

# Systematic review of the quality of the cross-cultural adaptations of Disabilities of the Arm, Shoulder and Hand (DASH)

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**KEYWORDS:** Cultures; languages; DASH; reliability; systematic review; validity

## ABSTRACT

**Background:** *The Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure is a widely used patient reported outcome measure. Objective:* *The aim of this study is to evaluate the quality of translation procedures and assessment of the psychometric properties of cross-cultural adaptations of the DASH. Methods:* *We reviewed the literature to identify all published studies of cultural adaptations of the DASH questionnaire. For the quality assessment, we used Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures, Quality Criteria for Psychometric Properties of Health Status Questionnaire and COSMIN Checklist for Cross-Cultural Validity. Results:* *We included 25 articles with 26 versions of the DASH. Only the Puerto Rican version followed all six of the processes of cross-cultural adaptation. None of the versions assessed all eight measurement properties for Quality Criteria for Psychometric Properties of Health Status Questionnaire and none of them had a positive rating from agreement, internal consistency, responsiveness and interpretability. All the studies got a poor rating according to the COSMIN checklist. Discussion:* *None of the versions got a good rating from all three checklists. We observed that supplementary tests for the adaptations are necessary, especially for assessing agreement, responsiveness and interpretability. We concluded that all versions need more research on psychometric properties.*

## INTRODUCTION

Culture is defined as the characteristics and knowledge of a particular group of people, defined by features such as language, beliefs, religion, cuisine, laws, customs, social habits, music, arts and marriage capabilities. Culture forms a people's way of life. Use of hand in various activities is tailored with an individual's occupation and culture. Therefore, the assessment of independence in those activities should include understanding the person's values and beliefs, and be sensitive to the person's culture (1, 2).

Recently, hand therapists, hand surgeons, occupational physician and occupational epidemiologist have mostly been using patient-reported outcome measures (PROMs) for measuring activity limitations. Over the years, advanced countries have developed a large number of PROMs (3).

Within the context of other languages and/or cultures, in order to be able to use the previously developed PROMs—most of which are in English—there is need to translate and validate them. Nevertheless, a simple translation of the original version of the PROMs does not warrant similar measure-

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ment properties due to the differences in cultural contexts (4). As Beaton suggests, “For the measures to be used across cultures, the items must not only be translated well linguistically, but also be adapted culturally in order to maintain the content validity of the instrument across different cultures”(5).

The Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure is a widely used 30-items PROM designed to measure physical, psychological and social role function in patients with upper limb dysfunction. DASH was originally developed in English in 1996 by the Institute for Work and Health (IWH) (6, 7). Since then, clinicians and researchers have been using it in the field of hand therapy. The DASH has proved to be a reliable and valid questionnaire for various upper extremity disorders and been translated into many different languages (8).

Many guidelines have been published for the assessment of the quality of Cross-Cultural Adaptation Process such as the Consensus-based Standards for the selection of health status Measurement Instruments (COSMIN) checklist, the Patient Reported Outcomes, and the Scientific Advisory Committee of the Medical Outcome Trust checklist (10, 11). These guidelines describe the stages of the cross-cultural adaptation process. Clear guidelines are also available on the DASH website for the translation and cross-cultural adaptation of the questionnaire (8). According to the “Recommendations for the Cross-Cultural Adaptation of the DASH & QuickDASH Outcome Measures”, cultural adaptation stages are defined as: “Stage I: Initial Translation”, “Stage II: Synthesis of these Translations”, “Stage III: Back Translation”, “Stage IV: Expert Committee”, “Stage V: Test of the Pre-Final Version”, “Stage VI: Submission of Documentation to the IWH”. However, adaptation of one questionnaire for another culture may prove to be problematic because of issues such as linguistic problems, cultural backgrounds, different ways of thinking of cultures. Hence, the quality of the translated surveys depends on successfully following the stages mentioned in the guidelines (5, 8).

Although a lot of cross-cultural adaptations of DASH were published, details about the quality of their cross-cultural adaptation and measurement properties have been difficult to obtain. The aim of

this study is to evaluate the translation procedures and the measurement properties of cross-cultural adaptations of DASH questionnaire.

## METHODS

Our study is a systematic review of original articles that reported a cross cultural translation of DASH.

### *Review protocol*

The protocol was developed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards. Our systematic review was registered on PROSPERO (registration number CRD 42018105996).

### *Literature Search Strategy*

We performed a literature review on PubMed, the Cochrane Library, Medline and EMBASE, in February 2019 to identify all published studies of cultural adaptations of the DASH questionnaire. We did not use time period restrictions. The keywords used in the searches were “Disabilities of the arm shoulder and Hand Questionnaire” or “DASH” and “cross-cultural\*” or “cultur\*” or “valid\*” or “equivalence” or “transl\*.” Reference lists of the articles and reviews were also searched to identify additional relevant studies. We also e-mailed the people who were indicated as a provider of a translation of the questionnaire on the DASH web site and requested the original article (8). The inclusion criteria were:

- (1) studies related to the cultural adaptation of DASH in a specific language/culture;
- (2) studies reporting the process of cross-cultural adaptations;
- (3) studies reporting the testing of cross-cultural adaptations;
- (4) studies conducted with adults with upper extremity conditions;
- (5) studies written in English and Turkish;
- (6) studies with a full-text original article;
- (7) studies published in peer-reviewed journals.

The exclusion criteria were: comments, letters, editorial guidelines, conference reports, reviews, and studies on patients with neurological problems or studies on children.

### *Article selection*

The results of database searches were imported into End Note X7. Two independent reviewers (ICS and CO) separately assessed titles, abstracts and full-text articles for eligibility. Discrepancies were discussed to reach consensus.

### *Assessment of the quality of the studies*

First descriptive variables of the studies like authors, year, study sample, gender and mean age (SD or range) were collected. Then, the methodological quality of included studies was evaluated by 2 independent reviewers (ICS and CO), according to three checklists: 1. The Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures; 2. The Quality Criteria for Psychometric Properties of Health Status Questionnaire; and 3. The COSMIN Checklist for Cross-Cultural Validity. Agreement about the quality assessment was assessed using the quadratic weighted  $\kappa$  statistic ( $K_w$ ). The results were adopted if the  $K_w$  was more than 0.75. Disagreements were resolved by consensus with authors.

Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures tool contains six items related to initial translation, synthesis of the translations, back translation, use of an expert committee, testing the prefinal version, and appraisal of the adaptation process (5). Quality Criteria for Psychometric Properties of Health Status Questionnaire tool contains Content validity, Criterion validity, Construct validity, Agreement, Reliability, Responsiveness, Floor or ceiling effects, Interpretability. Criterion validity was defined as “the degree to which the scores of a HR-PRO instrument are an adequate reflection of a “gold standard” (9). The criterion used should be considered as a reasonable “gold standard”. A Delphi Panel reached a consensus that no gold standard exists for HR-PRO instruments. So, we decided to exclude this item from the quality ratings.

Afterwards, the methodological quality of included studies was evaluated according to the COSMIN Cross Cultural Validity 4-point checklist. To determine the overall quality of a study, we used “worst score counts” principle, which means the lowest rating of any standard in the box is taken. The tool consists of nine items including missing

items, sample size, translation process, factor analysis and differential item function (10, 11).

In our study, we used three guidelines as each of them emphasize different points. The Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures focus on a particular adaptation process. On the other hand, the Quality Criteria for Psychometric Properties of Health Status Questionnaires focus on the assessment of the psychometric properties, while the COSMIN checklist focuses on both the adaptation process and the psychometric properties.

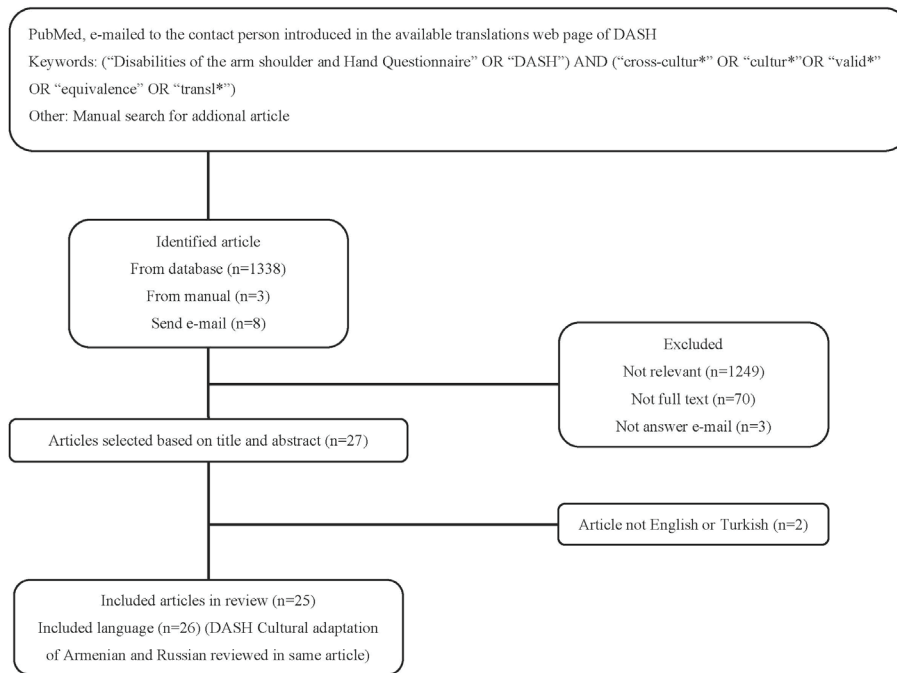
## RESULTS

The search strategy identified 1338 articles from databases, three articles were found by manual search, and five articles were received by e-mail. We removed 1249 articles as they were not relevant to our research question. We also excluded 70 articles as we could not obtain the full text. Based on the titles and abstracts, we selected 27 articles, and excluded the two versions that were in Norwegian and French. Finally, we included in this study, the 25 articles studying the cross-cultural adaptation of DASH. Our second search in 2019 did not produce new/additional articles (Figure 1).

In one of the 25 select articles, the Russian and Armenian (12) versions of DASH were published in the same article. Hence, we studied 25 articles in 26 languages, the characteristics of which are presented in Table 1. The 26 languages included Arabic (13), Armenian (12), Brazilian Portuguese (14), British English (15), Canadian French (16), Chinese (Mainland) (17), Chinese Hong Kong (18), German (19), Greek (20), Hindi (21), Hungarian (22), Italian (23), Japanese (24), Korean (25), Persian (26), Polish (27), Puerto Rican (36), Portuguese (28), Russian (12), Spanish (29), Sinhala (30), Slovene (31), Swedish (32), Taiwan (33), Thai (34) and Turkish (35).

### *Quality Assessment of the Cross-Cultural Adaptation of DASH*

The quality assessment of the adaptation process was evaluated by independent reviewers (ICS and CO) and achieved a  $\kappa$  value of 0.947.



**Figure 1.** Flow Chart

Only the Puerto Rican (36) version followed all six of the processes of cross-cultural adaptation, whereas the Portuguese version followed none. German (19) and Italian (23) versions only followed appraisal of the adaptation process. This process was performed in all the studies except for the Portuguese version. Expert committee review, back translation, and pretesting were conducted in only some of the studies (Table 2).

The British English (15), Greek (20), Hungarian (22), Persian (26), Polish (27), Puerto Rican (36) and Sinhala (30) versions reported suitable forward translation where the rest of the versions (Arabic (13), Armenian (12), Brazilian Portuguese (14), Canadian French (16), Chinese (Mainland) (17), Chinese Hong Kong (18), German (19), Italian (23), Hindi (21), Japanese (24), Korean (25), Portuguese (28), Russian (12), Spanish (29), Slovene (31), Swedish (32), Taiwan (33), Thai (34), Turkish (35)) did not report if the translators were independent or informed/uninformed.

German (19) and Italian (23) versions did not report the synthesis of the translations. There was only one back translator for the Italian (23), Russian

(12) and Thai (34) versions. Armenian (12), Brazilian Portuguese (14), German (19), Hindi (21), Persian (26) and Sinhala (30) versions did not report if the target language was the translator's mother tongue. On the other hand, British English version (15) reported that there is no need for back translation. Although Portuguese (28) version reported back translation, there was not any information about how the back translation was performed.

Arabic (13), British English (15), Greek (20), Hindi (21), Puerto Rican (36), Sinhala (30) and Slovene (31) versions met the standard for having an expert committee. German (19), Italian (23) and Thai (34) versions did not provide any information about the expert committee. Arabic (13), Armenian (12), British English (15), Canadian French (16), Korean (25), Persian (26), Polish (27), Puerto Rican (36), Russian (12), Spanish (29) and Turkish (35) versions reported that 30-40 patient completed the pre-final version.

#### *Methodology Used in the Measurement Properties*

The Kw of the two independent reviewers (ICS and CO) was 0.937. Table 3 shows the quality as-

**Table 1. Characteristic of the Studies**

Reference, Language	Author	Year	No.	Age, yMean ±SD (range)	Gender	Region/Disorder
13, Arabic	Alotaibi	2010	40	36.9±13.3 (21-70)	20 F 20 M	Upper extremity disorder
12, Armenian	Yaghjyan et al.	2005	40	36±13.89 (14-67)	8 F 32 M	Neurorrhaphy on forearm
14, Brazilian Portuguese	Orfale et al.	2005	25	48.25 (18-60)	22 F 3 M	Rheumatoid arthritis
15, British English	Hammond et al.	2018	340	61.96±12.09	251F 89M	Rheumatoid arthritis
16, Canadian French	Durand et al.	2004	40	43.1±12.4	20 F 20 M	Different upper extremity disorder
17, Chinese (Mainland)	Chen et al.	2015	300	46.7±29.4 (18-76)	157 F 143 M	Upper extremity problems
18, Chinese Hong Kong	Lee et al.	2004	88	42.5±11.7	51 F 37 M	Upper extremity disorder
19, German	Offenbacher et al.	2002	49	58.7±8.3 (40-84)	36 F 13 M	Shoulder pain
20, Greek	Themistocleous et al.	2006	106	48 (20-68)	51 F 55 M	Unilateral upper limb disorder
21, Hindi	Mehra et al.	2015	30	53.3±6.9	16 F 14 M	Shoulder tendonitis
22, Hungarian	Varju et al.	2008	128 87* 41*	*57.3±10.3 *52.6±13.7	116 F 12 M	Systemic sclerosis
23, Italian	Padua et al.	2003	108	54 (20-72)	49 F 59 M	Upper extremity pathologies
24, Japanese	Imaeda et al.	2005	72	54.1±14.9 (20-81)	55 F 17 M	Upper extremity disorders
25, Korean	Lee et al.	2008	161	51.8±12.2 (19-84)	117 F 44 M	Upper limb dysfunctions
26, Persian	Mousavi et al.	2007	271	44.9±17.9 (18-76)	88 F 133 M	Upper limb disorder
27, Polish	Golicki et al.	2014	30	41.1±18.1 (13-79)	10 F 20 M	Illness or injury of the upper extremity
28, Portuguese	Santos et al.	2006	54	-	-	Upper limb disorder
29, Puertorican	Mulero-Portela et al.	2009	44	52.59 (34-84)	44 F	Breast cancer survivors
12, Russian	Yaghjyan et al.	2005	30	37±12.15 (16-68)	15 F 15 M	Upper limb disorder
29, Spanish	Rosales et al.	2001	50	54 (34-63)	36 F 14 M	Carpal Tunnel Syndrome
30, Sinhala	Amara et al.	2017	40	43.87±17.37 (12-75)	20 F 20 M	Upper limb condition
31, Slovene	Semprimoznik	2014	48	-	-	Hand problems
32, Swedish	Atroshi et al.	2000	176	52 (18-85)	100 F 76 M	Upper extremity disorders
33, Taiwan	Liang et al.	2004	82	46.6±14.7 (18-78)	46 F 36 M	Upper extremity disorders
34, Thai	Jianmongkol et al.	2011	34	28.62 (16-50)	1 F 33 M	Brachial plexus injuries
35, Turkish	Düger et al.	2006	134	38.5±3.02 (18-77)	70 F 64 M	Upper extremity injuries

\* IcSSc patient

**Table 2.** Quality Assessment of the Cross-Cultural Adaptation of DASH

Reference, Language	Initial Translation	Synthesis of The Translations	Back Translation	Expert Committee	Test Pre-final Version	Appraisal of the Adaptation Process
13, Arabic	?	+	+	+	+	+
12, Armenian	?	?	?	-	+	+
14, Brazilian Portuguese	?	+	?	?	-	+
15, British English	+	+	?	+	+	+
16, Canadian French	?	+	+	-	+	+
17, Chinese (Mainland)	?	+	+	-	0	+
18, Chinese Hong Kong	?	+	+	-	-	+
19, German	?	-	?	0	0	+
20, Greek	+	+	+	+	0	+
21, Hindi	?	+	?	+	-	+
22, Hungarian	+	+	+	-	-	+
23, Italian	?	-	-	0	0	+
24, Japanese	?	+	+	-	?	+
25, Korean	?	+	+	-	+	+
26, Persian	+	+	?	-	+	+
27, Polish	+	+	+	-	+	+
28, Portuguese	?	?	?	?	?	?
29, Puertorican	+	+	+	+	+	+
12, Russian	?	?	-	-	+	+
29, Spanish	?	+	+	?	+	+
30, Sinhala	+	+	?	+	?	+
31, Slovene	?	+	+	+	0	+
32, Swedish	?	+	+	-	-	+
33, Taiwan	?	+	+	?	0	+
34, Thai	?	+	-	0	0	+
35, Turkish	?	+	+	-	+	+

+ = Positive rating; - = negative rating; 0 = no information available; ? = unclear

assessment of the studies. None of them assessed all eight measurement properties and none of them had a positive rating from agreement, internal consistency, responsiveness and interpretability.

For content validity, 22 versions provide a clear description of the measurement aim and target population. However, the British English (15), Brazilian Portuguese (14), Hungarian (22) and Puerto Rican (36) versions reported to involve no target patients with diagnoses.

It is suggested that internal consistency should be tested by Cronbach's alpha and factor analysis (Supplement S2). With regard to internal consistency, 17 versions' methodological quality was found

to be poor because factor analysis was not conducted. Moreover, five studies (Greek (20), Hungarian (22), Japanese (24), Persian (26) and Taiwan (33)) got negative ratings because they reported to have Cronbach alpha > 0.96. Brazilian Portuguese (14), Polish (27), Slovene (31) and Turkish (35) versions did not report any information about internal consistency.

In order to indicate a good construct validity, specific hypotheses should be formulated and at least 75% of the results should be in accordance with these hypotheses (Supplement S2). In nine versions (British English (15), German (19), Hindi (21), Hungarian (22), Italian (23), Japanese (24), Persian

**Table 3.** Quality criteria for measurement properties of health status questionnaires

Reference, Language	Cont. Val.	IC	Constr. Val.	Agree	Rel	Resp	Floor & ceiling	Int
13, Arabic	+	?	?	0	+	0	+	0
12, Armenian	+	?	-	0	+	0	0	0
14, Brazilian Portuguese	-	0	?	0	+	0	0	0
15, British English	-	?	+	?	+	0	+	0
16, Canadian French	+	?	0	0	0	0	+	0
17, Chinese (Mainland)	+	?	?	0	+	0	+	0
18, Chinese Hong Kong	+	?	0	0	+	0	+	0
19, German	+	?	+	0	?	0	0	0
20, Greek	+	-	?	?	-	?	0	0
21, Hindi	+	?	+	0	+	?	+	0
22, Hungarian	-	-	+	0	+	-	+	0
23, Italian	+	?	+	0	+	0	+	?
24, Japanese	+	-	+	0	+	?	+	?
25, Korean	+	?	?	0	+	0	0	?
26, Persian	+	-	+	0	+	0	+	?
27, Polish	+	0	0	0	0	0	-	0
28, Portuguese	+	?	?	0	+	0	+	0
29, Puertorican	-	?	?	0	?	0	0	0
12, Russian	+	?	-	0	+	0	0	0
29, Spanish	+	0	0	0	0	0	0	0
30, Sinhala	+	?	0	0	+	0	0	0
31, Slovene	+	?	-	0	?	0	+	0
32, Swedish	+	?	+	0	+	0	+	?
33, Taiwan	+	-	0	0	+	0	+	?
34, Thai	+	?	?	0	-	0	+	?
35, Turkish	+	0	+	0	+	0	0	0

Cont. Val. = Content validity; IC = Internal consistency; Constr. Val. = Construct validity; Agree = Agreement; Rel. = Reliability; Resp. = Responsiveness; Floor & ceiling = Floor and ceiling; Int. = Interpretability  
 +=Positive rating; ?=doubtful design or method; -=negative rating; 0=no information available.

(26), Swedish (32) and Turkish (35)) specific hypotheses were formulated. In these studies, Pearson or Spearman rank correlation coefficient was used to assess the correlation between DASH and rheumatoid arthritis quality of life scale, symptom 10-point numeric rating scales, measure of activity performance of the hand, the health assessment questionnaire, VAS scales and shoulder AROM, Health Assessment Questionnaire Disability Index, SF-36, Carpal Tunnel Questionnaire and SF-12. Armenian and Russian (12) versions hypothesized that the DASH scores would have moderate levels of inverse

correlation with SF-36 scores. However, they could not report any correlation between DASH and general health, vitality and social functioning subscales of SF-36. So, we concluded that less than 75% of the hypotheses were confirmed.

Only the British English (15) version reported the standard error of measurement (SEM) and minimal detectable change. Other studies did not provide a clear description about agreement. The limit of agreement was calculated in the Greek (20) version but the minimal important change was not defined. Greek (20), Hindi (21) and Japanese (24)

versions defined effect size and standardized response means. The Hungarian version reported response rate as 0.28 (22).

Eighteen versions met the criterion of reliability on the basis of an intraclass correlation coefficient or Kappa of 0.70 or greater. However, for Thai (34) and Greek (20) versions intraclass correlation coefficient or Kappa was 0.52. No information was found for reliability in Canadian French (16), Polish (27) and Slovene (31) versions.

Fifteen versions reported to have  $\leq 15\%$  of the respondents achieved the highest or lowest possible scores. Only Polish (27) version reported that  $> 15\%$  of the respondents achieved the highest or lowest possible scores, despite adequate design and methods. Armenian (12), Brazilian Portuguese (14), German (19), Greek (20), Korean (25), Puerto Rican (36), Russian (12), Slovene (31), Spanish (29) and Turkish (35) versions did not mention floor and ceiling effects.

Interpretability is defined as the degree to which one can assign qualitative meaning to quantitative scores. For this, the mean and SD scores should be presented as at least four relevant subgroups of patients, and the minimal important change (MIC) should be defined (Supplement S2). Although Italian (23), Japanese (24), Korean (25), Persian (26), Swedish (32), Taiwan (33) and Thai (34) versions reported mean and standard deviation for less than four subgroups, they did not calculate minimal important change. No information was found on the interpretation of 19 versions.

#### *COSMIN Cross Cultural Validity*

The Kw value of the two reviewers was 0.91. All of the studies got a poor rating according to the "worst score counts" method. The best rated item was item 4 (Table 4). In all of the studies, both source language and target language were described.

Missing item is a very important factor for DASH questionnaire because a DASH score may not be calculated if there are more than three missing items (8, 37). Ten studies described the percentage of the missing items and how they were handled.

According to COSMIN checklist (Supplement S3), sample size should be calculated as  $7 \times \text{item}$  and should be  $\geq 100$  (10,11). DASH is a 30-item ques-

tionnaire, so at least 210 patients should be included in the study according to COSMIN. Only British English (n= 340) (15), Chinese (Mainland) (n= 300) (17) and Persian (n= 271) (26) got excellent rating. Most of the versions got a poor rating because of the inadequate sample size.

Ten versions were complied with item 5 of the COSMIN. Most versions reported that the translators worked independently from each other. All the versions reported multiple forward and backward translations except for Italian (23) and Thai (34) versions.

For item 8, except for the Portuguese version (28), which is rated as good, all of the studies were rated as excellent. The Portuguese version (28) was rated as good, because how the differences between the translators were resolved either was not described or poorly described. Translation should be reviewed by a committee involving other people than the translators, such as the original developers. Only German (19), Italian (23) and Thai (34) versions stated that the translation was not reviewed by such a committee.

Arabic (13), Armenian (12), Canadian French (16), Chinese Hong Kong (18), Hindi (21), Hungarian (22), Korean (25), Persian (26), Polish (27), Russian (12), Spanish (29), Sinhala (30), Swedish (32) and Turkish (35) versions reported pretesting on the target population.

Excluding the Brazilian Portuguese (14), British English (15), Hungarian (22) and Puerto Rican (36) versions, the rest showed that samples were similar for all characteristics except for language/culture. In the former versions, the sample population comprised of breast cancer survivors, rheumatoid arthritis or systemic sclerosis patients.

For item 13, all of the studies had poor or fair rating. We rated the version as poor if there was an important methodological flaw in the design or execution of the study, or if there was an important problem that would affect the cross-cultural adaptation process such as not having a pretest or multiple translations. We rated the version as fair, if there was a minor methodological flaw in the design or execution of the study such as inadequate sample size or no factor analysis.

Only the Greek (20), Hungarian (22), Japanese (24), Persian (26) and Taiwan (33) versions per-



**Table 4. The Consensus Based Standards for the Selection of Health Status Measurement Instruments (COSMIN) Checklist for Cross Cultural Validity: E=excellent; G=good; F=fair; P=poor**

Reference, Language	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Result
13, Arabic	E	E	P	E	E	E	E	E	E	E	F	E	F	P	P
12, Armenian	G	F	P	E	G	G	E	E	E	E	E	E	P	P	P
14, Brazilian Portuguese	G	F	P	E	F	E	E	E	E	F	E	P	P	P	P
15, British English	E	E	E	E	E	E	E	E	E	F	E	P	P	P	P
16, Canadian French	E	G	P	E	E	G	E	E	E	E	E	E	F	P	P
17, Chinese (Mainland)	E	G	E	E	G	G	E	E	E	P	F	E	P	P	P
18, Chinese Hong Kong	G	F	P	E	G	G	E	E	E	E	F	E	F	P	P
19, German	E	E	P	E	E	F	E	E	G	P	F	F	P	P	P
20, Greek	E	E	P	E	G	E	E	E	E	P	F	E	P	E	P
21, Hindi	G	F	P	E	G	G	E	E	E	E	F	E	F	P	P
22, Hungarian	E	E	P	E	F	E	E	E	E	E	E	P	P	E	P
23, Italian	E	G	P	E	F	E	G	E	G	P	F	E	F	P	P
24, Japanese	E	E	P	E	F	E	E	E	E	F	F	E	F	E	P
25, Korean	G	F	G	E	F	F	E	E	E	E	F	E	P	P	P
26, Persian	G	F	E	E	G	E	E	E	E	E	F	E	F	E	F
27, Polish	E	E	P	E	F	G	E	E	E	E	E	E	F	P	P
28, Portuguese	G	F	P	E	F	F	E	G	E	G	F	E	P	P	P
29, Puertorican	G	F	P	E	E	G	E	E	E	F	F	P	F	P	P
12, Russian	G	F	P	E	G	G	E	E	E	E	E	E	P	P	P
29, Spanish	G	F	P	E	E	G	E	E	E	P	F	E	F	P	P
30, Sinhala	G	F	P	E	G	E	E	E	E	E	F	E	F	P	P
31, Slovene	E	F	P	E	E	E	E	E	E	E	F	E	F	P	P
32, Swedish	E	E	G	E	E	F	E	E	E	E	E	E	F	P	P
33, Taiwan	E	E	P	E	E	G	E	E	E	P	F	E	P	E	P
34, Thai	E	E	P	E	E	F	G	E	G	P	F	E	P	P	P
35, Turkish	E	F	G	E	G	G	E	E	E	E	E	E	F	P	P

formed multiple-group confirmatory factor analysis for item 14.

## DISCUSSION

This study has assessed the translation procedures and the measurement properties of 26 cultural adaptations of DASH questionnaire. None of them obtained a good rating from all three checklists. Only Puerto Rican (36) version had positive ratings from all subparameters of the Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures. Responsiveness, agreement and interpretability

are the problematic areas for all versions according to Quality Criteria for Measurement Properties of Health Status Questionnaires. According to COSMIN checklist, all the versions' quality was rated as poor. Our results demonstrated that there was a lack of measurement testing in the majority of translated versions. Based on our findings, we recommend that all versions need further research for measurement properties.

Before translating a questionnaire, obtaining from the original developer the permission to use an instrument is important not only due the copyright issues, but also for transferring the experience

and knowledge of the tool (37, 38). Appraisal is a submission of final version to the developers to keep track of the translated version (Supplement S1). All the versions, except for the Portuguese one, which by the way was found to be the weakest version according to the Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures, got a positive rating from the Appraisal of the Adaptation Process. This indicates a good communication between the IWH and the translators, and also makes it easy to keep the track of the versions. There are 54 approved languages and dialects available on the DASH website (8). Nevertheless, the cultural adaptation process of most languages either were not published as a full text article or were published in their native language. The first cultural adaptation version for DASH was published in 2000 and was the Swedish version. This was followed by the Spanish (29), German (19), Italian (23) and Chinese Hong Kong (18) versions. Since the Russian and Armenian versions of DASH (12) were published in the same article, we were able to include only 25 articles with 26 languages in our study. Therefore, not being able to include all translated versions of DASH has been a limitation of our study.

Except for the Chinese (Mainland) (17), Chinese Hong Kong (18), Persian (26) and Thai (34) version, all the other versions stated that they followed the Beaton guidelines for the cross-cultural adaptation of health-related quality of life measures (39). In the 4 articles that created the exception, reference was made to Beaton studies, therefore we assumed that Beaton guidelines were followed. In 2007, the IWH published Recommendations for the Cross-Cultural Adaptation of the DASH and QuickDASH Outcome Measures parallel to the Beaton guidelines in order to improve the quality of the translation process (37). It was observed that the majority of the poorest quality criteria for measurement properties were found before the publication of the first version of the guidelines for cross-cultural adaptation. This provides evidence of the importance of guidelines for quality improvement of the cultural adaptations.

These two guidelines consist of Initial Translation, Synthesis of these Translations, Back Translation, Expert Committee, Test of the Pre-Final

Version stages and Submission of Documentation to the Developers or Coordinating Committee for Appraisal of the Adaptation Process. All these stages are described in detail. With the help of these guidelines, for most of the versions, the items were translated forward and backward, how differences between the original and translated versions resolved were adequately described, and all the translations were reviewed by a committee. Although clear definitions were provided in the guidelines about having informed/uninformed and independent translators and about the composition of the committee, most of the versions had an unclear rating from these stages. It is noteworthy that despite the clarity of this process, most of the versions in our review had a poor rating from the methodological quality of the cross-cultural adaptations of self report measures. This may suggest that the process was poorly understood, performed and/or reported. A clear checklist for the stages could prove to be helpful for the translators.

According to these three checklists, there are two issues that require attention. One is the inadequacy of the sample size. According to COSMIN checklist, the adequate sample size for classical test theory is calculated as the the number of items multiplied by 7, which in our case, should have been at least 210 patients (10, 40). Only three versions had populations larger than 210. The second issue is the insufficient assessment of the measurement properties of the adaptations, which have to be verified through further testing (37). According to the results of our review, the majority of the adaptations did not assess all the measurement properties. Although the translation procedure was described in detail in the Beaton process, no information was given in that guideline on how to assess the psychometric properties of cultural adaptations. Therefore, especially for the old versions of DASH, internal consistency, agreement, responsiveness, interpretability, differential item function and factor analysis were not assessed. Responsiveness presents the ability of an instrument to detect true change in a patient's status (9). No version was tested for responsiveness, interpretability and agreement. The tests for agreement, responsiveness and interpretability need to report minimal important change or the smallest

detectable change measurements for clinical decision-making, power calculations, sample size estimates, and cost evaluations in clinical research (41). Floor and ceiling effect assesses if the instrument can fail to detect deterioration or improvement in certain patients (9). Fifteen versions report the floor and ceiling effect. Test re-test reliability was the only measurement property assessed for most of the versions. This clearly indicates a clear picture of need to evaluate the measurement properties of all versions of the DASH questionnaire. On the other hand, there is an obvious need for a guideline to assess the measurement properties of the questionnaires.

#### *Strengths and limitations of this study*

We evaluated the quality of translation procedures and assessment of the measurement properties of cross-cultural adaptations of DASH.

All studies were evaluated according to the current guidelines for crosscultural adaptation process, measurement properties and methodological quality.

A limitation of our study is that we were not able to include all translations of the questionnaire as we only included articles published in peer review journals.

We recommend that the current adapted versions of DASH undergo further testing especially for assessing agreement, responsiveness and interpretability before use.

## CONCLUSION

Although there are well-established guidelines for cross cultural translation, adaptation and validation of patient reported outcome measures, a great variation in the use of these approaches continues to prevail in the health care literature. We think that following those guidelines will maximize the quality of the cultural adaptation process. We should keep in mind that a poor translation process and/or lack of cross-cultural validation may affect the validity of the questionnaire.

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