Journal of Hand Therapy 32 (2019) 243–261

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

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Scientific/Clinical Article

# Linking commonly used hand therapy outcome measures to individual areas of the International Classification of Functioning: A systematic review

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ARTICLE INFO

*Article history:*
Received 11 August 2017
Received in revised form
21 November 2017
Accepted 25 November 2017
Available online 9 February 2018

*Keywords:*
Patient-reported outcomes
Hand therapy
Linking to ICF

ABSTRACT

*Study Design:* Systematic review.
*Introduction:* Identifying outcome measures that correspond to the International Classification of Functioning (ICF) provides insight into selecting appropriate outcome tools in hand therapy practice.
*Purpose of the Study:* The objective of this study is to systematically review patient-reported outcome measures commonly used in hand therapy to determine the extent to which the content represents the biopsychosocial view of the ICF.
*Methods:* A comprehensive literature search was conducted. Studies that met inclusion criteria were identified, and outcome measures were extracted. The meaningful concept was determined for each item on the measure and linked to the most specific ICF category. Summary linkage calculations were completed.
*Results:* Eleven patient-reported outcomes were identified from 43 included studies. Activity and participation had the highest content coverage followed by body functions. There was linking to personal factors and not defined—disability and mental health. Environmental factors were not represented in any of the included outcome measures. The core set representation of unique codes ranged from 8.55% to 18.80% (mean: 11.97%) for the Comprehensive ICF Core Set for Hand Conditions and from 30.43% to 47.83% (mean: 31.40%) for the Brief ICF Core Set for Hand Conditions. The percent representation of the Comprehensive ICF Core Set for Hand Conditions for unique disability ranged from 21.62% to 43.24% (mean: 20.33%) and from 62.50% to 87.50% (mean: 72.22%) for the Brief ICF Core Set for Hand Conditions.
*Discussion:* None of the included measures represent all categories of the ICF Core Sets for Hand Conditions.
*Conclusion:* Utilizing the most recent refinement rules for the linking process, this study provides comparisons of measures along with clarity of content coverage for the most commonly used tools in the practice of hand therapy.



## Introduction

It has been established that individuals with a hand, wrist, or elbow injury or impairment incur many functional performance deficits including difficulty with self-care,[1,2] work,[3] mobility,[4] homemaking, and housekeeping activities,[5] along with social[6] and economical[7] implications. The introduction of patient-reported outcome measures (PROs) has been helpful for clinicians practicing in the field of hand therapy as it has allowed a paradigm shift from a pure biomechanical assessment to a more comprehensive assessment of the patient as a whole. These instruments are useful tools for identifying functional deficits, outlining patient-centered treatment plans, and establishing collaborative goals. There are a plethora of available PROs and they may be joint specific, disease specific, or region specific, and the determination as the most appropriate tool may in part be guided by the psychometric properties of the tool and its relevance to the patient.

Despite an increase in popularity of PROs noted in the hand therapy literature and via survey study,[8] it remains unclear whether the "commonly" used tools are representative of the current concepts and constructs of the International Classification of

The authors received no funding for this project and have no financial disclosures.
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https://doi.org/10.1016/j.jht.2017.11.039

Functioning (ICF).[9] The purpose of the ICF and its biopsychosocial philosophy is to describe a person's health and his or her lived experience of health[9] with a focus on an individual's ability to function and interact with his or her environment. The ICF contains 1450 hierarchically organized categories.[10] There are 2 main components to the ICF. Part 1 involves functioning and disability and includes the categories related to body functions (physiological functions of the body systems), body structures (anatomical parts of the body), and activity and participation (execution of a task or action by an individual and involvement in life situations, respectively).[9,10] Part 2 covers what has been termed contextual factors and includes environmental factors (the physical, social, and attitudinal environment in which people live), which serve as facilitators or barriers to health, and the not yet classified personal factors.[9,10] Personal factors are described as an individual's demographic information, inherent physical and mental constitution, attitude, behavior pattern, coping skills, and life situation.[11]

In an effort to make the ICF applicable in practice and to provide a better description of functioning and disability, ICF Core Set for hand conditions were developed.[12] ICF Core Set for hand conditions facilitates the description of function in clinical practice by providing the lists of categories that are relevant for specific health conditions. For example, the Comprehensive Hand Core Set includes 117 components, 37 of which refer to the activity and participation categories, including writing, carrying out daily routine, and using communication devices and techniques.[13] There is also a Brief Core Set for hand conditions which is a more concise reference with 23 categories.[13]

Identifying PROs that characterize and correspond to the domains of the ICF will provide greater insight into selecting appropriate outcome tools in hand therapy practice. In a qualitative study, Coenen et al.[14] identify a gap in the current PROs specific to environmental factors including the support needed from colleagues, family, and friends following a hand injury or disorder. In a systematic review linking flexor tendon rehabilitation to ICF components, Oltman et al.[15] found that although activity and participation restrictions are considered, health outcomes typically refer to physical impairment. A systematic review[16] of outcomes used after carpal tunnel release concurs with the aforementioned findings and suggests that there is an opportunity to use more PROs in outcome assessment to more comprehensively address a patient's status and cover the categories of the ICF. Another systematic review[17] regarding orthotic intervention and carpometacarpal joint osteoarthritis concludes that employing the use of outcome measures that comprehensively include the ICF Core Sets will better define functional status of individuals following a hand injury. Lawrence et al.[18] note that the multidimensional ICF model underscores the need to examine outcome measures across the 3 ICF components in functioning and disability, while at the same time, mapping them to meaningful functional domains. This holds especially true when considering the highly complex nature of the hand and its impact on activity and quality of life. Although there is increased recognition for the importance of assessing activity and participation, environmental factors, and personal factors, there is a paucity in the literature for supportive evidence that our current PROs are fully reflective of the constructs of the ICF framework.

### *Purpose of the study*

The purpose of this systematic review is to determine if the content of commonly used PROs in hand therapy (for assessment of hand, wrist, and elbow involvement) is inclusive and representative of the biopsychosocial perspective of the ICF framework.

## Methods

### *Identification and selection of studies*

Inclusion and exclusion criteria for the articles were identified. Inclusion criteria were randomized controlled trials (RCTs) that include participants with an orthopedic hand, wrist, forearm, or elbow injury and assess hand therapy interventions, published between 2012 and March 2017, written in English, and with participants aged 18 years or older. In addition, one of the outcome measures in the study had to be a validated PRO. Articles were excluded if the hand condition was related to a neurological condition, the orthopedic condition involved the shoulder or neck, the intervention involved treatment not able to be performed by a hand therapist, or if a validated PRO was not included as an outcome measure.

### *Search strategy*

A computer search was conducted using the following databases: PubMed, Physiotherapy Evidence Database (PEDro), OTseeker, and ProQuest. Refer to Table 1 for detailed information on the search strategy. The literature search was conducted by the 2 authors who performed separate but identical searches of the same previously selected databases and discussed their findings to jointly determine if each paper identified was eligible. Both authors performed abstract screening of all potential hits. Bibliographies of relevant papers were reviewed, and additional hand searches were performed to identify potential additional studies. There was no difference in opinion between the authors as to which papers would be included.

### *Data extraction and analysis*

Descriptive information was gathered from the included studies to provide relevant information to the reader. This information

**Table 1**
Search strategy and search terms using PICO analysis

| PICO category | Definition | Main search terms |
|---|---|---|
| Participants | Individuals aged 18 years and older receiving hand therapy intervention for an orthopedic hand, wrist, or elbow injury or disease | Hand, wrist, forearm, elbow, injury, carpal tunnel syndrome, distal radius fracture, Dupuytren's contracture, extensor tendon, flexor tendon, arthritis, lateral epicondylitis, mallet finger, thumb CMC arthritis, nerve, medial epicondylitis, TFCC, ligament, dislocation, fracture, cubital tunnel syndrome, joint sprain, trigger finger, crush injury, de Quervain's syndrome, tendonitis, pain syndrome, burn, and carpal instability |
| Intervention | Hand therapy treatment | Hand therapy, therapy, and rehabilitation |
| Comparison | Different hand therapy treatment or placebo | |
| Outcome | Patient-reported outcome measure (validated) | Questionnaire and function |
| Study design | Randomized controlled trials | RCT |

PICO = participant, intervention, comparison, outcome; TFCC = triangular fibrocartilaginous complex; CMC = carpometacarpal; RCT = randomized controlled trial.

substantiated that each study included a treatment that could be rendered by an occupational or physical therapist and to verify that the outcome assessment tool had been previously validated for the hand and upper extremity population. Outcome measures were extracted and defined. The outcome of interest was defined as an outcome measure if data calculations were performed on the validated measure and if it addressed the orthopedic condition or diagnosis being studied. The outcome instrument and the primary constructs it measures were then identified and categorized according to the ICF. The number of meaningful concepts in each outcome measure according to the ICF was recorded.

*Linking to the ICF*

The outcome measures used in the studies were linked to the ICF following the procedure described by Cieza et al.[10,19] Additional research[20-26] was referenced for further interpretation and assignment of meaningful concepts. The ICF framework was used to analyze and determine whether the outcome assessment tools commonly used for hand-related diagnoses characterize and represent the ICF components of health outcomes (body structures, body functions, activity and participation, environmental factors, personal factors, not defined [nd], or not covered [nc]).

An item analysis was completed for the included outcome measures to determine the number of meaningful concepts in each of the PROs. Each individual question from each PRO was linked to the most specific category and level of the ICF by the authors based on the definition of each category. If a meaningful concept was nc by the ICF, it could be linked to nc, which includes nc health condition (nc-hc) or nc quality of life (nc-qol).[10] In addition, there are several nd categories of the ICF including not defined-general health (nd-gh), physical health (nd-ph), mental health (nd-mh), development (nd-dev), and not defined-disability (nd-dis) and not defined-functioning (nd-func).[10] The nd categories can be used when the information provided is not sufficient for making a decision about ICF category.[10]

The ICF Comprehensive Core Set for hand conditions was used as a reference during linking. However, other categories and levels were used from the ICF to allow for appropriate linking of the included PROs considering the specificity of the latest refinements of the linking rules.[10] The authors linked each PRO individually and then came to a consensus on linking. If there were discrepancies in linking, a third reviewer could be consulted although not needed for this review. The authors are certified hand therapists with prior experience researching the ICF framework in relation to outcome assessment and the hand and upper extremity. Consensus was measured by percentage agreement between the raters and was calculated by dividing the observed agreement by the possible agreement.[27]

*ICF linkage calculations/summary linkage indicators*

Calculations were completed to provide further information on the coverage of the ICF related to each PRO via summary linkage indicators. The calculations used were proposed by MacDermid.[25] The measure of ICF linkage was determined using the formula (total number of items on the PRO that were linked to at least 1 ICF code/total number of items on the PRO) × 100%.[25] Core set representation was determined using the formula (number of unique ICF codes from the measure that appear in the Comprehensive ICF Core Set for Hand Conditions/total number of codes on the Comprehensive ICF Core Set for Hand Conditions) × 100%.[25] This calculation was also run for the Brief ICF Core Set for Hand Conditions substituting the Brief ICF Core Set for Hand Conditions figures in the formula. In addition, the core set unique disability representation was calculated using the formula (number of unique [d] codes from measure that appear in the Comprehensive ICF Core Set for Hand Conditions/total number of disability codes on the Comprehensive ICF Core Set for Hand Conditions) × 100%.[25] This calculation was also run for the Brief ICF Core Set for Hand Conditions. Disability in this case refers to activity and participation codes. Since functional outcome measures are a measure of disability, this calculation was included to help determine the extent to which they measure this aspect of content.[25]

The ICF contains main or first-level categories, which are broader headings such as d9 community, social, and civic life. Under these falls, more specific second levels such as d920 recreation and leisure and under that a third level of d9201 sports. When determining the number of unique ICF codes from each measure that appear in the core set, items that fell under more specific categories of the core set were counted once under the lower level that the core set contained. So for instance, the Disabilities of Arm, Shoulder and Hand (DASH) was found to link to d9204 hobbies in 4 questions and d9201 sports in 4 questions, but this was counted as 1 unique ICF code under the d920 recreation and leisure when considering the Comprehensive Core Set for hand conditions because d920 recreation and leisure is part of the Comprehensive Core Set, but the more specific codes for d9204 hobbies and d9201 sports are not. The optional module was included in the numbers for the DASH-related calculations. In the calculations, the total number of codes in the Comprehensive Core Set for hand conditions is 117 and 23 total for the Brief Core Set. There are 37 (d) codes in the Comprehensive Hand Core Set and 8 in the Brief Hand Core Set.[12,13]

*Study quality assessment*

The quality of the included studies was evaluated as a requirement of a systematic review using the PEDro scale. The PEDRo scale is an 11-item tool developed to rate the quality of RCTs on physical therapy interventions. The tool is scored between 0 and 11 with a point being awarded for each of the 11 criteria/items met by the RCT (with 11 being the highest score). It has been found to be valid[28] and reliable.[29] Each of the reviewer's scores were blinded to the other reviewer until scores were compared. Discrepancies were discussed until consensus was achieved.

## Results

*Search results*

The initial search strategy identified a total of 3145 papers. Following the removal of duplicates, a total of 2732 potentially relevant papers remained. After screening of abstracts and titles, 59 papers were reviewed in full text, revealing that 16 of these papers did not fully meet inclusion requirements. Forty-three studies[30-72] fully met the inclusion criteria for this review. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram depicts the flow of information through the different phases of the systematic review (Fig. 1).

*Included studies*

RCTs from the past 5 years that were published in English were used to identify commonly used and psychometrically sound PROs in the field of hand therapy. Therefore, the PROs identified and discussed in this review are not all inclusive. The 43 included studies involved a total of 2972 subjects with diagnoses impacting functional activity performance with elbow, wrist, or hand involvement including carpal tunnel syndrome,[44-47,61,64,67,68]

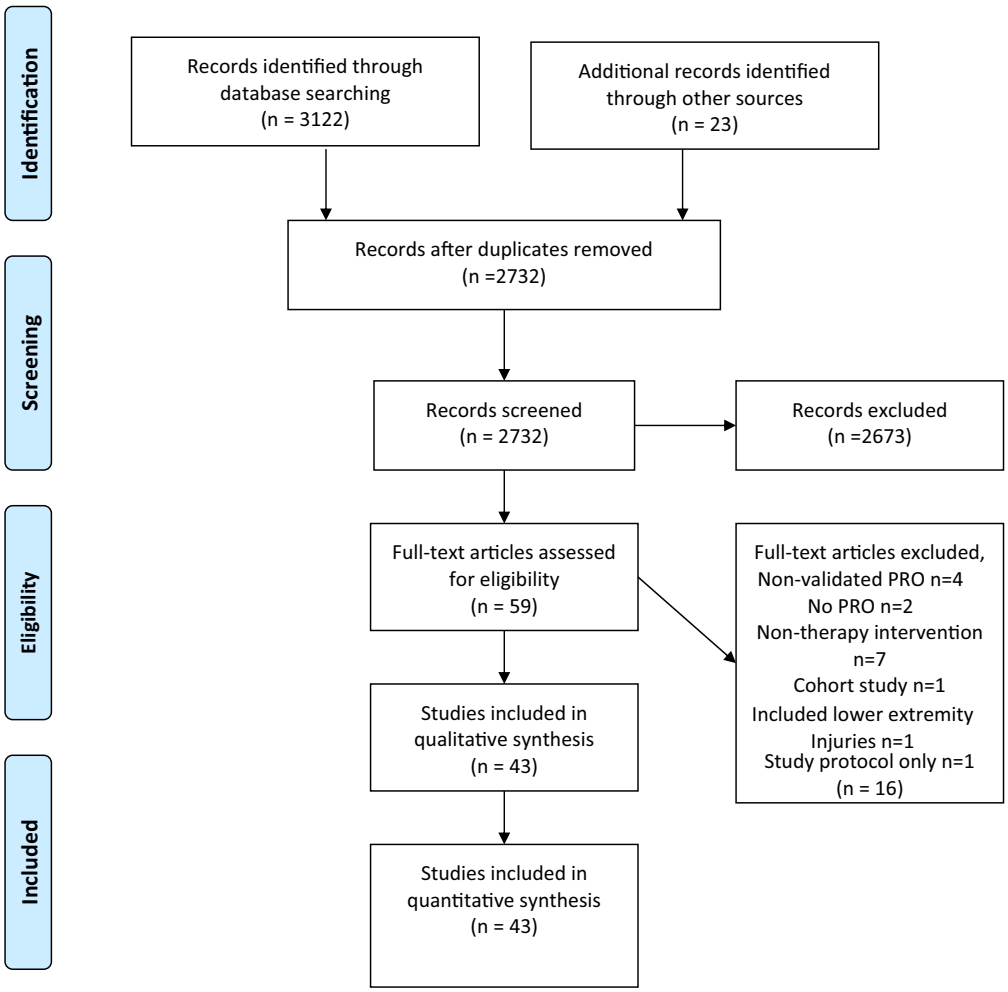


**Fig. 1.** PRISMA 2009 flow diagram. PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

osteoarthritis,[31,32,42,52-54,63,65,71] rheumatoid arthritis,[58] distal radius fracture,[33,37,48,51,59,60,66,69] joint contracture and decreased range of motion,[30,34,36,38,40,42,49,66] lateral epicondylitis,[55-57,72] Dupuytren's disease,[35] hand and wrist fractures,[62] thumb ulnar collateral ligament repair,[70] and nerve and tendon lacerations and repairs.[38,39,41,43] The interventions provided in the studies varied and included supervised/skilled therapy vs performance of home exercises,[36,48,51,52,56] core stabilization,[30] mirror therapy,[41,42,59] a variety of therapeutic modalities,[44,45,54,57,61,62,64,67] elastic taping,[46,72] myofascial release,[55] joint protection and exercises,[63] orthoses,[65,66,70,71] massage technique,[68] strength training for the noninvolved extremity,[69] and occupation-based interventions.[36,43] A majority of the included studies involved 1 PRO, but all the studies also included other assessment tools to evaluate body functions such as range of motion and strength or body functions such as altered sensation. Detailed descriptive information specific to the study participants, outcome measures, intervention, and main findings is provided in Table 2.

*Patient-rated outcome measures and linking to the ICF*

In the 43 included studies, 11 outcome instruments were identified that are self-reported by the patient and have been validated for hand injuries or conditions. Table 3 describes the PROs and provides information on their psychometric properties. Reporting the psychometric properties was done via individual searching of the particular measure, specifically, validity, responsiveness, and minimal clinically important difference, if established. The DASH was incorporated most frequently as the primary or secondary outcome tool and was included in 14[30-43] of the 43 included studies. The Boston Carpal Tunnel Questionnaire was the second most commonly used PRO and was included in 8 studies.[44-47,61,64,67,68] The Patient-Rated Wrist (Hand) Evaluation was represented in 6 studies,[48-51,66,69] the Functional Index for Hand Osteoarthritis[52,53,71] or the Dreiser Functional Index[54,70] was used in 5 studies, and the Patient-Rated Tennis Elbow Evaluation was used in 4 studies.[55-57,72] The Canadian Occupational Performance Measure was incorporated in 3 studies[36,43,66] as were the QuickDASH[48,49,62] and the Australian Canadian Osteoarthritis Hand Index.[54,63,65] The Michigan Hand Questionnaire (MHQ)[54,58] and the Patient-Specific Functional Scale[52,53] were each incorporated twice. One measure was found in only 1 study; the Manual Ability Measure-36.[60] Table 3 also presents the frequency of incorporation of each PRO in the studies included in this systematic review. The Patient-Specific Functional Scale and the Canadian Occupational Performance Measure were not able to be included in further data calculations or analysis as the items included on these questionnaires are specific to each patient and by the patient at the time of use.

A detailed item analysis was completed for each PRO in order to most effectively link to the ICF. Refer to Appendices A-H for the specific linking process for each question on each of the 9 PROs. There was 100% consensus between reviewers on the linking. The

**Table 2**
Descriptive information on the included studies

| Study | Participants | Intervention | Validated patient-reported outcome measure | Main findings |
|---|---|---|---|---|
| Ahyan et al (2014)[30] | 27 individuals with wrist and elbow disorders | Core stabilization exercises in addition to routine intervention vs routine intervention | DASH | Core stabilization exercises assisted with decreasing compensatory movement patterns and participants demonstrated a trend toward better functional outcomes than controls. |
| Barbosa et al. (2015)[44] | 48 individuals with CTS | Use of an orthosis, patient education, and low-level laser therapy vs orthosis and patient education | BCTQ | A minimal clinical change was observed via severity of symptoms, subdomain of the BCTQ favoring the low-level laser therapy group, otherwise no difference between groups. |
| Bani et al (2013)[31] | 35 participants with symptomatic arthritis at the base of the thumb | Prefabricated, neoprene vs a custom-made thumb orthosis | DASH | Pain decreased to a greater extent with use of the custom orthosis. Function and pinch strength increased for both groups. |
| Banyon et al (2016)[59] | 22 patients with closed distal radius fractures | Conventional skilled therapy with mirror therapy vs conventional skilled therapy alone | Q-DASH | Both groups had improved motion, pain, and function, but there were no differences between groups. |
| Becker et al (2013)[32] | 119 participants clinically diagnosed with arthritis at the base of the thumb | Prefabricated neoprene orthosis vs a custom orthosis with the thumb MP joint included | DASH | There was no detectable difference in function, pain, grip, and pinch strength or satisfaction between groups. |
| Brehner and Husband (2014)[33] | 81 patients after operation for an ORIF to stabilize a distal radius fracture | An accelerated vs a standard rehabilitation protocol | DASH | Patients with accelerated rehab program had more mobility, strength, and function at the early postoperative time points (0-8 weeks). |
| Bruder et al (2016)[48] | 35 adults treated with a cast following a distal radius fracture | A program of exercise and structured advice vs structured advice only | PRWHE and Q-DASH | There was no difference between groups in function, motion, strength, and pain. |
| Cantero-Tellez et al (2015)[34] | 60 adults with a proximal interphalangeal joint flexion contracture | An exercise program vs a static progressive night orthosis and a dynamic daily orthosis | DASH | The orthosis group had a greater increase in proximal interphalangeal joint extension, but there was no difference in the improvement in function between groups. |
| Chang et al (2014)[45] | 60 individuals with CTS | Use of an orthosis and paraffin treatments vs use of an orthosis and ultrasound therapy | BCTQ | Symptom severity scores improved in both groups, but after adjusting for age, gender, and baseline data, only the ultrasound group improved in function and pain. |
| Chang et al (2014)[62] | 50 people with a closed bone fracture in the wrist and hand | Use of low-level laser therapy vs sham placebo | QuickDASH | Pain, functional disability, and grip strength were significantly more improved in the laser group. |
| Collis et al (2013)[35] | 56 patient after surgery for Dupuytren's contracture | Night extension orthosis vs hand therapy without orthosis | DASH | There were no differences between groups for ROM, grip strength, and function. |
| Daud et al (2016)[36] | 46 adults with hand injuries | Occupation-based intervention and therapeutic exercise vs therapeutic exercise alone | DASH COPM | The individuals in the occupation-based intervention group had greater improvements in their function, ROM, pain, and satisfaction. |
| Dilek et al (2013)[54] | 56 patients with bilateral hand OA | Paraffin hand bath treatments vs control | AUSCAN Dreiser Functional Hand Index | Individuals in the paraffin bath treatment group had less pain and stiffness and better strength than the control group. |
| Dundar et al (2015)[57] | 93 patients with lateral epicondylitis | High-intensity laser therapy vs counterforce brace vs placebo treatment | PRTEE | Individuals in the laser therapy and brace groups had improvement in their pain, grip strength, and function. |
| Dziedzic et al (2015)[63] | 257 individuals with hand OA | Joint protection alone vs hand exercises alone vs joint protection and hand exercises combined vs no joint protection or hand exercises | AUSCAN | Differences in outcomes were not noted except improvement in pain self-efficacy with joint protection at 6-month follow-up. |
| Filipova et al (2015)[37] | 61 people conservatively treated after distal radius fracture | Physical therapy vs physical and occupational therapy | DASH | Grip strength was greater in the physical and occupational therapy group between weeks 12-16. |
| Fusakul et al (2014)[64] | 66 individuals (112 hands) with CTS | Low-level laser treatment with orthosis use vs placebo treatment with orthosis use | BCTQ | Distal motor latency of the median nerve and grip strength were significantly better in the laser treatment group. |
| Geler-Kulcu et al (2015)[46] | 45 patients (65 wrists) with CTS | Experimental elastic taping vs placebo elastic taping, vs orthosis | BCTQ | All groups had improvement in pain and function. The orthosis group had an increase in grip strength. |

(*continued on next page*)

**Table 2** (*continued*)

| Study | Participants | Intervention | Validated patient-reported outcome measure | Main findings |
|---|---|---|---|---|
| Gruber et al (2014)[38] | 41 patients with a conservatively treated mallet finger injury | Night orthosis following immobilization vs no night orthosis | DASH | There were no differences between groups for extensor lag, function, and treatment satisfaction. |
| Gurcay et al (2012)[61] | 52 patients with CTS | Phonophoresis with betamethasone and orthosis vs iontophoresis with betamethasone and orthosis vs wrist orthosis alone | BCTQ | There was greater improvement in symptom severity in the iontophoresis group. |
| Hall et al (2013)[47] | 62 individuals with CTS | Continuous wrist orthosis use and education vs control group | BCTQ | The treatment group had improvement in symptom severity and function during the study, but the control group did not. |
| Hennig et al (2015)[52] | 80 women with hand OA | Hand OA education plus home exercises vs information only | PSFS<br>FIHOA | The individuals in the exercise group had greater improvement in function, grip strength, pain and fatigue. |
| Hermann et al (2014)[65] | 59 patients with thumb CMC joint OA | Hand exercises and an orthosis (soft, elastic fabrifoam) vs hand exercises alone | AUSCAN | Pain was significantly less in the orthosis group when wearing the orthosis than when not wearing it, otherwise no differences between groups. |
| Jongs et al (2012)[66] | 40 individuals with contractures after distal radius fracture | Dynamic orthosis for wrist extension and routine care vs routine care | PRWHE and COPM | No differences were found between groups for the outcomes assessed. |
| Khuman et al (2013)[55] | 30 subjects with chronic lateral epicondylitis | Myofascial release and conventional therapy vs conventional therapy | PRTEE | There was improvement in pain, function, and grip in both groups, but the myofascial release had a greater effect on the outcome measures. |
| Kitis et al (2012)[39] | 52 individuals with simple and complete lacerations of the extensor tendon in zone V-VII | Static orthosis vs dynamic orthosis after primary acute repair | DASH | There were improved functional levels in the dynamic orthosis group at follow-ups. |
| Koca et al (2014)[67] | 75 people with mild to moderate CTS | Orthosis vs TENS vs IFC therapy | BCTQ | The IFC group had statistically significant greater improvement in pain and nerve conduction than the orthosis group, whereas the TENS and orthosis group had no differences. |
| Kuo et al (2013)[60] | 22 patients with an external fixator after distal radius fracture | Early skilled rehabilitation session for digits while external fixator intact vs usual home program | MAM-36 | The early rehab group had greater thumb and finger motion at the 12-week follow-up, but there were no other differences between groups. |
| Lamb et al (2015)[58] | 490 adults with rheumatoid arthritis and pain and dysfunction of their hands | Usual care vs usual care and a tailored strengthening and stretching hand exercise program | MHQ | Hand function was significantly greater in the exercise group at 12 month follow-up. |
| Lindenhovius et al (2012)[40] | 66 patient with posttraumatic elbow stiffness | Static progressive vs dynamic orthosis | DASH | No significant difference in flexion arc or function via the DASH between groups. |
| Madenci et al (2012)[68] | 84 patients with CTS | Wrist orthosis and massage techniques vs wrist orthosis only | BCTQ | Pain and grip strength were statistically significantly improved for the massage group compared to the orthosis group. |
| Magnus et al (2013)[69] | 51 women aged 51 and older with a unilateral distal radius fracture | Standard care vs standard care with strength training for the nonfractured extremity for 3 weeks during casting | PRWHE | The training group had statistically significantly greater wrist flexion and extension and strength at 12 weeks after fracture, but there was no difference at 9 and 26 weeks after fracture. |
| Miller et al (2016)[49] | 66 participants within 1 week of open reduction and internal fixation for a proximal phalanx fracture | 6 weeks of synergistic wrist and finger exercises with MCP joint constrained vs finger exercises with MCP unconstrained | PRWHE | There were no significant differences between groups for ROM, strength, pain, or function. |
| Osteras et al (2014)[53] | 130 individuals with hand OA | Exercises (group and home-based) vs usual care | FIHOA<br>PSFS | Small significant differences were found in favor of the exercise group for pain, stiffness, and activity but no difference for dexterity or strength. |
| Paula et al (2016)[41] | 20 patients with median and ulnar nerve and flexor tendon repair | Early reeducation program with mirror therapy vs classic sensory program when protective sensation restored | DASH | No between-group differences were observed for function or the Rosen score. |
| Prosser et al (2014)[50] | 56 people who underwent thumb basal joint arthroplasty | Rigid orthotic vs a semi-rigid orthotic | PRHWE<br>MHQ | There was no significant difference between groups for function, ROM, or pinch strength. |
| Rocchi et al (2014)[70] | 30 participants status after thumb ulnar collateral ligament repair | Standard hand-based thumb spica orthosis vs a hand-based thumb spica designed to allow immediate motion | Dreiser Functional Hand Index | Range of motion and function at 1-, 2-, and 6-month assessments were greater in the group that used the orthosis that allowed immediate motion. |

| | | | | |
|---|---|---|---|---|
| Rostami et al (2013)[42] | 30 individuals with active range of motion impairment following orthopedic injury | Mirror therapy vs active range of motion with direct observation of the affected hand | DASH | Individuals in the mirror therapy group had significantly more improvement in function and ROM. |
| Rostami et al (2016)[43] | 36 participants with chronic median and ulnar nerve injuries | Meaningful occupation-based activity vs exercise both with noninvolved arm constrained vs control group | DASH<br>COPM | Scores significantly increased in the intervention group vs the control group. There was significantly more improvement in the Box and Block Test and static 2-point discrimination for the occupation-based group vs exercise group. |
| Thakare et al (2014)[56] | 30 subjects with tennis elbow | Supervised exercise vs Cyriax physiotherapy with supervised exercises | PRTEE | There was a significantly greater improvement in pain and function in the Cyriax physiotherapy group. |
| Valdes et al (2015)[51] | 50 patients' status after volar plate fixation for distal radius fracture | Supervised exercises with a certified hand therapist vs home exercise program provided by certified hand therapist | PRWHE | There were no significant differences between function, ROM, or strength. |
| Vegt et al (2017)[71] | 63 individuals with OA at the base of the thumb | Crossover trial comparing a small prefabricated CMC brace with a custom orthosis | FIHOA | Both orthoses decreased pain significantly. The small prefabricated option was preferred based on participant satisfaction. |
| Wegener et al (2016)[72] | 40 participants with lateral epicondylitis | Elastic tape with eccentric exercises vs sham tape with eccentric exercises vs eccentric exercises alone | PRTEE | There were no differences between groups in pain-free grip strength and function. |

DASH = Disabilities of Arm, Shoulder and Hand; CTS = carpal tunnel syndrome; CMC = carpometacarpal; Q-DASH = QuickDASH; PRWHE = Patient-Rated Wrist (Hand) Evaluation; BCTQ = Boston Carpal Tunnel Questionnaire; COPM = Canadian Occupational Performance Measure; ORIF = open reduction internal fixation; MP/MCP = metacarpal phalangeal; OA = osteoarthritis; AUSCAN = Australian Canadian Osteoarthritis Hand Index; PRTEE = Patient-Rated Tennis Elbow Evaluation; PSFS = Patient-Specific Functional Scale; FIHOA = Functional Index for Hand Osteoarthritis; TENS = transcutaneous electrical nerve simulation; MAM-36 = Manual Ability Measure-36; MHQ = Michigan Hand Questionnaire; ROM = Range of Motion.

item analysis revealed 274 meaningful concepts with the MHQ having the greatest number at 106, which is primarily due to repetition of questions for the right and left hand. The DASH, Manual Ability Measure-36, and Boston Carpal Tunnel Questionnaire followed at 42, 36, and 22, respectively. The Patient-Rated Tennis Elbow Evaluation, Patient-Rated Wrist (Hand) Evaluation, and Australian Canadian Osteoarthritis Hand Index emerged with 15 each, the Q-DASH was identified to have 12 meaningful concepts, and the Functional Index for Hand Osteoarthritis/Dreiser Functional Index covered 11 (Table 4). Content coverage was most noteworthy in the activity and participation category (d) followed by the body function category (b) with prevalence represented with pain, stiffness, strength, sensation, and sleep. Both body structure (s) and environmental factors (e) were not represented by any of the assessment tools. Linking to personal factors (pf) was found with 21 questions; however, 9 are duplicates in the MHQ. Although not yet classified under the current framework, personal factors are defined in the category coding. One question on the MHQ related to the hands making me feel depressed was linked to not defined-mental health (nd-mh). One question from the DASH was linked to not defined-disability (nd-dis). According to our linking, no items in the questionnaires were found to be nc by the ICF (Table 5). The number of questions linked to the most specific level of the Comprehensive Core Set for hand conditions of the ICF for each PRO is outlined on Table 5. As mentioned, the authors provided more detailed levels and/or categories to Table 5 for linking albeit not included in the Comprehensive ICF Core Set for Hand Conditions. This decision is reflective of the most updated refinements to the linking rules,[10] suggesting that the most specific code be used when linking. The levels and/or categories that are in italics (Table 5) were added for detail but are not included in the Comprehensive ICF Core Set for Hand Conditions. The items in the parentheses in both Table 4 and Table 5 are strictly examples provided with the items on the questionnaires and per the linking rules[10] should be in parentheses.

### *ICF Linkage Calculations/Summary Linkage Indicators*

Summary linkage indicators or ICF linkage calculations were completed for the included measures based on the linking of each item on the questionnaires (Table 6). All but 2 of the PROs had all of their items linked to a specified category covered by the ICF allowing the majority of the PROs to have 100% measure ICF linkage. The DASH and MHQ had 94.74% and 91.89% of their measure, respectively, link to the ICF due to the questions on these PROs that were not defined. When comparing the specific number of unique ICF categories from each measure that appear in the core set to the total number of categories in the core set, the percentages are low ranging from 8.55% to 18.80% (mean: 11.97%) when considering the Comprehensive ICF Core Set for Hand Conditions and from 30.43% to 47.83% (mean: 31.40%) when considering the Brief ICF Core Set for Hand Conditions. This means that the identified commonly used questionnaires are low in representation of the Brief ICF Core Set for Hand Conditions and even lower in representation of the Comprehensive ICF Core Set for Hand Conditions. The MHQ was found to have the highest percentage representation of the Brief ICF Core Set for Hand Conditions at 47.83% representation.

Additional calculations were completed just on the category of disability which is covered by the codes in activity and participation. The percent representation of the Comprehensive ICF Core Set for Hand Conditions for unique disability ranged from 21.62% to 43.24% (mean: 20.33%) and the percent representation of the Brief ICF Core Set for Hand Conditions for unique disability ranged from 62.50% to 87.50% (mean: 72.22%). These percentages are higher due to the greater coverage of activity and participation by the questionnaires

**Table 3**
Information on the included outcome measures

| Outcome measure | Type | Description | Validated | Responsiveness | Minimal clinically important difference | Frequency of PRO incorporation in this review (listed as number of studies and percent of studies) |
|---|---|---|---|---|---|---|
| Disabilities of Arm, Shoulder and Hand (DASH)/ QuickDASH | Region specific | 30/11-item self-report questionnaire for musculoskeletal disorder of the upper limb. Both have 2 optional work and sports/ performing arts modules. Rating on a 5-point Likert scale from "no difficulty" to "unable." | Yes[73] | Effect size: 1.49 and SRM: 1.37[74] | DASH MCID for shoulder: 10 and for elbow, wrist, and hand: 17[75] QuickDASH MCID: 14-19[76,77] | 14 (32.56%) DASH and 3 (6.98%) QuickDASH |
| Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) | Diagnosis specific | A self-reported measure which is divided into 2 components. One is an 11-item symptom severity scale which is based on a 5-point Likert scale from normal to very serious. The other component is an 8-item functional status scale based on a 5-point Likert scale from "no difficulty" to "not able to perform the activity due to hand and wrist symptoms" | Yes Construct validity[78,79] | Effect size: 1.4 for symptom severity scale and 0.82 for functional scale[80] | BCTQ MCID: 0.75[79] | 8 (18.60%) |
| Michigan Hand Questionnaire (MHQ) | Region specific | A 37-item self-report questionnaire divided into 6 modules plus 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" | Yes Construct validity[81,82] Convergent validity[81] | SRM-function: 1.42, activities of daily living: 0.89, esthetics: 1.23, satisfaction: 1.76, overall score: 1.61, pain: 0.63, and work: 0.47[82] | MCIDs of 3, 11, and 13 were identified for the pain, function, and activities of daily living subscales, respectively[83] | 2 (4.65%) |
| Patient-Rated Wrist (Hand) Evaluation | Region specific | Patient self-rated, joint-specific questionnaire about symptoms of the wrist (presence, intensity, and frequency of pain) and functional limitations in relation to activities of daily livings, response scale is a numeric rating scale from 0 to 10 points comparable to a Visual Analogue Scale (VAS) | Yes[84] | Effect size: 1.61, SRM: 1.51[74] | MCID: 11.0-14 points[76,85] | 6 (13.95%) |
| Functional Index for Hand Osteoarthritis/Dreiser Functional Index | Disease specific | A 10-item self-report measure of hand function in persons with hand osteoarthritis. Items are rated on a 4-point scale from 0 (possible without difficulty) to 3 (impossible). | Yes[81] | SRM: 0.58[86] | Not established | 5 (11.63%) |
| Patient-Rated Tennis Elbow Evaluation | Disease specific | A 5-item self-reported questionnaire to measure perceived pain and disability in people with tennis elbow, includes 3 subscales for pain, usual activities (work and recreation), and specific activities (difficulty | Yes Construct validity[87-89] | SRM: 2.1 Effect size: 1.50 and SRM: 1.37 in total elbow arthroplasty. In a variety of elbow[90] pathologies, effect size: 1.6 and 1.7[88] | MCID: 7-11 for lateral tendinopathy[91] | 4 (9.30%) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | experienced with tasks)<br>Each of the items of the PRTEE is scored on a 0-10 scale, where 0 is “no pain” or “no difficulty” and 10 is “worst ever” or “unable to do” | | | | |
| Canadian Occupational Performance Measure | Client-centered | An outcome measure consisting of a semi-structured interview and structured scoring method that is designed to assess change in self-perception in occupational performance over time. | Yes<br>Divergent and convergent validity[92] | Responsiveness for hand OA for performance 1.51 points and 2.22 points for satisfaction.[93]<br>Criterion responsiveness using area under curve ranged from 0.79 to 0.85, optimal cutoff values for the performance scores and satisfaction scores ranged from 0.9 to 1.9.[94] | Not established | 3 (6.98%) |
| Patient-Specific Functional Scale | Client-centered | The Patient-Specific Functional Scale (PSFS) is a self-reported, patient-specific measure, designed to assess functional change, primarily in patients presenting with musculoskeletal disorders. Patients are asked to identify up to 5 important activities they are unable to perform or are having difficulty with as a result of their problem. In addition to identifying the activities, patients are asked to rate, on an 11-point scale, the current level of difficulty associated with each activity. | Yes<br>Concurrent validity[95] | SRM for CTS: 0.65<br>SRM for finger contracture: 0.64<br>SRM not sufficiently responsive for wrist pain or tumor[96] | 1.2 for upper extremity musculoskeletal disorders[95] | 2 (4.65%) |
| Australian Canadian Osteoarthritis Hand Index | Disease specific | A 15-item self-report measure to assess hand pain, stiffness, and hand function in persons with osteoarthritis Likert scale format from 0 (none) to 4 (extreme); 100-mm VAS format from 0 (none) to 100 (extreme). | Yes<br>Convergent validity in OA,[97] rheumatoid arthritis,[98] familial hand OA[99] | SRM ranged from −0.74 to −0.23 for the Likert scale and from −0.84 to −0.39 for the VAS<br>SRM for stiffness: 0.23-0.31[97,99] | Not established | 3 (6.98%) |
| Manual Ability Measure-36 | Region specific | A 36-item task oriented patient-reported functional assessment tool which has 2 sections. The first section contains demographic and clinical information, and the second section is a rating scale of 36 items. It is a 4-point scale ranging from 1-cannot do to 4-easy. | Yes<br>Construct validity[100] | SRM: 1.18[101] | Not established | 1 (2.32%) |

PRO = patient-reported outcome measure; SRM = standardized response mean; MCID = Minimal clinically important difference; CTS = carpal tunnel syndrome; PRTEE = Patient-Rated Tennis Elbow Evaluation; OA = osteoarthritis.

**Table 4**
Linking outcome measures meaningful concepts to the ICF

| | DASH | PRW(H)E | MHQ | QuickDASH | PRTEE | BCTQ | FIHOA/DFI | AUSCAN | MAM |
|---|---|---|---|---|---|---|---|---|---|
| Meaningful concepts identified (duplicates are counted) | 42 | 15 | 106 (53 meaningful concepts doubled for right and left) | 12 | 15 | 22 | 11 | 15 | 36 |
| Body functions | 16 | 10 | 38 | 6 | 10 | 17 | 1 | 11 | 0 |
| Body structure | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Activities and participation | 39 (7) | 15 | 50 (4) | 9 (3) | 16 | 11 | 11 | 13 | 36 |
| Environmental factors | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Personal factors | 3 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 |
| Concepts not defined | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Concepts not covered | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

ICF = International Classification of Functioning; DASH = Disabilities of Arm, Shoulder and Hand; PRW(H)E = Patient-Rated Wrist (Hand) Evaluation; MHQ = Michigan Hand Questionnaire; PRTEE = Patient-Rated Tennis Elbow Evaluation; BCTQ = Boston Carpal Tunnel Questionnaire; FIHOA = Functional Index for Hand Osteoarthritis; DFI = Dreiser Functional Index; AUSCAN = Australian Canadian Osteoarthritis Hand Index; MAM = Manual Ability Measure.

but are still less than 45% representative in all cases when considering the Comprehensive ICF Core Set for Hand Conditions.

*Study Quality Assessment*

The quality of the studies ranged from 3 to 9 out of 11 total (average 7.14) according to the PEDro scale (Table 7). All included studies met the criteria to receive a score for their inclusion criteria and the data calculations for their study results. Only 1 study[62] study met the criteria of blinding the therapist who was providing treatment to the study participants.

## Discussion

This systematic review included commonly used PROs in the practice of hand therapy and despite the difference in the highlighted features, the greatest number of linkages for the items on the questionnaires were to the body functions (b) and activity and participation (d) categories. The currently used PROs are also low in their percent coverage of the Comprehensive and Brief ICF Core Sets for Hand Conditions. Our findings are similar to the work of Vincent et al,[25] which evaluated the Patient-Rated Elbow Evaluation and the self-report section of the American Shoulder and Elbow Surgeons society-Elbow form and its relation to the ICF. Their findings revealed that the measures represented less than 20% of the Comprehensive ICF Core Set for Hand Conditions and approximately 74% and 70% of the Brief ICF Core Set for Hand Conditions.[25] The authors also found with specific examination of the unique disability representation that there were 32% and 26% coverage of the Comprehensive ICF Core Set for Hand Conditions but 100% coverage for both outcome measures when considering the Brief ICF Core Set for Hand Conditions.[25]

The current outcome assessment tools present with an obvious void in the representation of environmental factors. A systematic literature search[14] that linked PROs used for hand injury assessment to the ICF found only 2 of 8 measures addressed environmental factors. The Patient Evaluation Measure and the Upper Extremity Questionnaire contained a total of 3 items (e110 products or substances for personal consumption; e3 support and relationships; and e580 health services, systems, and policies). Furthermore, the qualitative review included in their study[14] determined that the PROs generally capture only in parts the functioning aspects important to patients with hand injuries. Our findings concur with those by Coenen et al.[14] in that commonly used PROs do not cover all categories of the ICF and environmental factors in particular are less covered than other categories.

Personal factors are acknowledged by the ICF, however, have not yet been formally classified. In an effort to stimulate further discussion, Grotkamp et al[11] have researched and systematically cataloged personal factors to aid in the development process. The identification of personal factors allows the linking process to be more precise and allows a differentiation from further meaningful concepts that are not yet covered in the ICF. We concur with the findings of Squitieri et al,[102] which identified that psychosocial, personal, and environmental factors contribute to overall satisfaction. Similarly, in a study that evaluated activity and impairment, Dekkers and Sobal[103] found that frequency of pain, range of motion, grip strength, and dexterity did not correlate well with improvement in performance or patient satisfaction with the performance of their activities following a Colles fracture.

Concepts covered by the ICF are represented in the included PROs; however, no one assessment tool was able to be linked to all components of the ICF. The intention of the ICF is to be a holistic and all-encompassing model creating commonality with language and health concepts across the health spectrum. Linking patient-rated assessment tools to the ICF provides additional and pertinent information about the instruments which can provide assistance in choosing appropriate tools and allow further development of existing measures and development of new ones. The linking also provides users of these outcome measures with a better understanding of what exactly they are assessing.

In a scoping review[104] assessing the relationship between psychological features and PROs for upper extremity conditions, it was noted that psychological status is a personal factor that may influence patient outcomes after treatment for an upper extremity injury or condition. Psychological features and personality traits are found distinct from specific mental health conditions.

The authors of this systematic review opted to identify commonly used PROs through RCTs on a hand therapy intervention from the past 5 years. A survey study[8] of American Society of Hand Therapists members completed on the use of PROs in clinical practice found the DASH to be used by an overwhelming majority of respondents at 75%.[8] Likewise, the survey identified 2 less commonly used outcome measures, the Upper Limb Functional Index (ULFI) and Upper Extremity Functional Index (UEFI) used by 6.48% and 5.21% of respondents, respectively. These 2 measures were not used in any of the included studies, however, due to their familiarity and identified use by the survey[8] and to be more encompassing of available tools, we have included an item analysis and linking for them in Appendices I and J.

According to our linking, all items on the UEFI (with 21 meaningful concepts) link to the activities and participation (d) category, with the exception of the question on sleep function, which links to body function (b). In the ULFI, there were 31 meaningful concepts, 25 of which linked to activities and participation (d), 10 linked to body functions (b), and 2 were not defined-disability (nd-dis). Refer

**Table 5**
Linking outcome measures to ICF category

| ICF main category and chapter level | ICF code (second to fourth level) | DASH | PRW(H)E | MHQ | QuickDASH | PRTEE | BCTQ | FIHOA/DFI | AUSCAN | MAM |
|---|---|---|---|---|---|---|---|---|---|---|
| b Body functions | b134 Sleep functions | 1 | | 2 | 1 | | 2 | | | |
| b1 Mental functions | **b152 Emotional functions** | | | 2 | | | | | | |
| | b1801 Body image | | | | | | | | | |
| | b260 Proprioceptive function | | | | | | | | | |
| | **b265 Touch function** | | | | | | | | | |
| | **b270 Sensory functions related to temperature and other stimuli** | | | | | | | | | |
| b2 Sensory functions and pain | b2700 Sensitivity to temperature | | | | | | | | | |
| | b2701 Sensitivity to vibration | | | | | | | | | |
| | b2702 Sensitivity to pressure | | | | | | | | | |
| | b2703 Sensitivity to noxious stimulus | | | | | | | | | |
| | **b280 Sensation of pain** | | | | | | | | | |
| | *b28014 Pain in upper limb* | 5 | 5 | 10 | 2 | 5 | 5 | | 5 | |
| | *b28016 Pain in joints* | 5 | 5 | 8 | 2 | 5 | 5 | | 5 | |
| b4 Functions of the cardiovascular, hematological, immunological, and respiratory systems | b415 Blood vessel function | | | | | | | | | |
| | *b4550 General physical endurance* | 2 | | | | | | | | |
| | **b710 Mobility of joint functions** | | | | | | | | | |
| | b7100 Mobility of a single joint | | | | | | | | | |
| | b7101 Mobility of several joints | | | 8 | | | | 1 | | |
| | **b715 Stability of joint functions** | | | | | | | | | |
| | b720 Mobility of bone functions | | | | | | | | | |
| | **b730 Muscle power functions** | | | | | | | | | |
| b7 Neuromusculoskeletal and movement-related functions | b7300 Power of isolated muscles and muscle groups | | | | | | | | | |
| | b7301 Power of muscles of one limb | 1 | | 4 | | | 1 | | | |
| | b735 Muscle tone functions | | | | | | | | | |
| | b740 Muscle endurance functions | | | | | | | | | |
| | **b760 Control of voluntary movements functions** | | | | | | | | | |
| | b765 Involuntary movements functions | | | | | | | | | |
| | b780 Sensations related to muscles and movement functions | | | | | | | | | |
| | *b7800 Sensation of muscle stiffness* | 1 | | | | | | | 1 | |
| | **b810 Protective functions of the skin** | | | | | | | | | |
| | b820 Repair functions of the skin | | | | | | | | | |
| b8 Functions of the skin and related structures | b830 Other functions of the skin | | | | | | | | | |
| | b840 Sensation related to the skin | 1 | | 4 | 1 | | 4 | | | |
| | b860 Functions of the nails | | | | | | | | | |
| | **s120 Spinal cord and related structures** | | | | | | | | | |
| | s410 Structure of cardiovascular system | | | | | | | | | |
| | s710 Structure of head and neck region | | | | | | | | | |
| s Body structures | **s720 Structure of shoulder region** | | | | | | | | | |
| | **s730 Structure of upper extremity** | | | | | | | | | |
| | s7300 Structure of upper arm | | | | | | | | | |
| | s7301 Structure of forearm | | | | | | | | | |
| | s7302 Structure of hand | | | | | | | | | |
| | s770 Additional musculoskeletal structures related to movement | | | | | | | | | |
| | s810 Structure of areas of skin | | | | | | | | | |
| | s830 Structure of nails | | | | | | | | | |
| d Activities and participation | | | | | | | | | | |
| d1 Learning and applying knowledge | d170 Writing | 1 | | | | | 1 | 1 | | 1 |
| d2 General tasks and demands | **d230 Carrying out daily routine** | | | | | | | | | |
| | *d2309 Carrying out daily routine, unspecified* | 5 | 1 | 12 | 1 | 1 | | | | |
| d3 Communication | d360 Using communication devices and techniques | | | | | | | | | |
| | d410 Changing basic body position | | | | | | | | | |
| | d420 Transferring oneself | | | | | | | | | |
| | **d430 Lifting and carrying objects** | | | 2 | | 1 | | | | 1 |
| | *d4300 Lifting* | | 1 | | | 1 | | 1 | 2 | |
| | d4301 Carrying in the hands | 2 | 1 | | 1 | 1 | 1 | | 1 | |
| | **d440 Fine hand use** | | | | | | | | | |
| | d4400 Picking up | | | 2 | | | | | | 1 |
| | d4401 Grasping | | | 2 | | | 3 | 1 | 2 | 2 |
| d4 Mobility | d4402 Manipulating | | | | | | 1 | | | 5 |
| | d4403 Releasing | | | | | | | | | |
| | d4408 Fine hand use, other specified | | | 2 | | | | 2 | 1 | 5 |
| | **d445 Hand and arm use** | | | | | | | | | |

(*continued on next page*)

**Table 5** (*continued*)

| ICF main category and chapter level | ICF code (second to fourth level) | DASH | PRW(H)E | MHQ | QuickDASH | PRTEE | BCTQ | FIHOA/DFI | AUSCAN | MAM |
|---|---|---|---|---|---|---|---|---|---|---|
| | d4450 Pulling | | | | | | | | | |
| | d4451 Pushing | 1 | | | | | | | | |
| | d4452 Reaching | | | | | | | | | |
| | d4453 Turning or twisting the hands and arms | 2 | 1 | 4 | | 2 | | 2 | 4 | 3 |
| | d4454 Throwing | | | | | | | | | |
| | d4455 Catching | | | | | | | | | |
| | d4458 Hand and arm use, other specified | 2 | 1 | 2 | 1 | 1 | 1 | | 1 | 3 |
| | *d4459 Hand and arm use, unspecified* | | | 4 | | | | | | |
| | d455 Moving around | | | | | | | | | |
| | d465 Moving around using equipment | | | | | | | | | |
| | d470 Using transportation | | | | | | | | | |
| | *d4709 Using transportation, unspecified* | 1 | | | | | | | | |
| | d475 Driving | | | | | | | | | |
| | d510 Washing oneself | | 1 | (2) | | 1 | 1 | | | 1 |
| | *d5100 Washing body parts* | 1 | | | 1 | | | | | |
| | d520 Caring for body parts | | | | | | | | | 2 |
| | *d5202 Caring for hair* | 1 | | 2 | | | | | | 1 |
| **d5 Self-care** | d530 Toileting | | 1 | | | | | | | |
| | d540 Dressing | | 1 | | | 1 | 1 | | | |
| | *d5400 Putting on clothes* | 1 | 1 | 2 | | 1 | 1 | 1 | 1 | 3 |
| | *d5402 Putting on footwear* | | | | | | | | | 1 |
| | d550 Eating | 1 | 1 | 2 (2) | 1 | | | 1 | | 3 |
| | d560 Drinking | | | | | | | | | 1 |
| | d570 Looking after one's health | | | | | | | | | |
| | d620 Acquisition of goods and services | | | | | | | | | |
| | d630 Preparing meals | 1 | | | | | | | | |
| | *d6308 Preparing meals, other specified* | | | | | | | | 1 | 2 |
| | d640 Doing housework | | | | | | | | | |
| **d6 Domestic life** | *d6401 Cleaning cooking area and utensils* | | 1 | 2 | | 1 | | | | |
| | *d6402 Cleaning living area* | (1) | 1 | | (1) | 1 | | | | |
| | *d6408 Doing housework, other specified* | 1 | | | | | | | | 1 |
| | *d6409 Doing housework, unspecified* | 1 | | | 1 | | 1 | | | |
| | d650 Caring for household objects | | | | | | | | | |
| | *d6500 Making and repairing clothes* | | | | | | | 1 | | |
| | *d6505 Taking care of plants, indoors, and outdoors* | 1 | | | | | | | | |
| | *d6509 Caring for household objects, unspecified* | | 1 | | | 1 | | | | |
| | d660 Assisting others | | | | | | | | | |
| **d7 Interpersonal interactions and relationships** | *d7105 Physical contact in relationships* | | | | | | | 1 | | |
| | d810-d839 Education | | | | | | | | | |
| d8 Major life areas | **d840-d859 Work and employment** | | | | | | | | | |
| | *d8509 Remunerative employment, unspecified* | 5 | 1 | 10 | 1 | 1 | | | | |
| | d920 Recreation and leisure | | | | | | | | | |
| | *d9200 Play* | (2) | | | | | | | | |
| d9 Community, social, and civic life | *d9201 Sports* | 4 (2) | | | (1) | 1 | | | | |
| | *d9203 Crafts* | (1) | | | | | | | | |
| | *d9204 Hobbies* | 4 (1) | | | (1) | | | | | |
| | *d9205 Socializing* | 1 | | 2 | 1 | | | | | |
| | *d9209 Recreation and leisure, unspecified* | 3 | 1 | | 1 | 1 | | | | |
| E 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 | | | | | | | | | |
| | e125 Products and technology for communication | | | | | | | | | |
| **e1 Products and technology** | e130 Products and technology for education | | | | | | | | | |
| | e135 Products and technology for employment | | | | | | | | | |
| | e140 Products and technology for culture, recreation, and sport | | | | | | | | | |

(*continued on next page*)

**Table 5** (*continued*)

| ICF main category and chapter level | ICF code (second to fourth level) | DASH | PRW(H)E | MHQ | QuickDASH | PRTEE | BCTQ | FIHOA/DFI | AUSCAN | MAM |
|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | | | | | | | | | |
| | e165 Assets | | | | | | | | | |
| e2 Natural environment and human-made changes to environment | e225 Climate | | | | | | | | | |
| | e310 Immediate family | | | | | | | | | |
| | e315 Extended family | | | | | | | | | |
| | e320 Friends | | | | | | | | | |
| | e325 Acquaintances, peers, colleagues, neighbors, and community members | | | | | | | | | |
| **e3 Support and relationships** | e330 People in positions of authority | | | | | | | | | |
| | e335 People in subordinate positions | | | | | | | | | |
| | e340 Personal care providers and personal assistants | | | | | | | | | |
| | e345 Strangers | | | | | | | | | |
| | e355 Health professionals | | | | | | | | | |
| | e360 Other professionals | | | | | | | | | |
| | e410 Individual attitudes of immediate family members | | | | | | | | | |
| | e420 Individual attitudes of friends | | | | | | | | | |
| | e425 Individual attitudes of acquaintances, peers, colleagues, neighbors, and community members | | | | | | | | | |
| | e430 Individual attitudes of people in positions of authority | | | | | | | | | |
| e4 Attitudes | e440 Individual attitudes of personal care providers and personal assistants | | | | | | | | | |
| | e445 Individual attitudes of strangers | | | | | | | | | |
| | e450 Individual attitudes of health professionals | | | | | | | | | |
| | e455 Individual attitudes of other professionals | | | | | | | | | |
| | e460 Societal attitudes | | | | | | | | | |
| | e465 Social norms, practices and ideologies | | | | | | | | | |
| | e525 Housing services, systems and policies | | | | | | | | | |
| | e530 Utilities services, systems and policies | | | | | | | | | |
| | e535 Communication services, systems and policies | | | | | | | | | |
| | e540 Transportation services, systems and policies | | | | | | | | | |
| | e550 Legal services, systems and policies | | | | | | | | | |
| **e5 Services, systems, and policies** | e555 Associations and organizational services, systems and policies | | | | | | | | | |
| | e570 Social security services, systems and policies | | | | | | | | | |
| | e575 General social support services, systems and policies | | | | | | | | | |
| | e580 Health services, systems and policies | | | | | | | | | |
| | e585 Education and training services, systems and policies | | | | | | | | | |
| | e590 Labor and employment services, systems and policies | | | | | | | | | |
| *Personal factor* | N/A | 3 | | 18 | | | | | | |
| *Not defined-disability* | N/A | 1 | | | | | | | | |
| *Not defined-mental health* | N/A | | | 2 | | | | | | |

ICF = International Classification of Functioning; DASH = Disabilities of Arm, Shoulder and Hand; PRW(H)E = Patient-Rated Wrist (Hand) Evaluation; MHQ = Michigan Hand Questionnaire; PRTEE = Patient-Rated Tennis Elbow Evaluation; BCTQ = Boston Carpal Tunnel Questionnaire; FIHOA = Functional Index for Hand Osteoarthritis; DFI = Dreiser Functional Index; AUSCAN = Australian Canadian Osteoarthritis Hand Index; MAM = Manual Ability Measure; N/A = Not Applicable.
Items in bold denote inclusion in the Brief Hand Core Set.
Codes and categories written in italics are not part of the Comprehensive Hand Core Set but were added for improved detail in linking.

to Appendices K and L for more specifics on the linking of the items included in these PROs to the ICF. The authors also opted to perform the summary linkage indicator calculations for the UEFI and the ULFI (Appendix M) to provide readers with more detailed information. While the UEFI scored similar to the average for the other measures for all calculations, the ULFI scored higher or equal to the

**Table 6**
ICF linkage calculations/summary linkage indicators

| PRO | Measure to ICF linkage (%) | Comprehensive ICF core set for hand conditions representation (%) | Brief ICF core set for hand conditions representation (%) | Comprehensive ICF core set for unique disability representation (%) | Brief ICF core set for unique disability representation (%) |
|---|---|---|---|---|---|
| DASH | 94.74 | 18.80 | 34.78 | 43.24 | 75.00 |
| PRW(H)E | 100 | 11.97 | 30.43 | 32.43 | 75.00 |
| MHQ | 91.89 | 17.09 | 47.83 | 37.84 | 87.50 |
| QuickDASH | 100 | 9.40 | 30.43 | 21.62 | 75.00 |
| PRTEE | 100 | 10.26 | 30.43 | 29.73 | 75.00 |
| BCTQ | 100 | 10.26 | 30.43 | 21.62 | 62.50 |
| FIHOA/DFI | 100 | 8.55 | 30.43 | 24.32 | 75.00 |
| AUSCAN | 100 | 8.55 | 26.09 | 21.62 | 62.50 |
| MAM-36 | 100 | 12.82 | 21.74 | 40.54 | 62.50 |

ICF = International Classification of Functioning; PRO = patient-reported outcome measure; DASH = Disabilities of Arm, Shoulder and Hand; PRW(H)E = Patient-Rated Wrist (Hand) Evaluation; MHQ = Michigan Hand Questionnaire; PRTEE = Patient-Rated Tennis Elbow Evaluation; BCTQ = Boston Carpal Tunnel Questionnaire; FIHOA = Functional Index for Hand Osteoarthritis; DFI = Dreiser Functional Index; AUSCAN = Australian Canadian Osteoarthritis Hand Index; MAM-36 = Manual Ability Measure-36.

highest score in comparison to the PROs included in this review for all calculations. The ULFI is a 25-item questionnaire; although when linked to the most specific category, there is a greater variety in the coverage of the specific codes in comparison to other commonly used hand therapy PROs.

The linking process revealed that not all meaningful concepts could be linked to a defined ICF category, and in such cases as described by Cieza et al,[19] these areas should be considered "not defined" if covered by the ICF. Moreover, in the updated refinement ICF article, Cieza et al.[10] suggest taking into consideration the distinction between capacity and performance. As stated in the ICF,[9] capacity refers to what a person living with any health condition can do in a standardized environment while performance refers to what a person can actually do in their actual environment. Therefore, the reviewers for this review agreed that the question on the DASH specific to sexual activity does not reflect either intimate relationships under participation or that of sexual function under body functions according to the particular definitions associated with these areas. This is in agreement with the Forget and Higgins study.[22] Similarly, areas associated with emotional functions, appearance, and satisfaction are not found with a precise association to an ICF category. While personal factors (pf) are not yet classified by the ICF, they are recognized as a contributing factor and based on components of the definition of coping styles, past, and current experiences[11] we applied (pf) to areas concerning satisfaction and aesthetics, for example, Satisfaction with the appearance of hand and satisfaction with motion in fingers. Likewise, the ICF does not specifically address the unwelcome effects of a hand condition such as "being depressed"; therefore, as recommended by Forget and Higgins,[22] this meaningful concept was allocated to not defined-mental health (nd-mh) category.

Furthermore, as suggested by the ICF refinement article,[10] the authors proceeded with a process which recommends the use of "unspecifiec" or "other specified" terminology in an effort to fully capture the content of questions and not to lose relevant information. As advised by Cieza et al,[10] the information either not specified or other specified was documented along with the ICF category as appropriate during the linking process. The reviewers likewise agreed that the particularities of buttoning and shoe tying would be associated with the concept of d5400 putting on clothes as we feel this incorporates the coordinated action and manipulation required along with the individuals' ability to participate in the activity. Similarly, the choice was made to place opening a jar lid to d4458 hand and arm use, other specified, as our determination considered the complete activity which includes stabilizing the jar along with twisting and turning. However, the refinements to the linking rules[10] do suggest that linking in this case and in many cases can be completed as the linker interprets the question. This means that there is not necessarily 1 accurate answer with every linkage.

The MHQ includes questions that are subjective and introspective, having to do with duration, modification, and accomplishing functional performance tasks (work and daily routine) in relation to the "problems with your hands or wrist." For these questions, the reviewers took into account the recently refined ICF Linking Rule 4.[10] This rule takes documentation of perspective into consideration. The authors acknowledge that documenting the perspective is an important component for capturing subtleties that can otherwise be missed when comparing health information. Cieza et al[10] acknowledge that the most prominent perspectives are descriptive perspectives, for example, to the ability or extent of a problem or difficulty a person experiences in performing a certain activity or task. Therefore, we interpreted the question as the "difficulty completing your normal work the way you normally do in amount of time, capacity, and so forth," which lead to the decision to use a combination of d8509 remunerative employment, unspecified and d2309 carrying out daily routine, unspecified.

### *Clinical application*

This systematic review provides a copious amount of details which in turn will provide greater clarity to determine if the chosen assessment tool is reflective of what is intended to be assessed during hand therapy evaluation with a PRO. Furthermore, it may help identify and utilize outcome assessment tools that are more precise and relevant to our target population. In addition, it encourages the incorporation of more than 1 measurement tool in order to gain a more comprehensive patient perspective which is in accordance with the ICF model. This review continues to highlight the importance of understanding and recognizing the value of the ICF for further research and development of new tools and for operational considerations of clinicians.

### *Limitations*

Our study included research published in the last 5 years to allow for a manageable review. The authors concluded the literature search in March as it would be difficult to add additional studies during the writing of this paper due to the continual publication of RCTs related to hand therapy. Although the study identified the most common outcome measures used in high-level studies for this population, along with 2 additional familiar measures, limiting the inclusion criteria to RCTs only may have influenced the identification of all possible options. Due to the sizable search of the literature for this review, some studies could have possibly been missed. However, the literature was thoroughly scrutinized to minimize this possibility. Although the studies included in this review were RCTs, not all had strong methodological rigor. Some of the limitations included: small sample sizes,

**Table 7**
PEDro scores for study quality assessment

| Study | PEDro item 1 | PEDro item 2 | PEDro item 3 | PEDro item 4 | PEDro item 5 | PEDro item 6 | PEDro item 7 | PEDro item 8 | PEDro item 9 | PEDro item 10 | PEDro item 11 | Total score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ahyan et al.[30] | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 8 |
| Barbosa et al.[44] | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 6 |
| Bani et al.[31] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 7 |
| Bayon-Calatayud et al.[59] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| Becker et al.[32] | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 6 |
| Brehmer and Husband[33] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 6 |
| Bruder et al.[48] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Cantero-Tellez et al.[34] | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 7 |
| Chang et al.[45] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7 |
| Chang et al.[62] | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| Collis et al.[35] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 8 |
| Daud et al.[36] | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 8 |
| Dilek et al.[54] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 8 |
| Dundar et al.[57] | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 7 |
| Dziedzic et al.[63] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Filipova et al.[37] | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 7 |
| Fusakul et al.[64] | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 |
| Geler-Kuluc et al.[46] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 7 |
| Gruber et al.[38] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 6 |
| Gurcay et al.[61] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 6 |
| Hall et al.[47] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 6 |
| Hennig et al.[52] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Hermann et al.[65] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Jongs et al.[66] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 7 |
| Khuman et al.[55] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 8 |
| Kitis et al.[39] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 5 |
| Koca et al.[67] | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 5 |
| Kuo et al.[60] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 8 |
| Lamb et al.[58] | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 7 |
| Lindenhovius et al.[40] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 7 |
| Madenci et al.[68] | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 5 |
| Magnus et al.[69] | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 5 |
| Miller et al.[49] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 8 |
| Osteras et al.[53] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Paula et al.[41] | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 6 |
| Prosser et al.[50] | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 9 |
| Rocchi et al.[70] | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 |
| Rostami et al.[42] | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 7 |
| Rostami et al.[43] | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 |
| Thakare et al.[56] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 8 |
| Valdes et al.[51] | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 6 |
| Vegt et al.[71] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 7 |
| Wegener et al.[72] | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 8 |

PEDro = Physiotherapy Evidence Database.
PEDro items defined:
1. Eligibility criteria were specified.
2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated in an order in which the treatment was received).
3. Allocation was concealed.
4. Groups were similar at baseline regarding the most important prognostic indicators.
5. There was blinding of all subjects.
6. There was blinding of all therapists who administered the therapy.
7. There was blinding of all assessors who measured as least 1 key outcome.
8. Measures of at least 1 key outcome were obtained from more than 85% of the subjects initially allocated to groups.
9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least 1 key outcome was analyzed by "intention-to-treat" analysis.
10. The results of between-group statistical comparisons are reported for at least 1 key outcome.
11. The study provides both point measure and measures of variability for at least 1 key outcome.

lack of blinding, lack of long-term follow-up, considerable loss to follow-up, and insufficient data analyses.

### *Future research*

This systematic review indicates that the majority of PROs in the current research are reflective of disability as it relates to activity limitations and participation restrictions followed by impairment as it relates to body functions. The current studies reveal that the commonly used assessment tools do not capture the area of environmental factors. More robust patient-centered outcomes that address personal factors and environmental factors are needed. Until such measures are developed, there should be consideration given to the inclusion of more than 1 measure in an effort to fully represent the current measure of disability and health for each individual hand therapy patient.

## Conclusion

The commonly used patient-involved outcomes have obvious deficiencies for capturing the expansive nature of the ICF categories. Identifying the most appropriate instrument can be a daunting task. However, the results of this review, which includes the refinements of the ICF linking rules, provide both clarity and

currency from the prior method. This allows for a greater understanding of content coverage and comparison of the commonly used measures in the field of hand therapy. Ultimately, this review may serve as a helpful resource in determining appropriate measures for our population and in-depth information for the research and establishment of new measures.

## Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jht.2017.11.039.

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## Quiz: # 612

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#1. The study design is
   a. retrospective cohort
   b. a case series
   c. a systematic review
   d. RCTs

#2. The ICF contains _____ hierarchically organized categories
   a. 1450
   b. 1250
   c. 1050
   d. 50

#3. PROs are useful in
   a. outling patient-centered treatment plans
   b. establishing treatment goals
   c. identifying functional deficits
   d. all of the above

#4. ICF _____ facilitate the description of function
   a. Base Scores
   b. Rank Settings
   c. Core Sets
   d. Central Themes

#5. This study casts light on the refinements of the ICF linking rules
   a. false
   b. true

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