary, our results indicated that pain level exerts a significant impact on patient-reported functional capacity. Additionally, our results suggest that, because of the low prediction, the properly adapted NRS could not take the place of the 10-item NDI as an easy-to-use and fast-reported instrument of daily living disability due to neck/arm pain, in patients with cervical radiculopathy. Moreover, the sections of the NDI provide a tool to compare within and between patients. An "NRS for pain influence on daily living activities" may be effective for repeated measures of the same patient, but it is unknown how the activities/sections taken into consideration might compare between individuals. Diminished or unknown standardization between patients is an important limitation in considering the use of NRS. In addition, NRS seems to be faster and simpler than NDI, but it cannot represent the thresholds that NDI presents (NDI scores of >40 is associated with increased risk of persistent pain and disability, whereas NDI scores <8 can be considered to represent recovery to a normal pain/function state).

4 Conclusion

Despite its weaknesses of time-consumption and complexity, NDI remains a proper instrument for the assessment of daily living disability due to neck/arm pain, in patients with cervical radiculopathy.

Competing Interest
The authors have no conflicts of interest concerning the content of this article.

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References

Bicer, A., Yazici, A., Camdeviren, H., & Erdogan, C. (2004). Assessment of pain and disability in patients with chronic neck pain: reliability and construct validity of the Turkish version of the neck pain and disability scale. *Disability and rehabilitation*, *26*(16), 959-962.

Cleland, J. A., Fritz, J. M., Whitman, J. M., & Palmer, J. A. (2006). The reliability and construct validity of the Neck Disability Index and patient specific functional scale in patients with cervical radiculopathy. *Spine*, *31*(5), 598-602.

Daffner, S. D., Hilibrand, A. S., Hanscom, B. S., Brislin, B. T., Vaccaro, A. R., & Albert, T. J. (2003). Impact of neck and arm pain on overall health status. Spine, 28(17), 2030-2035.

Jovicic, M. D., Konstantinovic, L. M., Grgurevic, A. D., Milovanovic, N. D., Trajkovic, G., Jovicic, V. Z., ... & Draganac, S. M. (2018). Validation of the neck disability index in Serbian patients with cervical radiculopathy. *Journal of manipulative and physiological therapeutics*, *41*(6), 496-502. https://doi.org/10.1016/j.jmpt.2017.10.018

Kyte, D. G., Calvert, M., Van der Wees, P. J., Ten Hove, R., Tolan, S., & Hill, J. C. (2015). An introduction to patient-reported outcome measures (PROMs) in physiotherapy. *Physiotherapy*, *101*(2), 119-125. https://doi.org/10.1016/j.physio.2014.11.003

Lara-Muñoz, C., De Leon, S. P., Feinstein, A. R., Puente, A., & Wells, C. K. (2004). Comparison of three rating scales for measuring subjective phenomena in clinical research: I. Use of experimentally controlled auditory stimuli. *Archives of medical research*, *35*(1), 43-48. https://doi.org/10.1016/j.arcmed.2003.07.007

MacDermid, J. C., & Walton, D. M. (2022). Development and validation of the ND10 to measure neck-related functional disability. *BMC Musculoskeletal Disorders*, *23*(1), 605.

MacDermid, J. C., Walton, D. M., Avery, S., Blanchard, A., Etruw, E., McAlpine, C., & Goldsmith, C. H. (2009). Measurement properties of the neck disability index: a systematic review. *Journal of orthopaedic & sports physical therapy*, *39*(5), 400-417.

Pietrobon, R., Coeytaux, R. R., Carey, T. S., Richardson, W. J., & DeVellis, R. F. (2002). Standard scales for measurement of functional outcome for cervical pain or dysfunction: a systematic review. *Spine*, *27*(5), 515-522.

Portney, L.G., & Watkins, M.P. (2000). *Foundations of clinical research: Applications to practice.* 3rd ed. New Jersey, Prentice Hall.

Spanos, S. L., Siasios, I. D., Dimopoulos, V. G., Paterakis, K. N., Mastrogiannis, D. S., Giannis, T. P., ... & Fountas, K. N. (2018). Correlation of clinical and radiological outcome after anterior cervical discectomy and fusion with a polyetheretherketone cage. *Journal of clinical medicine research*, *10*(3), 268.

Trouli, M. N., Vernon, H. T., Kakavelakis, K. N., Antonopoulou, M. D., Paganas, A. N., & Lionis, C. D. (2008). Translation of the Neck Disability Index and validation of the Greek version in a sample of neck pain patients. *BMC musculoskeletal disorders*, *9*, 1-8.

Young, I. A., Cleland, J. A., Michener, L. A., & Brown, C. (2010). Reliability, construct validity, and responsiveness of the neck disability index, patient-specific functional scale, and numeric pain rating scale in patients with cervical radiculopathy. *American journal of physical medicine & rehabilitation*, *89*(10), 831-839.

Table 1
Demographic characteristics of enrolled participants (N=75)

Characteristic	No. of Participants/Value (%)
male/female ratio	37:38
age (yrs)	
mean	50.09 ± 13.54
range	28-86
BMI	
mean	27.82 ± 4.73
range	20.3-42.0

yrs: *years,* ***BMI:*** *Body Mass Index*

Table 2
Outcomes of clinical parameters (mean ± SD)

NRS (pain severity) (N=75)	NRS (pain influence on daily living activities) (N=75)	NDI (N=75)
6.16 ± 2.7 (0-10)	6.35 ± 2.74 (0-10)	23.88 ± 14.4 (0-74)

*min-max in brackets

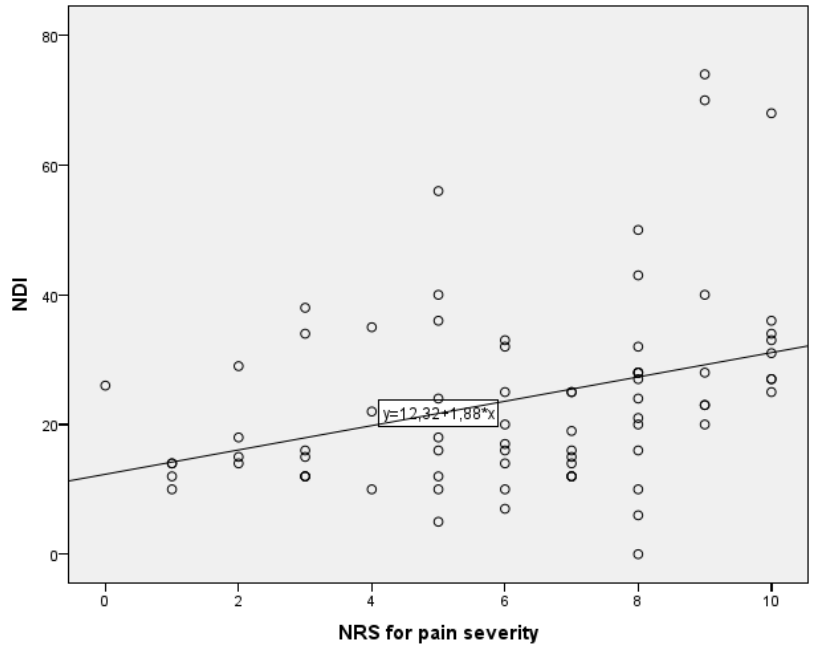


Figure 1. Scatter plot illustrating correlation of NDI and NRS for neck/arm pain severity

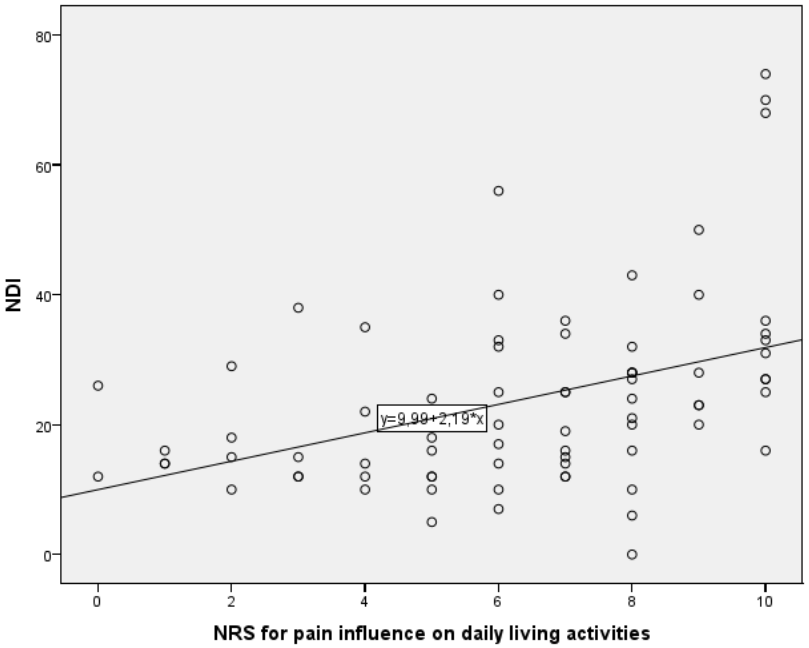
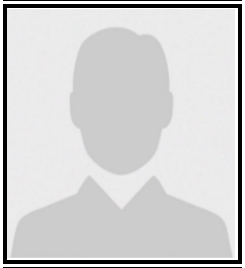
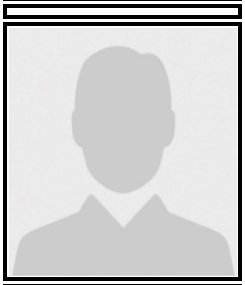
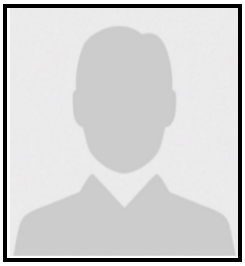
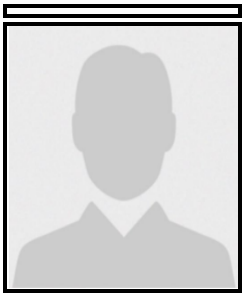
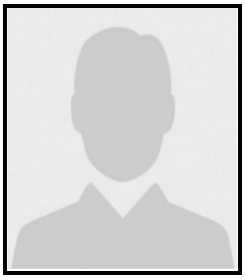
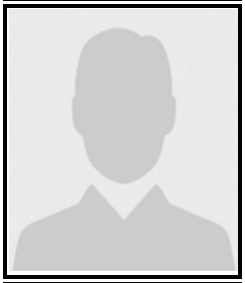


Figure 2. Scatter plot illustrating the correlation of NDI and NRS for pain influence on daily living activities

Biography of Authors

	**Savvas Spanos** Human Performance and Rehabilitation Laboratory, University of Thessaly, Lamia, Greece ORCID: 0000-0001-5458-8485 *Email: sspanos@uth.gr*
	**Ioannis Siasios** Department of Neurosurgery, University Hospital of Alexandroupolis, Alexandroupolis, Greece ORCID: 0000-0001-7945-9604 *Email: isiasios@med.duth.gr*
	**Eleni Kortianou** Clinical Exercise Physiology and Rehabilitation Laboratory, University of Thessaly, Lamia, Greece ORCID: 0000-0003-2214-5545 *Email: ekortianou@uth.gr*
	**George Paras** Human Performance and Rehabilitation Laboratory, University of Thessaly, Lamia, Greece *Email: gparas@uth.gr*
	**Ioannis Poulis** Human Performance and Rehabilitation Laboratory, University of Thessaly, Lamia, Greece ORCID: 0000-0002-0871-6260 *Email: ipoulis@uth.gr*



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