Limitations in Screening Instruments for Psoriatic Arthritis: A Comparison of Instruments in Patients with Psoriasis

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ABSTRACT. ***Objective.*** To compare the abilities of 3 validated screening instruments to predict the diagnosis of psoriatic arthritis (PsA) in patients with psoriasis.

Methods. Prior to a rheumatologic evaluation, 213 participants in the Utah Psoriasis Initiative completed the Psoriasis Epidemiology Screening project (PEST), the Toronto Psoriatic Arthritis Screen (ToPAS), and the Psoriatic Arthritis Screening and Evaluation (PASE). Previously established instrument cutoff scores were used to designate positive and negative classifications. Sensitivities and specificities were determined by comparing instrument classifications to the rheumatologist's diagnosis. Phenotypic features and alternative diagnoses were compared between participants who screened positively and negatively on each instrument. Discrepancies between the rheumatologist's examination findings and responses to specific instrument questions were compared.

Results. The sensitivities of PEST, ToPAS, and PASE were 85%, 75%, and 68%, and the specificities were 45%, 55%, and 50%, respectively. The instruments were less sensitive in patients with lower disease activity, fewer PsA features, and shorter disease duration. The instruments did not consistently differentiate between PsA and other types of musculoskeletal disease. Discrepancies between examination findings and responses to instrument questions occurred more frequently with ToPAS than with PEST and PASE.

Conclusion. Sensitivities and specificities for PEST, ToPAS, and PASE were lower than previously reported. This population included patients with PsA and other types of musculoskeletal disease and may represent those most likely to complete a screening instrument and follow through with a rheumatology referral. Further analyses may enable the development of more successful screening strategies for PsA in psoriasis patients with musculoskeletal complaints. (First Release Feb 1 2013; J Rheumatol 2013;40:287–93; doi:10.3899/jrheum.120836)

Key Indexing Terms:
PSORIATIC ARTHRITIS SCREENING

Psoriatic arthritis (PsA) is a chronic and potentially disabling condition that affects up to 30% of people with psoriasis[1]. According to the 2011 National Psoriasis Foundation Survey, 22% of patients with psoriasis with undiagnosed PsA have symptoms of PsA, and 29% received a diagnosis of PsA ≥ 2 years after the onset of symptoms[2]. Earlier recognition and treatment of PsA may lead to reductions in joint destruction and disability[3]. Joint damage occurs within the first 2 years of disease in nearly half of patients with PsA, and the onset of arthritis symptoms often precedes the diagnosis of PsA by several years[4]. Prevention of joint damage with early therapy is important for maximizing patient quality of life and function. Further, higher mortality rates reported in patients with PsA who have joint damage suggest that minimizing disease activity may improve survival[5,6,7].

Several self-assessment screening instruments have been developed to facilitate early recognition of PsA, including the Psoriasis Epidemiology Screening project (PEST), the Toronto Psoriatic Arthritis Screen (ToPAS), and the Psoriatic Arthritis Screening and Evaluation (PASE). PEST consists of 5 questions and a drawing of a mannequin. The mannequin was included to help providers identify symptomatic joints, but it does not add to the discriminative value of the instrument. The sensitivity was 92% and the specificity was 78% in a study of 93 participants[8]. ToPAS includes 35 questions and pictures of psoriasis lesions, psoriatic nails, inflamed joints, and a dactylitic digit. Nine questions contribute to the ToPAS score. In 688 patients recruited from family medicine, dermatology, rheumatology, psoriasis, and PsA clinics, the sensitivity was 87% and the specificity was 93%[9]. PASE consists of 15 questions. In a pilot study of 69 participants, the sensitivity

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was 82% and the specificity was 73%[10]. In a validation study of 190 patients with psoriasis, the sensitivity and specificity were both 76%[11].

The primary objective of this project was to evaluate the performances of PEST, ToPAS, and PASE in patients with psoriasis who had musculoskeletal symptoms. The second objective was to evaluate these instruments in subsets of PsA participants at high risk for unrecognized PsA, including patients with less active disease, fewer disease features, and early disease. The third objective was to explore the abilities of the instruments to differentiate between PsA and other types of musculoskeletal disease. The final objective was to evaluate discrepancies between examination findings and responses to relevant instrument questions, to determine whether instrument performance(s) may be improved with question modification.

MATERIALS AND METHODS

Patient selection. This research used a prospective cross-sectional study design. Recruitment letters were mailed to 1213 people enrolled in the Utah Psoriasis Initiative (UPI) registry. Interested participants were invited to arrange an appointment with the principal investigator (JAW) for a rheumatologic evaluation. Patients with psoriasis attending dermatology and rheumatology clinics at the University of Utah were also invited to participate. Enrollment and evaluation occurred between December 1, 2009, and October 31, 2011. All patients with psoriasis documented by a dermatologist were eligible to participate. This research was conducted in compliance with the Declaration of Helsinki and with the approval of the University of Utah Institutional Review Board.

Data collection and measures. The PEST, ToPAS, and PASE instruments were assembled in random order into packets and completed by participants prior to a rheumatologic evaluation by the principal investigator. Previously established instrument cutoff scores were used to designate positive and negative instrument classifications. Positive instrument classifications indicated a high risk for PsA and negative instrument classifications indicated a low risk for PsA.

The rheumatologic evaluation included a history and a physical examination. All participants also completed the Psoriatic arthritis Quality of Life (PsQOL) questionnaire. Laboratory and imaging tests were requested when clinically indicated. Historical disease features were ascertained with participant interviews and medical record review. Historical data included age, sex, date of arthritis symptom onset, a history of PsA diagnosed by a rheumatologist, date of PsA diagnosis, medication history, personal history of psoriasis, inflammatory back pain, morning stiffness ≥ 30 min, sausage digit(s), heel tenderness, nail pitting, tender joint(s), swollen joint(s), and family history of psoriatic disease. Inflammatory back pain was defined as pain for > 3 months with ≥ 4 of the 5 following characteristics: (1) age of onset < 40 years, (2) insidious onset, (3) improvement with exercise, (4) no improvement with rest, and (5) pain at night (with improvement upon getting up)[12].

The number of PsA features ranged from 0 to 6 and included patient reports of current or past joint tenderness and/or swelling, inflammatory back pain, morning stiffness ≥ 30 min, sausage digit(s), heel tenderness, and nail pitting. Discrepancies in historical data between patient report and medical records were adjudicated with participants during study visits or a followup telephone interview.

Data collected from examination included tender joint count, swollen joint count, dactylitis, enthesitis, nail pitting, body surface area of psoriasis, and static physician global assessment (PGA). The PGA score ranged from 0 to 5 and was determined by averaging the erythema, induration, and desquamation scores of psoriasis lesions across all body sites. Imaging was not required, but available musculoskeletal imaging data were used by investigators for diagnostic assessments.

The diagnostic assessment included the assignment by the principal investigator of each participant into categories of PsA, no PsA, or unclear diagnosis after the interview, examination, and review of medical records. All cases with unclear diagnoses were adjudicated by a co-investigator with expertise in PsA (DOC). Cases with discrepancies between any screening instrument classification and the principal investigator's diagnostic assessment were also adjudicated. Discrepancies were defined as a positive instrument classification in a participant without PsA or a negative instrument classification in a participant with PsA. Adjudication included detailed reviews of medical records, imaging, and study documents. Participants were excluded if there was disagreement between the diagnostic assessment of the principal investigator and the rheumatology co-investigator. Alternative diagnoses were made if the principal investigator considered an alternative diagnosis to be more likely than PsA. ClASsification criteria for Psoriatic ARthritis (CASPAR)[13] and axial Assessment of SpondyloArthritis international Society (ASAS) criteria[14] were applied to participants who had sufficient data available to make these assessments.

Data analyses. Sensitivities and specificities were calculated for each instrument, using the rheumatologists' diagnostic assessments as the reference standard. PEST scores ≥ 3, ToPAS scores ≥ 8, and PASE scores ≥ 47 were considered positive classifications. These cutoff scores were established in the investigations in which PEST, ToPAS, and PASE were developed[8,9,10]. Because an alternative cutoff score of ≥ 44 was recommended in a validation study of PASE[11], the sensitivity and specificity of PASE were also calculated using a cutoff score of ≥ 44 ($PASE_{44}$). For all subgroup analyses, data using the PASE cutoff score of ≥ 47 ($PASE_{47}$) are shown.

Sensitivity and specificity analyses were calculated using Excel 2007 software. Student's t test was used to compare continuous variables, and Fisher's exact test was used for categorical variables. Screening instruments were excluded from analyses if missing answers had the potential to change the outcome. Missing historical data were collected in followup telephone interviews. Missing data about the disease state at the time of the evaluation were excluded from analyses of the relevant disease feature.

RESULTS

Patient population. Two hundred thirteen participants completed the instruments and a rheumatologic evaluation by the principal investigator (Figure 1). The principal investigator assigned 191 participants to the diagnostic categories of PsA or no PsA. The diagnosis was unclear in 22 patients. Of the 22 in the unclear diagnosis category, 14 (59%) had a history consistent with PsA, but they lacked both objective evidence of inflammatory arthritis and a more likely alternative diagnosis. Nine of the 22 (41%) had objective evidence of inflammatory arthritis, but it was unclear whether it was PsA or an alternative diagnosis, such as gout, rheumatoid arthritis, calcium pyrophosphate disease, septic arthritis, or enteropathic arthritis. The principal investigator and rheumatology co-investigator agreed that the diagnosis of PsA or no PsA was uncertain in all 22 cases in the unclear diagnosis category.

Instrument classifications (PsA or no PsA) were compared to the principal investigator's diagnosis in 191 patients with diagnoses of PsA and no PsA. The principal investigator's diagnosis agreed with the classification from all 3 instruments in 53 cases; these were included in the

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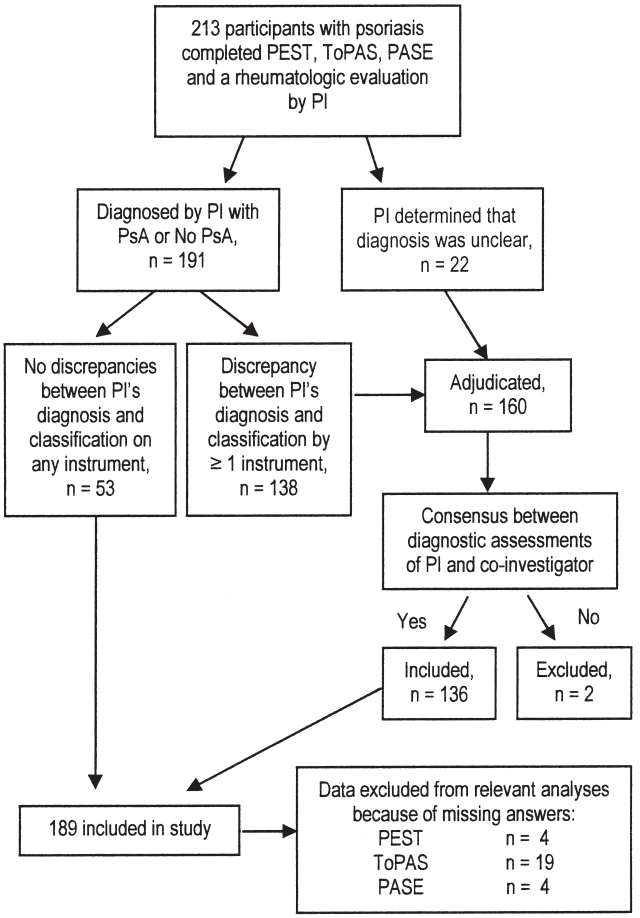

Figure 1. Study profile. PEST: Psoriasis Epidemiology Screening project; ToPAS: the Toronto Psoriatic Arthritis Screen; PASE: Psoriatic Arthritis Screening and Evaluation; PI: principal investigator.

study per protocol. Diagnostic adjudication by the co-investigator was carried out in 138 participants because of discrepancies between the principal investigator's diagnosis and the classification from one or more instrument(s). Disagreement between the diagnostic assessments of the principal investigator and the rheumatology co-investigator occurred in 2 of the adjudicated cases. One of these patients had unexplained subtle monoarticular joint swelling without extraarticular disease features, and he declined testing. The second patient had arthralgias while taking methotrexate and infliximab, and an indistinct lesion on hand imaging that may have been an erosion or a cyst. Those 2 cases were then excluded.

A total of 189 participants were included in our study. Exclusions from relevant analyses for unanswered questions occurred with 4 participants with PEST, 19 participants with ToPAS, and 4 participants with PASE. Among the 189 participants included in the analyses, 32 (17%) were not enrolled in the UPI prior to our study and were recruited at the time of the first encounter with the principal investigator in a rheumatology or combined rheumatology/dermatology clinic.

One hundred thirty-seven (64%) screened participants had PsA. The mean duration of arthritis symptoms was 13.5 years in patients with PsA, 13.0 years in participants without PsA, and 8.9 years in participants with an unclear diagnosis (Table 1). A previous diagnosis of PsA by a rheumatologist was reported by 66% of patients with PsA, 4% of participants without PsA, and 9% of participants with an unclear diagnosis. CASPAR criteria were fulfilled in 93% of the patients with PsA, 12% of participants without PsA, and 59% of participants with an unclear diagnosis. Among participants with sufficient data to apply axial ASAS criteria, criteria were fulfilled in 41% of PsA participants, 5% of participants without PsA, and 9% of participants with an unclear diagnosis. Methotrexate was used at the time of evaluation by 31% of patients with PsA, 15% of participants without PsA, and 32% with an unclear diagnosis. Tumor necrosis factor (TNF) inhibitors were used at the time of evaluation by 37% of patients with PsA, 22% of participants without PsA, and 23% of participants with an unclear diagnosis.

Sensitivities and specificities. Sensitivities for PEST, ToPAS, $PASE_{47}$, and $PASE_{44}$ were 85%, 75%, 68%, and 78%, respectively (Table 2). Specificities for PEST, ToPAS, $PASE_{47}$, and $PASE_{44}$ were 45%, 55%, 50%, and 40%. In the subset of participants who did not report a previous diagnosis of PsA, the sensitivities of PEST, ToPAS, $PASE_{47}$, and $PASE_{44}$ were 69%, 60%, 63%, and 76%, and the specificities were 47%, 55%, 52%, and 41%. Among participants without a previous diagnosis of PsA and without current immunomodulator therapy, the sensitivities of PEST, ToPAS, $PASE_{47}$, and $PASE_{44}$ were 70%, 60%, 62%, and 73% and the specificities were 55%, 52%, 60%, and 47%. In the 9 PsA participants who did not fulfill CASPAR criteria, the sensitivities were 55% for PEST, 33% for ToPAS, 44% for $PASE_{47}$, and 55% for $PASE_{44}$.

Disease activity and PsA features in PsA participants. Phenotypic features of PsA participants who screened positively and negatively for each instrument are shown in Table 3. Several measures of current disease activity were higher or more frequent in participants who screened positively on the instruments, compared to patients who screened negatively. Specifically, tender joint counts were higher in participants with true-positive classifications than false-negative classifications for PEST (11.4 vs 4.4) and $PASE_{47}$ (11.6 vs 6.3). Dactylitis at the time of evaluation was more common in participants with true-positive classifications for all instruments (PEST 25% vs 0, ToPAS 28% vs 3%, $PASE_{47}$ 28% vs 7%). PsQOL scores were higher in participants with true-positive classifications than false-negative classifications for PEST (8.4 vs 5.7), ToPAS (8.7 vs 6.1), and $PASE_{47}$ (10.1 vs 4.7). The number of

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Table 1. Baseline demographics and characteristics. Data are no. ± SD, or n (%).

	PsA	n	No PsA	n	Unclear Diagnosis	n
Age, yrs	50.7 ± 13.4	137	54.5 ± 16.7	52	55.5 ± 12.9	22
Male	60 (44)	137	17 (33)	52	14 (64)	22
Yrs since psoriasis diagnosed	19.9 ± 15.6	129	20.4 ± 17.4	49	24.6 ± 13.7	20
Yrs of arthritis symptoms	13.5 ± 13.8	137	13.0 ± 11.7	52	8.9 ± 11.1	22
Prior PsA diagnosis	91 (66)	137	2 (4)	52	2 (9)	22
CASPAR	125 (93)	134	6 (12)	51	13 (59)	22
ASAS, axial	33 (41)	81	1 (5)	19	2 (9)	22
Tender joint count	10.4 ± 11.6	137	10.1 ± 17.0	52	3.3 ± 3.6	22
Swollen joint count	3.6 ± 6.1	137	0.3 ± 0.7	52	0.9 ± 1.2	22
Nail pitting, current	69 (51)	134	20 (43)	47	13 (62)	21
Psoriasis, current	120 (88)	137	43 (80)	52	19 (86)	22
PGA	1.5 ± 1.0	137	1.3 ± 0.8	52	2.0 ± 1.4	22
Body surface area	4.1 ± 9.1	137	3.1 ± 4.4	52	4.2 ± 6.1	22
PsQOL	8.4 ± 6.1	136	6.7 ± 6.1	51	6.9 ± 5.8	22
MTX, current	43 (31)	137	8 (15)	52	7 (32)	22
TNF inhibitor, current	51 (37)	137	11 (21)	52	5 (23)	22
Ustekinumab, current	6 (3)	137	2 (4)	52	0	22
Other current immunomodulators*	3 (2)	137	1 (2)	52	1 (5)	22

* Other immunomodulators included cyclosporine, sulfasalazine, and hydroxychloroquine. PsA: psoriatic arthritis; CASPAR: ClASsification criteria for Psoriatic ARthritis; ASAS: Assessment of Spondyloarthritis International Society; PsQOL: psoriatic arthritis quality of life; PGA: physician global assessment; MTX: methotrexate; TNF: tumor necrosis factor.

Table 2. Sensitivity and specificity of screening instruments. Data are percentage (95% CI).

	All Participants, n = 170–185		Participants Without Previous PsA Diagnosis, n = 88–95		Participants Without Previous PsA Diagnosis and Without Current Immunomodulators, n = 54–58	
	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
PEST	85 (79–91)	45 (31–59)	69 (56–82)	47 (33–61)	70 (53–88)	55 (37–72)
ToPAS	75 (67–82)	55 (41–70)	60 (53–81)	55 (35–65)	60 (41–79)	52 (34–70)
$PASE_{47}$	68 (61–76)	50 (36–64)	63 (47–75)	52 (44–72)	62 (39–75)	60 (42–78)
$PASE_{44}$	78 (73–86)	40 (26–53)	76 (57–83)	41 (32–61)	73 (51–85)	47 (29–65)

PsA: psoriatic arthritis; PEST: Psoriasis Epidemiology Screening project; ToPAS: the Toronto Psoriatic Arthritis Screen; PASE: Psoriatic Arthritis Screening and Evaluation.

patient-reported PsA disease features was higher in participants with true-positive classifications for each instrument, compared to false-negative classifications (PEST 3.6 vs 2.7, ToPAS 4.0 vs 2.8, $PASE_{47}$ 4.0 vs 2.7).

Types of musculoskeletal disease in patients without PsA. Similar numbers of participants with osteoarthritis (OA) screened positively and negatively on the instruments (Table 4). Higher proportions of participants with fibromyalgia (FM) and other types of inflammatory arthritis screened positively than negatively, but the differences were not statistically significant. The presence of other types of musculoskeletal disease including bursitis, injury, degenerative disk disease, and spinal stenosis associated with true-negative classifications for PEST (41% vs 7%).

Discrepancies between question responses and examination findings. Table 5 summarizes the discrepancies between examination findings and responses to relevant instrument questions in participants with active disease feature(s) at the time of examination. Among participants with swollen and tender joints, the number of participants indicating that they did not have peripheral arthritis was higher for ToPAS (24%) than PEST (3%) and $PASE_{47}$ (4%). Discrepancies between dactylitis on examination and corresponding question responses were infrequent for each instrument.

DISCUSSION

The UPI is a registry of over 1200 participants with psoriasis who have never been systematically screened for

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Table 3. Disease activity, psoriatic arthritis features, and disease duration in patients with PsA. Data are no. ± SD or no. (%).

	PEST			ToPAS			$PASE_{47}$		
	True-Positive, n = 112–115	False-Negative, n = 20	p	True-Positive, n = 89–91	False-Negative, n = 30–31	p	True-Positive, n = 89–92	False-Negative, n = 43	p
Disease activity at the time of evaluation									
TJC	11.4 ± 12.3	4.4 ± 2.8	0.02	8.8 ± 11.8	7.0 ± 10.1	0.46	11.6 ± 12.5	6.3 ± 6.4	0.05
SJC	4.9 ± 6.9	1.9 ± 1.6	0.09	4.1 ± 7.1	2.1 ± 3.0	0.14	5.1 ± 0.2	2.4 ± 2.4	0.08
Dactylitis	29 (25)	0	< 0.01	25 (28)	1 (3)	< 0.01	26 (28)	3 (7)	< 0.01
Heel enthesitis	36 (31)	3 (15)	0.11	27 (30)	11 (35)	0.45	30 (33)	10 (23)	0.18
Nail pitting	61 (54)	7 (35)	0.09	54 (61)	9 (30)	0.003	44 (49)	24 (56)	0.31
PsQOL	8.4 ± 6.0	5.7 ± 5.8	0.05	8.7 ± 5.6	6.1 ± 5.8	0.02	10.1 ± 5.3	4.7 ± 7.2	< 0.001
PGA	1.5 ± 1.0	1.4 ± 1.0	0.77	1.5 ± 1.0	1.7 ± 1.1	0.46	1.5 ± 1.0	1.3 ± 0.9	0.19
BSA	4.5 ± 9.9	1.6 ± 1.8	0.20	4.3 ± 10.3	3.3 ± 6.1	0.63	5.1 ± 10.8	2.1 ± 3.0	0.08
PsA features (patient-reported, past or present)									
Joint pain or swelling	114 (99)	19 (95)	0.28	90 (99)	30 (97)	0.45	92 (100)	41 (95)	0.10
Inflammatory back pain	52 (45)	7 (35)	0.47	42 (46)	14 (45)	1.00	50 (54)	10 (23)	< 0.001
Morning stiffness ≥ 30 min	90 (78)	14 (68)	0.40	68 (74)	22 (70)	0.81	79 (86)	20 (48)	< 0.001
Sausage digits	61 (53)	3 (15)	< 0.01	53 (58)	3 (10)	< 0.001	52 (57)	12 (28)	< 0.01
Heel tenderness	57 (50)	6 (30)	0.15	46 (51)	16 (52)	1.00	50 (54)	14 (33)	0.03
Nail pitting	67 (58)	7 (35)	0.09	61 (67)	9 (29)	0.003	49 (53)	24 (56)	0.85
No. PsA features	3.6 ± 1.3	2.7 ± 1.0	< 0.001	4.0 ± 1.2	2.8 ± 1.2	< 0.001	4.0 ± 1.2	2.7 ± 1.2	< 0.001
Yrs of arthritis symptoms	15.6 ± 19.0	8.8 ± 10.5	0.12	14.4 ± 14.4	8.0 ± 8.4	0.02	15.2 ± 19.3	12.5 ± 13.0	0.38
Immunomodulator, current	55 (48)	8 (40)	0.34	46 (51)	10 (32)	0.28	46 (50)	17 (40)	0.16

PsA: psoriatic arthritis; TJC: tender joint count; SJC: swollen joint count; PsQOL: Psoriatic arthritis Quality of Life; PGA: physician global assessment; BSA: body surface area; PEST: Psoriasis Epidemiology Screening project; ToPAS: the Toronto Psoriatic Arthritis Screen; PASE: Psoriatic Arthritis Screening and Evaluation.

Table 4. Types of musculoskeletal disease in participants without PsA. Data are no. (%).

	PEST			ToPAS			$PASE_{47}$		
	True-Negative, n = 22	False-Positive, n = 27	p	True-Negative, n = 21	False-Positive, n = 26	p	True-Negative, n = 24	False-Positive, n = 24	p
Osteoarthritis	9 (41)	9 (33)	0.46	8 (38)	9 (35)	0.68	11 (46)	7 (29)	0.30
Fibromyalgia	2 (9)	8 (30)	0.13	2 (10)	8 (31)	0.14	2 (8)	8 (33)	0.08
Other inflammatory arthritis*	2 (9)	8 (30)	0.13	3 (14)	6 (23)	0.40	3 (13)	7 (29)	0.21
Other musculoskeletal disease**	9 (41)	2 (7)	0.03	8 (38)	3 (12)	0.09	8 (33)	2 (8)	0.08

* Other inflammatory arthritis types included gout, pseudogout, erosive OA, and hepatitis C. ** Other types of musculoskeletal disease included bursitis, injury, degenerative disk disease, and spinal stenosis. PsA: psoriatic arthritis; PEST: Psoriasis Epidemiology Screening project; ToPAS: the Toronto Psoriatic Arthritis Screen; PASE: Psoriatic Arthritis Screening and Evaluation.

Table 5. Discrepancies between examination findings and responses to instrument questions in participants with active disease feature(s). Data are n (%).

Active Disease Feature on Examination	PEST	n	ToPAS	n	$PASE_{47}$	n	PEST-ToPAS p	PEST-$PASE_{47}$ p	ToPAS-$PASE_{47}$ p
SJC and TJC	3 (3)	103	24 (24)	99	4 (4)	104	< 0.001	1.00	< 0.001
Sausage digit(s)	0	29	2 (7)	29	1 (3)	29	0.49	1.00	1.00
Nail pitting	12 (13)	89	9 (11)	83	NA	NA	0.65	NA	NA
Heel enthesitis	9 (21)	42	NA	NA	NA	NA	NA	NA	NA
Psoriasis	NA	NA	10 (6)	159	NA	NA	NA	NA	NA

PEST: Psoriasis Epidemiology Screening project; ToPAS: the Toronto Psoriatic Arthritis Screen; PASE: Psoriatic Arthritis Screening and Evaluation; TJC: tender joint count; SJC: swollen joint count; NA: not available.

psoriatic arthritis. The prevalence of PsA in this population is estimated at 27%, based on patient report at the time of enrollment. Many enrolled patients also report joint symptoms without a formal diagnosis of PsA. Given the importance of early recognition and treatment of PsA, we wanted to implement a screening strategy to help identify

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patients with PsA. Specifically, we aimed to evaluate the performance of PASE, PEST, and ToPAS in a registry-based population.

The primary goal for our study was to determine the sensitivities and specificities of the 3 screening instruments in the UPI. We found that the instrument sensitivities and specificities were lower than reported in the studies in which the instruments were developed and validated. The lower specificities were likely caused by the high prevalence of musculoskeletal disease in this population. Although we invited all members of the registry to participate, only patients with musculoskeletal complaints volunteered for a rheumatologic evaluation. Because several types of musculoskeletal disease may mimic PsA, the high prevalence of musculoskeletal disease likely contributed to the low specificities in this population.

A wide diversity of PsA phenotypes may have contributed to the lower instrument sensitivities in this population. The inclusion of patients with PsA who did not meet CASPAR criteria increased the phenotype diversity. CASPAR criteria were developed to identify relatively homogeneous populations of patients with PsA for research purposes. CASPAR criteria were fulfilled by all patients with PsA from the ToPAS PsA clinics and all newly diagnosed patients with PsA from the PEST study. In contrast, 7% of patients with PsA in our study did not meet CASPAR criteria because of less typical disease phenotypes. Because the instrument sensitivities in our study were low in the participants who did not meet CASPAR criteria (33% to 55%), the inclusion of these patients with more diverse phenotypes reduced the overall instrument sensitivities.

PEST, ToPAS, and PASE were also recently compared by Haroon, *et al*[15] in a psoriasis population without established PsA. Consecutively encountered patients from a dermatology clinic were recruited. The Haroon study reported lower sensitivities (24%–41%) than those in the initial instrument validation studies (76%–92%) and in the subset of our population without a previous PsA diagnosis (60%–76%)[8,9,10,11]. We suspect that these sensitivity differences were due to differences in the study populations, because they were recruited differently, had varying patterns of immunomodulator use, and had different durations of psoriasis.

Strategies for improving PsA recognition ideally target the patients at highest risk for unrecognized disease. Therefore, the second objective was to compare the instrument performances in phenotypic subsets of PsA that may be challenging for patients and providers to recognize. In particular, we analyzed the instrument performances in participants with less active disease at the time of evaluation, fewer patient-reported disease features, and shorter disease duration. Identifying PsA in patients with less active disease is important because PsA is characterized by flares interspersed with periods of less active disease. Additionally, joint damage does not consistently mirror the severity of symptoms and may occur in patients who perceive their disease to be inactive. Patients with only 1 or 2 disease features are important to recognize because their symptoms and outcomes may be as severe as those of patients with multiple disease features. Finally, early disease recognition and therapy are important for symptom reduction and prevention of joint damage. Our analysis demonstrated that the instruments were less successful in patients at high risk for unrecognized PsA. These findings highlight the challenges of identifying PsA in patients with early or more subtle disease and suggest that these patient subsets should be specifically considered in future efforts to improve disease recognition.

The third study objective was to determine how well the instruments differentiated between PsA and other types of musculoskeletal disease. We anticipated that patients with other types of inflammatory arthritis would frequently screen positively on the instruments, because other types of inflammatory arthritis may closely mimic PsA in patients with psoriasis. We consider false-positive classifications in patients with other types of inflammatory arthritis acceptable, because a simple instrument is unlikely to differentiate between the subtleties of various types of inflammatory arthritis, and patients with inflammatory arthritis would likely benefit from a referral to a rheumatologist. However, an efficient screening instrument should discriminate between PsA and other types of musculoskeletal disease, including OA and FM. As expected, our data demonstrated that participants with other types of inflammatory arthritis more frequently screened positively than negatively on the instruments. The instruments were useful for differentiating PsA from other types of musculoskeletal disease, including bursitis, injury, degenerative disk disease, and spinal stenosis. However, the instruments did not adequately differentiate PsA from OA or FM.

The fourth objective was to investigate the performance of specific questions on each instrument to determine whether the screening instrument(s) may be improved by modifying questions. We found that discrepancies between responses to peripheral arthritis questions and examination findings occurred more frequently with ToPAS than with PEST or PASE. This likely reflects differences in the wording of the questions. The PEST question asks about swollen joints, the PASE question asks about painful joints, and the ToPAS question asks about swollen and red joints. These data suggest that the wording of specific questions may be altered to improve instrument performances.

Our study has limitations that must be considered. The primary limitation is that the study population was not representative of the general psoriasis population. Because this institution is a referral center for psoriatic diseases, the study population likely included patients with moderate to

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severe psoriasis who may have had a higher prevalence of PsA[15]. Additionally, there was a selection bias toward patients with musculoskeletal symptoms. Patients with undiagnosed or inadequately controlled musculoskeletal disease were motivated to participate because of immediate access to a free rheumatology evaluation. While this population is not representative of all patients with psoriasis, it may be similar to the subset of such patients who are likely to use a screening instrument and follow through with a rheumatology referral. Therefore, our findings may reflect instrument outcomes in real-life settings.

This investigation was also limited by a study population that did not closely represent a screening population of psoriasis patients with potentially unrecognized PsA, because patients with previously diagnosed PsA were included. To address this limitation, we analyzed the subset of participants without previously diagnosed PsA; the sensitivities and specificities were lower or similar in this subset compared to the entire study population. Therefore, the inclusion of previously diagnosed patients with PsA did not change our conclusion that PEST, ToPAS, and PASE are not well suited for PsA screening in our population of psoriasis patients with musculoskeletal complaints.

There continues to be an unmet need for methods of improving recognition of PsA. A simple instrument administered by patients and/or psoriasis providers is ideal for facilitating PsA risk assessments that enable earlier diagnoses of PsA. Further analyses may identify the most effective questions from each instrument and enable the development of efficient strategies for identifying PsA in psoriasis patients with musculoskeletal symptoms.

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