

Article

Validation of Bengali Modified Barthel Index in aged patients of Bangladesh

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Abstract: Functional independence is an integral part for reflection of quality of living. Many scales have been utilised for it and the Barthel Index (BI) is one of them, which later modified on 10 activities having the score range of 0-20. English version of the Modified Barthel Index (MBI) is widely used to measure disability also in Bangladesh and an important tool for assessment of activities of daily living in aged patients. However, a validated and culturally adapted Bengali version of MBI has not been produced yet. This study describes the validation and reliability into Bengali of the modified 10-item version of MBI, and reports the procedures for testing its validity and reliability. For validation process a two phased study was conducted based on data from aged patients in out and in patient department of Bangabandhu Sheikh Mujib Medical University. After pre-testing of the Bengali version of MBI (B-MBI) among 30 aged patients in phase-1 of the study whereas total 129 patients were submitted to the adapted scale for testing its acceptability and internal consistency in second phase. The internal consistency by Cronbach's alpha resulted equal to 0.880. The score was also tested against the Bengali adapted SF-36 (Short Form-36) to compare with physical functioning and mental health domains. It yielded Spearman's correlation coefficient (r_s) 0.787 ($p < 0.001$), indicating strong positive correlation of B-MBI with physical functioning part and a weak correlation ($r_s = 0.191$; $p = 0.031$) was found with mental health domain of SF-36. Reliability was evaluated on 124 cases as 5 participants were missed for re-test; at test-retest was ICC=0.961 (95%IC: $p < 0.001$). This study provides a new tool for professionals in Bangladesh to measure functional disability in aged patients both in inpatient and outpatient department of hospitals and also in the health and social care settings along the continuum of care.

Keywords: Modified Barthel Index; functional disability; validation; reliability

1. Introduction

Independence in self-care activities is a common outcome measure to assess disability of human being. Many scales have been developed and utilized to determine functional independence. Each instrument has its own unique application, format, advantages and disadvantages, as discussed in several recent excellent critical reviews. Among all other instruments Barthel Index (BI) has been regarded as the most popular in terms of sensitivity, simplicity, communicability and ease of scoring in activities of daily living (Shah and Cooper, 1999; Granger *et al.*, 1995; Wade *et al.*, 1983; Bentur and Eldar, 1993; Campbell *et al.*, 2005). The BI was first developed by Mahoney and Barthel in 1965 and scored in steps of five points to give a maximum total score of 100 (Mahoney and Barthel, 1965) and a widely adopted modification to the index by Collin and Wade (Collin *et al.*, 1988) includes a revised score range of 0–20. The 10-item form consists of 10 activities of daily living (ADL) including feeding, bathing, grooming, dressing, bowel and bladder control, toilet use, transfers (bed to

chair and back), mobility, and stairs climbing. Items are rated in terms of whether patients can perform the task independently, with assistance or are totally dependent (scored as 0, 1, 2, 3 points per item for transfers and mobility). The total score is calculated by adding up the individual scores, and ranges from 0 (total dependence) to 20 (total independence). There is little consensus over which of the versions should be considered as definitive, but this 10-item versions are the most commonly used (Collin and Wade, 1988). The index measures the functional status in activities of daily living in different age group, more preferably in geriatric patients and has been recommended by the Royal College of Physicians in UK for routine use in the assessment of elderly people. Globally, the number of older persons (aged 60 years or over) is expected to more than double, from 841 million people in 2013 to more than 2 billion in 2050. Older persons are projected to exceed the number of children for the first time in 2047. Presently, about two thirds of the world's older persons live in developing countries (United Nations, 2013). Bangladesh had 3% 65 years or older population in 2000. However, 65-and-older population in Bangladesh is projected to rise to 5% in 2025 and 11% in 2050 (Health Bulletin, 2016). Meanwhile, according to population census report in 2011 aged population (aged 60 years and over) in Bangladesh was 7.7%. The Modified BI was translated and validated in many languages, such as Turkish, German, Persian, Italian, Chinese, Brazilian, Dutch and Japanese (Kucukdeveci *et al.*, 2000; Oveisgharan *et al.*, 2006; Leung *et al.*, 2006; Cincura *et al.*, 2009; Post *et al.*, 1995; Ohura *et al.*, 2014). There are about two hundred ten million Bengali speaking people all around the world and it was the 7th language according to population as reported by the Ethnologue: languages of the world in 2016. This language is one of the most widely spoken languages in the world. Total users in all countries: 208,344,830 (as L1: 189,144,830; as L2: 19,200,000) (Ethnologue, 2016). According to the United Nations Population Division (2013), the size of population of Bangladesh aged 65 years or more has reached about 8 million in 2010 from 4 million in 1990, and this pattern of increase is forecasted to be steeper in the coming years. With this pattern of increase in ageing population, the question on whether ageing has really emerged as a demographic issue is already on (Wild *et al.*, 2005). A culturally adapted and validated Bengali version of the modified Barthel index (B-MBI) for the people of Bangladesh is not yet available although Bangladesh is need of this to determine the disability criteria for patients, specially the aged one. Simple translation misses cultural peculiarities with consequent distortions of items' meaning and for this validation is necessary.

The scopes 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. So properly validated B-MBI might fulfil the need of assessment of functional status and disability of Bengali speaking patients of Bangladesh. In this study the prime objectives were to validate B-MBI in aged patients and to assess the reliability of same tool in the same group of persons.

2. Materials and Methods

To find out the validity of Bengali version of Modified Barthel Index (MBI), we did an observational study which was conducted in two phases. The study was conducted in the Department of Internal Medicine (both outpatient & inpatient), Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka for period of 12 months (January 2017 to December 2017). Aged patients (60 years or more) were included attending inpatient and outpatient of Department of Internal Medicine, Bangabandhu Sheikh Mujib Medical University (BSMMU), Shahbag, Dhaka who gave consent and were willing to participate our study. But aged persons who were severely sick to understand the questions, needed immediate interventions or who demanded acute management within 3 days of visit were not included in the study.

2.1. Data source and analysis

On the first phase translation and cross-cultural adaptation was done of the English MBI into Bengali where 30 aged patients were interviewed for pre-test and then assessment of the psychometric properties of the developed Bengali version of the MBI in aged patients (60 years or more) to develop the validated Bengali version of the Modified Barthel Index (B-MBI). In the study convenient sampling was done. The sample size for the second phase was determined based on the parameter, the test-retest reliability which was measured by the intra-class correlation coefficient (ρ). It is expected the Bengali version of the Modified Barthel Index to have a ρ of 0.8 in this study, and a ρ of 0.7 or higher would be acceptable to us. Thus, $H_0: \rho_0 = 0.7$ and $H_1: \rho_1 = 0.8$. Using a

two-sided test as suggested by Walter et al. (1998) with β (probability of type II error) = 0.2 (80% power) and α (probability of type I error) = 0.05, a sample size of 117 evaluable subjects would be required. Assuming that 10% of subjects might refuse to undergo retest, a total of 129 subjects were enrolled. A semi-structured questionnaire was prepared to collect the data regarding socio-demographic characteristics, to find out the functional status of the patients data were collected by both translated and cross-culturally adapted Bengali version of MBI and the Bengali version of the SF-36 (Islam *et al.*, 2012).

For data entry, processing and analysis, we used Statistical Package for Social Sciences (SPSS) version 22.0. All tests were two tailed and were conducted at a 5% level of significance. There was no missing data for any items. Content and Construct Validity were assessed. Content validity was assessed by scoring from by three experts: one geriatric medicine expert, one psychiatrist, one epidemiologist and Construct validity was demonstrated by comparing the Modified Barthel Index score with the scores of the physical functioning and mental health domain of the Bengali version of the SF-36 through Spearman's correlation coefficient (r_s). Reliability was assessed through three ways: internal consistency, exploratory factor analysis and test-retest reliability. Internal consistency is typically a measure based on the correlation between different items on the same test (or the same subscale on a larger test). This is usually measured with Cronbach's alpha, a statistic calculated from the pair-wise correlations between items. Internal consistency ranges between negative infinity and one. Internal consistency was considered acceptable when Cronbach's alpha was equal to or exceeded 0.70 (George and Mallery, 2003). Item to scale correlation was assessed using Spearman's rank correlation (ρ) between scale and their constituent items taking a value of $\rho \geq 0.40$ as acceptable (Tuzun *et al.*, 2005). Test-retest reliability was assessed using intra-class correlation coefficient (ICC). ICC describes how strongly units in the same group resemble each other. One of its prominent application is the assessment of consistency or reproducibility of quantitative measurements made by different observers measuring the same quantity. An ICC between 0.60 and 0.74 was considered good, between 0.75 and 1.00 was excellent and considered acceptable for test-retest reliability (Cicchetti, 1994).

2.2. Ethical consideration

The participants were informed in details about the nature of the study. They were not exposed to any physical, psychological and social risk. Only the individuals willing to participate in the study were included. Informed written consent was taken from the participants. Every participant enjoyed his/her right to participate or refuse to participate and to withdraw participation at any time. The confidentiality of the information obtained from the participants was maintained by the principal investigator. Data were intended to be used solely for this study.

3. Results

In first phase of study 30 aged persons were included in the study. The mean age of the respondents was 66.80 (± 4.49) years with 12 male (40.0%), female 18 (60%). There were 5 persons (41.9%) who were illiterate, while 1 person (3.3%) was capable of reading only and 16 persons (53.3%) were capable of reading and writing, and 8 persons (26.7%) had higher secondary education. 9 persons (30%) hailed from rural area while 21 persons (70%) were from urban area. Most of the participants were from Dhaka 15 (50%), least from Rajshahi 1(3.3%) and no represent from Sylhet and Mymensingh Division (Table 1) and on the second phase of the study 129 patients were included in the study. The mean age of the respondents was 66.01(± 6.90) years with 77 male (59.7%), female 52 (43.7%). There were 54 patients (41.9%) who were illiterate, while 5 patients (3.9%) were capable of reading only and 4 patients (3.1%) were capable of reading and writing, 23 patients (17.8%) had a primary school education, 21 patients (16.3%) had secondary education, and 9 patients (7.0%) had higher secondary education, 13 patients (10.1%) had a Bachelor/Master degree. 57 patients (44.2%) hailed from rural area while 72 (55.8%) patients were from urban area (Table 2). Though MBI total and subscale was slightly higher in Female but that is not statistically significant ($p=0.620$) (Table 3). There is no significant correlation between age and MBI ($p=0.138$) Relationship between educational status and MBI. Though mean MBI score was lower in Primary level of educational status There is no significant correlation between education level and MBI ($p=0.246$) (Table 4).

3.1. Content validity

Content validity of the adapted version was assessed by three experts: one geriatric medicine expert, one psychiatrist, one epidemiologist. Item-level content validity index (I-CVI) was found to be 1 (Table 5) for each item and scale-level content validity index (S-CVI) was therefore 1 by the averaging calculation method depicts the rating of each item by each of the experts, corresponding I-CVIs and the S-CVI.

3.2. Construct validity

Construct validity was demonstrated by comparing the MBI score with the scores of the physical functioning and mental health domain of the Bengali version of the SF-36 through Spearman's correlation coefficient (r_s), which was found to be 0.787 and 0.191 respectively, indicating moderate positive correlation.

3.2.1. Discriminant validity

Shapiro-Wilk test was performed to assess the mode of distribution of MBI total scores and SF-36 mental health scores. In each of the cases, the test turned out to be significant ($p \approx 0.000$) thereby indicating a skewed distribution. Visual inspection of normal Q-Q plots (Figures 1 & 2) also indicated as such. Discriminant validity of the MBI total score was assessed through comparison with the Mental Health (MH) score of the Bangla version of the SF-36 (Mental Health Domain) by Spearman's correlation coefficient. A weak correlation ($r_s = 0.191$; $p = 0.031$) was found and discriminant validity was thus demonstrated.

3.2.2. Convergent validity

Shapiro-Wilk test was performed to assess the mode of distribution of SF-36 scores. In each of the cases, the test turned out to be significant ($p = 0.001$) thereby indicating a skewed distribution. Visual inspection of normal Q-Q plots (Figure 3) also indicated as such. Convergent validity was demonstrated by comparing the MBI (Bangla version) total score with the score of the Physical Function (PF) of the Bangla version of the SF-36 (Physical health domain) through Spearman's correlation coefficient (r_s), which was found to be 0.787 ($p < 0.001$), indicating strong positive correlation.

3.2.3. Internal consistency

The Bengali version of the total Modified Barthel Index score showed excellent total internal consistency in the form of a Cronbach's alpha value of 0.880 (Table 6).

3.2.4. Factor analysis

KMO (Kaiser-Meyer-Olki) test was done at first. It yielded a KMO value of 0.901 (Table 7) which was indicative of marvellous sampling adequacy for each variable and suitability of the data for factor analysis. Then exploratory factor analysis was performed by principal component analysis that yielded first factor explains 54% variation, though 3 factors explain $>70\%$ of the total variation, but Eigen value of score 3-10 is <1 . Scree plot also showed from the third factor on, line is almost flat, meaning the each successive factor is accounting for smaller and smaller amounts of the total variance and this suggests that the scale items are two-dimensional (Figure 4).

3.3. Test-retest reliability

Out of the 129 respondents who were initially tested, 124 could be retested and rest five respondent could not be followed-up for retest. So the drop-out rate was 3.87%. The test-retest reliability of the Modified Barthel Index scale was measured by intra-class correlation coefficient, which were found to be 0.896, 0.874, 0.803, 0.830, 0.799, 0.922, 0.897, 0.872, 0.947, 0.844 and 0.961 ($p < 0.001$) (Table 8) for sub scale scores and total MBI respectively, indicative of strong correlation between test & retest scores and hence excellent test-retest reliability. Moreover, there was a negligible difference of 0.50 between the mean of the test scores (16.11) and that of the retest scores (16.61).

Table 1. Demographic Characteristics of Participants in Phase-1 (n=30).

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
60 - 64	11	36.7
65 - 69	9	30.0
70 - 74	9	30.0
75 - 79	1	3.3
Mean (\pm SD)	66.80 (\pm 4.49)	
Gender		
Male	12	40.0
Female	18	60.0
Residence		
Rural	9	30.0
Urban	21	70.0
Division		
Dhaka	15	50.0
Chittagong	6	20.0
Rajshshi	1	3.3
Khulna	3	10.0
Barisal	5	16.7
Educational status		
Illiterate	5	16.7
Capable of reading only	1	3.3
Capable of both reading & writing	16	53.3
Higher secondary level	8	26.7
Occupation		
Housewife	15	50.0
Private Service	3	10.0
Businessman	6	20.0
Farmer	6	20.1

Table 2. Demographic Characteristics of Participants in Phase-2 (n=129).

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
60 - 64	56	43.4
65 - 69	32	24.8
70 - 74	23	17.8
75 - 79	12	9.3
\geq 80	6	4.7
Mean \pm SD	66.01(\pm 6.90)	
Gender		
Male	77	59.7
Female	52	40.3
Residence		
Rural	57	44.2
Urban	72	55.8
Division		
Dhaka	61	47.3
Chittagong	48	37.2
Rajshshi	5	3.9
Khulna	2	1.6
Barisal	8	6.2
Sylhet	3	2.3
Mymensingh	2	1.6
Educational status		
Illiterate	54	41.9
Capable of reading only	5	3.9

Capable of both reading & writing	4	3.1
Primary level	23	17.8
Secondary level	21	16.3
Higher secondary level	9	7.0
Bachelor/Master degree	13	10.1
Occupation		
Housewife	49	38.0
Govt. Service	6	4.7
Private Service	15	11.6
Businessman	19	14.7
Farmer	19	14.7
Rickshaw or van puller	1	0.8
Others	20	15.5

Table 3. Modified Barthel Index total and subscale scores of male and female.

Score	Male (Mean±SD)	Female (Mean±SD)	Total (Mean±SD)	P-value
Bowels	1.42 ± 0.86	1.56 ± 0.78	1.47 ± 0.83	0.342
Bladder	1.65 ± 0.64	1.60 ± 0.60	1.63 ± 0.63	0.638
Grooming	0.83 ± 0.41	0.87 ± 0.34	0.84 ± 0.38	0.622
Toilet use	1.53 ± 0.70	1.62 ± 0.60	1.57 ± 0.66	0.486
Feeding	1.79 ± 0.44	1.81 ± 0.40	1.80 ± 0.42	0.839
Transfer	2.35 ± 0.84	2.56 ± 0.87	2.43 ± 0.86	0.179
Mobility	2.47 ± 0.70	2.65 ± 0.59	2.54 ± 0.66	0.177
Dressing	1.75 ± 0.57	1.73 ± 0.49	1.74 ± 0.53	0.816
Stairs	1.19 ± 0.80	1.27 ± 0.79	1.22 ± 0.79	0.603
Bathing	0.73 ± 0.45	0.75 ± 0.44	0.74 ± 0.44	0.850
MBI total	15.87 ± 4.41	16.26 ± 4.55	16.03 ± 4.46	0.620

Table 4. Educational Level & MBI.

Educational status	MBI (Median)	p value
Illiterate	15.57	0.246
Capable of reading only	16.80	
Capable of both reading and writing	20.00	
Primary level	14.73	
Secondary level	17.14	
Higher secondary level	15.33	
Bachelor/Master degree	16.76	

Table 5. Item descriptive of content validity of the adapted Bengali Version of the MBI.

Item	Rating by experts*			Item-level content validity index (I-CVI)	Scale-level content validity index (S-CVI)
	Expert 1	Expert 2	Expert 3		
1	4	4	4	1	1
2	4	4	4	1	
3	4	4	3	1	
4	3	4	4	1	
5	3	4	4	1	
6	4	4	4	1	
7	4	4	4	1	
8	3	4	3	1	
9	4	4	4	1	
10	4	4	4	1	

*1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant

Table 6. Internal consistency of MBI.

Cronbach's Alpha	Modified Barthel Index subscales	N of Items
0.880	Total MBI	10

Table 7. Total variance explained.

Component	Initial Eigen values		
	Total	% of Variance	Cumulative %
1	5.431	54.311	54.311
2	1.168	11.681	65.992
3	0.733	7.335	73.326
4	0.674	6.742	80.069
5	0.567	5.667	85.736
6	0.441	4.415	90.150
7	0.315	3.152	93.302
8	0.297	2.966	96.268
9	0.225	2.249	98.517
10	0.148	1.483	100.000

Table 8. Correlation coefficients (r) between MBI and subscales.

Item	r	p
Bowels	0.896	<0.001
Bladder	0.874	<0.001
Grooming	0.803	<0.001
Toilet Use	0.830	<0.001
Feeding	0.799	<0.001
Transfer	0.922	<0.001
Mobility	0.897	<0.001
Dressing	0.872	<0.001
Stairs	0.947	<0.001
Bathing	0.844	<0.001
Total score	0.961	<0.001

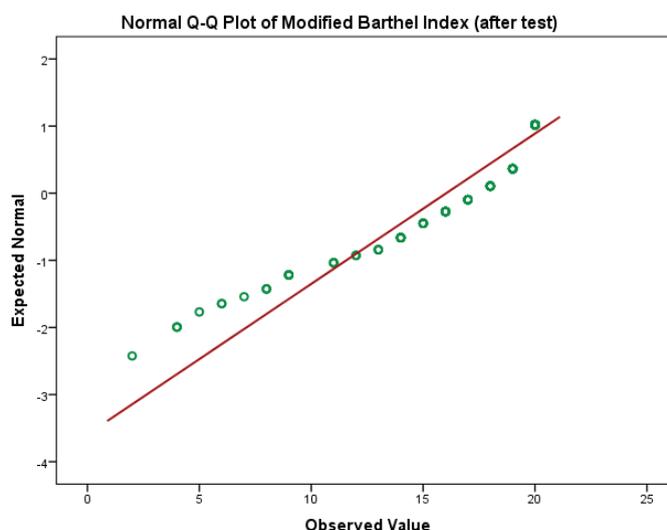


Figure 1. Normal Q-Q Plot of MBI Test Scores.

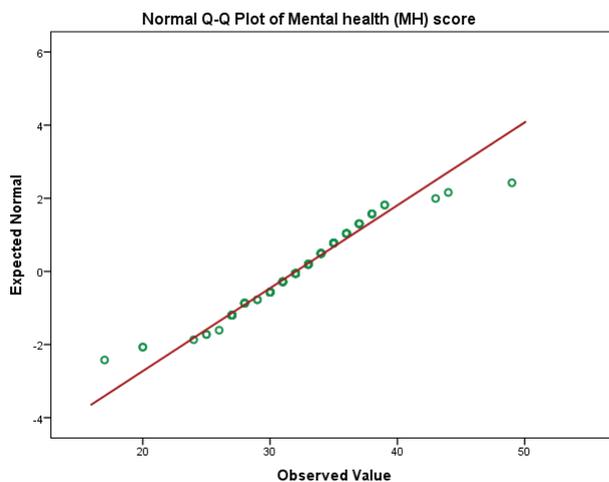


Figure 2. Normal Q-Q Plot of SF-36 Mental Health Domain Scores.

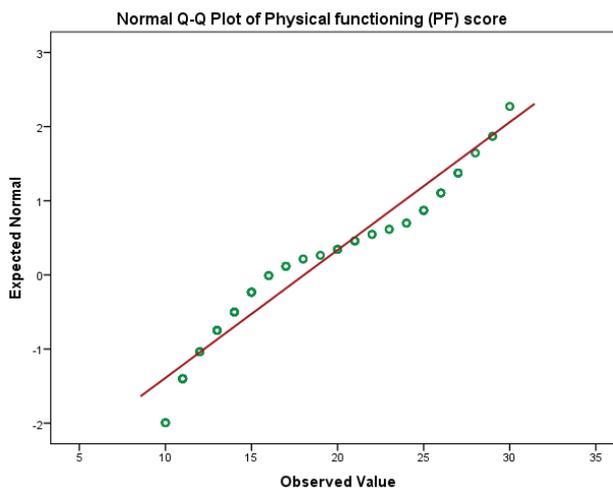


Figure 3. Normal Q-Q Plot of SF-36 Physical Functioning (PF) Scores.

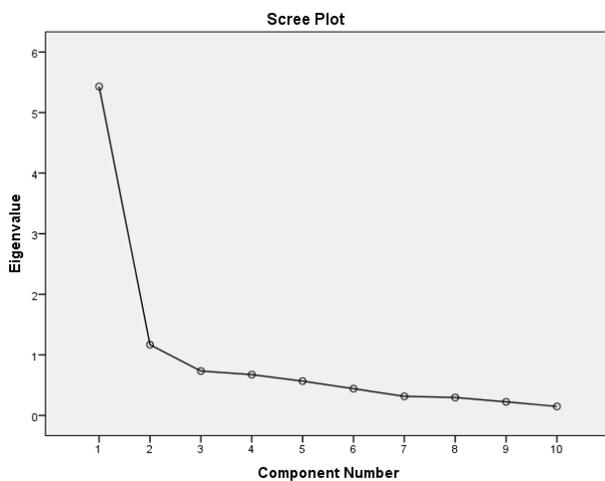


Figure 4. Scree Plot of Components.

4. Discussion

The adapted version of the scale was found to have acceptable Content validity in the form of ICVI (=1), S-CVI (=1). For establishment of validity of new index construct validity is important which lack in previously translated indexes is. This was done by comparing the B-MBI with B-SF36. Convergent validity was demonstrated by comparing the MBI (Bangla version) total score with the score of the physical health domain of the Bengali version of the SF-36 score through Spearman's correlation coefficient (r_s), which was found to be 0.787 ($p < 0.001$), indicating strong positive correlation. Discriminant validity of the MBI total score was assessed through comparison with the score of the Bangla version of the SF-36 (Mental health domain score) by Spearman's correlation coefficient. A weak correlation ($r_s = 0.191$; $p = 0.031$) was found and discriminant validity was thus demonstrated.

The most important index of test reliability is the alpha coefficient (Kline, 2000). Nunnally and Bernstein (1994) has implicated that if a new questionnaire is going to be used, its alpha coefficient should be at least 0.7. The Dutch translated version of the BI has been reported to have a Chronbach's alpha of 0.87. The Turkish have validated BI for rehabilitation patients, reporting an internal consistency of 0.88, whereas the Japanese validated the scale for older people living at home, and reported a Chronbach's alpha equal to 0.93. Most of those studies have been performed on stroke cases. They reported an internal consistency nearly at 0.93, the Chinese at 0.92, the Brazilian at 0.967 (Kucukdeveci *et al.*, 2000; Oveisgharan *et al.*, 2006; Leung *et al.*, 2006; Cincura *et al.*, 2009; Post *et al.*, 1995; Ohura *et al.*, 2014). The high level of interrelatedness among the items represents the cross – cultural validity of the adapted scale that reflects adequately the performances of the original English version.

Test-retest intra-rater reliability has been calculated for B-MBI and resulted equal to 0.983; ICC's value ≥ 0.70 is considered optimal to establish the degree to which repeated measurements are free from measurement error. The score ranges from 0.803 to 0.947 showing the most inter-rater consistent item among the MBI-B items was 'Stairs' the same as Chinese version (Leung *et al.*, 2006). The high reliability indicates that scores of patients remain stable after repeated measurement, as in the original version and this value matches the Italian Validation (Galeoto *et al.*, 2015) Persian 0.989 ($p < 0.001$) (Oveisgharan *et al.*, 2006) of MBI and this result was not influenced by age ($p = 0.620$), gender ($p = 0.138$) and educational level ($p = 0.246$).

Though our study showed acceptable validity and reliability of the Bengali version of the MBI there are few limitations. As the study was carried out in a tertiary level hospital, it is not fully representative of the whole population of Bangladesh and sensitivity to change could not be evaluated due to temporal constraint. On the basis of statistical calculations, an optimum number of patients were enrolled in the second phase of the study. Some of the previous studies (Italian MBI, Iranian MBI, and Turkish MBI) did internal consistency and test retest reliability for validation of the scale only, but lack of construct validity which is much needed for establishment of validity of new translated index. In the study, construct validity has been done and it showed strong convergent and discriminant validity with respect to similar (Physical Component Scale) and dissimilar (Mental Health Domain) components of the Bangla version of the SF-36 respectively as well as good reliability.

5. Conclusions

Aged populations are the asset of any nation. They have experience, wisdom and knowledge which can be used for the national reconstruction. It is the responsibility of everyone to take care of our national asset and utilized their experience. Being aged is a serious reality and last step of our life cycle. So it is the responsibility of our nation to come forward for the wellbeing of our respected senior citizen of Bangladesh. This study was intended to develop a Bengali version of MBI for the evaluation of functional status of aged patients. Following standard procedure, a Bengali version of MBI was developed. This Bengali version of MBI showed good internal consistency and test-retest reliability. Construct validity showed reasonable convergent and discriminant validity. Thus, the Bengali version of MBI may be useful as a comprehensive evaluation tool to measure functional status of aged patients. MBI can guide clinicians to predict patients, who are in need of rehabilitation and thus treatment can be modified accordingly. B-MBI being a valid & reliable tool, may be used to screen probability of rehabilitation. This study was conducted in internal medicine setting upon the patients suffering from medicine related illness. This study recommends this tool to validate and use in other disciplines related with geriatric illness, e.g. patients suffering from stroke in neurology, neuro-surgery, physical medicine department, where rehabilitation is prime concern for the aged patients.

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Conflict of interest

None to declare.

Authors' contribution

Sujan Saha: conceptualization, methodology, data collection and analysis, manuscript writing.

Md. Tanvir Islam: conceptualization, methodology, data collection supervision.

Shamsul Ahsan: supervised the validation procedure.

Md. Moniruzzaman: manuscript writing, reviewing and editing.

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