Performance of three composite measures for disease activity in peripheral spondyloarthritis

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Abstract

Objectives: To investigate concurrent validity and discrimination of the Disease Activity Psoriatic Arthritis score (DAPSA), Psoriatic Arthritis Disease Activity Score (PASDAS) and Ankylosing Spondylitis Disease Activity Score (ASDAS) in peripheral spondyloarthritis (pSpA) in clinical practice.

Methods: Data from a Dutch registry for SpA (SpA-Net) were used. Predefined hypotheses on concurrent validity of the composite measures with 15 other outcome measures of disease activity, physical function and health-related quality of life were tested. Concurrent validity was considered acceptable if ≥75% of the hypotheses were confirmed. Discrimination was assessed by stratifying patients in DAPSA, PASDAS and ASDAS predefined disease activity states and studying mean differences in health outcomes by one-way ANOVA. Furthermore, the concordance in disease activity states was determined. All analyses were repeated in subgroups with and without psoriasis.

Results: DAPSA, PASDAS and ASDAS scores were available for 191, 139 and 279 patients with pSpA, respectively. The concurrent validity and discrimination of all composite measures were acceptable as the strength of correlations were as hypothesized in ≥75% of the studied correlations. With increasing disease activity states, scores in nearly all outcome measures worsened significantly. The DAPSA, PASDAS and ASDAS classified 22%, 56% and 48% of the patients, respectively, in the two highest disease activity states. Stratified analyses for concomitant psoriasis revealed no relevant subgroup differences.

Conclusions: The performance of DAPSA, PASDAS and ASDAS in pSpA was acceptable, and independent of concomitant psoriasis. Due to discrepancy in classification, the validity of existing thresholds for disease activity states warrants further study in pSpA.

INTRODUCTION

Peripheral spondyloarthritis (pSpA) is characterized by the presence of arthritis, enthesitis and/or dactylitis. Concomitant extra-musculoskeletal manifestations such as uveitis, psoriasis and inflammatory bowel disease may occur [1]. The treatment of pSpA usually consists of a combination of education, exercise therapy, and pharmacotherapy [2-4]. Response to treatment can be evaluated with the Peripheral SpondyloArthritis Response Criteria (pSpARC40) [5]. Such response criteria have been developed to assess how many and which patients have responded adequately to treatment in randomised controlled trials, to facilitate comparison across different trials, and to assess factors that predict treatment response [6]. In clinical practice, response criteria may not be useful for monitoring disease activity as there is no "baseline visit" against which to compare [7]. Furthermore, their dichotomous scores only show whether the criteria are met, but they do not give any information on the degree of disease activity nor are they able to identify disease activity states.

Currently, a tool specifically developed and validated to quantify and monitor disease activity in a comprehensive way in clinical practice is lacking for pSpA. Assessment of disease activity in pSpA is commonly physician-oriented and single or multiple components of the construct 'disease activity' are considered, such as the number of tender and swollen joints or the presence of enthesitis or dactylitis, but these are not explicitly integrated into a composite score to support management decisions.

For psoriatic arthritis (PsA), a subpopulation of pSpA, the Disease Activity in Psoriatic Arthritis (DAPSA) score has been recommend as an instrument to measure disease activity in a treat-to-target strategy [8] , while the Group for Research and Assessment of Psoriasis and Psoriatic Arthritis (GRAPPA) recently voted to use the Psoriatic Arthritis Disease Activity Score (PASDAS) as the preferred measure for disease activity in clinical trials [9]. Both the DAPSA and PASDAS are joint-based composite scores. The PASDAS also assesses extra-articular involvement components and physical health-related quality of life (HR-QoL) (box 1) [10-12]. The performance of the DAPSA and PASDAS have been studied in patients with PsA in clinical practice, but not yet in the total pSpA population, including those without psoriasis [10,13].

Alternative composite measures for disease activity in PsA are the Minimal Disease Activity (MDA) index, the modified MDA (mMDA), the Composite Psoriatic Disease Activity Index (CPDAI) and the GRAPPA Composite Exercise (GRACE) index [12,14-17]. However, these instruments may be less useful, as (except for the mMDA) the presence of psoriasis is included in their calculation, which is not applicable to patients without psoriasis.

For patients with axSpA, the Ankylosing Spondylitis Disease Activity Score (ASDAS) has been developed to assess disease activity (box 1) [19]. The ASDAS might also be useful for pSpA, as it also contains a question related to peripheral joint pain and swelling and two general questions on morning stiffness and global disease activity. To date, the performance of the ASDAS in pSpA has only been studied in clinical trial settings and selected patient populations. It was shown that the ASDAS had a high sensitivity to change and

a high ability to discriminate both between active and placebo treatment and between high and low disease activity [20,21]. Furthermore, the ASDAS improvement criteria were able to detect a clinically important or major improvement in patients with active treatment compared to placebo treatment [20,22]. Although promising in trials, the performance of the ASDAS in pSpA in daily practice is unknown.

Therefore, the primary aim of the present study was to investigate the concurrent validity of the DAPSA, PASDAS and ASDAS as well as their discrimination across thresholds of disease activity in pSpA in clinical practice. A secondary aim was to study the performance of these disease activity measures in subgroups of patients with pSpA with and without psoriasis. In addition, data on the performance of the ASDAS in axSpA are provided as benchmark for interpretation of the findings of the ASDAS in pSpA.

METHODS

Study population

Cross-sectional data from an ongoing, disease-specific, prospective registry for SpA in daily practice in the Netherlands (SpA-Net) were used. SpA-Net started in April 2016 and is registered in the Netherlands Trial Registry (NTR 6740) [23]. For the current study, data collected in two medical centers participating in SpA-Net (Maastricht University Medical Center and Medisch Spectrum Twente) were used. All care-providers were trained to use SpA-Net in clinical practice and a standard operating procedure was provided for optimal record keeping. Patients with clinically diagnosed SpA were included if ≥1 DAPSA score, ≥1 PASDAS or ≥1 ASDAS could be calculated. Patients were categorized into axSpA or pSpA according to current or past SpA-features (figure 1). For sub-analyses, the group of patients with pSpA was further stratified for the presence or absence of psoriasis.

Methods of data collection

Clinical characteristics, outcome measures, results of clinical examinations and laboratory investigations were collected in SpA-Net at every outpatient visit. Clinical examination was performed for the number of tender and swollen joints (TJC68 and SJC66, respectively), presence of enthesitis (any location) and presence of dactylitis (any location), depending on the patient's presenting symptoms without structured examination. Outcome measures in this registry consisted of validated measures of disease activity, physical function, overall SpA specific health impact, generic HR-QoL and health utility.

In SpA-Net, the ASDAS question related to back pain, "How do you rate your back pain due to your AS?", was slightly adapted to "How do you rate your back pain due to your rheumatic condition?" in order to make this also applicable to patients with other forms of SpA.

The patient global assessment (PGA) on a visual analogue scale (VAS, 0-10) was defined as "How active was your disease on average in the last week?" and the physician global assessment (PhGA) on a VAS (0-10) was defined as "How active is the patients' disease on average?". Enthesitis and dactylitis were measured with the Leeds Enthesitis Index (LEI score) and dactylitis count respectively [24].

Physical function was measured with the Health Assessment Questionnaire for Spondyloarthropathies (HAQ-S) [25]. Overall SpA specific health impact was measured with the ASAS Health Index (ASAS HI) [26]. HR-QoL was measured by the MOS Short Form Health Survey (SF36), having a physical component summary (SF36-PCS) and a mental component summary (SF36-MCS), and health utility was measured by the EuroQoL with 5 dimensions (EQ-5D) [27,28].

Ethics considerations

The ethics committee of the university hospital Maastricht/Maastricht University determined that the Medical Research Involving Human Subjects Act did not apply as data were collected in routine care and official approval was not required for this study. Patients provided written informed consent to use the patients' data for research purposes.

Statistical analyses

All data were checked for outliers using scatterplots and data were cleaned if erroneous measurements were suspected. Clinical and demographic characteristics were summarized using descriptive statistics.

Concurrent validity was assessed by Spearman correlations (r_s) of the DAPSA, PASDAS or ASDAS with all outcome measures, because not all assumptions for Pearson correlations checked with scatterplots were met in some of the outcome measures. The expected degree of correlation was hypothesized a priori (supplementary file 1). The strength of correlation was based on predefined criteria: (r_s) ≤0.29 is very low correlation, 0.30 ≤ (r_s) ≤0.49 is low correlation, 0.50 ≤ (r_s) ≤0.69 is moderate correlation, 0.70 ≤ (r_s) ≤0.89 is high correlation and (r_s) ≥0.90 is very high correlation [29]. The frequency in which the hypotheses were confirmed between the DAPSA (11 hypotheses), PASDAS (8 hypotheses) or ASDAS with other outcome measures (13 hypotheses), that were no components of the composite score, was calculated (box 1). Concurrent validity was considered acceptable if ≥75% of the observed correlations were as hypothesized [30]. This threshold for hypothesis testing has been accepted by international experts in a Delphi study [31]. Observed correlations were considered comparable if they had the same level of strength.

Discrimination across thresholds of disease activity in pSpA was assessed by stratifying patients according to established DAPSA, PASDAS and ASDAS disease activity states and subsequently comparing the means of several external health outcomes across these states by one-way ANOVA analyses [32,33]. We hypothesized that worsening in disease activity states would also be reflected in worsening of other health outcomes. In addition, we determined the concordance in DAPSA, PASDAS and ASDAS disease activity classification of patients.

Subgroup analyses were performed on data from patients who had all three disease activity measures available at the same point in time. Furthermore, all analyses were repeated after stratification for the

presence of psoriasis. We hypothesized that the performance of the disease activity measures would be comparable in patients with or without psoriasis.

To allow benchmarking for the ASDAS performance, the results of the ASDAS in patients with pSpA were compared to the results of the ASDAS in patients with axSpA, who were also included in SpA-Net (figure 1). We hypothesized that the performance would be comparable in all subgroup analyses.

Statistical analyses were performed using IBM SPSS Statistics 24.

RESULTS

Study population

In 781 patients, at least one DAPSA, PASDAS or ASDAS score could be calculated (figure 1). Three patients had to be excluded because of inconsistencies in the data. Of the remaining 778 patients, 249 patients had axSpA, 304 patients had pSpA, and 225 patients could not be classified due insufficient or missing variables. Of the patients with pSpA, 222 (73%) had concomitant psoriasis. In 124 of the 304 (41%) patients with pSpA all three disease activity measures were simultaneously available.

On average, disease activity in patients with pSpA was low according to the DAPSA, moderate according to the PASDAS and high according to the ASDAS (table 1). Patients had low TJC68 and SJC66 scores and they experienced moderate difficulties in daily functioning based on the HAQ-S. Clinical characteristics and health outcomes were comparable between patients with and without psoriasis, except for gender distribution and csDMARDs use (supplementary file 1). Patients with pSpA differed clinically from patients with axSpA, but health outcomes were comparable (table 1 and supplementary file 2).

Concurrent validity by correlation with external measures

In the total population of patients with pSpA, the strength of correlation between the DAPSA and other outcome measures was as hypothesized for 10 out of 11 (90%) measures (table 2 and supplementary file 3), between the PASDAS and other outcome measures as hypothesized for 6 out of 8 (75%) measures and between the ASDAS and other outcome measures as hypothesized for 11 out of 13 (85%) measures. The correlations were lower than expected between the PASDAS with SF36 MCS, between the ASDAS with VAS pain, and ASDAS with PhGA (table 2 and supplementary file 3). Nearly all hypotheses were confirmed between the disease activity measures and measures of physical function, overall SpA specific health impact, HR-QoL and health utility.

Discrimination across thresholds of disease activity and concordance in classification

In the total population of patients with pSpA, we found with worsening DAPSA, PASDAS or ASDAS disease activity states, significant worsening for all other scores for measures of disease activity, physical function,

overall SpA specific health impact, HR-QoL and health utility (all p<0.01, table 3), except for enthesitis and dactylitis (all measures), CRP in worsening PASDAS disease activity states (F-value = 2.4, p-value = 0.07) and SJC66 in worsening ASDAS disease activity states (F-value=2.2, p-value=0.09).

Overall, substantially less patients were categorized as having high disease activity by the DAPSA (n=1 (0.8%) and PASDAS (n=5 (4.0%)) compared to having high or very high disease activity by the ASDAS (n=60 (48.4%), table 4). When moderate disease activity was included in the definition of high disease activity by the DAPSA, the difference with the ASDAS remained substantial (n=27 (21.8%) versus n=60 (48.4%)), while including moderate disease activity into the definition of high disease activity by the PASDAS resulted in more patients classified as having high disease activity compared with the ASDAS (n=70 (56.4%) versus n=60 (48.4%).

Subgroup analyses

Subgroup analyses in patients with simultaneously available DAPSA, PASDAS and ASDAS measures showed that nearly all results for concurrent validity and discrimination across thresholds of disease activity were comparable to the total pSpA sample in which at least one disease activity measure was available (supplementary file 4 and 5). The strength of correlations between the DAPSA, PASDAS or ASDAS with other outcome measures in patients with all three disease activity measures s available were as hypothesized for 9 out of 11 (81.8%) outcome measures, 5 out of 8 (62.5%) and 8 out of 13 (61.5%) outcome measures, respectively. The hypotheses for concurrent validity of the PASDAS with DAPSA and ASAS-HI, and ASDAS with HAQ-S and ASAS-HI were not met as the correlations were in fact higher than expected.

In patients with and without psoriasis, the strength of correlation between either the DAPSA, PASDAS or ASDAS with other health and clinical outcome measures was almost always comparable (table 2).

Discrimination across existing thresholds of disease activity did not differ substantially after stratification for the presence or absence of psoriasis (supplementary file 6, 7 and 8).

Benchmark analyses

As a benchmark, the performance of the ASDAS in the total population of pSpA was compared with the performance of the ASDAS in patients with axSpA. The correlations between the ASDAS and other outcome measures were as hypothesized in axSpA for 10 out of 12 (83%) measures and in pSpA for 11 out of 13 (85%) measures (table 2 and supplementary file 9).

The results for discrimination across thresholds of disease activity were comparable for the ASDAS in both pSpA and axSpA populations, except that significant differences in TJC68 were found across ASDAS states in patients with pSpA, but not in patients with axSpA (table 3 and supplementary file 10).

Discussion

This study showed acceptable concurrent validity and discrimination across thresholds of disease activity of the DAPSA, PASDAS and ASDAS in clinical practice patients with pSpA, with on average a low degree of peripheral joint involvement. The strength of correlation between the disease activity measures with a variety of other outcome measures was correct in more than 75%. In addition, increasing DAPSA, PASDAS or ASDAS disease activity states were associated with worsening in patient and physician reported outcome measures for disease activity, impairment in physical function, overall SpA specific health impact, generic HR-QoL and health utility. Remarkably, classifying patients in the disease activity states showed discordance in the high disease activity states.

The results of the subgroup analyses in patients with simultaneously available disease activity measures were comparable to the results of the total pSpA population. Subgroup analyses in patients with and without psoriasis showed some difference in the performance of the disease activity measures. However, these results should be interpreted with caution as they may have been caused by the small number of patients without psoriasis.

As no gold standard exists to assess disease activity in pSpA, the performance of the DAPSA, PASDAS and ASDAS was studied in relation to multiple subjective and objective outcome measures capturing several disease aspects from both the physician and patient perspective. Overall, these analyses provided elaborated evidence on the performance of these disease activity measures in patients with pSpA with low peripheral joint involvement in the majority of the patients in clinical practice. The comparable performance of the ASDAS in patients with pSpA and axSpA strengthens the hypothesis that the ASDAS could also be a valid measure in patients with pSpA.

An important finding was the substantial discordance when classifying patients into the disease activity states. The DAPSA classified 22%, the PASDAS 56% and the ASDAS 48% of the patients in the two highest disease activity states. These results might be explained by different individual components of each composite measure. Involvement of peripheral joints has substantially more weight in the cumulative calculation of the DAPSA, where the absolute number of affected joints is included, compared to the ASDAS, where only a general question on peripheral joint involvement is asked, and the PASDAS where joint involvement has a relative weight. Alternatively, the discrepancy could also be an indication that the existing thresholds for disease activity states of the DAPSA and PASDAS used for patients with PsA and the ASDAS for axSpA might not be applicable to patients with pSpA, but this interpretation requires a cautious note, as the number of patients with a high number of swollen joints was limited in our study [32,33]. However, the discrepancy may have large implications for clinical practice. The number of patients with pSpA who did not achieve remission or low disease activity was much higher using the PASDAS and ASDAS compared to DAPSA and consequentially more patients would qualify for treatment intensification based on the

PASDAS and ASDAS compared to the DAPSA. This discrepancy in classification and the validity of existing thresholds for disease activity states therefore warrants further study in pSpA.

Practically, the ASDAS might have some advantages over the DAPSA and PASDAS. First, assessment of the ASDAS is much faster than the DAPSA and PASDAS, which require full joint examination. Second, the ASDAS can be used for remote monitoring of disease activity as its components, including measuring C-reactive protein (CRP) levels, are assessor independent. Third, with the ASDAS, disease activity can be assessed in both axSpA and pSpA with the same measure, allowing comparison as well as aggregation of the two populations. The DAPSA might also have an advantage over the PASDAS and ASDAS, as calculating these measures is complex and requires an online tool.

Some concerns about the usefulness of the DAPSA as measure of disease activity for patients with PsA have been expressed [34]. The DAPSA assesses peripheral joint disease, but does not take into account other aspects of disease activity, such as psoriasis, dactylitis and enthesitis which are important to patients. This limitation of the DAPSA also applies to the ASDAS.

Our study has several strengths. The performance of the disease activity measures in pSpA was evaluated in daily practice and the results therefore represent real-life rather than research settings, increasing the generalizability of the findings. Furthermore, data from all patients with pSpA and axSpA were collected in one patient register using the same standardized method.

This study also has several limitations. First, patients in this study were adequately treated and had on average low CRP levels, and low tender and swollen joint counts, which limit the generalizability to other pSpA populations with more active disease. Second, the sample size of patients with pSpA without psoriasis was relatively low, which might have affected the results when comparing the performance of the disease activity measures between patients with or without psoriasis. Third, we have not tested the responsiveness of the DAPSA, PASDAS and ASDAS in pSpA in our population, because we have only limited follow up data from our patients thus far as SpA-Net is an observational cohort of well-treated patients with only a limited number of treatment adaptations.

In conclusion, this study showed that the DAPSA, PASDAS and ASDAS have acceptable concurrent validity and discrimination across thresholds of disease activity in pSpA, which was independent of the presence of psoriasis. Based on results of clinical trial data and our results in daily practice, the DAPSA, PASDAS and ASDAS could be useful for measuring disease activity in pSpA in clinical practice. However, the discrepancy in classification of individual patients in disease activity states currently limits their use for decision making in clinical practice and warrants further study in pSpA.

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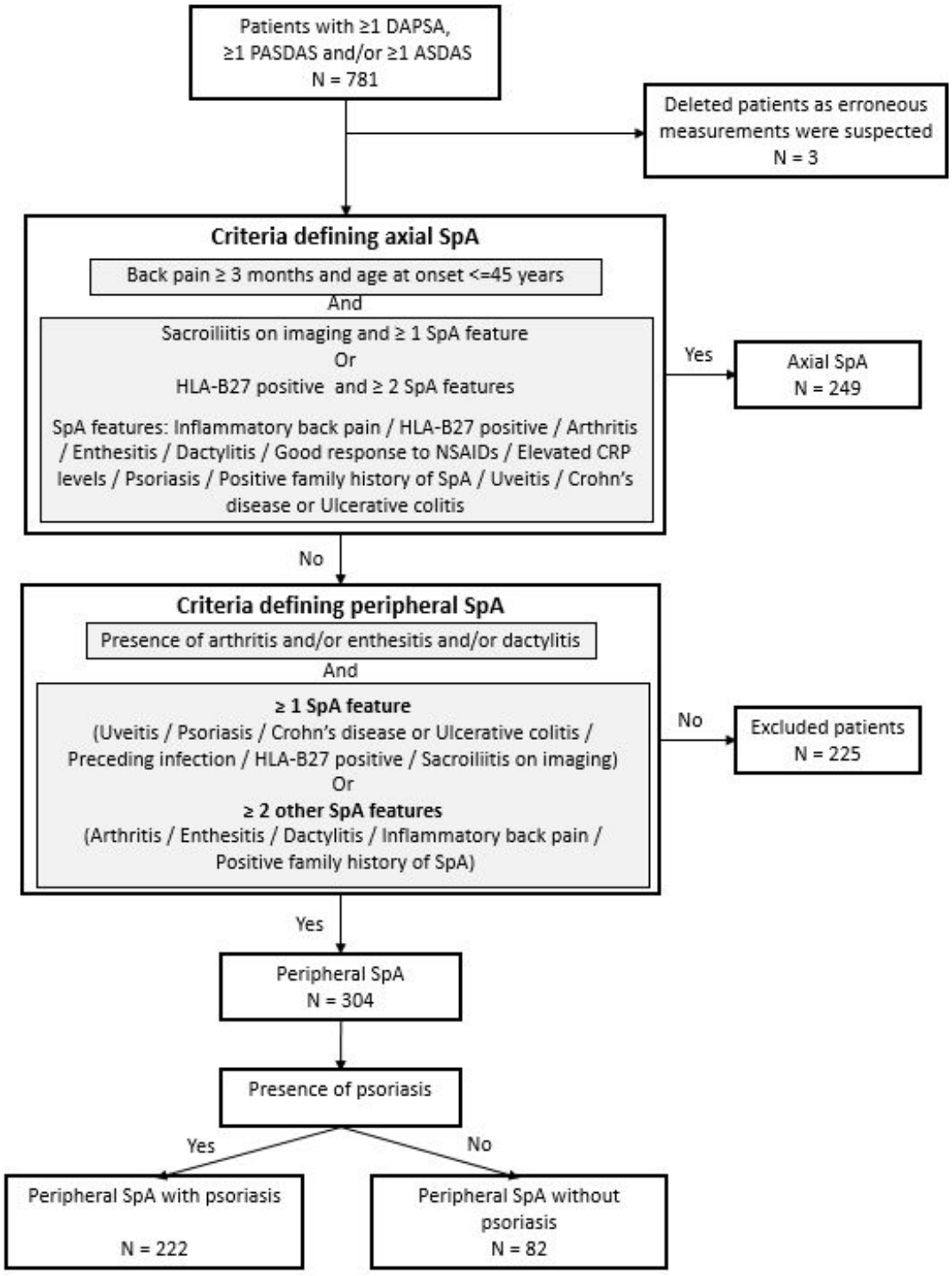

Figure 1. Flowchart of patients included in this study

Table 1. Clinical and demographic characteristics of patients with peripheral SpA

	DAPSA (n = 191)		PASDAS (n =139)		ASDAS (n = 279)	
Variable	Patients with an available assessment	Value	Patients with an available assessment	Value	Patients with an available assessment	Value
Age, years	191	56.1 (11.2)	139	57.2 (10.3)	279	55.7 (12.3)
Female, n (%)	191	103 (53.9%)	139	76 (54.7%)	279	145 (52.0%)
Symptom duration, years	140	13.4 (9.1)	112	13.2 (8.7)	213	12.6 (9.4)
Current NSAID use, n (%)	-	91 (47.6%)	-	70 (50.4%)	-	132 (47.3%)
Current cDMARD use, n (%)	-	117 (61.3%)	-	70 (50.4%)	-	158 (56.6%)
Current bDMARD use, n (%)	-	97 (50.8%)	-	77 (55.4%)	-	137 (49.1%)
Current glucocorticoid use, n (%)	-	10 (5.2%)	-	10 (7.2%)	-	14 (5.0%)
Disease activity						
DAPSA (0-∞)	191	9.9 (6.9)	129	9.5 (6.7)	159	9.6 (6.7)
PASDAS (0-10)	115	3.3 (1.4)	139	3.3 (1.4)	123	3.3 (1.4)
ASDAS (0-∞)	160	2.2 (1.0)	130	2.1 (1.0)	279	2.2 (1.0)
BASDAI (0-10)	161	4.2 (2.4)	132	4.1 (2.4)	279	4.1 (2.3)
PGA (0-10)	191	4.0 (2.7)	139	3.9 (2.7)	279	4.0 (2.6)
VAS pain (0-10)	191	3.9 (2.6)	129	3.7 (2.5)	230	3.9 (2.6)
PhGA (0-10)	144	1.7 (1.5)	139	2.0 (1.5)	184	1.8 (1.6)
CRP, mg/L (0-∞)	191	4.4 (6.0)	139	4.0 (5.4)	279	4.6 (9.1)
Psoriasis body surface area (0-100%)	142	1.4 (5.5)	127	1.4 (5.7)	166	1.3 (5.1)
Tender joint count (0-68)	191	1.2 (2.4)	139	1.1 (2.5)	197	1.1 (2.3)
Swollen joint count (0-66)	191	0.4 (0.9)	139	0.4 (0.9)	197	0.4 (1.1)
LEI score (0-6)	161	0.1 (0.4)	139	0.0 (0.2)	201	0.1 (0.3)
Dactylitis count (0-20)	161	0.1 (0.3)	139	0.0 (0.3)	201	0.0 (0.2)
Physical function and health impact						
HAQ-S (0-3)	128	0.8 (0.7)	106	0.8 (0.7)	194	0.8 (0.6)
ASAS-HI (0-17)	147	5.3 (3.6)	127	5.2 (3.6)	219	5.3 (3.5)

Health-related quality of life						
EQ-5D (0-1)	130	0.77 (0.18)	106	0.78 (0.20)	194	0.78 (0.19)
SF36 MCS (0-100)	155	49.5 (10.9)	139	49.3 (10.9)	228	49.5 (10.8)
SF36 PCS (0-100)	155	39.8 (10.4)	139	40.6 (10.7)	228	40.0 (9.9)

Values are presented as mean (SD) unless stated otherwise.

DAPSA = Disease Activity Psoriatic Arthritis Score, Psoriatic Arthritis Disease Activity Score (PASDAS), ASDAS = Ankylosing Spondylitis Disease Activity Score, NSAID = Non-Steroidal Anti Inflammatory Drug, cDMARD = conventional Disease Modifying Anti-Rheumatic Drug, bDMARD = biological Disease Modifying Anti-Rheumatic Drug, BASDAI = Bath Ankylosing Spondylitis Disease Activity Index, PGA = Patient Global Assessment, VAS = Visual Analog Scale, PhGA = Physician Global Assessment, CRP = C-Reactive Protein, LEI score = Leeds Enthesitis Index score, HAQ-S = Health Assessment Questionnaire for Spondyloarthritis, ASAS-HI = Assessment of SpondyloArthritis international Society Health Index, EQ-5D = EuroQol 5D, SF36 = Medical Outcomes Study 36-Question Short Form, MCS = Mental Component Score, PCS = Physical Component Score, SpA = Spondyloarthritis

Table 2. Spearman correlations of DAPSA, PASDAS and ASDAS with outcomes measures in peripheral SpA

	DAPSA						PASDAS						ASDAS					
	Total pSpA population n = 191		pSpA without psoriasis n = 49		pSpA with psoriasis n = 142		Total pSpA population n = 139		pSpA without psoriasis n = 42		pSpA with Psoriasis n = 97		Total pSpA population n = 279		pSpA without psoriasis n = 82		pSpA with psoriasis n = 197	
Outcome measure	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis	R_s	Hypothesis
Disease activity																		
DAPSA†	NA		NA		NA		0.91*	- H	0.85*	+	0.90*	- H	0.80*	+	0.79*	+	0.89*	+
PASDAS§	0.92*	- H	0.85*	+	0.91*	- H	NA		NA		NA		0.84*	+	0.80*	+	0.83*	+
ASDAS	0.81*	+	0.77*	+	0.80*	+	0.85*	+	0.81*	+	0.84*	+	NA		NA		NA	
BASDAI‡	0.76*	+	0.73*	+	0.76*	+	0.78*	+	0.67*	- L	0.80*	+	0.85*		0.83*		0.84*	
PGA†,§ ‡	0.89*		0.87*		0.89*		0.92*		0.88*		0.91*		0.82*		0.79*		0.79*	
VAS pain†	0.89*		0.86*		0.90*		0.74*	+	0.71*	+	0.74*	+	0.69*	- L	0.63*	- L	0.69*	- L
PhGA§	0.61*	+	0.61*	+	0.60*	+	0.81*		0.76*		0.80*		0.49*	- L	0.46*	- L	0.48*	- L
CRP†,§ ‡	0.19*		0.33*		0.13		0.15		0.25		0.12		0.48*		0.56*		0.44*	
Psoriasis BSA	-0.04		NA		0.01	- L	-0.08		NA		0.00	- L	0.01		NA		0.14	- L
TJC68† §	0.67*		0.75*		0.67*		0.52*		0.48*		0.58*		0.39*	+	0.35*	+	0.44*	+
SJC66† §	0.46*		0.34		0.51*		0.43*		0.27		0.50*		0.19*	+	-0.00	+	0.28*	+
LEI score §	0.12	+	0.18	+	0.07	+	0.10		0.17		0.05		0.11	+	0.15	+	0.09	+
Dactylitis count §	0.22	+	ND		0.26*	+	0.19*		ND		0.23*		0.08	+	ND		0.12	+
Physical function and health impact																		
HAQ-S	0.59*	+	0.62*	+	0.56*	+	0.68*	+	0.73*	- H	0.65*	+	0.63*	+	0.65*	+	0.60*	+
ASAS-HI	0.67*	+	0.57*	+	0.67*	+	0.68*	+	0.60*	+	0.68*	+	0.63*	+	0.64*	+	0.57*	+
Health-related quality of life																		
EQ-5D	-0.69*	+	-0.65*	+	-0.69*	+	-0.50*	+	-0.40*	+	-0.53*	+	-0.62*	+	-0.64*	+	-0.60*	+
SF36 MCS	-0.30*	+	-0.31*	+	-0.28*	- L	-0.15	- L	-0.25	- L	-0.13	- L	-0.33*	+	-0.53*	+	-0.24*	- L

SF36 PCS §	-0.65*	+	-0.67*	+	-0.64*	+	-0.76*		-0.82*		-0.72*		-0.67*	+	-0.69*	+	-0.64*	+

† DAPSA components, § PASDAS components ‡ ASDAS components, Individual components of the DAPSA, PASDAS and ASDAS were not included in the calculation of the frequency of confirmed hypotheses for concurrent validity

ND = Correlation could not be calculated as standard deviation was zero, *Correlation is statistically significant at the 0.05 level (two-tailed), + = strength of correlation as hypothesized, L = strength of correlation is lower than hypothesized, H = strength of correlation is higher than hypothesized

DAPSA = Disease Activity Psoriatic Arthritis Score, PASDAS = Psoriatic Arthritis Disease Activity Score, ASDAS = Ankylosing Spondylitis Disease Activity Score, BASDAI = Bath Ankylosing Spondylitis Disease Activity Index, PGA = Patient Global Assessment, VAS= Visual Analog Scale, PhGA = Physician Global Assessment, CRP = C-Reactive Protein, LEI score = Leeds Enthesitis Index score, BSA = Body Surface Area, TJC68 = Tender Joint Count of 68 joints, SJC = Swollen Joint Count of 66 joints, HAQ-S = Health Assessment Questionnaire for Spondyloarthritis, ASAS-HI = Assessment of SpondyloArthritis international Society Health Index, EQ-5D = EuroQol 5D, SF36 = Medical Outcomes Study 36-Question Short Form, MCS = Mental Component Score, PCS = Physical Component Score, SpA = Spondyloarthritis, pSpA = peripheral Spondyloarthritis, axSpA = Axial Spondyloarthritis

Table 3. Outcome measures stratified for DAPSA, PASDAS or ASDAS disease activity states in peripheral SpA

	DAPSA Total pSpA population n = 191						PASDAS Total pSpA population n = 139						ASDAS Total pSpA population n = 279					
	DAPSA cut-offs				One-way ANOVA		PASDAS cut-offs				One-way ANOVA		ASDAS cut-offs				One-way ANOVA	
Outcome measure Disease activity	**≤4 n = 49 (25.7%)**	**5 to ≤14 n = 99 (51.8%)**	**15 to ≤28 n = 41 (21.5%)**	**≥29 n = 2 (1.0%)**	**F-value**	**P-value**	**≤1.9 n = 23 (16.5%)**	**1.9 to <3.2 n = 40 (28.8%)**	**3.2 to <5.4 n = 69 (49.6%)**	**≥5.4 n = 7 (5.0%)**	**F-value**	**P-value**	**<1.3 n = 59 (21.1%)**	**1.3 to <2.1 n = 83 (29.7%)**	**2.1 to ≤3.5 n = 105 (37.6%)**	**>3.5 n = 32 (11.5%)**	**F-value**	**P-value**
DAPSA (0-∞)	2.1 (1.4)	9.5 (2.9)	18.9 (3.0)	34.7 (7.8)	346.6	<0.01	1.7 (1.9)	5.5 (2.9)	13.3 (5.2)	22.1 (3.6)	69.7	<0.01	3.2 (2.9)	7.2 (4.8)	12.9 (5.9)	17.1 (3.8)	50.2	<0.01
PASDAS (0-∞)	1.7 (0.9)	3.4 (0.7)	5.0 (0.6)	- (-)	132.6	<0.01	1.0 (0.5)	2.7 (0.4)	4.1 (0.6)	5.9 (0.4)	307.7	<0.01	1.8 (0.9)	3.1 (1.0)	4.2 (0.7)	4.9 (0.6)	64.2	<0.01
ASDAS (0-∞)	1.1 (0.5)	2.2 (0.7)	3.2 (0.8)	3.2 (-)	62.5	<0.01	0.9 (0.3)	1.5 (0.6)	2.7 (0.7)	3.4 (0.8)	64.7	<0.01	0.9 (0.3)	1.7 (0.2)	2.7 (0.4)	3.9 (0.4)	717.4	<0.01
BASDAI (0-10)	1.8 (1.6)	4.6 (1.8)	6.2 (1.9)	7.6 (-)	45.5	<0.01	1.0 (0.8)	2.9 (1.7)	5.4 (1.7)	7.0 (1.7)	54.1	<0.01	1.5 (0.9)	3.2 (1.4)	5.3 (1.6)	7.0 (1.4)	151.8	<0.01
PGA (0-10)	1.0 (0.9)	4.1 (1.8)	7.2 (1.6)	7.5 (0.7)	117.0	<0.01	0.4 (0.7)	2.2 (1.1)	5.6 (1.8)	8.3 (1.1)	116.2	<0.01	1.1 (1.1)	3.2 (1.8)	5.2 (2.0)	7.4 (1.4)	119.0	<0.01
VAS pain (0-10)	0.7 (0.7)	4.2 (1.9)	6.7 (1.4)	6.3 (1.0)	119.6	<0.01	0.9 (1.9)	2.6 (2.2)	4.9 (1.8)	7.4 (0.8)	33.6	<0.01	1.6 (2.2)	2.9 (2.0)	5.3 (2.0)	6.3 (1.4)	56.2	<0.01
PhGA (0-10)	0.8 (0.9)	1.6 (1.0)	3.2 (1.6)	8.0 (-)	34.7	<0.01	0.3 (0.6)	1.4 (0.8)	2.4 (1.0)	5.6 (1.6)	70.2	<0.01	1.0 (1.1)	1.5 (1.2)	2.3 (1.7)	3.3 (1.8)	14.5	<0.01
CRP, mg/L (0-∞)	2.3 (2.1)	4.0 (4.2)	7.5 (9.8)	13.5 (16.3)	8.3	<0.01	3.2 (2.9)	2.4 (3.0)	5.1 (6.8)	5.6 (5.8)	2.4	0.07	1.6 (1.1)	2.5 (2.5)	4.7 (5.6)	15.2 (21.9)	21.9	<0.01
TJC68 (0-68)	0.0 (0.3)	0.6 (1.1)	3.2 (2.4)	15.5 (9.2)	94.5	<0.01	0.0 (0.2)	0.3 (0.6	1.7 (3.2)	3.1 (1.7)	6.5	<0.01	0.2 (0.5)	0.8 (1.3)	1.5 (3.1)	1.9 (2.0)	5.1	<0.01
SJC66 (0-66)	0.0 (0.3)	0.3 (0.6)	1.1 (1.3)	4.0 (1.4)	28.0	<0.01	0.0 (0.2)	0.2 (0.4)	0.4 (1.0)	1.9 (1.9)	9.2	<0.01	0.1 (0.4)	0.4 (0.8)	0.6 (1.4)	0.6 (1.2)	2.2	0.09
LEI score (0-6)	0.0 (0.0)	0.1 (0.3)	0.2 (0.7)	0.0 (-)	1.3	0.29	0.1 (0.2)	0.1 (0.2)	0.0 (0.2)	0.1 (0.4)	0.9	0.44	0.0 (0.0)	0.1 (0.3)	0.1 (0.4)	0.1 (0.3)	1.6	0.19
Dactylitis count (0-20)	0.0 (0.0)	0.0 (0.1)	0.2 (0.6)	0.0 (-)	2.4	0.07	0.0 (0.0)	0.0 (0.0)	0.0 (0.4)	0.1 (0.4)	0.7	0.54	0.0 (0.3)	0.0 (0.1)	0.0 (0.3)	0.1 (0.3)	0.5	0.71
Physical function and health impact																		
HAQ-S (0-3)	0.2 (0.3)	1.0 (0.6)	1.2 (0.7)	1.0 (-)	19.3	<0.01	0.1 (0.2)	0.5 (0.4)	1.2 (0.6)	2.0 (0.4)	27.7	<0.01	0.2 (0.3)	0.6 (0.6)	1.1 (0.6)	1.3 (0.6)	30.1	<0.01
ASAS-HI (0-17)	1.8 (1.7)	6.0 (3.1)	7.5 (3.3)	11.0 (-)	29.2	<0.01	1.5 (1.9)	3.3 (2.2)	7.1 (3.2)	8.2 (3.3)	28.1	<0.01	2.2 (1.7)	4.3 (2.7)	6.9 (3.4)	8.3 (3.2)	38.2	<0.01
Health-related quality of life																		
EQ-5D (0-1)	0.94 (0.06)	0.76 (0.12)	0.64 (0.23)	0.41 (-)	25.7	<0.01	0.92 (0.13)	0.85 (0.11)	0.70 (0.23)	0.87 (0.11)	8.0	<0.01	0.93 (0.08)	0.81 (0.14)	0.71 (0.18)	0.63 (0.24)	22.9	<0.01
SF36 MCS (0-100)	55.4 (7.1)	47.6 (10.9)	47.8 (11.4)	22.1 (-)	8.2	<0.01	54.3 (10.1)	49.4 (9.2)	47.4 (11.4)	50.8 (13.8)	2.4	0.07	54.5 (7.4)	51.9 (9.9)	46.1 (11.1)	44.9 (12.4)	10.0	<0.01
SF36 PCS (0-100)	49.7 (6.9)	38.5 (8.9)	32.1 (8.2)	35.9 (-)	31.2	<0.01	51.3 (7.5)	46.8 (7.6)	35.2 (7.3)	24.5 (9.2)	47.0	<0.01	49.1 (7.0)	42.9 (8.9)	35.4 (8.1)	30.8 (5.0)	47.9	<0.01

Values are presented as mean (SD) unless stated otherwise.

DAPSA = Disease Activity Psoriatic Arthritis Score, PASDAS = Psoriatic Arthritis Disease Activity Score ,ASDAS = Ankylosing Spondylitis Disease Activity Score, NSAID = Non-Steroidal Anti Inflammatory Drug, cDMARD = conventional Disease Modifying Anti-Rheumatic Drug, bDMARD = biological Disease Modifying Anti-Rheumatic Drug, BASDAI = Bath Ankylosing Spondylitis Disease Activity Index, PGA = Patient Global Assessment, VAS = Visual Analog Scale, PhGA = Physician Global Assessment, CRP = C-Reactive Protein, LEI score = Leeds Enthesitis Index score, HAQ-S = Health Assessment Questionnaire for Spondyloarthritis, ASAS-HI = Assessment of SpondyloArthritis international Society Health Index, EQ-5D = EuroQol 5D, SF36 = Medical Outcomes Study 36-Question Short Form, MCS = Mental Component Score, PCS = Physical Component Score, SpA = Spondyloarthritis, NA = not applicable

Table 4. Disease activity states of patients with pSpA with DAPSA, PASDAS and ASDAS scores simultaneously available

		PASDAS				ASDAS			
		Remission ≤1.9	**Low** >1.9 to <3.2	**Moderate** ≥3.2 to <5.4	**High** ≥5.4	**Inactive** <1.3	**Low** ≥1.3 to < 2.1	**High** ≥2.1 to ≤ 3.5	**Very high** >3.5
	n = 124	n = 18 (14.5%)	n = 36 (29.0%)	n = 65 (52.4%)	n =5 (4.0%)	n = 30 (24.2%)	n = 34 (27.4%)	n = 46 (37.1%)	n = 14 (11.3%)
DAPSA									
Remission ≤4	n = 33 (26.6%)	16	17	0	0	22	11	0	0
Low ≥5 to ≤14	n = 64 (51.6%)	2	19	43	0	8	20	33	3
Moderate ≥15 to ≤28	n = 26 (21.0%)	0	0	21	5	0	3	12	11
High ≥29	n = 1 (0.8%)	0	0	1	0	0	0	1	0
ASDAS									
Inactive <1.3	n = 30 (24.2%)	15	15	0	0				
Low ≥1.3 to <2.1	n = 34 (27.4%)	3	17	13	1				
High ≥2.1 to ≤ 3.5	n = 46 (37.1%)	0	4	40	2				
Very high >3.5	n = 14 (11.3%)	0	0	12	2				

DAPSA = Disease Activity Psoriatic Arthritis Score, PASDAS = Psoriatic Arthritis Disease Activity Score, ASDAS = Ankylosing Spondylitis Disease Activity Score, n = Number of patients