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ADAPTATION OF THE MODIFIED BARTHEL INDEX FOR USE IN PHYSICAL MEDICINE AND REHABILITATION IN TURKEY

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The aim of this study was to adapt the modified Barthel Index for Turkey and to determine its reliability and validity. After the translation procedure, 50 stroke patients and 50 spinal cord injury patients, undergoing inpatient rehabilitation were assessed by the newly adapted index at admission and discharge. Reliability was tested using internal consistency, inter-rater reliability and the intra-class correlation coefficient. Construct validity was assessed by association with impairments (Brunnstrom motor stages in stroke, American Spinal Injury Association motor/sensory scores and impairment scale in spinal cord injury) and by Rasch analysis. Internal consistency was good at 0.93 for stroke, and 0.88 for spinal cord injury. The level of agreement between two raters was sufficient with Kappa levels of above 0.5 for spinal cord injury and above 0.6 for stroke. Intra-class correlation coefficients were 0.99 and 0.77 for stroke and spinal cord injury, respectively. The newly adapted index showed expected associations with the impairment scales, confirming its construct validity. However, Rasch analysis showed that bladder and bowel items compromise unidimensionality. In conclusion, adaptation of the modified Barthel Index has been successful and it can be used in Turkey as long as its limitations are recognized.

Key words: rehabilitation, outcome, Rasch, Barthel Index, disability.

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INTRODUCTION

One of the primary clinical objectives in rehabilitation medicine is to reduce disability (1). Measurement of functional independence in patients with disabilities is an essential component of the rehabilitation process and has a variety of applications both in patient care and clinical research (2). The purposes of such an assessment are to provide objective and quantitative measures of patient function; to describe and communicate levels of ability in self-care and mobility skills; to monitor changes in clinical status; to guide management decisions; to evaluate treatment efficacy; to prevent additional disability; to predict prognosis; to plan placement; to estimate care requirements; and to determine compensation (3).

Many scales have been developed and utilized to determine functional independence (1, 4). Each instrument has its own unique application, format, advantages and disadvantages, as discussed in several recent excellent critical reviews (2, 3, 5, 6). Among many available assessment scales, the Barthel Index (BI) is one of the most popular (7). For many years it has been the mainstay of measuring functional ability in rehabilitation. It has been utilized both in the management of individual patients, and in the evaluation of the efficacy of various rehabilitation programs (8–12).

The BI has ten items and the values assigned to each item are based on the amount of physical assistance required to perform the task, being summed to give a total score ranging from 0 to 100 (0: fully dependent; 100: fully independent). In the original version, each item is scored in three steps (7). A modified Barthel Index (MBI) with a five-step scoring system, developed by Shah et al. (13) was found to achieve a greater sensitivity and improved reliability compared with the original version.

The importance of functional evaluation has been increasingly recognized among the rehabilitation medicine specialists in Turkey over the last decade. Thus, internationally accepted measures for the assessment of functional disability have been used, especially in clinical research (14–16). Different centres have used different instruments after translating them into Turkish. However, these translations were neither properly adapted to Turkish culture nor tested for validity and reliability. The BI has been one of the most widely used of these instruments. The aim of this study was to adapt the MBI for the Turkish population and to determine its reliability and validity.

PATIENTS AND METHODS

Translation procedure

Four health professionals (three medical doctors and one physiotherapist) and an English teacher who had been educated in the USA took part in the translation process. The first author (AK) had had considerable experience of rating the MBI while working in a UK rehabilitation unit. This author was one of the translators and was subsequently involved in the training process of the two MBI raters. Five Turkish people who were fluent in English therefore did independent literal translations. The first translated version was then discussed with a lay panel. Beyond the literal translation, a conceptual translation was found to be necessary for two of the items, as some of the activities explained in MBI were not identical within the Turkish setting. “Bathing” was accepted as “washing all over” either in a bath or in a shower or on a chair. “Using toilet” activity

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included not only the western type of toilets with sitting closets but also the eastern type with floor closets that require squatting down on the heels. After the translation process, the raters (GY and BS) were trained on the application of the MBI and applied the instrument to a group of 18 patients undergoing neurological rehabilitation in hospital as a test of face validity. Some modifications were felt to be necessary for the adaptation. For example some activities that operationalize items such as "cutting the meat", or "opening the milk carton", were not applicable to some patients. "Cutting the bread" and "breaking the bread into pieces with fingers" were thus added to descriptive activities associated with the fourth step of the feeding item. "Cleaning the face with a piece of wet and soapy cloth if given by the helper" was common among patients with limited mobility, and this activity was included in the fourth step of the personal hygiene item. After these modifications, the final version was documented.

Design and setting

For the reliability and the validity studies, two diagnostic groups, patients with stroke and spinal cord injury (SCI) were recruited. Consecutive patients with stroke and SCI admitted for rehabilitation to the Department of Physical Medicine and Rehabilitation at the Medical Faculty of Ankara University, Turkey, from 1993 to 1997 were assessed using the adapted measure. The assessments were undertaken by the same two raters involved in the earlier pilot study. Each patient was assessed at admission by the two raters and at discharge only by the first rater (GY). Additional measures assessing impairment were applied concurrently. Motor impairment in stroke group was evaluated according to the Brunnstrom Motor Recovery Stages in 7 stages, indicating Stage 1 the highest impairment, Stage 7 no impairment (17). The degree of impairment in SCI group was graded by the American Spinal Cord Injury Association (ASIA) Impairment Scale, and the ASIA motor and the ASIA sensory scores were also recorded for the detailed evaluation of motor and sensory functions (18).

Assessment of reliability

Reliability is the consistency of a measure from one use to the next. This is routinely tested by "test-re-test" reliability amongst patients who are stable on the relevant construct, and by "internal consistency". In addition, where the score arises from a professional who rates the patient, then inter-rater reliability is also important. Reliability of the Turkish version of MBI was determined by testing the latter two, internal consistency and inter-rater reliability.

Internal consistency was tested by Cronbach's alpha (α) coefficient (19). This has traditionally been used as a measure of reliability and the extent to which items comprising a scale measure the same concept. Recent work has shown that while α can be used as an indication of the connectedness of items within a scale, it does not confirm unidimensionality (20). Indeed, it is quite possible to have two or more dimensions in a large item set which nevertheless give a high α. Internal consistency using α is thus no guide as to whether or not the items of a scale belong to a single underlying construct.

Inter-rater reliability was assessed by the Kappa statistic (21). This is a ratio of the proportion of times the raters agree, corrected for chance agreement, to the maximum proportion that the raters could agree, corrected for chance (22).

Assessment of validity

Validity is concerned with whether the instrument measures the characteristic it purports to measure. Where there is no "gold standard" against which to contrast an instrument, construct validity is assessed. Here the instrument is contrasted against other measures where there would be an expected level of agreement (convergent validity) or disagreement (divergent validity) (23). Some evidence that the items in the instrument do measure a single construct would also be sought.

Construct validity of the translated version of the MBI has been assessed in two ways. The first, traditionally, by comparing the convergent validity of the instrument with the impairment measures for both diagnostic groups. Although impairments do not necessarily give rise to limitation in activities (disability), a moderate to strong association (>0.4) would be expected in the context of an acute rehabilitation ward. Secondly, a more recent innovation, by fit of the data to the one-parameter Item Response Theory (Rasch) model. The Rasch measurement model assumes that the data from an instrument are unidimensional (24). Thus the model can be used to test whether the items in the scale do belong to a single underlying construct (25). Testing the fit of the data to the Rasch model is equivalent to a test of the theoretical construct validity and adequacy of the scale (26). The data derived from the MBI were thus fitted to the Rasch model, operationalized by the unconditional maximum likelihood approach (27). Data were analysed using the Statistical Package for the Social Sciences (SPSS) (28), and a Rasch-Model Computer program BIGSTEPS (29).

Table I. *Modified Barthel Index (MBI) scores of patients with stroke (*n = *50)*

	Admission Mean ± SD (median)	Discharge Mean ± SD (median)
Transfer (0–15)	6.22 ± 5.85 (3)	8.94 ± 5.64 (10)
Ambulation (0–15)	5.56 ± 5.85 (3)	9.58 ± 5.57 (12)
Stairs (0–10)	1.98 ± 3.37 (0)	4.56 ± 3.55 (5)
Feeding (0–10)	5.02 ± 3.33 (5)	6.60 ± 2.88 (8)
Dressing (0–10)	3.06 ± 2.57 (2)	4.90 ± 2.91 (5)
Personal hygiene (0–5)	2.78 ± 1.73 (3)	3.60 ± 1.48 (4)
Bathing (0–5)	1.14 ± 1.14 (1)	1.84 ± 1.27 (1)
Use toilet (0–10)	3.90 ± 3.97 (2)	6.06 ± 3.82 (8)
Bladder (0–10)	7.20 ± 3.90 (10)	8.20 ± 3.28 (10)
Bowel (0–10)	8.00 ± 3.74 (10)	8.86 ± 2.86 (10)
Total MBI	44.86 ± 29.75 (39)	63.14 ± 28.16 (69)

RESULTS

Fifty patients with stroke and 50 with SCI were assessed. The mean age of the stroke group was 58 years and 74% were female. The mean length of time since the stroke was 2.8 months, ranging from 1 to 10 months. All had unilateral hemiplegia, 44% of which were right-sided. Mean age of the SCI group was 31.5 years and 56% were female. Mean time since the injury was 3.6 months, ranging between 1 and 24 months. The level of the injury was cervical in 22%, thoracic in 46% and lumbar in 32%.

Psychometric properties of the translated MBI

MBI scores of patients with stroke and SCI are presented at Tables I and II. MBI scores were significantly increased at

Table II. *Modified Barthel Index (MBI) scores of patients with spinal cord injury (*n = *50)*

	Admission Mean ± SD (median)	Discharge Mean ± SD (median)
Transfer (0–15)	4.25 ± 5.14 (3)	8.09 ± 5.85 (8)
Ambulation (0–15)	3.32 ± 5.04 (0)	6.89 ± 5.49 (5)
Stairs (0–10)	0.40 ± 1.65 (0)	2.21 ± 3.51 (0)
Feeding (0–10)	6.17 ± 4.13 (8)	8.66 ± 2.98 (10)
Dressing (0–10)	3.85 ± 3.51 (2)	6.70 ± 3.26 (8)
Personal hygiene (0–5)	2.85 ± 2.02 (3)	4.13 ± 1.57 (5)
Bathing (0–5)	1.47 ± 1.67 (1)	2.53 ± 1.78 (3)
Use toilet (0–10)	1.77 ± 2.95 (0)	4.68 ± 3.84 (5)
Bladder (0–10)	2.11 ± 3.74 (0)	4.68 ± 4.32 (5)
Bowel (0–10)	2.83 ± 4.21 (0)	5.62 ± 4.53 (8)
Total MBI	29.02 ± 25.17 (21)	54.19 ± 28.73 (51)

Table III. *Inter-rater reliability of Modified Barthel Index**

	SCI	Stroke
Transfer	0.66	0.82
Ambulation	0.71	0.67
Stairs	0.68	0.77
Feeding	0.70	0.67
Dressing	0.50	0.78
Personal hygiene	0.56	0.63
Bathing	0.63	0.61
Use toilet	0.71	0.84
Bladder	0.72	0.97
Bowel	0.78	0.95
Total	0.77	0.99

* Kappa.

discharge in both groups compared with the admission levels ($p < 0.001$, Wilcoxon signed ranks test).

Reliability of the MBI. The internal consistency of the MBI was tested by Cronbach's alpha (α). At admission α was 0.927 and upon discharge 0.930 for the stroke group. For the SCI group, α values were 0.88 and 0.90 at admission and discharge, respectively. This suggests a considerable degree of connectedness of items in the scale with an acceptable level of internal consistency for both diagnostic groups.

Inter-rater reliability results of MBI in both diagnostic groups are presented at Table III. The level of agreement between the two raters was sufficient, reflected by Kappa levels above 0.5 with SCI and above 0.6 with stroke. Overall agreement was good as expressed by the intra-class correlation coefficients of 0.77 in SCI and 0.99 in stroke.

Convergent validity of the MBI. In SCI group, total MBI score was found to be significantly related to ASIA Impairment Scale at both admission (Kruskal Wallis test, $p = 0.005$) and at discharge ($p = 0.003$). Correlation between the MBI scores and the ASIA motor-sensory scores are presented in Tables IV and V. As expected, correlation of MBI with motor function was stronger than the correlation with sensory function. These data supported the convergent validity of the new version for the patients with SCI.

In the stroke group, distribution of the Brunnstrom stages upon admission necessitated varying levels of aggregation for analytical purposes (Table VI). MBI scores were significantly related to both lower and upper extremity Brunnstrom stages (Kruskal Wallis, $p < 0.01$) and to hand function at admission but only to lower and upper extremity motor stages at discharge.

Table IV. *Correlation between Modified Barthel Index (MBI) and American Spinal Injury Association (ASIA) scores**

	Admission r	Discharge r
MBI-ASIA motor	0.55†	0.76†
MBI-ASIA sensory	0.43‡	0.51†

* Spearman correlation analysis.
† $p < 0.001$. ‡ $p < 0.01$.

Table V. *Correlation of American Spinal Injury Association (ASIA) scores with the items of Modified Barthel Index**

	ASIA Motor r	ASIA Sensory r
Transfer	0.58	0.39
Ambulation	0.68	0.40
Stairs	0.63	0.49
Feeding	0.27	0.05
Dressing	0.54	0.22
Personal hygiene	0.25	0.17
Bathing	0.61	0.41
Use toilet	0.61	0.41
Bladder	0.82	0.63
Bowel	0.69	0.58

* Spearman Correlation Analysis.

Table VI. *Frequency of Brunnstrom Motor stages at admission*

Score/Level	Hand	Upper	Lower
1	33	18	13
2	12	15	9
3	1	12	15
4	2	3	6
5	1	1	7
6	1	1	0
7	0	0	0
Total	50	50	50

Construct validity of the MBI by Rasch model. Within each diagnostic group the data from the MBI were fitted to the Rasch partial credit model (30). Table VII shows the fit of the 10 items for stroke patients. Items are ordered by their level of difficulty, thus for this group of patients, climbing a flight of stairs independently, dressing and ambulation are the most difficult, whereas independence in bladder and bowel will be the most easy to achieve (if not already independent upon admission). Fit of the items to the Rasch model is shown by two fit statistics, the "infit" and "outfit" statistics. Acceptable values for infit and outfit are within the range 0.7–1.3. The items "bladder" and "bowel" show considerable levels of misfit, as determined by the OUTFIT statistic. OUTFIT is concerned with responses to items

Table VII. *Fit of admission Modified Barthel Index items to Rasch model in stroke group*

Item	Difficulty	Error	Infit	Outfit	Point-biserial
Stairs	2.53	0.24	0.46	0.26	0.74
Dressing	1.60	0.28	0.81	0.81	0.78
Ambulation	0.79	0.22	0.50	0.96	0.89
Use toilet	0.52	0.22	0.79	0.65	0.86
Transfer	0.36	0.22	0.66	0.90	0.88
Bathing	0.08	0.31	1.26	1.28	0.68
Feeding	0.02	0.24	1.25	1.23	0.73
Personal hygiene	−0.72	0.23	1.03	1.03	0.79
Bladder	−2.23	0.21	1.24	9.58	0.60
Bowel	−2.95	0.22	0.56	3.87	0.56
Total	0.0	0.24	0.86	2.06	

Table VIII. *Fit of admission Modified Barthel Index items to Rasch model in the spinal cord injury group*

Item	Difficulty	Error	Infit	Outfit	Point-Biserial
Stairs	1.87	0.34	1.35	0.62	0.36
Use toilet	0.70	0.19	0.78	0.53	0.72
Bathing	0.51	0.18	0.64	0.54	0.81
Bladder	0.46	0.15	1.48	0.87	0.49
Ambulation	0.21	0.11	0.93	0.55	0.72
Bowel	0.08	0.17	1.34	1.73	0.50
Transfer	0.08	0.17	0.56	0.63	0.83
Dressing	−0.50	0.18	0.84	0.75	0.72
Personal hygiene	−1.49	0.18	1.36	1.30	0.57
Feeding	−1.91	0.19	1.49	1.64	0.49
Total	0.0	0.18	1.08	0.92	

that are far removed from the persons' ability level. Thus some patients with a high level of disability will nevertheless have no problems with bladder and bowel, and vice versa. This reflects the discordance between impairment and disability. If this analysis was concerned with the development of a new scale, then these items would be omitted as they do not appear to measure the same construct (disability) as the other items.

The hierarchical ordering of items for SCI group as shown in Table VIII are different from that for stroke. Stairs remains the most difficult item, while toiletting, bathing and bladder items follow in the order of difficulty in achieving independence. Dressing and grooming are the easiest items. Thus the items mark considerably different levels of disability on the underlying construct in two diagnostic groups. This precludes a direct comparison of disability levels between these two groups. Bladder and bowel items continue to show levels of misfit to the underlying construct for patients with SCI.

DISCUSSION

The present study describes the adaptation of the MBI (13) for the Turkish neuro-rehabilitation patients. Two impairment groups; stroke and spinal cord injury were chosen for the reliability and the validity studies of the new version. Both diagnostic groups had considerably low MBI scores at admission and showed significant increases at discharge (Tables I and II), as would be expected from those undergoing rehabilitation.

The internal consistency of the MBI in this study is satisfactory, as shown by Cronbach's alpha coefficients of 0.93 for stroke and 0.88 for SCI on admission. These findings were consistent with previous reports (8, 13).

Interrater reliability of the Turkish MBI has proven to be adequate as expressed by the intra-class correlation coefficients of 0.77 in SCI and 0.99 in stroke. Although the level of agreement between the two raters was considerably good in stroke group, confirming other findings (31, 32), it could not reach the same high level for SCI group. This might be due to the difficulty of rating some items (dressing, transfer, bladder and bowel) in SCI. For example, rating both upper and lower body dressing in one item may cause confusion as a patient with SCI might be quite dependent in dressing the upper body whereas might have some difficulties in the lower body. The level of assistance that a patient with SCI requires might change according to the place of transfer (chair, toilet or bath) and this may also cause confusion while rating transfer in SCI where it is much easier to rate in stroke. Rating both the accidents and the assistance required with the devices in the same level of activity for bladder and bowel items may be difficult for raters as these two functions may not be in concordance in SCI. However this is not a problem for patients with stroke as they are usually continent or may have an occasional accident (33, 34). As a matter of fact the kappa values of those four items were considerably low in SCI compared with stroke.

Relationship between the physical disability and the neurological impairment in stroke has been investigated in various studies. Correlation coefficients between the BI and the stroke scales showing the severity of neurological impairment were reported to be around 0.70 (35). Some authors demonstrated significant associations of BI with arm and leg motor function (33, 35). Shah et al. showed that admission Brunnstrom stages were highly correlated with discharge BI (36). In the present study, convergent validity of the newly adapted measure was assessed by investigating the relation with the impairment levels in both patient groups. In stroke group, MBI scores were significantly related to lower extremity, upper extremity and to hand functions at admission, but only to lower and upper extremity functions at discharge. This expected finding supported the convergent validity in stroke group, as similar results had been reported previously (35, 37), validating the statement that stroke patients are able to achieve independence in ADL without a corresponding improvement in arm and hand recovery; i.e. the patients may compensate by performing ADLs with one-handed techniques.

Previous studies on patients with SCI, aiming to determine the factors that predict functional outcome has revealed that completeness of the spinal cord lesion, level of injury and motor function were significant predictors of Barthel score at discharge (38–40). Convergent validity of the Turkish MBI in SCI group has been therefore confirmed by the demonstration of both significant relation with completeness of injury (ASIA impairment scale) and significant correlations with motor and sensory functions.

Rasch analysis has emerged as a useful technique to evaluate instruments that are intended to measure scaled behaviour, including disability (24, 34, 41). The construct validity of the newly adapted MBI was examined by Rasch analysis and the results reveal that the hierarchical ordering of the items are not the same in two diagnostic groups. However the relative difficulty of items between these groups parallels the actual nature of these groups' medical condition, supporting the validity of the measurement system. For example, the bladder and bowel items are relatively easier to achieve independence with stroke but relatively harder to achieve in SCI. Also, dressing with one hand is relatively difficult for a hemiplegic,

while paraplegics may have fewer problems while dressing. Over three-quarters (78%) of our SCI group had thoracal/lumbar injuries and thus they were expected to have less problems with dressing. Differences in the hierarchical ordering of items prevent direct comparison between different diagnostic groups. These are new lessons that are being learned from the application of Rasch analysis and appear to apply to most health status measures, including the FIM (34).

Of crucial importance for cross-cultural studies, the hierarchical ordering of items for stroke in the adaptation for Turkey is similar to that in the UK (42). The items stairs, ambulation, dressing, toiletting and transfer, as well as bladder and bowel, are ordered (within one standard error) in the same way as the UK version. However, bathing is quite different, and may reflect the changes that were made to the operating instructions for assignment to this item. In the UK version, bathing was the most difficult item upon which to achieve independence in a neurological rehabilitation ward, whereas in Turkey it is an item of almost average difficulty.

Bladder and bowel items showed considerable levels of misfit to the underlying construct for both diagnostic groups. This level of misfit on these items is consistent with other findings on the MBI (42). The lack of in unidimensionality of the scale can compromise the responsiveness of the instrument. For the MBI, bladder and bowel is essentially a measure of the presence or absence of the incontinence, and its frequency, rather than the management of incontinence. As such, the bladder and bowel items (impairments) may be invariant for most patients with SCI, but some patients with stroke may be expected to recover this function. Thus having items which measure two dimensions may obscure the true change on the dimension of interest, in this case disability.

CONCLUSION

The adaptation of the MBI has demonstrated adequate levels of reliability, both internal consistency and inter-rater reliability, as well as convergent construct validity. There is some doubt about the unidimensionality of items given misfit to the Rasch model. However, this has been found in the UK version, and thus is an inherent weakness of the scale, rather than a result of the Turkish adaptation. The process of literal and conceptual translation of the instrument has shown not to be a sufficient condition for cross-cultural validity. Adapting a measure to meet local cultural needs has been shown to shift the difficulty levels of some items and thus render cross-cultural comparisons invalid, e.g. a score of 50 in the Turkish version would not imply the same level of disability in the same tasks as the English version. Other limitations for use, for example between diagnostic groups, are also likely to be found across cultures, just as the weakness of the construct with respect to the bowel and bladder items has been shown elsewhere. Thus the instrument can be used in Turkey in the field of neurological rehabilitation as long as these limitations are acknowledged.

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