

The Disabilities of the Arm, Shoulder, and Hand Scale in the evaluation of disability - A literature review

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PAROLE CHIAVE: Analisi fattoriale; DASH; validità; affidabilità; analisi di correlazione

SUMMARY

Background: *Work-related musculoskeletal disorders (WRMDs) interfere with workers' productivity and quality of life. Thus, early detection of disabilities caused by WRMDs is vital for preventing the aggravation of symptoms. Early detection aids and is aided by educational and preventive programs. WRMDs can be detected using the Disabilities of the Arm, Shoulder and Hand (DASH) Scale. Objectives:* *The present study aimed to review the literature on the application of the DASH Scale through a consideration of the cultural adaptation process and an evaluation of the scale's psychometric properties. Methods:* *The literature review was conducted using the terms "disabilities", "musculoskeletal disorders", "DASH" "questionnaire" and "upper limbs". Results:* *Forty-eight articles were collected, and these included only articles available in English which contained the full version of the DASH Scale and which focused on the evaluation of its psychometric properties (n=25). Conclusion:* *Most of the studies partially evaluated the psychometric properties of the DASH instrument; however, these properties were typically evaluated using only a correlation analysis involving other instruments.*

RIASSUNTO

«*La scala delle Disabilità di Braccio, Spalla e Mano per la valutazione della disabilità - Revisione della letteratura*». **Introduzione:** *I disturbi muscoloscheletrici legati al lavoro (WRMDs) interferiscono con la produttività e la qualità della vita tra i lavoratori. Così, il rilevamento tempestivo di disabilità causata dai WRMD è di vitale importanza per evitare l'aggravamento dei sintomi e per attuare programmi educativi e di prevenzione. Questo rilevamento può essere effettuato utilizzando la scala delle Disabilità di Braccio, Spalla e Mano (DASH). Obiettivi:* *Questo studio ha lo scopo di rivedere la letteratura per quanto riguarda l'applicazione della DASH, considerando il processo di adattamento culturale e valutazione delle proprietà psicometriche. Metodi:* *La revisione della letteratura è stata condotta utilizzando i termini "disabilities", "musculoskeletal disorders", "DASH", "questionnaire" e "upper limbs". Risultati:* *Sono stati raccolti quarantotto articoli e sono stati inclusi solo gli articoli disponibili in inglese, contenenti la versione completa della scala DASH, che si concentrava sulla valutazione delle proprietà psicometriche (n=25). Conclusione:* *La maggior parte degli studi hanno condotto una valutazione delle proprietà psicometriche dello strumento DASH, tuttavia, la valutazione di queste proprietà è stata effettuata mediante la sola analisi di correlazione con altri strumenti*

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INTRODUCTION

Work-related musculoskeletal disorders (WRMD) interfere with workers' productivity and quality of life (13, 28, 37). Those disorders mainly affect the upper limbs and involve a wide range of inflammatory and/or degenerative diseases that result in pain, functional impairment, and disability of various bodily structures (7, 26, 45).

Many professionals in a variety of occupations are affected by musculoskeletal disorders (10, 17, 28, 42), which often lead to upper limb disabilities. Thus, early detection of disabilities caused by WRMDs is vital for preventing the aggravation of symptoms. Early detection aids and is aided by educational and preventive programs. There are essentially two types of methods for evaluating the severity of disability among individuals: objective and subjective methods (6).

Objective methods are the most commonly used, as they evaluate both strength and range of joint movements. However, though they evaluate the degree of disability in large populations, these methods are sometimes unfeasible, since they require more time and more investigators (6). In contrast, subjective methods permit the study of a larger population with the same resources, since they are based on patient self-reporting obtained through the use of questionnaires that evaluate the ability to perform daily activities (20, 31).

Out of the instruments used for subjective measurements, the Disabilities of the Arm, Shoulder, and Hand (DASH) Scale is designed to be a complete instrument, since it assesses the upper limbs as one and is not limited to a single body segment (3, 4, 6, 16, 21, 22, 41).

The DASH Scale was originally developed in English in 1994 by the American Academy of Orthopedic Surgeons (AAOS) and the Institute for Work and Health (Toronto, Ontario, Canada). Initially, the instrument was created to assess functional capacity in individuals with musculoskeletal problems in the arms, shoulders, and hands (21). It has since been used to evaluate the degree of disability in the upper limbs, which allows for the early detection of disorders. Thus, this scale seems to provide particularly useful contributions to occu-

pational health in the field of dentistry. Because the DASH scale is a subjective instrument that involves psychological constructs, the data collected should have their metric properties tested for each population studied (27, 32).

The DASH questionnaire has been the subject of numerous studies that have been dedicated to proving its validity (3, 12, 14, 15, 18, 19, 28-30, 33-36, 38, 39, 41, 43, 44, 46, 47). There are two strategies that can be adopted to construct validity, and these are referred to as the "weak program" and the "strong program" (11). The weak program consists of using correlation analysis between instruments (24). In contrast, the strong program consists of three steps: assessment of the factor validity (exploratory or confirmatory), convergent validity, and discriminant validity (24).

Given the importance of analyzing the validation process to obtain valid and reliable data, the present study sought to review the literature on the application of the DASH Scale by considering the process of cultural adaptation and the strategies used to evaluate the psychometric properties.

METHODS

The literature used in the review was gathered from the following directories: Science Direct, the Scientific Electronic Library Online (SCIELO the Latin American and Caribbean Health Sciences (LILACS) database, and MEDLINE (the National Library of Medicine, USA). The articles were dated from 1996 to 2014.

Initially, only medical subject headings such as "disability evaluation" and "musculoskeletal abnormalities" were used to find the articles. However, these terms didn't produce enough articles related to the DASH Scale. Thus, further terms that were not indexed, such as "DASH", "questionnaire", and "upper limbs", were used. The terms were combined and used in isolation.

Forty-eight articles were collected based on title (the first step). In the second step, each abstract was read to determine whether the information in the article included an evaluation of the psychometric properties. When it did, the third step was to select only complete articles available in English and containing the complete version of the DASH Scale.

The articles were classified according to statistical method, as reported by Cronbach (11).

RESULTS

After this stage of the review process, 25 articles were obtained, the details of which are presented in table 1.

It was found that the DASH Scale has been widely studied (4, 12, 14-16, 19, 22, 28-30, 34-36, 41, 43) since its publication in 1996 (21). It is worth mentioning that, to use this scale in non-English-speaking countries, researchers must consider and apply a cultural adaptation process. Most studies (4, 14-16, 21, 22, 28-30, 34-36, 41, 43, 44) applied the DASH Scale to individuals diagnosed with musculoskeletal disorders, and the researchers often conducted an evaluation of its psychometric properties for the population studied (3, 12, 14-16, 18, 19, 28-30, 33-36, 38-41, 43, 46, 47). However, only a few studies followed the strong program using factor analysis (14, 30, 33, 43, 46, 47).

There were no studies found which used the DASH Scale in the field of dentistry.

DISCUSSION

The use of the DASH scale is common, and it can be applied to aid in the early diagnosis of disability among professionals and students. However, to ensure the reliability and validity of the data, the scale must go through a validation process which considers the target population. For this, knowledge of the factorial structure of the DASH Scale is crucial.

The development of the DASH Scale was based on three theoretical aspects (physical function, symptoms, and social function) and resulted in the current instrument's unifactorial structure (25).

Since the DASH Scale was developed, it has been used in several countries, and cross-cultural adaptations have been performed when it was used for the first time in another language (12, 19, 28-30, 34-36, 39, 43, 46). This process is important, since a poor translation may compromise the construct representativeness being assessed (5). An instrument under construction can be affected by cultural differences that mold its idiomatic and semantic

characteristics, elements which affect the way it is applied and understood (9). Therefore, the process of cultural adaptation is a strategy that can be used to adjust the content to the culture and the language so that it will be more relevant to the population being studied (1).

After a proper cross-cultural version is obtained, the psychometric properties of the instrument should be properly evaluated. Despite the importance of this process, most of the studies found herein performed incomplete evaluations of these properties. According to Cardoso (9), psychological instruments can have valid and reliable results only if they go through a process of validity and reliability.

For these reasons, any instrument that is intended to be adapted to another population must go through a validation process (2,8). It is important to emphasize that validity is not a property of the instrument, but is instead related to the sample. Therefore, a validation process should be performed every time a tool is applied to a different sample, and this validation must consider demographics, social elements, and cultural characteristics.

During the construct validation process, the ability of the instrument to capture the construct is assessed. For this purpose, researchers can apply weak or strong programs (11). In this review, many of the authors (table 1) were found to have chosen to follow the weak program (3, 12, 18, 19, 28, 29, 34-36, 38-41, 44). Correlation studies compared the DASH Scale and latent variables such as the SF-12 (3), the SF-36 (18, 28, 29, 36, 38, 41), the CTQ (36), VAS (29, 35, 38), the Ritchie Articular Index (35), the DAS 28 (38), the HAQ (38), the AIMS2 (38), the Nottingham Health Profile (40), the NRS (44), the SPADI (18), the NPRS (18), pain and overall patient assessment (34), and other variables such as age, comorbidity, medical diagnosis, and employment status (19). The weak program strategy is considered merely exploratory, since a correlation can be observed between variables without any theoretical relation, therefore creating the possibility of trivial results (23, 24).

In contrast, Veehof et al. (47), Liang et al. (30), Themistocleous et al. (43), Fayad et al. (14), Mousavi et al. (33), and Varju et al. (46), followed the strong

Table 1 - The use of the DASH scale and details on the country, study population, cultural adaptation and evaluation of metric properties

Authors	Location(s)	Study Population	Cultural Adaptation	Assessment of Psychometric Properties
Hudak et al. (21), 1996	USA, Canada, and Australia	People in the United States, Canada and Australia with disorders of the upper limbs.	Original English version	There was no evaluation, but the authors emphasize the need for a validation process in future studies
Atroshi et al. (3), 2000	Sweden	Patients with impaired upper limbs in Sweden	Swedish version	Face and content validation. Construct validation was performed through the study of correlations between the DASH Scale and Medical Outcomes Study Short Form-12 ($r=0.51-0.74$).
SooHoo et al. (41), 2002	USA	Patients at a tertiary referral center in Atlanta with upper limb problems	English version	Construct validation was performed through the study of the correlation between the DASH Scale and Medical Outcomes Study Short Form-36 ($r=-0.36$ to -0.62)
Rosales et al. (39), 2002	Spain	Patients from the hand clinic of the hand surgery unit in Tenerife	Spanish version	Face validity and internal consistency was performed (Cronbach's alpha ranged from 0.90 to 0.95). The study of reproducibility was conducted using the paired t test and the Pearson correlation coefficient ($r=0.85-0.97$).
Veehof et al. (47), 2002	Netherlands	Dutch patients with a variety of disorders in the upper limbs	Dutch version	The exploratory factor analysis using the method of the principal components analysis. Internal consistency (Cronbach's alpha= 0.95), re-test testing (Pearson correlation coefficient), and concurrent validity were performed through the study of the correlation between the DASH Scale and the Canadian Occupational Performance Measure, or the COPM ($r=0.98$).
Padua et al. (36), 2003	Italy	Italian patients with problems in the upper limbs	Italian version	Content validity. Construct validity was performed by studying the correlation between the DASH Scale, the Carpal Tunnel the Questionnaire, or the CTQ ($r=0.48-0.65$), and the SF-36 ($r=0.27-0.44$).
Gummeson et al. (16), 2003	Sweden	Swedish patients with musculoskeletal disorders in the upper limbs with referral for surgery	Swedish version	Reliability was assessed (Cronbach's alpha= 0.90). The longitudinal construct validity considered responsiveness (effect size, average score for obtaining the standardized response mean) only in patients undergoing surgery.

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Table 1 - The use of the DASH scale and details on the country, study population, cultural adaptation and evaluation of metric properties

Authors	Location(s)	Study Population	Cultural Adaptation	Assessment of Psychometric Properties
Offenbächer et al. (34), 2003	Germany	German patients of the hospital school at the University of Munich reporting shoulder pain	German version	Face validity, construct validity determined through the study of correlation between the DASH Scale and the variables referred to as pain and overall patient assessment ($r=0.76-0.81$).
Greenslade et al. (15), 2004	United Kingdom	Patients from the University Hospital of Southampton, UK diagnosed with carpal tunnel syndrome	English version	Reliability (0.79-0.90), Pearson coefficient correlation and responsiveness of the DASH Scale and the Boston Questionnaire - specific to carpal tunnel syndrome assessment (chi-square and t test).
Liang et al. (30), 2004	Taiwan	Patients with musculoskeletal disorders treated at the University Hospital of Taiwan	Mandarin version	Face validity, internal consistency (Cronbach's $\alpha=0.96$) and reliability re-test testing (intraclass correlation coefficient=0.90), psychometric sensitivity (skewness and kurtosis) and concurrent validity (correlation with the physical component of the SF-36 based on the Pearson coefficient correlation=-0.28 to -0.60), confirmatory factor analysis (principal component analysis - $\lambda=0.43-0.89$)
Orfale et al. (35), 2005	Brazil	Brazilian patients who have rheumatoid arthritis	Portuguese version	Correlation between the DASH Scale and the Visual Analog Scale, or VAS ($r=0.762-0.995$) for pain in the upper limbs and the Ritchie Articular Index.
Durand et al. (12), 2005	Canada	Individuals in Quebec with various disorders in the upper limbs	French Canadian version	Face and content validity determined by calculating the internal consistency (Cronbach's $\alpha=0.94$) and item-total correlation (Pearson coefficient correlation= 0.43-0.88)
Hervás et al. (19), 2006	Spain	Spanish patients treated at the Rehabilitation Center of Hospital Universitario Dr. Peset of Valencia with disorders in upper limbs	Spanish version	Face and content validity determined through the study of the correlation between the DASH Scale and the SF-36 ($r=0.96$), the construct validity through the correlation between the variables of age, co-morbidity, medical diagnosis, and employment status.
Themistocleous et al. (43), 2006	Greece	Greek patients treated at the Department of Hand Surgery who had a variety of musculoskeletal disorders in a unilateral upper limb	Greek version	The face and content validation was performed. Factor analysis (principal component analysis), internal consistency (Cronbach's α), test re-testing (paired t test), responsiveness (Pearson correlation coefficient=0.918 and coefficient of tau-b Kental=0.720), validity of known groups (analysis of variance) and study of the correlation between the DASH Scale and the 8 subscales of the SF-36 ($r=0.625$).

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Table 1 - The use of the DASH scale and details on the country, study population, cultural adaptation and evaluation of metric properties

Authors	Location(s)	Study Population	Cultural Adaptation	Assessment of Psychometric Properties
Fayad et al. (14), 2007	France	French patients with shoulder problems who were treated at the Assistance Publique Hopitaux de Paris	French version	Reliability determined through internal consistency (Cronbach's alpha=0.96) and test re-testing (intraclass correlation coefficient= 0.95); construct validity determined using convergent and divergent validity (Spearman correlation coefficient= -0.76-0.95)) and factor analysis (principal component analysis - $\lambda > 0.50$).
Raven et al. (38), 2008	Netherlands	Patients of a Dutch academic medical center with rheumatoid arthritis	Dutch version	Content validity; construct analyzed through the convergent and divergent validity; determined DASH Scale correlation with the Disease Activity Score, or the DAS28 $r=0.42$, the SF-36 Health $r=0.70$, the Health Assessment Questionnaire, or the HAQ, $r=0.88$, the Arthritis Impact Measurement Scale, or the AIMS2 ($r=0.85$), and the Visual Analog Scale, or VAS $r=0.60-0.65$). Reliability determined using internal consistency (Cronbach's alpha= 0.97) and test re-testing (intraclass correlation coefficient= 0.97, Bland Altman, and t test)
Varjú et al. (46), 2008	Hungary	Patients from a university in Hungary with systemic sclerosis	Hungarian version	Face validity, concurrent validity; correlation between the DASH Scale and HAQ determined by calculating the Spearman correlation coefficient (-0.77-0.89), discriminant validity (2-group Mann Whitney test), factor analysis (principal component analysis with Varimax orthogonal rotation), responsiveness (standardized response mean and effect size); reliability determined based on internal consistency (Cronbach's alpha= 0.94-0.97) and test-retesting reliability (intraclass correlation coefficient= 0.89).
Lee et al. (29), 2008	Korea	Korean patients with problems in the arms, shoulders, and hands	Korean version	Face and construct validity; determined correlation between the DASH, the VAS, and the SF-36 using the Pearson correlation coefficient ($r=-0.677-0.555$), reliability determined based on internal consistency (Cronbach's alpha= 0.94) and test-retest reliability (intraclass correlation coefficient=0.91).

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Table 1 - The use of the DASH scale and details on the country, study population, cultural adaptation and evaluation of metric properties

Authors	Location(s)	Study Population	Cultural Adaptation	Assessment of Psychometric Properties
Kitis et al. (28), 2008	Turkey	Employees from six textile industries in Turkey with complaints regarding the upper limbs	Turkish version	Face validity; content and construct validity determined through the study of the correlation between DASH and physical and mental components of the SF-36 (Pearson correlation coefficient=-0.32 to -0.82); reliability determined based on internal consistency (Cronbach's alpha=0.91) and test-retesting reliability (intraclass correlation coefficient=-0.92).
Mousavi et al. (33), 2008	Iran	Patients in Iran with musculoskeletal disorders in the upper limbs	Farsi version	Face and content validity. Convergent validity; correlation between the DASH, the VAS, and the functional components of the SF-36 determined using the Pearson correlation coefficient ($r=-0.25$ to -0.72). Factor analysis (principal component analysis with Varimax rotation), internal consistency reliability (Cronbach's alpha=0.92), and test-retesting reliability (intraclass correlation coefficient=0.82).
Schoneman et al. (40), 2011	Denmark	Patients in Denmark with wrist fractures	Danish version	Content validity. Reliability determined based on internal consistency (Cronbach's alpha) and test-retesting reliability (intraclass correlation coefficient) and agreement Bland Altman. Convergent and divergent validity (Pearson's correlation coefficient between the DASH and Nottingham Health Profile) and responsiveness (effect size calculated by Cohen's test d).
Haldorsen et al. (18), 2014	Norway	Patients with shoulder impingement syndrome	Norwegian version	Reliability determined based on internal consistency (Cronbach's alpha=0.93), item-total correlation and test-retest reliability (intraclass correlation coefficient=0.89), and construct validity determined using the Pearson correlation coefficient between the DASH Scale, the Shoulder Pain and Disability Index (SPADI), the SF-36, and the Numeric Pain Rating Scale, or the NPRS ($r=0.36-0.81$).
Tongprasert et al. (44), 2014	Thailand	Patients in Northern Thailand with problems in the arms, shoulders, and hands	Thai version	Face and content validity and construct validity determined using the Pearson product-moment correlation; correlation determined between the DASH Scale and the Numeric Rating Scale, or the NRS ($r=0.09-0.22$). and reliability determined based on internal consistency (Cronbach's alpha=0.938).

program using factor analysis and principal components, which allowed them to obtain a measurement closer to the true value. This strategy considers the theories of each instrument; therefore, a strong theory supporting the construct under evaluation is needed (23). As a result, the strong program is the most appropriate in research, since it allows researchers to select the theoretical framework that best fits the population (23).

Rosales et al. (39) and Durand et al. (12) performed face and content validation and an analysis of reliability based on internal consistency. Given the fact that reliability evaluates precision and validity evaluates accuracy, the reliability evaluation should be performed only after the construct validity is verified in this population. Thus, more attention should be given to the methodology in studies involving these questionnaires.

Although the strong program is considered the best option for producing scientific evidence, it can prove impractical for some researchers. Therefore, the weak program tends to be used instead, since this type of analysis does not require the existence of a strong theory supporting the construct (23, 24). This problem does not seem to affect the DASH Scale, since the DASH Scale was constructed by well-known experts based on sound scientific and statistical theory (21, 25).

Considering the importance of the DASH Scale for occupational health, more studies should be performed on different populations and, when necessary, a cross-cultural adaptation and evaluation using the strong program should be performed.

CONCLUSION

Most of the studies considered in this review evaluated the psychometric properties of the DASH instrument; however, these properties were evaluated using the weak program, which is considered to produce limited scientific evidence. Therefore, further studies should be performed using the strong program approach.

NO POTENTIAL CONFLICT OF INTEREST RELEVANT TO THIS ARTICLE WAS REPORTED BY THE AUTHORS

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