

## Are short forms of Barthel Index equally useful in the assessment of ADL?

### Czy skrócone wersje Skali Barthel są również przydatne do oceny ADL?

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#### Key words

ADL, Barthel Index, Barthel scale, clinimetrics, short forms

#### Abstract

It was more than 50 years ago, when in 1965, Florence Mahoney and Dorothea Barthel published an article entitled “Functional evaluation: the Barthel Index”. Since then, the Barthel scale, also known as the Basic ADL Index (BI), Barthel Score and Maryland Disability Index, has been one of the most well-known ADL scales (Activities of Daily Living) and is still popular today. As before, this simple scale is used by the representatives of a number of medical professions for many purposes, including the assessment of treatment results, rehabilitation, prognosis, assessment of self-reliance, assessment of needs for care and for evaluative purposes. Despite its simplicity, the administration of the original Barthel questionnaire takes about 5–10 minutes; that is why there is a demand for its shortened form. Based on a review of literature, the advantages and disadvantages of abbreviated BI versions in assessing activities of daily living have been presented.

#### Słowa kluczowe

czynności życia codziennego, indeks Barthel, skala Barthel, skale kliniczne, skrócone wersje

#### Streszczenie

Chociaż minęło ponad 50 lat, kiedy to w 1965 roku Florence Mahoney i Dorothea Barthel opublikowały artykuł zatytułowany “Functional evaluation: the Barthel Index”, skala Barthel, występująca również jako Basic ADL Index (BI), Barthel Score i Maryland Disability Index, należy do najbardziej znanych skal ADL (czynności życia codziennego, ang. *Activities of Daily Living*) i wciąż jest popularna. Ta prosta skala wykorzystywana jest ciągle przez przedstawicieli zawodów medycznych dla wielu celów, w tym oceny wyników leczenia, rehabilitacji, prognozowania, oceny samodzielności, oszacowania potrzeb co do opieki i dla celów orzecznictwa. Mimo swej prostoty wypełnienie kwestionariusza skali Barthel trwa około 5–10 minut, stąd pojawiło się zapotrzebowanie na skróconą formę BI, której wypełnienie zajmie mniej czasu. W artykule przeglądowym przedstawiono najczęściej stosowane skrócone wersje BI z ich wadami i zaletami.

## INTRODUCTION

In an article published in 2015, on the occasion of the 50<sup>th</sup> anniversary of the Barthel Index (BI) [Rehabilitacja Medyczna – Eng. Medical Rehabilitation 19(1): 34–38], I described the usefulness of this scale, both for the purpose of rehabilitative qualifi-

cation, as well as for evaluation of its results, long-term prognosis, evaluation of independence in performance of Activities of Daily Living (ADL), especially the abilities needed for self-care, to assess degree of disability and the need for potential care as well as for the purposes of adjudication about the ability to work<sup>1</sup>.

The authors of the only article published in their career – Florence Mahoney and Dorothea Barthel, did not even suppose that the scale named after the second author would become so popular. In literature on the BI, it also appears under the names: Basic ADL Index (BI), Barthel Score and the Maryland Disability Index<sup>2</sup>. De-

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spite the time lapse, this scale is still popular, ranking second among the most prevalent ADL scales and is still used in scientific as well as clinical research.

In an NIH report, Irvin et al. pointed out that at many centres in England and Wales, some patients are discharged without evaluation according to the BI or Rankin scale – this was explained by the lack of staff time<sup>3</sup>. Hence, the demand for a shortened BI form, which would take less time to complete.

## THE ORIGINAL VERSION OF THE BARTHEL SCALE

In the original version of the Barthel Index (BI), the ability to perform 10 basic daily activities is assessed. These are: eating meals, getting out of bed, personal hygiene, using the toilet, bathing, mobility, climbing the stairs, dressing, bowel and bladder control. Currently, 2 scoring scales of the Barthel Index are equally utilized: 0-1-2-3 gradation; in this version, the total, final result is within the range of 0-20; and in 5-point intervals: 0-5-10-15 points, the final result is then within the range of 0-100 points.

In 1989, Shah et al.<sup>4</sup> described the Modified Scoring for Barthel Index, in which they extended the score to 12 points, distinguishing as many as 9 possibilities: 0,1,2,3,4,5,8,10 and 12 points. The sum of the points is still 0 to 100. The Maryland State Medical Society (MSMS) has the sole right to use the BI. It can be used without the consent of MSMS for non-commercial purposes, however, any modifications or use for commercial purposes require consent.

In the scientific literature, a number of reports on the suitability of the Barthel scale can be found. They show high internal consistency, test-retest reliability, inter-rater reliability, as well as high correlation with other scales; although, according to many authors, its suitability for clinical trials is limited<sup>5-13</sup>.

The Barthel scale has a number of advantages: it is easy to use – completing the form takes 5-10 minutes. This time depends on personal ex-

perience, earlier knowledge about the patient and whether the evaluation is done directly or by telephone call, the total possible score of 100 points makes it easy to determine the patient's progress or decline in percentages. The weakness of this scale is too varied assessment of individual activities (2 activities are assessed on a scale of 0 and 5 points; 6 on a scale of 0, 5 and 10 points; and 2 on a scale of 0, 5 10 and 15 points) while there is a lack of speech evaluation. This scale loses sensitivity in the case of extreme positions – in relation to the most affected patients ("floor effect") and the most efficient patients ("ceiling effect"). Any proposals for dividing patients into groups depending on the degree of disability are arbitrary.

Despite its many limitations, the BI is still often used by doctors, nurses, occupational therapists, managers, as well as in the self-assessment of patients themselves, also by means of telephone interviews.

Research on compatibility between observers of the Dutch BI version conducted in 1994 by Rob de Haan et al. among 60 patients, involving 3 observers, provided results of kappa internal compliance from 0.50 to 1.0, proving the lowest to be for the assessment of personal hygiene among people who obtained a total score below 20 points (with a maximum of 32 points on the scale) and the highest for sphincteric assessment<sup>6</sup>.

## SHORT VERSIONS OF THE BARTHEL INDEX

Among other scales assessing Activities of Daily Living competing with the Barthel scale, the following should be mentioned: the Carol Scale, the Katz Index, the scale by Kenny, and ADL scales used for internal purposes at rehabilitation centres. Lindeboom et al., among 113 identified ADL scales, found 27 (24%) basic ADL scales intended for use in neurology. On these scales, basic domains such as mobility and self-care were present on 44% to 81% of them<sup>14</sup>.

Analysis of 25 ADL scales conducted by Donaldson in 1973 showed

that among 20 of the assessed activities, dressing, locomotion, bathing and eating were most often taken into consideration, while writing, home maintenance and feelings were the least frequent. On 5 scales, dressing, bathing, washing, eating and using the toilet were assessed together under the joint-term – "self-care"<sup>15</sup>.

Despite the fact that the BI takes approximately 10 minutes to fill out, a short version was searched for that would save the researcher and patient time. Short versions: the 3-item short form, the 4-item form and 5-item short form have not gained popularity so far. Hobart and Thomson's proposal, limited to the evaluation of 5 activities: transfer, bathing, using the toilet, climbing the stairs and mobility, was quite popular for a short period of time<sup>16</sup>.

Chronologically speaking, the oldest among articles devoted to shortened versions of the BI is a report by Granger et al.<sup>17</sup> from 1989, then reports by Ellul et al.<sup>18</sup> (1998), Hobart and Thomson<sup>16</sup> (2001), Hsueh et al.<sup>19</sup> (2002), Bohannon<sup>20</sup> (2004), Cho and Kim<sup>21</sup> (2009) and Lekamwasam et al.<sup>22</sup> (2011).

Granger et al.<sup>17</sup> presented the results of a 6-month follow-up among 539 patients after stroke at 17 American centres as part of the Stroke Rehabilitation Outcome study (SRO). The results of the original BI were compared with the short version regarding 4 basic elements: eating, hygiene, bowel and bladder control. It was found that a total score of the BI above 61 is accurate in predicting discharge time from the hospital, while the BI-4 version (especially in the case of urinary incontinence) is more useful in predicting the ability to live independently at home or having to move to a nursing home<sup>17</sup>.

Ellul et al.<sup>18</sup> were part of the European Stroke Database (ESDB) project to develop a "common clinical language" for the treatment of strokes by unifying terminology, definitions and clinical assessments. Their goal was to simplify the BI by reducing the number of items to a few key ones. They analysed data for 169 consecutive stroke patients discharged from one of British

hospitals and found that there was a simple formula that included combined results for 3 activities: bladder control, transfer and mobility. The accuracy of predicting the total BI score, with a 1-point accuracy, was 79% for the simplified version and with 2-point accuracy, in 95% of cases. Then, the 3-part BI-3 was tested 3 times: after 1 and 3 weeks, and after 3 months (total  $n = 824$ ). Predictions were accurate up to  $\pm 1$  point in 72-81% and up to  $\pm 2$  points in 88-97% of cases, and BI-3 represented 95% of the variance ( $R^2$ ) of the total BI score. Prediction was more accurate in patients without significant mental retardation. From the research, the authors concluded that for studies involving large groups of patients after stroke, it is enough to know 3 parameters (bladder control, transfer and mobility) at the time of discharge to assess the overall outcome of the BI<sup>18</sup>.

In 2001, Hobart and Thomson<sup>16</sup> described data from 844 consecutive admissions to the neurological rehabilitation department in London. Samples were randomly split in half. Short forms: BI-3, BI-4 and BI-5 were compared with the 10-item BI. Internal coefficients and the Bland/Altman method were used for assessment. It turned out that the BI-5 version (bathing, using the toilet, transfer, mobility and using the stairs) had the best measuring properties and was psychometrically synonymous with the BI-10. Consistency between the results generated in these 2 scales was excellent ( $ICC = 0.90$ ), but not identical (compatibility limit =  $1.84 \pm 3.84$ ). The authors' conclusions: the short BI-5 form may be an appropriate endpoint in comparative studies among groups with similar samples. Further assessment is necessary<sup>16</sup>.

Hsueh et al.<sup>19</sup> compared the reliability, accuracy and responsiveness of the shortened 5-point BI version (BI-5) with the FIM scale subscale (15 FIM positions) and the original 10-point BI in 118 stroke patients hospitalized at the rehabilitation ward. The BI-5 version includes bathing, using the toilet, transfer, mobility and using stairs. The BI and FIM motor subscales showed accept-

able distribution, high internal coherence ( $\alpha$  coefficient  $\geq 0.84$ ), high internal consistency (Spearman's correlation coefficient,  $r(s) \geq 0.92$ , ICC correlation coefficient  $\geq 0.83$ ) and high reactivity (standardized mean response  $\geq 1.2$ ,  $p < 0.001$ ). The BI-5 showed significant floor effect at admission, but not at discharge. BI-5 showed acceptable internal coherence at admission and discharge ( $\alpha$  coefficient  $\geq 0.71$ ). Internal consistency of the BI-5 was weak to moderate at admission ( $r(s) = 0.74$ ,  $ICC \geq 0.55$ ), but high at discharge ( $r(s) \geq 0.92$ ,  $ICC \geq 0.74$ ). It should be noted that the reactivity of BI-5 was as high as for the BI and FIM motor subscales. The authors' conclusions: BI and FIM movement subscales have very acceptable and similar psychometric features. It seems that the BI-5 has limited discriminatory capacity at admission, especially in patients with severe disabilities; in contrast, the BI-5 has very good psychometric properties. These results can provide information useful in the selection of ADL studies, both for clinicians and researchers<sup>19</sup>.

In his letter addressed to the Editor-in-Chief of the journal *Age & Aging*, in 2004, Bohannon<sup>20</sup> presented data regarding the self-esteem after admission to hospital of 251 stroke patients (mainly elder individuals). The BI-3 version known from the work by Ellul et al.<sup>18</sup> (urinating, transfer and mobility) was used. The average score for the sum of the BI-3 was 4.0; the average result for the total BI-10 value was 9.4. The average result predicted by the Ellul et al.<sup>18</sup> equation was 9.6. The total results on the BI-10 scale predicted according to this equation were within 1 point of the actual BI point in 47.8% of cases, within 2 points in 72.9% of cases, and within 3 points in 91.6% of cases. The BI-3 was internally consistent ( $\alpha = 0.874$ ) and explained 93.3% of variance of the total BI score. Although these results are not identical to the results of Ellul et al.<sup>18</sup>, they are similar and lead to the same conclusions. This means that the sum of 3, BI-3 elements reflects the total BI results. The author

expressed the opinion that the BI-3 may be recommended on the basis of its internal coherence and significant correlation with the outcome measures, while its advantage is placing significantly lower burden on personnel<sup>20</sup>.

In 2009, Cho and Kim<sup>21</sup> reported the results of oral citicoline usage in 4,191 patients diagnosed with acute ischemic stroke. In order to evaluate its efficacy, the primary results for patients were obtained with the short-National Institute of Health Stroke Scale of the Institute of Health (s-NIHSS), the short form of the Barthel index (s-BI) and the modified Rankin scale (mRS). The short form of the BI consisted in assessment of eating, dressing and climbing the stairs. All measured parameters, including s-NIHSS, s-BI and mRS improved after 6 weeks of treatment ( $P < 0.05$ ). The s-BI results showed no differences between early and late groups at the end of therapy<sup>21</sup>.

In 2011, Lekamwasam et al.<sup>22</sup> presented conformity assessment between the basic 10-item BI version and the shorter 5-item one. The short version includes, similarly to Hsueh et al., bathing, using the toilet, transfer, mobility and climbing stairs. The study was conducted among 286 patients, age 45 to 78 (median 68), including 102 men with various disabilities. The majority of respondents were diabetic, heart failure or ischemic heart disease was present in 120 people, and 59 had suffered stroke. The 5-element BI-5 showed high internal consistency (Cronbach's global  $\alpha = 0.93$ ). The version with 10 positions also showed similar internal consistency (Cronbach's global  $\alpha = 0.92$ ), while its correlations between total items varied from 0.64 to 0.90 for all positions, except urinal and bladder functions. The total score for the 10- and 5-item versions showed high correlation ( $r = 0.9$ ,  $p < 0.001$ ). On the Bland-Altman chart, over 95% of the points were within the tolerance range ( $SD \pm 1.96$ ). The authors' conclusions: this analysis indicates high compliance of measurements between the standard version (B-10) and the version abridged to 5 items (BI-5) in ADL assessment<sup>22</sup>.

**Table 1**

Collected information on the short-versions of the Barthel scale presented in the seven articles discussed in the text							
First Authors	Cho <sup>21</sup>	Granger <sup>17</sup>	Ellul <sup>18</sup>	Hobart <sup>16</sup>	Hsueh <sup>19</sup>	Bohannon <sup>20</sup>	Lekamwasan <sup>22</sup>
Year	1989	1998	2001	2002	2004	2009	2011
Version	BI-4	BI-3	BI-5	BI-5	BI-3	BI-3	BI-5
Number of cases	539	169	844	118	251	4191	286
1. Feeding	X					X	
2. Bathing			X	X			X
3. Personal hygiene	X						
4. Dressing						X	
5. Bowel control	X						
6. Bladder control	X	X			X		
7. Using the toilet			X	X			X
8. Transfer out of and onto bed		X	X	X	X		X
9. Mobility		X	X	X	X		X
10. Stairs			X	X		X	X
Total items	4	3	5	5	3	3	5

In 2017, MacIsaac et al.<sup>23</sup> published the results of a systematic review and external validation regarding the use of the 3-item short version of the BI in stroke patients using VISTA (Virtual International Stroke Trials Archive) resources. Among 3,546 titles, 8 articles describing 6 different abridged BI versions (sf-BI) were found. After using the sharp data for testing (n = 8852), internal reliability suggested redundancy in the BI (Cronbach’s  $\alpha = 0.96$ ). The 3-element abbreviated version BI (sf-BI) containing the assessment of bathing ability, bladder function and transfer, showed a strong correlation with the BI-10, the modified Rankin scale and the NIHSS scale (all  $p \geq 0.83$ ,  $P < 0.001$ ). Using the data from rehabilitation trials (n = 332), sf-BI showed a small correlation with the quality of life indicators assessed using the Stroke Impact Scale (SIS) questionnaire and the EQ-5D scale ( $p \geq 0.50$ ,  $P < 0.001$ ). Pre-determined prognostic factors were related to sf-BI results (all  $P < 0.001$ ). Authors’ conclusions: there is redundancy in the original BI; the internal and external compliance of the 3-element sf-BI scale has been demonstrated, which should be easy to use<sup>23</sup>. The use of the BI-3 version, taking much less time, creates that this simplified ADL scale will be widely used.

### CONCLUSIONS

Creating shortened versions of the Barthel scale resulted from the necessity to reduce the time needed to complete the BI questionnaire. 6 abbreviated BI versions contain 3, 4 or 5 items. Most often, they assess the ability to use the toilet, to transfer from bed and onto the bed, mobility and the ability to climb stairs. The BI-4 version (especially the assessment of bladder control) presented by Granger et al.<sup>17</sup> is most useful for predicting the need to refer patients to a nursing home.

A systematic review of literature conducted by MacIsaac et al. shows that shortened BI versions demonstrate a strong correlation with the BI=10, the modified Rankin scale and the NIHSS stroke scale. The authors consider the BI-3 version as an optimal one, including bathing, bladder control and transfer ability.

The internal and external compatibility of this 3-element scale means that nothing prevents this time-saving, simplified ADL scale from being widely used. This may prove particularly useful in large, multicentre studies in which a range of different assessment methods are used.

**Conflict of interest: none**

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