




Comparing the contents of outcome measures in upper-limb amputation using the International Classification of Functioning, Disability, and Health: A systematic review

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Abstract

The International Classification of Functioning, Disability, and Health (ICF) provides a universal framework for assessing the functioning of any person. To facilitate the application of the ICF in practice, ICF core sets are being developed. This study is part of a project intended to develop an ICF core set for upper-limb amputation (ULA) and aims to identify relevant concepts included in the outcome measurements used in studies of ULA. Articles involving ULA aged 18 years or older from January 2011 to December 2021 were searched on Cumulative Index to Nursing and Allied Health Literature, SPORTdiscus, and Medical Literature Analysis and Retrieval System Online. We included studies with particular designs (randomized controlled trials, before/after studies, cross-sectional studies, and longitudinal observational studies) and published in English. Relevant concepts were extracted from measurements and linked to the ICF using linking rules, and a frequency analysis was conducted. Sixty-one of the 1272 identified publications were included, from which 86 measurements were extracted. Concepts extracted from measurements were linked to 129 ICF categories. Three hundred twenty-six (29.23%) of the 1115 concepts were related to body functions, 643 (57.66%) to activity and participation, 96 (8.60%) to environmental factors, 19 (1.70%) to body structures, and 6 (0.53%) to personal factors. Twenty-five (2.24%) were characterized as “nd—not definable.” “Fifty-four” categories identified in at least 5% of the publications will be considered for inclusion in the final ICF core set for ULA during the consensus conference. This review provides information about the content of measures, and the identified ICF categories reveal the research perspective for developing an ICF core set for ULA.

Keywords

ICF, linking, rehabilitation, upper-limb amputee

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Introduction

Limb amputations result in significant changes in body structures and functions. Limb loss not only represents a major structural and functional deficit but also affects the patient emotionally and psychosocially. Individuals exposed to amputation may experience a wide range of activity limitations and participation restrictions as a result of structural, functional, emotional, and psychosocial effects, as well as contextual factors such as environmental and personal factors.¹

Studies related to upper-limb amputation (ULA) include clinical trials, observational studies, semistructured patient interviews, cross-sectional studies, and systematic reviews reporting the

consequences of amputation and the outcomes of treatment strategies.^{2–6} The literature on upper-limb amputees has many outcome measurement methods, including self-report and observer- or clinician-reported measurements with different aims and concepts. The selection of an appropriate outcome measure depends on the research question, the type of research, the intervention, psychometric properties, and the content of the measurement. Previous reviews have provided useful information on the psychometric properties or theoretical background of outcome measures used in upper-limb amputees.^{6–8} In addition to these features of outcome measurement, it is also important to understand the content and the purpose of the measures and

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identify areas of overlap by comparing the content of the outcome measures with each other. ICF describes human functioning as an umbrella concept of the interaction of 4 basic components: “body functions and structures,” “activities and participation,” “environmental factors,” and “personal factors.” The ICF framework can be used as a common reference to identify the content of outcome measurements, to compare the content of outcome measures, and to develop a comprehensive outcome measurement method as ICF core sets. In the process of developing ICF core sets, an evidence-based methodology is used to determine the content of outcome measures and link the content of outcome measures to the most relevant ICF categories in the entire classification system using ICF linking rules.^{9–11}

The ICF has a standardized terminology but cannot be directly applied to a specific disease group because it contains more than 1400 categories. However, specific ICF core sets can be developed for a particular population. Specific ICF core sets for musculoskeletal, cardiopulmonary, neurological, neurodevelopmental, and psychiatric conditions are available in the literature. There are currently 6 musculoskeletal-specific ICF core sets. Each set consists of a brief (20–30 categories) and a comprehensive version (70–100 categories).¹² A guideline for the development phases of the ICF core set has already been published, under which the development process consists of 3 phases. The first phase is the preparatory phase, the second phase is an international consensus conference to decide on the ICF codes, and the final phase is the implementation of the first version of the ICF core set. The preparatory phase consists of a systematic literature review (researchers’ perspectives), an empirical multicenter study (clinical perspective), an expert survey (health professional’s perspectives), and a qualitative study (perspectives of people with ULA). Core sets are highly important because they provide standardized terminology and facilitate the comparability of the results of studies on an international basis.¹² There is a need ICF core set for upper extremity amputees to provide a common language and facilitate the comparability of the results of studies on an international basis. Therefore, this systematic review was planned to reflect the researchers’ perspectives on the development process of the ICF core set for upper-limb amputees.

This systematic review was planned to provide information about the content of the outcome measurements and the most cited functioning areas of the literature related to adult upper-limb amputees. The intensity and impact of disabilities are different in children and adults.¹³ Furthermore, it was considered that the etiology plays a major role in the long-term physical and psychosocial adaptation.¹⁴ There is a study in the literature that identifies the areas of functioning that are prominent in children with congenital hand deficits.¹⁵ Therefore, we focused on the functioning areas of the adult upper-limb amputees in this review. Previous systematic reviews related to upper-limb amputees provided useful information on the psychometric properties and theoretical background of the outcome measurements.^{6–8} Only one of these reviews was designed to perform conceptual analysis according to the ICF. This previous review did not aim to develop the ICF core set and was performed for conceptually analyzing only questionnaire-based outcome measurement methods according to ICF.⁷ The ICF core sets can support the assessment of a patient’s health status, goal-setting, and the planning of

interventions that target individual functioning needs. To date, no ICF core set has been developed for upper-limb amputees. There is a need to update the most cited functioning areas of adult upper-limb amputees for the ICF core set development process.

In the context of the development of the ICF core set for upper-limb amputees, the aims of this systematic review, which is a preparatory study to develop an ICF core set for adult upper extremity amputees, were as follows: (1) to identify the content of the outcome measurement methods used upper-limb amputee patients with the ICF linking rules and (2) to identify the most frequently addressed areas of functioning in these measurements.

Methods

We conducted a systematic review of the literature for original intervention and observational studies that included adult upper-limb amputees. This literature review has been registered in PROSPERO (International Prospective Register of Systematic Reviews) (CRD42021256225).

Study design

This review was conducted using the methodology proposed by the ICF Research Branch.¹² This methodology is composed of 3 steps. A systematic literature review was conducted to identify outcome measurements for upper-limb amputees in the first stages. The content of those measures was extracted and linked to ICF codes using established linking rules in the second stage.¹¹ The frequency analysis of the ICF categories was performed in the third stage.

Eligibility criteria and search strategy

The selection of the inclusion criteria was guided by the Population, Intervention, Comparison, Outcomes, and Study design framework. Only the “P,” “O,” and “S” were relevant to our review focus. For this reason, the inclusion criteria consisted of the following: studies of upper-limb amputees aged 18 years or older, studies with particular designs (randomized controlled trials, before/after studies, cross-sectional studies, and longitudinal observational studies), and studies published in English. All multiple- and single-item outcome measures involved in the eligible studies were included. Study-specific and nonvalidated surveys were excluded. Studies related to lower-limb amputees and congenital limb deficiencies, validity/reliability studies, phase I/II clinical trials, and secondary analyses of published data were also excluded. This study also did not include protocols, reviews, or meta-analyses.

Electronic searches were performed on Cumulative Index to Nursing and Allied Health Literature, SPORTdiscus (through EBSCOhost), and Medical Literature Analysis and Retrieval System Online (through PubMed) to identify potentially relevant publications from January 2011 to December 2021. MeSH terms and keywords were used. Terms searched included upper extremity, arm, hand, amputee, amputation, arm prosthesis, limb loss, Prosthe*, disarticulation, amputation stumps, phantom limb, outcome, survey, quality of life, health status, health, assessment, and questionnaire (Supplemental Digital Content 1, <http://links.lww.com/POI/A253>).

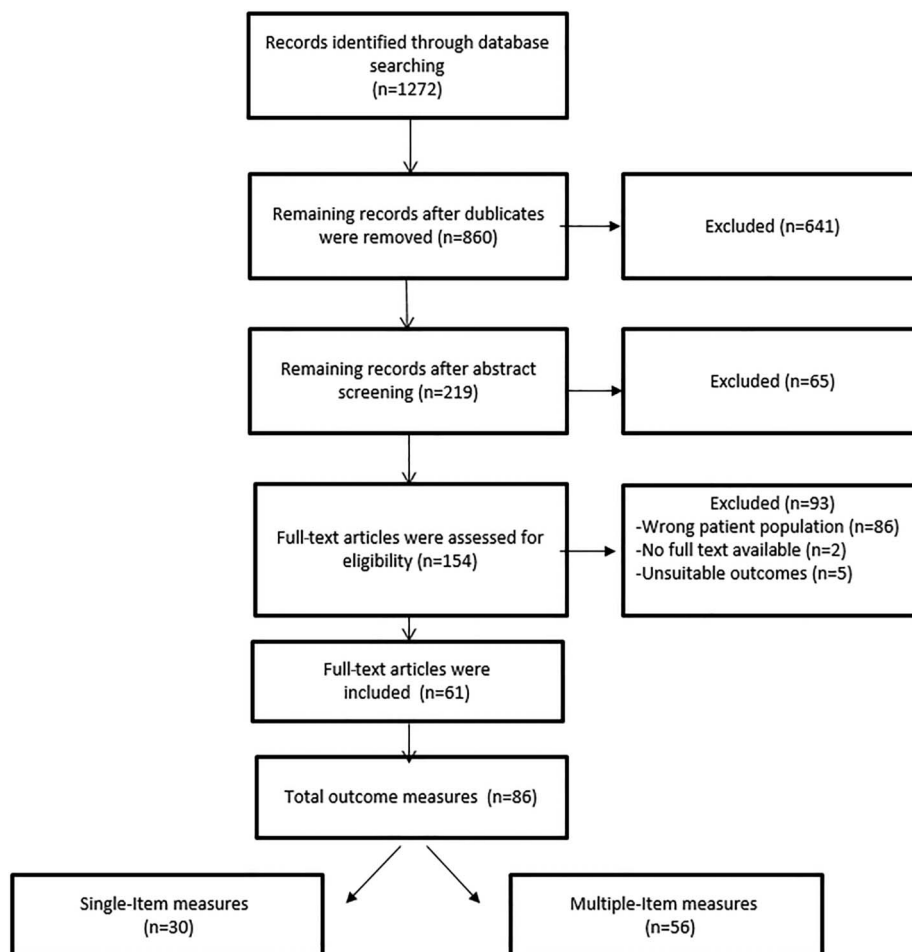


Figure 1. Flow chart of search and screening steps.

Article processing

The publications found in the databases were exported to EndNote. After the removal of duplicates, all identified studies were subjected to a preliminary check of abstracts and titles by 2 researchers independently of 1 another. A third individual resolved any conflicts. The title and abstract of each publication were screened. The full texts were subsequently screened by 2 independent researchers based on the adopted inclusion and exclusion criteria. The results were compared, and any disagreement was resolved in discussion with the all researchers.

All studies identified through the literature review and eligible for inclusion were examined in this review. No quality assessment of the studies was conducted because this review was not intended to evaluate the effectiveness of specific interventions.

Data extraction and data synthesis

We extracted study design, outcome measures, and country where the study was conducted for all included studies. In the data extraction phase, the researchers identified the outcome measures used in the studies and then extracted the main and additional concepts regarding the parameters or items of the outcome measures.¹¹ Concepts from the questionnaire items and the instructions for clinical tests analyzed in this systematic review

were identified. The items and response options of each assessment instrument and the instruction of clinical test were listed on a single table. Subsequently, the main and additional concepts contained within each item response option or instruction were extracted. The concepts were linked to appropriate ICF categories by 2 researchers using established linking rules. Disagreement between the 2 researchers regarding the extracted data was solved by discussion. When 2 researchers were unable to reach a consensus, a third researcher was consulted.

ICF coding

ICF linking rules were used to link the items of the outcome measurement to ICF codes. Before starting the linking process, the information that might be yielded by the item in question was considered. The main concept and additional concepts of the item/outcome measurement were thus identified. All determined concepts were linked to an appropriate ICF code. It is, therefore, possible that an item might have been linked to more than 1 ICF code.¹¹

According to linking rules, each concept should be linked to the most relevant ICF category. If necessary, third- or fourth-level ICF categories with code numbers ending in 8 (other specified) and 9 (unspecified) should be used to define the content. If the concept cannot be linked to the most precise ICF category but is related to

Table 1. Distribution of contents of the most used multiple-item measures by ICF component.

Name (abbreviation) ^a	No of citations	No of items	BF n (%)	BS n (%)	A&P n (%)	EF n (%)	PF n (%)	Others n (%)	No of unique concepts ^b	Linked to ICF	Brief description of measure
Activities Measure for Upper-Limb Amputees (AM-ULA)/Brief Activities Measure for Upper-Limb Amputees (BAM-ULA)	6	18 10	— —	— —	8 (88.88) 6 (85.71)	1 (11.11) 1 (14.28)	— —	— —	9 7	Items	Functionality
Amputee Body Image Scale (ABIS)/Revised Amputee Body Image Scale (ABIS-R)	3	20 14	2 (16.66) 2 (16.66)	1 (8.33) 1 (8.33)	5 (41.66) 4 (33.33)	3 (25) 3 (25)	— —	1 (8.33) 2 (16.66)	12 12	Items	Amputee's perception of his or her body image
Chronic Pain Grade (CPG)	2	7	2 (100)	—	—	—	—	—	2	Items	Pain grade
Clothespin Relocation Test (CPRT)	4	2	1 (33.33)	—	2 (66.66)	—	—	—	3	Task	Functionality
Depression screen (DS)	2	4	1 (100)	—	—	—	—	—	1	Items	Mental health condition
Disabilities of the Arm, Shoulder, and Hand (DASH/QuickDASH with optional modules)	8	30 19	6 (24) 3 (20)	— —	19 (76) 12 (80)	— —	— —	— —	25 15	Items	Disability
Functional capacity evaluation—one handed (FCE-OH)	2	6	1 (25)	—	3 (75)	—	—	—	4	Items	Functionality
Hospital Anxiety and Depression Scale (HADS)	2	14	1 (100)	—	—	—	—	—	1	Items	Mental health condition
Jebsen-Taylor Hand Function Test (JTHFT)	6	7	—	—	4 (100)	—	—	—	4	Task	Functionality
Orthotics and Prosthetics User Survey Health Quality of Life Index (OPUS-HQOL)	3	23	4 (36.36)	—	3 (27.27)	3 (27.27)	—	1 (9.09)	11	Items	Quality of life
Orthotics and Prosthetics User Survey Satisfaction with Device Scale (OPUS-CSD)	2	11	2 (40)	—	2 (40)	1 (20)	—	—	5	Items	Devices satisfaction
Orthotics and Prosthetics User Survey Upper Extremity Functional	9	23	—	—	10 (90.90)	1 (9.09)	—	—	11	Items	Activity of daily life

(continued on next page)

Table 1. Distribution of contents of the most used multiple-item measures by ICF component. (Continued)

Name (abbreviation) ^a	No of citations	No of items	BF n (%)	BS n (%)	A&P n (%)	EF n (%)	PF n (%)	Others n (%)	No of unique concepts ^b	Linked to ICF	Brief description of measure
Status Module (OPUS-UEFS)											
Pain Disability Index (PDI)	3	7	3 (33.33)	—	6 (66.66)	—	—	—	9	Items	Disability and pain
Patient-Specific Functional Scale (PSFS)	3	1	—	—	—	—	—	1 (100)	1	Items with fill in the blank	Disability
Post-traumatic stress disorder (PTSD) screen	4	17	1 (100)	—	—	—	—	—	1	Items	Mental health condition
Short-Form Survey 36-Item/12-Item (SF-36)/(SF-12)	8	36 12	4 (20) 4 (28.57)	— —	15 (75) 9 (64.28)	— —	— —	1 (5) 1 (7.14)	20 14	Items	Quality of life
Southampton Hand Assessment Procedure (SHAP)	9	26	—	—	3 (100)	—	—	—	3	Task	Functionality
Trinity Amputation and Prosthesis Experience Scales (TAPES)	9	54	7 (26.92)	2 (7.69)	10 (38.46)	4 (15.38)	2 (7.69)	1 (3.84)	26	Items	Psychosocial adjustment, activity limitation, and prosthetic satisfaction
University of New Brunswick (UNB)	3	5	—	—	6 (85.71)	1 (14.28)	—	—	7	Task	Functionality

Abbreviations: A&P, activity and participation; BF, body function; BS, body structures; EF, environmental factors; PF, personal factors; Others, not definable plus not covered by the ICF.
Full list of multiple-item measures is shown in Appendix 4.
^aMeasures order by alphabetical order.
^bTotal number of meaningful concepts without duplications per measure.

several categories, it is coded as “not definable” (nd). If the meaningful concept is not contained in the ICF, this concept is classified as “not covered” (nc). For example, Trinity Amputation and Prosthesis Experience Scales (TAPES) (the item related to phantom limb pain, residual limb pain, and other medical problems) asks “*In general, would you say your health is very poor, poor, fair, good, or very good?*” The meaningful concept of the item was extracted as “health.” The concept “health” is not sufficient for deciding on the most precise ICF category; therefore, the concept was assigned to nd (not definable). On the other hand, according to linking rules that the meaningful concept of the question “How would you rate your quality of life?” is extracted as “quality of life,” and concepts referring to quality of life or life in general are assigned to nc (not covered).¹¹ If the meaningful concept is not contained in the ICF, but is clearly a personal factor as defined in the ICF, it is assigned to personal factors. The response options of the extracted instruments that contained additional information were linked to the relevant ICF categories.¹¹

Data analysis

We used Microsoft Excel 2019 (Microsoft Corporation) to calculate the frequency of measurement reporting in the screening full-text materials, the linking frequency of the ICF domains, and the frequency

of nc or nd contents for each of the instruments. Even if a specific ICF category was repeatedly assigned in an outcome measurement, it was counted only once. According to the guide for developing the ICF core set, an ICF category that repeatedly appeared in a publication was counted only once.¹² We used frequencies and percentage analyses to determine the most frequently identified ICF categories. The ICF categories identified in at least 5% of the publications were included in the list of candidate categories.

Results

Study selection

A total of 1272 publications were identified. After removal of duplicates, 860 potentially relevant publications remained. Full-text screening of 154 articles was performed in the abstract screening. Sixty-one articles were subsequently included for data extraction (see Figure 1). The details of the included studies are available in Supplemental Digital Content 2, <http://links.lww.com/POI/A254>.

Article characteristics

The 61 eligible studies, from 17 different countries, were included in this review. Twenty-four (39.34%) of the studies were

conducted in the United States, 7 (11.47%) in the Netherlands, and 6 (9.83%) in the United Kingdom. The investigated study population consisted of 3767 adult upper-limb amputees. The majority of the studies (77.04%) were observational in design, and 22.95% were intervention studies.

An overview of the measures

The TAPES, Southampton Hand Assessment Procedure, and the Upper Extremity Functional Status module of the Orthotics and Prosthetics User Survey were the most frequently used measures among the 56 multiple-item measures linked to the ICF, followed by the Disabilities of the Arm, Shoulder, and Hand (DASH/QuickDASH), and Short-Form Survey (SF-36/SF-12). Table 1 shows a list of the 19 most used multiple-item measures linked to the ICF. Most of the measures covered the components of activity and participation and body functions. Overall, the most common chapters were d4 “Mobility,” b1 “Mental functions,” d5 “Self-care,” and d6 “Domestic life” (Supplemental Digital Content 3, <http://links.lww.com/POI/A255>). Only 2 of the measures (TAPES and Amputee Body Image Scale) covered almost all the ICF components, including body functions, body structures, activity and participation, and contextual factors (Supplemental Digital Content 4, <http://links.lww.com/POI/A256>).

Thirty single-item measures were linked to the ICF. The box and block test (BBT) was the most frequently used single-item measure, followed by electromyography (EMG) analysis, and gaze behavior

(GB) analysis. Table 2 shows a list of the 9 most used single-item measures linked to the ICF. Most of the measures covered the components of body functions. The most common chapters were b7 “Neuromusculoskeletal and movement-related functions” and b1 “Mental functions” (Supplemental Digital Content 5, <http://links.lww.com/POI/A257>). The content-related categories’ distribution of all single-item measurement methods is given in Supplemental Digital Content 6, <http://links.lww.com/POI/A258>.

The most frequently covered areas of functioning: ICF categories

We identified 86 outcome measures (56 multiple- and 30 single-item measures), which contained 1115 concepts. Overall, the content of the outcome measures covered 129 independent ICF categories. Three hundred twenty-six (29.23%) of the 1115 concepts were related to body functions, 643 (57.66%) to activities and participation, 96 (8.60%) to environmental factors, 19 (1.70%) to body structures, and 6 (0.53%) to personal factors. Twenty-five (2.24%) concepts could not be assigned to a specific ICF category, and these were characterized as “nd—not definable.”

The ICF categories identified in at least 5% of the publications are presented in Table 3 (full list shown in Supplemental Digital Content 7, <http://links.lww.com/POI/A259>, supporting information online). The most frequently identified categories were “d445 Hand and arm use” mentioned 67 times, “d440 Fine hand use”

Table 2. Distribution contents of the most used single-item measures by ICF component.

Name (abbreviation) ^a	No of citation	BF n (%)	BS n (%)	A&P n (%)	EF n (%)	PF n (%)	Others n (%)	No of unique concepts ^b	Brief description of measure
Box and block test (BBT)	8	1 (25)	—	3 (75)	—	—	—	4	Functionality
Electromyography (EMG)	7	1 (100)	—	—	—	—	—	1	Muscle strength
Functional magnetic resonance imaging (fMRI)	2	—	1 (100)	—	—	—	—	1	Brain reorganization
Gaze behavior (GB)	7	3 (100)	—	—	—	—	—	3	Attention, eye-hand coordination, and perception
Kinematic analysis—arm swing (AS)	2	1 (100)	—	—	—	—	—	1	Coordination
Kinematic analysis—compensatory trunk movement (CTM)	5	1 (100)	—	—	—	—	—	1	Compensatory movement
Kinematic analysis—prosthetic functionality (PF)	3	—	—	—	1 (100)	—	—	1	Prosthetic skill
Kinematic analysis—range of motion of residual limb (ROM)	4	1 (100)	—	—	—	—	—	1	Joint mobility
Visual analog scale (VAS)	2	2 (100)	—	—	—	—	—	2	Phantom pain severity and phantom limb movement degree

Abbreviations: A&P, activity and participation; BF, body function; EF, environmental factors; Others, not definable plus not covered by the ICF; PF, personal factors; BS, body structure.

^aMeasures order by abbreviation alphabetical order.

^bTotal number of meaningful concepts without duplications per measure.

Table 3. The representation of ICF categories identified in at least 5% of the publications.

ICF categories (code and name of categories)	Representation count of certain ICF code in the outcomes (n)	Representation count of certain ICF code in the studies (n)	% of studies applying the categories n = 61
Body functions			
b126 Temperament and personality functions	17	12	19.67
b130 Energy and drive functions	17	14	22.95
b134 Sleep functions	16	13	21.31
b140 Attention functions	19	14	22.95
b144 Memory functions	6	4	6.55
b152 Emotional functions	35	20	32.78
b156 Perceptual functions	6	6	9.83
b160 Thought functions	10	8	13.11
b164 Higher-level cognitive functions	15	12	19.67
b180 Experience of self and time functions	13	11	18.03
b265 Touch function	12	10	16.39
b280 Sensation of pain	38	23	37.70
b640 Sexual functions	5	5	8.19
b710 Mobility of joint functions	11	10	16.39
b720 Mobility of bone functions	4	4	6.55
b730 Muscle power functions	18	14	22.95
b760 Control of voluntary movement functions	34	22	36.06
b780 Sensations related to muscles and movement functions	9	7	11.47
Activity and participation			
d170 Writing	24	18	29.50
d230 Carrying out daily routine	22	14	22.95
d240 Handling stress and other psychological demands	11	9	14.75
d360 Using communication devices and techniques	14	12	19.67
d410 Changing basic body position	4	4	6.55
d430 Lifting and carrying objects	48	34	55.73
d440 Fine hand use	65	32	52.45
d445 Hand and arm use	67	35	57.37
d450 Walking	13	9	14.75
d455 Moving around	9	8	13.11
d470 Using transportation	4	4	6.55
d510 Washing oneself	23	18	29.50
d520 Caring for body parts	24	15	24.59
d540 Dressing	31	19	31.14

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Table 3. The representation of ICF categories identified in at least 5% of the publications. (Continued)

ICF categories (code and name of categories)	Representation count of certain ICF code in the outcomes (n)	Representation count of certain ICF code in the studies (n)	% of studies applying the categories n = 61
d550 Eating	31	19	31.14
d560 Drinking	15	13	21.31
d630 Preparing meals	14	12	19.67
d640 Doing housework	26	19	31.14
d649 Household tasks, other specified and unspecified	4	4	6.55
d650 Caring for household objects	11	11	18.03
d720 Complex interpersonal interactions	5	4	6.55
d750 Informal social relationships	22	15	24.59
d760 Family relationships	9	10	16.39
d770 Intimate relationships	6	6	9.83
d845 Acquiring, keeping, and terminating a job	10	9	14.75
d850 Remunerative employment	26	20	32.78
d859 Work and employment, other specified and unspecified	6	6	9.83
d910 Community life	12	9	14.75
d920 Recreation and leisure	39	24	39.34
Environmental factors			
e115 Products and technology for personal use in daily living	55	29	47.54
e340 Personal care providers and personal assistants	5	5	8.19
e460 Societal attitudes	9	7	11.47
e499 Attitudes, unspecified	5	5	8.19
Body structures			
s730 Structure of upper extremity	4	4	6.55
s799 Structures related to movement, unspecified	7	7	11.47
s810 Structure of areas of skin	5	5	8.19
Personal factors—pf	6	6	9.83
Not definable—nd	25	20	32.78

mentioned 65 times, and “d430 Lifting and carrying objects” mentioned 48 times in the “activity and participation” component. The category “b280 Sensation of pain” in the “body function” component, “e115 Products and technology for personal use in daily living” in the “environmental factors” components, and “s799 Structures related to movement, unspecified” in the “body structures” component were most frequently identified. All 54 ICF categories will serve as candidates for inclusion in the final ICF core set for upper-limb amputees during the consensus conference.

Discussion

This systematic review was performed to identify concepts of functioning considered relevant in outcome measurements published in the scientific literature related to upper-limb amputees. Our findings show that current outcome measures in the field of upper-limb amputees primarily focus on assessing the activity and participation, body functions, and environmental factor components of the ICF. The “personal factors” component is less frequently considered, and the “body structures” component is rarely measured.

There is a need for ICF core set for upper-limb amputees to provide a practical tool that maps the entire spectrum of functioning and to provide a common language that can be used to document, report, and assess upper-limb amputee patients' performance across the globe. This systematic review, which is the first step in the preparatory studies for the development of the ICF core set for upper-limb amputees, gives us information about the most cited areas of functioning and contextual factors. Previous systematic reviews related to upper-limb amputees provided useful information on the psychometric properties and theoretical background of the outcome measurements.⁶⁻⁸ Only one of these reviews was designed to perform conceptual analysis and identify the most cited areas of functioning according to the ICF. Our results can, therefore, be compared with a systematic review that conceptually analyzed only questionnaire-based outcome measurement methods according to ICF.⁷ Similarly to that previous review, the activity and participation domains were the subject of most focused in the current review. Important chapters of activity and participation were mobility and self-care. An important two-level category in the d4 Mobility was "hand and arm use" and in the d5 Self-care chapter was "dressing" and "eating." As in previous systematic reviews, it was expected that the "d4 Mobility" category would be the most frequently used code in this review. As a result of the inclusion of both clinical and questionnaire-based outcome measurement methods, the categories that fell under the component "body functions" were more accurately coded than in the previous systematic review.⁷ Important chapters of body functions were neuromusculoskeletal, movement-related functions, and mental functions. In addition to the results of the previous systematic review, mental functions were revealed to a higher degree in this systematic review. Important two-level categories in the mental function chapter were emotional function and attention function. This is consistent with recent systematic reviews, which highlighted that traumatic peripheral lesions can lead to a wide range of cognitive impairments in areas such as attention, memory, language, visuospatial capacities, and cognitive flexibility.^{16,17} Outcome measurement methods included in this systematic review also point to similar cognitive impairments. Another important component was "environmental factors." An important chapter on environmental factors was the two-level category e115 Products and technology for personal use in daily living, which addressed prostheses for upper-limb amputees. Similar to the results of the previous systematic review, the personal factors component is less frequently considered, and the body structures component is rarely measured. According to the results of this systematic review, 54 ICF categories were identified in at least 5% of the publications. These categories obtained from the systematic review will serve as information for the development of the final ICF core set, which will then be voted on in an international consensus. The final ICF core set will facilitate multidisciplinary collaboration to encourage all team members to use the same language "ICF categories" when describing functioning in upper-limb amputees.

The findings of this systematic review provide a content analysis according to the ICF, allowing clinicians and researchers to understand the content and purpose of the measures. Similar to our results, previous systematic reviews have stated that Upper Extremity Functional Status module of the Orthotics and Prosthetics User Survey, TAPES, Southampton Hand Assessment Procedure, and DASH are frequently used to evaluate upper-limb amputees.^{7,18} These outcome measurements are valid, reliable, and

frequently used for evaluating upper-limb amputees.¹⁹⁻²³ TAPES was developed for lower-limb amputees.¹⁹ In 2005, TAPES Upper was developed for individuals with an ULA. TAPES Upper differs from TAPES because of the inclusion of 2 additional subscales, 1 in the adjustment domain (optimal adjustment) and 1 in the activity restriction domain (occupational restriction).²⁰ In the present research, the psychosocial subscales and satisfaction with the prosthesis subscale were frequently used in upper-limb amputees. The original DASH was used more than QuickDASH in the articles reviewed in this systematic review. SF-36/12 has been used to assess the health-related quality of life of upper-limb amputee.²⁴ This study showed that the SF-36/12 was 1 of the most frequently used outcome measurement methods besides these scales. SF-12 was used more than SF-36. The pain, general health, and mental health subscales of the SF-36 were frequently used in upper-limb amputees in the present research. When we compared the content of these outcome measures, they overlapped in some ICF components, mainly activity and participation, especially in d4 mobility. In addition, TAPES and Amputee Body Image Scale fully represent all the ICF components and overlap in some ICF categories. Activity Measure for Upper-Limb Amputees (AM-ULA) and Jebsen-Taylor Hand Function Test (JTHFT) were the most featured outcome measurement methods in this review as in the previous review.⁶ AM-ULA assesses self-care tasks and skillfulness of prosthetic use, and JTHFT assesses fine and manual finger dexterity. Correlations between the JTHFT and AM-ULA were reported as page-turning (d1), hand-related mobility activities such as small items, checkers, light cans, and heavy cans (d4), and self-care activities such as feeding (d5).⁶ This content relationship between 2 outcome measurements is also demonstrated in this review.

In terms of clinical tests involving a single item or task, our results showed that the BBT, EMG analysis, and GB analysis are frequently used for evaluating upper-limb amputees. Similar to our results, a previous systematic review of upper-limb amputee and upper-limb trauma identified the BBT as one of the most frequently used and most highly rated performance measures in terms of psychometric properties.⁶ GB analysis evaluated with eye tracking systems has recently been used to determine the visuomotor behaviors of upper-limb prosthesis users. Gaze behavior analysis can be used as an outcome measure to understand the impact of prosthetic interventions in cases of decreasing visual and cognitive demands.²⁵ Upper-limb amputees experience cognitive load or mental fatigue when using their prosthetic device. With the development of technological prostheses, GB, EMG analysis, and performance-based measures such as the BBT may provide more reliable data on the daily prosthetic use performance.²⁵⁻²⁸ Most single-item outcome measurement methods in the review covered the component body functions and overlapped in the b7 "Neuromusculoskeletal and movement-related functions" first-level category.

The results of our review are important because this is the first study to aim to develop ICF core set for upper-limb amputees and conduct a conceptual analysis of both the single-item clinical tests and the multiple-item outcomes by ICF. Qualitative statements were not included because our aim was to determine which ICF areas were most frequently covered by outcome measurement methods. The principal limitation of this review is that only studies in English were included.

Conclusions

This systematic review identified the content of outcome measures used in studies of adults with ULA and showed the areas of functioning most frequently studied in this population. This systematic review demonstrates that the outcome measurements in upper-limb amputees mainly focus on activity and participation, body functions, and environmental factors, whereas the personal factors component is only minimally addressed. The body structures component is also rarely considered. The results of this systematic literature review capture the perspective of researchers on the person with ULA. According to the results of this systematic review, 54 ICF categories identified in at least 5% of the publications will serve as candidates for inclusion in the final ICF core set for upper-limb amputees. Development of the core set for upper-limb amputees is important because it can serve as a standardized method to compare data across disciplines and countries, assess the needs of upper-limb amputees, and determine rehabilitation goals.

In future studies, we will plan to capture different perspectives; an empirical multicenter study (clinical perspective), an expert survey (health professional's perspectives), and a qualitative study (perspectives of a person with ULA) for the preparatory phase of the ICF core set development.

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Data availability

All data that support the findings of this study are contained within the manuscript. Additional data can be made available on reasonable request from the corresponding author.

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