Psychometric properties of the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI): Comparison of the different versions available in English

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ABSTRACT

Objective. *International ASAS consensus statement proposed the use of the BASDAI to evaluate active disease in ankylosing spondylitis patients before the use of anti-TNF agents. To analyze the psychometric properties of the different versions of the BASDAI.*

Methods. *All versions available in English were analyzed according to the methods developed by the American Psychological Association. Except for the initial version, the procedure of translation was accepted if a translation followed by a back translation was carried out. The psychometric properties analyzed were: face validity, content validity, construct validity (factorial analysis, convergent and divergent validity), reliability (test retest, Cronbach's coefficient α), and responsiveness.*

Results. *Except for the German version which was not available in English, the following versions were analyzed: English (En), French (Fr), Swedish (Sw), Spanish (Sp), and Turkish (Tu). The procedure translation was correct in all the versions without taking into account the initial En version. Face validity was validated in all versions. No version initially defined the dimensions for the content validity. Construct validity was partially studied and validated in En, Fr and Sp. Reliability was validated in En, Fr, Tu, and partially in other versions. In all versions, except for the Fr, responsiveness was demonstrated.*

Conclusion. *The English version of the BASDAI is the most validated tool. Some efforts had to be made to continue the validation procedure of all versions of the BASDAI. This is an important step for further international comparison.*

Introduction

The Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) was developed first in the English language to evaluate disease activity in ankylosing spondylitis (AS) patients (1). This tool was used as one important result to decide treatment by anti-TNF biotherapy in AS patients and to follow them (2). A recent critical analysis on AS measures was available in the literature (3), but the authors did not compare the different versions and did not clearly raise the psychometric properties of them. The comparison of the different versions was important for the relevance of international study using the BASDAI. Therefore, the objective of our study was to compare and analyze the psychometric properties of the different available versions of the BASDAI.

Methods

We selected papers on the validation of the BASDAI available in English. We described the typology of the first version and compared it to the others. We analyzed the different psychometric properties according to the methods developed by the American Psychological Association (4-5). Except for the first description of the BASDAI, we examined the procedure of translation and judged it as relevant if a translation and a back translation were carried out. For each version, the following psychometric properties were analyzed:

- *Face validity* – To evaluate the degree of acceptance of the questionnaire by AS patients;
- *Content validity* – To evaluate the previous definition of the dimensions of the questionnaire before the description of the items;
- *Construct validity* – Three aspects belonged to construct validity:
  - *Factorial analysis* – followed if necessary by a varimax rotation – to define using statistical methods the number of components available in the questionnaire and to validate the previous description of them;
  - *Convergent validity* – to compare the BASDAI score with those of relevant tools evaluating the activity of AS patients (at least one accepted if the coefficient correlation, r, was equal to or higher than 0.50);
  - *Divergent validity* – to show different results of the BASDAI score in different AS populations defined, for example, by different disease activity;

- *Reliability*
  - Test retest: To evaluate that the BASDAI gave a similar result during a period where the statute of the patient does not change. Three statistical methods were accepted: the intra-class correlation (ICC), the Pearson's correlation coefficient, and the Bland and Altman's method with $r \geq 0.50$.
  - Internal consistency – To show the internal relevance of the BASDAI. The method accepted for this evaluation was the Cronbach's coefficient α, considered as relevant if ≥ 0.70, and the correlation between each item and the BASDAI score or between each item.

- *Sensitivity to change or responsiveness* – To evaluate that the BASDAI score varied during a period where the statute of the patient changed. Different statistical methods were accepted: the standardized mean response, the effect size, and the comparison of the means with t paired test or Wilcoxon's test.

Results
Typology of the BASDAI
Garrett *et al*. (1) first described a self-report questionnaire, the English version of the BASDAI, as a tool to evaluate disease activity in AS patients. A multidisciplinary team defined 6 items (10 cm horizontal visual analog scales)

to measure severity of fatigue, spinal and peripheral joint pain, localized tenderness and morning stiffness (qualitative and quantitative evaluation with an interval of 15 minutes). For the morning stiffness, the mean score of the quantitative and qualitative evaluation was used. The resulting score for the overall index (from 0 to 50) was then converted to a final score range of 0 to 10.

The BASDAI has been further developed in English (6, 7), in French (8), in Swedish (9), in Spanish (10), German (11, 12) and Turkish (13). As the German version was not available in the English language, we excluded it from the analysis.

Table I. Psychometric properties of the English version of BASDAI (1, 6-7).

Patients	154 AS patients (of which 46 inpatients) (1), 2744 AS patients (6), 349 AS patients (7)
Face validity	Good
Content validity	No previous definition of the different dimensions
Construct validity	*Factorial analysis*: one single component (all-items loading above 0.65), no varimax rotation realised but not necessary after the factorial analysis (7)
	Convergent validity: not studied despite the use of the Bath Disease Activity Index (DAI) and the Newcastle Enthesis index only used for the responsiveness (1), use of a non-published tool (AS-quality of life questionnaire, Body Chart) and a tool without information about its psychometric properties (Revised Leeds Disability Questionnaire) (7)
	Divergent validity: higher score reflected greater disease activity (1), significant increase of the BASDAI in not working AS patients compared to employed patients (7)
Reliability	*Test retest*: Pearson's coefficient = 0.93 after comparison Day 0 vs Day 1 (1), ICC = 0.87 [0.83-0.91] (7)
	Internal consistency: Cronbach's coefficient α = 0.839 (6), 0.87 (7)
Sensitivity to change	Significant improvement after management of illness (Day 0 vs Day 18) in inpatients (1, p=0.009), relevant standardized response mean (7)
Conclusion	Content validity not studied at the initial development of the questionnaire To further examine the convergent validity

Table II. Psychometric properties of the French version of BASDAI (8).

Patients	293 AS consecutive patients who fulfilled the criteria of the European Spondylarthropathy Study group or Amor (23.5% psoriasis, 8.5% inflammatory bowel disease)
Translation	Translation and back translation
Face validity	Good
Content validity	No previous definition of the different dimensions
Construct validity	*Factorial analysis*: not performed *Convergent validity*: $r \geq 0.50$ only for evaluation of the disease by the doctor (not relevant for the evaluation of the disease by the patient, the number of nocturnal awakenings, Schöber's test, erythrocyte sedimentation rate, C-reactive protein) *Divergent validity*: not studied
Reliability	*Test retest*: Pearson's coefficient = 0.75 *Internal consistency*: Cronbach's coefficient α = 0.78 Correlation of each item with the BASDAI score (r from 0.62 to 0.77) and between each item (r 0.09 to 0.64)
Sensitivity to change	Not available because of the small number of patients
Conclusion	Content validity not studied at the initial development of the questionnaire To examine further divergent validity and the sensitivity to change.

Table III. Psychometric properties of the Swedish version of BASDAI (9).

Patients	65 AS consecutive patients of which 39 AS outpatients in a exercise program and 48 inpatients in rehabilitation program
Translation	Translation and back translation
Face validity	Good
Content validity	No previous definition of the different dimensions
Construct validity	*Factorial analysis*: not carried out *Convergent validity*: not studied *Divergent validity*: not studied
Reliability	*Test retest*: No adequate use of the statistical test *Internal consistency*: Cronbach's coefficient α = not realized Correlation of each item with the BASDAI score (r from 0.69 to 0.83) and between each item (r 0.35 to 0.60)
Sensitivity to change	Significant change only in inpatients after comparison of the initial score of the BASDAI with those obtained 2 or 3 weeks later ($p < 0.001$) No significant change in outpatients after comparison of the initial score with those obtained 2 or 3 months later
Conclusion	Content validity not studied at the initial development of the questionnaire To examine further the construct validity and reliability.

Table IV. Psychometric properties of the Spanish version of BASDAI (10).

Patients	28 AS patients for reliability (in physiotherapy program), 144 patients for validity (64 AS and 80 with undifferentiated spondylarthropathy)
Translation	Translation and back translation
Face validity	Good
Content validity	No previous definition of the different dimensions
Construct validity	*Factorial analysis*: not carried out *Convergent validity*: $r \geq 0.50$ only for spinal pain, duration of morning stiffness and general well being last week (not relevant for the use of total enthesis count) *Divergent validity*: not studied
Reliability	Test retest: ICC 0.74 [0.52-0.88] between Day 0 vs Day 1, no observation on the outside of the 95% confidence intervals (graphic by plotting the difference against the mean according to Bland and Altman) *Internal consistency*: Cronbach's coefficient α = not realized
Sensitivity to change	Relevant effect size in AS patients in a physiotherapy group (effect size = 1.6) compared to the controlled group (effect size = 0.07) after 28 days, standardized response mean = 1.5
Conclusion	Content validity not studied at the initial development of the questionnaire To examine further the factorial analysis, divergent validity and internal consistency.

The presentation of the BASDAI was similar in each version excepted for the Spanish version where the quantitative evaluation of morning stiffness was proposed with an interval of every half hour instead of 15 minutes.

Psychometric properties analysis
Tables I to V showed the relevant points about psychometrics properties of the BASDAI developed for use in English (Table I), French (Table II), Swedish (Table III), Spanish (Table IV), and Turkish (Table V). In each table, we described the psychometric properties which were not studied or not validated by the authors.

Discussion
The BASDAI was defined and proposed as a tool to evaluate the activity of the disease in AS patients, but its psychometric properties were in variable status of validity according to the versions, except for the German which was not available in English and not analyzed. The English version was the most validated and three papers were necessary to demonstrate the relevant psychometric properties of the BASDAI except for the convergent validity. We found in the literature other papers in which authors studied whether the BASDAI was an accurate expression of the component parts or whether ad-

ditional weighting would enhance its efficacy in evaluating disease activity in 473 AS patients from different countries (14) or evaluated the smallest detectable difference of symptomatic outcome or process variables of which BASDAI in 120 AS patients from different countries (Spain, Netherlands, France, Morocco) (15). But these data had to be interpreted with precaution because different versions of the BASDAI were used, pooled and analyzed. And, for example, we do not know if the French version of the BASDAI was appropriate to be used in Morocco, despite the fact that the French language is spoken in this country, this

Table V. Psychometric properties of the Turkish version of BASDAI (13).

Patients	71 AS patients according to the New York criteria in a rehabilitive department during 6 months
Translation	Translation and back translation
Face validity	Good
Content validity	No previous definition of the different dimensions
Construct validity	*Factorial analysis*: not carried out
	Convergent validity: r not relevant for the physician's assessment, results of the correlation between the BASDAI and the BASFI or the BASMI or the BAS-G was not "relevant" because these tools were validated in the same paper.
	Divergent validity: not studied
Reliability	*Test retest*: no significant difference
	Internal consistency: Cronbach's coefficient $\alpha = 0.80$
	Correlation of each items with the BASDAI score (r from 0.53 to 0.85) and between each item (r from 0.25 to 0.60)
Sensitivity to change	Significant improvement of the BASDAI score in the 16 patients in the program of home exercise
Conclusion	Content validity not studied at the initial development of the questionnaire
	To examine further the construct validity and internal consistency.

BASFI: Bath Ankylosing Spondylitis Functional Index.
BASMI: Bath Ankylosing Spondylitis Metrology Index.
BAS-G: Bath Ankylosing Spondylitis Patient Global Score.

tool was may be not adapted to the Moroccan population.

We described in our process of validation the typology of the patients who participated in the study. All versions focused their analysis strictly on AS patients except for the French and Spanish which introduced other spondylarthropathies and undifferentiated ones, respectively. The use of the BASDAI in other spondylarthropathies and undifferentiated ones had to be evaluated.

Except for the German version which needed to be analyzed, we outlined the importance of continuing the process of validation in adequacy with the status of validity of each version of the BASDAI. This process was important to compare and analyze the effect of drugs in clinical trials where BASDAI was used to assess disease activity in AS patients.

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