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ORIGINAL RESEARCH

A Study on Early Screening and Disease Characteristics of Psoriatic Arthritis Based on PEST Questionnaire and Musculoskeletal Ultrasound

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Background: Psoriatic arthritis (PsA) is a chronic inflammatory joint disease associated with psoriasis. Early diagnosis is crucial for preventing structural joint damage and improving long-term prognosis.

Aim: This retrospective study applied the Psoriasis Epidemiology Screening Tool (PEST) combined with musculoskeletal ultrasound (MSUS) to identify early PsA and analyze differences in clinical and ultrasonographic features among patient subgroups.

Methods: Psoriasis outpatients with a PEST score ≥1, who presented to the dermatology department between September 2022 and December 2023, were enrolled and underwent systematic MSUS examination covering 68 joints, 54 tendons, and 56 entheses. Based on MSUS findings and the Classification Criteria for Psoriatic Arthritis (CASPAR) criteria, patients were classified into high-risk PsA, subclinical PsA, and clinical PsA groups. Baseline characteristics, lesion distribution, and types were compared.

Results: Among 178 included patients, 143 (80.34%) showed abnormal MSUS findings. The clinical PsA group had a significantly higher proportion of patients over 40 years compared to the high-risk PsA group (P=0.002) and subclinical PsA group (P<0.001). Nail involvement was less frequent in the high-risk PsA group compared to the clinical PsA group (P=0.026) and subclinical PsA group (P=0.055). In patients with abnormal MSUS findings, the knees, metatarsophalangeal, and metacarpophalangeal joints were the most commonly affected sites. Hand proximal interphalangeal joint involvement was significantly more frequent in clinical PsA than in subclinical PsA (P=0.035). Enthesitis, synovitis, and joint effusion were predominant in both subclinical PsA and clinical PsA groups, but synovitis (P=0.008) was significantly more common in clinical PsA.

Conclusion: Using a PEST score ≥1 as a screening threshold enables MSUS to effectively identify substantial subclinical and clinical lesions in psoriasis patients, thereby facilitating the early, broad detection of high-risk PsA individuals.

Keywords: psoriatic arthritis, psoriasis epidemiology screening tool, musculoskeletal ultrasound, high-risk factors, sub-clinical PsA

Introduction

Psoriatic arthritis (PsA) is a chronic, systemic autoimmune inflammatory disorder associated with psoriasis (PsO). In approximately 75% of patients, skin lesions precede the onset of arthritis, while simultaneous occurrence is observed in about 15%, and arthritis precedes skin manifestations in approximately 10% of cases.[1] It is estimated that 5% to 42% of psoriasis patients will eventually develop PsA.[2] The core pathological features include synovitis, enthesitis, tenosynovitis, and dactylitis, often accompanied by characteristic skin and nail lesions. The clinical presentation of PsA is highly

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heterogeneous, with a variable disease course that can lead to progressive structural joint damage and functional impairment.[3,4]

PsA is a complex disease characterized by a multifactorial etiology and interconnected pathological circuits. Against a background of genetic susceptibility, environmental exposures like mechanical stress, smoking, and infection trigger aberrant immune responses.[5] Inflammation of the synovium and entheses constitutes the core pathological site, involving angiogenesis, aggressive proliferation of fibroblast-like synoviocytes, and sustained activation of the Th17 axis. These processes ultimately lead to cartilage degradation, bone resorption, and pathological new bone formation.[6] Advances in understanding these key mechanisms have facilitated the development of numerous targeted therapies, ranging from TNF-α inhibition and IL-23/IL-17 pathway blockade to JAK inhibitors and angiogenesis inhibitors, all of which have demonstrated significant efficacy in clinical practice.[7]

The diagnosis of PsA relies on a comprehensive assessment incorporating clinical features, imaging findings, and laboratory tests.[8] With advances in the understanding of PsA pathophysiology, international rheumatology organizations, including the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis (GRAPPA) and the European Alliance of Associations for Rheumatology (EULAR), have developed classification criteria and assessment tools specifically for PsA. The most widely accepted classification criteria are the Classification Criteria for Psoriatic Arthritis (CASPAR) criteria, established in 2006, which demonstrate high sensitivity and specificity.[9,10] According to the latest EULAR expert consensus,[11] the development of PsA is categorized into three stages: people with PsO at high-risk PsA, subclinical PsA, and clinical PsA. Factors such as nail involvement, obesity, PsO severity, and family history of PsA may be more strongly associated with medium- to long-term PsA risk, whereas arthralgia and subclinical imaging-confirmed disease may be more relevant to short-term PsA risk. Patients in the subclinical stage experience arthralgia and/or imaging findings suggestive of synovitis or enthesitis. Those in the clinical stage meet the CASPAR diagnostic criteria, exhibiting clinical symptoms of arthritis, such as persistent joint swelling, pain, and morning stiffness.

Despite widespread recognition of the importance of PsA, significant underdiagnosis and diagnostic delays persist among psoriasis patients. Some individuals are not diagnosed with PsA until 10 years or more after their initial psoriasis diagnosis.[12] Early identification is crucial for improving prognosis, and evidence suggests that a diagnostic delay exceeding 6 months may lead to irreversible joint structural damage.[13] However, the reality remains concerning, with multiple studies consistently reporting that approximately 10.1% to 15.5% of PsO patients with concomitant PsA remain undiagnosed.[14,15] Current research primarily focuses on clinical PsA, yet subclinical PsA represents a precursor stage to clinical disease. Early identification and progression screening during this phase are key to preventing joint structural damage and reducing long-term disability risk.[16]

Magnetic resonance imaging (MRI) is the gold standard for assessing bone marrow edema and pathological changes in deep joints such as the sacroiliac joints.[17] However, its high cost, long acquisition time, and high patient compliance requirements make it challenging to implement on a large scale in dermatology outpatient settings. In contrast, high-resolution musculoskeletal ultrasound (MSUS) is more suitable for early screening due to its convenience, cost-effectiveness, and reproducibility. MSUS can not only detect structural changes such as joint effusion and bone erosion using gray-scale imaging but also assess subclinical inflammatory activity in real time with power Doppler technology.[18,19] Studies have shown that MSUS has high sensitivity comparable to MRI in detecting peripheral joint, tendon, and entheseal abnormalities, and it offers unique advantages in dynamic assessment.[17,20,21] As a result, MSUS has been included as a core imaging tool for PsA by EULAR. Given that this study focuses on early screening in dermatology outpatient settings and primarily targets peripheral joint involvement, we selected MSUS as the imaging modality to balance diagnostic accuracy with study feasibility.

To enhance the efficiency of early identification, various questionnaire-based screening tools have been developed internationally. Among these, the Early Arthritis for Psoriatic patients (EARP) questionnaire is known for its high sensitivity, particularly in capturing subtle symptoms such as morning stiffness,[22] while tools like Psoriatic Arthritis Screening and Evaluation (PASE) also have distinct strengths. Among the available options, the Psoriasis Epidemiology Screening Tool (PEST) was selected for this study due to its unique structural advantages and extensive clinical validation.[23] PEST includes specific questions addressing core features of PsA, such as dactylitis, nail lesions, and enthesitis, and innovatively incorporates a human body diagram (manikin) that allows patients to mark painful areas

directly.[24] This design not only helps reduce information bias caused by differences in language comprehension but also provides rheumatologists with intuitive references for subsequent precise assessment. Moreover, PEST has demonstrated balanced sensitivity and specificity in multiple large-scale population studies and is recommended by authoritative guidelines,[23] including those from the EULAR, ensuring strong international comparability for the findings of this study.

In this context, it is particularly crucial for dermatologists to systematically employ simple and sensitive PsA screening tools during follow-up visits with psoriasis patients and to provide clear usage guidance. Therefore, this study aims to investigate whether a positive PEST score combined with musculoskeletal ultrasound can assist clinicians in identifying early PsA patients.

Patients and Methods

Study Design

This study is a single-center retrospective study conducted at the Department of Dermatovenereology, Tianjin Medical University General Hospital. As a tertiary care hospital, this center has a well-established dermatology-rheumatology multidisciplinary team (MDT) mechanism, as well as a standardized musculoskeletal ultrasound image database and an electronic medical records (EMR) system, providing a reliable source for retrospective data extraction. The study population consisted of psoriasis patients who attended the dermatology outpatient clinic of this hospital between September 2022 and December 2023. All patients were diagnosed with psoriasis by dermatologists and had complete PEST questionnaire records and musculoskeletal ultrasound examination data. Based on MSUS findings and CASPAR criteria, patients were categorized into high-risk PsA, subclinical PsA, and clinical PsA groups (Figure 1). Detailed definitions of these groups are provided in Supplementary Table 1. Written informed consent was obtained from all participants for both participation in this study and the publication of the results. The study complied with the Declaration of Helsinki and was approved by the Ethics Committee of Tianjin Medical University General Hospital (Ethics No. IRB2022-YX-179-01).

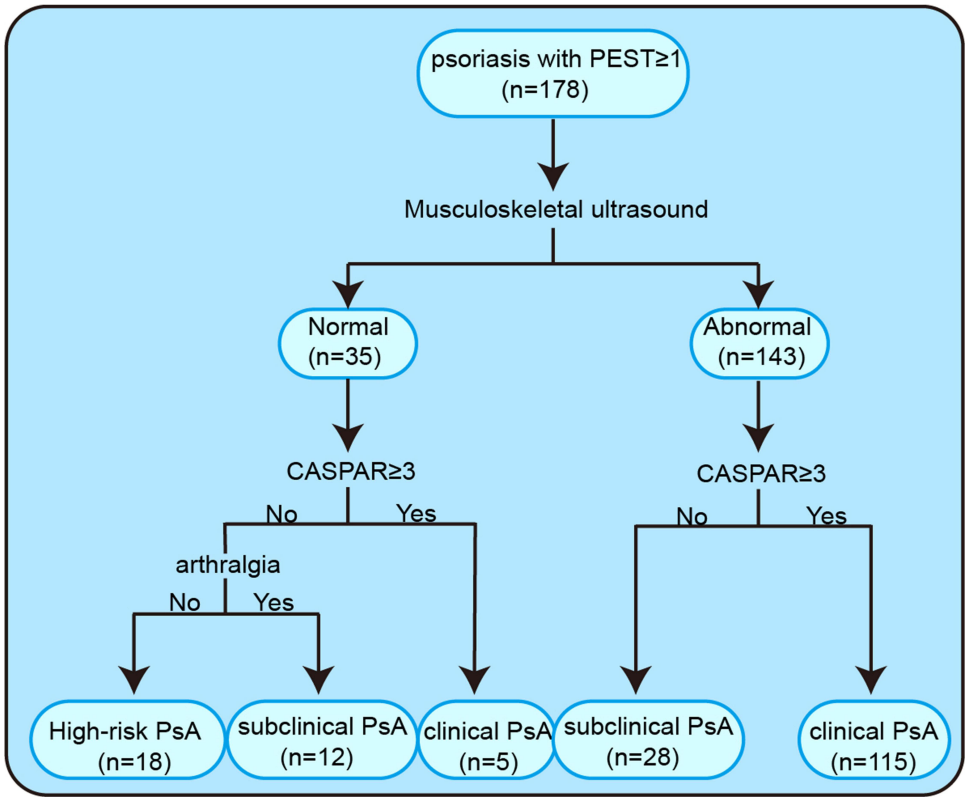

Figure 1 Flow chart.

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Patients

Inclusion and Exclusion Criteria

All patients (including those with clinical PsA) were required to meet the following inclusion and exclusion criteria.[25] Inclusion Criteria: (1) adult patients (≥18 years) with a confirmed diagnosis of psoriasis vulgaris established by a dermatologist based on typical clinical features. (2) PEST (detailed in Supplementary Table 2) score greater than or equal to 1. Exclusion Criteria: (1) Diagnosis of any other form of arthritis, including rheumatoid arthritis, osteoarthritis, gouty arthritis, ankylosing spondylitis, and similar conditions. (2) History of trauma or strenuous physical activity prior to the ultrasound examination. (3) Patients planning pregnancy, or those who are pregnant or lactating during the study period. (4) Patients diagnosed with malignant tumors or severe visceral organ dysfunction.

From an initial pool of psoriasis patients visiting our department during the study period, those with a documented PEST score ≥1 were assessed for eligibility. A total of 181 patients met all criteria and constituted the study.

Clinical Characteristics

Patient baseline characteristics were systematically recorded, including demographics (sex, age, height, weight), genetic history, and disease duration. Potential contributing factors, such as smoking, alcohol consumption, history of infection, psychological stressors, sleep disturbances, and work-related stress, were also documented. Disease severity and manifestations were assessed using the Psoriasis Area and Severity Index (PASI), along with the specific areas of skin involvement, and the presence of nail involvement, scalp involvement or inverse psoriasis.

Ultrasonographic Assessment

Articular ultrasound examinations were independently performed by two radiologists, both blinded to the patients' clinical information. Each radiologist possessed over five years of experience and had reached a consensus on the standardized ultrasound definitions employed in this study prior to the initiation of patient enrollment.

Examinations were conducted using a color Doppler ultrasound machine (IU22, Philips, Best, The Netherlands) equipped with a linear array transducer (5–17 MHz). The following standardized settings were applied: B-mode frequency of 12–15 MHz for superficial structures and 7–10 MHz for deeper joints; power Doppler settings were optimized for sensitivity with a pulse repetition frequency (PRF) of 500–750 Hz and low wall filters, and the color gain was adjusted just below the threshold of artifact appearance. During scanning, the transducer was positioned perpendicular to the skin surface over the examined area, with an adequate amount of coupling gel applied to ensure optimal acoustic interface quality.

All patients underwent a systematic MSUS examination covering 68 joints, 54 tendons, and 56 entheses. A comprehensive assessment was performed utilizing both longitudinal and transverse scans. The detailed scanning protocol, including anatomical sites and pathological definitions according to the Outcome Measures in Rheumatology (OMERACT) criteria, is provided in Supplementary Tables 3 and 4. Ultrasound data were collected as binary variables (present/absent), and all abnormal sites with corresponding pathological types were recorded.

To assess interrater reliability, a random sample of 30 patients (17%) was independently evaluated by both radiologists. The kappa (κ) value for the detection of overall MSUS abnormalities was 0.86 (95% CI: 0.79–0.93), indicating excellent agreement.

Statistical Analysis

Statistical analyses were performed using SPSS version 27.0. Continuous data are presented as mean ± standard deviation or median (25th percentile, 75th percentile) and were analyzed using the Student's *t*-test or Mann–Whitney *U*-test, as appropriate. Categorical data are expressed as numbers (percentages) and were compared using the chi-square test. A two-tailed P-value of less than 0.05 was considered statistically significant.

Results

Demographic and Clinical Characteristics

A total of 178 psoriasis patients with a PEST score ≥1 who underwent MSUS examination were included in this study. Among them, 35 (19.66%) patients showed normal MSUS findings, while 143 (80.34%) patients exhibited abnormal findings. Comparative analysis of baseline characteristics between the normal and abnormal MSUS groups (Table 1) revealed generally similar demographic and clinical profiles. However, patients in the abnormal group were significantly older ($P<0.001$), with a notably higher proportion being over 40 years of age ($P=0.002$).

Based on MSUS findings and CASPAR criteria, patients were categorized into three groups: high-risk PsA (18, 10.11%), subclinical PsA (40, 22.47%), and clinical PsA (120, 67.42%). The baseline clinical characteristics of all patients are detailed in Table 2. The results demonstrated overall similarity in demographic and clinical features between the high-risk and subclinical PsA groups, with no statistically significant differences observed. Comparative analysis between the high-risk and clinical PsA groups revealed that the high-risk group (5, 27.78%) had a significantly lower rate of nail involvement compared to the clinical PsA group (67, 55.83%, $P=0.026$). Although no statistical difference in nail involvement was found between the high-risk (5, 27.78%) and subclinical PsA groups (22, 55.00%, $P=0.055$), the prevalence in the subclinical group was twice that of the high-risk group. Furthermore, advanced age was identified as a risk factor in the clinical PsA (89, 74.17%) group, which showed a significantly higher proportion of patients aged ≥40 years compared to both the high-risk (7, 38.89%, $P=0.002$) and subclinical PsA groups (16, 40.00%, $P<0.001$). Comparison between subclinical and clinical PsA groups revealed that, in addition to demographic differences in age, the subclinical PsA group demonstrated significantly higher rates of current smoking ($P=0.022$), alcohol consumption ($P=0.020$), and reported work-related stress ($P=0.009$). Notably, across all three groups, over 80% of patients exhibited psoriasis lesions involving more than three body areas and scalp involvement.

Table 1 Clinical Features Analysis Based on the MSUS Results

Characteristics	MSUS Normal	MSUS Abnormal	*P*
Number of patients	35(19.66)	143(80.34)	
Gender			0.736
Male	18(51.43)	69(48.25)	
Female	17(48.57)	74(51.75)	
Age, years	38.09±10.34	47.83±15.32	<0.001
≥40 years	14(40.00)	98(68.53)	0.002
Psoriasis duration, years	10(5,16)	7(4,15)	0.182
BMI	24.69(22.3,27.78)	24(22,26)	0.218
BMI≥24	21(60.00)	70(48.95)	0.241
Family history of psoriasis	8(22.86)	33(23.08)	0.978
PASI	7.2(3.6,15)	6(4,14.85)	0.679
≥3 skin areas affected	31(88.57)	133(93.00)	0.601
Nail affected	14(40.00)	81(56.64)	0.077
Scalp affected	32(91.43)	117(81.82)	0.168
Inverse psoriasis	10(28.57)	40(27.97)	0.944
Current smoker	12(34.29)	36(25.17)	0.276
Current drinker	15(42.86)	38(26.57)	0.059
Infection	5(14.29)	22(15.38)	0.871
Psychological factors	9(25.71)	27(18.88)	0.367
Sleep disorder	13(37.14)	43(30.07)	0.419
Work pressure	11(31.43)	32(22.38)	0.262

Note: n (%), mean ± SD; M (P25, P75).
Abbreviations: MSUS, musculoskeletal ultrasound; BMI, body mass index; PASI, psoriasis area and severity index.

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Table 2 Clinical Features Analysis

Characteristics	High-Risk PsA	Subclinical PsA	PsA	*P*		
				High-Risk PsA vs Subclinical PsA	High-risk PsA vs PsA	Subclinical PsA vs PsA
Number of patients	18(10.11%)	40(22.47)	120(67.42)			
Gender				0.270	0.912	0.121
Male	8(44.44)	24 (60.00)	55 (45.83)			
Female	10(55.56)	16 (40.00)	65 (54.17)			
Age, years	38.44±8.85	41.10±12.87	18.6±15.62	0.431	<0.001	0.007
≥40 years	7(38.89)	16(40.00)	89(74.17)	0.936	0.002	<0.001
Psoriasis duration, years	13(3.75, 17)	10(5, 19.25)	7(4, 15.5)	0.428	0.871	0.258
BMI	25.03±3.57	24.53±3.54	24.54±3.33	0.621	0.562	0.992
BMI≥24	10(55.56)	20(50.00)	60(50.00)	0.695	0.660	1.000
Family history of psoriasis	3(16.67)	10(25.00)	28(23.33)	0.716	0.742	0.830
PASI	8.25(3.38,16)	8.2 (3.6, 15.6)	4.95 (3.6, 14.33)	0.870	0.532	0.191
≥3 skin areas affected	17(94.44)	34(85.00)	113(94.17)	0.558	1.000	0.133
Nail affected	5(27.78)	22(55.00)	67(55.83)	0.055	0.026	0.927
Scalp affected	15(83.33)	35(87.50)	99(82.50)	0.989	1.000	0.458
Inverse psoriasis	6(33.33)	13(32.50)	30(25.00)	0.950	0.643	0.354
Current smoker	6(33.33)	16(40.00)	26(21.67)	0.628	0.427	0.022
Current drinker	8(44.44)	17(42.50)	28(23.33)	0.890	0.106	0.020
Infection	2(11.11)	6(15.00)	18(15.00)	1.000	0.938	1.000
Psychological factors	4(22.22)	11(27.50)	20(16.67)	0.920	0.805	0.133
Sleep disorder	8(44.44)	15(37.50)	32(26.67)	0.617	0.121	0.193
Work pressure	6(33.33)	15(37.50)	21(17.50)	0.760	0.208	0.009

Note: n (%), mean ± SD; M (P25, P75).
Abbreviations: PsA, psoriatic arthritis; BMI, body mass index; PASI, psoriasis area and severity index.

Comparison of the Affected Sites of Subclinical PsA and Clinical PsA Under MSUS

Among patients with abnormal MSUS findings, patients who meet the CASPAR criteria were in the clinical PsA group, while the rest were in the subclinical PsA group. We systematically compared the distribution of abnormalities across various joint regions between these two groups, with the results summarized in Table 3. Regarding hand joints, the clinical PsA group (40,

Table 3 Analysis of MSUS Abnormalities in Various Region

Region	Subclinical PsA (n=28)	PsA (n=115)	*P*
Hand			
MCP	10(35.71)	47(40.86)	0.617
PIP	4(14.29)	40(34.78)	0.035
DIP	6(21.43)	32(27.83)	0.492
Wrist	5(17.86)	29(25.22)	0.412
Elbow	2(7.14)	13(11.30)	0.764
Foot			
MTP	11(39.29)	52(45.22)	0.571
PIP	4(14.29)	28(24.35)	0.745
DIP	5(17.86)	11(9.57)	0.699
Heel	2(7.14)	9(7.83)	0.903
Ankle	4(14.29)	22(19.13)	0.551
Knee	14(50.00)	50(43.48)	0.534

Note: n (%).
Abbreviations: MSUS, musculoskeletal ultrasound; PsA, psoriatic arthritis; MCP, Metacarpophalangeal Joint; PIP, Proximal Interphalangeal Joint; DIP, Distal Interphalangeal Joint; MTP, Metatarsophalangeal Joint.

Table 4 Analysis of Abnormal MSUS Results

	Subclinical PsA (n=28)	PsA (n=115)	*P*
Synovitis	4(14.29)	47(40.87)	0.008
Tenosynovitis	2(7.14)	15(13.04)	0.589
Enthesitis	9(32.14)	40(34.78)	0.792
Joint effusion	11(39.29)	56(48.70)	0.371
New bone formation	4(14.29)	21(18.26)	0.826

Note: n (%).
Abbreviations: MSUS, musculoskeletal ultrasound; PsA, psoriatic arthritis.

34.78%) demonstrated a significantly higher prevalence of ultrasound-detected abnormalities in the proximal interphalangeal joints compared to the subclinical PsA group (4, 14.29%, *P*=0.035). No statistically significant differences were observed in the occurrence of abnormalities in other hand joints, including the metacarpophalangeal joints (*P*=0.617), distal interphalangeal joints (*P*=0.492), wrists (*P*=0.412), and elbows (*P*=0.764). In the foot and lower limb joints, the prevalence of ultrasound abnormalities in the metatarsophalangeal joints (*P*=0.571), proximal interphalangeal joints (*P*=0.745) of the feet, distal interphalangeal joints (*P*=0.699) of the feet, heels (*P*=0.903), ankles (*P*=0.551), and knees (*P*=0.534) showed no statistically significant differences between the two groups. Furthermore, the knees, metatarsophalangeal joints, and metacarpophalangeal joints were the three most frequently involved sites in both groups, with abnormality rates exceeding 30% in each.

Comparison of Abnormal Lesion Types Between Subclinical PsA and Clinical PsA Under MSUS

A comparative analysis of lesion types was conducted between patients with abnormal MSUS findings in the subclinical PsA and clinical PsA groups, with detailed data presented in Table 4. Among the various ultrasonic abnormalities, the prevalence of synovitis was significantly higher in the clinical PsA group (4,14.29%) compared to the subclinical PsA group (47, 40.87%, *P*=0.008). In contrast, the incidence rates of other lesion types—including tenosynovitis (*P*=0.589), enthesitis (*P*=0.792), joint effusion (*P*=0.371), and new bone formation (*P*=0.826)—showed no statistically significant differences between the two groups. These findings suggest that synovitis represents a more characteristic ultrasonic alteration in the clinical PsA stage and may play a significant role in the progression from subclinical status to clinically manifest disease.

Discussion

Currently, most research focuses on patients who already meet the CASPAR classification criteria for clinical PsA, while there is considerably less attention on the earlier subclinical stage and the high-risk stage with only risk factors in the disease continuum. This leads to a delayed diagnostic window and missed opportunities for early intervention. This study concentrates on the early identification of psoriatic arthritis among psoriasis patients. Utilizing musculoskeletal ultrasound technology in a PEST questionnaire-positive (score ≥1) cohort, it systematically evaluates the distribution and characteristics of lesions across the high-risk, subclinical, and clinical stages.

The CASPAR criteria, established as the authoritative basis for PsA classification, did not incorporate ultrasonographic imaging standards at the time of their development. Research indicates that replacing or supplementing radiographic findings with ultrasound demonstrates comparable sensitivity and specificity of the CASPAR criteria for diagnosing PsA.[26] In recent years, ultrasound, advantaged by its absence of radiation and capacity for real-time visualization of synovitis, tenosynovitis, and enthesitis, has been proven to significantly enhance the sensitivity and specificity of early PsA diagnosis.[27] However, whole-body ultrasound screening requires relatively long examination times and involves higher equipment costs. Furthermore, the widespread lack of specialized equipment and proficient operators in primary care settings limits its application in large-scale screening.[28]

Therefore, this study introduced the PEST questionnaire as an efficient initial screening tool.[23] Our findings revealed that among psoriasis patients with a PEST score ≥1, the rate of abnormal musculoskeletal ultrasound findings was as high

as 80.34%, and 67.42% of these patients were ultimately diagnosed with clinical PsA. This suggests that regarding PEST-positive individuals as a key target population for potential PsA development is highly reasonable and clinically valuable. Notably, current studies suggest that a PEST score ≥3 points indicates a high probability of PsA,[15,29] which is attributed to its assessment items being highly focused on clinical manifestations involving joints and periarticular tissues (such as tendons and nails). This study analyzed the distribution of different PEST score ranges across the three groups (Table 5). The results showed that all individuals with a PEST score ≥3 were diagnosed clinical PsA, consistent with the aforementioned research conclusions. However, although this threshold demonstrates high specificity, its ability to identify early-stage or at-risk individuals is relatively limited. In contrast, setting the threshold at PEST ≥1 significantly improves screening sensitivity, enabling the detection of more individuals in the early stages of the disease. Therefore, this study focuses on the population with PEST scores ≥1. This approach broadens the scope of screening sensitivity, represents an innovative aspect of this study, and provides new epidemiological evidence for identifying PsA risk at an earlier stage.

This study identified a clear gradient effect in the performance of the PEST questionnaire for screening early PsA. Specifically, all 40 patients with a PEST score ≥3 (including 23 with a score of 3, 12 with a score of 4, and 5 with a score of 5) were diagnosed with clinical PsA according to the CASPAR criteria, yielding a positive predictive value of 100%. This finding indicates that a PEST score ≥3 provides a high level of diagnostic certainty for identifying PsA patients with characteristic clinical manifestations. In clinical practice, such patients with elevated scores may be directly referred to rheumatology or considered for clinical intervention, thereby reducing reliance on time-consuming imaging to some extent and optimizing the allocation of medical resources.

However, the primary objective of this study was to identify early and subclinical PsA. If a PEST score ≥3 were used as the sole screening threshold, 80 patients with scores of 1–2 who were ultimately diagnosed with PsA would have been missed, accounting for 66.7% of all confirmed PsA cases in our cohort. Notably, among the 155 patients with a PEST score of 1, 55 (35.5%) were still diagnosed with PsA. These findings underscore the inherent limitation of relying solely on questionnaire-based screening: a low PEST score cannot reliably exclude PsA, particularly in the early stages or in subclinical phases with atypical symptoms.

Based on these findings, we propose the following clinical algorithm: For psoriasis patients with a PEST score ≥3, clinical diagnosis and intervention may be prioritized. For those with a PEST score ≤2 but presenting with high-risk factors—such as nail involvement—MSUS should be recommended to detect subclinical inflammatory activity, even if the questionnaire score is low. This stratified screening strategy not only helps avoid unnecessary imaging but also minimizes the risk of missed diagnoses in early PsA, highlighting the synergistic value of combining questionnaire-based screening with targeted imaging assessment.

In our results, the population with abnormal musculoskeletal ultrasound findings was significantly older than the normal population, and patients in the clinical PsA group were significantly older than those in both the high-risk and subclinical PsA groups, with a particularly higher proportion of patients over 40 years of age. Current research indicates that the peak age of onset for clinical PsA is 40–50 years.[30] In this study, the mean age was 38.44 years in the high-risk group, 41.10 years in the subclinical PsA group, and 48.65 years in the clinical PsA group, showing a trend of increasing mean age with disease progression. We hypothesize that this may be related to cumulative immune dysregulation with age, prolonged chronic inflammatory status, and exacerbated mechanical stress and wear on joint tissues, which

Table 5 Proportion of People with PEST Scores

Scores	High-Risk PsA	Subclinical PsA	PsA
1	18	40	55
2	0	0	25
3	0	0	23
4	0	0	12
5	0	0	5

Abbreviations: PEST, Psoriasis Epidemiology Screening Tool; PsA, psoriatic arthritis.

collectively promote the evolution from subclinical inflammation to clinical PsA. This also suggests that the 40–50 age group should be prioritized as a key target population for PsA detection.

The high-risk PsA group demonstrated a significantly lower rate of nail involvement compared to the clinical PsA group. Although no statistically significant difference was observed between the high-risk and subclinical PsA groups, the prevalence of nail involvement in the subclinical PsA group was approximately twice that of the high-risk group. Notably, among patients with MSUS abnormalities, nail involvement was also the most frequently observed positive item in the PEST questionnaire. Nail lesions are often considered early indicators in PsA,[31] though their frequency is influenced by disease activity, extent of skin lesions, and individual immune characteristics. Our findings suggest that nail involvement may already manifest during the subclinical stage, while its detection rate remains relatively lower in the high-risk stage, possibly because inflammation has not yet concentrated in the joints. The higher proportion of nail involvement in the subclinical stage indicates that clinicians should maintain a high index of suspicion for subclinical PsA changes when nail abnormalities are present.

Conversely, the subclinical PsA group exhibited significantly higher rates of current smoking, alcohol consumption, and self-reported work-related stress compared to the clinical PsA group. A potential explanation for this discrepancy may lie in the fact that these unhealthy lifestyle factors (such as smoking and alcohol use) and chronic stress states are established triggers of immune system dysregulation and environmental provocation.[32] They may actively drive early and aggressive inflammatory processes, enabling sensitive musculoskeletal ultrasound to detect inflammation in these patients even before they meet the formal diagnostic criteria for clinical PsA. Alternatively, patients in the clinical PsA group might have reduced these adverse lifestyle habits following diagnosis due to enhanced health education interventions. On the other hand, a cross-sectional study observed a beneficial association between alcohol consumption and both disease activity and functional status in patients with axial spondyloarthritis; however, no conclusive explanation was provided as to whether this is attributable to the biological effects of alcohol on the disease process or to behavioral changes associated with the condition.[33]

The clinical PsA group demonstrated a significantly higher prevalence of ultrasound-detected abnormalities in the proximal interphalangeal (PIP) joints compared to the subclinical group. The relatively low detection rate of PIP abnormalities during the subclinical stage may be attributed to their abundant blood supply, where early inflammation predominantly affects the synovial layer rather than causing overt soft tissue structural changes. As the disease progresses to the clinical stage, synovial hyperplasia and enhanced blood flow signals make PIP abnormalities more readily detectable by ultrasound. Furthermore, the knees, metatarsophalangeal (MTP), and metacarpophalangeal (MCP) joints were the most frequently involved sites in both subclinical and clinical PsA groups, showing similarly high prevalence without significant intergroup differences. This pattern suggests that these joints represent primary targets in the earliest phases of PsA, where subclinical inflammation may already be established even before patients develop characteristic symptoms or meet formal classification criteria. Consequently, focusing musculoskeletal ultrasound examinations on these high-frequency involvement sites during early screening of PEST-positive patients could substantially improve detection efficiency, facilitating the identification of high-risk individuals and enabling early intervention.

Comparative analysis of pathological patterns in patients with abnormal MSUS findings revealed that synovitis was significantly more prevalent in the clinical PsA group than in the subclinical group, while no statistically significant differences were observed for tenosynovitis, enthesitis, joint effusion, or new bone formation. These findings align with recent studies indicating that synovitis constitutes the predominant ultrasonographic abnormality in established PsA patients, whereas subclinical or high-risk populations tend to exhibit more "soft tissue" changes such as tenosynovitis or enthesitis.[25] The marked disparity in synovitis prevalence suggests it may serve as a key driver of disease progression, warranting particular attention during follow-up monitoring.

Limitations

This study is based on retrospective data, which means the data collection was not conducted within a strictly controlled prospective framework, thereby inherently limiting the robustness of its conclusions. In addition, this study was conducted exclusively in psoriasis patients with a PEST questionnaire score ≥1, which may introduce selection bias

and exclude individuals with low PEST scores who still harbor potential risk, thereby limiting the ability to comprehensively evaluate the full disease continuum. Moreover, medication data (including DMARDs, biologics, NSAIDs, and steroids) were not collected, which may have influenced the MSUS findings and clinical presentations. Future research should involve large-scale, prospective studies with long-term follow-up to further validate the efficacy of this screening strategy, elucidate the predictive role of ultrasound abnormalities in the early progression of PsA, and assess the potential impact of different therapeutic regimens on subclinical musculoskeletal involvement.

Conclusion

In summary, this study supports the utility of the PEST questionnaire as an efficient initial screening tool, complemented by targeted musculoskeletal ultrasound assessment of specific joints and lesion types. This integrated approach enables early identification and intervention during the high-risk and subclinical stages of PsA, thereby providing a crucial foundation for optimizing clinical screening strategies and mitigating disease progression.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval

Written informed consent was obtained from all participants for both participation in this study and the publication of the results. The study complied with the Declaration of Helsinki and was approved by the Ethics Committee of Tianjin Medical University General Hospital (Ethics No. IRB2022-YX-179-01).

Acknowledgment

This study is reported in accordance with the RECORD guidelines. The RECORD checklist has been submitted as a Supplementary Table 5.

Author Contributions

Huiping Wang: Conceptualization, Supervision, Writing - review & editing, Funding acquisition; Jingjing Wei: Methodology, Validation, Writing - original draft; Yali Guo: Data curation, Formal analysis; Jingyue Ma: Data curation; Suju Luo: Data curation; Yan Li: Data curation; Quan Zhou: Data curation; Xinzu Tong: Data curation; Zhimin Wang: Data curation. All authors took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The author(s) report no conflicts of interest in this work.

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