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ORIGINAL ARTICLE

Reliability, validity, and responsiveness of the Japanese version of the Neck Pain and Disability Scale

Rei Ono · Koji Otani · Misa Takegami · Yoshimi Suzukamo · Paula Goolkasian · Anthony H. Wheeler · Shin-ichi Konno · Shin-ichi Kikuchi · Shunichi Fukuhara

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Abstract
Background Until recently, no Japanese versions have existed of the more popular, patient-reported disability questionnaires for neck pain. This study aimed to test the reliability, validity, and responsiveness of the Japanese version of the Neck Pain and Disability Scale (NPDS), one of the most widely used questionnaires in patients with neck pain.
Methods In this validation study, 167 outpatients with neck pain participated. Patients received the NPDS and the Medical Outcome Study Short Form 36-item Health Survey (SF-36), and used Visual Analog Scales (VASs) to assess pain and global health. To examine test-retest reliability, patients who were considered stable by clinicians were given the NPDS 2 weeks after baseline. To examine responsiveness, patients who had not undergone treatment at the time of the first data collection or had no change in treatment over 3 months were studied again 2 weeks after starting a new medication or physical therapy.
Results Of the 167 participants, 143 completed the questionnaires (85.6%). Factor analysis showed two factors, defined as neck-pain-related disability (factor 1) and neck-related pain (factor 2). Cronbach's α coefficient for factor 1, factor 2, and total score was 0.94, 0.93, and 0.96. The intra-class correlation coefficients for the 19 more stable patients were 0.79, 0.88, and 0.87. For concurrent validity, the correlation between NPDS subscales and total score and SF-36 subscale scores ranged from $r = -0.54$ to -0.22 ($p < 0.01$). Correlations between the NPDS subscales and total score and VAS of pain ranged from 0.56 to 0.77 ($p < 0.01$) and those for VAS of global health ranged from 0.48 to 0.63 ($p < 0.01$). The NPDS subscales and total scores of the 41 patients retested after treatment were significantly improved.

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R. Ono (✉)
Department of Community Health Sciences,
Kobe University Graduate school of Health Sciences,
7-10-2 Tomogaoka, Suma, Kobe, Hyogo 654-0142, Japan
e-mail: ono@phoenix.kobe-u.ac.jp

R. Ono · M. Takegami · S. Fukuhara
Department of Epidemiology and Health Care Research,
Kyoto University Graduate School of Medicine
and Public Health, Kyoto, Japan

K. Otani · S. Konno · S. Kikuchi
Department of Orthopedic Surgery,
Fukushima Medical University School of Medicine,
Fukushima, Japan

Y. Suzukamo
Department of Physical Medicine and Rehabilitation,
Tohoku University Graduate School of Medicine, Sendai, Japan

R. Ono · M. Takegami · Y. Suzukamo · S. Fukuhara
Institute for Health Outcomes and Process Evaluation Research,
Kyoto, Japan

P. Goolkasian
Department of Psychology,
University of North Carolina at Charlotte,
Charlotte, NC, USA

A. H. Wheeler
Pain and Orthopedic Neurology,
Charlotte, NC, USA

Conclusions The Japanese version of the NPDS is a useful scale with reliability, validity, and responsiveness in assessing patients suffering from neck pain.

Introduction

Neck pain is a highly prevalent health problem associated with disability [1]. Its 1-month prevalence rate in the adult population ranges from 15.4 to 41.1% [2–5], and about two-thirds of the adult population will be affected at some time in their lives [1, 5]. In Japanese adults, the 1-month prevalence is higher for neck and shoulder pain (20.3%) than for lower back pain (19.1%) [6]. Neck problems can result in substantial medical consumption, absenteeism from work, and disability. The total cost of neck pain in The Netherlands, including direct and indirect costs, has been estimated at $686 million per year [7].

Quantification of neck pain is necessary not only for the evaluation of current and future therapies, but also for assessing clinical outcomes of impairment and disability. To assess the impact of neck pain, objective instruments such as those testing range of motion or muscle strength of the neck are conventionally used. These instruments are, however, poorly associated with outcomes that are more relevant to patients and to society [8].

The Neck Pain and Disability Scale (NPDS), one of the most widely used neck-related disability scales, consists of questions related to symptoms of neck pain and associated physical disability [9, 10]. It is a scale that allows patients themselves to assess 20 items using the Million Visual Analog Scale; these items address neck pain and its intensity, problems associated with neck pain, effects of neck pain on emotional well-being, and interference with activities of daily living. This questionnaire has been translated into eight languages other than English [11–18] and is used widely in the assessment of treatment of neck pain and in patient monitoring.

In light of this situation, we decided to develop a Japanese version of the Neck Pain and Disability Scale (NPDS). We have successfully completed translation and cross-cultural adaptation, and a pilot study demonstrated the feasibility, acceptability, and understandability [19]. The aims of this study were to test the reliability, validity, and responsiveness of the Japanese version of the NPDS.

Materials and methods

Subjects and setting

This study recruited Japanese patients with neck pain who were older than 20 and who were attending 15 orthopedic surgery departments on an outpatient basis from June 2007 to October 2007. We excluded patients who had experienced the following disorders in the previous 6 months: spinal malignancy, infection, or fracture; rheumatic disease; Paget's disease; fibromyalgia; psychiatric disorders; cerebrovascular disease; and Parkinson's disease.

Data collection

At baseline, 167 participants completed self-administered questionnaires that included questions about date of birth, medical history, sex, height, weight, occupation, household income, and the Japanese versions of the following scales: the NPDS, Medical Outcomes Study (MOS) short form-36 Health Survey (SF-36), Visual Analog Scale for Pain (VAS-P), and Visual Analog Scale for Global Health (VAS-H). The NPDS consisted of 20 items to which participants responded by marking a 10-cm scale (Appendix 1). The solid lines to 0, 1, 2, 3, 4, and 5 indicated whole points, and the dotted lines indicated half-point increments. When patients marked the space between solid and dotted lines, one quarter of a point was added to the score. Higher scores indicate higher pain and disability. The SF-36 consists of eight subscales, namely physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health [20, 21]. Each score has a 0–100 score range, and lower scores indicate poorer health-related quality of life. After completing the questionnaire, the participants placed it in a sealed envelope, which was collected by a researcher other than the physician in charge. For the outpatients, clinicians provided information on the degree of neck pain, diagnosis, treatment methods, and treatment duration.

We examined test-retest reliability among 41 patients who completed questionnaires including the NPDS and VAS-P 2 weeks after the first data collection. These patients had neck pain that was assessed as stable by their orthopedic surgeons. We also tested a more stable subgroup of these patients whose second VAS-P values were within one standard deviation of those at baseline.

To examine responsiveness, 58 patients who had not undergone treatment at the time of the first data collection or whose treatment had not been changed for more than 3 months were studied again 2 weeks after starting a new medication or physical therapy.

This study protocol was approved by the Research Ethics Committee of Fukushima Medical University School of Medicine.

Data analysis

All statistical analyses were performed using SPSS version 15.0 (SPSS Japan Inc., Tokyo, Japan), and p values <0.05 were considered statistically significant.

Item analysis

Mean and standard deviation of the NPDS total score and the percentage of missing values for each question were computed.

Validity

We used factor analysis with promax rotation to assess the dimensionality of the scale. Eigenvalues greater than 1.0 were used as a standard to identify dimensionality. We determined factor structure by attributing any items that had factor loading >0.4 to a specific factor.

To test for concurrent validity, we examined the relationship between NPDS and SF-36 subscales. We hypothesized that physical functioning and bodily pain would exhibit the strongest associations, and that mental health and vitality would exhibit the weakest associations. We also hypothesized that the correlation between NPDS and VAS-P and VAS-H would be high. To examine these hypotheses, we used Pearson's correlation coefficient for continuous variables.

Reliability

Cronbach's α coefficient was used as the index of internal consistency reliability [22]. The test-retest reliability (2-week interval) was assessed using the intra-class correlation coefficient (ICC) [23]. Of the 41 patients with stable neck pain, ICC was also calculated in a subset of more stable patients with second VAS-P values within one standard deviation (SD) of those at baseline.

Responsiveness

The improvement group was defined as those with a decrease on VAS-P of more than 10 mm after 2 weeks, the deterioration group as those with an increase of more than 10 mm, and the no change group as those with 10 mm decrease to 10 mm increase; 10 mm was estimated by moderate effect size (0.5) [24]. To compare scores before and after starting medication or physical therapy among these three groups, we used one-way analysis of variance (ANOVA) and the Scheffé test as a post-hoc test.

Results

Subject characteristics

Characteristics of the subjects are shown in Table 1 ($n = 167$). The subjects consisted of 57 men and 110 women, with a mean age of 53.9 years (SD = 17.4, range 22–87 years). The most common condition affecting the neck was cervical spondylosis ($n = 107$, 67%).

Psychometric properties

Item analysis

The mean NPDS total score was 38.0 (SD = 21.3). The percentage of missing values ranged from 0.6 to 4.2%.

Table 1 Participant characteristics ($n = 167$)

Variables	*n* (%)	Mean (SD)
Sex		
Female	110 (65.9)	
Age (years)		53.9 (17.4)
BMI (kg/m^2)		24.6 (17.8)
Disorders affecting the neck		
Herniated disk	13 (8.1)	
Ossification of posterior longitudinal ligament	6 (3.7)	
Cervical spondylosis	107 (66.5)	
Whiplash	12 (7.5)	
Cerebral palsy	2 (1.2)	
Other	21 (13.0)	
Disease duration (month)		52 (72)
Comorbidities		
0	38 (22.8)	
1	34 (20.4)	
>2	94 (56.3)	
Employment status		
Currently working	97 (63.3)	
Not working	56 (36.6)	
Annual household income (yen)		
<3,000,000	34 (22.5)	
<10,000,000	80 (53.0)	
≥10,000,000	18 (11.9)	
Unknown	19 (12.6)	
SF-36 (0–100)		
Physical functioning		79.9 (20.4)
Role physical		80.0 (25.6)
Bodily pain		46.6 (17.9)
General health		54.8 (16.2)
Vitality		50.6 (17.2)
Social functioning		72.2 (22.3)
Role emotional		72.8 (25.7)
Mental health		62.6 (17.1)
VAS for pain (mm)		46.7 (22.9)
VAS for global health (mm)		33.6 (23.5)

Validity

Factor analysis with promax rotation showed that the two-factor model was appropriate for the Japanese version of the NPDS. Two factors were identified to eigenvalues greater than 1.0 (Fig. 1). The total contribution of the two factors explained 62.0% of total variance. Table 2 shows the factor loadings. Factor 1 had significant loadings for items 12, 9, 8, 7, 11, 13, 10, 14, and 15, and therefore can be interpreted as a component of neck-pain-related disability and was termed the "disability" subscale. Factor 2 had significant loadings for items 3, 5, 1, 2, 6, 16, 18, 4, 17, 19, and 20, and was interpreted as a component of neck-related pain and termed the "pain" subscale. Item 20 did not show sufficient factor loading (<0.4) for either factor. Although the correlation between the disability subscale and pain subscale was high (0.726), the following analysis was used for the total score and subscale scores.

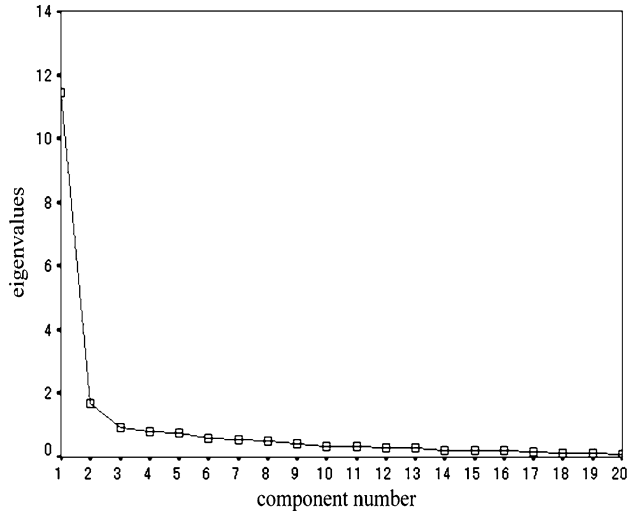

Fig. 1 Scree plot of the principal component

In terms of concurrent validity, there were correlations between the NPDS total and subscale scores and SF-36 subscale scores (Table 3). Correlations between the NPDS total and subscale scores and SF-36 subscale scores ranged from −0.54 to −0.22. The strongest correlations with NPDS total and subscales were observed for SF-36 "bodily pain" and the weakest for "physical functioning." The correlations between the NPDS disability subscale and the SF-36 "role physical" and "social functioning" were −0.35 and −0.42, respectively, and those between the NPDS pain subscale and these factors were −0.27 and −0.32, respectively. There were relatively strong correlations between the NPDS total and subscale scores and degree of pain and global health as measured by VAS ($r = 0.48$–0.77). The correlation between the NPDS pain subscale and VAS-P was 0.77, and that between the disability subscale and VAS-P was 0.56.

Table 2 Factor analysis with promax rotation for the Japanese version of the NPDS

Item number	Factor 1	Factor 2
12. Does your pain interfere with personal relationships (family, friends, sex, etc.)?	**0.970**	−0.176
9. Does your pain interfere with recreational activities?	**0.909**	−0.058
8. Does your pain interfere with social activities?	**0.812**	0.055
7. Does your pain interfere with driving or riding in a car?	**0.795**	0.010
11. Does your pain interfere with your personal care (eating, dressing, bathing, etc.)?	**0.786**	−0.038
13. How has your pain changed your outlook on life and future (depression, hopelessness)?	**0.755**	−0.006
10. Does your pain interfere with work activities?	**0.720**	0.194
14. Does pain affect your emotions?	**0.559**	0.253
15. Does your pain affect your ability to think or concentrate?	**0.526**	0.373
3. How bad is your pain at its worst?	−0.228	**0.919**
5. How bad is your pain with standing?	−0.068	**0.875**
1. How bad is your pain today?	−0.052	**0.856**
2. How bad is your pain on the average?	−0.040	**0.844**
6. How bad is your pain with walking?	0.150	**0.719**
16. How stiff is your neck?	0.204	**0.674**
18. How much trouble do you have looking up or down?	0.267	**0.515**
4. Does your pain interfere with your sleep?	0.251	**0.503**
17. How much trouble do you have turning your neck?	0.301	**0.493**
19. How much trouble do you have working overhead?	0.255	**0.484**
20. How much do pain pills help?	0.283	0.302

Bold type: attributed to the factor (factor loading ≥0.4)

Table 3 Correlation among scores for the Japanese version of the NPDS, SF-36 subscales, VAS for pain, and VAS for global health

NPDS	SF-36								VAS-P	VAS-H
	Physical functioning	Role physical	Bodily pain	General health	Vitality	Social functioning	Role emotional	Mental health		
Total	−0.24**	−0.33**	−0.54**	−0.37**	−0.31**	−0.39**	−0.31**	−0.35**	0.71**	0.59**
Disability subscale	−0.24**	−0.35**	−0.50**	−0.32**	−0.30**	−0.42**	−0.30**	−0.31**	0.56**	0.48**
Pain subscale	−0.22**	−0.27**	−0.51**	−0.37**	−0.29**	−0.32**	−0.28**	−0.35**	0.77**	0.63**

VAS-P Visual Analog Scale for pain, *VAS-H* Visual Analog Scale for global health

** $p < 0.01$

Table 4 Reliability score intra-class correlation coefficient

NPDS	Cronbach's α	ICC	
		All patients with stable neck pain[a] ($n = 34$)	Patients with more stable neck pain and VAS-P score[b] ($n = 19$)
Total score	0.96	0.77	0.87
Disability subscale score	0.94	0.75	0.79
Pain subscale score	0.93	0.77	0.88

ICC Intra-class correlation coefficient

[a] Patients were assessed as stable by their orthopedic surgeons

[b] Stable neck pain patients with second VAS-P values within one standard deviation of those at baseline

Reliability

Cronbach's α coefficients for the NPDS disability subscale, pain subscale, and total scores were 0.94, 0.93, and 0.96. This analysis involved 34 patients who were able to respond to the questionnaire among the 41 eligible patients, and the period between the first and second test was a mean of 15.5 days with a range of 7–28 days. ICCs of the NPDS disability subscale, pain subscale, and total scores were 0.75, 0.77, and 0.77. Of the 34 patients with stable neck pain who participated in the ICC analysis, 19 also had second VAS-P values that were within one standard deviation of those at baseline. For this subgroup, ICCs of the NPDS disability subscale, pain subscale, and total scores were 0.79, 0.88, and 0.87 (Table 4).

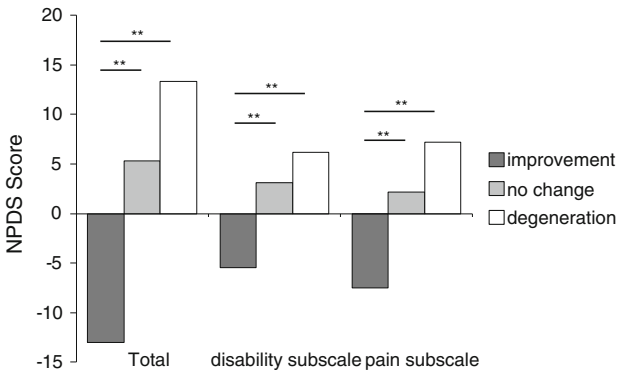

Fig. 2 Relationship between score changes in the Japanese version of the NPDS and effects of starting new treatment for neck pain

Responsiveness

This analysis involved 43 patients who were able to respond to the questionnaire among the 58 eligible patients, and the period between the first and second test was a mean of 15.6 days with a range of 9–22 days. According to changes in VAS-P score after the start of therapy, 25 patients (58.1%) were assigned to the improvement group, 12 (27.9%) to the no change group, and 6 (14.0%) to the deterioration group. In terms of the NPDS disability subscale, pain subscale, and total scores, ANOVA showed a significant difference among the improvement, no change, and deterioration groups ($p < 0.01$). The post-hoc test indicated significant differences between improvement and no change (disability subscale −5.5, 3.1; pain subscale −7.5, 2.2; total −13.0, 5.3, $p < 0.01$), and between improvement and deterioration (disability subscale −5.5, 6.2; pain subscale −7.5, 7.2; total −13.0, 13.3, $p < 0.01$). No significant relationship was observed between the no change and deterioration groups (Fig. 2).

Discussion

We documented the psychometric characteristics of a Japanese version of the NPDS. We found that this version of the NPDS had good reliability (both internal consistency and test-retest reliability), validity, and responsiveness.

Validity

Factor analysis showed the Japanese version of the NPDS consisted of two factors (neck-pain related disability and neck-related pain), which differ from those found in previous studies. For the French [11], Brazilian Portuguese [14], and Italian versions [17], NPDS items loaded on three factors, whereas in the original [9] and the Iranian version [16] items were divided into four subscales. The German version [18] had a single factor. Even among versions with three or four factors, the items constituting each factor were not the same. This suggests that neck-related pain and disability are not uniform across countries and are affected by culture. We therefore consider it preferable to examine total scores when comparing NPDS results between countries.

For concurrent validity, we hypothesized that physical functioning and bodily pain would exhibit the strongest associations with NPDS scores. Our results showed that bodily pain indeed exhibited the strongest association; however, physical functioning had the weakest association. The patients in this study had the strong pain. However, their functional disability might be lower. NPDS and SF-36 subscale scores have been compared for the Brazilian Portuguese [14], Iranian [16], and Italian versions [17]. Correlation coefficients among SF-36 subscale scores and NPDS scores ranged from −0.46 to −0.06 in the Brazilian Portuguese version [14], from −0.69 to −0.17 in the Iranian version [16], and from −0.46 to −0.16 in the Italian version [17]. There were weaker associations with the NPDS and SF-36 subscale in other languages. The strength of associations with the NPDS and SF-36 subscale scores differed slightly among the various versions, suggesting that populations vary in how they interpret the ill-defined concept of neck pain.

For the disability-related factors "role physical" and "social functioning," correlations with the disability subscale of the NPDS were stronger than those with the pain subscale. These findings support in part the hypothesis we constructed beforehand that the correlations between NPDS scores and those for both VAS-P and VAS-H would be high. The correlation coefficient between subscale scores for the Iranian version of the NPDS [16] and VAS scores ranged from 0.46 to 0.79, and that between the total scores of the French version of the NPDS [11] and VAS was 0.52. Hence, the relationship between NPDS scores and neck pain as measured by VAS is strong for other versions of the NPDS. The correlation with VAS-P for the Japanese NPDS pain subscale was stronger than that for the disability scale. These results fully support the hypotheses we created beforehand.

Reliability

The Japanese version of the NPDS had satisfactory internal consistency and test-retest reliability. Lower ICC values were observed in our study than in other studies (which found ICCs of 0.90–0.98). Although testing of reliability was performed within a short time interval (1 day or 1 week) in other studies, that in our study was performed during an average of 2 weeks. This might have influenced the present results because the status of neck-related pain/disability might have changed during the 2-week period. When we considered only patients with stable neck pain as subjects, ICC values improved to 0.79, 0.88, and 0.87.

Responsiveness

To our knowledge, no previous studies have investigated responsiveness in translated versions of the NPDS. Since in the original NPDS, Goolkasian et al. [10] indicated a significant improvement in scores after treatment, our results suggested good responsiveness for the Japanese version NPDS.

Limitation

Because the minimum clinically important difference of NPDS has been not shown yet, future research is needed. In the future we intend to investigate the characteristics of the Japanese version of the NPDS in healthy people.

Conclusion

In conclusion, psychometric testing indicated that data obtained with the Japanese version of the NPDS are sufficiently reliable, valid, and responsive. The Japanese version of the NPDS has a two-factor construction, unlike the original and other language versions; nonetheless, psychometric characteristics comparable or in some cases superior to other language versions were displayed. The Japanese version of the NPDS is well suited for disability assessment in patients with neck pain. Proper treatment of the neck requires adequate pain and disability evaluation; hence, this new version is anticipated to facilitate examination of neck pain and related disability in the Japanese population.

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Conflict of interest None of the authors has received any benefits from any commercial party related directly or indirectly to the subject of this article.

Appendix 1

The original version of the Neck Pain and Disability Scale

Please make an "X" along the line to show how far from normal toward the worst possible situation your pain problem has taken you

Number	Question	Answer	
		0	5
1.	How bad is your pain today?	No pain	Most severe pain
2.	How bad is your pain on the average?	No pain	Most severe pain
3.	How bad is your pain at its worst?	No pain	Cannot tolerate
4.	Does your pain interfere with your sleep?	Not at all	Can't sleep
5.	How bad is your pain with standing?	No pain	Most severe pain
6.	How bad is your pain with walking?	No pain	Most severe pain
7.	Does your pain interfere with driving or riding in a car?	Not at all	Can't drive or ride
8.	Does your pain interfere with social activities?	Not at all	Always
9.	Does your pain interfere with recreational activities?	Not at all	Always
10.	Does your pain interfere with work activities?	Not at all	Can't work
11.	Does your pain interfere with your personal care (eating, dressing, bathing, etc.)?	Not at all	Always
12.	Does your pain interfere with personal relationships (family, friends, sex, etc.)?	Not at all	Always
13.	How has your pain changed your outlook on life and future (depression, hopelessness)?	No change	Completely changed
14.	Does pain affect your emotions?	Not at all	Completely
15.	Does your pain affect your ability to think or concentrate?	Not at all	Completely
16.	How stiff is your neck?	Not stiff	Can't move neck
17.	How much trouble do you have turning your neck?	No trouble	Can't move neck
18.	How much trouble do you have looking up or down?	No trouble	Can't look up or down
19.	How much trouble do you have working overhead?	No trouble	Can't work overhead
20.	How much do pain pills help?	Complete relief	No relief

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