

Performance of the ASAS Classification Criteria for Axial and Peripheral Spondyloarthritis - A Systematic Literature Review and Meta-Analysis

Supplementary material

1. Search strategy

Online Supplementary Table S1. PICO

Patients	Adult (≥ 18 years) patients with i) chronic (>3 months) back pain of unknown origin (no definite diagnosis) with an age of onset below 45 years, with or without peripheral symptoms; ii) peripheral arthritis and/or enthesitis and/or dactylitis and absence of current back pain with only suspicion of SpA but no definitive diagnosis; iii) patients with clinical suspicion of SpA regardless of the presentation.
Intervention	The axSpA (including 'imaging arm' and 'clinical arm' separately), pSpA or the entire set of the ASAS SpA classification criteria.
Comparator	Rheumatologist's diagnosis
Outcome	Sensitivity, specificity, LR+, LR- of the ASAS axSpA (including 'imaging arm' and 'clinical arm' separately), pSpA and of the entire set.

ASAS, Assessment of SpondyloArthritis international Society; axSpA, axial spondyloarthritis; pSpA, peripheral spondyloarthritis; positive likelihood ratio (LR+); negative LR (LR-).

Online Supplementary Text 1

1.1 MEDLINE

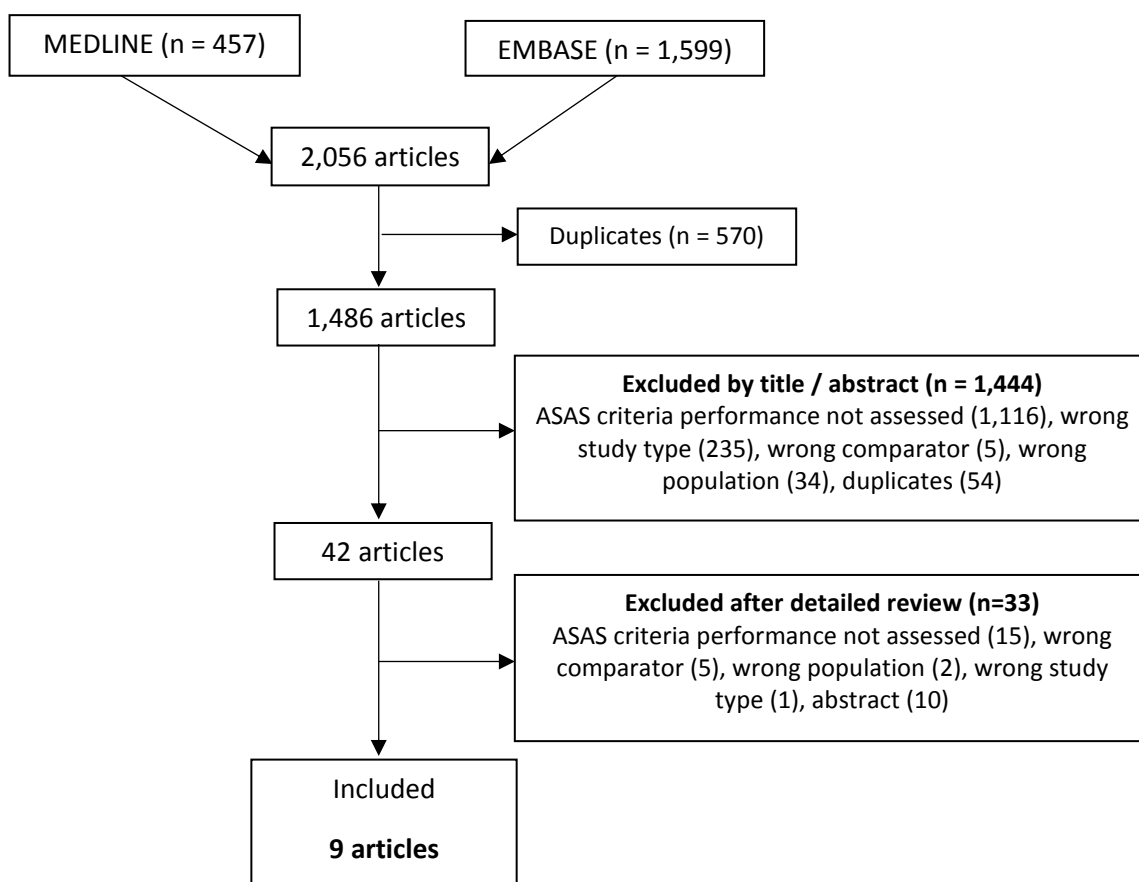
1. "ASAS".mp.
2. "Assessment of SpondyloArthritis international Society".mp.
3. 1 or 2
4. "standards".fs.
5. "standards".mp.
6. "criteria".mp.
7. exp "sensitivity and specificity"/
8. "sensitivity".mp.
9. "specificity".mp.
10. "classification".fs.
11. "classification".mp.

12. exp "classification"/
13. "assessment".mp.
14. "Validation Studies".pt.
15. exp "Validation Studies as Topic"/
16. "validation".mp.
17. "test".mp.
18. "testing".mp.
19. "tested".mp.
20. "predictive value".mp.
21. "likelihood ratio".mp.
22. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21
23. 3 and 22

1.2. EMBASE

1. "ASAS".mp.
2. "Assessment of SpondyloArthritis international Society".mp.
3. 1 or 2
4. exp standard/
5. "standards".mp.
6. "criteria".mp.
7. "sensitivity".mp.
8. "specificity".mp.
9. "classification".mp.
10. exp classification/
11. "assessment".mp.
12. exp Validation Study/
13. "validation".mp.
14. "test".mp.
15. "testing".mp.
16. "tested".mp.
17. "predictive value".mp.
18. "likelihood ratio".mp.
19. 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
20. 3 and 19

2. Review flowchart



Online Supplementary Figure S1. Flowchart of the SLR and results of the selection process.

3. Excluded papers

Online Supplementary Table S2. Excluded papers after detailed review and reasons thereof

Article	Study	Reason for exclusion
1	Lindström U, et al. Validity of ankylosing spondylitis and undifferentiated spondyloarthritis diagnoses in the Swedish National Patient Register. Scand J Rheumatol. 2015 Mar 23:1-8.	wrong comparator (ASAS criteria used as comparator and not as index test)
2	Bendahan LT, et al. Clinical performance of spondyloarthritis criteria in patients aged over 45 years: Which of them should be applied for diagnosis in late-onset ankylosing spondylitis? Clinical and Experimental Rheumatology 2014; 32 (5): 799	Only available as abstract. Not enough data provided (do not report data on criteria performance)
3	Olivieri I, et al. High sensitivity of the ASAS classification criteria in patients with HLA-B27 positive undifferentiated spondyloarthritis with onset of disease after age 45. Arthritis	Only available as abstract. Not enough data provided (comparator is not defined)

	and Rheumatology 2014; 66: S246	
4	Deodhar A, et al. Prevalence of axial spondyloarthritis among undiagnosed chronic back pain patients in the united states. Annals of the Rheumatic Diseases 2014; 73.	Only available as abstract. Not enough data provided.
5	Khan A, et al. Application of the ASAS criteria for spondyloarthritis to patients with fibromyalgia. Annals of the Rheumatic Diseases 2014; 73.	Only available as abstract. Not enough data provided.
6	Hamilton L., et al. The Prevalence of Axial Spondyloarthropathy in the UK: A Cross Sectional Cohort Study in a Primary Care Population. Rheumatology (United Kingdom) 2014; 53: i30-i31.	ASAS SpA criteria performance not assessed
7	Rao S, et al. Prevalence Estimates Of Axial Spondyloarthritis Among Patients In German Rheumatology Practices. Annals of the Rheumatic Diseases 2013; 72.	ASAS SpA criteria performance not assessed
8	Bautista-Molano W, et al. Analysis and performance of various classification criteria sets in a Colombian cohort of patients with spondyloarthritis. Clin Rheumatol. 2016; 35(7):1759-67.	ASAS SpA criteria performance not assessed (all patients with a clinical diagnosis of SpA)
9	Simsek I, et al, Utility of new asas classification criteria for axial and peripheral spondylarthritis in routine clinical care: A cohort study. Annals of the Rheumatic Diseases 2013; 72.	Only available as abstract. Not enough data provided.
10	Maldonado Ficco H, et al. Prevalence of psoriatic arthritis in psoriasis patients according to newer classification criteria. Clin Rheumatol 2014 Feb;33(2):243-6.	ASAS SpA criteria performance not assessed
11	Haroon N, et al. Predicting progression of non-radiographic axial spondyloarthritis. Arthritis and Rheumatism 2013; 65: S1060-S1061	ASAS SpA criteria performance not assessed
12	Ruderman E, et al. Spondyloarthritis epidemiology and burden phase 2 [speed 2] study: Disease progression in axial spondyloarthropathy (SpA). Arthritis and Rheumatism 2013; 65: S1052-S1053	ASAS SpA criteria performance not assessed
13	Benegas M, et al. Evaluation and comparison of performance of different classification criteria for reactive arthritis. Arthritis and Rheumatism 2013; 65: S137-S138	Only available as abstract. Not enough data provided.
14	Jariwala M. et al, Diagnostic value of the assessment of spondyloarthropathy international society (ASAS) criteria for children with enthesitis related arthritis (ERA): A single center study of 124 patients. Arthritis and Rheumatism 2012; 64: S718	Wrong population
15	Adshead R, et al. Referral recommendations for an early inflammatory back pain service. Rheumatology (United Kingdom) 2012; 51: iii92.	ASAS SpA criteria performance not assessed
16	Navarro-Zarza JE, et al. Classification of real-paper individuals with inflammatory back pain (IBP) as spondyloarthritis (SpA) by a group of experts. Ann Rheum Dis 2011;70(Suppl3):333	wrong comparator and index test (expert's diagnosis against ESSG criteria)
17	Wendling D, et al. Spondyloarthritis, spondyloarthritides: Diagnosis and classification criteria. Revue du Rhumatisme Monographies 2010; 77 (1): 43-47	Wrong study type: Review
18	Londono JD, et al. The new ASAS classification criteria for axial and peripheral spondylarthritis: Valid in the Latin American patients, but. Arthritis and Rheumatism 2010; 62: 552	Only available as abstract. Not enough data provided.
19	Lin ZM, et al. Verification of two sets of candidate criteria for	Only available as abstract. Not

	the diagnosis of axial spondyloarthritis in Chinese population. International Journal of Rheumatic Diseases 2010; 13: 148.	enough data provided.
20	Pelaez-Ballestas I, et al. The prevalence of inflammatory back pain, spondyloarthritis, and axial spondyloarthritis in the community. Arthritis and Rheumatism 2009; 60: 2026	Only available as abstract. Not enough data provided.
21	Rudwaleit, et al; Evaluation of the ASAS Classification Criteria for Axial Spondyloarthritis, A Diagnostic Algorithm and the Probability Approach (likelihood ratio product) in Diagnosing Axial Spondyloarthritis. Arthritis Rheum 2009;60 Suppl 10 :545	Only available as abstract. Not enough data provided.
22	Bakland G, et al. Assessment of SpondyloArthritis International Society criteria for axial spondyloarthritis in chronic back pain patients with a high prevalence of HLA-B27.Arthritis Care Res (Hoboken). 2013 Mar;65(3):448-53.	ASAS SpA criteria performance not assessed
23	Cheung PP, et al. Performance of the assessment in Spondyloarthritis International Society classification for axial and peripheral spondyloarthritis in an established clinical cohort: comparison with criteria sets of Amor and the European Spondylarthropathy Study Group. J Rheumatol. 2012 Apr;39(4):816-21.	wrong comparator (ASAS criteria against ESSG and Amor criteria)
24	Liao Z, et al. Clinical features of axial undifferentiated spondyloarthritis (USpA) in China: HLA-B27 is more useful for classification than MRI of the sacroiliac joint. Scand J Rheumatol. 2011 Nov;40(6):439-43.	wrong comparator (ASAS criteria against ESSG and Amor criteria)
25	Chung HY, et al. Comparison of performance of the Assessment of SpondyloArthritis International Society, the European Spondyloarthropathy Study Group and the modified New York criteria in a cohort of Chinese patients with spondyloarthritis. Clin Rheumatol. 2011 Jul;30(7):947-53.	ASAS SpA criteria performance not assessed
26	Aydin SZ, et al. Validation of the ASAS criteria and definition of a positive MRI of the sacroiliac joint in an inception cohort of axial spondyloarthritis followed up for 8 years. Ann Rheum Dis 2012;71(1):56-60.	wrong comparator (radiographic sacroiliitis according to the modified New York criteria)
27	Medina CL, et al. Analysis of the Characteristics of Patients with Chronic Back Pain Referred from Primary Care to a Rheumatology Service. Ann Rheum Dis 2015;74:498-499.	Only available as abstract. ASAS SpA criteria performance not assessed
28	Hamilton L, et al. The prevalence of axial spondyloarthritis in the UK: a cross-sectional cohort study. BMC Musculoskelet Disord 2015; 21;16:392.	ASAS SpA criteria performance not assessed
29	Onen F, et al. Prevalence of Inflammatory Back Pain and Axial Spondyloarthritis Among University Employees in Izmir, Turkey. J Rheumatol. 2015;42(9):1647-51.	ASAS SpA criteria performance not assessed
30	Holbrook T, et al. Standards for the Classification of Non-Radiographic Axial Spondyloarthritis: A European Real World Study. Arthritis Rheumatol. 2015; 67 (suppl 10).	Only available as abstract. ASAS SpA criteria performance not assessed
31	Bakker, P. The performance of different classification criteria sets for spondyloarthritis in the worldwide ASAS-comospa study. Arthritis Rheumatol. 2015; 67 (suppl 10).	Only available as abstract. ASAS SpA criteria performance not assessed

32	Burgos-Vargas R, et al. The prevalence and clinical characteristics of nonradiographic axial spondyloarthritis among patients with inflammatory back pain in rheumatology practices: a multinational, multicenter study. <i>Arthritis Res Ther</i> 2016;18(1):132.	ASAS SpA criteria performance not assessed
33	Sepriano A, et al. Predictive validity of the ASAS classification criteria for axial and peripheral spondyloarthritis after follow-up in the ASAS cohort: a final analysis. <i>Ann Rheum Dis</i> 2016;75:1034-42.	Overlap with studies performed in the ASAS-cohort

4. Risk of bias assessment

The QUADAS-2 comprises four domains: patient selection, index test, reference standard and flow and timing. Risk of bias is assessed in each domain, and concerns about applicability are assessed in the first three domains. Each domain is rated as high, low or unclear, where ‘high’ designates either a high risk of bias or substantial concerns about applicability.

Online Supplementary Table S3. Summary of risk of bias assessment (QUADAS-2 adaptation)

Study	RISK OF BIAS					APPLICABILITY CONCERNS			
	PATIENT SELECTION	INDEX TEST	REFERENCE STANDARD	FLOW AND TIMING	OVERALL	PATIENT SELECTION	INDEX TEST	REFERENCE STANDARD	OVERALL
1. Rudwaleit 2009	+	+	+	+	Low	+	+	+	Low
2. Rudwaleit 2011	+	+	+	+	Low	+	+	+	Low
3. Moltó 2013	+	+	+	+	Low	+	+	+	Low
4. van den Berg 2013	+	+	+	+	Low	+	+	+	Low
5. van den Berg 2012	+	+	+	+	Low	+	+	+	Low
6. Tomero 2014	?	+	+	+	Low	+	+	+	Low
7. Lin 2014	-	?	+	?	High	+	+	+	Low
8. Strand 2013	+	+	+	+	Low	+	+	+	Low
9. Deodhar 2016	+	+	+	+	Low	+	+	+	Low

+Low Risk; -High Risk; ? Unclear Risk

5. Sensitivity analyses

Sensitivity analyses were only possible to perform for the axSpA criteria, since not enough data was available for the 'imaging arm', 'clinical arm', pSpA criteria and for the entire set.

5.1. Target population

- 'Original' (N=5): Rudwaleit 2009, Moltó 2013, Strand 2013, van den Berg 2013, and Deodhar 2016.
- 'Restricted' (N=2): Tomero 2014 and Lin 2014.

5.2. Risk of bias

- Low risk of bias: (n=6) Rudwaleit 2009, Moltó 2013, Strand 2013, van den Berg 2013, Tomero 2014 and Deodhar 2016.
- High risk of bias (N=1): Lin 2014

5.3. Study main aim

- Criteria performance assessment (N=5): Rudwaleit 2009, Moltó 2013, van den Berg 2013 and Tomero 2014.
- Other (N=2): Strand 2013 and Deodhar 2016.

5.4. Setting

- Hospital only (N=4): Rudwaleit 2009, van den Berg 2013, Tomero 2014 and Lin 2014
- Mainly community (and also hospital) (N=3): Moltó 2013, Strand 2013 and Deodhar 2016.

5.5. Symptom duration

- < 2 years (N=3): Moltó 2013, van den Berg 2013 and Tomero 2014
- ≥ 2 years (N=3): Rudwaleit 2009, Lin 2014 and Deodhar 2016.

	LR + (95% CI)	LR – (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
Main analysis* (N=7)	6.2 (3.7; 10.5)	0.20 (0.16; 0.27)	0.82 (0.77; 0.86)	0.87 (0.78; 0.92)
Target population* (N=5)	5.3 (2.8; 10.2)	0.20 (0.15; 0.26)	0.83 (0.80; 0.86)	0.84 (0.72; 0.92)
Low bias* (N=6)	6.1 (3.2; 11.3)	0.22 (0.17; 0.29)	0.81 (0.75; 0.85)	0.87 (0.76; 0.93)
Study aim* (N=5)	8.9 (6.3; 12.5)	0.19 (0.13; 0.27)	0.83 (0.76; 0.88)	0.91 (0.86; 0.94)
Setting				
Hospital based* (N=4)	9.5 (4.8; 19.2)	0.23 (0.16; 0.35)	0.78 (0.69; 0.86)	0.92 (0.84; 0.96)
Community based[¥] (N=3)	4.1 (2.0; 8.4)	0.22 (0.17; 0.29)	0.82 (0.78; 0.86)	0.80 (0.62; 0.91)
Symptom duration				
< 2 years* (N=3)	11.8 (8.9; 15.6)	0.21 (0.13; 0.24)	0.80 (0.69; 0.88)	0.93 (0.90; 0.95)
≥ 2 years[¥] (N=3)	4.9 (3.5; 6.9)	0.18 (0.13; 0.26)	0.85 (0.80; 0.89)	0.83 (0.79; 0.87)

*Bivariate random-effects generalized mixed model. ¥ Univariate random-effects logistic regression. ASAS, Assessment of SpondyloArthritis international Society; axSpA, axial spondyloarthritis; pSpA, peripheral spondyloarthritis; CI, confidence interval; LR: likelihood ratio.