

Evaluation of the Content Validity Index of the Australian/Canadian Osteoarthritis Hand Index, the Patient-Rated Wrist/Hand Evaluation and the Thumb Disability Exam in People with Hand Arthritis

Pavlos Bobos (✉ p.bobos@mail.utoronto.ca)

Western University <https://orcid.org/0000-0002-5098-4840>

Joy C MacDermid

Western University

Eleni C. Boutsikari

National and Kapodistrian University of Athens

Emily A. Lalone

Western University

Louis Ferreira

Western University

Ruby Grewal

Western University

Research

Keywords: osteoarthritis, rheumatoid arthritis, psoriatic arthritis, content validity, hand arthritis

DOI: <https://doi.org/10.21203/rs.3.rs-32151/v3>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

Background The Australian/Canadian Osteoarthritis Hand Index (AUSCAN), the Patient-Rated Wrist/Hand Evaluation (PRWHE) and the Thumb Disability Exam (TDX) are patient-reported outcome measures (PROM) designed to assess pain and hand function in patients with hand arthritis, hand pain and disability, or thumb pathology respectively. This study evaluated the content validity of AUSCAN, PRWHE and TDX in people with hand arthritis.

Methods This study enrolled participants with hand arthritis to rate the items of all 3 PROM in terms of relevance and clarity. The Content Validity Index (CVI) was computed for each item in each scale (I-CVI) as well as for the overall scale (S-CVI). Kappa was used to determine the inter-rater agreement among the raters.

Results Overall, 64 individuals with hand arthritis (27% with OA, 67% with rheumatoid arthritis and 6% with psoriatic arthritis) participated in the study. The I-CVI for all items and all scales were very high (I-CVI > 0.76) and the modified Kappa agreement among the raters demonstrated excellent agreement ($k > 0.76$). The S-CVI for all PROMs was very high for relevance (AUSCAN = 0.92, 95% CI 0.90 to 0.94; PRWHE = 0.85, 95% CI 0.82 to 0.88 and TDX = 0.87, 95% CI 0.85 to 0.89) and for clarity (AUSCAN = 0.99, 95% CI 0.98 to 1.00; PRWHE = 0.95, 95% CI 0.93 to 0.97 and TDX = 0.91, 95% CI 0.89 to 0.94), respectively.

Conclusions This study demonstrated very high content validity indices for the AUSCAN, PRWHE and TDX; with strong consensus across raters. This augments prior studies demonstrating appropriate statistical measurement properties, to provide confidence that all three measures assess important patient concepts of pain and disability.

Introduction

Hand osteoarthritis (OA) is one of the most common musculoskeletal diseases and a leading cause of disability with an increasing prevalence mainly attributed to increased life expectancy.[1,2] Clinical characteristics of hand OA typically involve pain, reduced hand function, decreased hand grip strength, poor quality of life[3,4] joint degeneration, bony enlargements and joint swelling.[5] Rheumatoid arthritis, although leading to bone tissue abnormalities, loss of joint function and impact on quality of life similarly to OA, is a distinct pathology that mainly targets synovial and soft tissue structures.[6]

Patient-reported outcome measures (PROMs) are often administered to assess any health-related changes that may have occurred as a consequence of health-management interventions.[7,8] Many properties are important [9–13] during an instrument development such as reliability and validity but a key property is considered to be content validity.[14] Content validity can be defined as the degree of which the instrument or the questionnaire is an adequate reflection of the construct being measured.[15] Based on the Consensus-based Standards of the selection of health Measurement Instruments (COSMIN) initiative content validity is considered as one of the most important measurement properties.[14] While reliability, responsiveness and other types of validity can be pivotal for an outcome assessment they may be insufficient to establish the validity of a PROM.[16] When PROMs include irrelevant items and lack of clarity they are inefficient, and may have weaker measurement properties.[14] Most importantly, if key aspects are missing or the questions are not relevant responses, they may not reflect patient status or concerns, and may be biased because patients may get frustrated.[17]

The Australian/Canadian Osteoarthritis Hand Index (AUSCAN)[18], the Patient-Rated Wrist/Hand Evaluation (PRWHE)[18] and the Thumb Disability Exam (TDX)[19] are clinical tools designed to assess pain and hand function in hand arthritis. Their psychometric properties[18–21] such as reliability, validity and responsiveness have been studied however, the evaluation of relevance and clarity of all the individual items by including patient input as experts has not been quantified. Therefore, we aimed to investigate the quantification of content validity index by asking patients with hand arthritis to rate each of the instruments items in terms of relevance and clarity.

Primary Objective

To evaluate the Content Validity Index (CVI) of the Patient-Rated Wrist/Hand Evaluation (PRWHE), the Australian/Canadian Osteoarthritis Hand Index (AUSCAN) and Thumb Disability Exam (TDX) in patients with hand arthritis.

Methods

Study Design

This study was a cross-sectional design that investigated the content validity of patient-reported outcomes (PRWHE, AUSCAN and TDX) for hand arthritis. Ethical approval was granted from the Hamilton Integrated Research Ethics Board (HiREB).

Inclusion criteria:

1. The participant is able and willing to provide informed consent
2. Participants between 18 - 85 years old
3. The participant is of any gender
4. The participant has been diagnosed with hand arthritis.
5. The participant can read and write English.

Exclusion criteria

1. If participant has not been diagnosed with hand arthritis
2. If people cannot answer the survey questions and they do not understand English.

Setting and Recruitment

Participants were recruited through poster advertisements at The Roth McFarlane Hand and Upper Limb Centre (HULC) at St. Joseph's Health Care Hospital in London, Ontario and through The Arthritis Society main website. The patients that expressed interest to participate in the study received a letter of information about the survey. Both electronic and paper versions of the survey were available for participants. An email with the link of the online survey was sent out to the participants that were interested to complete the electronic version. The electronic version was hosted on Qualtrics from May 2019 till February 2020 which is a secure data collection platform.[22] Participants were asked to provide consent to proceed into the survey questions. All the items were rated for relevance and clarity in an order (PRWHE, AUSCAN, TDX). Participants were asked to rate the relevance and clarity of each item of PRWHE, AUSCAN and TDX.

Patient-reported Outcome Measures

The Australian/Canadian Osteoarthritis Hand Index (AUSCAN) is a 15-item self-reported disease specific questionnaire measuring pain (5-items), function (9-items) and stiffness (1-item) in the hand on a scale from 0 – none to 4 – extreme for all items.[18,20] The Patient-Rated Wrist/Hand Evaluation (PRWHE) is a self-administered questionnaire which has 2 subscales of pain (5-items) and function (10-items). The PRWHE was originally developed and tested for people with distal radius fracture (DRF)[21,23,24] and later validated as applicable to the wrist/hand for multiple conditions including arthritis as the PRWHE. [18,25] Each item is scored from 0 to 10 scale which 10 indicates the worst possible pain or disability. The Thumb Disability Exam (TDX) is composed of 20 questions divided into 3 sections: hand function (11-items), pain (5-items) and satisfaction (4-items). Each item for hand function is scored from 1 – not difficult to 5 – unable, for level of pain 1 – never to 5 – always and for satisfaction from 1 – very satisfied to 5 – very dissatisfied. [19]

Data Analysis

Descriptive statistics were used to capture the demographics characteristics (age, diagnosis, medications and whether they had surgery or not) of the included sample. A Content Validity Index (CVI) value was computed for each item on the AUSCAN, PRWHE and TDX (I-CVI) as well as for the overall scale (S-CVI). To calculate an item-level CVI (I-CVI), patients with hand arthritis were asked to rate the relevance of each item, on a 4-point scale. Four ordinal points were used for each scale which was 1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant. Then, for each item, the I-CVI was computed as the number of patients giving a rating of either 3 or 4, divided by the number of raters—that is, the proportion in agreement about relevance and clarity which is between 0 and 1. The S-CVI was calculated by averaging across the I-CVIs of each PROM. To calculate the modified kappa statistic, the probability of chance agreement (Pc) was first calculated for each item by the following formula: $Pc = [N! / A! (N$

-A)] $*0.5^N$ with N being the number of raters (patients with arthritis) and A is the number of patients that agree that the item was clear or relevant.[26] Then Kappa was calculated of entering the probability of chance agreement (Pc) and content validity index of each item (I-CVI) in the following formula: $K = (I-CVI - PC) / (1 - PC)$. Kappa values of 0.74 and above were considered as excellent, 0.60 to 0.74 as good and 0.54 to 0.59 as fair.[27] We performed a Shapiro-Wilk as the omnibus test for assessing univariate normality of each S-CVI distribution, in both relevance and clarity subscales of PROMs. Then, the S-CVI scores were compared with a paired student's t-Test if normality assumption was met or with Wilcoxon paired signed-ranks test, if assumptions of normality were violated. [28] We conducted all the analyses with STATA (StataCorp. 2019. Stata Statistical Software: Release 16. College Station, TX: StataCorp LLC)

Results

Overall, 64 individuals with hand arthritis (27% with hand OA, 67% with rheumatoid arthritis in the hand and 6% with psoriatic arthritis) participated in the study. Four individuals were excluded from the analysis because their arthritis was not affecting their hand. The majority of the participants (66%) were taking pain medication on a daily basis (Table 1). All individuals completed the electronic version of the survey.

Content Validity Index and Modified Kappa agreement of the PRWHE

The I-CVI and the S-CVI of the PRWHE for pain subscale and function subscales all supported the content validity of the PRWHE (Table 2). Five items of pain subscale were rated for relevancy and clarity with I-CVI values ranging from 0.79 to 0.89 and from 0.87 to 0.94, respectively. For function subscales, 10 items were rated for relevancy and clarity with I-CVI values ranging from 0.79 to 0.95 and from 0.92 to 1.00 respectively. The S-CVI for PRWHE was 0.85, 95% confidence intervals (CI): 0.82 to 0.88 for relevance and 0.95,95%CI: 0.93 to 0.97 for clarity. The modified Kappa agreement for every item of PRWHE demonstrated excellent agreement (K ranging from 0.79 to 1.00).

Content Validity Index and Modified Kappa agreement of the TDX

The I-CVI and the S-CVI supported the content validity of the TDX for hand function, pain and satisfaction subscales (Table 3). Eleven items of hand function were rated as relevant and clear with I-CVI values ranging from 0.82 to 0.93 and from 0.94 to 0.98 respectively. For pain subscale, five items were rated as relevant and clarity with I-CVI scores ranging from 0.78 to 0.85 and from 0.77 to 0.86 respectively. For the satisfaction subscale, four items were rated as relevant and clear based on I-CVI demonstrating scores from 0.83 to 0.95 and from 0.88 to 0.91. The S-CVI of TDX was rated as relevant and clear based on scores of 0.87,95% CI: 0.85 to 0.89 for relevancy and 0.91, 95% CI: 0.89 to 0.94 for clarity. The modified Kappa agreement demonstrated excellent inter-rater agreement on item ratings (K ranging from 0.77 to 0.98).

Content Validity Index and Modified Kappa agreement of the AUSCAN

The I-CVI and the S-CVI supported the content validity of the hand pain, stiffness and function items and subscales of the AUSCANs (Table 4). Five items of pain subscale were rated for relevancy and clarity with I-CVI scores ranging from 0.86 to 0.96 and from 0.92 to 1.00 respectively. For 1-item in stiffness subscale the I-CVI was found 0.93 for relevancy and 1.00 for clarity. For function subscale, 9-items were rated for relevancy and clarity with an I-CVI ranging from 0.88 to 0.97 and from 0.98 to 1.00 respectively. The S-CVI for AUSCAN was found 0.92,95% CI: 0.90 to 0.94 for relevance and 0.99, 95% CI: 0.98 to 1.00 for clarity. The modified Kappa agreement for every item of the AUSCAN demonstrated excellent agreement (K ranging from 0.86 to 1.00)

Discussion

This study established a high level of content validity for PRWHE, AUSCAN and TDX for patients with hand arthritis. The content validity index was very high for all the individual items for each questionnaire (I-CVI > 0.77) and for the overall score (S-CVI > 0.85) in terms of relevancy and clarity. The Kappa inter-rater agreement was excellent across all the individual items for all PROMs (PRWHE, AUSCAN and TDX) among the raters.

Content validity of PRWHE was established during the development of the PRWHE by using semi-structured interviews in patients with distal radius fracture and expert opinion. [29] However, neither were quantified. Thus, this study provides novel information on the content validity of the items of the PRWHE, with specific reference to those with hand arthritis. All items of PRWHE were found with very high content validity index in terms of relevance (I-CVI > 0.79) and clarity (I-CVI > 0.87).

For the AUSCAN the content validity was established during development using a formal clinimetric process where patients in a tertiary care centre rated items by importance and frequency to establish relevance.[20] This study provides additional support for the content validity in a community sample of people living with hand arthritis, and by adding new data on the clarity of the items.

It might have been expected that the AUSCAN would have more relevance to our sample, than the PRWHE since it a disease-specific PROM. Both point estimate and CI comparisons indicate that AUSCAN had slightly higher overall scores in terms of relevancy (S-CVI = 0.92, 95% CI: 0.90 to 0.94) and clarity (S-CVI = 0.99, 95% CI: 0.98 to 1.00) than the PRWHE (S-CVI=0.85, 95% CI :0.82 to 0.88 for relevancy and S-CVI=0.95, 95% CI: 0.93 to 0.97 for clarity). Although the CIs of the respective S-CVIs indicate that there was a small statistically significant difference (Table 5) between compared S-CVI values (AUSCAN vs TDX and AUSCAN vs PRWHE), all PROMs met standards of very high content validity. Finally, since 6 to 8 additional raters assessed the PRWHE than the AUSCAN, the small differences may reflect differences in rater pools rather than an actual difference in perceptions.

The TDX is relatively new developed PROM (Noback et al. 2017)[19] that was initially tested in patients with basal joint arthritis. The TDX demonstrated very high content validity index when assessed in terms of relevancy (S-CVI = 0.87, 95% CI: 0.85 to 0.89) and clarity (S-CVI = 0.91, 95% CI: 0.89 to 0.94). All the individual items of the TDX had a very high content validity index (I-CVI >0.77). To the authors knowledge, no previous studies exist to assess the content validity index of TDX in the current literature. The item generation of TDX included the review of items from relevant scales (Michigan Hand Questionnaire (MHQ)[30], Disabilities of the Arm, Shoulder, and Hand (DASH)[31], AUSCAN[20], PRWHE[24] and McGill Pain questionnaire[32]). Then, the development process included item reduction and pilot testing and then final item reduction.[19]

Our kappa statistics indicated excellent agreement between patient raters after correcting for chance agreement. ($K > 0.77$). The assessment from a large pool of patients ($n > 60$) generated similar scores between the I-CVI and K scores. This has been previously described in the literature when the number of raters increasing and the probability of chance (P_c) decreases the K agreement and I-CVI values tend to converge.[26]

This study provided novel data on the content validity index in 3 different PROMs in patients with hand arthritis. Since few studies address content validity, this is important to support the conceptual foundations of these measures and support their use in clinical practice. While the computation of CVI is relatively easy, its major weakness is the failure to adjust for chance agreement. However, the authors tried to mitigate this problem by calculating a modified kappa agreement. A potential limitation is that the items of the PROMs were not randomized but the items were rated for relevance and clarity in an order (PRWHE, AUSCAN, TDX). We deem that it is highly unlikely to have an order effect in the CVI values. First, higher scores were found in AUSCAN and not in PRWHE and second, all CVI scores were very high and this indicates that the conclusion is not affected by order. Future research directions should aim to evaluate item clarity through qualitative evaluations.

Conclusions

This study demonstrated evidence of very high content validity index for all the individual items and for the overall scale of PRWHE, AUSCAN and TDX for patients with hand arthritis, with high agreement across raters.

Declarations

Disclosure of Funding

This study is supported by the Canadian Institutes of Health Research (CIHR) with funding reference number (FRN: 201710GSD-402354-282879) and by an operating grant from the Arthritis Society of Canada.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data sharing is not permitted by our institutional research ethics board

Code availability

Code will be made available upon request

Authors' Contribution

PB conceived and designed the study, collected, analyzed and interpreted data, wrote the first draft of the article, and contributed to all revisions. JCM and ECB analyzed and interpreted data and contributed to all revisions. EL, RG and LF contributed to designing the study, collected and interpreted data, and contributed to all revisions. All authors read and approved the final manuscript.

Acknowledgements

Pavlos Bobos was supported by the Canadian Institutes of Health Research (CIHR) Doctoral Award. Joy C MacDermid was supported by a CIHR Chair in Gender, Work and Health and the Dr. James Roth Research Chair in Musculoskeletal Measurement and Knowledge Translation

References

1. Branco JC, Rodrigues AM, Gouveia N, Eusébio M, Ramiro S, Machado PM, et al. Prevalence of rheumatic and musculoskeletal diseases and their impact on health-related quality of life, physical function and mental health in Portugal: results from EpiReumaPt– a national health survey. *RMD Open*. 2016;2:e000166.
2. Dahaghin S, Bierma-Zeinstra SMA, Ginai AZ, Pols HAP, Hazes JMW, Koes BW. Prevalence and pattern of radiographic hand osteoarthritis and association with pain and disability (the Rotterdam study). *Ann Rheum Dis*. 2005;64:682.
3. Zhang Y, Niu J, Kelly-Hayes M, Chaisson CE, Aliabadi P, Felson DT. Prevalence of Symptomatic Hand Osteoarthritis and Its Impact on Functional Status among the Elderly The Framingham Study. *Am J Epidemiol*. Oxford Academic; 2002;156:1021–7.
4. Bobos P, Nazari G, Szekeres M, Lalone EA, Ferreira L, MacDermid JC. The effectiveness of joint-protection programs on pain, hand function, and grip strength levels in patients with hand arthritis: A systematic review and meta-analysis. *Journal of Hand Therapy*. 2019;32:194–211.
5. Kloppenburg M, Kroon FP, Blanco FJ, Doherty M, Dziedzic KS, Greibrokk E, et al. 2018 update of the EULAR recommendations for the management of hand osteoarthritis. *Ann Rheum Dis*. 2019;78:16.
6. Cai P, Jiang T, Li B, Qin X, Lu Z, Le Y, et al. Comparison of rheumatoid arthritis (RA) and osteoarthritis (OA) based on microarray profiles of human joint fibroblast-like synoviocytes: Bioinformation for RA and OA interpretation. *Cell Biochem Funct [Internet]*. 2019 [cited 2020 Apr 28];37:31–41. Available from: <http://doi.wiley.com/10.1002/cbf.3370>
7. Fitzpatrick R, Davey C, Buxton M, Jones D. Evaluating patient-based outcome measures for use in clinical trials: a review. *Health Technology Assessment [Internet]*. 1998 [cited 2020 Apr 17];2. Available from: <https://www.journalslibrary.nihr.ac.uk/hta/hta2140#/abstract>
8. Bijlsma JWW. Patient centred outcomes in osteoarthritis. *Ann Rheum Dis*. 2005;64:1.
9. Bobos P, Nazari G, Lu Z, MacDermid JC. Measurement Properties of the Hand Grip Strength Assessment: A Systematic Review With Meta-analysis. *Arch Phys Med Rehabil*. 2019;101:553–65.
10. Bobos P, MacDermid JC, Walton DM, Gross A, Santaguida PL. Patient-Reported Outcome Measures Used for Neck Disorders: An Overview of Systematic Reviews. *J Orthop Sports Phys Ther*. 2018;48:775–88.
11. Bobos P, MacDermid J, Nazari G, Furtado R. Psychometric properties of the global rating of change scales in patients with neck disorders: a systematic review with meta-analysis and meta-regression. *BMJ Open*. 2019;9:e033909.
12. Bobos P, Ziebart C, Furtado R, Lu Z, MacDermid JC. Psychometric properties of the global rating of change scales in patients with low back pain, upper and lower extremity disorders. A systematic review with meta-analysis. *Journal of Orthopaedics*.

2020;21:40–8.

13. McGee S, Sipos T, Allin T, Chen C, Greco A, Bobos P, et al. Systematic review of the measurement properties of performance-based functional tests in patients with neck disorders. *BMJ Open*. 2019;9:e031242.
14. Terwee CB, Prinsen C a. C, Chiarotto A, Westerman MJ, Patrick DL, Alonso J, et al. COSMIN methodology for evaluating the content validity of patient-reported outcome measures: a Delphi study. *Qual Life Res*. 2018;27:1159–70.
15. Mokkink LB, Terwee CB, Patrick DL, Alonso J, Stratford PW, Knol DL, et al. The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. *Journal of Clinical Epidemiology*. Elsevier; 2010;63:737–45.
16. Patrick DL, Burke LB, Gwaltney CJ, Leidy NK, Martin ML, Molsen E, et al. Content Validity—Establishing and Reporting the Evidence in Newly Developed Patient-Reported Outcomes (PRO) Instruments for Medical Product Evaluation: ISPOR PRO Good Research Practices Task Force Report: Part 2—Assessing Respondent Understanding. *Value in Health*. Elsevier; 2011;14:978–88.
17. Streiner DL, Norman GR, Cairney J. *Health Measurement Scales: A practical guide to their development and use* [Internet]. Health Measurement Scales. Oxford University Press; [cited 2020 Apr 17]. Available from: <https://oxfordmedicine.com/view/10.1093/med/9780199685219.001.0001/med-9780199685219>
18. McQuillan TJ, Vora MM, Kenney DE, Crisco JJ, Weiss A-PC, Ebert KA, et al. The AUSCAN and PRWHE Demonstrate Comparable Internal Consistency and Validity in Patients With Early Thumb Carpometacarpal Osteoarthritis: HAND [Internet]. SAGE PublicationsSage CA: Los Angeles, CA; 2017 [cited 2020 Apr 17]; Available from: <https://journals.sagepub.com/doi/10.1177/1558944717729217>
19. Noback PC, Lombardi JM, Seetharaman M, Lee DH, Strauch RJ, Rosenwasser MP. Development and Validation of a Disease-Specific Questionnaire for Basal Joint Arthritis. *Jnl Wrist Surg*. Thieme Medical Publishers; 2017;06:126–33.
20. Bellamy N, Campbell J, Haraoui B, Buchbinder R, Hobby K, Roth JH, et al. Dimensionality and clinical importance of pain and disability in hand osteoarthritis: Development of the Australian/Canadian (AUSCAN) Osteoarthritis Hand Index. *Osteoarthritis and Cartilage*. 2002;10:855–62.
21. Mehta SP, MacDermid JC, Richardson J, MacIntyre NJ, Grewal R. A Systematic Review of the Measurement Properties of the Patient-Rated Wrist Evaluation. *Journal of Orthopaedic & Sports Physical Therapy* [Internet]. JOSPT, Inc. JOSPT, 1033 North Fairfax Street, Suite 304, Alexandria, VA 22134-1540; 2015 [cited 2020 Apr 17]; Available from: <https://www.jospt.org/doi/abs/10.2519/jospt.2015.5236>
22. Qualtrics XM // The Leading Experience Management Software [Internet]. Qualtrics. [cited 2020 Apr 17]. Available from: <https://www.qualtrics.com/>
23. MacDermid JC, Tottenham V. Responsiveness of the disability of the arm, shoulder, and hand (DASH) and patient-rated wrist/hand evaluation (PRWHE) in evaluating change after hand therapy. *Journal of Hand Therapy*. Elsevier; 2004;17:18–23.
24. Packham T, MacDermid JC. Measurement properties of the Patient-Rated Wrist and Hand Evaluation: Rasch analysis of responses from a traumatic hand injury population. *Journal of Hand Therapy*. Elsevier; 2013;26:216–24.
25. MacDermid JC, Wessel J, Humphrey R, Ross D, Roth JH. Validity of self-report measures of pain and disability for persons who have undergone arthroplasty for osteoarthritis of the carpometacarpal joint of the hand. *Osteoarthritis and Cartilage*. Elsevier; 2007;15:524–30.
26. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Research in Nursing & Health*. John Wiley & Sons, Ltd; 2007;30:459–67.
27. Cicchetti DV, Sparrow SA. Developing criteria for establishing interrater reliability of specific items: Applications to assessment of adaptive behavior. *American Journal of Mental Deficiency*. US: American Assn on Mental Retardation; 1981;86:127–37.
28. MacFarland TW, Yates JM. Wilcoxon Matched-Pairs Signed-Ranks Test. In: MacFarland TW, Yates JM, editors. *Introduction to Nonparametric Statistics for the Biological Sciences Using R* [Internet]. Cham: Springer International Publishing; 2016 [cited 2020 May 5]. p. 133–75. Available from: https://doi.org/10.1007/978-3-319-30634-6_5
29. Kleinlugtenbelt YV, Krol RG, Bhandari M, Goslings JC, Poolman RW, Scholtes VAB. Are the patient-rated wrist evaluation (PRWE) and the disabilities of the arm, shoulder and hand (DASH) questionnaire used in distal radial fractures truly valid and

reliable? Bone & Joint Research [Internet]. The British Editorial Society of Bone and Joint Surgery London; 2018 [cited 2020 Apr 25]; Available from: <https://online.boneandjoint.org.uk/doi/abs/10.1302/2046-3758.71.BJR-2017-0081.R1>

30. Shauver MJ, Chung KC. The Michigan Hand Outcomes Questionnaire (MHQ) after 15 years of field trial. Plastic and reconstructive surgery. NIH Public Access; 2013;131:779e.
31. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery [Internet]. BMC musculoskeletal disorders. BMC Musculoskelet Disord; 2003 [cited 2020 Aug 9]. Available from: <https://pubmed.ncbi.nlm.nih.gov/12809562/>
32. Melzack R. The McGill Pain Questionnaire: major properties and scoring methods [Internet]. Pain. Pain; 1975 [cited 2020 Aug 9]. Available from: <https://pubmed.ncbi.nlm.nih.gov/1235985/>

Tables

| Table 1. Demographics of study participants | | |
|--|----|--------------|
| Variable | n | Percentage % |
| Age, years | | |
| 18-24 | 1 | 12% |
| 25-34 | 8 | 13% |
| 35-44 | 13 | 20% |
| 45-54 | 17 | 27% |
| 55-64 | 19 | 27% |
| 65-74 | 5 | 78% |
| 75-84 | 1 | 2% |
| Diagnosis | | |
| Osteoarthritis | 17 | 27% |
| Rheumatoid arthritis | 43 | 67% |
| Psoriatic arthritis | 4 | 6% |
| Frequency of Medication | | |
| Daily | 42 | 66% |
| Upon pain | 10 | 16% |
| Other | 12 | 19% |
| Surgery | | |
| No | 49 | 77% |
| Yes | 15 | 23% |

| Item | Relevance | | | Clarity | | | | Interpretation | |
|--|-----------|--------|---------------|---------|-----------|--------|---------------|----------------|-----------|
| | Agreement | I-CVI* | Pc** | K*** | Agreement | I-CVI* | Pc** | | K*** |
| 1. Pain subscale | | | | | | | | | |
| Rate your pain: At rest | 51/64 | 0.80 | < 10 -5 | 0.80 | 50/53 | 0.94 | < 10 -5 | 0.94 | Excellent |
| Rate your pain: When doing a task with a repeated wrist movement | 54/64 | 0.83 | < 10 -5 | 0.83 | 49/53 | 0.92 | < 10 -5 | 0.92 | Excellent |
| Rate your pain: When lifting a heavy object | 54/64 | 0.83 | < 10 -5 | 0.83 | 50/53 | 0.94 | < 10 -5 | 0.94 | Excellent |
| Rate your pain: When it is at its worst | 57/64 | 0.89 | < 10 -5 | 0.89 | 49/53 | 0.92 | < 10 -5 | 0.92 | Excellent |
| How often do you have pain? | 50/63 | 0.79 | < 10 -5 | 0.79 | 47/54 | 0.87 | < 10 -5 | 0.87 | Excellent |
| 2. Function | | | | | | | | | |
| A. Specific Activities | | | | | | | | | |
| Turn a doorknob using my affected hand | 53/63 | 0.84 | < 10 -5 | 0.84 | 52/52 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Cut meat using a knife in my affected hand | 54/63 | 0.86 | < 10 -5 | 0.86 | 53/53 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Fasten buttons on my shirt | 51/63 | 0.81 | < 10 -5 | 0.81 | 53/53 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Use my affected hand to push up from a chair | 50/63 | 0.79 | < 10 -5 | 0.79 | 51/52 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Carry a 10lb object in my affected hand | 58/63 | 0.92 | < 10 -5 | 0.92 | 52/53 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Use bathroom tissue with my affected hand | 50/63 | 0.79 | < 10 -5 | 0.79 | 51/52 | 0.98 | < 10 -5 | 0.98 | Excellent |
| B. Usual activities | | | | | | | | | |
| Personal care activities (dressing, washing) | 53/61 | 0.87 | < 10 -5 | 0.87 | 50/53 | 0.94 | < 10 -5 | 0.94 | Excellent |
| Household work (cleaning, maintenance) | 57/60 | 0.95 | < 10 -5 | 0.95 | 49/53 | 0.92 | < 10 -5 | 0.92 | Excellent |
| Work (your job or usual everyday work) | 52/60 | 0.87 | < 10 -5 | 0.87 | 49/53 | 0.92 | < 10 -5 | 0.92 | Excellent |
| Recreational activities | 54/60 | 0.90 | < | 0.90 | 51/53 | 0.96 | < | 0.96 | Excellent |

| | | |
|--------------------|---------------------------------------|---------------------------------------|
| | 10 -5 | 10 -5 |
| S – CVI/Ave | 0.85 (95% CI: 0.82 to 0.88) | 0.95 (95% CI: 0.93 to 0.97) |

Table 2. Content Validity Index of item relevancy and clarity and Modified Kappa agreement of Patient Rated Wrist/Hand Evaluation (PRWHE)

Table 3. Content Validity Index of item relevancy and clarity, and Modified Kappa agreement of the Thumb Disability Exam (TDX)

| Item | Relevance | | | Clarity | | | | Interpretation | |
|--|-----------|--------|---------------|---------|-----------|--------|---------------|----------------|-----------|
| | Agreement | I-CVI* | Pc** | K*** | Agreement | I-CVI* | Pc** | | K*** |
| A. Please indicate your ability to perform these activities with the affected hand | | | | | | | | | |
| Turn a Key | 54/61 | 0.89 | < 10 -5 | 0.89 | 51/53 | 0.96 | < 10 -5 | 0.96 | Excellent |
| Pick up a coin | 52/61 | 0.85 | < 10 -5 | 0.85 | 49/51 | 0.96 | < 10 -5 | 0.96 | Excellent |
| Write | 56/61 | 0.92 | < 10 -5 | 0.92 | 51/54 | 0.94 | < 10 -5 | 0.94 | Excellent |
| Squeeze Toothpaste | 52/60 | 0.87 | < 10 -5 | 0.87 | 51/53 | 0.96 | < 10 -5 | 0.96 | Excellent |
| Hold a glass of water | 50/61 | 0.82 | < 10 -5 | 0.82 | 51/54 | 0.94 | < 10 -5 | 0.94 | Excellent |
| Turn a doorknob | 52/61 | 0.85 | < 10 -5 | 0.85 | 51/53 | 0.96 | < 10 -5 | 0.96 | |
| Use a knife to cut food | 54/61 | 0.89 | < 10 -5 | 0.89 | 51/53 | 0.96 | < 10 -5 | 0.96 | Excellent |
| B. Please indicate your ability to perform the following task while using both your hands | | | | | | | | | |
| Open a jar | 57/61 | 0.93 | < 10 -5 | 0.93 | 50/51 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Button a shirt/blouse | 53/61 | 0.87 | < 10 -5 | 0.87 | 49/50 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Tie your shoes | 55/61 | 0.90 | < 10 -5 | 0.90 | 50/51 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Wring a dishcloth/washcloth | 53/61 | 0.87 | < 10 -5 | 0.87 | 49/51 | 0.96 | < 10 -5 | 0.96 | Excellent |
| II. The following questions refer to the level of pain in your thumb | | | | | | | | | |
| How often did you have pain in your thumb at rest? | 50/61 | 0.82 | < 10 -5 | 0.82 | 40/52 | 0.77 | < 10 -5 | 0.77 | Excellent |
| How often did the pain in your thumb interfere with your daily activities? | 49/60 | 0.82 | < 10 -5 | 0.82 | 44/51 | 0.86 | < 10 -5 | 0.86 | Excellent |
| How often did the pain in your hand interfere with recreational activities? | 51/60 | 0.85 | < 10 -5 | 0.85 | 44/52 | 0.85 | < 10 -5 | 0.85 | Excellent |

| | | | | | | | | | |
|--|-----------------------|------|---------------|-----------------------|-------|------|---------------|------|-----------|
| How often did the pain in your thumb interfere with your sleep? | 47/60 | 0.78 | < 10 -5 | 0.78 | 44/52 | 0.85 | < 10 -5 | 0.85 | Excellent |
| How often did the pain in your thumb worsen your mood? | 51/60 | 0.85 | < 10 -5 | 0.85 | 42/52 | 0.81 | < 10 -5 | 0.81 | Excellent |
| III. The following questions ask about your satisfaction with the indicated hand or thumb over the past week. | | | | | | | | | |
| Motion in your affected thumb | 48/58 | 0.83 | < 10 -5 | 0.83 | 47/53 | 0.89 | < 10 -5 | 0.89 | Excellent |
| Strength of your affected hand | 54/57 | 0.95 | < 10 -5 | 0.95 | 48/53 | 0.91 | < 10 -5 | 0.91 | Excellent |
| Pain level of your affected hand | 52/58 | 0.90 | < 10 -5 | 0.90 | 48/53 | 0.91 | < 10 -5 | 0.91 | Excellent |
| Overall function of your hand | 53/58 | 0.91 | < 10 -5 | 0.91 | 46/52 | 0.88 | < 10 -5 | 0.88 | Excellent |
| S-CVI | 0.87 | | | 0.91 | | | | | |
| | (95% CI: 0.85to 0.89) | | | (95% CI: 0.89to 0.94) | | | | | |

NOTE: *I-CVI: item-level content validity index, **pc (probability of a chance occurrence) was computed using the formula: $pc = [N! / A! (N - A)!] \cdot 0.5^N$ where N= number of raters and A= number of raters who agree that the item is relevant or clear, ***K(Modified Kappa) was computed using the formula: $K = (I-CVI - PC) / (1 - PC)$. Interpretation criteria for Kappa, using guidelines described in Cicchetti and Sparrow (1981): Fair=K of 0.40 to 0.59; Good=K of 0.60 to 0.74; and Excellent=K>0.74. I-CVI, item-level content validity index; scale-level content validity index, average (S-CVI/Ave).

Table 4. Content Validity Index of item relevancy and clarity, and Modified Kappa agreement of the Australian and Canadian Osteoarthritis Index (AUSCAN)

| Item | Relevance | | | | Clarity | | | | Interpretation |
|-------------------------------------|------------------------|--------|------------|------|------------------------|--------|------------|------|----------------|
| | Agreement | I-CVI* | Pc** | K*** | Agreement | I-CVI* | Pc** | K*** | |
| Rate your pain | | | | | | | | | |
| At rest | 49/57 | 0.86 | < 10 -5 | 0.86 | 49/50 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Gripping | 55/57 | 0.96 | < 10 -5 | 0.96 | 49/49 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Lifting | 55/57 | 0.96 | < 10 -5 | 0.96 | 49/50 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Turning | 54/57 | 0.95 | < 10 -5 | 0.95 | 46/50 | 0.92 | < 10 -5 | 0.92 | Excellent |
| Squeezing | 55/57 | 0.96 | < 10 -5 | 0.96 | 50/50 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Rate your stiffness | | | | | | | | | |
| After first wakening in the morning | 52/56 | 0.93 | < 10 -5 | 0.93 | 48/48 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Rate your difficulty when | | | | | | | | | |
| Turning taps/faucets on | 51/58 | 0.88 | < 10 -5 | 0.88 | 51/51 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Turning a round doorknob or handle | 54/59 | 0.92 | < 10 -5 | 0.92 | 53/53 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Doing up buttons | 52/59 | 0.88 | < 10 -5 | 0.88 | 52/52 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Fastening jewellery | 52/59 | 0.88 | < 10 -5 | 0.88 | 53/53 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Opening a new jar | 57/59 | 0.97 | < 10 -5 | 0.97 | 53/53 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Carrying a full pot with one hand | 56/59 | 0.95 | < 10 -5 | 0.95 | 52/53 | 0.98 | < 10 -5 | 0.98 | Excellent |
| Peeling vegetables/fruits | 56/59 | 0.95 | < 10 -5 | 0.95 | 53/53 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Picking up large heavy objects | 55/59 | 0.93 | < 10 -5 | 0.93 | 51/51 | 1.00 | < 10 -5 | 1.00 | Excellent |
| Wringing out wash cloths | 52/59 | 0.88 | < 10 -5 | 0.88 | 50/51 | 0.98 | < 10 -5 | 0.98 | Excellent |
| S - CVI | 0.92 | | | | 0.99 | | | | |
| | (95% CI: 0.90 to 0.94) | | | | (95% CI: 0.98 to 1.00) | | | | |

| Table 5: Comparison of content validity index (S-CVI) of Relevance and Clarity | | | | | | | |
|--|-----------------------------|--------------------------------|--------------------------------|---------|-----------------------------|--|--|
| Relevance | | | | Clarity | | | |
| | PRWHE | TDX | AUSCAN | | PRWHE | TDX | AUSCAN |
| PRWHE | 0.85 (95% CI: 0.82-0.88) | <i>Paired</i> <i>t-Test</i> | <i>Paired</i> <i>t-Test</i> | PRWHE | 0.95 (95% CI: 0.93-0.97) | <i>Wilcoxon</i> <i>Signed ranks</i> | <i>Wilcoxon</i> <i>Signed ranks</i> |
| TDX | p=0.523 | 0.87 (95% CI: 0.85-0.89) | <i>Paired</i> <i>t-Test</i> | TDX | p = 0.153 | 0.91 (95% CI: 0.89-0.94) | <i>Wilcoxon</i> <i>Signed ranks</i> |
| AUSCAN | p <0.001 | p = 0.001 | 0.92 (95% CI: 0.90-0.94) | AUSCAN | p = 0.001 | p = 0.002 | 0.99 (95% CI: 0.98-1.00) |

Paired t-Test: Student's t-Test for Matched Pairs; Wilcoxon Signed Ranks: Wilcoxon Matched-Pairs Signed-Ranks; Australian and Canadian Osteoarthritis Index (AUSCAN); Thumb Disability Exam (TDX); Patient Rated Wrist/Hand Evaluation (PRWHE)