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SYSTEMATIC REVIEW

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Rheumatoid Arthritis referral criteria: systematic review of the literature

João Madruga Dias[1,2,3,8*], Raquel Ribeiro[4], Teresa Costa[1], Sofia Silvério Serra[1], Sónia Silva[4], Annamaria Iagnocco[5], Helena Canhão[1,6] and Fernando Pimentel-Santos[2,7]

Abstract

Introduction Timely referral in Rheumatoid Arthritis (RA) is critical for early diagnosis and initiation of treatment, which are crucial to improve patient outcomes and limit radiographic progression. Optimized referral criteria, whether applied by clinicians or healthcare artificial intelligence systems, can facilitate faster and more accurate decisions regarding patient assessment by a Rheumatologist. Despite this need, a validated and widely adopted referral tool for RA is still lacking.

Objective To compile and analyse all available RA referral criteria since January 2001 until October 2023.

Methods We searched PubMed, Scopus and Web of Science in the considered period, using a defined set of strings. Studies were only included if they provided RA referral criteria or Inflammatory/Early Arthritis criteria directed at RA diagnosis.

Results We identified 19 publications. Most include symptoms in referral criteria, either arthralgia or stiffness (63%) and only 16% considered constitutional symptoms such as fever, fatigue or weight loss. However, the most prevalent criteria for referral is swollen joints (79%), while tender joints are included in 63% and squeeze test assessment in 33%. Regarding laboratory tests, rheumatoid factor is considered in 53% of referral criteria, while ACPA in 32%. Nearly half of the referral criteria consider inflammatory markers (CRP and/or ESR). Family history is present in 21% of the cases.

Discussion Published RA referral criteria encompass several components (symptoms, signs, laboratory and family history), but none were validated in a large cohort of patients. The vast majority, were either part of recommendations, published guidelines or based in expert opinion. There is an unmet need for evidence-based validated RA referral criteria.

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Keywords: Rheumatoid arthritis, Early arthritis, Referral, Criteria, Systematic review, Primary care

*Correspondence:
João Madruga Dias
joao_alexandre@hotmail.com
[1]CHRC, NOVA Medical School, Universidade Nova de Lisboa, Lisbon, Portugal
[2]iNOVA4Health, NOVA Medical School, Universidade Nova de Lisboa, Lisbon, Portugal
[3]Rheumatology Department, Unidade Local de Saúde Médio Tejo, Torres Novas, Portugal
[4]USF Barquinha, Unidade Local de Saúde Médio Tejo, Vila Nova da Barquinha, Portugal
[5]Academic Rheumatology Centre, Università degli Studi di Torino, Turin, Italy
[6]Rheumatology Unit, Unidade Local de Saúde São José, Hospital Santo António dos Capuchos, Lisbon, Portugal
[7]Rheumatology Department, Unidade Local de Saúde Lisboa Ocidental, Hospital de Egas Moniz, Lisbon, Portugal
[8]Centro Clínico Académico de Lisboa, Lisboa, Portugal

Introduction

Referral criteria for Rheumatoid Arthritis (RA) are useful for early disease diagnosis and treatment, which leads to better disease outcomes [1]. Some studies suggest better outcome for patients early referred (within 3 months) to Rheumatology appointments, which seems to lead to less frequent orthopaedic surgery [2] and more frequent prolonged (≥ 1 year) drug-free remission [3]. Compared to early referral patients those referred beyond 12 weeks had a higher rate (1.3-fold) of radiographic progression [3]. Nevertheless there is a lack of a validated tool for referring patients with early arthritis [4, 5]. Primary care seems to be a major contributor to overall delays between symptom onset and the first rheumatology visit, since general practitioners (GP) have barriers in identifying patients with early RA due to often non-specific nature of symptoms [6]. Patient delay (including acute persistent symptoms vs. palindromic insidious symptoms, usage of alternative therapies and over-the-counter drugs) and hospital delay are other relevant contributors [6].

It is possible that in a near future Artificial Intelligence will be useful in doing part of clinical work and patient evaluation [7]. A good algorithm might provide a more accurate pinpointing of a potential pathology, helping diagnosis. If RA referral criteria are effective, they would allow either the clinician or the AI machine to adequately propose the RA diagnosis in a high proportion of cases, based in clinical history and physical examination data and/or retrieval of already existing demographic and clinical data.

The objective of this systematic review is to compile and analyse all available RA referral criteria since the year 2001.

Methods

Search criteria

PICO (problem, intervention, comparison, outcome) process and PRISMA 2020 Checklist [8] were used to help elaborate this review. We searched PubMed, Scopus and Web of Science databases to identify any article published after 1st of January 2001 until the 24th and 25th October 2023 when the search was performed, using the following strings:

The search criteria, eligibility and exclusion criteria were established before the literature search was performed and any data extracted. An EMBASE search was initially registered in PROSPERO protocol, but due to subscription availability at the academic centre it was replaced by Scopus.

Eligibility criteria

Studies were only included in this review if they provided Rheumatoid Arthritis referral criteria or Inflammatory / Early Arthritis criteria directed at RA diagnosis. There was no language restriction.

Exclusion criteria

Studies with generic referral criteria to Rheumatology or a full range of diseases without specific RA-directed criteria were not included, as they are not disease specific. Studies involving only patient self-report questionnaires were not included as they are more directed towards patient than clinician assessment. In addition, studies concerning screening for the general population with/without observation of patients by Rheumatologists, before any GP observation, were also not included as they are not in the scope of this review.

Paper identification and selection

Two reviewers, a consultant Rheumatologist and a GP trainee, independently selected articles based on title and abstract. Articles were selected blindly and independently using Rayyan Professional online software. After this initial screening, an online videoconference was performed to confirm the inclusion or exclusion of articles with diverging opinions based on the first selection. To resolve disagreements between reviewers, both would read revaluate the abstract and if necessary the full article was retrieved for further enquiry. After this first selection process, the retrieval of the full articles was performed, with subsequent selection based on the entire article content. This was done independently by both reviewers using Rayyan Professional. After this second selection, another online videoconference was performed to confirm selection results. A search using the references present in the selected articles allowed inclusion of four additional articles for this review.

Evaluation of observational studies and guidelines

ROBINS-I (Risk Of Bias In Non-randomised Studies - of Interventions) [9] was used to evaluate bias in observational studies, while AGREE II (Appraisal of Guidelines

PubMed	"inflammatory arthritis"[All Fields] OR "arthritis, rheumatoid"[MeSH Terms] OR "rheumatoid arthritis"[All Fields] OR "early arthritis"[All Fields] Filter: Humans	AND	"early referral*"[All Fields] OR "reducing delay*"[All Fields] OR "referring patient*"[All Fields] OR "patient referral"[All Fields] OR "early diagnos*"[All Fields]
Scopus	TITLE-ABS-KEY ("inflammatory arthritis" OR "rheumatoid arthritis" OR "early arthritis")	AND	TITLE-ABS-KEY ("early referral*" AND patient*)
Web of Science	"inflammatory arthritis"(Topic) OR "rheumatoid arthritis"(Topic) OR "early arthritis"(Topic)	AND	"early referral*"(Topic) OR "reducing delay*"(Topic) OR "referring patient*"(Topic) OR "patient referral"(Topic)

for Research and Evaluation) [10] instrument as applied to assess the quality of clinical guidelines. The ROBINS-I tool assesses risk of bias across seven key domains: confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. Each domain was judged by two independent reviewers as having low, moderate, serious, or critical risk of bias, or noted as having insufficient information, with disagreements resolved through discussion. (Fig. 1) AGREE II consists of 23 items organized within six domains, each capturing a specific aspect of guideline quality rated on a seven-point scale from 1 (strongly disagree) to 7 (strongly agree): scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability, editorial Independence. A quality score was calculated for each of the six domains, which were independently scored by two independent reviewers. Domain scores were calculated by summing all the scores of items in that domain and then representing the total as a percentage of the maximum possible score for that specific domain.

Data collection

After article selection, one reviewer (JMD) collected data from each selected article. In order to obtain and confirm relevant data, focus was given on unambiguous referral criteria that could be applied to a general population, avoiding local idiosyncrasies. All criteria from each article were collected, with the most frequent ones grouped as symptoms, signs, laboratory, and family history. No automation tools were used to collect data and no software was used to extract data from figures. No articles required translation into another language to enable data collection. There were no multiple reports corresponding to a single study.

Results

The selection criteria in the initial search strategy allowed the identification of 560 references from PubMed, Scopus and Web of Science. We excluded 123 duplicates, leaving 437 papers to be screened. Of those in total 422 were excluded by both reviewers since they were not within the scope of this review and/or had absence of RA referral criteria in the text. Four articles were included by citation search. In total we identified and selected 19 papers since 2001 until 2023 (incomplete year) (Fig. 1). More than half (53%) of the analysed criteria were specifically directed at RA, while the remainder used the term early arthritis or inflammatory arthritis, but having as the main objective, to target RA. Two articles considered spondyloarthritis as well as RA, but allowing the differentiation between both diagnoses. Little over half of the selected articles were guidelines (10; 53%), of which half were evidence-based. The 9 remainder studies were observational with high variability in the design, criteria and number

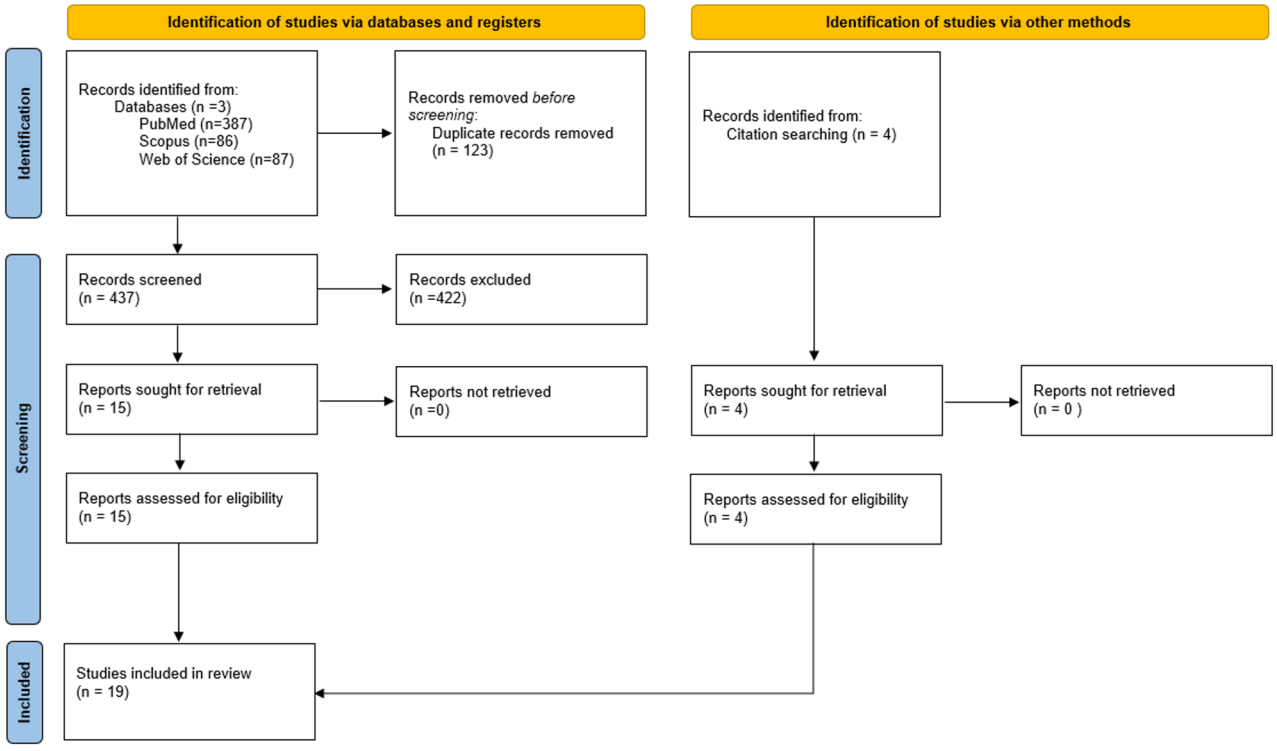

Fig. 1 PRISMA flow diagram

Table 1 Scores on all subscales of the AGREE II instrument of the selected guidelines. Results are presented in percentages

	Scope and purpose	Stakeholder involvement	Rigour of development	Clarity of presentation	Applicability	Editorial independence	Overall
Diagnosis of early rheumatoid arthritis: what the on-specialist needs to know.	95,2	61,9	36,7	90,5	25,0	14,3	57,1
Are early arthritis clinics necessary?	76,2	61,9	53,1	81,0	32,1	85,7	57,1
EULAR recommendations for the management of early arthritis: report of a task force of the European Standing Committee for International Clinical Studies Including Therapeutics (ESCISIT)	95,2	76,2	87,8	95,2	57,1	92,9	85,7
Management of rheumatoid arthritis: summary of NICE guidance.	100,0	95,2	100,0	100,0	92,9	100,0	100,0
Quality-of-care standards for early arthritis clinics	95,2	76,2	77,6	85,7	64,3	50,0	71,4
2016 update of the EULAR recommendations for the management of early arthritis	100,0	95,2	98,0	100,0	85,7	100,0	100,0
EULAR definition of arthralgia suspicious for progression to rheumatoid arthritis	100,0	90,5	89,8	81,0	42,9	92,9	85,7
City and Hackney Rheumatology Guidelines for Early Inflammatory Arthritis	100,0	71,4	28,6	90,5	42,9	35,7	57,1

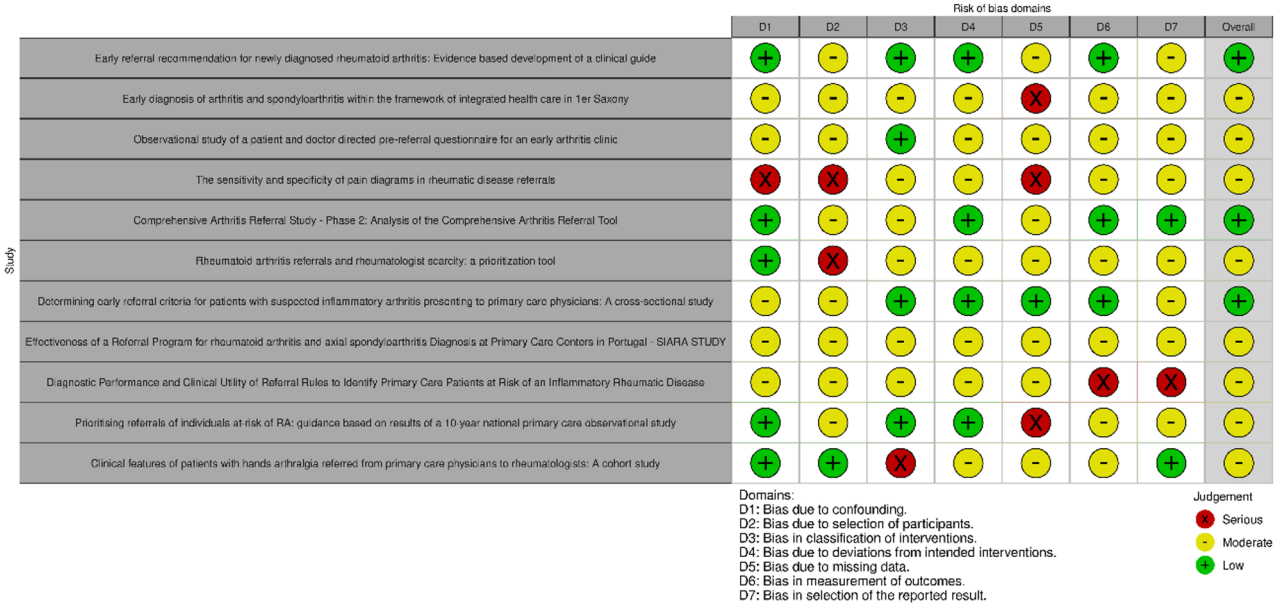

Fig. 2 Results of ROBINS-I assessment for all included observational studies

of patients included. Most (7 out of 9) of these observational studies were published in the last decade.

All included guidelines scored more than 50% on the AGREE II instrument subscale methodology. Table 1 presents quality scores of these guidelines, the scores on all subscales of the AGREE II instrument. There was variability in the domains that were effectively addressed by the guidelines, especially rigour of development, applicability and editorial independence. Among the included observational studies, the risk of bias as assessed using the ROBINS-I tool, was rated as low in three studies and moderate in eight (Fig. 2).

In order to improve systematization and enhance the objectiveness of the analysis we divided results into

symptoms, objective examination, laboratory tests and family history. Those were the most common variables found in the articles retrieved.

Most of the analysed published criteria include symptoms, either arthralgia or stiffness (Table 2). The arthralgia criterion mostly concerned hands and/or feet, while in some studies this criterion considered any joint. Stiffness varied between 30 and 60 min of minimum duration. Either arthralgia or stiffness were considered in almost two thirds (63%) of the analysed criteria and also in almost two thirds of the criteria both were simultaneously considered (63%). Only 16% of the criteria considered constitutional symptoms such as fever, fatigue or weight loss (Table 3).

Most criteria (79%) include swollen joints (with a variable minimum number between 1 and 3), that being the most prevalent criteria for referral. None of the criteria used ultrasonography or other imaging modality for synovitis assessment, being defined according to clinical examination alone. Tender joints are included in almost two thirds (63%) of referral criteria, with squeeze test mentioned as a possible modality of assessment in little under a third (32%) of these criteria.

Regarding laboratory tests rheumatoid factor was a criteria in almost half (53%) of referral criteria, while ACPA were used in nearly one third (32%). It is worth noting that no criteria previous to 2009 have ACPA as referral criterion and all those who suggest ACPA also suggest rheumatoid factor. Nearly half of the studies (47%) consider inflammatory markers (CRP and/or ESR) as criteria.

Family history is only considered in little above one fifth (21%) of the criteria.

Behind these criteria, two studies refer to paraesthesia of the hands (only one mentions carpal tunnel syndrome specifically) and other two consider the circadian rhythm of the symptoms. Only one study considered NSAID response and another study went as far as to determine the most commonly affected joints: 2nd and 5th metacarpophalangeal (MCP), 2nd and 3rd proximal interphalangeal (PIP) and wrists.

Other variables used were symmetry, paraesthesia, and other functional inquiries (fist clenching, shaking hands, for example).

Discussion

More than two decades ago, Rheumatology practice faced the emergence of early arthritis clinics, which played a pivotal role in the early detection and treatment of rheumatic diseases. However the clinical landscape has evolved significantly since then. Increased awareness among GPs [28] and patients [29] combined with the widespread availability of online information, has empowered an increasingly technologically literate population. While early diagnosis and treatment remain essential [1], advancements in healthcare-oriented algorithms and AI provide new opportunities to support clinical decision-making [30].

These changes prompt a reconsideration of the need for dedicated early arthritis clinics, as general rheumatology clinics with optimized referral systems and improved patient access may serve as a more viable alternative.

The ROBINS-I assessment showed a predominantly moderate risk of bias for most articles included in this review, with a low risk in three articles. The AGREE II instrument allowed the verify that the scope and purpose, clarity of presentation and stakeholder involvement of the included articles was generally very high, while applicability, rigour of development and editorial independence had more varied results.

Good referral criteria are essential for the early identification of rheumatoid arthritis (RA) and timely clinical decision-making. Although various referral criteria for RA exist, few have been validated in large, multinational patient cohorts. Most available criteria are based on expert opinions, recommendations, or guidelines rather than evidence-based validation. This highlights the pressing need to establish validated referral criteria for RA.

Our review suggests that certain symptoms, such as arthralgia and morning stiffness, should be prioritized, as they are more specific than constitutional symptoms like fatigue, fever, or weight loss. While features such as symmetry, paraesthesia, and functional limitations may provide additional information, they are seldom included in referral criteria and may compromise specificity. Defining which joints to focus on is crucial, with particular attention to the hands and feet, including metacarpophalangeal (MCP), proximal interphalangeal (PIP), and metatarsophalangeal (MTP) joints.

Morning stiffness, a key symptom, requires standardization regarding its duration (e.g., 30–60 min) for inclusion in referral criteria. Among objective criteria, swollen and tender joint identification remains vital. Improving GP training — both pre-graduate and post-graduate — can address challenges in arthritis recognition. Simple tools like the squeeze test may enhance diagnostic accuracy, though further refinement is needed.

Laboratory tests, such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), are widely accepted as part of referral criteria due to their low cost and accessibility. Autoantibodies, such as anti-citrullinated protein antibodies (ACPA) and rheumatoid factor (RF), have become more widely available and are now considered essential components of referral criteria [31]. These tests can be seamlessly integrated into automated algorithms, leveraging digital health systems to support clinicians.

Family history, although not part of current RA classification criteria, is gaining attention in recent literature

Table 2 Information about each Article included in this review, including year of publication, if it focuses on RA or IA/EA, and specific criteria used. EA – early arthritis; IA – inflammatory arthritis, RA - rheumatoid arthritis; SJ – swollen joints; TJ – tender joints; RF – rheumatoid factor, ACPA - anti–citrullinated peptide antibody; ESR – erythrocyte sedimentation rate; CRP – C-reactive protein

				Symptoms			Objective examination			Laboratory tests				
	Publication year	Article type	RA/EA/IA	Arthralgia	Stiffness	Constitutional symptoms	SJ	TJ	Squeeze test	RF	ACPA	ESR	CRP	Family History
Early referral recommendation for newly diagnosed rheumatoid arthritis: Evidence based development of a clinical guide [11]	2002	Evidence-Based Guidelines	RA	no	yes	no	yes	yes	yes	yes	no	yes	yes	no
Diagnosis of early rheumatoid arthritis: what the on-specialist needs to know. [12]	2004	Guidelines	RA	yes	yes	yes	yes	yes	no	yes	no	yes	yes	no
Are early arthritis clinics necessary? [13]	2005	Guidelines	EA	yes	yes	no	yes	yes	no	no	no	no	no	yes
Early diagnosis of arthritis and spondyloarthritis within the framework of integrated health care in Lower Saxony [14]	2006	Guidelines	RA	no	no	no	yes	no	no	no	no	yes	yes	no
EULAR recommendations for the management of early arthritis: report of a task force of the European Standing Committee for International Clinical Studies Including Therapeutics (ESCISIT) [15]	2007	Evidence-Based Guidelines	EA	no	yes	no	yes	yes	yes	no	no	no	no	no
Observational study of a patient and doctor directed pre-referral questionnaire for an early arthritis clinic [16]	2007	Observational	EA	no	yes	yes	yes	no	no	yes	no	yes	yes	no
Management of rheumatoid arthritis: summary of NICE guidance. [17]	2009	Evidence-Based Guidelines	RA	no	no	no	yes	no	no	yes	yes	yes	yes	no
The sensitivity and specificity of pain diagrams in rheumatic disease referrals. [18]	2012	Observational	RA	yes	no	no	no	no	no	no	no	no	no	no
Quality-of-care standards for early arthritis clinics [19]	2013	Survey-based Guidelines	EA	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	no
Comprehensive Arthritis Referral Study — Phase 2: Analysis of the Comprehensive Arthritis Referral Tool [20]	2014	Observational	IA	yes	yes	no	yes	yes	no	yes	no	no	no	no
Rheumatoid arthritis referrals and rheumatologist scarcity: a prioritization tool. [21]	2015	Observational	RA	yes	no	no	yes	yes	no	yes	yes	yes	yes	no
2016 update of the EULAR recommendations for the management of early arthritis [5]	2016	Evidence-Based Guidelines	EA	yes	yes	no	yes	no	no	no	no	no	no	no
Determining early referral criteria for patients with suspected inflammatory arthritis presenting to primary care physicians: A cross-sectional study [22]	2017	Observational	IA	no	no	no	yes	no	no	yes	yes	no	no	no
EULAR definition of arthralgia suspicious for progression to rheumatoid arthritis [4]	2017	Evidence-Based Guidelines	RA	yes	yes	no	no	yes	yes	no	no	no	no	yes
Effectiveness of a Referral Program for rheumatoid arthritis and axial spondyloarthritis Diagnosis at Primary Care Centers in Portugal - SIARA STUDY [23]	2018	Observational	RA	no	no	no	yes	yes	yes	no	no	yes	yes	no
City and Hackney Rheumatology Guidelines for Early Inflammatory Arthritis [24]	2019	Guidelines	EA	yes	yes	no	yes	yes	no	yes	yes	yes	yes	no
Diagnostic Performance and Clinical Utility of Referral Rules to Identify Primary Care Patients at Risk of an Inflammatory Rheumatic Disease. [25]	2022	Observational	IA	yes	yes	yes	yes	yes	no	no	no	no	no	yes

Table 2 (continued)

			Symptoms			Objective examination			Laboratory tests				
	Publication year	Article type	RA/EA/IA	Arthralgia	Stiffness	Constitutional symptoms	SJ	TJ	Squeeze test	RF	ACPA	ESR	CRP	Family History
Prioritising referrals of individuals at-risk of RA: guidance based on results of a 10-year national primary care observational study. [26]	2022	Observational	RA	yes	no	no	no	no	no	yes	yes	no	no	no
Clinical features of patients with hands arthralgia referred from primary care physicians to rheumatologists: A cohort study [27]	2023	Observational	RA	yes	yes	no	no	yes	yes	no	no	no	no	yes

due to the genetic component of RA, with individuals with first-degree relatives with RA having a 4.52-fold (95% CI 3.98, 5.12) increased risk of disease [32, 33]. Future advancements in affordable genetic analysis may further underscore the importance of family history in referral criteria. While some patients might be able to accurately know what type of arthritis affects a family member, digital health systems could facilitate access to such information, enabling its incorporation into diagnostic algorithms.

Imaging plays a crucial role in the diagnosis and management of RA, contributing to the detection of inflammation, structural damage, disease activity and even predicting outcome and response to treatment, progression and remission [34]. Common radiographs could enhance the specificity of referral criteria, identifying erosions and allowing the application of radiographic scores. AI may contribute to increase specificity of referral criteria by automated retrieval of existing radiograph images of hand and feet of patients and even AI image analysis towards erosions and radiographic scores [35]. However, modalities like ultrasonography and MRI are superior in detecting synovitis before structural damage occurs, but remain limited in accessibility within primary care settings. In some regional and national settings, the timing of imaging studies prior to rheumatology referral can represent a practical limitation in current clinical practice. Until these technologies become more universally available, referral criteria will rely primarily on symptoms, objective findings, and laboratory results.

Despite efforts to ensure a comprehensive search, there remains a possibility that relevant studies were not identified due to being indexed elsewhere, or due to variations in indexing across databases or the use of alternative terminology not captured by our search strategy. To strengthen the robustness of the review, two reviewers with complementary clinical perspectives — Rheumatology and General Practice — independently assessed study inclusion and exclusion. While this approach increases the breadth and depth of interpretation, it also introduces potential for subjective variation in the application of criteria. We addressed this by conducting joint discussions and evaluations of each abstract and article at two different time points, which we believe helped to reduce inconsistency. Additionally, some data extraction was performed manually, which inherently carries a risk of human error, although efforts were made to minimize inaccuracies through careful cross-checking.

Validated referral criteria for RA must integrate multiple components: symptom-based criteria, clinician-dependent objective criteria, laboratory and imaging data. Digital tools and AI can streamline the referral process by automating data collection, analysis, and integration [36]. By incorporating patient-reported symptoms,

Table 3 Absolute frequency and percentage of articles with the studied criteria

		Symptoms				Objective examination			Laboratory tests				
19 selected articles	**Observational studies**	**RA only**	**Arthralgia**	**Stiffness**	**Constitutional symptoms**	**SJ**	**TJ**	**Squeeze test**	**RF**	**ACPA**	**ESR**	**CRP**	**Family History**
Absolute frequency	9	10	12	12	3	15	12	6	10	6	9	9	4
percentage	47%	53%	63%	63%	16%	79%	63%	32%	53%	32%	47%	47%	21%

RA - rheumatoid arthritis; SJ – swollen joints; TJ – tender joints; RF – rheumatoid factor, ACPA - anti–citrullinated peptide antibody; ESR – erythrocyte sedimentation rate; CRP – C-reactive protein

enhanced GP training, and accessible laboratory and imaging data, referral systems can ensure earlier and more accurate diagnosis. Optimizing referral criteria and embracing technological advancements will ultimately improve patient outcomes and drive the future of rheumatology practice.

Abbreviations

EA	Early arthritis
IA	Inflammatory arthritis
RA	Rheumatoid arthritis
SJ	Swollen joints
TJ	Tender joints
MCP	Metacarpophalangeal
PIP	Proximal interphalangeal
MTP	Metatarsophalangeal
RF	Rheumatoid factor, ACPA–anti–citrullinated peptide antibody
ESR	Erythrocyte sedimentation rate
CRP	C–reactive protein
GP	General practitioners
ROBINS	I–Risk Of Bias In Non–randomised Studies–of Interventions
AGREE II	Appraisal of Guidelines for Research and Evaluation
PICO	Problem, intervention, comparison, outcome
PRISMA	Preferred Reporting Items for Systematic reviews and Meta–Analyses

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None.

Author contributions
JMD, HC and FPS conceptualized the study. JMD, TC and SSS developed database selection, search queries, collected the data and helped in result analysis and interpretation. JMD, RR and SS analyzed and interpreted the results, selected and reviewed abstracts and articles. JMD performed the statistical analysis and drafted and revised all versions of the article. All authors have revised the various versions of the article. All authors have approved the article's final version for submission.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Since this is a systematic review of the literature, no ethics approval was necessary in our institutions and consent for publication is not applicable.

Consent for publication
Not applicable.

Registration and protocol
Register name and number: Rheumatoid Arthritis referral criteria: systematic review of the literature at the advent of healthcare artificial intelligence; PROSPERO CRD42024499423

Competing interests
The authors declare no competing interests.

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References

1. Smolen JS, Landewé RB M, Anne Bergstra S, Kerschbaumer A, Sepriano A, Aletaha D, et al. EULAR recommendations for the management of rheumatoid arthritis with synthetic and biological disease-modifying antirheumatic drugs: 2022 update. Ann Rheum Dis [Internet]. 2023 [cited 2023 Dec 31];82:3–18. Available from: http://ard.bmj.com/
2. Feldman DE, Bernatsky S, Houde M, Beauchamp ME, Abrahamowicz M. Early consultation with a rheumatologist for RA: does it reduce subsequent use of orthopaedic surgery? Rheumatol (United Kingdom). 2013;52(3):452–9.
3. Van Der Linden MPM, Le Cessie S, Raza K, Van Der Woude D, Knevel R, Huizinga TWJ, et al. Long-term impact of delay in assessment of patients with early arthritis. Arthritis Rheum. 2010;62(12):3537–46.
4. Van Steenbergen HW, Aletaha D, Beaart-Van De Voorde LJJ, Brouwer E, Codreanu C, Combe B, et al. EULAR definition of arthralgia suspicious for progression to rheumatoid arthritis. Ann Rheum Dis. 2017;76(3):491–6.
5. Combe B, Landewe R, Daien CI, Hua C, Aletaha D, Álvaro-Gracia JM, et al. 2016 update of the EULAR recommendations for the management of early arthritis. Ann Rheum Dis [Internet]. 2017 Jun 1 [cited 2021 Nov 21];76(6):948–59. Available from: https://ard.bmj.com/content/76/6/948
6. Stack RJ, Nightingale P, Jinks C, Shaw K, Herron-Marx S, Horne R, et al. Delays between the onset of symptoms and first rheumatology consultation in patients with rheumatoid arthritis in the UK: an observational study. BMJ Open [Internet]. 2019 Mar 1 [cited 2021 Nov 21];9(3):e024361. Available from: https://bmjopen.bmj.com/content/9/3/e024361
7. Hü Gle M, Omoumi P, Van Laar JM, Boedecker J, Hü Gle T. Applied machine learning and artificial intelligence in rheumatology. Available from: https://academic.oup.com/rheumap
8. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372.
9. Lin MX, Wang C. Superb microvascular imaging evaluating joint lesion scores in rheumatoid arthritis compared with power doppler imaging: a meta-analysis. Medicine (Baltimore) [Internet]. 2020 Sep 11 [cited 2021 Nov 21];99(37):e22185. Available from: https://pubmed.ncbi.nlm.nih.gov/32925790/
10. Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, et al. The global rating scale complements the AGREE II in advancing the quality of practice guidelines. J Clin Epidemiol. 2012;65(5):526–34.
11. Emery P, Breedveld FC, Dougados M, Kalden JR, Schiff MH, Smolen JS. Early referral recommendation for newly diagnosed rheumatoid arthritis: evidence based development of a clinical guide. Ann Rheum Dis [Internet]. 2002 Apr 1 [cited 2021 Nov 21];61(4):290–7. Available from: https://ard.bmj.com/content/61/4/290
12. Suresh E. Diagnosis of early rheumatoid arthritis: what the non-specialist needs to know. J R Soc Med. 2004;97(9):421–4.

13. Quinn MA, Emery P. Are early arthritis clinics necessary? Best Pract Res Clin Rheumatol. 2005;19(1):1–17.
14. Hülsemann J, Mattussek S, Siegmund-Schultze E, Zeidler H. Frühdiagnose von arthritiden und spondyloarthritiden Im Rahmen einer integrierten versorgung in Niedersachsen. Z Rheumatol. 2006;65(1):70–4.
15. Combe B, Landewe R, Lukas C, Bolosiu HD, Breedveld F, Dougados M, et al. EULAR recommendations for the management of early arthritis: report of a task force of the European standing committee for international clinical studies including therapeutics (ESCISIT). Ann Rheum Dis. 2007;66(1):34–45.
16. Arndt U, Behrens F, Ziswiler HR, Kaltwasser JP, Möller B. Observational study of a patient and Doctor directed pre-referral questionnaire for an early arthritis clinic. Rheumatol Int. 2007;28(1):21–6.
17. Deighton C, O'Mahony R, Tosh J, Turner C, Rudolf M. Management of rheumatoid arthritis: summary of NICE guidance. BMJ. 2009;338(March):1–5.
18. Caines A, Samadi N, Ouimet G, Thompson A, Pope JE. The sensitivity and specificity of pain diagrams in rheumatic disease referrals. Rheumatol (United Kingdom). 2012;51(6):1093–8.
19. Ivorra JAR, Martínez JA, Lázaro P, Navarro F, Fernandez-Nebro A, De Miguel E, et al. Quality-of-care standards for early arthritis clinics. Rheumatol Int. 2013;33(10):2459–72.
20. Thompson AE, Haig SL, LeRiche NGH, Rohekar G, Rohekar S, Pope JE. Comprehensive arthritis referral study - Phase 2: analysis of the comprehensive arthritis referral tool. J Rheumatol. 2014;41(10):1980–9.
21. Cummins LL, Vangaveti V, Roberts LJ. Rheumatoid arthritis referrals and rheumatologist scarcity: A prioritization tool. Arthritis Care Res. 2015;67(3):326–31.
22. Almoallim H, Janoudi N, Attar SM, Garout M, Algohary S, Siddiqui MI, et al. Determining early referral criteria for patients with suspected inflammatory arthritis presenting to primary care physicians: A cross-sectional study. Open Access Rheumatol Res Rev. 2017;9:81–90.
23. Fonseca JE, Pereira da Silva JA, Bernardes M, Cernadas R, Canas da Silva J, Costa L, et al. Effectiveness of a referral program for rheumatoid arthritis and axial spondyloarthritis diagnosis at primary care centers in Portugal – SIARA STUDY. Acta Reumatol Port. 2018;43(1):40–51.
24. City and Hackney Rheumatology Guidelines for Early Inflammatory Arthritis. 2019;(September):2019. Available from: https://gp-website-cdn-prod.s3.amazonaws.com/pathway-downloads/1523535406-327026a45b58714313dced1dc8ef694b.pdf
25. van Delft ETAM, Barreto DL, van der Helm-van Mil AHM, Alves C, Hazes JMW, Kuijper TM, et al. Diagnostic performance and clinical utility of referral rules to identify primary care patients at risk of an inflammatory rheumatic disease. Arthritis Care Res. 2022;74(12):2100–7.
26. Garcia-Montoya L, Nam JL, Duquenne L, Villota-Eraso C, Di Matteo A, Hartley C, et al. Prioritising referrals of individuals at-risk of RA: guidance based on results of a 10-year national primary care observational study. Arthritis Res Ther [Internet]. 2022;24(1):1–11. Available from: https://doi.org/10.1186/s13075-022-02717-w
27. Figueroa-Parra G, Castañeda-Martinez MM, Herrera-Sandate P, Castañeda-Martinez DD, Esquivel-Valerio JA, Vega-Morales D. Clinical features of patients with hands arthralgia referred from primary care physicians to rheumatologists: a cohort study. Reumatol Clínica. 2023.
28. Yailian A-L, Estublier C, Fontana A, Vignot E, Confavreux C, Chapurlat R, et al. Practices among general practitioners in rheumatoid arthritis (GEPRA-I): results of a region-wide online survey. BMC Prim Care. 2022;23(1):144.
29. Thomas J, Bansback N, Barber C, Wells G, Hazlewood G. Personalized medicine in rheumatoid arthritis: combining biomarkers and patient preferences to guide therapeutic decisions. Best Pract Res Clin Rheumatol. 2022;36(4):101812.
30. Momtazmanesh S, Nowroozi A, Rezaei N. Artificial Intelligence in rheumatoid arthritis: current status and future perspectives: a state-of-the-art review. Rheumatol Ther [Internet]. 2022;9(5):1249–304. Available from: https://doi.org/10.1007/s40744-022-00475-4
31. Martin L, Steber A, Lupton W, Mahler TL, Fitch M, McMillan CM, et al. JD,. Clinical and serological analysis of patients with positive anticyclic citrullinated Peptide antibodies referred through a Rheumatology Central Triage System. J Rheumatol [Internet]. 2015 May 1 [cited 2021 Dec 13];42(5):771–7. Available from: https://pubmed.ncbi.nlm.nih.gov/25641884/
32. Padyukov L. Genetics of rheumatoid arthritis. Semin Immunopathol. 2022;44(1):47–62.
33. Kim HJ, Swan H, Kazmi SZ, Hong G, Kim YS, Choi S, et al. Familial risk of seropositive rheumatoid arthritis and interaction with smoking: a population-based cohort study. Rheumatology (Oxford). 2023;62(9):3006–13.
34. Colebatch AN, Edwards CJ, Østergaard M, Van Der Heijde D, Balint PV, D'Agostino MA, et al. EULAR recommendations for the use of imaging of the joints in the clinical management of rheumatoid arthritis. Ann Rheum Dis. 2013;72(6):804–14.
35. Bird A, Oakden-Rayner L, McMaster C, Smith LA, Zeng M, Wechalekar MD, et al. Artificial intelligence and the future of radiographic scoring in rheumatoid arthritis: a viewpoint. Arthritis Res Ther [Internet]. 2022;24(1):1–10. Available from: https://doi.org/10.1186/s13075-022-02972-x
36. Tarakci Fatih OI, Ali Y, Sema T, Dilek. Diagnosing rheumatoid arthritis disease using fuzzy expert system and machine learning techniques. J Intell Fuzzy Syst [Internet]. 2022;44(4):5543–57. Available from: https://journals.sagepub.com/action/showAbstract

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