J Rehabil Med 2011; 43: 374–381

REVIEW ARTICLE

DO PATIENT-REPORTED OUTCOME MEASURES USED IN ASSESSING OUTCOMES IN REHABILITATION AFTER HIP AND KNEE ARTHROPLASTY CAPTURE ISSUES RELEVANT TO PATIENTS? RESULTS OF A SYSTEMATIC REVIEW AND ICF LINKING PROCESS

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Objective: **To compare the contents of patient-reported instruments used in hip and knee arthroplasty rehabilitation with the International Classification of Functioning, Disability and Health (ICF).**

Methods: **A search of PubMed, CINAHL, Cochrane Central Registry, SCOPUS and PEDro identified patient-reported outcome instruments. The meaningful concepts extracted from the instruments were linked to the ICF based on established linking rules and compared with the osteoarthritis core set. The number of concepts per item, the breadth, and the depth of coverage of instruments in relation to the ICF were determined through calculation of content density, bandwidth per ICF component, and content diversity, respectively.**

Results: **Eight instruments were reviewed and 375 meaningful concepts were linked to the ICF. Activity and participation had the most representation (61%). The Hip Disability and Osteoarthritis Outcome Score and Knee Injury and Osteoarthritis Outcome Score had the widest coverage (bandwidth) for body functions (1.62%, 1.22%, respectively). The Arthritis Impact Measurement Scales had the broadest bandwidth (8.4%) for activity and participation. All tools addressed general mobility but lacked coverage in "driving", "assisting others", "interpersonal relationships" and "community life". The majority of tools did not address environmental factors.**

Conclusion: **Patient-reported outcome measures in arthroplasty rehabilitation do not fully address relevant areas of activity, participation and environment, suggesting limited clinical applicability.**

Key words: arthroplasty; joint replacement; ICF; outcome assessment; content validity.

J Rehabil Med 2011; 43: 374–381

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Submitted November 11, 2010; accepted February 16, 2011

INTRODUCTION

The increased aging of the population worldwide has led to a rise in chronic degenerative diseases, including osteoarthritis (OA). Osteoarthritis may affect up to 40% of persons aged over 65 years in the community (1). Amongst developed countries, it is 1 of the 3 most disabling conditions with a significant public health impact (2). Joint replacements are becoming more frequent for advanced OA. In the USA, Canada, Australia, New Zealand, England, Denmark, Norway, and Sweden, the crude incidence rates (per 100,000) range from 77 to 153 and from 66 to 143 for primary hip and primary knee arthroplasty, respectively (3). These procedures have been shown to improve pain and function (4, 5).

Following arthroplasty, patients may be referred for rehabilitation. A systematic review showed that early multidisciplinary rehabilitation after hip and knee joint replacement in patients with chronic arthropathy improves outcomes in terms of function, activity and participation (6). "Activity" is the execution of a task, while "participation" is the involvement in a life situation (7). With the increasing role of rehabilitation in the growing arthroplasty population, outcome assessment becomes important in determining the most effective and efficient rehabilitation strategy.

In rehabilitation, outcome measurement focuses on function, activity and participation. At present, many instruments are used to assess these outcomes (8), but there is little consensus on how these domains should be measured. Measures consist of radiographic parameters, implant analyses, performance-based tests, physician-based outcome measures and patient-reported outcome instruments (9). Of these, the patient-reported outcome instruments are frequently used with the increasing recognition and appreciation of patient perspective in outcome assessment. To determine whether patient-reported outcome measures are applicable in measuring the outcomes in hip/knee arthroplasty rehabilitation, two considerations are vital. These are: the relevance of the instrument for the study population and objectives; and the measurement attributes. Intuitively, the first thing most clinicians and researchers do is to look at the instrument and make a judgment as to whether it is reasonable and whether it appears to be assessing the desired outcomes. This represents face validity, where subjective judgment is made about its relevance and adequacy on the face of it (10). This concept is closely related to content validity, which considers

whether the instrument has enough items and covers all the relevant domains (10). Thus, content validity is the first and most crucial consideration. Instruments must reflect issues that are important to patients. Following arthroplasty, patients are concerned about their functioning and activities at home and in the community (11).

The International Classification of Functioning, Disability and Health (ICF) is an international framework for describing health and functioning of an individual (7). As such, it has been used as a reference to compare the contents of outcome instruments because it comprehensively defines function, activity and participation. Attempts in examining the contents of outcome measures following arthroplasty in relation to ICF have been made, but efforts so far involve classifying instruments in terms of the components (impairment, activity/disability, participation) covered (6, 8). A review showed that most tools used frequently measured impairment and activity and a few included participation (8). Another study looked at the items of OA-specific instruments and classified these as impairment, activity limitation or participation restriction based on definitions (12). A survey in Europe revealed that most tools for orthopaedic rehabilitation related to impairment measures (13). These studies, however, have not explicitly linked each meaningful concept within the items of the instruments to the specific components and categories of the ICF to allow for a detailed exploration and comparison of the contents of the instruments. One study linked two OA-specific outcome measures, the Western Ontario McMaster Osteoarthritis Index (WOMAC) and the Lequesne Algofunctional Index (LAI), to the ICF and showed common categories between the measures and the ICF (14). Another ICF-based comparison was performed particularly for hand OA questionnaires (15). To the best of our knowledge, a comprehensive examination of the contents of multidimensional, disease/site-specific patient-reported instruments used in arthroplasty rehabilitation has not been carried out. The results of the content examination will provide information on the extent, depth, and complexity of the measures to clarify their relevance, coverage and clinical applicability.

This paper compares the contents of patient-reported outcome measures used in hip and knee arthroplasty rehabilitation with the ICF.

METHODS

This study was part of a broader systematic review undertaken by our group to evaluate the measurement properties of current multidimensional patient-reported outcome instruments used in hip and knee arthroplasty rehabilitation.

Identification of studies

Literature search. We searched PubMed, CINAHL, Cochrane Central Registry, SCOPUS and PEDro in two stages using MESH and free text for literature published up to December 2009. The first stage of the literature search identified the multidimensional, patient-reported outcome tools used in hip/knee arthroplasty rehabilitation. The search terms were "arthroplasty," "replacement," "hip," "knee," "rehabilitation," "physiotherapy," "physical therapy," "exercise," "occupational therapy," "hydrotherapy," "gait training," "activity of daily living". The exact search terms varied per database. The second stage of the literature search looked for related studies on the measurement properties. The search terms were "arthroplasty," "replacement," "hip," "knee," valid*, reliab*, sensitiv*, responsive*, "ceiling effect", "floor effect", psychometric*, clinimetric, attribute*, "measurement properties", "instrument validation", "validation studies" and the name of the instrument.

Inclusion and exclusion criteria. We included patient-reported, multidimensional outcome measures in prospective studies and reviews involving arthroplasty patients undergoing any rehabilitation intervention/discipline. "Multidimensional" is defined in this review as 2 or more domains with at least one domain on activity or participation. A patient-reported instrument in this review is a tool that is exclusively patient-assessed and is either self- or interviewer-administered. Personalized tools where patients supply the domains were not included. We included only those instruments that were meant to be evaluative and not predictive. Studies with the aim of examining any of the measurement properties of instruments were included. Non-English studies, theses, conference proceedings, and studies with sample size of less than 10 were excluded. Three reviewers independently assessed the eligibility of the studies. The kappa statistic for agreement in study selection was calculated. For practicability reasons, we selected the most frequently-studied (≥ 2 clinimetric studies), specific (disease- or site-specific), multidimensional, patient-reported instruments.

Content coverage and content relevance

Linking procedure. The contents of each instrument were linked to the ICF based on established ICF linking rules (16, 17). For some of the instruments in this review that have already been linked (e.g. WOMAC, LAI, Health Assessment Questionnaire (HAQ)), linking procedures were no longer performed.

The categories of the ICF are arranged in a hierarchical nested structure represented by an alphanumeric code. The letter stands for the component (body functions, b; body structures, s; activity and participation, d; and environmental factors, e) and the numbers correspond to the categories (1st, 2nd, 3rd, 4th levels) (7) (Table I).

We first extracted the items from the patient-reported outcome measure and then identified the meaningful concepts per item. These meaningful concepts were then linked to the most specific ICF category. For example, an item from the Oxford Hip Scale (OHS), "Have you been able to *climb a flight of stairs*?" (18), has been linked to the ICF category "d4551 Climbing". Prior to the linking activity, the reviewers underwent orientation and studied references on linking rules (16, 17). Inter-rater reliability (kappa) for the linking procedure was performed.

We summarized the number of all the meaningful concepts and the number of the concepts that could not be linked. Concepts that are not currently classified in the ICF are represented as "not covered" (nc) (e.g. personal factors) and concepts that are not precise enough for linking are labelled as "not defined" (nd) (e.g. health). The frequencies of ICF components in the different instruments are also presented. For each instrument, content density, bandwidth (per ICF component), and content diversity indices were calculated (Table II). For instruments that were previously linked but indices were not reported, additional calculations were performed based on the reported linking. For instruments that were previously linked and indices were reported, these indices were incorporated in the review to aid comparisons among the tools.

Table I. *International Classification of Functioning, Disability and Health (ICF) structure (7)*

Level	Description	Coding
Component	Body Functions	b
1st (chapter)	Sensory functions and pain	b2
2nd	Sensation of pain	b280
3rd	Pain in body part	b2801
4th	Pain in joints	b28016

Table II. *Definition of concepts (15, 22)*

Content density: number of all meaningful concepts/number of items in the tool. A content density of 1 means that each item contains 1 concept and more than 1 means more than 1 concept (15, 22).
Bandwidth%: number of distinct ICF categories in the instrument/total number of ICF categories×100% (22). The greater the bandwidth, the greater the coverage that particular tool has of the ICF.
Content diversity: total number of the different ICF categories/number of the meaningful concepts in that instrument (15, 22). A value closer to 0 (lower diversity) suggests that several concepts of the tool correspond to the same ICF category. The lower the content diversity, the greater the depth that particular tool has for a certain area (15, 22).

Examining the content of the instruments in relation to the osteoarthritis core set

Using a matrix, we plotted the different concepts contained in the items of the instruments against the categories contained in the OA core set. The OA core set has been used as a yardstick in this review for several reasons. First, the majority of these procedures are done for severe or advanced OA. Secondly, the core set represents a spectrum of pertinent domains in patients with severe arthritis (19) and these concepts have been shown to be valid (20). Thirdly, the core set was able to show the changes in the profile of functioning of arthroplasty patients at the different evaluation time points following surgery (21).

RESULTS

The literature search identified 1702 titles and abstracts that were relevant to the research problem. The final selection identified 68 clinimetric studies examining 28 instruments, for which more than 2 clinimetric studies were reported for 8 instruments and these formed the basis of the review (Table III). The kappa statistic for agreement in identifying the studies ranged from 0.77 to 0.83, indicating good agreement.

Linking to the ICF

Meaningful concepts. A total of 375 meaningful concepts were identified from the selected instruments (Fig. 1). Thirty five percent of these ($n = 132$) were from the WOMAC, LAI, and HAQ, which were previously linked to the ICF (14, 15). The results from these studies were summarized and integrated in this review and additional calculations (e.g. content density, bandwidth, content diversity) were also performed when necessary to facilitate comparisons across the tools. The estimated kappa values for the reliability of the linkage procedure were 0.93, 0.96, 0.85, and 0.78 for the component, 1st, 2nd, and 3rd levels, respectively.

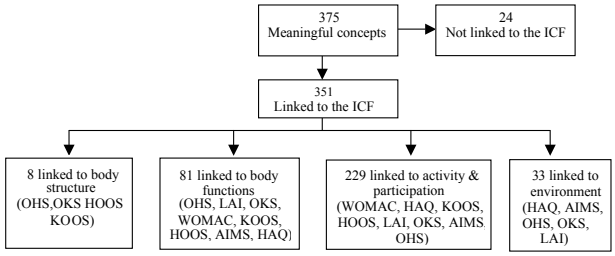

Fig. 1. Number of meaningful concepts identified in the multidimensional patient-reported outcome measures and their distribution across the major International Classification of Functioning, Disability and Health (ICF) components. OHS: Oxford Hip Score; OKS: Oxford Knee Score; HOOS: Hip Dysfunction and Osteoarthritis Outcome Score; KOOS, Knee Injury and Osteoarthritis Outcome Score; LAI: Lequesne Algofunctional Index; WOMAC: Western Ontario McMaster University Osteoarthritis Index; AIMS: Arthritis Impact Measurement Scales; HAQ: Health Assessment Questionnaire.

Representation of the meaningful concepts by ICF categories. Two hundred and twenty-nine (61%) concepts mapped to the activity and participation component (Fig. 1) . Twenty-four concepts (7%) were not linked and were coded "nd" e.g. *"because of your health"* or "nc" e.g. *"feel that nothing turned out for you the way you wanted it to"*. The concept "help needed" was coded as e3 as it was less precise than the available second-level categories in the chapter; and "help from someone" and "assisted by another person" were coded as e399 (unspecified).

Content density, bandwidth, content diversity indices. The LAI (hip and knee) had the biggest content density (2.6) while the Hip Disability and Osteoarthritis Outcome Score (HOOS) had the least (1.35). Of the 4 ICF components, activity and participation had the broadest coverage (highest bandwidth) (2.8–8.4%) among the tools, while body structure had the least bandwidth (from 0% to 0.32%). For body functions, the HOOS and Knee Injury and Osteoarthritis Outcome Score (KOOS) had the biggest bandwidth, 1.62 % and 1.22%, respectively. The

Table III. *Specific multidimensional patient-reported outcome measures in arthroplasty rehabilitation*

Name of instrument	Dimensions/domains	Items *n*
WOMAC (23)	Pain, physical function, stiffness	24
OKS (24)	Pain, physical function	12
OHS (18)	Pain, physical function	12
KOOS (25)	Pain, other disease-specific symptoms, ADL function, sport and recreation, function, knee-related quality of life	42
HAQ (26)	Disability, pain	20
HOOS (27)	Pain, symptoms, activity limitations-daily living, sport and recreation function, hip-related quality of life	40
LAI (28)	Pain or discomfort, maximum walking distance, physical disability	10
AIMS (29)	Mobility, physical activity, dexterity, household activity, social activity, activities of daily living, pain, depression, anxiety	45

WOMAC: Western Ontario McMaster University Osteoarthritis Index; OKS: Oxford Knee Score; OHS: Oxford Hip Score; KOOS: Knee Injury and Osteoarthritis Outcome Score; HOOS: Hip Dysfunction and Osteoarthritis Outcome Score; LAI: Lequesne Algofunctional Index; HAQ: Health Assessment Questionnaire; AIMS: Arthritis Impact Measurement Scales.

Table IV. *Frequencies of items, identified meaningful concepts and International Classification of Functioning, Disability and Health (ICF) categories and their relation to each other for frequently-studied specific multidimensional, patient-reported instruments applied in hip/knee arthroplasty rehabilitation*

							LAI[a]		
	WOMAC[a]	OKS	OHS	KOOS	HAQ[b]	HOOS	Hip	Knee	AIMS
Items, *n*	24	12	12	42	20	40	10	10	45
Meaningful concepts, *n*	33	26	25	57	47	54	26	26	81
Content density[c]	1.38	2.17	2.08	1.36	2.4	1.35	2.6	2.6	1.8
Concepts linked to the ICF, *n*	33	25	25	51	47	50	26	26	68
Per component, *n (%)*									
Body structure	0 (0)	3 (11.54)	3 (12)	1 (1.75)	0 (0)	1 (1.85)	0 (0)	0 (0)	0 (0)
Body functions	8 (24.24)	8 (30.77)	9 (36)	11 (19.3)	0 (0)	10 (18.52)	11 (42.30)	12 (46.15)	12 (14.81)
Activity & participation	25 (75.75)	13 (50)	12 (48)	39 (68.42)	35 (74)	39 (72.22)	14 (53.85)	13 (50)	39 (48.15)
Environmental	0 (0)	1 (3.85)	1 (4)	0 (0)	12 (26)	0 (0)	1 (3.85)	1 (3.85)	17 (20.99)
Concepts not linked to the ICF, *n*	0	1	0	6	0	4	0	0	13
Total number of different ICF categories used for linkage	19	18	17	34	31	34	17	17	43
Bandwidth %[d], *n*=1454[e]	1.31	1.24	1.17	2.34	2.13	2.34	1.17	1.17	2.96
Per ICF component									
Body structure, *n*	0	1	1	1	0	1	0	0	0
Bandwidth %, *n*=310	0	0.32	0.32	0.32	0	0.32	0	0	0
Body function, *n*	4	4	4	6	0	8	3	4	3
Bandwidth %, *n*=493	0.81	0.81	0.81	1.22	0	1.62	0.61	0.81	0.61
Activity & participation, *n*	15	12	11	27	28	25	13	12	33
Bandwidth %, *n*=393	3.82	3.05	2.8	6.87	7.12	6.36	3.31	3.05	8.4
Environmental factors , *n*	0	1	1	0	3	0	1	1	7
Bandwidth %, *n*=258	0	0.39	0.39	0	1.16	0	0.39	0.39	2.71
Content diversity[f]	0.58	0.72	0.71	0.60	0.70	0.62	0.65	0.65	0.53

[a]Based on linkage reported by Weigl et al. (14).
[b]Based on linkage and indices reported by Stamm et al. (15).
[c]Number of meaningful concepts/number of items.
[d]Number of distinct ICF categories/total number of ICF categories.
[e]Total number of all ICF categories.
[f]Total number of the different ICF categories/ number of the meaningful concepts in that instrument.
WOMAC: Western Ontario McMaster University Osteoarthritis Index; OKS: Oxford Knee Score; OHS: Oxford Hip Score; KOOS: Knee Injury and Osteoarthritis Outcome Score; HOOS: Hip Dysfunction and Osteoarthritis Outcome Score; LAI: Lequesne Algofunctional Index; HAQ: Health Assessment Questionnaire; AIMS: Arthritis Impact Measurement Scales.

Arthritis Impact Measurement Scales (AIMS) had the widest bandwidth (8.4%) for activity and participation, whereas the OHS had the narrowest (2.8%). The AIMS and WOMAC had the lowest content diversity ratios (0.53 and 0.58, respectively) (Table IV).

Examining the content of the instruments in relation to the osteoarthritis core set

"Sleep functions", "sensation of pain" and "sensations related to muscles and movement functions" were common in the majority of the tools. Only the AIMS covered "emotional functions". All tools addressed the following activity and participation categories: "changing basic body position", "walking" and "moving around". None of the tools addressed the specific areas "driving", "assisting others", "intimate relationships", "community life", "immediate family", "friends", "personal care providers and personal assistants", and "health professionals". The AIMS had the greatest coverage for activity and participation, while the LAI had the least. Among the environmental factors, "products and technology for personal use in daily living", "products and technology for personal indoor and outdoor mobility and transportation", and "design, construction and building products and technology of buildings for private use" were represented in 5 instruments (Table V).

DISCUSSION

This is the first study to compare the contents of multidimensional patient-reported outcome instruments applied to assess outcomes in hip and knee arthroplasty rehabilitation by linking the meaningful concepts from the instruments' items to the ICF as well as relating these to specific categories of the OA core set. There are 2 key findings in this review. First, activity and participation had the most representation in all the instruments, but the relevant activity and participation issues were not fully captured. Secondly, significant environmental factors were not addressed in the majority of the tools.

Of the 4 ICF components, activity and participation accounted for nearly two-thirds of the contents of all the reviewed instruments. A similar focus on this component is evident in tools that assess outcomes in neurological and musculoskeletal conditions (14, 15, 22). Participation encompasses domains related to community reintegration and quality of life (7). Two weeks following hip and knee arthroplasty, patients rank par-

Table V. *International Classification of Functioning, Disability and Health core set for osteoarthritis categories represented in specific, multidimensional patient-reported instruments used to assess outcomes in hip and knee arthroplasty*

							LAI		
	WOMAC	OKS	OHS	KOOS	HOOS	HAQ	Hip	Knee	AIMS
BODY STRUCTURE									
s720 Structure of shoulder region									
s730 Structure of upper extremity									
s740 Structure of pelvic region									
s750 Structure of lower extremity		+	+	+	+				
s770 Additional musculoskeletal structures related to movement									
s799 Structures related to movement, unspecified									
BODY FUNCTIONS									
b130 Energy and drive functions									
b134 Sleep functions	+	+	+	+	+				
b152 Emotional functions									+
b280 Sensation of pain	+	+	+	+	+	+	+	+	+
b710 Mobility of joint functions				+	+				
b715 Stability of joint functions		+		+	+				
b720 Mobility of bone functions									
b730 Muscle power functions									
b735 Muscle tone functions									
b740 Muscle endurance functions									
b760 Control of voluntary movement functions								+	
b770 Gait pattern functions		+	+						
b780 Sensations related to muscles and movement functions	+		+	+	+		+	+	+
ACTIVITY AND PARTICIPATION									
d410 Changing basic body position	+	+	+	+	+	+	+	+	+
d415 Maintaining a body position	+			+	+		+	+	
d430 Lifting and carrying objects						+			+
d440 Fine hand use					+	+	+		+
d445 Hand and arm use				+	+	+			+
d450 Walking	+	+	+	+	+	+	+	+	+
d455 Moving around	+	+	+	+	+	+	+	+	+
d470 Using transportation		+	+						+
d475 Driving									
d510 Washing oneself	+	+	+	+	+	+			+
d530 Toileting	+			+	+	+			+
d540 Dressing	+		+	+	+	+	+		+
d620 Acquisition of goods and services	+	+	+	+	+	+			+
d640 Doing housework	+	+	+	+	+	+			+
d660 Assisting others									
d770 Intimate relationships									
d850 Remunerative employment		+	+						
d910 Community life									
d920 Recreation and leisure	+				+				+
ENVIRONMENTAL FACTORS									
e110 Products or substances for personal consumption									
e115 Products and technology for personal use in daily living						+			+
e120 Products and technology for personal indoor and outdoor mobility and transportation		+	+			+	+	+	+
e135 Products and technology for employment									
e150 Design, construction and building products and technology of buildings for public use									
e155 Design, construction and building products and technology of buildings for private use									+
e225 Climate									
e310 Immediate family									
e320 Friends									
e340 Personal care providers and personal assistants									
e355 Health professionals									
e410 Individual attitudes of immediate family members									
e450 Individual attitudes of health professionals									
e460 Societal attitudes									
e540 Transportation services, systems and policies									
e575 General social support services, systems and policies									
e580 Health services, systems and policies									

WOMAC: Western Ontario McMaster University Osteoarthritis Index; OKS: Oxford Knee Score; OHS: Oxford Hip Score; KOOS: Knee Injury and Osteoarthritis Outcome Score; HOOS: Hip Dysfunction and Osteoarthritis Outcome Score; HAQ: Health Assessment Questionnaire; LAI: Lequesne Algofunctional Index; AIMS: Arthritis Impact Measurement Scales.

ticipation issues as most important as they think about returning to their previous life at home and in the community (30).

The AIMS had the broadest bandwidth for activity and participation, while the OHS had the narrowest. This suggests that the former has more concepts relating to the ICF activity and participation component and thus has wider coverage or breadth. The AIMS captured areas of mobility, activities of daily living, shopping, and domestic activities. However, it did not address specific relevant categories for patients with hip and knee OA such as "maintaining body position", "driving", "assisting others", "intimate relationships", "remunerative employment" and "community life". "Driving a car" is an important issue for pre-operative and post-operative lower limb arthroplasty patients (11, 31, 32). Patients under 65 years of age are concerned about return to work (31). The AIMS was developed for rheumatic conditions (e.g. rheumatiod arthritis, OA) and not specifically for lower extremity arthritis (29). Its scope also includes hand and fine motor use, which may not be very relevant to patients with arthritis primarily affecting the hips and knees. On the other hand, the OHS and Oxford Knee Score (OKS) were specifically developed for hip and knee arthroplasty populations respectively; however, these did not also address the above-mentioned categories as well as pertinent areas such as "toileting" and "dressing" (for OKS), and "recreation and leisure". "Return to hobbies or leisure" is a goal of pre- and post-arthroplasty patients (11, 32).

The activity and participation bandwidth of the widely-used tool, WOMAC, was also narrower than those of the AIMS, KOOS, HOOS and HAQ, implying a relatively smaller scope. The WOMAC has fewer distinct activity and participation concepts compared with the others and focuses on specific issues in lower extremity OA for which it was developed (23). The WOMAC covered more than half the activity and participation categories of the OA core set. However, like the AIMS, the WOMAC did not address significant areas, such as "using transportation", "driving", "assisting others", "intimate relationships", "remunerative employment", and "community life". The KOOS and HOOS were developed as extensions of the WOMAC to include the issues of younger and more active individuals and have additional items on sports activities (25, 27, 33), thus the relatively greater bandwidth. Despite this, they are not different from the WOMAC in the lack of representation of the aforementioned concerns. Interestingly, another study that utilized focus group discussions also showed that the KOOS and WOMAC did not pick up more than 50% of patients' issues (11).

For function, the KOOS had the highest bandwidth, as it has more detailed functions of joints (e.g. mobility and stability), which the other instruments lacked (25). Joint stiffness and range of motion are major concerns found in several studies (11, 31, 32). The constant area addressed by all the tools was "sensation of pain". Patients who are undergoing hip/knee arthroplasty are considered to have a more advanced stage of arthritis and have more severe pain when walking and at night (34). Decrease in pain in the surgical joint is a primary concern found in both pre- and post-operative patient groups (11, 31, 32). The other common area was "sleep functions". Arthritis patients experience sleep disturbances (35) and "sleeping better at night" is an issue for post-arthroplasty patients (11). Only one instrument (AIMS) looked at emotional functions although depression is a common finding in patients with OA (36).

As for depth of coverage, the AIMS and WOMAC explores certain ICF categories in greater detail compared with the other tools, as evidenced by their low content diversity indices. Instruments with low indices tend to be more specific and probing (22). The AIMS has no less than 4 items addressing each domain on mobility, physical activity, dexterity, household activities, activities of daily living, and social activities. The WOMAC contains several items concepts that focus on a distinct ICF category. This is evident for the categories "maintaining a lying position", "maintaining a sitting position", "climbing", and "pain in joints". The OKS and OHS had the highest indices and are more parsimonious with their items.

Whilst adequate representation of the relevant issues is important, the complexity (or simplicity) of the instruments is another consideration. The instruments included in this study varied in their number of items and meaningful concepts. The LAI (hip and knee) had the highest content density index as more concepts are contained in an item, suggesting the complexity of the tool. For example, an item in LAI asks about pain and discomfort during nocturnal bed rest on movement or in certain positions. On the other hand, the HOOS, KOOS, and the WOMAC had the lowest indices. The WOMAC also had the least items. A tool with a relatively lower content density and smaller number of items might be simpler to use. The majority of patients undergoing arthroplasty due to chronic arthropathy are 65 years of age or older and may have reduced physical endurance and mental concentration. Therefore, a less complicated tool might be a more appropriate and practical instrument choice.

The other main finding in this review relates to the lack of coverage of the tools for environmental factors. Environmental factors (e.g. devices, relationships) can modify functioning (7) and can help in community reintegration. The AIMS had extensive coverage for mobility devices, equipment for personal use in daily living, and support and relationships compared with the other tools. The HAQ included items pertaining to "assistive products and devices" for personal use in daily living and mobility, as also reported in another study (15). The environmental component was not represented in WOMAC, KOOS and HOOS. The majority of environmental factors, particularly support and relationships, attitudes and services, in the OA core set were not addressed in nearly all instruments. Post-arthroplasty patients worry about the support from family members, neighbours and healthcare workers (11).

The study offered insights into the similarities and differences, relevance and adequacy, as well as breadth and depth of existing instruments in arthroplasty rehabilitation. This may guide appropriate tool selection as well as further instrument improvement and development. The study had several limitations. The tools included in this ICF-based content comparison study were identified based on a literature search for clinimetric studies, as this was part of a broader review of psychometric properties of evaluative instruments

in arthroplasty. We limited the study to specific tools and did not compare these with generic ones. For content validation, a common method utilizes some form of review by an expert panel (10). We assumed that content examination in relation to the ICF and the OA core set would be adequate for the purpose of this study. The ICF was used as standard because it provides a comprehensive model of functioning and at present there is no gold standard with which the contents of tools could be compared. In addition, the OA core set was derived from a consensus process using Delphi exercise, empirical data collection and literature search representing physician, patient and researcher perspectives, respectively (19). This core set, however, specifies categories pertinent for persons with OA affecting any joint and is not limited to the hip and knee or those undergoing arthroplasty. In the linking process, we relied on two raters and the reliability of the procedure could further be strengthened with the increase in the number of raters. The differentiation between activity and participation was not done in the items of instruments that contain concepts concerning aspects of the component activity and participation. Also, other important factors (e.g. personal) affecting outcomes are not currently classified in the ICF. In this paper, only the contents of instruments were examined. In clarifying the clinical applicability of these instruments in arthroplasty rehabilitation, other considerations would include psychometric attributes and practical aspects, and these are discussed in a separate paper.

In conclusion, the comparison of the contents of existing multidimensional patient-reported outcome instruments in hip and knee arthroplasty rehabilitation with the ICF and OA core set found some gaps in coverage for significant areas of activity, participation and environment that are necessary in adequately assessing rehabilitation outcomes. This could be a limitation when used in arthroplasty rehabilitation outcome studies, but also provides the basis for further improvement and development of outcome assessment instruments in the field of arthroplasty rehabilitation.

ACKNOWLEDGEMENTS

The authors would like to thank Ms Alex Gorelik (Centre for Clinical Epidemiology, Biostatistics and Health Services Research The University of Melbourne and The Royal Melbourne Hospital) for statistical support.

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