
Article:
Helliwell, PS, Coates, LC, Ransom, M orcid.org/0000-0003-4359-8287 et al. (6 more authors) (2023) The comparative performance of three screening questionnaires for psoriatic arthritis in a primary care surveillance study. Rheumatology. kead310. ISSN 1462-0324

https://doi.org/10.1093/rheumatology/kead310

The comparative performance of three screening questionnaires for psoriatic arthritis in a primary care surveillance study

Philip S Helliwell[1], Laura C Coates[2], Myka Ransom[3], Sarah T Brown[3], Jonathan Packham[4], Jake Weddell[1], William Tillett[5] and Neil McHugh[5] on behalf of the PROMPT study group

[1]Leeds Institute of Rheumatic and Musculoskeletal Medicine, University of Leeds, and NIHR Leeds Biomedical Research Centre, Leeds Teaching Hospitals NHS Trust
[2]Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, UK
[3]Clinical Trials Research Unit, Leeds Institute of Clinical Trials Research, University of Leeds
[4]Academic Unit of Population and Lifespan Sciences, University of Nottingham, UK
[5]Department of Life Sciences, University of Bath, UK.

Corresponding author:
Dr Philip Helliwell
LIRMM
Chapel Allerton Hospital
Chapeltown Road
Leeds LS7 4SA
UK
Tel: +44 (0)113 392 3064 Fax: +44 (0)113 392 4991
Email: p.helliwell@leeds.ac.uk

Abstract

Objectives

To compare the performance of three psoriatic arthritis (PsA) screening questionnaires in a primary care psoriasis surveillance study.

Methods

Participants with psoriasis, and not known to have psoriatic arthritis (PsA), were identified from general practice databases and invited to attend a secondary care centre for a clinical assessment. The three patient-completed screening questionnaires (PEST, CONTEST, and CONTESTjt) were administered along with other patient reported measures and a clinical examination of skin and joints was performed. Participants who demonstrated signs of inflammatory arthritis suggestive of PsA were referred, via their GP, for a further assessment in a secondary care rheumatology clinic.

Results

A total of 791 participants attended the screening visit and 165 participants were judged to have signs and symptoms of inflammatory arthritis, of which 150 were referred for assessment. Of these 126 were seen and 48 were diagnosed with PsA. The results for each questionnaire were as follows: PEST: Sensitivity 0.625 (95% CI 0.482 to 0.749), specificity 0.757 (0.724 to 0.787). CONTEST: Sensitivity 0.604 (0.461 to 0.731), specificity 0.768 (0.736 to 0.798). CONTESTjt: Sensitivity 0.542 (0.401 to 0.676), specificity 0.834 (0.805 to 0.859). CONTESTjt demonstrated marginally superior specificity to PEST though the area under the ROC curve was similar for all three instruments.

Conclusions

Minimal differences between the three screening questionnaires were found in this study and no preference can be made based on these results. The choice of which instrument to choose will depend on other factors, such as simplicity and low patient burden.

Key words: psoriasis, psoriatic arthritis, screening tools, outcome measures

Key points:

- Screening for prevalent PsA in people with psoriasis helps to identify previously undiagnosed PsA
- Several patient-completed questionnaires are available to help screen for PsA in people with psoriasis
- This study has shown no clear superiority of any of the tested screening questionnaires

Introduction

The incidence of psoriatic arthritis (PsA) in a psoriasis population varies between 20 to 300 per 10,000 person years (1, 2), the wide range reflecting differences in the population setting and the methods of ascertaining a diagnosis. The prevalence of PsA also differs according to the population sampled: the prevalence is up to 30% in secondary and tertiary care but is less in the community (3, 4) Cross-sectional prevalence studies consistently identify previously undiagnosed cases of PsA in people with psoriasis and earlier identification of these people would likely mean better outcomes for them. National guidance recommends that people with psoriasis are offered an annual assessment for PsA (5). However, this is not uniformly implemented and the current method of assessment is not standardised. Several screening tools have been developed for identifying cases of PsA in people with psoriasis and the annual application of such tools would partly fulfil the need to assess for PsA. In the UK, the National Institute for Clinical Excellence (NICE) reviewed the performance of all questionnaires and recommended the Psoriasis Epidemiology Screening Tool (PEST), and in the US the National Psoriasis Foundation have also adopted this screening tool (6).

NICE raised concerns about the performance of the PEST, particularly in certain PsA subtypes (oligoarthritis, axial and pure entheseal disease (5)). The PEST was initially developed in a general practice setting but has had extensive further study in both primary and secondary care settings, often in comparison to other screening questionnaires. In one such study the most discriminatory items from PEST and the other questionnaires (PASE and TOPAS) were used to design a new instrument (CONTEST) which was subsequently tested in data from the UK, Dublin and Utah. Analysis to date has shown, as might be expected, slightly improved performance of the CONTEST questionnaire compared to the other questionnaires (4, 7).

The TUDOR trial was designed to investigate whether the early detection of undiagnosed PsA in people with psoriasis results in improved outcome. In addition to addressing this area of uncertainty, the trial allowed for a comparison of the

performance of the PEST and CONTEST questionnaires during the initial screening phase. Here we report the results of that comparison.

Methods

TUDOR was a two-arm, 2-year, prospective, multi-centre, parallel-group cluster randomised controlled trial conducted in primary and secondary care in three major areas (Bath, Stoke-on-Trent, and West Yorkshire) in the UK. GP practices were randomised on a 1:1 basis to either an enhanced surveillance arm (ES), or a standard care arm. Participants, age 18 to 70y, identified as having a READ code for psoriasis (and not psoriatic arthritis, ankylosing spondylitis or rheumatoid arthritis) were invited by letter to take part in the study. All consenting participants in the ES arm underwent a clinical assessment by a clinician who was either a consultant rheumatologist, a clinical research fellow, or a trained allied health professional. Clinical data included history and examination, recording details of psoriasis and arthritis, if present. Arthritis assessment included a full 68/66 tender and swollen joint count, a count of dactylitic digits, a Leeds Enthesitis count, and measures of spinal movement if inflammatory back pain was reported. At the baseline visit participants also completed the Health Assessment Questionnaire (HAQ) and the PEST and CONTEST questionnaires. All participants with suspected inflammatory arthritis, as determined by the assessing clinician, were referred to their primary care physician requesting formal referral to a hospital-based rheumatology outpatient clinic for a full assessment, including any necessary investigations. The final diagnosis rested with the rheumatology clinic who were blind to the study and its procedures.

The PEST questionnaire consists of 5 questions, with a simple yes/no answer. Each positive response scores 1 point: a threshold of 3 points has previously been used to indicate a positive test (8). The CONTEST questionnaire contains 8 questions and a threshold of 4 was suggested in the development paper (7). A further modification of the CONTEST questionnaire has been proposed – the use of the joint manikin (presented in the PEST questionnaire but not scored), in which a score of 1 was given if 6 or more joints on the manikin were ticked: in this case (CONTESTjt) the optimal cut off was 5. The order of PEST and CONTEST in the questionnaire packs was randomly assigned in a 1:1 ratio to order of completion (PEST first/CONTEST first) to minimise any potential bias, i.e. an order effect.

Ethical approval for this study was given by the South West – Central Bristol Research Ethics Committee Ref: 16/SW/0161. All patients signed written consent in accordance with the Declaration of Helsinki.

Sample size and statistics

The TUDOR study aimed to recruit a minimum of 958 participants to the ES arm and assumed that 15% of these would be diagnosed with PsA at baseline. Thus, the precision estimates were based on a minimum of 144 participants with a new diagnosis of PsA (for sensitivity) and a minimum of 814 participants without PsA (for specificity).

Assuming sensitivity and specificity of the CONTEST questionnaire to be 70%, the precision of sensitivity was estimated to be a minimum of ±11.2% and specificity at ±4.7% (corresponding to half width of a 95% confidence interval around the parameter estimate), taking into account practice clustering.

Diagnostic accuracy of the PEST and CONTEST questionnaires was compared by calculating estimates and 95% confidence intervals for differences between their sensitivity, specificity, and area under the receiver operating curve (ROC) using the diagnosis of PsA by the rheumatologist as the gold standard. Pre-defined decision thresholds (definition of positive results) of 4 for CONTEST, 5 for CONTESTjt, and 3 for PEST were used for estimating sensitivity and specificity, but other cut-points were explored using the ROC and distance to (0,1). Wald confidence intervals are reported for sensitivity and specificity; Bonnet-Price confidence intervals were also calculated as a sensitivity analysis. Positive and negative predictive values are also presented.

In the subjects with a final diagnosis of PsA the following phenotypes were defined: polyarthritis, 5 or more swollen or tender peripheral joints using a 68 tender, 66 swollen joint count; oligoarthritis, fewer than 5 swollen or tender joints; enthesitis, 1 or more tender enthesis using a combined LEI (9) and SPARCC (10) enthesitis assessment; dactylitis, one or more digits with dactylitis adjudged to be present by the examiner; axial disease, fulfilment of the modified New York criteria (11), or the ASAS criteria (12),or any radiographic or MRI evidence of spondyloarthritis (such as sacroilitis or syndesmophytes) on imaging.

Results

1123 participants were recruited to the ES arm. Of these participants, 332 (29.6%) were excluded from the analysis due to not attending the baseline visit (n=330, 29.4%) or not returning the PEST/CONTEST questionnaires (n=2, 0.2%). A total of 791 participants attended the baseline visit and returned the PEST/CONTEST questionnaires. Of the 791 participants, there were 22 (2.8%) participants for whom a final clinical diagnosis was not available, leaving 769 participants with both index test scores and a final clinical diagnosis. At baseline 165 participants were judged to have signs and symptoms of inflammatory arthritis and 150 were referred for assessment. Of these 126 were seen and received clinical judgement regarding PsA status. 48 (6.1%) participants were given a final diagnosis of PsA (45 were assessed by CASPAR criteria and of these 38 (84.4%) had a CASPAR score ≥ 3, thus fulfilling the CASPAR criteria for PsA). The participant flow is given in Figure 1 and patient demographics are given in Table 1.

Of the 721 participants in the ES arm with a negative PsA diagnosis, 304 (42.1%) of these participants were reported as displaying signs or symptoms of non-PsA musculoskeletal disorders. Of these, the most frequently reported were osteoarthritis (n = 193, 26.8%), mechanical back or joint pain (n = 37, 5.1%), gout (13, 1.8%), injury (12, 1.7%) and muscular or other pain (12, 1.7%).

Sensitivity and specificity of questionnaires

Final clinical diagnosis is tabulated against questionnaire results in Table 2. Cutpoints, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and distance to (0,1) are given in Table 3. ROC curves demonstrating performance of the three questionnaires are given in Figure 2. At the recommended cutpoints figures for sensitivity were similar (0.625, 0.604, and 0.542 for PEST, CONTEST and CONTESTjt respectively), but the figure for specificity was higher for CONTESTjt (0.757, 0.768, and 0.834 for PEST, CONTEST and CONTESTjt respectively).

The differences in *sensitivity* between the PEST and the CONTEST questionnaires are as follows: PEST – CONTEST: Wald 0.021 (-0.087 to 0.129), Bonnett-Price 0.021 (-0.097 to 0.137); PEST – CONTESTjt: Wald 0.083 (-0.030 to 0.196), Bonnett-

Price 0.083 (-0.042 to 0.202). The differences in *specificity* between the PEST and the CONTEST questionnaires are as follows: PEST – CONTEST: Wald -0.011 (-0.040 to 0.018)), Bonnett-Price -0.011 (-0.040 to 0.018); PEST – CONTESTjt: Wald -0.076 (-0.104 to -0.049), Bonnett-Price -0.076 (-0.104 to -0.049). Area under the ROC curve (AUC) was similar for all three questionnaires (PEST: 0.787 (95% CI 0.727 to 0.847); CONTESTjt: 0.765 (0.695 to 0.835); CONTEST: 0.768 (0.699 to 0.837) Figure 2. The difference between the AUC were as follows: PEST-CONTESTjt: 0.022 (-0.023 to 0.067); PEST-CONTEST: 0.019 (-0.025 to 0.062).

Phenotype of PsA and relationship to questionnaire results

Table 4 gives the screening questionnaire results for each phenotype. Of the 48 subjects newly identified as having PsA 16 (33.3%) had polyarthritis, 20 (41.7%) oligoarthritis, and 12 (25.0%) no peripheral arthritis. The median tender and swollen joint counts of those subjects with peripheral arthritis were 4 (IQR 2 – 7) and 2 (IQR 1 – 3) respectively, and the median skin body surface area affected by psoriasis? was 4% (IQR 1.2% to 10.2%).

Of the 36 participants with peripheral arthritis 11 (30.6%) also had enthesitis. There were 4 patients with pure entheseal disease. Of the patients with enthesitis the median enthesitis score was 2 (IQR 1 to 4). Thirteen patients had dactylitis with a median number of digits affected by dactylitis of 1 (IQR 1 to 2). Two of these patients had dactylitis recorded but no other peripheral arthritis.

Of those with peripheral arthritis 10 also had axial disease, though the status of axial involvement could not be confirmed in 6 subjects. In addition, there was 1 patient with pure axial disease.

In 5 patients there was no peripheral disease recorded (of these 3 also did not have any axial disease, but axial disease status could not be confirmed in the other 2). These patients had answered positively to previous swollen joints or inflammatory back pain and were adjudged to have PsA on consultant review.

From table 4 in terms of peripheral arthritis, the PEST questionnaire was slightly superior in identifying subjects with both poly- and oligoarthritis but slightly inferior in identifying pure enthesitis. Only one patient had pure axial disease and none of the screening tools identified this patient.

Discussion

This community surveillance study of people with psoriasis, comparing different screening tools for PsA, found very similar performance with a larger gain in specificity for CONTESTjt, albeit in conjunction with loss of sensitivity; there was no difference between the questionnaires in terms of area under the ROC curve.

PsA is a complex heterogeneous disease with several clinical phenotypes and, as such, provides a challenge to identification by patient completed questionnaires. A number of such tools are available and are widely implemented in practice, but none are optimal. The PEST, similar to the PURE-4 (13), was developed using statistical regression using a number of clinical variables; others like the ToPAS (14), and EARP (15), were developed by expert consensus, the latter focussing on regional musculoskeletal symptoms. The CONTEST questionnaires amalgamated the best performing items from a number of screening tools and, as such demonstrated marginal superiority in performance (7). In any screening study the performance of instruments will vary according to the study methodology and population. A study comparing PEST, PASE and ToPAS in hospital settings found very similar results for each questionnaire, with mostly equivalent sensitivity and specificity, though the latter were much worse than specificities found in instrument development (16). A study specifically comparing the PEST and CONTEST questionnaires, conducted in a primary care setting, also found equivalent performance with figures for sensitivity and specificity similar to those found in this study (4). A further study from Dublin found poor sensitivities and excellent specificities for screening questionnaires in a secondary care setting but pre-screening of participants for other musculoskeletal disease may have produced these results (17). Despite the above comments about methodology and population a systematic literature review and meta-analysis has been conducted, noting the marked heterogeneity between studies; it was concluded that the EARP had the best sensitivity, though with some loss of specificity (18).

A criticism of the PEST questionnaire has been its fallibility in identifying certain phenotypes of PsA – notably oligoarthritis, enthesitis (except at the Achilles insertion) and axial disease. The current study found the PEST slightly superior to the CONTEST questionnaires in identifying peripheral arthritis, both oligo- and

polyarticular disease, though better in cases of polyarthritis than oligoarthritis. Cases of pure enthesitis were uncommon (n = 4) so it is difficult to draw firm conclusions, but PEST was inferior to CONTEST in identifying this domain. The CONTEST questionnaire includes questions about back and neck pain so would be expected to identify more cases of axial disease: in this study there was only one case of pure axial disease which none of the questionnaires identified. However, it must be noted, that the pure axial phenotype of PsA is uncommon and cases with concomitant peripheral and axial disease will be identified by instruments that address only the peripheral joints, as in this study.

The cut-offs for each questionnaire were derived from previous work but this study allowed a further examination of these cut-offs (Table 3). The optimum cut-off is described by the best combination of sensitivity and specificity, allowing that these two figures are reciprocal – what is gained by optimising one is lost in the other. Combining the optimal sensitivity and specificity requires an appreciation of this and may be done in several ways. In this study the nearest distance to the ROC curve (distance 0,1 in Table 3) indicates that the pre-defined cut-offs of 3 for the PEST, and 4 for the CONTEST are optimal, but the cut-off for CONTESTjt might be more optimal as 4.

As the majority of cases of PsA have pre-existing psoriasis this provides an ideal opportunity to screen for PsA in this population, and previous studies have shown a high prevalence of unrecognised disease in secondary care patients with psoriasis (16). The ideal screening test should have high sensitivity so as not to miss cases of disease, and ideally high specificity in order not to identify cases with other musculoskeletal disorders. Observational studies suggest the earlier the diagnosis (and treatment) the better the outcome in PsA providing further support for regular screening (19, 20). In the UK NICE has recommended that the recommended period between screening tests is 12 months, though this was only consensus based (https://www.nice.org.uk/guidance/cg153/chapter/1-recommendations, accessed December 16th 2022). The ‘parent’ study within which the current investigation took place (TUDOR) is designed to assess the benefit of early diagnosis (and intervention) on the outcome of PsA and is the first prospective study in this field. However, it must be recognised that the patients identified with PsA at baseline are likely to be unrecognised prevalent cases, and those picked up at subsequent study

visits are more likely to be incident cases, in which case a different approach to screening may be required.

There are several limitations to this study. Firstly, the lower than expected prevalence of undiagnosed PsA, and the lower figure for specificity with CONTESTjt (54.2% v 70% estimated), reduced the precision of the estimates of sensitivity and specificity: the revised estimates for CONTESTjt are ±13.8% and ±2.7% for sensitivity and specificity respectively. Secondly, where participants were not diagnosed with PsA, alternative diagnoses were not systematically collected so that this information was available for less than half (42.1%) of the PsA-negative participants. Thirdly, some patients judged to have PsA by the research clinician may not have been referred by the primary care physician for a rheumatology clinic assessment. Fourthly, clinical judgement formed the basis of final PsA diagnosis, in preference to the patient fulfilling the CASPAR criteria, though 84% of those diagnosed with PsA clinically did fulfil the CASPAR criteria. In early disease the CASPAR criteria may not be fulfilled though it has been shown that the CASPAR criteria can function well in an early arthritis cohort (21). Fifthly, as the COMPARE analysis population was restricted to participants who attended the baseline assessments, there is a potential risk that the participants who did not attend the baseline assessments may have different characteristics and outcomes compared to the participants who did attend. And, as patients were referred through standard NHS routes, a significant delay occurred between initial study assessment and rheumatology specialist outpatient review. Participants may have had symptoms which fluctuated over this time, but it is likely that assessing clinicians would have asked about present and recent symptoms/signs of PsA. Finally, although this study recruited in 4 diverse areas of England, over 95% of participants self-identified as White, making the results applicable to this group only.

In conclusion, this study has shown no difference in sensitivity between CONTEST and CONTESTjt in comparison to PEST, but a statistically significant improvement in specificity for CONTESTjt compared to PEST, though the magnitude of that difference was minimal, and the overall performance of the instruments, as reflected in the area under the ROC curve, was similar. The PEST questionnaire has now been in the public domain for 13 years, is a simple and quick test to administer and

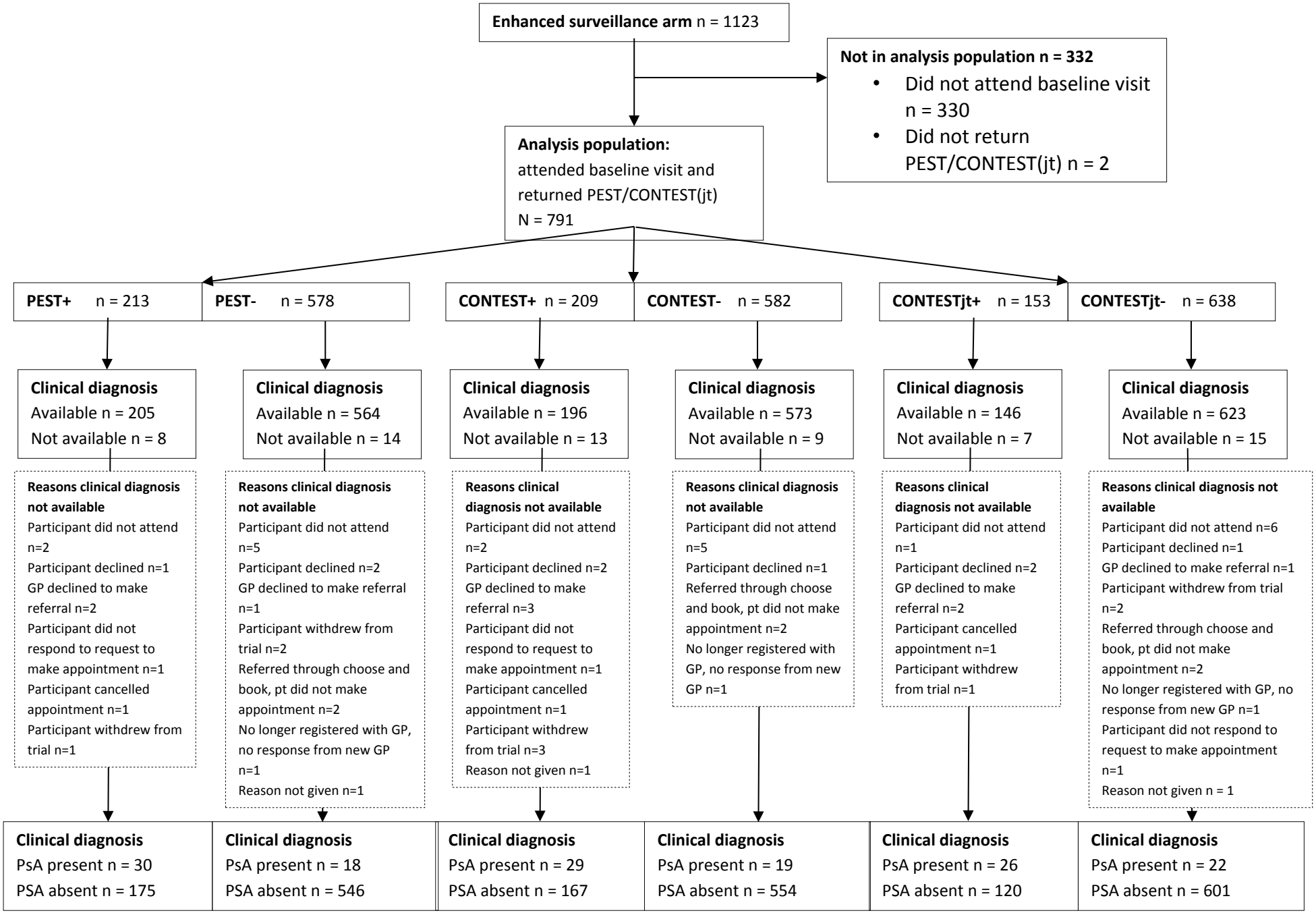
complete, is available in several languages, has been adopted by several organisations and has been studied in community and hospital settings, both on its own and compared with other tools. As no overall significant differences between the PEST and the CONTEST questionnaires have been demonstrated in this study there is no reason to stop using the PEST in favour of these alternatives at this time. Without further head-to-head studies, in varied populations, the same cannot be said of other screening questionnaires, but to date, other studies in secondary care have not shown major differences in performance of the different questionnaires.

Funding: This report is independent research funded by the National Institute for Health Research, Programme Grants for Applied Research [Early detection to improve outcome in patients with undiagnosed PsA ('PROMPT'), RP-PG-1212-20007]. The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Data Availability: The data underlying this article may be shared on reasonable request to the study Chief Investigator, Prof Neil McHugh.

Conflicts of interest: The authors have declared no conflicts of interest.

Figure 1. Participant flow



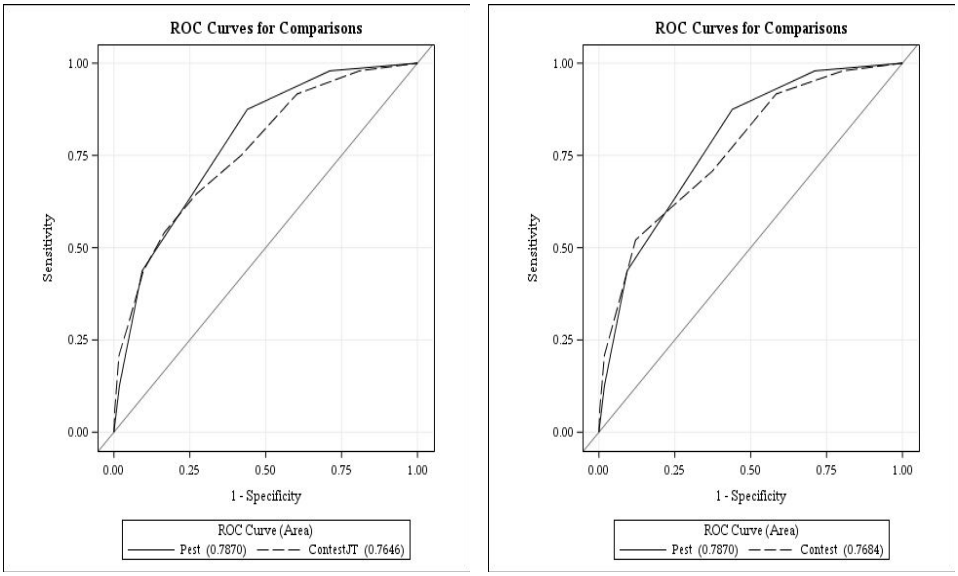


Figure 2. Receiver operating characteristic (ROC) curves comparing PEST, CONTESTjt and CONTEST. A: PEST and CONTESTjt. B: PEST and CONTEST

References

1. Wilson FC, Icen M, Crowson CS, McEvoy MT, Gabriel SE, Kremers HM. Incidence and clinical predictors of psoriatic arthritis in patients with psoriasis: a population-based study. Arthritis and rheumatism. 2009;61(2):233-9.

2. Eder L, Haddad A, Rosen CF, Lee KA, Chandran V, Cook R, et al. The Incidence and Risk Factors for Psoriatic Arthritis in Patients With Psoriasis: A Prospective Cohort Study. Arthritis & rheumatology (Hoboken, NJ). 2016;68(4):915-23.

3. Mease P, Gladman D, Papp K, Khraishi M, Thaci D, Behrens F, et al. Prevalence of rheumatologist-diagnosed psoriatic arthritis in patients with psoriasis in European/North American dermatology clinics. J Am Acad Dermatol. 2013;69(5):729-35.

4. Coates LC, Savage L, Waxman R, Moverley A, Worthington S, Helliwell P. Comparison of screening questionnaires to identify psoriatic arthritis in a primary-care population: a cross-sectional study. The British journal of dermatology. 2016;175:542-8.

5. NICE. Psoriasis: assessment and management: National Institute for Health and care excellence; 2012 [Available from: https://www.nice.org.uk/guidance/cg153.

6. NPF. About psoriatic arthritis: National Psoriasis Foundation; 2022 [Available from: https://www.psoriasis.org/about-psoriatic-arthritis/.

7. Coates LC, Walsh J, Haroon M, FitzGerald O, Aslam T, Al Balushi F, et al. Development and testing of new candidate psoriatic arthritis screening questionnaires combining optimal questions from existing tools. Arthritis Care Res (Hoboken). 2014;66(9):1410-6.

8. Ibrahim GH, Buch MH, Lawson C, Waxman R, Helliwell PS. Evaluation of an existing screening tool for psoriatic arthritis in people with psoriasis and the development of a new instrument: the Psoriasis Epidemiology Screening Tool (PEST) questionnaire. Clinical & Experimental Rheumatology27(3):469-74. 2009:Jun.

9. Healy P, Helliwell PS. Measuring clinical enthesitis in psoriatic arthritis:assessment of existing measures and development of an instrument specific for psoriatic arthritis. Arthr Care & Res. 2008;59(5):686-91.

10. Gladman DD, Inman RD, Cook RJ, Maksymowych WP, Braun J, Davis JC, et al. International spondyloarthritis interobserver reliability exercise--the INSPIRE study: II. Assessment of peripheral joints, enthesitis, and dactylitis. The Journal of rheumatology. 2007;34(8):1740-5.

11. The HSG, Steven MM, Van der Linden SM, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis: a comparison of the Rome, New York, and modified New York criteria in patients with a positive clinical history screening test for ankylosing spondylitis. British Journal of Rheumatology. 1985;24:242-9.

12. Rudwaleit M, van der HD, Landewe R, Listing J, Akkoc N, Brandt J, et al. The development of Assessment of SpondyloArthritis international Society classification criteria for axial spondyloarthritis (part II): validation and final selection. Annals of the Rheumatic Diseases68(6):777-83. 2009.

13. Audureau E, Roux F, Lons Danic D, Bagot M, Cantagrel A, Dernis E, et al. Psoriatic arthritis screening by the dermatologist: development and first validation of the 'PURE-4 scale'. Journal of the European Academy of Dermatology and Venereology. 2018;32(11):1950-3.

14. Tom BD, Chandran V, Farewell VT, Rosen CF, Gladman DD. Validation of the Toronto Psoriatic Arthritis Screen Version 2 (ToPAS 2). The Journal of rheumatology. 2015.

15. Tinazzi I, Adami S, Zanolin EM, Caimmi C, Confente S, Girolomoni G, et al. The early psoriatic arthritis screening questionnaire: a simple and fast method for the identification of arthritis in patients with psoriasis. Rheumatology (Oxford). 2012;51(11):2058-63.

16. Coates LC, Aslam T, Al Balushi F, Burden AD, Burden-Teh E, Caperon AR, et al. Comparison of three screening tools to detect psoriatic arthritis in patients with psoriasis (CONTEST study). British Journal of Dermatology. 2013;168:802-7.

17. Haroon M, Kirby B, FitzGerald O. High prevalence of psoriatic arthritis in patients with severe psoriasis with suboptimal performance of screening questionnaires. Annals of the Rheumatic Diseases. 2013;72(5):736-40.

18. Iragorri N, Hazlewood G, Manns B, Danthurebandara V, Spackman E. Psoriatic arthritis screening: a systematic review and meta-analysis. Rheumatology. 2009;58:692707.

19. Haroon M, Gallagher P, FitzGerald O. Diagnostic delay of more than 6 months contributes to poor radiographic and functional outcome in psoriatic arthritis. Annals of the Rheumatic Diseases. 2015;74(6):1045-50.

20. Gladman D, Thavaneswaran A, Chandran V, Cook RJ. Do patients with psoriatic arthritis who present early fare better than those presenting later in the disease? Ann Rheum Dis. 2011;70(12):2152-4.

21. Coates LC, Conaghan PG, Emery P, Green MJ, Ibrahim G, MacIver H, et al. Sensitivity and specificity of the Classification of Psoriatic Arthritis criteria in early psoriatic arthritis. Arthritis and rheumatism. 2012;64(10):3150-5.

	Clinical diagnosis: PsA positive N = 48	Clinical diagnosis: PsA negative N = 721	Clinical PsA diagnosis not known N = 22	All participants N = 791
Age at registration (years)				
Mean (s.d.)	51.5 (11.96)	52.4 (12.78)	50.5 (14.12)	52.3 (12.76)
Gender				
Male	26 (54.2%)	340 (47.2%)	13 (59.1%)	379 (47.9%)
Female	22 (45.8%)	380 (52.7%)	9 (40.9%)	411 (52.0%)
Missing*	0 (0.0%)	1 (0.1%)	0 (0.0%)	1 (0.1%)
Ethnicity				
White	47 (97.9%)	688 (95.4%)	22 (100.0%)	757 (95.7%)
Asian/Asian British	1 (2.1%)	15 (2.1%)	0 (0.0%)	16 (2.0%)
Missing	0 (0.0%)	9 (1.2%)	0 (0.0%)	9 (1.1%)
Mixed/Multiple ethnic groups	0 (0.0%)	6 (0.8%)	0 (0.0%)	6 (0.8%)
Black/African/Caribbean/Black British or other ethnic group	0 (0.0%)	2 (0.3%)	0 (0.0%)	2 (0.3%)
Not stated	0 (0.0%)	1 (0.1%)	0 (0.0%)	1 (0.1%)
Age at psoriasis diagnosis (years)				
Mean (s.d.)	24.0 (15.76)	28.3 (16.62)	28.7 (14.66)	28.0 (16.53)
Missing	2	43	0	45
Current medical conditions				
Hypertension	4 (8.3%)	78 (10.8%)	1 (4.5%)	83 (11.5%)
Asthma	4 (8.3%)	65 (9.0%)	1 (4.5%)	70 (9.7%)
Osteoarthritis	7 (14.6%)	52 (7.2%)	2 (9.1%)	61 (8.5%)
Diabetes	3 (6.3%)	42 (5.8%)	0 (0.0%)	45 (6.2%)
Thyroid dysfunction	4 (8.3%)	25 (3.5%)	2 (9.1%)	31 (4.3%)
Inflammatory bowel disease	1 (2.1%)	26 (3.6%)	0 (0.0%)	27 (3.7%)
Hypercholesterolaemia	0 (0.0%)	16 (2.2%)	0 (0.0%)	16 (2.2%)
Ischemic heart disease	0 (0.0%)	9 (1.2%)	0 (0.0%)	9 (1.2%)
Kidney disease	0 (0.0%)	8 (1.1%)	0 (0.0%)	8 (1.1%)
Chronic liver disease	0 (0.0%)	4 (0.6%)	0 (0.0%)	4 (0.6%)
Myocardial infarction	0 (0.0%)	3 (0.4%)	0 (0.0%)	3 (0.4%)
PASI Score				
Mean (s.d.)	4.8 (3.33)	3.2 (3.05)	3.9 (2.98)	3.3 (3.09)
Missing or n/a	4	122	2	128
Nail involvement				
Present	34 (70.8%)	322 (44.7%)	17 (77.3%)	373 (47.2%)
Absent	13 (27.1%)	371 (51.5%)	4 (18.2%)	388 (49.1%)
Missing	1 (2.1%)	28 (3.9%)	1 (4.5%)	30 (3.8%)
Dactylitis				
Present	14 (29.2%)	15 (2.1%)	1 (4.5%)	30 (3.8%)
Absent	34 (70.8%)	701 (97.2%)	21 (95.5%)	756 (95.6%)
Missing	0 (0.0%)	5 (0.7%)	0 (0.0%)	5 (0.6%)
Tender and/or swollen joints				
Present	36 (75.0%)	220 (30.5%)	15 (68.2%)	271 (34.3%)

	Clinical diagnosis: PsA positive N = 48	Clinical diagnosis: PsA negative N = 721	Clinical PsA diagnosis not known N = 22	All participants N = 791
Absent	12 (25.0%)	497 (68.9%)	7 (31.8%)	516 (65.2%)
Missing	0 (0.0%)	4 (0.6%)	0 (0.0%)	4 (0.5%)
Of those reporting tender joints, number of tender joints				
Mean (s.d.)	6.2 (6.28)	3.4 (3.86)	3.8 (3.34)	3.8 (4.36)
Median (range)	4.0 (1.0, 24.0)	2.0 (1.0, 21.0)	2.0 (1.0, 10.0)	2.0 (1.0, 24.0)
IQR	2.0, 7.0	1.0, 4.0	1.0, 6.0	1.0, 5.0
N	33	181	13	227
Of those reporting swollen joints, number of swollen joints				
Mean (s.d.)	2.3 (1.31)	2.5 (2.37)	2.8 (2.64)	2.4 (2.22)
Median (range)	2.0 (1.0, 5.0)	2.0 (1.0, 13.0)	2.0 (1.0, 8.0)	2.0 (1.0, 13.0)
IQR	1.0, 3.0	1.0, 3.0	1.0, 3.0	1.0, 3.0
N	21	94	6	121
Participant currently has inflammatory back pain				
Yes	12 (25.0%)	67 (9.3%)	8 (36.4%)	87 (11.0%)
No	23 (47.9%)	298 (41.3%)	8 (36.4%)	329 (41.6%)
Missing	13 (27.1%)	356 (49.4%)	6 (27.3%)	375 (47.4%)
BASMI~ score				
Mean (s.d.)	2.0 (0.80)	2.2 (0.97)	2.3 (1.33)	2.2 (0.97)
Median (range)	2.0 (0.8, 3.2)	2.0 (0.6, 5.2)	1.9 (1.0, 4.6)	2.0 (0.6, 5.2)
IQR	1.4, 2.0	1.8, 2.8	1.4, 2.8	1.4, 2.8
Missing	3	25	2	30
N	9	42	6	57
HAQ-DI score				
Mean (s.d.)	0.310 (0.469)	0.171 (0.414)	0.324 (0.504)	0.184 (0.422)
Median (range)	0.063 (0.000, 2.125)	0.000 (0.000, 3.000)	0.125 (0.000, 1.750)	0.000 (0.000, 3.000)
IQR	0.000, 0.500	0.000, 0.125	0.000, 0.375	0.000, 0.125
Missing	0	1	0	1

Table 1. Patient demographics and clinical scores

** The demographic screening questionnaire was completely missing for one participant.*

~ BASMI: Bath Ankylosing Spondylitis Metrology Index

Table 2. Questionnaire result tabulated by final clinical diagnosis

	Clinical diagnosis			
	PsA positive	PsA negative	PsA status not known	Total
PEST				
PsA positive	30 (3.8%)	175 (22.1%)	8 (1.0%)	213 (26.9%)
PsA negative	18 (2.3%)	546 (69.0%)	14 (1.8%)	578 (73.1%)
Total	48 (6.1%)	721 (91.2%)	22 (2.8%)	791 (100%)
CONTESTjt				
PsA positive	26 (3.3%)	120 (15.2%)	7 (0.9%)	153 (19.3%)
PsA negative	22 (2.8%)	601 (76.0%)	15 (1.9%)	638 (80.7%)
Total	48 (6.1%)	721 (91.2%)	22 (2.8%)	791 (100%)
CONTEST				
PsA positive	29 (3.7%)	167 (21.1%)	13 (1.6%)	209 (26.4%)
PsA negative	19 (2.4%)	554 (70.0%)	9 (1.1%)	582 (73.6%)
Total	48 (6.1%)	721 (91.2%)	22 (2.8%)	791 (100%)

Table 3. Cutpoints, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and distance to (0,1). Currently accepted and used cut-offs for a positive test are highlighted

Cut point	True positive	True negative	False positive	False negative	Sensitivity	Specificity	PPV	NPV	Distance to (0,1)
PEST									
1	47	208	513	1	0.979	0.288	0.084	0.995	0.712
2	42	404	317	6	0.875	0.560	0.117	0.985	0.457
3	30	546	175	18	0.625	0.757	0.146	0.968	0.447
4	21	654	67	27	0.438	0.907	0.239	0.960	0.570
5	6	708	13	42	0.125	0.982	0.316	0.944	0.875
CONTESTjt									
1	47	138	583	1	0.979	0.191	0.075	0.993	0.809
2	44	286	435	4	0.917	0.397	0.092	0.986	0.609
3	36	419	302	12	0.750	0.581	0.107	0.972	0.488
4	31	525	196	17	0.646	0.728	0.137	0.969	0.446
5	26	601	120	22	0.542	0.834	0.178	0.965	0.488
6	21	651	70	27	0.438	0.903	0.231	0.960	0.571

7	14	687	34	34	0.292	0.953	0.292	0.953	0.710
8	10	709	12	38	0.208	0.983	0.455	0.949	0.792
9	3	719	2	45	0.063	0.997	0.600	0.941	0.938
CONTEST									
1	47	142	579	1	0.979	0.197	0.075	0.993	0.803
2	44	300	421	4	0.917	0.416	0.095	0.987	0.590
3	34	451	270	14	0.708	0.626	0.112	0.970	0.475
4	29	554	167	19	0.604	0.768	0.148	0.967	0.459
5	25	634	87	23	0.521	0.879	0.223	0.965	0.494
6	16	678	43	32	0.333	0.940	0.271	0.955	0.669
7	10	708	13	38	0.208	0.982	0.435	0.949	0.792
8	3	719	2	45	0.063	0.997	0.600	0.941	0.938

Table 4. Screening questionnaire results by PsA phenotype in patients diagnosed with PsA

Note: peripheral arthritis refers to tender and swollen joints, peripheral disease refers to any of tender and swollen joints, enthesitis and dactylitis

The row figures represent the number of cases and the row percentage

Phenotype	PEST+	CONTESTjt+	CONTEST+	Total
Peripheral disease				
Polyarthritis	13 (81)	12 (75)	12 (75)	16 (100)
Oligoarthritis	13 (65)	10 (50)	11 (55)	20 (100)
Enthesitis				
Enthesitis with peripheral arthritis	10 (91)	9 (82)	10 (91)	11 (100)
Enthesitis without peripheral arthritis	1 (25)	2 (50)	3 (75)	4 (100)
Dactylitis				
Dactylitis with peripheral arthritis	8 (73)	9 (82)	9 (82)	11 (100)
Dactylitis without other peripheral arthritis	0	0	0	2 (100)
Axial disease				
Axial disease with peripheral disease	6 (60)	4 (40)	4 (40)	10 (100)
Axial disease without peripheral disease	0	0	0	1 (100)
No current axial or peripheral disease				
No current peripheral or axial disease	2 (67)	1 (33)	2 (67)	3 (100)
No current peripheral disease and axial disease status not known	1 (50)	1 (50)	1 (50)	2 (100)