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2023 EULAR classification criteria for hand osteoarthritis

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ABSTRACT

Objectives The objective of this study is to develop classification criteria for overall hand osteoarthritis (OA), interphalangeal OA and thumb base OA based on self-reported data and radiographic features.

Methods The classification criteria sets were developed in three phases. In phase 1, we identified criteria that discriminated hand OA from controls. In phase 2, we used a consensus-based decision analysis approach to derive a clinician-based evaluation of the relative importance of the criteria. In phase 3, we refined the scoring system, determined the cut-offs for disease classification and compared the sensitivity and specificity of the European Alliance of Associations for Rheumatology (EULAR) criteria with the 1990 American College of Rheumatology (ACR) criteria.

Results In persons with hand symptoms and no other disease (including psoriasis) or acute injury that can explain the hand symptoms (mandatory criteria), hand OA can be classified based on age, duration of morning stiffness, number of joints with osteophytes and joint space narrowing, and concordance between symptoms and radiographic findings. Using a sum of scores based on each diagnostic element, overall hand OA can be classified if a person achieves 9 or more points on a 0–15 scale. The cut-off for interphalangeal OA and thumb base OA is 8 points. While the EULAR criteria demonstrated better sensitivity than the ACR criteria in the phase 1 data set, the performance of the two criteria sets was similar in two external cohorts.

Conclusions International experts developed the EULAR criteria to classify overall hand OA, interphalangeal OA and thumb base OA in clinical studies using a rigorous methodology.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Available classification criteria for hand osteoarthritis (OA) are based on clinical findings and do not distinguish between different hand OA phenotypes.

WHAT THIS STUDY ADDS

⇒ We present classification criteria for hand OA, which should be applied in a target population with pain, aching and/or stiffness in hand joints and no other disease or acute injury explaining the symptoms.

⇒ The criteria include age, duration of morning stiffness, radiographic osteophytes, radiographic joint space narrowing and symptom-structure concordance, allowing researchers to apply the criteria in large studies without the need of a clinical joint examination.

⇒ Separate criteria for overall hand OA, interphalangeal OA and thumb base OA are presented.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ New classification criteria for overall hand OA, interphalangeal OA and thumb base OA will enable the inclusion of more homogenous patient populations in research studies and clinical trials.

⇒ Separate classification criteria for different hand OA phenotypes may facilitate clinical trials on targeted interventions.

INTRODUCTION

Hand osteoarthritis (OA) mainly affects the distal interphalangeal (DIP), proximal interphalangeal (PIP) and thumb base joints,[1] leading to joint pain, aching and/or stiffness. The prevalence estimates vary depending on the study population and the definition used.[1 2] Currently, there is no approved disease-modifying treatment for OA,[3–5] although several promising candidates are being tested.[6]

Using classification criteria is the standard method of assembling a homogenous group of people with the disease of interest for enrolment in clinical trials and observational studies. The 1990 American College of Rheumatology (ACR) criteria set is currently the only available classification criteria set for hand OA.[7] The ACR criteria set uses clinical

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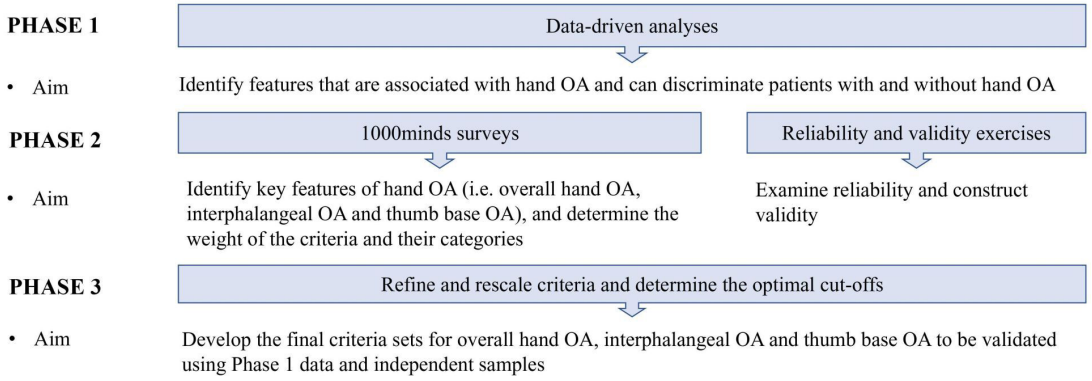

Figure 1 Three phases in developing classification criteria for overall hand osteoarthritis (OA), interphalangeal OA and thumb base OA.

features only and advises against hand OA classification based on radiographs. It classifies hand OA as present almost exclusively based on joint involvement in the second–third fingers and the thumb base. The ACR criteria set may be less suited to classify hand OA in primary care settings or the general population as it was primarily developed to distinguish hand OA from rheumatoid arthritis (RA).[7] Moreover, the ACR criteria set does not classify hand OA phenotypes such as interphalangeal or thumb base OA, which are two phenotypes that may require different treatment strategies. Based on these limitations, members of the European Alliance of Associations for Rheumatology (EULAR) taskforce for evidence-based recommendations on hand OA diagnosis ranked the development of new classification criteria as a top research priority.[8]

Hence, we aimed to develop new classification criteria sets incorporating radiographic features for overall hand OA, interphalangeal OA and thumb base OA in a population with hand pain, aching and/or stiffness.

METHODS

Three phases for the development of the EULAR classification criteria sets were defined a priori (figure 1). The methods of phases 1–2 have been detailed in previous publications[9 10] and are thus briefly summarised. The current report mainly focuses on phase 3. The EULAR/ACR methodology for the development of classification criteria was used.

Phases 1 and 2

Using data from a multicentre observational study of persons with hand complaints due to hand OA (n=128) or other inflammatory and non-inflammatory conditions (n=70) as determined by the physician, logistic regression analyses were performed to identify self-reported, clinical, radiographic and laboratory features associated with hand OA (phase 1). We assessed the discrimination capacity of each feature in classifying hand OA.[9]

In phase 2, we used a consensus-driven decision-making approach to refine the criteria identified in phase 1 and determine their relative importance (ie, weight). Our multidisciplinary expert panel (n=21) included 13 rheumatologists, 2 primary care physicians, 2 surgeons, 2 occupational therapists, 1 physical therapist and 1 physician assistant. The experts were spread across Europe (n=17), North America (n=2), Asia (n=1) and Australia (n=1). Only 7 of 21 experts had also been actively involved in the data collection in phase 1. In addition to the 21 experts, 1 person developed all surveys and performed the analyses (IKH) and 8 experts were involved in the discussion about the results in phase 2 and/or a reliability exercise.[10]

Groups of case vignettes were created, presenting positive or negative findings from the diagnostic tests identified in phase 1. The experts ranked the cases according to their likelihood of having hand OA as cause of the complaints, both individually and in consensus. Sets of criteria and categories were drafted and tested in a series of surveys using the 1000minds software to determine the relative weights of the criteria and their categories.[10]

Phase 3

In phase 3, we refined the scoring system developed in phase 2 and determined the optimal cut-off for disease classification. The sensitivity and specificity of the proposed criteria were tested.

Rescaling

Rescaling was done to ensure feasibility and user-friendliness of the criteria. The impact of rescaling was evaluated by looking at the Spearman correlation between the total scores based on original weighting and the rescaled criteria. We also evaluated whether rescaling changed the ranking of patients. We used 3 sets of patient vignettes for overall hand OA, interphalangeal OA and thumb base OA, each with 30 patients with pain, aching and/or stiffness in at least 1 target joint on most days of the prior 6 weeks and without psoriasis (sets 2A–C).[10]

Determination of cut-off

We used a consensus-based approach to identify the optimal cut-off. Using the proposed criteria score (range 0–100), 30 patient vignettes (set 2A) were ranked according to their likelihood of having hand OA. The 21 experts, who were unaware of the criteria score, were asked to examine the rankings of patients and to indicate the point at which the patients changed from ‘probable’ to ‘definite’ overall hand OA as the cause of the complaints. This exercise was repeated for interphalangeal OA and thumb base OA using other patient vignettes (sets 2B–C).

In addition, a data-driven approach based on analyses of phase 1 data was applied. We calculated the area under the curve (AUC) for the proposed criteria for overall hand OA (range: 0–100) using as a reference the physician’s evaluation of the primary cause of the hand complaints (ie, OA vs non-OA conditions). The optimal cut-off value was the point closest to the upper left corner of the receiver-operating curve. The data-driven approach was applied only to the overall hand OA criteria, as we lacked information regarding the physician’s specific opinion about interphalangeal OA and thumb base OA being the cause

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of the complaints. Two webinars were arranged to present and discuss the results of these surveys.

Validation of the final criteria set

The proposed EULAR criteria were validated in two external cohorts: a Dutch hand OA cohort (Hand OA in Secondary Care Study, HOSTAS)[11] and a Norwegian study of people with self-reported OA (Musculoskeletal pain in Ullensaker STudy, MUST).[12] In HOSTAS, we restricted the analyses on sensitivity of the EULAR and ACR criteria to those with a high likelihood of having hand OA based on an evaluation by the physician (score ≥7 on a 0–10 scale). In the absence of a control group without hand OA in HOSTAS, we could not calculate specificity. In MUST, the sensitivity and specificity of the EULAR and ACR criteria were examined using persons with self-reported hand OA (ie, diagnosed with hand OA by a medical doctor and/or radiographs) as reference and persons without self-reported hand OA as controls.

The validation of the criteria was also complemented using data from phase 1.[9] We restricted the analyses to cases with clearcut hand OA (score ≥7 on a 0–10 scale concerning the likelihood of having complaints due to hand OA based on the opinion by the physician) and cases where other conditions were clearly the cause of their hand complaints (score ≤3). We calculated the sensitivity and specificity of the EULAR and ACR criteria using the physician's evaluation of hand OA or other conditions as the cause of complaints as reference.

Sensitivity analyses of radiographic ACR criteria were performed replacing bony enlargement with radiographic osteophytes.

Patient and public involvement

Two European patient research partners were involved in phases 1–2. One patient research partner was replaced prior to phase 3, and two research partners (HL, EG) from Norway and the Netherlands were involved in preparations of this manuscript.

RESULTS

Target population

The criteria can be applied to any person as long as two mandatory criteria are met. First, the person must have symptoms (pain, aching and/or stiffness) in at least one target joint on most days of the previous 6 weeks (tables 1–3). Second, the symptoms should not be better explained by acute injury or another disease such as crystal arthropathies, non-inflammatory hand conditions or systemic inflammatory joint diseases. Experts recommended that people with psoriasis should be excluded from the target population, since psoriatic arthritis may be difficult to distinguish from hand OA.[8] In phase 2, persons with morning stiffness of 60 min or longer were initially excluded from the target population due to concerns about systemic inflammatory joint diseases. Due to high frequency of long morning stiffness among patients with hand OA,[13] the experts in phase 3 decided to retain persons with long morning stiffness in the target population to preserve the sensitivity of the criteria.

The following target joints should be evaluated for symptoms and radiographic features: bilateral second–fifth DIPs, second–fifth PIPs, first interphalangeal (IP1) and thumb base joints. For radiographic features in the thumb base joints, the experts agreed that the first carpometacarpal (CMC1) should be evaluated.[9]

Table 1 The 2023 EULAR classification criteria set for overall hand OA

	Score
Target population (mandatory criteria): persons with pain, aching and/or stiffness in at least one target joint (bilateral second–fifth DIPs, second-fifth PIPs, IP1 and thumb base joints) on most days of the previous 6 weeks, and no other disease or acute injury that can explain the symptoms.*	
Classification criteria for overall hand OA (score-based algorithm: the scores of the five criteria A–E should be added, and a score of ≥9/15 is needed for classification of overall hand OA):	
Age	
Below 45 years	0
45–54 years	1
55–64 years	2
65 years and above	3
Duration of morning stiffness in DIPs, PIPs, IP1 and thumb base joints	
Long (more than 30 min)	0
None	1
Short (30 min or less)	2
Number of DIPs, PIPs, IP1 and CMC1 joints with osteophytes	
None	0
1–2 joint(s)	2
3–5 joints	3
6 or more joints	4
Number of DIPs, PIPs, IP1 and CMC1 joints with JSN	
None	0
1–2 joint(s)	1
3–5	2
6 or more joints	3
Symptom-structure concordance†	
No	0
Yes	3

*Differential diagnoses may include crystal arthropathies, non-inflammatory hand conditions such as haemochromatosis and systemic inflammatory joint diseases such as rheumatoid arthritis and psoriatic arthritis. People with a history of psoriasis should be excluded from the target population.
†Radiographic OA (osteophytes or JSN) in at least 50% of the joints (DIPs, PIPs, IP1 and CMC1), in which the person has experienced pain, aching and/or stiffness on most days of the previous 6 weeks.
CMC1, first carpometacarpal; DIPs, distal interphalangeal joints; EULAR, European Alliance of Associations for Rheumatology; IP1, first interphalangeal; JSN, joint space narrowing; OA, osteoarthritis; PIPs, proximal interphalangeal joints.

Criteria sets for overall hand OA, interphalangeal OA and thumb base OA

Five additional criteria can then be applied to eligible persons to identify those with overall hand OA, interphalangeal OA or thumb base OA as the cause of their complaints (tables 1–3). The five criteria include age, morning stiffness duration, number of joints with osteophytes, number of joints with joint space narrowing (JSN) and symptom-structure concordance. Table 4 includes a detailed description of the criteria. It is impossible to fulfil any of the criteria sets without radiographic changes in the target joints, and radiographs are thus strictly needed when applying the criteria.

The sections below briefly describe the domains and their weights (phases 1–2), rescaling, determination of cut-off for disease classification and validation of the final criteria sets (phase 3).

Domains and categories

In phase 1, we identified variables that could discriminate persons with and without hand OA as the primary cause of their complaints, as determined by the physician: age, duration of morning stiffness, radiographic osteophytes and JSN, symptom-structure concordance and inflammatory biomarkers (online supplemental table 1). Importantly, no single feature could perfectly discriminate persons with and without hand OA. Radiographic findings showed better discrimination than features by clinical examination.[9]

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Table 2 The 2023 EULAR classification criteria set for interphalangeal OA

	Score
Target population (mandatory criteria): persons with pain, aching and/or stiffness in at least one target joint (bilateral second–fifth DIPs, second–fifth PIPs and IP1 joints) on most days of the previous 6 weeks, and no other disease or acute injury that can explain the symptoms.*	
Classification criteria for interphalangeal OA (score-based algorithm: the scores of the five criteria A–E should be added, and a score of ≥8/15 is needed for classification of interphalangeal OA):	
Age	
Below 45 years	0
45–54 years	1
55–64 years	2
65 years and above	3
Duration of morning stiffness in DIPs, PIPs and IP1 joints	
Long (more than 30 min)	0
None	1
Short (30 min or less)	2
Number of DIPs, PIPs and IP1 joints with osteophytes	
None	0
1–2 joint(s)	2
3–5 joints	3
6 or more joints	4
Number of DIPs, PIPs and IP1 joints with JSN	
None	0
1–2 joint(s)	1
3–5	2
6 or more joints	3
Symptom-structure concordance †	
No	0
Yes	3

*Differential diagnoses may include crystal arthropathies, non-inflammatory hand conditions such as haemochromatosis and systemic inflammatory joint diseases such as rheumatoid arthritis and psoriatic arthritis. People with a history of psoriasis should be excluded from the target population.
†Radiographic OA (osteophytes or JSN) in at least 50% of the joints (DIPs, PIPs and IP1), in which the person has experienced pain, aching and/or stiffness on most days of the previous 6 weeks.
DIPs, distal interphalangeal joints; EULAR, European Alliance of Associations for Rheumatology; IP1, first interphalangeal; JSN, joint space narrowing; OA, osteoarthritis; PIPs, proximal interphalangeal joints.

Table 3 The 2023 EULAR classification criteria set for thumb base OA

	Score
Target population (mandatory criteria): persons with pain, aching and/or stiffness in at least one target joint (bilateral thumb base joints) on most days of the previous 6 weeks, and no other disease or acute injury that can explain the symptoms.*	
Classification criteria for thumb base OA (score-based algorithm: the scores of the five criteria A–E should be added, and a score of ≥8/15 is needed for classification of thumb base OA):	
Age	
Below 45 years	0
45–54 years	1
55–64 years	2
65 years and above	3
Duration of morning stiffness in thumb base joints	
Long (more than 30 min)	0
None	1
Short (30 min or less)	2
Number of CMC1 joints with osteophytes	
None	0
1 joint	2
2 joints	4
Number of CMC1 joints with JSN	
None	0
1 joint	2
2 joints	3
Symptom-structure concordance †	
No	0
Yes	3

*Differential diagnoses may include crystal arthropathies, non-inflammatory hand conditions such as haemochromatosis and systemic inflammatory joint diseases such as rheumatoid arthritis and psoriatic arthritis. People with a history of psoriasis should be excluded from the target population.
†Radiographic CMC1 OA (osteophytes or JSN) in at least one thumb base joint with pain, aching and/or stiffness on most days of the previous six weeks.
CMC1, first carpometacarpal; EULAR, European Alliance of Associations for Rheumatology; JSN, joint space narrowing; OA, osteoarthritis.

The relative weight of the domains and their categories derived from phase 2 are shown in online supplemental tables 2A–C. Inflammatory biomarkers were excluded during phase 2 due to concerns about feasibility and limited impact on the validity of the proposed scoring system.[10] Analyses yielded a score for each patient (range: 0–100), representing the likelihood that the complaints were due to overall hand OA, interphalangeal OA and thumb base OA, respectively.[10]

Rescaling of the criteria

Different scales were tested manually. We found that a 0–15 scale performed better than, for example, a 0–10 scale in terms of keeping the rounded scores close to the original weight and retaining the differences between the categories. First, we rescaled the scoring system from a 0–100 to a 0–15 scale and then rounded each score to multiples of 0.5. Finally, we rescaled all criteria in the scoring system to an integer scale for ease of use (online supplemental tables 2A–C).

We found perfect correlation between the scores based on the original weighting (range: 0–100) and the rescaled criteria set (range: 0–15) for all criteria sets (Spearman correlation coefficients: 0.99–1.00). Rescaling did not change the rank of any patient in the sets of vignettes.

Determination of the optimal cut-off for hand OA

The analyses of the optimal cut-off were done using the original weighting of the criteria (range: 0–100). Using the consensus-based approach with expert opinions, the mean (SD) cut-off value for defining overall hand OA on the 0–100 scale was 58 (15), while the mean (SD) cut-off values for interphalangeal OA and thumb base OA were 52 (18) and 65 (12), respectively. Analyses of phase 1 data revealed good discrimination of persons with versus without hand OA using the proposed criteria for overall hand OA (AUC=0.81). The optimal cut-off corresponded to a score of 61 on the 0–100 scale with a sensitivity of 0.70 and a specificity of 0.83.

Based on a discussion within the expert panel of which patient vignettes had definite hand OA, the experts agreed on a threshold of 60 of 100 points (corresponding to 9 of 15 points) as the optimal cut-off value for overall hand OA. For interphalangeal OA and thumb base OA, the experts agreed on a slightly lower cut-off value (8 of 15 points). Since the classification of

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Table 4 Definitions of the 2023 EULAR classification criteria of hand OA

Criteria	Definition
Pain, aching and/or stiffness in target joints as an entry criterion	Pain, aching and/or stiffness should be present in target joints on most days of the previous 6 weeks. The question can be asked without the need of a hand diagram. The target joints is defined depending on which criteria set is being applied. The symptoms may be present in different joints as long as the symptoms are present in any joint on most days of the last 6 weeks. Hand symptoms outside the joints should not be evaluated.
Other diseases or acute injury as an exclusion criterion	An exhaustive list of possible differential diagnoses and diagnostic tests that should be done to exclude these diseases is intentionally not provided. The physician (or other health professionals with relevant expertise) should exclude persons with relevant differential diagnoses based on a clinical evaluation or using self-reported data or diagnostic codes if clinical evaluation is not feasible. Persons with a history of psoriasis should be excluded from the target population. Investigators should determine relevant differential diagnoses and acute injuries based on the study population.
Target joints	The target joints for the criteria for overall hand OA are the bilateral second–fifth DIP, second–fifth PIP joints, IP1 and thumb base joints. Similarly, the bilateral second–fifth DIP, second–fifth PIP and IP1 should be assessed for the classification of interphalangeal OA, whereas the bilateral thumb base joints should be evaluated for the classification of thumb base OA. For the assessment of symptoms in the thumb base, the thumb base area is being assessed as a whole, while radiographic features should be evaluated in the CMC1 joints. Radiographic evaluation of the STT joint is not needed.
Duration of morning stiffness	Morning stiffness is defined as self-reported limitations of joint movement that are present on awakening in the morning. The duration of morning stiffness should be assessed in minutes. The presence of morning stiffness is defined as morning stiffness lasting for at least 1 min. If shorter, no morning stiffness is present. If morning stiffness varies across different hand joints, the target joint with the longest morning stiffness should be considered. Stiffness lasting the whole day should be categorised as 'long' morning stiffness. The question can be asked as an open question asking the candidate for the number of minutes with morning stiffness (with a clear instruction that no morning stiffness should be listed as 0 min) or as one question with three response alternatives, as listed in tables 1–3.
Osteophytes and JSN	The criteria about osteophytes and JSN refer to the number of target joints with bone spurs at the joint margins and narrowing of the joint space between the bone ends, respectively. There is no requirement regarding the number or size of osteophytes or the severity of JSN, meaning that one small osteophyte or mild JSN is sufficient. In the case of uncertainty, a validated atlas should be used as a reference.[24]
Symptom-structure concordance	Symptom-structure concordance is present if the majority (≥50%) of the symptomatic joints demonstrate radiographic findings. A symptomatic joint is defined as pain, aching and/or stiffness present on most days of the previous 6 weeks. A hand diagram should be used to mark the symptomatic joints (online supplemental figure 1). Radiographic OA is defined as either osteophytes and/or JSN, as detailed above.

CMC1, first carpometacarpal; DIPs, distal interphalangeal joints; EULAR, European Alliance of Associations for Rheumatology; IP1, first interphalangeal; JSN, joint space narrowing; OA, osteoarthritis; PIPs, proximal interphalangeal joints; STT, scaphotrapeziotrapezoidal;

interphalangeal OA and in particular thumb base OA involves fewer target joints than for overall hand OA, there was an agreement among experts that less affected joints (and consequently less points) should be needed in order to fulfil the interphalangeal OA and thumb base OA criteria.

In studies with no information about morning stiffness, the experts agreed that the criteria could be applied using a reduced cut-off value (8 of 13 points for classification of overall hand OA and 7 of 13 points for classification of interphalangeal and thumb base OA). There was an excellent agreement regarding the classification of hand OA based on the EULAR criteria on 0–15 scales and the modified EULAR criteria on 0–13 scales that did not incorporate morning stiffness in the phase 1 data set (kappa 0.95–0.99).

Validation of criteria sets

We have described the application of the EULAR and ACR criteria in the HOSTAS, MUST and phase 1 data set in online supplemental table 3. The sensitivity of the EULAR criteria for overall hand OA ranged from 0.57 to 0.74, while the sensitivity of the EULAR criteria for interphanageal and/or thumb base OA ranged from 0.66 to 0.78 (table 5). This sensitivity was similar to the sensitivity of the ACR criteria in the two external cohorts (HOSTAS and MUST) and higher in the phase 1 data set. The EULAR and ACR criteria sets demonstrated similar specificity in MUST and the phase 1 data set (table 5).

In all three cohorts, we compared persons fulfilling the EULAR criteria only and persons fulfilling the ACR criteria only with similar results. In the phase 1 data set, 69 (40.8%) fulfilled both the EULAR criteria for interphalangeal and/or thumb base OA and the ACR criteria and 62 (36.7%) fulfilled none. Comparing 28 (16.6%) persons who fulfilled the EULAR criteria only and 10 (5.9%) persons who fulfilled the ACR criteria only, we found higher average number of target joints with osteophytes (7.2 vs 2.0) and JSN (5.8 vs 1.6) and higher proportion of radiographic OA findings in the thumb base joints (75.0% vs 20.0%) among those fulfilling the EULAR criteria only. We found more frequent bony enlargement in those fulfilling the ACR criteria only (100% vs 14.3% in ≥2 of 10 selected joints, and 100% vs 10.7% in ≥2 DIP joints). None of the persons fulfilling the ACR criteria only had radiographic findings in the majority of symptomatic joints.

DISCUSSION

The proposed EULAR hand OA classification criteria are the final result of an international collaboration based on data-driven and consensus-based approaches, including expert opinion. The criteria are intended for use in clinical trials and observational studies.

The criteria include two mandatory criteria, which means that the criteria should be used in persons with hand symptoms, not better explained by another disease or acute injury. The requirement for hand symptoms is crucial in most clinical trial settings, where an effect on symptoms is often the primary outcome.

There are similarities and differences between the proposed EULAR criteria and the 1990 ACR criteria.[7] While the original paper about the ACR criteria did not specify the duration of symptoms,[7] it was mentioned that pain, aching or stiffness should be present on most days of the prior month in a later review paper.[14] In the proposed EULAR criteria, we require pain, aching and/or stiffness to be present on most days of the previous 6 weeks. A cut-off of 6 weeks was also used in the ACR/EULAR classification criteria for RA.[15] The benefit of the EULAR criteria is the ability to classify hand OA, independent of which DIP and PIP joints are affected, in contrast to the ACR criteria, which mainly concern the second–third DIP and PIP joints. Age and morning stiffness are included in the proposed EULAR criteria, but not in the ACR criteria. Including these features in the criteria set allows persons with higher age (and thus higher risk of hand OA) and short-lived morning stiffness to fulfil the criteria despite limited structural damage.

While the ACR criteria set includes clinical examination features, the proposed EULAR criteria set involves radiographic features. Radiographic features showed better discrimination of hand OA cases and controls than clinical features in phase 1.[9] In line with these results, Cicuttini *et al* showed that radiographic osteophytes were better markers of OA in other joints than clinical nodes.[16] Furthermore, due to poor agreement between clinical nodes and radiographic findings, these features were not interchangeable.[16] According to clinical guidelines,[8 17]

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Table 5 The sensitivity and specificity of the EULAR and ACR classification criteria sets for hand OA

	Sensitivity*	Specificity*†
HOSTAS		
► ACR criteria for hand OA ‡	0.69 (300/433)	–
► EULAR criteria for overall hand OA	0.57 (246/433)	–
► EULAR criteria for interphalangeal OA and/or thumb base OA	0.66 (287/433)	–
MUST		
► ACR criteria for hand OA ‡	0.71 (193/270)	0.63 (211/333)
► EULAR criteria for overall hand OA	0.70 (189/270)	0.63 (209/333)
► EULAR criteria for interphalangeal OA and/or thumb base OA	0.73 (196/270)	0.60 (201/333)
Phase 1 data set		
► ACR criteria for hand OA ‡	0.63 (66/105)	0.80 (51/64)
► EULAR criteria for overall hand OA	0.74 (78/105)	0.78 (50/64)
► EULAR criteria for interphalangeal OA and/or thumb base OA	0.78 (82/105)	0.77 (49/64)

*The sensitivity and specificity were tested in participants with available information about both criteria sets. People with previous surgery of thumb base joint were excluded from analyses since missing information about bony enlargement, deformity and radiographic findings in the thumb base joints would affect the ability to apply the criteria, and in particular the EULAR criteria for thumb base OA.
†When people with psoriasis (n=28 in HOSTAS, n=56 in MUST and n=15 in phase 1 data set) were classified as non-hand OA cases, the specificity of the EULAR criteria for overall hand OA increased from 0.63 to 0.67 in MUST and 0.78 to 0.83 in the phase 1 data set, while the sensitivity decreased from 0.57 to 0.54 in HOSTAS, 0.70 to 0.60 in MUST and 0.74 to 0.67 in the phase 1 data set.
‡Using the traditional format of the clinical ACR criteria, as described by Altman in 1990.[7] In comparison with the ACR clinical criteria, sensitivity analyses of ACR radiographic criteria demonstrated lower sensitivity (0.64) in HOSTAS, similar sensitivity (0.72) and specificity (0.62) in MUST, and higher sensitivity (0.69) and specificity (0.83) in the phase 1 data set.
ACR, American College of Rheumatology; EULAR, European Alliance of Associations for Rheumatology; HOSTAS, Hand OA in Secondary Care Study; MUST, Musculoskeletal pain in Ullensaker STudy; OA, osteoarthritis.

radiographs are not needed for the diagnosis of hand OA. Importantly, these criteria are meant for use in research settings, and not clinical practice. We acknowledge that radiographs may not be feasible in all research settings, and the ACR criteria can still be an option to classify overall hand OA in these settings. Ultrasound may be helpful to detect OA pathology instead of radiographs. However, it is challenging to obtain reliable evaluation of cartilage in finger joints,[18] and we therefore do not recommend to replace radiographs with ultrasound for the assessment of OA pathology.

Prolonged morning stiffness is often considered a sign of inflammatory joint diseases,[19 20] and long morning stiffness was negatively associated with hand OA in phase 1.[9] However, 17% of the participants in HOSTAS had morning stiffness of at least 1 hour, highlighting that long morning stiffness should not preclude the diagnosis of hand OA.[13] The experts thus decided to remove long morning stiffness as an exclusion criterion. Information about morning stiffness is often not available in prior studies of hand OA. Hence, the experts agreed that it should be possible to apply the criteria without this information, using a slightly lower cut-off value for disease classification. The agreement between the original and modified criteria sets was excellent, suggesting a minor impact of this modification. Since the modified criteria sets are more heavily dependent on structural pathology, they may be less sensitive to classify hand OA in populations with less advanced disease. Hence, the experts recommend that morning stiffness should be included in the data collection of future studies and that the modified criteria sets should only be used in studies, in which information about morning stiffness is lacking.

Our experts considered concordance between symptoms and joint pathology important, while this criterion was not included in the ACR criteria. Hand symptoms are common with a wide variety of causes, and it may be challenging to distinguish symptoms from joints versus extraarticular tissues. Hence, our experts were reluctant to include persons with poor concordance between symptoms and radiographic findings in a clinical trial, since their symptoms may be caused by non-OA conditions. Since joints may have early OA pathology despite normal radiographs,[21] the symptom-structure concordance criterion may push our criteria sets towards classification of more advanced disease.

The proposed EULAR criteria are meant for classification of established disease with a limited risk of false positive cases. Our goal was *not* to develop criteria for early symptomatic hand OA, which would have required analyses to differentiate not only hand OA versus mimickers, but also early versus established hand OA. Due to the lack of data on early hand OA symptoms and findings in a stage before the radiographic changes occur, it is challenging to develop criteria for early disease with high sensitivity and specificity. This would have required identification of typical early symptomatic hand OA features through patient surveys, expert surveys and/or additional data collections that were not part of this proposal. It is also important to bear in mind that hand OA differs from knee OA, as many patients have a combination of joints with early and established OA.

A major advantage of the proposed EULAR criteria is their ability to classify interphalangeal OA and thumb base OA separately. For persons with isolated thumb base OA, it is challenging, although not impossible, to fulfil the ACR and the EULAR criteria for overall hand OA. A separate criteria set for this phenotype is thus essential since studies may focus specifically on risk factors or treatments for thumb base OA. The interphalangeal OA criteria are identical to the overall hand OA criteria except that the thumb base joints are not included as target joints, that is, fewer target joints. Hence, the expert panel agreed that it was appropriate to have a slightly lower cut-off value for the classification of interphalangeal OA than for overall hand OA. This allows us to classify interphalangeal and thumb base OA in cases that do not fulfil the criteria for overall hand OA. This is reflected by the higher sensitivity of the criteria when applying the interphalangeal OA and/or thumb base OA criteria compared with the overall hand OA criteria (table 5).

We found better sensitivity and similar specificity of the proposed EULAR criteria compared with the ACR criteria in the phase 1 data set.[9] These results should be treated with caution since we used phase 1 data to inform the development of the criteria. The promising results were supported by comparable sensitivity and specificity of the EULAR and ACR criteria in MUST.[12] The lower specificity of both the EULAR and the ACR criteria in MUST is likely explained by the reference 'self-reported hand OA', as many people may have hand OA despite no diagnosis. In a study of patients with hand OA from secondary care (HOSTAS),[11] the EULAR criteria for interphalangeal and/or thumb base OA demonstrated similar sensitivity as the ACR

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criteria, while the sensitivity of EULAR criteria for overall hand OA was slightly lower. These results are likely a reflection of high proportion of people with isolated thumb base OA. In sensitivity analyses, replacement of bony enlargement with radiographic osteophytes led to decreased sensitivity of the ACR criteria, suggesting that the evaluation of radiographic findings in this cohort was less sensitive than clinical examination. The sensitivity of the ACR criteria in HOSTAS is lower than previously reported due to different definitions of the mandatory criterion (online supplemental table 3).[22] The participants had not indicated whether stiffness and aching were present on most days or not, and these symptoms were therefore not included.

In clinical trials, high specificity is more important than high sensitivity. The proposed EULAR criteria prespecify the exclusion of those with known other causes of hand pain, whereas ACR criteria do not. Other known causes of hand OA such as RA were either representing the control group (phase 1), excluded in advance (HOSTAS) or scarcely reported (MUST). Hence, the testing of validity was performed without classifying those with other conditions as non-hand OA cases. In a general population with hand pain, EULAR criteria would, by definition, have higher specificity. Classifying people with psoriasis as non-hand OA cases led to an increased specificity in our analyses, which exceeded the specificity of the ACR criteria (table 5).

The proposed EULAR criteria clearly have benefits in clinical trials and observational studies. They allow the classification of thumb base OA, which is poorly classified by the ACR criteria unless occurring in combination with interphalangeal OA. Furthermore, radiographic assessment of OA instead of clinical joint assessment may be done centrally by trained readers, and thus with higher reliability.[23] People fulfilling the EULAR criteria only and not the ACR criteria were more likely to have radiographic findings in the majority of symptomatic joints, which is a benefit in clinical trials. The ACR criteria also allow persons to be classified as having OA if they have pain in metacarpophalangeal joints only and clinical features of OA in other joints, which may raise a clinical suspicion of RA.

In conclusion, we have presented the EULAR classification criteria for hand OA based on rigorous methodology by international experts. Separate criteria were developed for overall hand OA and two phenotypes (interphalangeal OA and thumb base OA), which may facilitate the entry of suitable candidates most likely to benefit from specific therapies in clinical trials and more homogenous populations in observational studies. Future studies with a control group without OA are needed for further validation of these criteria.

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