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ORIGINAL ARTICLE

Cross-cultural adaptation and psychometric evaluation of the Malay version of the Neck Disability Index

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ABSTRACT

Purpose: Translating the Neck Disability Index (NDI) into the Malay language (NDI-M); evaluation of psychometric properties in patients with neck pain.

Methods: The NDI-M was translated according to established guidelines. In the first visit, 120 participants completed the NDI-M, visual analogue scale (VAS) for pain and demographic details. 98 participants returned to complete similar questionnaires and the Global Rating of Change (GRoC) scale. The NDI-M was evaluated for internal consistency, test-retest reliability, content validity, construct validity and responsiveness.

Results: The NDI-M demonstrated excellent internal consistency (Cronbach's $\alpha = 0.84$) and good test-retest reliability ($ICC_{2,1} = 0.79$). Content validity was confirmed with no floor or ceiling effects. Construct validity was established revealing three-factor subscales explaining 68% of the total variance. The NDI-M showed a moderate correlation with VAS ($R_p = 0.49$, $p < 0.001$). Regarding responsiveness, a moderate correlation between NDI-M change scores and VAS change scores was found ($R_p = 0.40$, $p < 0.001$). However, there was no significant correlation between NDI-M with GRoC ($R_s = 0.11$, $p = 0.27$).

Conclusions: The NDI-M is a reliable and valid tool to measure functional outcomes in patients with neck pain. It is responsive in detecting changes in pain intensity during a patient's rehabilitation journey.

➤ IMPLICATIONS FOR REHABILITATION

- The NDI was translated into the Malay language and culturally adapted for Malay-speaking patients with neck pain.
- The NDI-M demonstrated an excellent level of internal consistency and good test-retest reliability. It demonstrated content and construct validity, with three-factor subscales, and moderate responsiveness for pain intensity.
- The NDI-M is a reliable, valid and responsive instrument to measure functional limitations in patients with neck pain for rehabilitation.

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KEYWORDS
Neck disability index; Malay; translation; reliability; validity; responsiveness

Introduction

Neck pain is a highly prevalent musculoskeletal disorder with an annual prevalence rate exceeding 30% in the general population [1,2]. In Singapore, neck pain is the second most common reported musculoskeletal complaint following lower back pain [3]. According to the International Association for the Study of Pain, neck pain is defined as pain perceived anywhere in the posterior region of the cervical spine, from the superior nuchal line to the first thoracic spinous process [4].

In a retrospective study by Praveen et al. [3], more than 60% of patients with neck pain in Singapore who had received physiotherapy rehabilitation had symptoms lasting longer than 3 months. The chronicity and persistence of neck pain symptoms would have numerous negative effects on a patient's functional status and quality of life [5,6]. In addition, the intensity of symptoms can vary largely, causing a similarly large variance in self-reported disability as a result of neck pain [7]. Therefore, quantification of neck pain is necessary to determine how it may impact patients' perception of disability and assessment of clinical outcomes [8].

The Neck Disability Index (NDI) is the most commonly used and validated self-administered questionnaire for this purpose [9,10]. It has been translated and culturally adapted to be used in various languages [11–24]. This provides a standard measure for comparisons of different populations and allows the exchange of information across linguistic and cultural barriers among clinicians and researchers [25,26]. As yet, no Malay language neck pain and disability questionnaires exist. The aims of this study are to translate and culturally adapt the NDI into the Malay language and to evaluate the reliability, validity, and responsiveness of the new questionnaire in Malay-speaking patients with neck pain.

Methods

Instruments

NDI

The NDI is a validated and reliable assessment tool to measure functional disability related to neck pain [27,28]. It comprises of

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Supplemental data for this article can be accessed here.

10 self-reported questions regarding pain intensity, headache, concentration and various activities of daily living. Six possible scores from 0 (no pain and no functional limitation) to 5 (worst pain and maximal limitation) are provided for each question. The participants were instructed to choose the best answer that represents their current condition and they were allowed to omit items that were not related to their daily living. The total score of the NDI ranges from 0 to 50. This score was then presented as a percentage with higher scores indicating higher levels of functional disability.

Translation and cultural adaptation

Permission was obtained from the developer and copyright holder of NDI prior to the initiation of the linguistic validation process. This process was conducted based on the guidelines by Beaton et al. [25]. Two independent physiotherapists who are proficient in both the Malay and English languages translated the NDI into the Malay version (forward translation). Both Malay versions of the NDI (NDI-M) were discussed among the two physiotherapists to obtain consensus. Backward translation of this consensus version was done by another two translators that were both unaware of the English version of the NDI. An expert review committee including the authors, all translators, and another two experienced physiotherapists reviewed all the translations and one pre-final version of NDI-M was developed. This pre-final version was tested on 15 participants with neck pain to ensure all translations were clear and understandable. General impression and feedback on the wording and instructions were gathered. All comments were evaluated by the expert committee and the final version of NDI-M was developed without any modifications needed. A digital version of the NDI-M is available for this article in the Supplementary Material.

Visual analogue scale (VAS) for pain

The VAS is an 11-point scale from 0 (indicating no pain) to 10 (indicating the worst possible pain) on a 100 mm horizontal line [29]. The participants were instructed to put down a vertical mark on the line that indicates the current level of their neck pain. The VAS has been shown to be a valid and reliable tool to quantify pain intensity [30,31].

Global Rating of Change (GRoC)

The GRoC is an outcome measure that assesses patients' self-perception of change in their condition between sessions [32]. Participants were asked to rate the change in their condition on a 15-point transitional scale from -7 (a very great deal worse) to 7 (a very great deal better).

Participants

Participants were recruited from four primary healthcare polyclinics in Singapore between May to September 2019. Inclusion criteria were: age between 21 to 75, able to read and comprehend Malay language and the presence of neck pain. Participants were excluded if they have symptoms below the elbows related to specific neck disorders, inflammatory arthritis disease, history of cervical spine fracture or surgery, current infections, malignancy or suspected tumors, cervical myelopathy or radiculopathy, or clinically recognizable cognitive impairments. All participants were screened by one of four physiotherapists that were familiar with the NDI-M. Signed informed consent was obtained prior to the study. This study was approved by the SingHealth Centralized Institutional Review Board (CIRB 2019/2259), Singapore.

Procedures

Demographic data such as age, gender, educational background and pain duration were obtained. All participants completed the NDI-M and VAS scoring on their first visit. After a one-to-two week interval, participants returned to complete the VAS, GRoC and reordered version of the NDI-M to prevent participant recall bias. This interval period was chosen to allow more realistic estimates of the variability to be observed among control subjects when assessing the reproducibility by retest [33]. Participants were provided with a single physiotherapy treatment session consisting of neck stretches and strengthening exercises between the first and second visits.

Statistical analyses

All statistical analyses were done using IBM SPSS 25 (IBM Corp., Armonk, NY, USA). Data were tested for normality using the Shapiro–Wilk test and the p-value was set at < 0.05. Participants' demographics and characteristics were illustrated using descriptive statistics. Each item and total scores for the first and second completion of NDI-M were calculated using mean and standard deviations (SD).

Reliability

Internal consistency, test-retest reliability, and measurement errors were used to determine reliability in this study. Internal consistency of the NDI-M was assessed using Cronbach's α and α value higher than 0.8 was deemed to be good-excellent [34,35]. Intraclass Correlation Coefficient (ICC) and Bland and Altman method were used to calculate test-retest reliability.

ICC (2, 1) model was chosen as the primary reliability measure with a two-way random effects model of variance, and absolute agreement definition reporting single measures, as participants completed the NDI-M only once per session [36]. ICC values less than 0.5, between 0.5 and 0.75, between 0.75 and 0.9, and greater than 0.90 are indicative of poor, moderate, good, and excellent reliability, respectively [37]. A Bland and Altman plot was used to compare the difference in scores between the test and retest scores for each individual. It is expected that 95% of the differences to be less than two SD [38]. Sample size was estimated based on a method developed to calculate the required number of subjects in a reliability study [39]. Parameters regarding the probability of error type I and type II were $\alpha = 0.05$ and $\beta = 0.20$ respectively, with an estimated ICC value of more than 0.70. Following these assumptions, at least 104 participants will be necessary for the test-retest analysis. To account for the estimated 20% attrition rate in the retest session, we inflated the sample size to 120.

Measurement errors were determined by calculating the standard error of measurement (SEM) and the minimal detectable change (MDC). Participants' GRoC scores between -3 and $+3$ were included in the test-retest analysis and were assumed that they did not demonstrate any clinically relevant changes during this interval period [32].

Content validity

Content validity was assessed by the completeness of the item responses in NDI-M as well as the magnitude of floor and ceiling effects. Floor and ceiling effects were regarded to be present if more than 15% of the participants attained the lowest or highest possible total score [40]. Should floor and ceiling effects be present, content validity will be limited. This would imply a lack of representativeness and clarity of the translated questionnaire in

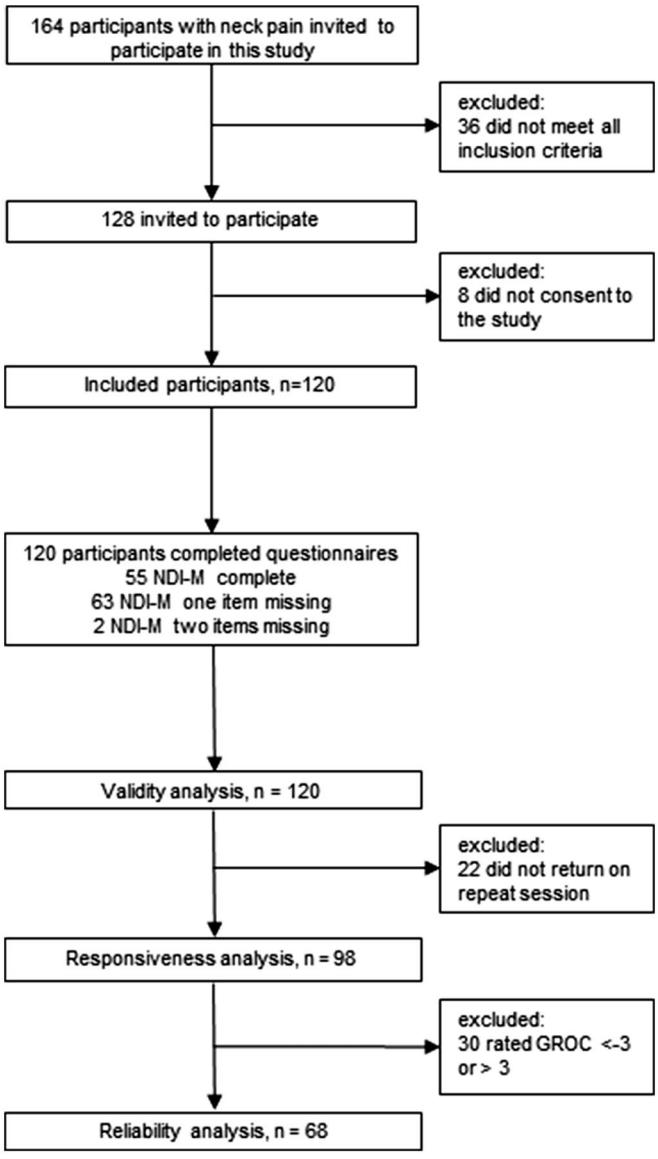

Figure 1. Flowchart of participants.

measuring functional disability and outcomes in patients with neck pain.

Construct validity

Construct validity was calculated using exploratory factor analysis *via* varimax rotation [41]. Correlation between NDI-M and VAS was determined using Pearson's correlation coefficients. Pearson's correlation coefficients values greater than 0.6, of 0.6 to 0.3, and of less than 0.3 were considered strong, moderate, and weak correlations, respectively [42].

Responsiveness

Responsiveness is defined as the ability to measure and recognize change when a change has occurred. This was assessed by determining the association between change scores of NDI-M and GRoC, as well as the change scores of NDI-M and VAS using Spearman's and Pearson's correlation coefficients. Similar to Pearson's correlation coefficients, Spearman's correlation coefficients values greater than 0.6, of 0.6 to 0.3, and of less than 0.3 were also considered strong, moderate, and weak correlations, respectively [42].

Table 1. Demographic and participants' characteristics at baseline ($n = 120$). Outcome measures of VAS and NDI-M at second assessment. ($n = 98$).

	N	*N*%	Mean	SD
Age (years)			45.4	13.2
Gender				
Female	103	85.8		
Male	17	14.2		
Education				
Primary	9	7.5		
Secondary	50	41.7		
Tertiary (Junior Colleges/Polytechnics)	37	30.8		
University	19	15.8		
Post-graduate	3	2.5		
Pain duration				
$<$ 8 days	55	45.8		
$\geq$ 8 days to $\leq$ 12 weeks	20	16.7		
$>$ 12 weeks	45	37.5		
Previous episodes of neck pain				
None	22	18.3		
1–10	77	64.2		
>10	21	17.5		
Trauma				
Yes	1	0.8		
No	119	99.2		
First assessment				
VAS (0–10)			4.5	2.1
NDI–M (0–100%)			22.4	14.1
Second assessment				
VAS (0–10)			2.9	1.9
NDI–M (0–100%)			15.2	12.9
Change scores between first and second session				
VAS (0–10)			−1.7	2.2
NDI–M (0.100%)			−6.7	9.6

VAS: Visual Analogue Scale; NDI-M: Neck Disability Index – Malay.

Results

Participants

One hundred and sixty-four patients with neck pain were invited to participate in this study. Forty-four participants were excluded as they did not meet the inclusion criteria or did not consent to the study. A total of 120 participants were recruited in the study. Twenty-two participants (18.3%) did not return on the second retest session (Figure 1). All descriptive statistics were reported using mean ± SD. There were 17 males and 103 females in this study with a mean age of 45 ± 13 years. The demographics and clinical characteristics of the participants were summarized in Table 1.

NDI-M instrument

Reliability

Sixty-eight participants who scored between −3 and +3 on the GRoC were included in the test-retest analysis. The mean duration interval between the first and second session was 13 ± 8 days. Cronbach's α for the NDI-M was 0.84 indicating excellent internal consistency. The item-scale correlations between single items and total scores of the NDI-M were fair to strong with correlation coefficients ranging from 0.35 to 0.76, confirming the internal consistency of the NDI-M (Table 2). ICC value was 0.79, indicating good reliability. The Bland and Altman analysis showed that the mean of the difference was −5.59 ± 18.1 (Figure 2). SEM and MDC for the NDI-M scores were 6.7 and 18.6 respectively.

Content validity

Of the 120 NDI-M scores included in the analyses, 55 (45%) had no missing NDI-M item, 63 (52.5%) had one missing item and 2 (2.5%) had two missing items. Of all the questionnaires that were

Table 2. Test-retest reliability, measurement errors and item-scale correlations ($n = 68$).

NDI-M Score (0–100%)	1st measurement mean ± SD	2nd measurement mean ± SD	$ICC_{2,1}$ (95% CI)	SEM	MDC_{95}	Item-scale correlation
1. Pain Intensity	1.4 ± 1.0	1.1 ± 0.9	0.47 (0.26–0.64)	0.7	2.0	0.51
2. Personal Care	0.5 ± 0.9	0.3 ± 0.5	0.56 (0.37–0.70)	0.6	1.7	0.76
3. Lifting	1.2 ± 1.4	0.5 ± 0.9	0.70 (0.55–0.80)	0.8	2.1	0.46
4. Reading	1.1 ± 1.2	0.6 ± 0.8	0.68 (0.53–0.79)	0.7	1.8	0.55
5. Headaches	1.8 ± 1.3	1.0 ± 1.3	0.62 (0.30–0.79)	0.8	2.3	0.35
6. Concentration	0.6 ± 0.8	0.9 ± 1.1	0.49 (0.28–0.65)	0.6	1.6	0.75
7. Work	0.9 ± 1.0	0.8 ± 1.4	0.65 (0.46–0.78)	0.6	1.7	0.75
8. Driving	0.9 ± 1.4	1.0 ± 1.2	0.93 (0.86–0.97)	0.4	1.1	0.64
9. Sleeping	1.3 ± 1.3	0.8 ± 1.4	0.52 (0.33–0.68)	0.9	2.4	0.56
10. Recreation	1.1 ± 1.1	1.2 ± 1.1	0.74 (0.53–0.85)	0.6	1.5	0.56
Total	21.8 ± 14.6	16.2 ± 14.2	0.79 (0.48–0.86)	6.7	18.6	

NDI-M: Neck Disability Index – Malay; ICC: Intraclass correlation coefficient; CI: Confidence interval; SEM: Standard error of measurement; MDC: Minimal detectable change.

completed, none had more than two missing items. For missing item scores, total scores were calculated using percentage by adding the total item scores and dividing it by the maximum score possible obtained from the remaining items. Most of the missing values were from the driving-related item as most of our participants do not drive. No floor and ceiling effects were seen for the total scores as only three participants (2.5%) had the lowest score and none had the highest score. All individual items did not have ceiling effects but showed floor effects, with 39.1% of all item entries had the lowest possible values.

Construct validity

A moderate correlation was found between NDI-M and VAS ($R_p = 0.49$, $p < 0.001$). Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (0.784), and Bartlett's test of sphericity (216.27, $p < 0.001$) showed sufficient sample size to conduct a satisfactory exploratory factor analysis. A three-factor structure with eigenvalues > 1 was extracted by factor analysis, which explained over a total of 68% of the variance of the item scores. The Scree test also showed three factors further confirming internal construct validity (Figure 3). Factor loadings of all the items were similar. Rotated component loadings ranged from 0.437 to 0.847 for factor one, 0.492 to 0.932 for factor two, and 0.515 to 0.867 for factor three with Item 4 (Reading), Item 3 (Lifting) and Item 5 (Headaches) receiving the highest value in factor one, factor two and factor three respectively (Table 3).

Responsiveness

The correlation between NDI-M change scores and VAS change scores was moderate ($R_p = 0.40$, $p < 0.001$). However, there was no relationship found between the NDI-M and GRoC ($R_s = 0.11$, $p = 0.27$). Table 4 represents the descriptive statistics of the mean change NDI-M scores according to each GRoC grading.

Discussion

The aims of this study were to translate the NDI into the Malay version and to evaluate its psychometric properties. Our results showed that the NDI-M had good reliability and validity. Although the NDI-M was moderately responsive in detecting a change in pain intensity, it was not responsive to detect a corresponding change in functional status in patients with neck pain.

Our study had participants with a mean age of 45 ± 13 years which was similar to other studies [13,14,19,24]. The proportion of female participants (85.8%) was also significantly higher than male participants. This may be attributable to the higher prevalence of neck pain in females than males as reported in previous studies [13,43]. Notably, the mean NDI-M score was also lower than the previously reported studies [13,22,24]. Participants were classified as having a mild-to-moderate disability as participants received physiotherapy rehabilitative care at a much earlier onset of neck pain in our local primary healthcare setting.

Internal consistency of NDI-M was also acceptable and good with Cronbach's $\alpha = 0.84$, which is comparable with previous studies with values ranging from 0.74–0.97 [11,12,14–16,20]. Test-retest reliability is good with ICC = 0.79. Where previous studies reported higher ICC values ranging from 0.84–0.99 [14,20,21,44], the test-retest duration was also shorter which may explain the differences in ICC values obtained. The results of SEM in this study were similar to those of other NDI versions [17,22]. The MDC value of the NDI-M is higher than that reported by Nakamaru et al. [18] but comparable to values reported by other studies [22,27,45].

With the embracement of a car-lite society in Singapore, the NDI-M had significantly more missing "driving" responses. This was not a translation issue and was similar to previous studies [21,23,24]. No floor and ceiling effect was observed for the total score of NDI-M which was consistent with other studies [11,14,18–21]. To the best of our knowledge, only Farooq et al. [14] reported floor effects of individual items with 35.5% of the participants scoring the lowest possible value. This result was similar to our study where floor effect was observed for all items in our study (39.1%).

Interestingly, our study is the first to report a three-factor structure related to "pain and cognitive function", "daily function" and "pain and sensory function" that explained 68% of the total variance. Past studies reported a single or two-factor structure in the exploratory factor analysis [11,14,18–20]. This dissimilarity may be attributed to linguistic and cultural differences [46], perhaps in part due to the interpretation of the neck pain experience, combined with a person's cognitive understanding of neck pain and societal influence on daily living demands, as described in the factor phenomenon above.

Responsiveness of NDI-M was measured by correlating the NDI-M change scores with the VAS change scores, was found to be moderate ($R_p = 0.40$, $p < 0.001$). However, there was no significant relationship between NDI-M with GRoC. Given the lower NDI-M mean scores in our study, we postulate that the NDI-M may not be responsive to measuring a change in functional status in patients with mild-to-moderate functional disability. In our study, only 28.6% of participants demonstrated improvements in function as evidenced by GRoC scores of more than 3 in the retest session (Table 4). Where a longer test-retest interval may also reflect better responsiveness in NDI-M with GRoC over time, our choice interval duration was consistent with previous studies

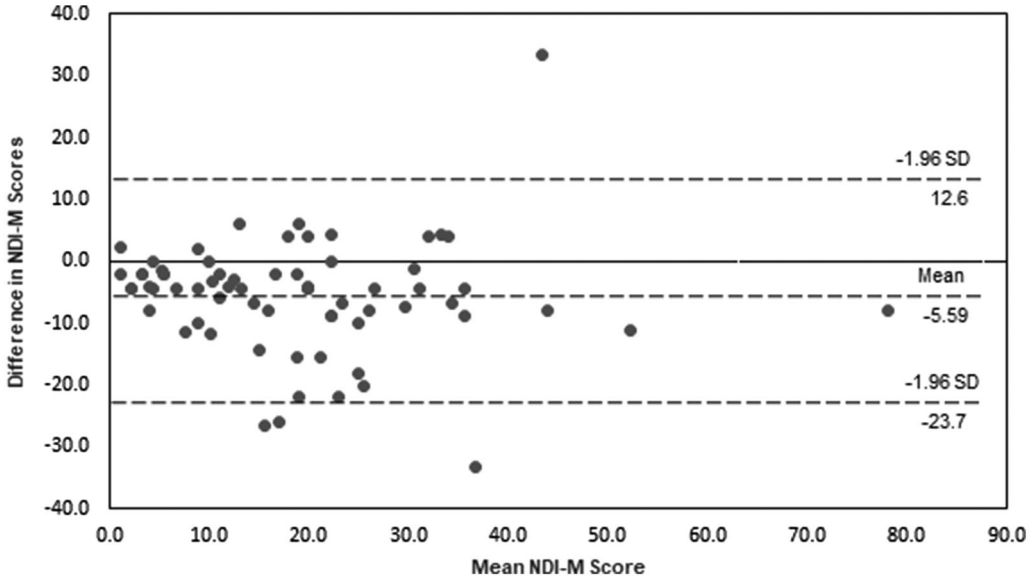

Figure 2. Bland–Altman plot illustrating the test-retest reliability of the NDI-M. The central line represents the mean difference between test and retest scores, and the outer reference lines represent the 95% limits of agreement.

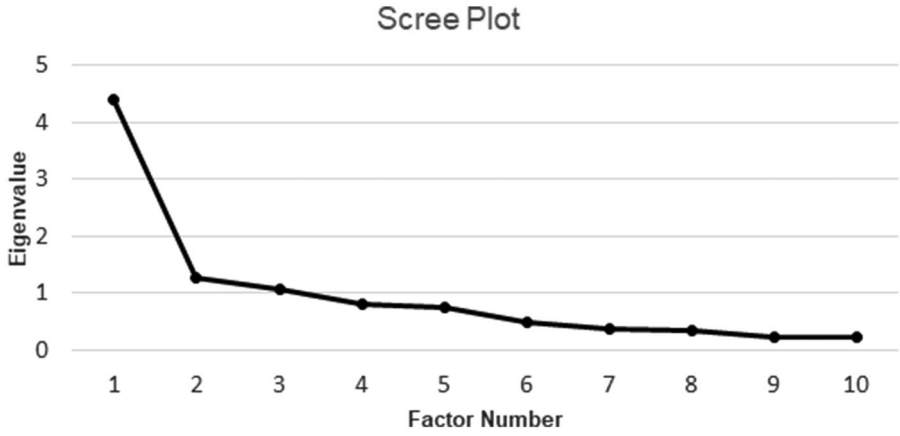

Figure 3. Scree plot for the 10 items of the NDI-M.

Table 3. Exploratory factor analysis for the NDI-M*.

NDI-M Items	Factor 1	Factor 2	Factor 3
1. Pain Intensity	0.672		0.515
2. Personal Care		0.602	
3. Lifting		0.932	
4. Reading	0.847		
5. Headaches			0.867
6. Concentration	0.765		
7. Work		0.684	
8. Driving			
9. Sleeping		0.606	0.629
10. Recreation	0.716		

NDI-M: Neck Disability Index – Malay.
*Factor loadings of less than 0.5 were suppressed.

[19,45]. Future studies may consider assessing the responsiveness of the NDI-M in patients with higher functional disability scores.

Limitations

Criterion validity was not assessed in our study as there was no alternative criterion standard for the NDI-M. Furthermore, only VAS and GRoC were used to compare with the NDI-M in view of our high patient load in primary care. Our participants were also recruited from community-dwelling adults in an outpatient primary care setting receiving physiotherapy care at an earlier onset of neck pain. Therefore, the psychometric properties may differ in a population of patients with higher NDI-M scores.

Table 4. Mean score changes for the NDI-M, according to GRoC grading, $n = 98$.

GRoC Score	*N* (*N*%)	NDI-M Mean change ± SD
≥ -3 and <0	5 (5.1)	5.7 ± 7.8
0	24 (24.5)	5.1 ± 11.3
+1	6 (6.1)	8.4 ± 5.0
+2	15 (15.3)	4.6 ± 6.4
+3	20 (20.4)	6.2 ± 10.2
>3	28 (28.6)	9.5 ± 9.9

GRoC: Global Rating of Change; NDI-M: Neck Disability Index-Malay.

Conclusions

The NDI has been successfully translated and cross-culturally adapted into the Malay version. The NDI-M is a reliable and valid measurement tool of pain and functional ability. It is also moderately responsive in detecting a change in pain intensity in Malay-speaking patients with neck pain.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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