

# Instruments Measuring Pain, Physical Function, or Patient's Global Assessment in Hand Osteoarthritis: A Systematic Literature Search

A. Willemien Visser, Pernille Bøyesen, Ida K. Haugen, Jan W. Schoones, Désirée M. van der Heijde, Frits R. Rosendaal, and Margreet Kloppenburg

**ABSTRACT. Objective.** Description of use and metric properties of instruments measuring pain, physical function, or patient's global assessment (PtGA) in hand osteoarthritis (OA).

**Methods.** Medical literature databases up to January 2014 were systematically reviewed for studies reporting on instruments measuring pain, physical function, or PtGA in hand OA. The frequency of the use of these instruments were described, as well as their metric properties, including discrimination (reliability, sensitivity to change), feasibility, and validity.

**Results.** In 66 included studies, various questionnaires and performance- or assessor-based instruments were applied for evaluation of pain, physical function, or PtGA. No major differences regarding metric properties were observed between the instruments, although the amount of supporting evidence varied. The most frequently evaluated questionnaires were the Australian/Canadian Hand OA Index (AUSCAN) pain subscale and visual analog scale (VAS) pain for pain assessment, and the AUSCAN function subscale and Functional Index for Hand OA (FIHOA) for physical function assessment. Excellent reliability was shown for the AUSCAN and FIHOA, and good sensitivity to change for all mentioned instruments; additionally, the FIHOA had good feasibility. Good construct validity was suggested for all mentioned questionnaires. The most commonly applied performance- or assessor-based instruments were the grip and pinch strength for the assessment of physical function, and the assessment of pain by palpation. For these measures, good sensitivity to change and construct validity were established.

**Conclusion.** The AUSCAN, FIHOA, VAS pain, grip and pinch strength, and pain on palpation were most frequently used and provided most supporting evidence for good metric properties. More research has to be performed to compare the different instruments with each other. (J Rheumatol First Release October 15 2015; doi:10.3899/jrheum.141228)

*Key Indexing Terms:*

OSTEOARTHRITIS	HAND	PAIN	PHYSICAL FUNCTION
PATIENT'S GLOBAL ASSESSMENT			SYSTEMATIC REVIEW

Hand osteoarthritis (OA) is a highly prevalent disorder, characterized by bony enlargements and deformities<sup>1,2,3</sup>.

*From the Department of Rheumatology, and Department of Clinical Epidemiology, and Walaeus Library, Leiden University Medical Center, Leiden, the Netherlands; Department of Rheumatology, Diakonhjemmet Hospital, Oslo, Norway.*

*Supported by the Dutch Arthritis Foundation (grant number 10-1-309).*

*A.W. Visser, MD, Department of Rheumatology, Leiden University Medical Center; P. Bøyesen, MD, PhD, Department of Rheumatology, Diakonhjemmet Hospital; I.K. Haugen, MD, PhD, Department of Rheumatology, Diakonhjemmet Hospital; J.W. Schoones, MA, Walaeus Library, Leiden University Medical Center; D.M. van der Heijde, MD, PhD, Department of Rheumatology, Leiden University Medical Center, and Department of Rheumatology, Diakonhjemmet Hospital; F.R. Rosendaal, MD, PhD, Department of Clinical Epidemiology, Leiden University Medical Center; M. Kloppenburg, MD, PhD, Department of Rheumatology, and Department of Clinical Epidemiology, Leiden University Medical Center.*

*Address correspondence to Dr. A.W. Visser, Leiden University Medical Center, Department of Rheumatology, C1-R, P.O. Box 9600, 2300 RC Leiden, the Netherlands. E-mail: a.w.visser@lumc.nl*

*Accepted for publication July 14, 2015.*

Most studies on individuals with OA are based on the general population. Individuals with hand OA can experience symptoms such as pain, decreased grip strength, and disability, leading to a high clinical burden<sup>4,5,6</sup>. In clinical practice, treatment for patients with hand OA (individuals with hand OA seeking healthcare) is administered to decrease symptoms and improve function; however, the evidence to support these treatments is limited because few high-quality clinical trials have been performed in hand OA<sup>7,8</sup>.

An important problem in the lack of high-quality clinical trials in hand OA is the lack of standardization of outcome measures<sup>8</sup>. Therefore, the Outcome Measures in Rheumatology (OMERACT) and the Osteoarthritis Research Society International Task Force on Clinical Trials Guidelines defined core domains to describe outcomes in clinical trials on symptom modification, consisting of pain, physical function, and patient's global assessment (PtGA)<sup>9,10,11,12</sup>.

For the assessment of these domains, several patient-reported outcome measures are available. Hand OA-specific

questionnaires such as the Functional Index for Hand OA (FIHOA) and the Australian/Canadian Hand OA Index (AUSCAN)<sup>13,14</sup> have been developed, but also hand disorder- or arthritis-specific questionnaires such as the Michigan Hand Outcomes Questionnaire (MHQ), Arthritis Impact Measurement Scale-2 (AIMS-2), and Health Assessment Questionnaire (HAQ), to assess 1 or more of these domains<sup>15,16,17</sup>. In addition, physical function can be assessed using performance-based measures such as the grip or pinch strength or the Arthritis Hand Function Test (AHFT). In addition to self-report and performance-based instruments, assessor-based measures such as joint tenderness upon palpation are used for the assessment of pain<sup>18,19</sup>. Besides the above-mentioned questionnaires and assessor- or performance-based measures, several other instruments, which will be described in this manuscript, are used for the clinical assessment of hand OA. Although most available instruments have been shown to be reliable for the measurement of pain, physical function, or PtGA, a systematic comparison of the different instruments for the assessment of hand OA has not been performed.

Our study was conducted in the framework of the OMERACT hand OA working group, aiming to identify instruments for the measurement of pain, physical function, and PtGA in hand OA that can be recommended for use in clinical trials on OA. Therefore, insight into available instruments and their metric properties is needed. To this end, we performed a systematic literature review aiming to describe the frequency of use of available instruments measuring pain, physical function, or PtGA in studies on hand OA, and to describe the metric properties of these instruments<sup>20</sup>. Metric properties were described using the OMERACT filter<sup>21</sup>, focusing on the aspects of discrimination (reliability and sensitivity to change), feasibility, and truth (validity).

## MATERIALS AND METHODS

*Study design and identification of studies.* The study design and performance followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines<sup>20</sup>. In cooperation with a medical librarian (JWS), a systematic literature search was performed to obtain all manuscripts reporting on instruments measuring pain, physical function, or PtGA in hand OA. Medical literature databases (PubMed, Embase, Web of Science, COCHRANE, CINAHL, Academic Search Premier, and ScienceDirect) were searched from the date of their inception up to January 2014, using all variations of the following key words: “hand,” “osteoarthritis,” “outcome assessment,” “reliability,” “sensitive,” “feasibility,” and “validity” (Supplementary Data available from the authors on request).

*Inclusion and exclusion criteria.* First, all retrieved titles were screened, subsequently selected abstracts were reviewed, and finally full-text articles of the remaining references were read by 1 reviewer (AWV). A random sample of 200 titles (9% of the titles identified by literature search) was also reviewed by a second reviewer (MK). Because of the similar selection of titles, further extraction was done by a single reviewer, but in case of uncertainties, these were discussed and solved by consensus.

Studies reporting on the metric properties of the instruments assessing pain, physical function, and PtGA in hand OA were included. The metric properties of the studied instruments were described according to 4 items:

reliability, sensitivity to change, feasibility, and validity. Inclusion criteria differed per item:

- Reliability was described based on studies evaluating the reliability of 1 or more instruments performed more than once in the same group of patients, either by the same performer over time or by different performers during 1 study visit. Both cross-sectional and longitudinal studies were included.
- Sensitivity to change was described based on longitudinal studies evaluating change of pain, physical function, or PtGA in hand OA measured by 1 or more instruments.
- Feasibility was described based on studies evaluating this item of 1 or more instruments.
- Validity was described based on studies comparing different instruments assessing pain, physical function, or PtGA in the same patients. Again, both cross-sectional and longitudinal studies were included.

Studies that fulfilled the requirements for at least 1 of these 4 items were included in our review. To be able to generalize the description of the metric properties of the applied instruments to different populations, evaluation by only 1 study was considered as insufficient evidence to draw conclusions. Therefore, only instruments that were assessed by at least 2 studies were included in the description of metric properties.

Studies reporting on surgical interventions, less than 25 patients having hand OA, or on diseases other than hand OA were excluded, as well as animal studies, reviews, abstracts, letters to the editor, and studies in languages other than English. Because of the published systematic literature review on outcome measures in trapeziometacarpal OA by Marks, *et al*<sup>22</sup>, studies reporting only on trapeziometacarpal OA were also excluded.

*Data extraction.* A self-made standardized form was used to extract information on the following data: (1) study population (population size, setting, age, sex), (2) instruments and assessed domains, (3) study design and followup duration, (4) results concerning measures of reliability [intraclass correlation coefficient (ICC),  $\kappa$  value, percentage of agreement, smallest detectable difference (SDD)], sensitivity to change (percentage of change, amount of change, standardized response mean), feasibility (time needed to perform outcome measure), and validity (correlation, association, and measures of agreement between different instruments assessing the same domain). From 6 random studies, data were also extracted by MK, resulting in similar extracted data. All extracted results were discussed by both reviewers to avoid missing information.

*Statistical analyses.* Because of the heterogeneity of the studies with respect to the evaluated instruments, it was not possible to perform a metaanalysis. Therefore, we performed a descriptive review.

## RESULTS

*Literature flow.* In total, 4351 titles were identified and 2244 unique references were left for screening after removing duplicate references (Figure 1). During the screening, 2008 references could be removed based on title. After reviewing 236 abstracts and 92 full-text articles, 66 studies satisfied the inclusion criteria (Table 1<sup>13,18,19,23–33,34–44,45–55,56–66,67–77,78,79,80,81,82,83,84,85</sup>).

*Clinical outcome measures.* The instruments used for the assessment of the OMERACT core domains pain, physical function, and PtGA in the 66 identified studies are specified in Table 2<sup>13,14,15,16,17,18,86–96,97,98,99,100,101,102</sup>. Different instruments were applied, consisting of 12 questionnaires, 1 interview, and a number of rating scales [visual analog scale (VAS), numeric rating scale (NRS), or Likert]. Further, 9 different performance- or assessor-based measures were applied for the assessment of physical function; pain was

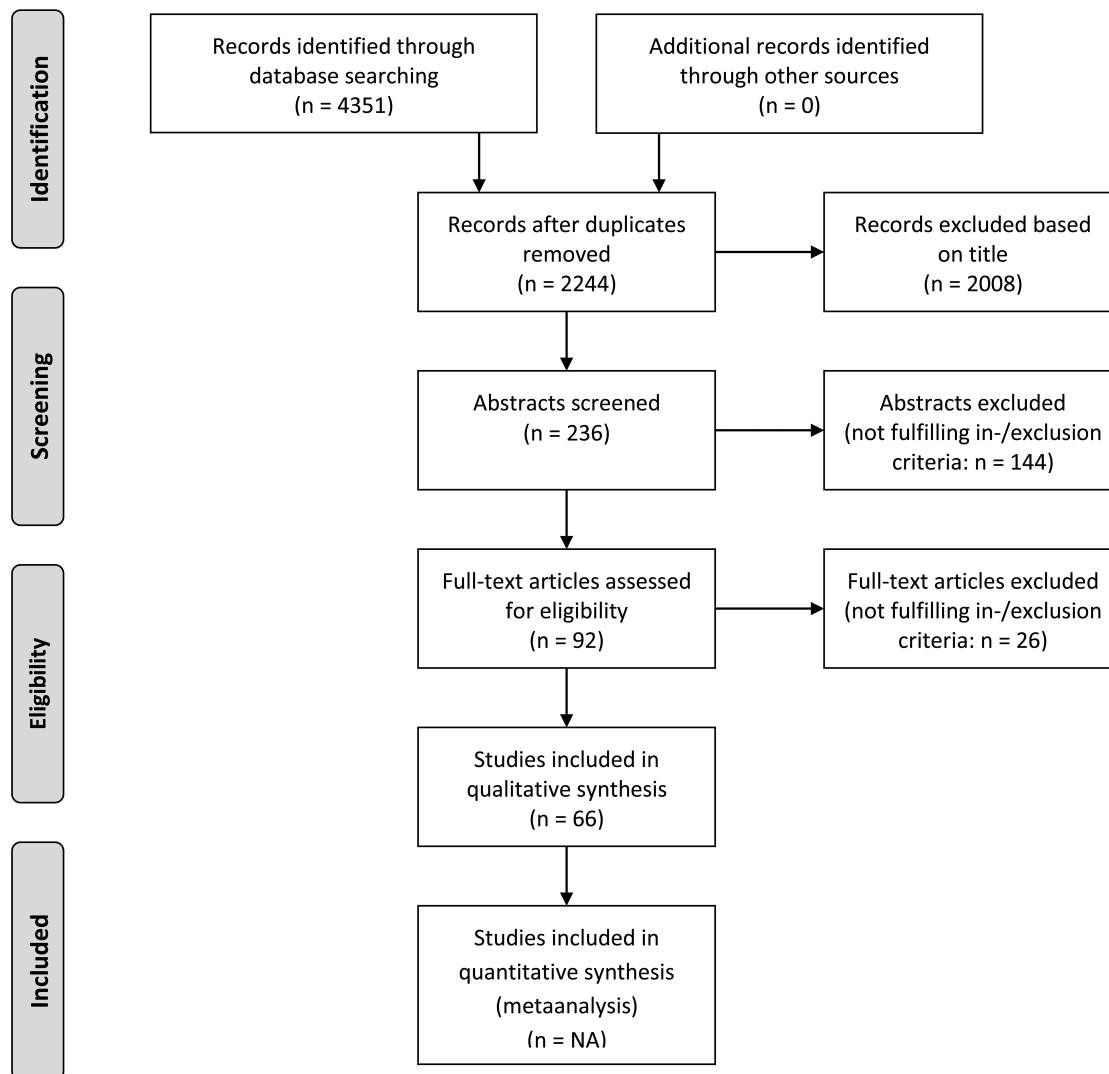


Figure 1. Overview of literature research. NA: not applicable.

assessed by palpation, using the number of painful or tender joints, the Doyle index, or the Ritchie articular index.

The AUSCAN was most frequently applied (n = 34), followed by the VAS pain (n = 30), VAS global (n = 16), FIHOA (n = 17), and HAQ (n = 12). The AIMS-2 was applied in 5 studies, the Cochin scale and Score for Assessment and Quantification of Chronic Rheumatoid Affections of the Hands (SACRAH) in 4 studies, the Canadian Occupational Performance Measure (COPM) in 3 studies, and the Arthritis Self Efficacy Scale (ASES) in 2 studies. The Measure of Activity Performance (MAP-hand), MHQ, Older Americans' Resources and Services Multidimensional Functional Assessment Questionnaire, Patient-Rated Wrist/Hand Evaluation (PRWHE), and Revel functional index were all used in only 1 study each.

Of the performance- or assessor-based measures, grip strength was applied most frequently (n = 35), followed by

pain or tenderness on palpation (n = 21). Other applied performance- or assessor-based measures were pinch strength (n = 17), the grip ability test (GAT; n = 4), Moberg Pick-Up Test (MPUT; n = 3), AHFT (n = 2), evaluation of dexterity (n = 3), button test (n = 1), Hand Mobility in Scleroderma Test (HAMIS; n = 1), Hand Functional Index (HFI; n = 1), and Jebsen-Taylor Hand Function Test (JTHFT; n = 1).

*Study characteristics.* The characteristics of the 66 included studies are described in Table 1. The source populations were predominantly secondary care (n = 41), in addition to primary care (n = 6), population-based (n = 6), and familial OA studies (n = 5). All studies included more women than men, and the mean age was > 50 years in almost all studies. Different study designs were included: 26 observational studies, 35 randomized controlled trials (RCT), and 4 intervention studies.

Of the included studies, 25 studies were primarily aimed

at the evaluation of metric properties of 1 or more instruments measuring pain, physical function, or PtGA<sup>13,18,19,23–33,34–44</sup>. The remaining studies applied these instruments to evaluate the effect of a treatment or intervention (n = 37)<sup>45–55,56–66,67–77,78,79,80,81</sup>, or to evaluate disease course over time (n = 4)<sup>82,83,84,85</sup>.

*Metric properties of clinical outcome measures (discrimination: reliability).* Only 11 studies provided data on measures of reliability, including 7 instruments<sup>13,19,25,27,30,34,35,36,37,43,44</sup>. The FIHOA and AUSCAN were most frequently evaluated (Table 3). The AHFT and GAT were evaluated in only 1 study each<sup>18,35</sup>. The reported measures of reliability of instruments that were assessed in at least 2 studies are listed in Table 3.

In general, all evaluated instruments showed good measures of reliability. Three studies evaluated 2 questionnaires for the assessment of physical function, enabling direct comparison of these measures<sup>34,37</sup>. Haugen, *et al* reported excellent reliability for both the AUSCAN function subscale and FIHOA<sup>30</sup>. Moe, *et al* reported the same, in addition to comparable SDD for both questionnaires<sup>34</sup>. Poole, *et al* evaluated the FIHOA, in addition to the Cochin scale, reporting the highest ICC for the Cochin scale<sup>37</sup>.

Performance- or assessor-based measures were assessed less frequently, but showed good measures of reliability.

Only 2 instruments (AUSCAN and FIHOA) were extensively tested, showing excellent measures of reliability for both questionnaires. Other instruments, while showing good measures of reliability, had only been tested in 1 or 2 studies. Therefore, only tentative conclusions can be drawn for these instruments.

*Discrimination: Sensitivity to change.* Of the 45 studies assessing change over time in pain, physical function, or PtGA<sup>25,26,29,36,42,45,47–57,58–68,69–79,80,81,82,83,84,85</sup>, 7 studies did not demonstrate any significant change (1 observational study, 6 RCT)<sup>62,69,75,78,79,80,81</sup>. Six studies observed only a statistically significant change in pain or PtGA (1 observational study, 5 RCT)<sup>29,50,54,60,61,77</sup>, and 5 studies only observed the change in physical function (all RCT)<sup>45,47,59,65,76</sup>.

The studies that detected change in at least 1 instrument assessing the corresponding domain are summarized in Table 4. The results of these studies regarding measured change over time are described in the Supplementary Table (available from the authors on request).

Pain was most frequently assessed using the VAS or NRS, detecting change in 88% of these studies. Other applied instruments were the AUSCAN pain scale and pain/tenderness assessed on palpation, detecting change in 77% and 92% of the studies, respectively (Table 4)<sup>29,36,48,49,52,54,56,61,72,73,74,83,84</sup>. The ASES pain scale was applied in only 1 study and therefore not included in the table<sup>50</sup>.

Physical function was most frequently assessed by measured grip strength, detecting change in 75% of these

studies. Other commonly applied instruments were the AUSCAN function scale (82% detecting change), FIHOA (67% detecting change), HAQ (50% detecting change), and grip strength (57% detecting change). The Cochin scale and VAS or NRS were less frequently used (Table 4). The AIMS-2<sup>67</sup>, COPM<sup>59</sup>, dexterity<sup>68</sup>, GAT<sup>50</sup>, and MPUT<sup>77</sup> were all assessed in only 1 study each.

PtGA was assessed using the VAS global, detecting change in 60% of these studies. The 40% that did not detect change over time did measure change in the AUSCAN function, COPM, or number of tender joints. A few studies assessed change in PtGA using the AUSCAN total (Table 4).

The VAS pain was by far the most frequently applied instrument for the assessment of change over time of pain in hand OA, followed by the AUSCAN pain subscale and pain on palpation. For the assessment of change of physical function, the AUSCAN function subscale, FIHOA, and grip strength assessment were commonly used. Change in PtGA was most frequently evaluated using the VAS global. The majority of studies that reported change in pain, physical function, or PtGA detected this change by all applied instruments assessing the corresponding domain, suggesting good sensitivity to change for all evaluated instruments.

*Feasibility.* The number of items of the different applied instruments is described in Table 2. Although most of these instruments are available in the public domain, payment is required for the use of the AUSCAN.

Only 4 of the included studies reported data on the time needed to apply the used instruments<sup>13,19,37,39</sup>. Two studies reported the completion time of a questionnaire: for completion of the modified SACRAH, a median of 95 s was measured (range 80–175 s)<sup>39</sup>, and for completion of the FIHOA, a mean of 165 s (SD 119 s, range 50–600) was measured in patients with painful OA whereas inactive OA patients needed on average 136 s (SD 97 s, range 20–240)<sup>13</sup>. The other 2 studies reported the time required to administer 1 or 2 assessor- or performance-based measures: for the Doyle index, a mean time of 5.1 min (range 2.4–7.8) was reported<sup>19</sup>, and the AHFT and HAMIS were reported to require 20–25 min and 5 min, respectively<sup>37</sup>.

Questionnaires took less time than assessor- or performance-based measures. The completion time of both assessed questionnaires was short, so both the FIHOA and the modified SACRAH were highly feasible.

*Validity.* Eighteen studies correlated different instruments (mostly questionnaires), providing information on construct validity. The reported correlations between instruments assessing either pain or physical function, or PtGA are presented in Table 5. Most of the studies (n = 16) reported cross-sectional correlations, whereas correlations or associations between assessed change over time were reported in only 3 studies<sup>23,28,46</sup>.

The AUSCAN, grip strength, and FIHOA scores were most frequently compared with other outcome measures

Table 1. Overview of included studies (n = 66).

Studies	Source Population, No. Patients (% Women), Mean Age, Yrs	Definitions of Hand OA	Study Designs	Applied Instruments
Allen, <i>et al</i> <sup>23</sup>	GOGO study (familial OA), <b>531 (80)</b> , 68	Bony enlargement, KL $\geq 2$ in $\geq 1$ DIP	Observational, mean FU 4 yrs	- AUSCAN (Likert) - Grip/pinch strength
Allen, <i>et al</i> <sup>24</sup>	GOGO study, <b>878 (80)</b> , 69	Bony enlargement, KL $\geq 2$ in $\geq 1$ DIP	Observational, cross-sectional	- AUSCAN (Likert) - Self-reported pain, 0–3 - Grip/pinch strength
Altman, <i>et al</i> <sup>45</sup>	Secondary care, <b>385 (77)</b> , 64	ACR criteria	RCT (intervention > control)*, duration 8 weeks	- AUSCAN (VAS) - VAS pain, global
Backman and Mackie <sup>18</sup>	Secondary care, <b>26 (88)</b> , 67	OA $\geq 2$ joints, rheumatologist confirmed	Observational, test-retest after 2 weeks	- OMFAQ - AHFT
Barthel, <i>et al</i> <sup>46</sup>	Secondary care, <b>783 (80)</b> , 64	ACR criteria, KL $\geq 1$ , symptoms $\geq 1$ yr	RCT (intervention > control), duration 8 weeks	- AUSCAN (VAS) - VAS pain, global
Bellamy, <i>et al</i> <sup>25</sup>	Study 1: secondary care, <b>50 (80)</b> , 60. Study 2: secondary care, <b>44 (86)</b> , 60	ACR criteria	Study 1: Observational, test-retest after 1 week. Study 2: Intervention, duration 6 weeks	Study 1 and 2: - AUSCAN (Likert, VAS) - FIHOA (original, Likert, VAS) Study 1 only: - HAQ, HAQ pain scale - Global pain/function, 0–4 - Modified Doyle Index - Grip/pinch strength - AUSCAN (Likert)
Bijsterbosch, <i>et al</i> <sup>19</sup>	GARP study (familial polyarticular OA), <b>260 (84)</b> , 65	ACR criteria	Observational, cross-sectional	- Doyle index
Bijsterbosch, <i>et al</i> <sup>82</sup>	GARP study, <b>289 (83)</b> , 60	ACR criteria	Observational, FU 6 yrs	- AUSCAN (Likert)
Botha-Scheepers, <i>et al</i> <sup>83</sup>	GARP study, <b>289 (83)</b> , 60	ACR criteria	Observational, FU 2 yrs	- AUSCAN (Likert) - Pain intensity score (pain on pressure, 0–60) - AUSCAN (Likert)
Brosseau, <i>et al</i> <sup>47</sup>	Secondary care, <b>88 (78)</b> , 65	ACR criteria, radiographic OA	RCT (intervention = control) <sup>#</sup> duration 6 weeks	- VAS pain - Grip/pinch strength
Dilek, <i>et al</i> <sup>48</sup>	Secondary care, <b>56 (89)</b> , 59	ACR criteria, bilateral	RCT (intervention > control), duration 3 weeks	- AUSCAN (not specified) - FIHOA - VAS pain rest/during ADL - Grip/pinch strength - No. painful/tender joints
Dreiser, <i>et al</i> <sup>49</sup>	Secondary care, <b>60 (85)</b> , 59	Radiographic OA	RCT (intervention > control), duration 2 weeks	- FIHOA - VAS pain - Pain movement/pressure, 1–5
Dreiser, <i>et al</i> <sup>13</sup>	Secondary care, <b>200 (84)</b> , 66	Radiographic OA	Observational, cross-sectional	- FIHOA - VAS pain
Dreiser, <i>et al</i> <sup>26</sup>	Not specified, <b>261 (92)</b> , 61	ACR criteria, radiographic OA $\geq 2$ joints bilateral, symptoms	RCT (effect not specified), duration 6 mos	- FIHOA - VAS pain - Grip strength
Dziedzic, <i>et al</i> <sup>27</sup>	Primary care, <b>55 (60)</b> , 67	Hand problems (symptoms, nodes)	Observational, test-retest after 1 mo	- AUSCAN (Likert) - Grip/pinch strength, GAT
Dziedzic, <i>et al</i> <sup>50</sup>	Primary care, <b>257 (66)</b> , 66	ACR criteria	RCT (intervention > control), duration 6 mos	- AUSCAN (not specified) - ASES pain - Average pain severity, 0–10 - Satisfaction hand function, 0–10 - Severity functional problem, 0–10 - Grip/pinch strength, GAT
Fernandes, <i>et al</i> <sup>28</sup>	Secondary care, <b>211 (95)</b> , 63	ACR criteria	Observational, FU 3 mos	- AUSCAN (Likert) - ASES pain - COPM - MAP-hand - Modified HAQ - Grip strength, GAT
Fioravanti, <i>et al</i> <sup>51</sup>	Primary care, <b>60 (87)</b> , 71	ACR criteria, symptomatic	RCT (intervention > control), duration 2 weeks	- FIHOA - HAQ - VAS pain

Table 1. Continued.

Studies	Source Population, No. Patients (% Women), Mean Age, Yrs	Definitions of Hand OA	Study Designs	Applied Instruments
Flynn, <i>et al</i> <sup>52</sup>	Secondary care, <b>26 (88)</b> , range 52–82	ACR criteria	RCT (intervention > control), duration 2 mos	- Disease severity, 1–10 - Global assessment, 1–6 - Grip strength
Gabay, <i>et al</i> <sup>53</sup>	Secondary care, <b>162 (74)</b> , 63	ACR criteria, radiographic OA ≥ 2 joints ≥ 2 flares finger OA	RCT (intervention > control), duration 6 mos	- No. painful/tender joints - FIHOA - VAS pain - Grip strength
Garfinkel, <i>et al</i> <sup>54</sup>	Not specified, <b>25 (56)</b> , range 52–79	ACR criteria	RCT (intervention > control), duration 10 weeks	- Pain rest/activity (not specified) - Hand function (not specified) - Grip strength - Tenderness
Grifka, <i>et al</i> <sup>55</sup>	Secondary care, <b>594 (83)</b> , 62	ACR criteria, symptomatic ≥ 3 mos	RCT (intervention > control), duration 4 weeks	- AUSCAN (Likert) - HAQ - VAS pain, global - Grip strength
Haugen, <i>et al</i> <sup>29</sup>	Secondary care, <b>83 (93)</b> , 60	ACR criteria, KL ≥ 2, ≥ 1 swollen/tender joint, VAS pain ≥ 30	RCT (intervention > control), duration 42 days	- AUSCAN (not specified) - VAS pain, global - No. tender joints
Haugen, <i>et al</i> <sup>30</sup>	Secondary care (Oslo hand OA cohort), <b>209 (91)</b> , 62	ACR criteria	Observational, FU 7 yrs	- AUSCAN (Likert) - AIMS-2 - FIHOA
Haugen, <i>et al</i> <sup>84</sup>	Oslo hand OA cohort, <b>209 (91)</b> , 62	ACR criteria	Observational, FU 7 yrs	- AUSCAN - Grip strength - No. tender joints
Hirsch, <i>et al</i> <sup>31</sup>	Women's Health and Aging Study, <b>919 (100)</b> , age ≥ 65	ACR criteria	Observational, cross-sectional	- Pain/tenderness (no./intensity, 0–3) - Grip/pinch strength
Horvath, <i>et al</i> <sup>56</sup>	Secondary care, <b>63 (81)</b> , 63	ACR criteria, radiographic OA, pain ≥ 3 mos	RCT (intervention > control), duration 3 weeks	- HAQ - VAS pain (rest/exertion), global - Grip/pinch strength - No. tender joints
Kanat, <i>et al</i> <sup>57</sup>	Not specified, <b>50 (100)</b> , 63	ACR criteria	RCT (intervention > control), duration 10 days	- AUSCAN (not specified) - Cochin scale - Pain rest/motion, 0–10 - Grip/pinch strength
Keen, <i>et al</i> <sup>58</sup>	Secondary care, <b>36 (86)</b> , 58	ACR criteria or radiographic OA	Intervention, FU 4 weeks (after injection)	- AUSCAN (VAS) - VAS pain (most painful/all), global
Kjeken, <i>et al</i> <sup>59</sup>	Secondary care, <b>70 (97)</b> , 61	ACR criteria	RCT (intervention = control), duration 3 mos	- AUSCAN (Likert) - COPM, 0–10 - Modified HAQ - VAS pain, global
Kovacs, <i>et al</i> <sup>60</sup>	Secondary care, <b>45 (93)</b> , 59	ACR criteria, KL ≥ 2 in ≥ 2 joints, VAS pain ≥ 30	RCT (intervention > control), duration 3 weeks	- AUSCAN (Likert) - HAQ - VAS pain - Grip strength
Kvien, <i>et al</i> <sup>61</sup>	Secondary care, <b>83 (93)</b> , 60	ACR criteria, KL ≥ 2, ≥ 1 swollen/tender joint, VAS pain ≥ 30	RCT (intervention > control), duration 42 days	- AUSCAN (not specified) - VAS pain, global - No. tender joints
Kwok, <i>et al</i> <sup>62</sup> MacIntyre and Wessel <sup>32</sup>	Secondary care, <b>195 (87)</b> , 59 Community-dwelling, <b>99 (80)</b> , 67	Diagnosed by rheumatologist ACR criteria (dominant hand)	Observational, FU 3 mos Observational, cross-sectional	- AUSCAN (Likert) - AIMS-2 - Dexterity - Grip strength
MacIntyre, <i>et al</i> <sup>33</sup>	Community-dwelling, <b>104 (81)</b> , 68	ACR criteria (dominant hand)	Observational, cross-sectional	- PRWHE - Dexterity - Grip/pinch strength
Marshall, <i>et al</i> <sup>85</sup>	Primary care, <b>1076 (60)</b> , 65	Hand symptoms	Observational, FU 3 yrs	- AUSCAN (Likert)

Table 1. Continued.

Studies	Source Population, No. Patients (% Women), Mean Age, Yrs	Definitions of Hand OA	Study Designs	Applied Instruments
Moe, <i>et al</i> <sup>34</sup>	Secondary care (Oslo hand OA cohort), <b>128 (91)</b> , 69	ACR criteria	Observational, test-retest after 1 week	- AIMS-2 - AUSCAN (not specified) - FIHOA - HAQ - VAS pain - Grip strength - MPUT
Moratz, <i>et al</i> <sup>63</sup>	Population/secondary care, <b>77 (73)</b> , 69	Not specified	Intervention, duration 12 weeks	- Disability, 0–3 - Grip/pinch strength
Myers, <i>et al</i> <sup>35</sup>	Primary care, <b>55 (60)</b> , 66	Hand pain/problems	Observational, test-retest after 1 mo	- Interview on hand problems - Pain, 0–10 - Grip/pinch strength, GAT - Pain/tenderness palpation
Myrer, <i>et al</i> <sup>64</sup>	Volunteers, <b>35 (77)</b> , 64	ACR criteria, FIHOA > 5	RCT (intervention > control), duration 4 weeks	- FIHOA - VAS pain (rest/movement)
Pastinen, <i>et al</i> <sup>65</sup>	Secondary care, <b>29 (79)</b> , 58	Clinical/radiographic finger OA	RCT (intervention > control), duration 14 weeks	- VAS pain (during grip/pinch) - Grip/pinch strength
Poiraudou, <i>et al</i> <sup>36</sup>	Secondary care, <b>89 (91)</b> , 63	ACR criteria	Observational, FU 6 mos	- Cochin scale - FIHOA - Revel functional index - Ritchie articular index - VAS pain, handicap
Poole, <i>et al</i> <sup>37</sup>	Population based (senior centers), <b>40 (60)</b> , 63	Diagnosis of OA (not specified), symptoms	Observational, test-retest 1 week	- Cochin scale - FIHOA - MHQ - AHFT - HFI, HAMIS
Reeves and Hassanein <sup>66</sup>	Not specified, <b>27 (59)</b> , 64	Radiographic OA, pain	RCT (intervention > control), FU 6 mos (after injection)	- VAS pain (rest/movement/grip) - Flexion motion
Rintelen, <i>et al</i> <sup>38</sup>	Secondary care, <b>71 (91)</b> , 60	ACR criteria	Observational, cross-sectional	- Short-form SACRAH - Modified SACRAH
Rogers and Wilder <sup>67</sup>	Secondary care, <b>55 (80)</b> , 72	KL ≥ 2	Intervention, duration 2 yrs	- AIMS-2 - Pain, 0–10 - Grip strength
Rogers and Wilder <sup>68</sup>	Community-based, <b>46 (87)</b> , 75	KL ≥ 2	RCT (intervention = control), duration 6 weeks	- AUSCAN (VAS) - Dexterity - Grip/pinch strength
Romero-Cerecero, <i>et al</i> <sup>69</sup>	Not specified, <b>113 (95)</b> , 62	ACR criteria, radiographic OA ≥ 2 joints VAS ≥ 40, FIHOA ≥ 5	RCT (intervention = control), duration 4 weeks	- FIHOA - VAS pain
Rothacker, <i>et al</i> <sup>70</sup>	Not specified, <b>49 (84)</b> , 66	Physician/radiographic confirmed OA, symptoms	RCT (intervention > control), FU 45 min (after cream)	- Pain 0–5
Rothacker, <i>et al</i> <sup>71</sup>	Secondary care, <b>81 (74)</b> , 61	Physician confirmed OA, symptoms	RCT (intervention > control), FU 45 min (after cream)	- Pain 0–5
Sautner, <i>et al</i> <sup>39</sup>	Secondary care, <b>60 (73)</b> , 62	ACR criteria	Observational, cross-sectional	- SACRAH, modified SACRAH - VAS global
Sautner, <i>et al</i> <sup>40</sup>	Secondary care, <b>66 (77)</b> , 58	ACR criteria	Observational, cross-sectional	- AUSCAN (VAS) - SACRAH, modified SACRAH - VAS global
Saviola, <i>et al</i> <sup>72</sup>	Secondary care, <b>38 (95)</b> , 61	Radiographic erosive OA ≥ 2 joints, VAS ≥ 40	RCT (intervention 1 > intervention 2), duration 2 yrs (intervention 2 only 1 yr)	- FIHOA - VAS pain, global - Grip strength
Schnitzer, <i>et al</i> <sup>73</sup>	Not specified, <b>59 (68)</b> , 68	Radiographic/ physical OA findings	RCT (intervention > control), duration 9 weeks	- No. tender joints - HAQ - VAS pain - Grip strength
Seiler <sup>74</sup>	Secondary care, <b>41 (90)</b> , median 63	Radiographic OA, ≥ 3 painful/tender joints, ≥ 1 inflamed Heberden node	RCT (intervention > control), duration 4 weeks	- Joint tenderness (by dolorimeter) - No. painful joints - Grip strength - Pain index (no./intensity, 0–3)

Table 1. Continued.

Studies	Source Population, No. Patients (% Women), Mean Age, Yrs	Definitions of Hand OA	Study Designs	Applied Instruments
Shin, <i>et al</i> <sup>75</sup>	Secondary care, <b>86 (97)</b> , 58	ACR criteria	RCT (intervention = control), duration 12 weeks	- AUSCAN (not specified) - HAQ - VAS global - No. tender joints
Stamm, <i>et al</i> <sup>41</sup>	Secondary care, <b>100 (87)</b> , 61	Bony swelling $\geq 1$ DIP/PIP, pain/bony swelling $\geq 1$ CMC1	Observational, cross-sectional	- AIMS-2 - AUSCAN (not specified) - Cochin scale - FIHOA - HAQ - SACRAH, modified SACRAH - Grip strength - JTHFT, MPUT, button test
Stamm, <i>et al</i> <sup>76</sup>	Secondary care, <b>40 (88)</b> , 60	ACR criteria	RCT (intervention > control), duration 3 mos	- HAQ - VAS pain, global - Grip strength
Stange-Rezende, <i>et al</i> <sup>77</sup>	Secondary care, <b>45 (93)</b> , 60	ACR criteria	RCT (intervention = control), duration 3 weeks	- AUSCAN (Likert) - VAS pain (general/hands), global - Grip strength - MPUT
Stukstette, <i>et al</i> <sup>78</sup>	Secondary care, <b>151 (83)</b> , 59	ACR criteria	RCT (intervention = control), duration 3 mos	- AUSCAN (Likert) - COPM - Grip/pinch strength
Tubach, <i>et al</i> <sup>42</sup>	Secondary care, <b>249 (88)</b> , 64	ACR criteria	Intervention, FU 4 weeks	- VAS pain, global, functional disability
Verbruggen, <i>et al</i> <sup>79</sup>	Secondary care, <b>60 (85)</b> , 61	ACR criteria	RCT (intervention = control), duration 1 yr	- AUSCAN (not specified) - Grip strength - No. tender joints
Wenham, <i>et al</i> <sup>80</sup>	Not specified, <b>70 (81)</b> , 61	ACR criteria	RCT (intervention = control), duration 4 weeks	- AUSCAN (VAS) - VAS pain (average/worst joint), global - No. tender joints
Widrig, <i>et al</i> <sup>81</sup>	Primary and secondary care, <b>204 (74)</b> , 64	ACR criteria, radiographic OA $\geq 2$ joints VAS $\geq 40$ , FIHOA $\geq 5$	RCT (intervention = control), duration 3 weeks	- FIHOA - VAS pain - No. tender joints
Wittoek, <i>et al</i> <sup>43</sup>	Secondary care, <b>72 (89)</b> , 62	ACR criteria	Observational, cross-sectional	- AUSCAN (Likert) - FIHOA - VAS pain
Ziv, <i>et al</i> <sup>44</sup>	Not specified, <b>32 (100)</b> , 70	ACR criteria	Observational, test-retest after 1 week	- Grip/pinch strength

\* Intervention group performed better than control group, according to primary outcome measure. # Intervention group did not perform better than control group, according to primary outcome measure. OA: osteoarthritis; GOGO: Genetics of Generalized OA; KL: Kellgren-Lawrence; DIP: distal interphalangeal joint; FU: followup; AUSCAN: Australian/Canadian Hand OA Index; ACR: American College of Rheumatology; RCT: randomized controlled trial; VAS: visual analog scale; OMFAQ: Older Americans' Resources and Services Multidimensional Functional Assessment Questionnaire; AHFT: Arthritis Hand Function Test; FIHOA: Functional Index for Hand OA; HAQ: Health Assessment Questionnaire; GARP: Genetics osteoArthritis and Progression; ADL: activities of daily living; GAT: grip ability test; ASES: Arthritis Self Efficacy Scale; COPM: Canadian Occupational Performance Measure; MAP-hand: Measure of Activity Performance; AIMS-2: Arthritis Impact Measurement Scale-2; PRWHE: Patient-Rated Wrist/Hand Evaluation; MPUT: Moberg Pick-Up Test; MHQ: Michigan Hand Outcomes Questionnaire; HFI: hand functional index; HAMIS: Hand Mobility in Scleroderma Test; SACRAH: Score for Assessment and Quantification of Chronic Rheumatoid Affections of the Hands; PIP: proximal interphalangeal joint; CMC1: first carpometacarpal joint; JTHFT: Jebsen-Taylor Hand Function Test.

(Table 5). Correlations of the ASES pain scale, COPM, and MAP-hand with other clinical outcome measures were evaluated in only 1 study<sup>28</sup>, as were the JTHFT<sup>41</sup>, Revel functional index<sup>36</sup>, PRWHE<sup>33</sup>, MHQ, HFI, and HAMIS<sup>37</sup>. These studies were therefore not included in Table 5.

Varying correlation coefficients were reported among the

different studies. In general, correlations between different questionnaires were stronger than correlations of performance-based measures with other performance-based measures or with questionnaires. Correlations between different instruments assessing physical function ranged from 0.52–0.89 between questionnaires, from 0.05–0.67 between



Table 2. Instruments measuring pain, physical function, or patient's global assessment applied in the included studies.

Studies	Domains	Specifications	No. Studies Applied
<b>Questionnaires</b>			
AIMS-2 <sup>16</sup>	Physical function	78 items, rated on 5-point scale. Transformed into 12 scales, score range 0–10 (worst possible). 1 scale for hand/finger function.	5
ASES <sup>86</sup>	Pain, physical function	20 items, scored 10 (very uncertain) to 100 (very certain can do). 3 subscales: pain/function /other symptoms, scored by taking mean of subscale items (range 10–100).	2
AUSCAN <sup>14</sup>	Pain, physical function, global assessment	15 items, Likert (0 = none to 4 = extreme)/VAS version. Summed into 3 subscales: pain (Likert range 0–20/VAS range 0–100), stiffness (0–4/0–100), function (0–36/0–100).	34
Cochin scale <sup>87</sup>	Physical function	18 items, rated on Likert scale (0 = without difficulty to 5 = impossible). Summed to final score, range 0–90.	4
COPM <sup>88</sup>	Physical function	Interview on most important activities. 5 most important activities scored for performance/satisfaction (1–10). Subscale scores range 0 (not able to do/satisfied) to 10 (extremely able to do/satisfied).	3
FIHOA <sup>13</sup>	Physical function	10 items, range 0 (no difficulty) to 3 (impossible). Total score range 0–30. Original, VAS, Likert version.	15
HAQ <sup>17</sup>	Physical function	20 items. Total score range 0 to 3 (higher score indicates poorer functioning).	12
MAP-hand <sup>89</sup>	Physical function	18 items, range 0 (no difficulty) to 4 (not able to do). Total mean score calculated.	1
MHQ <sup>15</sup>	Pain, physical function	37 items, rated on 5-point Likert (1 = very good to 5 = very poor). Scores normalized to 0–100 scale.	1
OMFAQ <sup>90</sup>	Physical function	5 domains of functioning, scored 1 (excellent) to 6 (total impaired). Total score range 5–30. Physical/instrumental ADL scale.	1
PRWHE <sup>91</sup>	Physical function	15 item scale, rated on 0–10 NRS. Summed to subscales: pain (0–50), disability (0–60).	1
Revel functional index <sup>92</sup>	Physical function	10 questions, rated 0 (without difficulty) to 2 (impossible). Total score range 0–20.	1
SACRAH <sup>93</sup>	Pain, physical function	23 questions, rated on VAS scale. 3 domains: functional status, stiffness, pain. Original, short-form, modified version.	4
VAS <sup>94</sup> /NRS/Likert	Pain, physical function, global assessment	Used for assessment of pain, patient's global assessment, functioning, perceived strength, etc.	43
<b>Performance- or assessor-based instruments</b>			
AHFT <sup>18</sup>	Physical function	11-item test, 4 subscales: grip/pinch strength, dexterity, applied dexterity, applied strength. Score per subscale.	2
Button Test <sup>95</sup>	Physical function	Unbutton and button 5 buttons using a standard board. Score recorded in seconds.	1
Dexterity	Physical function	Assessed using dexterity/Purdue Pegboard.	2
GAT <sup>96</sup>	Physical function	Modification of Grip Function Test. 3 items, timed (sec) and summed to total GAT score. GAT score < 20 s = normal.	4
Grip strength	Physical function	Measured in mmHg or in kg.	35
HAMIS <sup>97</sup>	Physical function	9 items rated 0 (no problems performing the motion) to 3 (unable). Total score range 0–27.	1
HFI <sup>98</sup>	Physical function	9 wrist/hand items from Keitel Function Test, measuring motion patterns. Items ranged 0 (no difficulties) to 3 (much difficulty). Total score 0–52 (0–26 for each upper extremity).	1
JTHFT <sup>99</sup>	Physical function	7 items, timed in seconds. Summed to total score.	1
MPUT <sup>100</sup>	Physical function	Picking up 10 items and placing in container, timed in seconds.	3
Pinch strength	Physical function	Measured in mmHg or in kg.	17
Tenderness/pain on palpation, Doyle <sup>101</sup> /Ritchie articular index <sup>102</sup>	Pain	Tenderness on palpation. Score range Doyle total 0–144, Doyle hand 0–72. Score range Ritchie articular index 0–60.	21

AIMS-2: Arthritis Impact Measurement Scale-2; ASES: Arthritis Self Efficacy Scale; OA: osteoarthritis; AUSCAN: Australian/Canadian Hand OA Index; COPM: Canadian Occupational Performance Measure; FIHOA: Functional Index for Hand OA; HAQ: Health Assessment Questionnaire; MAP-hand: Measure of Activity Performance; MHQ: Michigan Hand Outcomes Questionnaire; OMFAQ: Older Americans' Resources and Services Multidimensional Functional Assessment Questionnaire; PRWHE: Patient-Rated Wrist/Hand Evaluation; SACRAH: Score for Assessment and Quantification of Chronic Rheumatoid Affections of the Hands; VAS: visual analog scale; NRS: numeric rating scale; AHFT: Arthritis Hand Function Test; GAT: grip ability test; HAMIS: Hand Mobility in Scleroderma Test; HFI: hand functional index; JTHFT: Jebsen-Taylor Hand Function Test; MPUT: Moberg Pick-Up Test.

questionnaires and performance-based measures, and from 0.25–0.96 between performance-based measures. For the assessment of pain, correlations between 0.55–0.81 were observed between questionnaires, and correlations between 0.47–0.65 between questionnaires and pain on palpation.

However, only a few correlation coefficients above 0.90 were observed, suggesting that different instruments detect different aspects of the assessed domain.

Two of the 3 studies associating change over time by different instruments presented correlation coefficients,

Table 3. Metric properties of instruments measuring pain, physical function, or patient's global assessment — reliability\*.

Variables	Studies	Relevant Results
Questionnaires		
AUSCAN	Bellamy, <i>et al</i> <sup>25</sup>	ICC (Likert/VAS): - Pain: 0.70/0.84 - Function: 0.86/0.90
	Dziedzic, <i>et al</i> <sup>27</sup>	ICC: - Pain: 0.88 - Function: 0.87
	Haugen, <i>et al</i> <sup>30</sup>	ICC: - Pain: 0.93 - Function: 0.94 - Total: 0.96
	Moe, <i>et al</i> <sup>34</sup>	ICC, SDD: - Pain: 0.80, 1.06 - Function: 0.92, 0.80 - Total: 0.87, 0.76
Cochin scale	Poiraudeau, <i>et al</i> <sup>36</sup> Poole, <i>et al</i> <sup>37</sup>	Interrater ICC: 0.96 ICC: 0.94
FIHOA	Dreiser, <i>et al</i> <sup>13</sup>	ICC: 0.95, mean difference 0.17 ± 1.64
	Haugen, <i>et al</i> <sup>30</sup>	ICC: 0.88
	Moe, <i>et al</i> <sup>34</sup>	ICC: 0.94, SDD 5.55
	Poole, <i>et al</i> <sup>37</sup>	ICC: 0.74
	Wittoek, <i>et al</i> <sup>43</sup>	ICC: 0.96
Performance- or assessor-based instruments		
Grip strength	Myers, <i>et al</i> <sup>35</sup> Ziv, <i>et al</i> <sup>44</sup>	Inter-/intraobserver ICC: range per hand 0.91–0.94/0.90–0.92 SDD (right, left): 2.48, 1.94
	Pinch strength	Myers, <i>et al</i> <sup>35</sup> Ziv, <i>et al</i> <sup>44</sup>
Tenderness/pain on palpation		Bijsterbosch, <i>et al</i> <sup>19</sup> Myers, <i>et al</i> <sup>35</sup>

\* Only instruments assessed in  $\geq 2$  studies were included in this table. OA: osteoarthritis; AUSCAN: Australian/Canadian Hand OA Index; FIHOA: Functional Index for Hand OA; ICC: intraclass correlation coefficient; VAS: visual analog scale; SDD: smallest detectable difference.

which were in line with the results described above<sup>28,46</sup>. The third study calculated  $\beta$  coefficients for the association of change of the AUSCAN and grip and pinch strength with global assessment of change, adjusted for age, sex, number of osteoarthritic hand joints, and time between assessments. The strongest association with global assessment of change was observed for the AUSCAN<sup>23</sup>.

Construct validity of various instruments measuring pain, physical function, or PtGA has been assessed in multiple cross-sectional studies, but only few longitudinal data are available. Moderate to good correlations were observed, especially between questionnaires, suggesting good construct validity.

Table 6 summarizes the available information of metric properties per domain for the 6 most frequently applied instruments for the assessment of pain, physical function, and PtGA. Information of metric properties was considered established when supporting results were observed in at least 3 studies. The unavailability of the AUSCAN in the public domain was included as negative evidence regarding its feasibility.

## DISCUSSION

The most frequently applied and evaluated instruments for the assessment of pain were the AUSCAN pain subscale, VAS pain, and pain on palpation. The AUSCAN function subscale, FIHOA, and grip and pinch strength were most frequently applied and evaluated for the assessment of physical function. PtGA was most frequently evaluated using the VAS global.

In the description of discrimination, the reliability of the AUSCAN and FIHOA were found to be extensively tested and shown to be excellent. The reliability of other instruments was suggested to be good, but only scarce evidence was available.

The VAS pain was by far the most commonly used instrument for the assessment of the change of pain, followed by the AUSCAN pain subscale and pain on palpation. The AUSCAN function subscale, FIHOA, and assessment of grip and pinch strength were regularly applied for the assessment of the change of physical function. The change of PtGA was

Table 4. Metric properties of instruments measuring pain, physical function, or patient's global assessment — sensitivity to change.\* Only studies demonstrating significant change in pain, physical function, or patient's global assessment by at least 1 of the applied instruments are shown.

Variable	No. Studies Reporting Change in Corresponding Instrument	No. Studies Not Reporting Change, Discordant with Other Instruments Assessing Corresponding Domain	Percentage of Studies that Detected Change
<b>RCT/intervention studies</b>			
<b>Questionnaires</b>			
AUSCAN function	5 <sup>25,45,48,55,58</sup>	2 <sup>47,59</sup>	71
AUSCAN pain	6 <sup>25,29,55,58,61,77</sup>	2 <sup>48,60</sup>	75
AUSCAN total	2 <sup>55,57</sup>	0	100
Cochin scale	1 <sup>57</sup>	0	100
FIHOA	6 <sup>26,49,51,53,64,72</sup>	3 <sup>25,36,48</sup>	67
HAQ	3 <sup>51,56,73</sup>	3 <sup>55,59,76</sup>	50
VAS/NRS pain	20 <sup>26,29,42,48,49,51,53,54,55,56,57,58,60,61,64,66,67,70,71,72</sup>	3 <sup>36,73,77</sup>	88
VAS global	6 <sup>29,42,55,61,72,76</sup>	4 <sup>45,52,56,59</sup>	60
VAS/NRS function	2 <sup>42,63</sup>	0	100
<b>Performance- or assessor-based instruments</b>			
Grip strength	11 <sup>26,47,56,63,65,67,68,72,73,74,76</sup>	4 <sup>48,53,55,57</sup>	73
Pinch strength	4 <sup>56,63,65,68</sup>	3 <sup>47,48,57</sup>	57
Tenderness/pain on palpation	9 <sup>48,49,52,54,56,61,72,73,74</sup>	1 <sup>29</sup>	90
<b>Observational studies</b>			
<b>Patient-reported instruments</b>			
AUSCAN function	4 <sup>82,83,84,85</sup>	0	100
AUSCAN pain	4 <sup>82,83,84,85</sup>	1 <sup>50</sup>	80
Cochin scale	1 <sup>36</sup>	0	100
VAS pain	1 <sup>50</sup>	0	100
<b>Performance- or assessor-based measures</b>			
Grip strength	1 <sup>84</sup>	0	100
Tenderness/pain on palpation	3 <sup>36,83,84</sup>	0	100

\* Only instruments that detected change in  $\geq 1$  instrument assessing the corresponding domain were included in this table. RCT: randomized controlled trial; OA: osteoarthritis; AUSCAN: Australian/Canadian Hand OA Index; FIHOA: Functional Index for Hand OA; HAQ: Health Assessment Questionnaire; VAS: visual analog scale; NRS: numeric rating scale.

most often evaluated by the VAS global. The majority of studies detected change by all used instruments, suggesting good sensitivity to change for the evaluated instruments. The change in pain was detected most frequently by the VAS pain or pain on palpation, whereas the change in physical function was detected most frequently by the AUSCAN function subscale or measured grip strength.

In the description of feasibility, only a few of the studies reported on the time needed to perform the instruments. Questionnaires took less time than performance-based measures. Of the frequently applied instruments, only the FIHOA was evaluated and seemed feasible. This is supported by the availability of this questionnaire in the public domain, in contrast with the AUSCAN.

For the description of validity, numerous cross-sectional studies assessed correlations between various instruments, but few longitudinal data were available. The strongest correlations were reported between different questionnaires assessing pain or physical function. Remarkably, the VAS pain, as 1 of the most frequently applied instruments, was evaluated in only a limited number of studies.

For further evaluation of validity, comparison with an

external standard should be performed. However, no external standards for the evaluation of pain, physical function, and PtGA have been agreed upon, perhaps because of the varying definitions and measurement of these concepts. For the assessment of physical function, observation of the performance of tasks as described by specific instruments assessing physical function may be useful in the evaluation of validity of these instruments<sup>103</sup>.

Based on our review, it is not possible to decide on 1 instrument that should be recommended for the measurement of pain, physical function, or PtGA in hand OA research. Although no major differences regarding metric properties of the evaluated instruments were observed, the amount of supporting evidence varied extensively between the instruments.

Before consensus can be reached on which instruments should be applied, some aspects need further investigation. The reliability of the VAS pain, grip and pinch strength, and pain on palpation needs to be further established in a variety of populations. Regarding the sensitivity to change, the minimal clinically important difference of instruments needs to be determined. Only for the AUSCAN has a minimal clini-

Table 5. Metric properties of instruments measuring pain, physical function or patient global assessment – validity.\* Correlations between different instruments as observed in cross-sectional and longitudinal studies are shown.

Instruments	Studies	Correlation with:
Cross-sectional studies		
Questionnaires		
AIMS-2	MacIntyre and Wessel <sup>32</sup>	- Dexterity small/large objects: r range per item 0.23–0.40/0.14–0.31 <sup>#</sup> - Grip strength: r range per item –0.23 to –0.37 <sup>#</sup>
	Moe, <i>et al</i> <sup>34</sup>	AIMS-2 physical/arm/hand: - AUSCAN function: r 0.83/0.70/0.77 <sup>†</sup> - FIHOA: r 0.80/0.71/0.69 <sup>†</sup> - JTHFT: r 0.67 <sup>‡</sup>
AUSCAN function	Stamm, <i>et al</i> <sup>41</sup>	- Grip strength right, left: r –0.42, –0.40 <sup>†</sup> - Pinch strength right, left: r –0.23, –0.16 <sup>†</sup>
	Allen, <i>et al</i> <sup>24</sup>	Likert, VAS: - Global function, 0–4: r 0.72, 0.74** - FIHOA, original: r 0.78, 0.86** - HAQ: r 0.65, 0.68** - Grip strength: r –0.39, –0.45** - Pinch grip: r –0.31, –0.36** - GAT: r 0.54**
	Bellamy, <i>et al</i> <sup>25</sup>	- Grip strength: r –0.56** - Pinch strength: r –0.60** - MAP-hand: r 0.76 <sup>#</sup>
	Dziedzic, <i>et al</i> <sup>27</sup>	- AIMS-2 physical: r 0.83, arm: r 0.70, hand: r 0.77 <sup>†</sup> - FIHOA: r 0.88 <sup>†</sup> - HAQ: r 0.80 <sup>†</sup> - Grip strength: r –0.62 <sup>†</sup> - MPUT right, left: r 0.58, 0.63 <sup>†</sup> - VAS global: r 0.55 <sup>‡</sup> - JTHFT: r 0.386 <sup>‡</sup> - FIHOA: r 0.81 <sup>†</sup> - Pain severity right, left: r 0.58, 0.55 <sup>†</sup>
AUSCAN pain	Fernandes, <i>et al</i> <sup>28</sup>	Likert, VAS: - Global pain, 0–4: r 0.57, 0.64** - HAQ pain: r 0.57, 0.66** - Doyle: r 0.56, 0.47** - Doyle hand, total: r 0.65, 0.61 <sup>†</sup> - VAS pain: r 0.77 <sup>†</sup> - VAS pain: r 0.79 <sup>†</sup> - FIHOA: r 0.87 <sup>#</sup> - Revel functional index: r 0.86 - VAS handicap: r 0.67 - FIHOA: r 0.89** - MHQ: r –0.82** - AHFT: r range per item –0.64 to 0.57** - HFI: r 0.55, HAMIS: r 0.49** - JTHFT: r 0.369**
	Moe, <i>et al</i> <sup>34</sup>	Original/Likert/VAS: - AUSCAN function (Likert, VAS): r 0.78, 0.86/0.80, 0.85/0.80, 0.88** - AIMS-2 physical/arm/hand: r 0.80/0.71/0.69 <sup>†</sup> - AUSCAN function: r 0.88 <sup>†</sup> - HAQ: r 0.73 <sup>†</sup> - Grip strength: r –0.5 <sup>†</sup> - MPUT right/left: r 0.55/0.59 <sup>†</sup> - Cochin scale: r 0.87 <sup>#</sup> - Cochin: r 0.89** - MHQ: r –0.86** - AHFT: r range per item –0.57 to 0.46** - HFI: r 0.53, HAMIS: r 0.50** - JTHFT: r 0.387 <sup>‡</sup> - AUSCAN function: r 0.81 <sup>†</sup>
	Sautner, <i>et al</i> <sup>40</sup>	
	Stamm, <i>et al</i> <sup>41</sup>	
Cochin scale	Wittoek, <i>et al</i> <sup>43</sup>	
	Allen, <i>et al</i> <sup>24</sup>	
	Bellamy, <i>et al</i> <sup>25</sup>	
	Bijsterbosch, <i>et al</i> <sup>19</sup>	
FIHOA	Moe, <i>et al</i> <sup>34</sup>	
	Wittoek, <i>et al</i> <sup>43</sup>	
	Poiraudreau, <i>et al</i> <sup>36</sup>	
	Poole, <i>et al</i> <sup>37</sup>	
FIHOA	Stamm, <i>et al</i> <sup>41</sup>	
	Bellamy, <i>et al</i> <sup>25</sup>	
	Moe, <i>et al</i> <sup>34</sup>	
	Poiraudreau, <i>et al</i> <sup>36</sup>	
FIHOA	Poole, <i>et al</i> <sup>37</sup>	
	Stamm, <i>et al</i> <sup>41</sup>	
FIHOA	Wittoek, <i>et al</i> <sup>43</sup>	

Table 5. Continued.

Instruments	Studies	Correlation with:
HAQ	Bellamy, <i>et al</i> <sup>25</sup> Fernandes, <i>et al</i> <sup>28</sup> Moe, <i>et al</i> <sup>34</sup>	- AUSCAN function (Likert, VAS): r 0.65, 0.68** Modified HAQ with MAP-hand: r 0.46 <sup>#</sup> - AUSCAN function: r 0.80 <sup>†</sup> - FIHOA: r 0.73 <sup>†</sup>
SACRAH	Stamm, <i>et al</i> <sup>41</sup> Rintelen, <i>et al</i> <sup>38</sup> Sautner, <i>et al</i> <sup>39</sup>	- JTHFT: r 0.424 <sup>‡</sup> Short-form SACRAH with modified SACRAH: r 0.699 <sup>†</sup> Modified SACRAH: - SACRAH: r 0.978 (range subscales 0.912–0.958) <sup>‡</sup> - VAS global: r 0.64 <sup>‡</sup>
VAS global	Sautner, <i>et al</i> <sup>40</sup> Stamm, <i>et al</i> <sup>41</sup>	Modified SACRAH function/total with VAS global: r 0.55/0.65 <sup>‡</sup> SACRAH/M-SACRAH: - JTHFT: r 0.436 (range per scale 0.371–0.437)/0.388 <sup>‡</sup> - Modified SACRAH: r 0.64 <sup>‡</sup>
VAS pain	Sautner, <i>et al</i> <sup>39</sup> Sautner, <i>et al</i> <sup>40</sup>	- Function AUSCAN/modified SACRAH: r 0.55/0.55 <sup>‡</sup> - Pain AUSCAN/modified SACRAH: r 0.59/0.56 <sup>‡</sup> - Total modified SACRAH: r 0.65 <sup>‡</sup>
VAS pain	Moe, <i>et al</i> <sup>34</sup> Wittoek, <i>et al</i> <sup>43</sup>	- AUSCAN pain: r 0.77 <sup>†</sup> - AUSCAN pain: r 0.79 <sup>†</sup>
Performance- or assessor-based instruments		
AHFT	Backman and Mackie <sup>18</sup>	- OMFAQ instrumental ADL scale: range per item r –0.75 to 0.75 <sup>†</sup> - OMFAQ physical ADL scale: range per item r –0.67 to 0.68 <sup>†</sup>
	Poole, <i>et al</i> <sup>37</sup>	- Cochin scale: r range per item –0.64 to 0.57** - FIHOA: r range per item –0.57 to 0.46** - MHQ: r range per item –0.48 to 0.65**
Dexterity	MacIntyre and Wessel <sup>32</sup>	Large/small objects: - AIMS-2: r range per item 0.14–0.31/0.23–0.40 <sup>#</sup>
	MacIntyre, <i>et al</i> <sup>33</sup>	Large/small objects: - Grip strength: r –0.32 (range digits –0.25 to –0.30)/ –0.28 (–0.10 to –0.41) <sup>#</sup> - Pinch (tripod, narrow, wide key): r –0.37, –0.30, –0.34/–0.34, –0.25, –0.25 <sup>#</sup> - AUSCAN function: r 0.54** - MAP-hand: r 0.43 <sup>#</sup>
GAT	Dziedzic, <i>et al</i> <sup>27</sup> Fernandes, <i>et al</i> <sup>28</sup>	- AUSCAN function (right, left): r –0.42, –0.40 <sup>†</sup> - AUSCAN function (Likert, VAS): r –0.39, –0.45** - AUSCAN function: r –0.56** - MAP-hand: r –0.32 <sup>#</sup>
Grip strength	Allen, <i>et al</i> <sup>24</sup> Bellamy, <i>et al</i> <sup>25</sup> Dziedzic, <i>et al</i> <sup>27</sup> Fernandes, <i>et al</i> <sup>28</sup> MacIntyre and Wessel <sup>32</sup> MacIntyre, <i>et al</i> <sup>33</sup>	- AIMS-2: r range per item –0.23 to –0.37 <sup>#</sup> - PRWHE activities: r –0.23 <sup>#</sup> - Dexterity large: r –0.32, small: –0.28 <sup>#</sup> - Pinch strength (range per test): r 0.76–0.78 <sup>#</sup> - AUSCAN function: r –0.62 <sup>†</sup> - FIHOA: r –0.50 <sup>†</sup>
	Moe, <i>et al</i> <sup>34</sup>	- JTHFT: r –0.395 <sup>‡</sup>
MPUT	Stamm, <i>et al</i> <sup>41</sup> Moe, <i>et al</i> <sup>34</sup>	- AUSCAN function (right, left): r 0.58, 0.63 <sup>†</sup> - FIHOA (right, left): r 0.55, 0.59 <sup>†</sup> - JTHFT: r 0.690 <sup>‡</sup>
Pinch strength	Stamm, <i>et al</i> <sup>41</sup> Allen, <i>et al</i> <sup>24</sup> Bellamy, <i>et al</i> <sup>25</sup> Dziedzic, <i>et al</i> <sup>27</sup> MacIntyre, <i>et al</i> <sup>33</sup>	- AUSCAN function (right, left): r –0.23, –0.16 <sup>†</sup> - AUSCAN function (Likert, VAS): r –0.31, –0.36** - AUSCAN function: r –0.60** - PRWHE activities (range per test): r –0.22 to –0.26 <sup>#</sup> - Dexterity (range per test) large: r –0.30 to –0.37, small: r –0.25 to –0.34 <sup>#</sup> - Grip strength (range per test): r 0.75–0.96 <sup>#</sup>
Tenderness/pain on palpation	Bellamy, <i>et al</i> <sup>25</sup> Bijsterbosch, <i>et al</i> <sup>19</sup>	- Doyle with AUSCAN (Likert, VAS) pain: r 0.56, 0.47** - Doyle hand/total with AUSCAN pain: r 0.65/0.61 <sup>†</sup>
Longitudinal studies		
Questionnaires		
AUSCAN total	Allen, <i>et al</i> <sup>23</sup>	- Association global assessment of change (right, left) with AUSCAN total: $\beta$ 0.29, 0.27 (p < 0.001). Stronger among greater radiographic OA severity.
AUSCAN function	Fernandes, <i>et al</i> <sup>28</sup>	- Change MAP-hand: r 0.52 <sup>#</sup>
AUSCAN pain	Barthel, <i>et al</i> <sup>46</sup>	- Change VAS pain: r 0.81 <sup>†</sup>

Table 5. Continued.

Instruments	Studies	Correlation with:
VAS global	Barthel, <i>et al</i> <sup>46</sup>	- Change AUSCAN function: $r\ 0.71^\dagger$ , pain: $r\ 0.75^\dagger$
VAS pain	Barthel, <i>et al</i> <sup>46</sup>	- Change VAS pain: $r\ 0.76^\dagger$ - Change AUSCAN pain: $r\ 0.81^\dagger$
Performance- or assessor-based instruments		
GAT	Fernandes, <i>et al</i> <sup>28</sup>	- Change MAP-hand: $r\ 0.06^\#$
Grip strength	Allen, <i>et al</i> <sup>23</sup>	- Global assessment of change (right, left): $\beta\ -0.16, -0.13$ ( $p\ 0.003, 0.015$ ). Stronger associations among greater radiographic OA severity.
Pinch strength	Fernandes, <i>et al</i> <sup>28</sup> Allen, <i>et al</i> <sup>23</sup>	- Change MAP-hand: $r\ -0.05^\#$ - Global assessment of change (right, left): $\beta\ -0.13, -0.11$ ( $p\ 0.022, 0.060$ ). Stronger associations among greater radiographic OA severity.

\* Only instruments assessed in  $\geq 2$  studies were included in this table. <sup>#</sup> No p values provided. <sup>\*\*</sup> p value  $< 0.05$ . <sup>†</sup> p value  $< 0.001$ . <sup>‡</sup> p value  $< 0.0001$ . AIMS-2: Arthritis Impact Measurement Scale-2; OA: osteoarthritis; AUSCAN: Australian/Canadian Hand OA Index; FIHOA: Functional Index for Hand OA; HAQ: Health Assessment Questionnaire; SACRAH: Score for Assessment and Quantification of Chronic Rheumatoid Affections of the Hands; VAS: visual analog scale; AHFT: Arthritis Hand Function Test; GAT: grip ability test; MPUT: Moberg Pick-Up Test; JTHFT: Jebsen-Taylor Hand Function Test; MAP-hand: Measure of Activity Performance; MHQ: Michigan Hand Outcomes Questionnaire; HFI: hand functional index; OMFAQ: Older Americans' Resources and Services Multidimensional Functional Assessment Questionnaire; PRWHE: Patient-Rated Wrist/Hand Evaluation; HAMIS: Hand Mobility in Scleroderma Test.

Table 6. Available information of metric properties from at least 3 studies for the most frequently applied instruments (in at least 15 clinical studies) for evaluation of pain, physical function, or patient's global assessment.

Variable	Reliability	Sensitivity to Change	Feasibility	Validity
Questionnaires				
AUSCAN	+	+	- <sup>#</sup>	+
FIHOA	+	+	+ <sup>**</sup>	+
VAS pain		+		+
Performance- or assessor-based instruments				
Grip strength	+*	+		+
Pinch strength	+*	+		+
Tenderness/pain on palpation	+*	+		+*

\* Supporting evidence in only 2 studies. \*\* Supporting evidence in only 1 study. <sup>#</sup> Not available in public domain. OA: osteoarthritis; AUSCAN: Australian/Canadian Hand OA Index; FIHOA: Functional Index for Hand OA; VAS: visual analog scale; +: established evidence.

cally important improvement been proposed<sup>104</sup>. Validity of instruments assessing physical function should be further investigated by comparing these instruments with an external standard. Further, future research should evaluate instruments within specific subtypes of hand OA.

Our study has some limitations. We intended to include as many available studies as possible that provided information on instruments and their metric properties, and not only studies that actually aimed at evaluating this. Because of the large heterogeneity across studies regarding their purpose (primarily aiming at evaluation instruments or applying instruments for other primary aims) and study design, the methodological quality of the included studies was not assessed. Further, the heterogeneity did not enable the pooling of data into a metaanalysis and addressing the presence of publication bias.

Limitations regarding the literature search are the included databases, restriction to English language, and exclusion of abstracts and unpublished results.

Within all studies assessing the VAS pain or VAS global, different questions were used. The individual questions were observed to be highly variable, especially regarding the type of pain (global pain, overall disease severity, intensity, not specified) and time settings (last 24 h or 48 h, 2 days, 2 weeks, not specified). In future research, this phrasing should be standardized. Further, the VAS pain score has been shown to be influenced by the information on the disease and its consequences that is given to patients when determining the VAS<sup>105</sup>, which could not be addressed because of the lack of information on this topic in the included studies. However, future studies evaluating the VAS should take the effect of patient information into account.

Our systematic literature review provides an overview of the instruments that are used for the measurement of pain, physical function, and PtGA in hand OA. Most information on the metric properties of these instruments was available for the questionnaires AUSCAN (assessing pain and function), FIHOA (assessing function), and VAS pain, and

for the performance- or assessor-based instruments grip and pinch strength, and pain on palpation. To enhance comparability across future studies in hand OA, consensus has to be reached on recommended instruments for the measurement of pain, physical function, and PtGA in hand OA. More research has to be performed to compare the different instruments with each other.

## REFERENCES

- Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al; National Arthritis Data Workgroup. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. *Arthritis Rheum* 2008;58:26-35.
- van Saase JL, van Romunde LK, Cats A, Vandenbroucke JP, Valkenburg HA. Epidemiology of osteoarthritis: Zoetermeer survey. Comparison of radiological osteoarthritis in a Dutch population with that in 10 other populations. *Ann Rheum Dis* 1989;48:271-80.
- Zhang W, Doherty M, Leeb BF, Alekseeva L, Arden NK, Bijlsma JW, et al; ESCISIT. EULAR evidence-based recommendations for the diagnosis of hand osteoarthritis: report of a task force of ESCISIT. *Ann Rheum Dis* 2009;68:8-17.
- 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* 2002;156:1021-7.
- Kjeken I, Dagfinrud H, Slatkowsky-Christensen B, Mowinckel P, Uhlig T, Kvien TK, et al. Activity limitations and participation restrictions in women with hand osteoarthritis: patients' descriptions and associations between dimensions of functioning. *Ann Rheum Dis* 2005;64:1633-8.
- Bijsterbosch J, Watt I, Meulenbelt I, Rosendaal FR, Huizinga TW, Kloppenburg M. Clinical burden of erosive hand osteoarthritis and its relationship to nodes. *Ann Rheum Dis* 2010;69:1784-8.
- Kloppenburg M. Hand osteoarthritis-nonpharmacological and pharmacological treatments. *Nat Rev Rheumatol* 2014;10:242-51.
- Mahendira D, Towheed TE. Systematic review of non-surgical therapies for osteoarthritis of the hand: an update. *Osteoarthritis Cartilage* 2009;17:1263-8.
- Kloppenburg M, Bøyesen P, Smeets W, Haugen IK, Liu R, Visser W, et al. Report from the OMERACT Hand Osteoarthritis Special Interest Group: advances and future research priorities. *J Rheumatol* 2014;41:810-8.
- Altman R, Brandt K, Hochberg M, Moskowitz R, Bellamy N, Bloch DA, et al. Design and conduct of clinical trials in patients with osteoarthritis: recommendations from a task force of the Osteoarthritis Research Society. Results from a workshop. *Osteoarthritis Cartilage* 1996;4:217-43.
- Bellamy N, Kirwan J, Boers M, Brooks P, Strand V, Tugwell P, et al. Recommendations for a core set of outcome measures for future phase III clinical trials in knee, hip, and hand osteoarthritis. Consensus development at OMERACT III. *J Rheumatol* 1997;24:799-802.
- Maheu E, Altman RD, Bloch DA, Doherty M, Hochberg M, Mannoni A, et al; Osteoarthritis Research Society International Hand OA Task Force. Design and conduct of clinical trials in patients with osteoarthritis of the hand: recommendations from a task force of the Osteoarthritis Research Society International. *Osteoarthritis Cartilage* 2006;14:303-22.
- Dreiser RL, Maheu E, Guillou GB, Caspard H, Grouin JM. Validation of an algofunctional index for osteoarthritis of the hand. *Rev Rhum Engl Ed* 1995;62 Suppl 1:43S-53S.
- 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 Cartilage* 2002;10:855-62.
- Chung KC, Pillsbury MS, Walters MR, Hayward RA. Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am* 1998;23:575-87.
- Meenan RF, Mason JH, Anderson JJ, Guccione AA, Kazis LE. AIMS2. The content and properties of a revised and expanded Arthritis Impact Measurement Scales Health Status Questionnaire. *Arthritis Rheum* 1992;35:1-10.
- Fries JF, Spitz P, Kraines RG, Holman HR. Measurement of patient outcome in arthritis. *Arthritis Rheum* 1980;23:137-45.
- Backman C, Mackie H. Reliability and validity of the arthritis hand function test in adults with osteoarthritis. *OTJR* 1997;17:55-66.
- Bijsterbosch J, Wassenar MJ, le Cessie S, Slagboom PE, Rosendaal FR, Huizinga TW, et al. Doyle Index is a valuable additional pain measure in osteoarthritis. *Osteoarthritis Cartilage* 2010;18:1046-50.
- Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009; 339:b253.
- Boers M, Brooks P, Strand CV, Tugwell P. The OMERACT filter for Outcome Measures in Rheumatology. *J Rheumatol* 1998;25:198-9.
- Marks M, Schoones JW, Kolling C, Herren DB, Goldhahn J, Vliet Vlieland TP. Outcome measures and their measurement properties for trapeziometacarpal osteoarthritis: a systematic literature review. *J Hand Surg Eur Vol* 2013;38:822-38.
- Allen KD, Jordan JM, Renner JB, Kraus VB. Relationship of global assessment of change to AUSCAN and pinch and grip strength among individuals with hand osteoarthritis. *Osteoarthritis Cartilage* 2006;14:1281-7.
- Allen KD, Jordan JM, Renner JB, Kraus VB. Validity, factor structure, and clinical relevance of the AUSCAN Osteoarthritis Hand Index. *Arthritis Rheum* 2006;54:551-6.
- Bellamy N, Campbell J, Haraoui B, Gerecz-Simon E, Buchbinder R, Hobby K, et al. Clinimetric properties of the AUSCAN Osteoarthritis Hand Index: an evaluation of reliability, validity and responsiveness. *Osteoarthritis Cartilage* 2002;10:863-9.
- Dreiser RL, Maheu E, Guillou GB. Sensitivity to change of the functional index for hand osteoarthritis. *Osteoarthritis Cartilage* 2000;8 Suppl A:S25-8.
- Dziedzic KS, Thomas E, Myers H, Hill S, Hay EM. The Australian/Canadian osteoarthritis hand index in a community-dwelling population of older adults: reliability and validity. *Arthritis Rheum* 2007;57:423-8.
- Fernandes L, Grotle M, Darre S, Nossom R, Kjeken I. Validity and responsiveness of the Measure of Activity Performance of the Hand (MAP-Hand) in patients with hand osteoarthritis. *J Rehabil Med* 2012;44:869-76.
- Haugen IK, Slatkowsky-Christensen B, Lessem J, Kvien TK. The responsiveness of joint counts, patient-reported measures and proposed composite scores in hand osteoarthritis: analyses from a placebo-controlled trial. *Ann Rheum Dis* 2010;69:1436-40.
- Haugen IK, Moe RH, Slatkowsky-Christensen B, Kvien TK, van der Heijde D, Garratt A. The AUSCAN subscales, AIMS-2 hand/finger subscale, and FIOHA were not unidimensional scales. *J Clin Epidemiol* 2011;64:1039-46.
- Hirsch R, Guralnik JM, Leveille SG, Simonsick EM, Ling S, Bandeen-Roche K, et al. Severity of hand osteoarthritis and its association with upper extremity impairment in a population of disabled older women: the Women's Health and Aging Study. *Aging* 1999;11:253-61.
- MacIntyre NJ, Wessel J. Construct validity of the AIMS-2 upper limb function scales as a measure of disability in individuals with osteoarthritis of the hand. *Clin Rheumatol* 2009;28:573-8.

33. MacIntyre NJ, Wessel J, MacDermid JC, Galea V. Assessment of strength of individual digits in persons with osteoarthritis of the hand. *Hand Ther* 2010;15:39-44.
34. Moe RH, Garratt A, Slatkowsky-Christensen B, Maheu E, Mowinckel P, Kvien TK, et al. Concurrent evaluation of data quality, reliability and validity of the Australian/Canadian Osteoarthritis Hand Index and the Functional Index for Hand Osteoarthritis. *Rheumatology* 2010;49:2327-36.
35. Myers HL, Thomas E, Hay EM, Dziedzic KS. Hand assessment in older adults with musculoskeletal hand problems: a reliability study. *BMC Musculoskelet Disord* 2011;12:3.
36. Poiraudreau S, Chevalier X, Conrozier T, Flippo RM, Lioté F, Noël E, et al. Reliability, validity, and sensitivity to change of the Cochin hand functional disability scale in hand osteoarthritis. *Osteoarthritis Cartilage* 2001;9:570-7.
37. Poole JL, Lucero SL, Mynatt R. Self-reports and performance-based tests of hand function in persons with osteoarthritis. *BMC Geriatr* 2010;28:249-58.
38. Rintelen B, Haindl PM, Mai HT, Sautner J, Maktari A, Leeb BF. A tool for the assessment of hand involvement in rheumatic disorders in daily routine—the SF-SACRAH (short form score for the assessment and quantification of chronic rheumatic affections of the hands). *Osteoarthritis Cartilage* 2009;17:59-63.
39. Sautner J, Andel I, Rintelen B, Leeb BF. Development of the M-SACRAH, a modified, shortened version of SACRAH (Score for the Assessment and Quantification of Chronic Rheumatoid Affections of the Hands). *Rheumatology* 2004;43:1409-13.
40. Sautner J, Andel I, Rintelen B, Leeb BF. A comparison of the modified score for the assessment of chronic rheumatoid affections of the hands and the Australian/Canadian osteoarthritis hand index in hand osteoarthritis patients. *Int J Rheumatol* 2009;2009:249096.
41. Stamm T, Mathis M, Aletaha D, Kloppenburg M, Machold K, Smolen J. Mapping hand functioning in hand osteoarthritis: comparing self-report instruments with a comprehensive hand function test. *Arthritis Rheum* 2007;57:1230-7.
42. Tubach F, Ravaud P, Martin-Mola E, Awada H, Bellamy N, Bombardier C, et al. Minimum clinically important improvement and patient acceptable symptom state in pain and function in rheumatoid arthritis, ankylosing spondylitis, chronic back pain, hand osteoarthritis, and hip and knee osteoarthritis: results from a prospective multinational study. *Arthritis Care Res* 2012; 64:1699-707.
43. Wittoek R, Cruyssen BV, Maheu E, Verbruggen G. Cross-cultural adaptation of the Dutch version of the Functional Index for Hand Osteoarthritis (FIHOA) and a study on its construct validity. *Osteoarthritis Cartilage* 2009;17:607-12.
44. Ziv E, Patish H, Dvir Z. Grip and pinch strength in healthy subjects and patients with primary osteoarthritis of the hand: a reproducibility study. *Open Orthop J* 2008;2:86-90.
45. Altman RD, Dreiser RL, Fisher CL, Chase WF, Dreher DS, Zacher J. Diclofenac sodium gel in patients with primary hand osteoarthritis: a randomized, double-blind, placebo-controlled trial. *J Rheumatol* 2009;36:1991-9.
46. Barthel HR, Peniston JH, Clark MB, Gold MS, Altman RD. Correlation of pain relief with physical function in hand osteoarthritis: randomized controlled trial post hoc analysis. *Arthritis Res Ther* 2010;12:R7.
47. Brosseau L, Wells G, Marchand S, Gaboury I, Stokes B, Morin M, et al. Randomized controlled trial on low level laser therapy (LLLT) in the treatment of osteoarthritis (OA) of the hand. *Lasers Surg Med* 2005;36:210-9.
48. Dilek B, Gözümlü M, Şahin E, Baydar M, Ergör G, El O, et al. Efficacy of paraffin bath therapy in hand osteoarthritis: a single-blinded randomized controlled trial. *Arch Phys Med Rehabil* 2013;94:642-9.
49. Dreiser RL, Gersberg M, Thomas F, Courcier S. [Ibuprofen 800 mg in the treatment of arthrosis of the fingers or rhizarthrosis]. [Article in French] *Rev Rhum Ed Fr* 1993;60:836-41.
50. Dziedzic K, Nicholls E, Hill S, Hammond A, Handy J, Thomas E, et al. Self-management approaches for osteoarthritis in the hand: a 2x2 factorial randomised trial. *Ann Rheum Dis* 2015;74:108-18.
51. Fioravanti A, Tenti S, Giannitti C, Fortunati NA, Galeazzi M. Short- and long-term effects of mud-bath treatment on hand osteoarthritis: a randomized clinical trial. *Int J Biometeorol* 2014;58:79-86.
52. Flynn MA, Irvin W, Krause G. The effect of folate and cobalamin on osteoarthritic hands. *J Am Coll Nutr* 1994;13:351-6.
53. Gabay C, Medinger-Sadowski C, Gascon D, Kolo F, Finckh A. Symptomatic effects of chondroitin 4 and chondroitin 6 sulfate on hand osteoarthritis: a randomized, double-blind, placebo-controlled clinical trial at a single center. *Arthritis Rheum* 2011;63:3383-91.
54. Garfinkel MS, Schumacher HR Jr, Husain A, Levy M, Reshetar RA. Evaluation of a yoga based regimen for treatment of osteoarthritis of the hands. *J Rheumatol* 1994;21:2341-3.
55. Grifka JK, Zacher J, Brown JP, Seriola B, Lee A, Moore A, et al. Efficacy and tolerability of lumiracoxib versus placebo in patients with osteoarthritis of the hand. *Clin Exp Rheumatol* 2004;22:589-96.
56. Horváth K, Kulisch Á, Németh A, Bender T. Evaluation of the effect of balneotherapy in patients with osteoarthritis of the hands: a randomized controlled single-blind follow-up study. *Clin Rehabil* 2012;26:431-41.
57. Kanat E, Alp A, Yurtkuran M. Magnetotherapy in hand osteoarthritis: a pilot trial. *Complement Ther Med* 2013;21:603-8.
58. Keen HI, Wakefield RJ, Hensor EM, Emery P, Conaghan PG. Response of symptoms and synovitis to intra-muscular methylprednisolone in osteoarthritis of the hand: an ultrasonographic study. *Rheumatology* 2010;49:1093-100.
59. Kjekken I, Darre S, Smedslund G, Hagen KB, Nossrum R. Effect of assistive technology in hand osteoarthritis: a randomised controlled trial. *Ann Rheum Dis* 2011;70:1447-52.
60. Kovács C, Pezce M, Tihanyi Á, Kovács L, Balogh S, Bender T. The effect of sulphurous water in patients with osteoarthritis of hand. Double-blind, randomized, controlled follow-up study. *Clin Rheumatol* 2012;31:1437-42.
61. Kvien TK, Fjeld E, Slatkowsky-Christensen B, Nichols M, Zhang Y, Prøven A, et al. Efficacy and safety of a novel synergistic drug candidate, CRx-102, in hand osteoarthritis. *Ann Rheum Dis* 2008;67:942-8.
62. Kwok WY, Kloppenburg M, Beaat-van de Voorde LJ, Huizinga TW, Vliet Vlieland TP. Role of rheumatology clinical nurse specialists in optimizing management of hand osteoarthritis during daily practice in secondary care: an observational study. *J Multidiscip Healthc* 2011;4:403-11.
63. Moratz V, Muncie HL Jr, Miranda-Walsh H. Occupational therapy in the multidisciplinary assessment and management of osteoarthritis. *Clinical Therapeutics* 1986;9 Suppl B:24-9.
64. Myrer JW, Johnson AW, Mitchell UH, Measom GJ, Fellingham GW. Topical analgesic added to paraffin enhances paraffin bath treatment of individuals with hand osteoarthritis. *Disabil Rehabil* 2011;33:467-74.
65. Pastinen O, Forsskahl B, Marklund M. Local glycosaminoglycan polysulphate injection therapy in osteoarthritis of the hand. A placebo-controlled clinical study. *Scand J Rheumatol* 1988;17:197-202.
66. Reeves KD, Hassanein K. Randomized, prospective, placebo-controlled double-blind study of dextrose prolotherapy for osteoarthritic thumb and finger (DIP, PIP, and trapeziometacarpal) joints: evidence of clinical efficacy. *J Altern Complement Med* 2000;6:311-20.
67. Rogers MW, Wilder FV. The effects of strength training among persons with hand osteoarthritis: a two-year follow-up study. *J Hand Ther* 2007;20:244-9.



68. Rogers MW, Wilder FV. Exercise and hand osteoarthritis symptomatology: a controlled crossover trial. *J Hand Ther* 2009;22:10-7.
69. Romero-Cerecero O, Meckes-Fischer M, Zamilpa A, Enrique Jiménez-Ferrer J, Nicasio-Torres P, Pérez-García D, et al. Clinical trial for evaluating the effectiveness and tolerability of topical *Sphaeralcea angustifolia* treatment in hand osteoarthritis. *J Ethnopharmacol* 2013;147:467-73.
70. Rothacker D, Difiigilo C, Lee I. A clinical trial of topical 10% trolamine salicylate in osteoarthritis. *Curr Ther Res Clin Exp* 1994;55:584-97.
71. Rothacker DQ, Lee I, Littlejohn TW 3rd. Effectiveness of a single topical application of 10% trolamine salicylate cream in the symptomatic treatment of osteoarthritis. *J Clin Rheumatol* 1998;4:6-12.
72. Saviola G, Abdi-Ali L, Camprotrini L, Sacco S, Baiardi P, Manfredi M, et al. Clodronate and hydroxychloroquine in erosive osteoarthritis: a 24-month open randomized pilot study. *Mod Rheumatol* 2012;22:256-63.
73. Schnitzer T, Morton C, Coker S. Topical capsaicin therapy for osteoarthritis pain: Achieving a maintenance regimen. *Semin Arthritis Rheum* 1994;6 Suppl 3:34-40.
74. Seiler V. Meclofenamate sodium in the treatment of degenerative joint disease of the hand (Heberden nodes). *Arzneimittelforschung* 1983;33:656-9.
75. Shin K, Kim JW, Moon KW, Yang JA, Lee EY, Song YW, et al. The efficacy of diacerein in hand osteoarthritis: a double-blind, randomized, placebo-controlled study. *Clin Ther* 2013;35:431-9.
76. Stamm TA, Machold KP, Smolen JS, Fischer S, Redlich K, Graninger W, et al. Joint protection and home hand exercises improve hand function in patients with hand osteoarthritis: a randomized controlled trial. *Arthritis Rheum* 2002;47:44-9.
77. Stange-Rezende L, Stamm TA, Schiffert T, Sahinbegovic E, Gaiger A, Smolen J, et al. Clinical study on the effect of infrared radiation of a tiled stove on patients with hand osteoarthritis. *Scand J Rheumatol* 2006;35:476-80.
78. Stukstette MJ, Dekker J, den Broeder AA, Westeneng JM, Bijlsma JW, van den Ende CH. No evidence for the effectiveness of a multidisciplinary group based treatment program in patients with osteoarthritis of hands on the short term; results of a randomized controlled trial. *Osteoarthritis Cartilage* 2013;21:901-10.
79. Verbruggen G, Wittoek R, Vander Cruyssen B, Elewaut D. Tumour necrosis factor blockade for the treatment of erosive osteoarthritis of the interphalangeal finger joints: a double blind, randomised trial on structure modification. *Ann Rheum Dis* 2012;71:891-8.
80. Wenham CY, Hensor EM, Grainger AJ, Hodgson R, Balamoody S, Doré CJ, et al. A randomized, double-blind, placebo-controlled trial of low-dose oral prednisolone for treating painful hand osteoarthritis. *Rheumatology* 2012;51:2286-94.
81. Widrig R, Suter A, Saller R, Melzer J. Choosing between NSAID and arnica for topical treatment of hand osteoarthritis in a randomised, double-blind study. *Rheumatol Int* 2007;27:585-91.
82. Bijsterbosch J, Watt I, Meulenbelt I, Rosendaal FR, Huizinga TW, Kloppenburg M. Clinical and radiographic disease course of hand osteoarthritis and determinants of outcome after 6 years. *Ann Rheum Dis* 2011;70:68-73.
83. Botha-Scheepers S, Riyazi N, Watt I, Rosendaal FR, Slagboom E, Bellamy N, et al. Progression of hand osteoarthritis over 2 years: a clinical and radiological follow-up study. *Ann Rheum Dis* 2009;68:1260-4.
84. Haugen IK, Slatkowsky-Christensen B, Boyesen P, van der Heijde D, Kvien TK. Cross-sectional and longitudinal associations between radiographic features and measures of pain and physical function in hand osteoarthritis. *Osteoarthritis Cartilage* 2013;21:1191-8.
85. Marshall M, Peat G, Nicholls E, van der Windt D, Myers H, Dziedzic K. Subsets of symptomatic hand osteoarthritis in community-dwelling older adults in the United Kingdom: prevalence, inter-relationships, risk factor profiles and clinical characteristics at baseline and 3-years. *Osteoarthritis Cartilage* 2013;21:1674-84.
86. Lorig K, Chastain RL, Ung E, Shoor S, Holman HR. Development and evaluation of a scale to measure perceived self-efficacy in people with arthritis. *Arthritis Rheum* 1989;32:37-44.
87. Duruöz MT, Poiraudou S, Fermanian J, Menkes CJ, Amor B, Dougados M, et al. Development and validation of a rheumatoid hand functional disability scale that assesses functional handicap. *J Rheumatol* 1996;23:1167-72.
88. Law M, Baptiste S, Carswell A, McColl M, Polatajko H, Pollock N. Canadian Occupational Performance Measure (Manual), 4th edition. Ottawa: CAOT Publications ACE; 2005.
89. Paulsen T, Grotle M, Garratt A, Kjekken I. Development and psychometric testing of the patient-reported measure of activity performance of the hand (MAP-Hand) in rheumatoid arthritis. *J Rehabil Med* 2010;42:636-44.
90. Fillenbaum GG, Smyer MA. The development, validity, and reliability of the OARS multidimensional functional assessment questionnaire. *J Gerontol* 1981;36:428-34.
91. MacDermid JC, Turgeon T, Richards RS, Beadle M, Roth JH. Patient rating of wrist pain and disability: a reliable and valid measurement tool. *J Orthop Trauma* 1998;12:577-86.
92. Revel M, Amor B. [Orthopedic treatment of swan-neck deformities of the rheumatoid hand]. [Article in French] *Rev Rhum Mal Osteoartic* 1989;56:93-6.
93. Leeb BF, Sautner J, Anel I, Rintelen B. SACRAH: a score for assessment and quantification of chronic rheumatic affections of the hands. *Rheumatology* 2003;42:1173-8.
94. Huskisson EC. Measurement of pain. *Lancet* 1974;2:1127-31.
95. Pincus T, Brooks RH, Callahan LF. Reliability of grip strength, walking time and button test performed according to a standard protocol. *J Rheumatol* 1991;18:997-1000.
96. Dellhag B, Bjelle A. A Grip Ability Test for use in rheumatology practice. *J Rheumatol* 1995;22:1559-65.
97. Sandqvist G, Eklund M. Hand Mobility in Scleroderma (HAMIS) test: the reliability of a novel hand function test. *Arthritis Care Res* 2000;13:369-74.
98. Eberl DR, Fasching V, Rahlfs V, Schleyer I, Wolf R. Repeatability and objectivity of various measurements in rheumatoid arthritis. A comparative study. *Arthritis Rheum* 1976;19:1278-86.
99. Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. *Arch Phys Med Rehabil* 1969;50:311-9.
100. Ng CL, Ho DD, Chow SP. The Moberg pickup test: results of testing with a standard protocol. *J Hand Ther* 1999;12:309-12.
101. Doyle DV, Dieppe PA, Scott J, Huskisson EC. An articular index for the assessment of osteoarthritis. *Ann Rheum Dis* 1981;40:75-8.
102. Ritchie DM, Boyle JA, McInnes JM, Jasani MK, Dalakas TG, Grievson P, et al. Clinical studies with an articular index for the assessment of joint tenderness in patients with rheumatoid arthritis. *Q J Med* 1968;37:393-406.
103. van den Ende CH, Hazes JM, Le Cessie S, Breedveld FC, Dijkman BA. Discordance between objective and subjective assessment of functional ability of patients with rheumatoid arthritis. *Br J Rheumatol* 1995;34:951-5.
104. Bellamy N, Wilson C. International estimation of minimally clinically important improvement (MCII75): the Reflect study. 2007;37:Suppl 2:A36.
105. Rovetta G, Monteforte P, Molfetta L. Evaluating pain in osteoarthritis of the hands: the effect of patient information. *Int J Clin Pharmacol Res* 2003;23:61-7.