

ORIGINAL REPORT

COMPARISON OF GENERIC PATIENT-REPORTED OUTCOME MEASURES USED WITH UPPER EXTREMITY MUSCULOSKELETAL DISORDERS: LINKING PROCESS USING THE INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY, AND HEALTH (ICF)

Nancy J. Forget, PhD(c)^{1,2,3*} and Johanne Higgins, PhD^{4,5,6*}

From the ¹École de santé publique de l'Université de Montréal (ESPUM), ²School of Physical and Occupational Therapy, McGill University, ³Centre de la main, Centre hospitalier de l'Université de Montréal (CHUM), ⁴École de réadaptation, Université de Montréal, ⁵Centre de recherche interdisciplinaire en réadaptation du Montréal métropolitain (CRIR), and ⁶Institut de réadaptation Gingras-Lindsay de Montréal (IRGLM), Montreal, Canada.

*Both authors have contributed equally.

Objective: To report the theoretical foundation of generic patient-reported outcomes for measuring functioning related to upper extremity musculoskeletal disorders and perform content coverage analysis and content comparison using the International Classification of Functioning, Disability and Health (ICF).

Methods: A literature search was performed to identify commonly used patient-reported outcomes. A comparison of their theoretical foundations and a linking exercise between the measures' meaningful concepts and the ICF and Brief ICF Core Set for Hand Conditions was accomplished based on established rules.

Results: Fifteen measures were selected. Multiple theoretical foundations were identified, and only 7 measures were developed based on a known conceptual model. Six measures were chosen for the linking process with 232 meaningful concepts retrieved and linked to 54 ICF categories. No concept was linked to the Body Structures component and two measures stood out for their Activity and Participation coverage. No measure covered all Brief ICF Core Set for Hand Conditions recommended categories.

Conclusion: Some heterogeneity was observed with regards to the theoretical foundations on which the identified measures are based. The results of the linking process should help reduce these inconsistencies. They enable easy identification of content coverage and content comparison between measures using a common framework and can be used as a reference when selecting the most appropriate patient-reported outcome measure.

Key words: ICF; outcome assessment; disability evaluation; activities of daily living; upper extremity; musculoskeletal disorders.

J Rehabil Med 2014; 46: 327–334

Correspondence address: Nancy J. Forget, 3630 Promenade Sir William Osler, Montreal, H3G 1Y5, Canada. E-mail: nancy.forget@mcgill.ca

Accepted Nov 21, 2013; Epub ahead of print Feb 14, 2014

INTRODUCTION

Normal hand use is vital to the performance of usual activities of daily living (ADL). Following a trauma or disease, hand

integrity may be altered impairing function. A musculoskeletal disorder affecting the upper extremity (MSD/UE) can seriously impede the performance of daily activities and may have important affective, as well as societal and economical repercussions (1, 2).

When measuring a person's functional status, monitoring change in a condition or evaluating the effectiveness of a treatment or intervention program, one needs valid measurements. Choosing an appropriate outcome measure is as important as it is difficult to do (3). Researchers and clinicians are faced with difficult choices when deciding which measure to use, and the assessment of functional status following a MSD/UE is no exception.

Frequently used for research and in clinical settings to quantify function, patient-reported outcome measures are easy to administer, quick, portable, inexpensive and do not usually require specific training from the evaluator. Ideally, the measure should be based on a recognized theoretical foundation, defined as *the availability of a clear description of the construct, and the theory on which it is based* (4). However, original articles describing a measure's development seldom provide a clear definition of their theoretical foundation. One way to overcome this gap is to perform a content analysis of the measure by examining the correspondence between the items' content with elements of a conceptual model (linking process) (5), like the International Classification of Functioning, Disability and Health (ICF) (6). This linking process allows for an easy identification of the content covered by the measure and provides a common framework for comparing measures, directly showing similarities and differences in their content. This information may serve as a guide to help health professionals make an informed decision when choosing the most appropriate measure.

Endorsed by the World Health Organisation, the ICF is a classification of health and health-related domains for measuring functioning and disability. It illustrates *“the complex and dynamic interaction between, on one hand, health conditions, body functions, activities, and participation, and, on the other hand, extrinsic factors that represent the circumstances in which the individual lives”* (7). The ICF aims to provide a com-

mon language to improve communication across users, such as health care professionals, researchers, and policy makers, as well as a framework to guide the development of rehabilitation outcomes measures (6). The ICF is used internationally in research, clinic and academic institutions and is divided in 5 components, 4 of which are categorized: *Body Functions (b)*, *Body Structures (s)*, *Activities and Participation (d)* and *Environmental Factors (e)*. The ICF is organized in a stem-and-leaf structure so that a lower-level category shares attributes of the higher-level categories of which it is a member (Table 1) (6). From the ICF, multiple Core Sets have been developed in order to prioritize categories that relate to specific populations (8). Targeting hand conditions, an international panel of experts developed a comprehensive ICF Core Set for Hand Conditions along with a Brief ICF Core Set, which “provides a list of functioning aspects that serves as the minimal international standard that should be addressed to report about functioning and disability of individuals with hand conditions” (9).

Several patient-reported outcome measures have been linked to the ICF (10–12). To the authors’ knowledge, the only generic patient-reported outcome measure submitted to a descriptive linking process with the ICF among measures developed for MSD/UE is the Disabilities of the Arm, Shoulder and Hand (DASH) (13, 14). Its content, however, was not compared with the content of other measures. Moreover, no measure was investigated specifically in relation to the Brief ICF Core Set for Hand Conditions.

The aim of this study was to report the theoretical foundation of generic patient-reported outcomes measuring functioning and disability with MSD/UE and to analyse and compare content coverage of the 6 most frequently used measures in research using a linking process with the ICF and the Brief ICF Core Set for Hand Conditions.

METHODS

Patient-reported outcome measures’ identification & review

A structured literature search was undertaken in MEDLINE (1969–2012), EMBASE (1988–2012), PsychINFO, CINAHL and HAPY to identify patient-reported outcomes that measure functioning and disability in relation to MSD/UE. The MeSH terms used were ‘Questionnaire’ AND ‘Exp Upper extremity’ AND ‘Exp musculoskeletal diseases’ OR ‘Exp Arm injuries AND ‘*Health status indicators’ OR ‘Quality of life’ OR ‘Activities of daily living’ OR ‘*Disability evaluation’ OR ‘*Outcome assessment (health care) OR ‘Functional assessment’ (this latter as a keyword). The abstracts were reviewed and patient-reported outcome measures selected if (i) the identified studies used them as outcome measure or was studying the measure’s psychometric properties (ii) they were used to measure functioning in relation MSD/UE; (iii) they did not target a specific condition or proximal anatomical structure (ie: shoulder or elbow); (iv) they were available in English and (v)

Table 1. Example of structural organisation of the International Classification of Functioning, Disability and Health

Identification	Category	Level
d	Activity and Participation	Component level
d5	Self-Care	Chapter level
d510	Washing oneself	Second level
d5100	Washing body parts	Third level

the manuscript describing the development process was accessible in English. Based on the latter, a review of the retained patient-reported outcome measure’s theoretical foundation was undertaken.

Linking procedures with the ICF

Measures’ selection. A search in MEDLINE (1996–) was performed using the identified measures’ complete name as keyword to compute the number of citing articles (as of April 18th 2012). The number obtained was used as a proxy for frequency of use in studies. A decision was made to only link the 6 most cited measures in order to ensure clarity and not to overburden the results.

Linking process. Two health professionals (NJF and JH) with previous knowledge of the ICF performed the linking process independently. Based on established linking rules developed by Cieza et al. (15, 16), each measure’s items were examined to identify their constituting meaningful concepts, defined as a “unit of text” identified to convey a single theme based on the linker’s judgement and expertise of functioning and the ICF (17). The concepts were linked to the most precise ICF level of classification (or category) (ex: *Patient Evaluation Measure (PEM) item Most of the time, the PAIN in my hand is now...* refers to the meaningful concepts *pain* and *hand* and was linked to b28014 *Pain in upper limb*. Consensus between the two reviewers had to be reached for the final linkage decision. A third reviewer was available in the event of an unresolvable divergence of opinion between the two main reviewers. As per linking rules (15, 16), the concepts that could not be classified in the ICF were labeled as “not covered” (nc) and those that were not precise enough were labeled as “not definable” (nd) or “not definable – mental health” (nd-mh) when referring precisely to a mental health issue. Moreover, numbers in parentheses were added to denote that the meaningful concept was referred to in an example given within the item (ie: *Are you able to eat (eg: grasp your knife and fork)?* – d550 *Eating (d4401 Grasping)*). Optional modules were not included in the linking process when their results are not accounted for in the overall scoring as this may mean that these items measure a different construct than functioning. Finally, linked ICF categories were revised and compared to the Brief ICF Core Set for Hand Conditions (9).

RESULTS

Patient-reported outcome measures review

Using the search strategy, 715 original articles were identified. Two hundred seventy-six articles were discarded, as they were not related to adult MSD/UE. Four hundred thirty-nine abstracts were reviewed and 10 generic patient-reported outcome measures were identified. Two measures were rejected because of unpublished development procedures. Seven measures were added based on the authors’ knowledge of existing relevant measures. Table II provides the listing and a brief description of identified measures.

Theoretical foundation. Eight of the 15 identified measures provided a clear and referenced definition of their theoretical foundation. Of these, 7 relied on classifications developed by the World Health Organization (WHO). However, only 3 measures operationalized the selected conceptual model during the development process (18, 19, 25). Heterogeneity was observed amongst the theoretical foundations reported by the identified measures (Table II).

Linking process to the ICF

Measures selected for the linking process. Based on the literature search, the 7 most cited measures were selected for

Table II. Patient-reported outcome measures' review

	Abbreviation	Format	Theoretical foundation
Disabilities of the arm, shoulder and hand (18) & QuickDASH (19)	DASH & QuickDASH	30-items and 11-items respectively. Both have 2 optional work and sports/performing arts modules Rating on a 5-point Likert scale from 'no difficulty' to 'unable'	Symptoms Functional status/disability (20)
Hand Function Sort (21)	HFS	25-items Rating on a 4-point Likert scale from 'easy' to 'impossible' with a 'not relevant' rating	Subjective views on hand function Activities of daily living (22)
Modern activity subjective survey (of 2007) (23)	MASS07	10-items focusing on modern activities Rating done on a 0–10 scale going from 'no difficulty' to 'unable to do' with a 'non-applicable' category	Functional impairment Functional limitations in high-frequency modern activities
Michigan Hand Questionnaire (24)	MHQ	62-items divided in 6 modules + a module for demographic variables. Some modules subdivided for right/left/bilateral activities Rating on a 5-point Likert from 'strongly agree' to 'strongly disagree'	Hand function Overall hand function Activities of daily living Pain Work performances Aesthetics Patient satisfaction
Milliken Activity of Daily Living Scale (25)	Milliken	47-items divided into 6 categories (eating/meal preparation, personal hygiene, dressing, object manipulation, cleaning/laundry and other) Two rating scales: current ability level and level of necessity, based on 5- and 3-points Likert scales	Activity limitation (6)
Neck and Upper Limb Index (26)	NULI	20-items divided into 2 categories (activities and impact). Rating on a 7-point Likert scale going from 'no difficulty at all' to 'cannot do'	Functional status
Patient Evaluation Measure (27)	PEM	18-items divided into 3 modules: treatment, present hand condition and overall assessment Rating on a 7-point Likert scale – wording changes throughout scale	Overall hand health
Patient-focused wrist outcome OR Adelaide Questionnaire (28)	PFWO	56-items divided into 3 sections: pre-morbid functioning, post-morbid functioning and identification of difficult activities Rating of the 2 first sections are with a dichotomous scale with a 'non-applicable' and/or 'haven't tried' categories	Performance in activities of daily living (ability)
Patient outcomes of surgery – hand/arm (29)	POS-Hand/Arm	29-items divided into 5 categories (symptoms, daily activities, sleep, affective and self-consciousness). An extra 4-item may be asked post-surgery Rating based on 4- or 5-points Likert scales depending on section	Health impact of hand/arm conditions and surgery
Patient rated wrist evaluation (30)	PRWE & PRWHE	15-items divided into 2 modules: pain and function Rating on a scale from 0 'none' – 10 'worst'	Based on the PRWE (30) Pain
Patient rated wrist/hand evaluation (31)		PRWHE based on the PRWE, its distinctions are (1) the term "wrist" is replaced with "wrist/hand"; (2) has an optional aesthetics question (not part of the scoring)	Disability (20)
Upper extremity functional index (32)	UEFI	20-items Rating on a 5-point Likert scale from 'extreme difficulty or unable to perform activity' to 'no difficulty'	Functional status (20)
Upper Extremity Function Scale (33)	UEFS	8-items Rating on a 0–10 scale ('no problem' to 'major problem')	Functional outcome Ability to perform physical tasks Functional dimension of disease impact
Upper limb functional index (34)	ULFI	25-items + 2 questions on specific activity identification and on overall status rating compared to pre-injury level which are not part of the total scoring Rating on a dichotomous scale (statement applies or not)	Activity limitations (6)

the linking process (Table III). Analyses were performed on 6 measures as the results obtained on the PRWHE can be generalized to the PRWE due to their content similarities.

Meaningful concepts. A total of 232 meaningful concepts emerged from the measures' items analysis. The MHQ has 96 concepts, the high number being partly due to the repetition of the items for

Table III. Patient-reported outcome measures' rating

Abbreviation	'Matches' in Medline
DASH ^a	677
PRWE ^a	59
PEM ^a	18
QuickDASH ^a	17
MHQ ^a	13
UEFI ^a	11
PRWHE ^a	6
ULFI	5
UEFS	4
HFS	3
PFWO	3
MASS07	2
POS-Hand/Arm	1
MAS	1
NULLI	0

^aMeasures selected for ICF linking process. For abbreviations see Table II.

the right and left hands. The DASH and QuickDASH include 43 and 17 concepts respectively, while the PEM, UEFI and PRWHE include 22, 28, and 26 meaningful concepts respectively.

Linking process

The results of the linking process are summarized in Table IV. Consensus was achieved between the two reviewers for 100% of the linkage and the involvement of a third reviewer was not necessary.

Content coverage of each measure to the ICF. All selected patient-reported outcome measures, except for the PEM, cover mainly the Activity and Participation component, ranging from 40% of its meaningful concepts for the MHQ up to 96% for the UEFI with a mean of 18 categories covered (range 11–23). Between 16% to 33% of the measures' meaningful concepts relate to Body Functions, except for the UEFI (4%). Only one measure covers the Environmental Factors component (PEM) and none covers Body Structure. The "not covered" category was employed mainly for meaningful concepts relating to the appearance of the hand and patients' level of satisfaction for which no corresponding ICF category could be identified. The ones labelled "not definable - mental health" referred mainly to the affective repercussions of the hand condition (ie: being uncomfortable, confidence) for which no precise enough ICF category captures the meaningful concept.

Table IV. Linking of the patient-reported outcome measures' meaningful concepts to the International Classification of Functioning, Disability and Health categories

ICF code and category title	DASH	PRWHE ^a	PEM	QuickDASH	MHQ	UEFI
<i>b Body functions</i>						
<i>b1 Mental functions</i>						
b134 Sleep functions ^c	1			1	2	1
b152 Emotional functions ^b					2	
<i>b2 Sensory functions and pain</i>						
b265 Touch function ^b						
b270 Sensory functions related to temperature and other stimuli ^b						
b280 Sensation of pain ^b						
b28014 Pain in upper limb	3	6	2	2	12	
<i>b7 Neuromusculoskeletal and movement-related functions</i>						
b710 Mobility of joint functions ^b					8	
b715 Stability of joint functions ^b						
b730 Muscle power functions ^b	1					
b7301 Power of muscles of one limb			1		4	
b760 Control of voluntary movements functions ^b						
b7800 Sensation of muscle stiffness	1		1			
<i>b8 Functions of the skin and related structures</i>						
b810 Protective functions of the skin ^b						
b840 Sensation related to the skin	1		1	1	4	
<i>s Body Structures</i>						
s120 Spinal cord and related routine ^b						
s720 Structure of shoulder region ^b						
s730 Structure of upper extremity ^b						
s830 Structure of nails ^c						
<i>d Activities and Participation</i>						
<i>d1 Learning and applying knowledge</i>						
d170 Writing	1					
<i>d2 General tasks and demands</i>						
d230 Carrying out daily routine ^b	1		1	1	2	
<i>d3 Communication</i>						
<i>d4 Mobility</i>						
d4200 Transferring oneself while sitting						(1)
d430 Lifting and carrying objects ^b	1					1
d4300 Lifting		1				2

Table IV. *Cont.*

ICF code and category title	DASH	PRWHE ^a	PEM	QuickDASH	MHQ	UEFI
d4301 Carrying in the hands	1	1		1	1	
d440 Fine hand use ^b	1		1		3	1
d4400 Picking up					2	
d4401 Grasping		1	1		6	
d4402 Manipulating		1			1	1
d445 Hand and arm use ^b		1			4	1
d4451 Pushing	1	1				1
d4452 Reaching	2					
d4453 Turning or twist the hands or arms	3			1	3	1
d4454 Throwing						1
d470 Using transportation	1					
d475 Driving						1
<i>d5 Self-Care^b</i>		1				
d510 Washing oneself		(1)			(2)	
d5100 Washing body parts	1			1	1	
d5202 Caring for hair	1					1
d530 Toileting		1				
d540 Dressing		(1)				1
d5400 Putting on clothes	1	1			1	1
d5402 Putting on footwear					1	1
d550 Eating	1	1		1	1 (2)	
<i>d6 Domestic Life^b</i>						
d630–d649 Household tasks		1				
d630 Preparing meals	1					1
d640 Doing housework	2			1		2
d6400 Washing and drying clothes and garments						1
d6401 Cleaning cooking area and utensils					1	
d6402 Cleaning living area	(2)	(1)		(2)		
d6403 Using household appliances						2 (1)
d650 Caring for household objects		(1)				
d6505 Taking care of plants, indoors, and outdoors	1					
<i>d7 Interpersonal interactions and relationships^b</i>						
<i>d8 Major life areas</i>						
d820 School education						1
d840–d859 Work and employment ^b						
d850 Remunerative employment	1	1	1	1	5	1
<i>d9 Community, social and civic life</i>						
d920 Recreation and leisure	3	1		1		1
d9200 Play	(1)					
d9201 Sports	(2)			(1)		1
d9203 Crafts	(1)					
d9204 Hobbies						1
d9205 Socializing	1			1	2	
<i>e Environmental factors</i>						
<i>e1 Products and technology^b</i>						
<i>e2 Natural environment and human-made changes to environment</i>						
e225 Climate ^c						
<i>e3 Support and relationships^b</i>						
e355 Health professionals			1			
<i>e4 Attitudes</i>						
e410 Individual attitudes of immediate family members ^c						
e425 Individual attitudes of acquaintances, peers, colleagues, neighbours, and community members ^c						
e450 Individual attitudes of health professionals ^c			4			
e460 Societal attitudes ^c						
<i>e5 Services, systems and policies^b</i>						
e5800 Health Services			1			
Not definable	1					
Not definable – mental health	3		2		4	
Not covered	(1)	3	5	(1)	22	

^aResults may be generalized to the PRWE; ^bIncluded in the Brief ICF Core Set for Hand Conditions; ^cRecommended added categories to the Brief ICF Core Set for Hand Conditions (35). For abbreviations see Table II. (.) Meaningful concept referred into example within item.

Table V. Number of meaningful concepts identified per ICF component (number of categories covered in parentheses)

	DASH	PRWHE*	PEM	QuickDASH	MHQ	UEFI
Concepts identified	43	26	22	17	96	28
Body Functions	7 (5)	6 (1)	5 (4)	4 (3)	32 (6)	1 (1)
Body Structure	0	0	0	0	0	0
Activities and Participation	31 (23)	17 (17)	4 (4)	12 (11)	38 (16)	27 (23)
Environmental factors	0	0	6 (3)	0	0	0
Concepts not linked to the ICF	5	3	7	1	26	0

*Results may be generalized to the PRWE.

For abbreviations see Table II.

Linking process to the Brief ICF Core Set for Hand Conditions. Only 22% of the recommended Body Functions categories are covered by the patient-reported outcome measures under study (ranging from 0% for the UEFI up to 44% by the MHQ). No measure covers any of the recommended Body Structure categories. For Activities and Participation, the recommended categories are covered on average at 73%, ranging from 38% for the PEM up to 88% by the DASH and MHQ. Finally, the Environmental Factors are covered at 67% but only by the PEM. Five second-level categories in Body Functions (b265, b270, b715, b760, b810), all 3 second-level categories in Body Structures (s120, s720, s730), one chapter-level category in Activities and Participation (d7) and one chapter-level category in Environmental Factors (e1) are not covered by any of the measures.

Content comparison of the selected patient-reported outcome measures

A summary of the content coverage was performed for the different measures under study in order to allow for a direct content comparison (Table V). For the Body Functions component, the MHQ includes more concepts and covers more categories than the other measures, whereas the PRWHE has 6 related concepts but these are only linked to one category: Sensation of pain. No measure captures the Body Structure component. For Activities and Participation, the concepts included in the UEFI cover the most categories with a total of 23. Finally, only the PEM covers the Environmental Factors within 3 categories.

DISCUSSION

To our knowledge, this is the first study to describe and compare the theoretical foundation of different patient-reported outcomes used to measure functioning and disability related to MSD/UE. The majority of the identified measures were developed using a rigorous methodology. However, even if the necessity to link the development process to a conceptual model is widely acknowledged, some of them lack a clear definition of the theoretical foundation used, making it difficult to clearly identify which construct the patient-reported outcome is intended to measure and thus potentially raising doubts about its content validity (5). *Functioning* being a latent trait, a clear and explicit definition of the construct is necessary as

its measurement depends upon its definition (36). Seven of the identified measures based their theoretical foundations on classifications developed by the WHO; the ICF, and its precursor the International Classification of Impairments, Disabilities and Handicaps (ICIDH) (6, 20). Using these internationally known classifications permits professionals to use “*a standardized common language permitting communication about health and health care across the world in various disciplines and sciences*” (6). Despite sharing a common language, these two classifications describe functioning differently, one seeing it as *consequences of disease* whereas the other more as *components of health* (6) thus offering two visions of functioning. The first classification provides a more complete picture of the determinants (ie: including environmental factors), thus providing a holistic picture of the construct of functioning.

Three patient-reported measures referred to ADLs as the focus of their theoretical foundation, but only the developers of the HFS provided a referenced definition of the construct in their manuscript, being the “*use of the hand while dressing, in personal hygiene, eating, communication and other domestic matters*” (21). After reviewing the 3 measures’ composing items, the MHQ seems to be targeting ADLs, but the PFWO instrument contains items such as *Disturbed your partners sleep?* or *Taking weight through your wrist?* which may be more related to psychosocial and physical issues.

The remaining 5 patient-reported measures utilize different constructs to designate their theoretical foundation. A few of them relate to *hand function* in reference to the physical capacities of the hand (ie: strength, range of motion, sensation...) (21, 24) while others use it as a substitute to *functional limitations* (23). Interestingly, even if the HFS defines *hand function* more in terms of hand capacities, its composing items all relate to tasks performed with the use of the hands.

The identified patient-reported measures were all selected because they are mainly composed of items describing tasks performed in a daily routine using one or both hands. At first glance, they all seem to relate to the common construct of *functioning*. However, as presented in Table II, a certain heterogeneity exists between the theoretical foundations defined in the articles presenting the measures’ development process. This may lead to a number of drawbacks: no common language making communication between utilisers difficult, no common keywords making difficult their identification when searching the literature, uncertainty as the equivalency of the measures (are they measuring the same construct?). This makes the

choice of an appropriate outcome measure for the task at hand arduous and hinders the comparison of the results obtained by different measures. Reliance on a valid theoretical foundation a priori in the development process of the measure with a clear description, or a posteriori by subjecting the measure to a linking exercise with a conceptual model, should help reduce these difficulties (5).

The results of this study also provide content coverage and content comparison of the 6 most frequently used patient-reported outcome measures with MSD/UE in relation to the ICF. It was found that each measure relates mainly to one component. The majority of the UEFI meaningful concepts link to Activity and Participation and both the UEFI and DASH cover the most categories of the Activity and Participation component. For Body Functions, the MHQ contains the most concepts related to this component and is the one that covers the most categories. As for the Environmental Factors component, only the PEM covers part of it.

This study also specifically looked at patient-reported outcome measures' content coverage in relation to the Brief ICF Core Set for Hand Conditions, an analysis never been done before to the best of our knowledge. The latter represents the minimal categories that should be addressed when measuring function for people with a MSD/UE (9, 35). It was found that none of the measures cover all recommended categories. The MHQ was identified to be the one that covers the most of the recommended categories. This finding may be used as a warning to health professionals and researchers to use those patient-reported outcome measures in conjunction with other measures in order to have a complete picture of their client when assessing functioning.

Following the linking process, some meaningful concepts included in the measures could not be linked to any ICF categories, the categories being too broad (ie: Emotional Functions) or not classifiable (ie: satisfaction, aesthetics/appearance). As suggested by Cieza & Stucki (37), some ICF categories might not be precise enough to differentiate some concepts. Only one concept was classified as being "not definable" (DASH's item *Sexual activities*). The reviewers reached a consensus not to include it in the category b640 *Sexual function* as this category is part of Body Functions and refers to a possible impairment to the physiologic functions of the body systems (6). The reviewers agreed that the meaning of this item, within this patient-reported outcome measure, was referring to a restriction of participation and could not be linked to any category within Activity and Participation. Future research should focus on the refinement of a conceptual model that best describes the patient reality of living with a MSD/UE as this could provide a conceptual basis for future patient-reported outcome measures development and facilitate communication amongst health professionals.

When considering future measure development, the Brief ICF Core Set for Hand Conditions is a convenient model upon which to base the development process and should be consulted as a guide. Developed to offer a comprehensive, but concise, picture of functioning in relation to MSD/UE, it is

composed of a restricted number of categories whose relevance in relation with this population has been demonstrated (35). Also, the categories being divided into the 4 ICF components (Body Functions, Body Structures, Activities and Participation, and Environmental Factors), researchers will be able to clearly identify and utilize sub-sections that can best capture the targeted outcomes for their research.

Limitations of the study

The independent linking process demonstrated few discrepancies between the two reviewers' results. Some concepts were initially perceived differently by the two reviewers and linked to different ICF categories. A consensus was reached at 100% between the two reviewers for the final linkage decision, but this initial difference in conceptualisation might partly explain the discrepancies observed between the results of this study and those from previous studies that performed the same exercise with the DASH (13).

In conclusion, despite the shortcomings of clear definitions and the heterogeneity of the theoretical foundations on which the selected measures are grounded that have been highlighted by this study, the results reported with the linking process should help reduce these inconsistencies by providing, using a common framework, a clear image of the content coverage and allowing direct content comparison between the measures. These results can be used as a reference for health professionals and researchers when choosing the most appropriate patient-reported outcome for measuring function with MSD/UE.

ACKNOWLEDGEMENTS

The authors want to acknowledge the support of Michèle Rivard Sc.D. for the conduction of this study. The authors also want to acknowledge the financial support from the American Society of Hand Therapists (ASHT), Département de Chirurgie du Centre Hospitalier de l'Université de Montréal (CHUM), Fondation du CHUM, and Fonds de Recherche du Québec en Santé (FRQ-S).

REFERENCES

1. Morse TF, Dillon C, Warren N, Levenstein C, Warren A. The economic and social consequences of work-related musculoskeletal disorders: the Connecticut Upper-Extremity Surveillance Project (CUSEP). *Int J Occup Environ Health* 1998; 4: 209–216.
2. Yelin E, Callahan LF. The economic cost and social and psychological impact of musculoskeletal conditions. *National Arthritis Data Work Groups. Arthritis Rheum* 1995; 38: 1351–1362.
3. Tessier A, Mayo NE, Cieza A. Content identification of the IWQOL-Lite with the International Classification of Functioning, Disability and Health. *Qual Life Res* 2011; 20: 467–477.
4. Mokkink LB, Terwee CB, Knol DL, Stratford PW, Alonso J, Patrick DL, et al. The COSMIN checklist for evaluating the methodological quality of studies on measurement properties: a clarification of its content. *BMC Med Res Methodol* 2010; 10: 22.
5. de Vet HCW, Terwee CB, Mokkink LB, Knol DL. *Measurement in medicine: a practical guide*. New York: Cambridge University Press; 2011.
6. World Health Organization. *International classification of functioning, disability and health: ICF*. Geneva: WHO; 2001.

7. Levasseur M, Desrosiers J, St-Cyr TD. Comparing the Disability Creation Process and International Classification of Functioning, Disability and Health models. *Can J Occup Ther* 2007; 74: 233–242.
8. Yen TH, Liou TH, Chang KH, Wu NN, Chou LC, Chen HC. Systematic review of ICF core set from 2001 to 2012. *Disabil Rehabil* 2014; 36: 177–184.
9. Rudolf KD, Kus S, Chung KC, Johnston M, LeBlanc M, Cieza A. Development of the International Classification of Functioning, Disability and Health core sets for hand conditions – results of the World Health Organization International Consensus process. *Disabil Rehabil* 2012; 34: 681–693.
10. Oliveira CC, Lee A, Granger CL, Miller KJ, Irving LB, Denehy L. Postural control and fear of falling assessment in people with chronic obstructive pulmonary disease: A systematic review of instruments, International Classification of Functioning, Disability and Health linkage, and measurement properties. *Arch Phys Med Rehabil* 2013; 1784–1799.
11. Viehoff PB, Hidding JT, Heerkens YF, van Ravensberg CD, Neumann HA. Coding of meaningful concepts in lymphedema-specific questionnaires with the ICF. *Disabil Rehabil* 2013; 35: 2105–2112.
12. Bladh S, Nilsson MH, Carlsson G, Lexell J. Content analysis of four fear of falling rating scales by linking to the International Classification of Functioning, Disability and Health. *PM R* 2013; 5: 573–582.
13. Silva Drummond A, Ferreira Sampaio R, Cotta Mancini M, Noce Kirkwood R, Stamm TA. Linking the Disabilities of Arm, Shoulder, and Hand to the International Classification of Functioning, Disability, and Health. *J Hand Ther* 2007; 20: 336–343.
14. Velstra IM, Ballert CS, Cieza A. A systematic literature review of outcome measures for upper extremity function using the international classification of functioning, disability, and health as reference. *PM R* 2011; 3: 846–860.
15. Cieza A, Geyh S, Chatterji S, Kostanjsek N, Ustun B, Stucki G. ICF linking rules: an update based on lessons learned. *J Rehabil Med* 2005; 37: 212–218.
16. Cieza A, Brockow T, Ewert T, Amman E, Kollerits B, Chatterji S, et al. Linking health-status measurements to the international classification of functioning, disability and health. *J Rehabil Med* 2002; 34: 205–210.
17. Escorpizo R, Cieza A, Beaton D, Boonen A. Content comparison of worker productivity questionnaires in arthritis and musculoskeletal conditions using the International Classification of Functioning, Disability, and Health framework. *J Occup Rehabil* 2009; 19: 382–397.
18. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). *Am J Ind Med* 1996; 29: 602–608.
19. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: comparison of three item-reduction approaches. *J Bone Joint Surg Am* 2005; 87: 1038–1046.
20. World Health Organization. *International Classification of Impairments, Disabilities, and Handicap*. Geneva: WHO; 1980.
21. Watts AM, Greenstock M, Cole RP. Outcome following the rehabilitation of hand trauma patients. The importance of a subjective functional assessment. *J Hand Surg Br* 1998; 23: 485–489.
22. Lawton EB. *Activities of daily living for physical dysfunction*. New York: McGraw-Hill; 1963.
23. Alexander M, Franko OI, Makhni EC, Zurakowski D, Day CS. Validation of a modern activity hand survey with respect to reliability, construct and criterion validity. *J Hand Surg Eur Vol* 2008; 33: 653–660.
24. Chung KC, Pillsbury MS, Walters MR, Hayward RA. Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am* 1998; 23: 575–587.
25. Seaton MK, Groth GN, Matheson L, Feely C. Reliability and validity of the Milliken Activities of Daily Living Scale. *J Occup Rehabil* 2005; 15: 343–351.
26. Stock S, Streiner D, Reardon R, Darzins S, Dilworth P, Tugwell P, et al. The impact of neck and upper limb musculoskeletal disorders on the lives of affected workers: Development of a new functional status index. *Qual Life Res* 1995; 4: 491.
27. Macey AC, Burke FD, Abbott K, Barton NJ, Bradbury E, Bradley A, et al. Outcomes of hand surgery. *J Hand Surg Br* 1995; 20: 841–855.
28. Bialocerkowski AE, Grimmer KA, Bain GI. Development of a patient-focused wrist outcome instrument. *Hand Clinics* 2003; 19: 437–448.
29. Cano SJ, Browne JP, Lamping DL, Roberts AHN, McGrouther DA, Black NA. The Patient Outcomes of Surgery-Hand/Arm (POS-Hand/Arm): a new patient-based outcome measure. *J Hand Surg Br* 2004; 29: 477–485.
30. MacDermid JC. Development of a scale for patient rating of wrist pain and disability. *J Hand Ther* 1996; 9: 178–183.
31. MacDermid JC, Tottenham V. Responsiveness of the disability of the arm, shoulder, and hand (DASH) and patient-rated wrist/hand evaluation (PRWHE) in evaluating change after hand therapy. *J Hand Ther* 2004; 17: 18–23.
32. Stratford PW, Binkley JM, Stratford DM. Development and initial validation of the upper extremity functional index. *Physiother Can* 2001; 53: 259–267.
33. Pransky G, Feuerstein M, Himmelstein J, Katz JN, Vickers-Lahti M. Measuring functional outcomes in work-related upper extremity disorders. Development and validation of the Upper Extremity Function Scale. *J Occup Environ Med* 1997; 39: 1195–1202.
34. Gabel CP, Michener LA, Burkett B, Neller A. The Upper Limb Functional Index: development and determination of reliability, validity, and responsiveness. *J Hand Ther* 2006; 19: 328–348.
35. Kus S, Oberhauser C, Cieza A. Validation of the brief International Classification of Functioning, Disability, and Health (ICF) core set for hand conditions. *J Hand Ther* 2012; 25: 274–286.
36. Streiner DL, Norman GR. *Health measurement scales: a practical guide to their development and use*. 4th ed. Oxford: Oxford University Press; 2008.
37. Cieza A, Stucki G. Content comparison of health-related quality of life (HRQOL) instruments based on the international classification of functioning, disability and health (ICF). *Qual Life Res* 2005; 14: 1225–1237.