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Clinically Relevant Deficits in Performance Tests in Patients With Axial Spondyloarthritis

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ABSTRACT. ***Objective.*** To assess the association between self-reported and performance-based physical functioning and to evaluate which performance tests are most frequently impaired in patients with axial spondyloarthritis (axSpA).

Methods. Consecutive patients with axSpA underwent standardized assessments including patient and disease characteristics; patient-reported outcomes for disease activity, functioning, depression, mobility, and physical activity; and performance tests. Patients were defined as being impaired if they were not able to perform ≥ 1 of the performance tests. Validated cut-offs were used to define impaired physical performance. Impairment of performance tests as well as discrimination between subgroups were analyzed.

Results. A total of 200 patients (radiographic axSpA 66.5%, nonradiographic axSpA 33.5%) were included: 69% males, mean age 44.3 (SD 12.5) years, and mean symptom duration 17.9 (SD 12.6) years. The 2 most frequently impaired performance tests were the repeated chair stand test (n = 75, 37.5%) and putting on socks (n = 44, 22%). An impairment in ≥ 1 performance test was seen in 91 patients (45.5%). Patients with impairments were older (49.1 yrs vs 40.3 yrs); had a higher BMI (28.9 kg/m^2 vs 25.8 kg/m^2); a more active disease (Ankylosing Spondylitis Disease Activity Score, 3.0 vs 2.1); higher Bath Ankylosing Spondylitis Functional Index (BASFI; 5.8 vs 2.7), Bath Ankylosing Spondylitis Metrology Index (BASMI; 4.4 vs 2.7), and Assessment of Spondyloarthritis international Society Health Index scores (9.5 vs 4.9); and higher depression screen values (9-item Patient Health Questionnaire, 11.6 vs 6.5; all $P < 0.01$).

Conclusion. Many patients with axSpA had impairments in physical performance tests. Importantly, this was frequently seen in tasks requiring coordination and muscle power of the lower extremity. Performance tests provide qualitatively different information than BASFI and BASMI assessments in patients with axSpA.

Key Indexing Terms: ankylosing spondylitis, performance test, physical functioning, spondyloarthritis

A fundamental component in the management of patients with axial spondyloarthritis (axSpA) is the assessment of physical function.[1] Since pain, stiffness, and decreased spinal mobility are very common in patients with axSpA, regular assessment of physical function and mobility is highly recommended.[2,3] Limitations in physical function and impairments in activities of daily living (ADL) occur more frequently in patients with axSpA compared to the normal population.[4] Longer disease duration and increased age are associated with decreased physical function, whereas back exercise and higher levels of social support contribute to improved physical function.[5] In axSpA, physical function usually deteriorates slowly over time, with both reversible (eg, inflammation) and irreversible changes (eg, structural changes) occurring during the variable disease process.[6] Beside pathophysiological changes, physical activity (PA) and performance need to be considered to understand impairments in physical function. Educating patients about starting and maintaining regular exercise as well as PA are important components of education programs/recommendations for patients with inflammatory arthritis.[7] However, several factors such as the presence of depressive symptoms might negatively influence PA and physical function in axSpA.[8,9]

In routine care for patients with axSpA, physical function is usually evaluated by disease-specific assessments such as self-reported questionnaires, mobility tests, and, rarely, performance tests. The most commonly used assessments are the Bath Ankylosing Spondylitis Functional Index (BASFI) and the Bath Ankylosing Spondylitis Metrology Index (BASMI).[10,11] Both physical function and spinal mobility are main domains in the recently updated Assessment of Spondyloarthritis international Society (ASAS)/Outcome Measures in Rheumatology (OMERACT) core outcome set for patients with axSpA.[12] However, self-reported physical function or mobility measures do not necessarily indicate the real physical performance level of a

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patient. Generic performance tests used to assess physical performance can objectively quantify the physical function of patients and can be assessed as a single task such as grip strength or as a compound measure, such as the Short Physical Performance Battery (SPPB).[13] Impaired performance on these tests are all associated with negative health outcomes. A disease-specific performance test is also available, which has been shown to be feasible, reliable, and sensitive to change.[14-16] This Ankylosing Spondylitis Performance Index (ASPI) is based on 3 BASFI items and measures the time, pain, and exertion to perform ADL.

The aim of this study was to assess the association between self-reported and performance-based physical function and to investigate which performance tests are most frequently impaired in patients with axSpA.

METHODS

Patients. Adult patients with a clinical diagnosis of axSpA who also fulfilled the ASAS classification criteria for axSpA[17] were consecutively recruited. Patients with significant impairment in physical function affecting their ability to perform ADL independent of axSpA were excluded. Patients were seen once when visiting our tertiary care hospital. The study was approved by the ethics committee of the Ärztekammer Westfalen-Lippe (2017-665-f-S), and all patients gave written informed consent.

Data collection. All patients underwent a standardized assessment including collection of patient and disease characteristics, patient-reported outcomes (PROs), and performance tests. The following demographic and clinical information were collected: age, gender, BMI (calculated as weight in kilograms divided by height in meters squared), disease duration, joint counts, presence of extraspinal (sum of arthritis, enthesitis, and/or dactylitis) and extraarticular manifestations (uveitis, psoriasis, and/or inflammatory bowel disease), laboratory values (C-reactive protein [CRP], HLA-B27 status), and current treatment. Conventional radiographs of the cervical and lumbar spine from routine care (timeframe was the previous 2 years) were used to calculate the modified Stoke Ankylosing Spondylitis Spinal Score (mSASSS) to quantify structural damage of the spine.[18] Information about PA during the last 3 months was collected by a questionnaire.

Assessment tools. Assessment tools included the following: disease activity by Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) and the Ankylosing Spondylitis Disease Activity Score (ASDAS),[19,20] pain by a numerical rating scale 0 to 10 (10 being severe pain), self-reported physical function by BASFI,[10] spinal mobility by BASMI,[11] health-related quality of life (HRQOL) by 5-level EuroQol 5 dimensions questionnaire (EQ-5D-5L index and thermometer), country-specific value set for Germany,[21] health status with 36-item Short Form Health Survey (SF-36),[22] ASAS Health Index (ASAS HI), screening for depressive symptoms by 9-item Patient Health Questionnaire (PHQ-9),[23] work productivity by Work Productivity and Activity Impairment questionnaire (WPAI),[24] PA by International PA Questionnaire (IPAQ),[25] and the Short Questionnaire to Assess Health-enhancing PA (SQUASH).[26] Validated thresholds for disease status were applied for ASDAS and ASAS HI.[20,27]

Performance tests. Patients were asked to perform a single stance, and as part of the SPPB, a tandem stance, repeated chair stand test, and gait speed test.[13] We tested grip strength with a dynamometer in all patients. Validated cut-off thresholds were applied to define impairment as follows: SPPB total score ≤ 8; repeated chair stand test > 15 seconds; gait speed ≤ 0.8 m/s, grip strength male < 27 kg, female < 16 kg; and single stance ≤ 10 seconds.[28,29] In addition, all patients were asked to perform the 3 ASPI tests (bending to pick up 6 pencils from the floor [ASPI 1], putting on socks [ASPI 2], and getting up from the floor [ASPI 3]).[15] To standardize a nonimpaired performance situation, patients were not allowed to use a chair or bench to sit or lean on. For ASPI tests 2 and 3, putting on socks and getting up from floor, the time documented in seconds was based on the mean of 3 repetitions. Patients were defined as being impaired if they were not able to perform at least one of the performance tests.

Statistics. Descriptive data are presented as mean (SD) when referring to quantitative variables and as absolute frequencies and percentages when referring to qualitative variables. Comparisons of continuous variables between groups were made by *t* test and categorical variables by chi-square test. A value of $P < 0.05$ was considered significant. Spearman ρ correlation was used. Correlation was considered low if ≤ 0.30, moderate if > 0.30 and ≤ 0.50, high if between 0.50 and 0.80, and very high if ≥ 0.80. Logistic regression models were used to calculate the association between impairment in ≥ 1 performance test (dependent variable) and various patient characteristics (independent variables), adjusted for potential confounders (age, sex). Statistical analyses were performed using SPSS version 25 (IBM Corp).

RESULTS

Patient demographics. A total of 200 patients were included and analyzed. Of these, 69% were male with a mean age of 44.3 (SD 12.5) years (9 patients were aged > 65 yrs) and a mean symptom duration of 17.9 (SD 12.6) years (136 patients with a longstanding disease ≥ 10 yrs; Table 1). Only 101 out of 191 patients of working age had a full-time job (52.9%). The remaining patients had a part-time job (n = 31, 16.2%), were receiving disability pension (n = 33, 17.3%), were unemployed (n = 15, 7.9%), were students (n = 4, 2.1%), or were housekeepers (n = 7, 3.7%). Nine patients were retired (4.7%). Of the total cohort, the majority of patients (66.5%) were classified as having radiographic axSpA (r-axSpA). Extraspinal manifestations were seen in 13% (n = 26) of patients for arthritis, 6.5% (n = 13) for enthesitis, and 2% (n = 4) for dactylitis. Tender and swollen joint counts were low and did not differ between patients with and without impairments. Six patients underwent hip joint replacement, and 1 patient had a spinal vertebroplasty in the past. A total of 133 patients (66.5%) were treated with biologic disease-modifying antirheumatic drugs (bDMARDs). Patients had moderate disease activity and self-reported physical function was moderately impaired. ASDAS inactive disease was seen in 30 patients (15%). The PHQ-9 score indicated a high prevalence of patients with major depression (n = 79, 39.5%). Concordantly, HRQOL was reduced (EQ-5D 0.7 [SD 0.2] or SF-36 physical component summary 36.5 [SD 10.9] and mental component summary 45.8 [SD 12.8]). Structural damage was rated as low in 157 patients for whom radiographs were available. Sixty-nine patients (34.5%) were in a good state of global functioning (as per ASAS HI). A considerable number of patients (n = 71, 35.5%) reported no regular PA in the last 3 months. The median IPAQ total score was 2.346 metabolic equivalence unit minutes per week (IQR 686-4320) and median SQUASH total activity score was 6000 (IQR 1740-9765).

Physical performance in patients with axSpA. An impairment in ≥ 1 performance test including SPPB and ASPI was found in 91 patients (45.5%). The SPPB mean value was 10.3 (SD 1.8) and 22 (11%) patients were ≤ 8, indicating severely impaired performance. No impaired performance in SPPB tasks was found in 68 patients (34%) who reached the highest possible value of 12. No patient had a score of 0 or 1 in the SPPB. As many as 156

Table 1. Patient characteristics, health status, and outcomes at baseline.

	axSpA, n = 200	Impaired Population, n = 91	Nonimpaired Population, n = 109	*P*[*]
Male, n (%)	138 (69)	64 (70.3)	74 (67.9)	0.77
Age, yrs	44.3 (12.5)	49.1 (10.9)	40.3 (12.4)	**< 0.01**
BMI	27.3 (5.4)	28.9 (6.2)	25.8 (4.2)	**< 0.01**
HLA-B27 positive, n (%)	170 (86.7)	75 (82.4)	95 (87.2)	0.24
Symptom duration, yrs	17.9 (12.6)	20.7 (14)	15.5 (10.9)	**0.02**
Nr-axSpA, n (%)	67 (33.5)	46 (42.2)	21 (23.1)	**0.02**
History of extraspinal manifestation, n (%)[a]	108 (54)	55 (60.4)	53 (48.6)	0.09
mSASSS, 0-71 (n = 157)	10.2 (18.8)	12.6 (20.2)	7.9 (17.2)	0.22
Current drug treatment, n (%)[b]				
NSAID intake	122 (61)	63 (69.2)	59 (54.1)	**0.04**
Prednisolone intake	15 (7.5)	9 (9.8)	6 (5.5)	0.25
bDMARD intake	133 (66.5)	55 (60.4)	78 (71.6)	0.08
csDMARD intake	20 (10)	9 (9.9)	11 (10.1)	0.89
Self-reported exercise (last 3 months), n (%)	129 (64.5)	53 (58.2)	76 (69.7)	0.07
ASDAS, 0-10	2.5 (1.1)	3.0 (0.9)	2.1 (1)	**< 0.01**
ASDAS inactive disease, n (%)	30 (15)	3 (0.3)	27 (24.8)	**< 0.01**
BASDAI, 0-10	4.3 (2.3)	5.6 (1.8)	3.3 (2.2)	**< 0.01**
Pain, NRS 0-10	4.9 (2.8)	6.2 (2.3)	3.8 (2.7)	**< 0.01**
BASFI, 0-10	4.0 (2.7)	5.8 (2.3)	2.7 (2.1)	**< 0.01**
BASMI, 0-10	3.5 (1.8)	4.4 (1.7)	2.7 (1.5)	**< 0.01**
Current joint count, tender joints	3.4 (6.5)	2.1 (2.6)	4.4 (8.3)	0.38
Current joint count, swollen joints	1.0 (1.8)	0.5 (1.0)	1.4 (2.3)	0.25
ASAS HI, 0-17	7.0 (4.1)	9.5 (3.4)	4.9 (3.4)	**< 0.01**
PHQ-9, 0-27, sum score	8.8 (6.2)	11.6 (6.5)	6.5 (4.8)	**< 0.01**
PHQ-9, major depression (≥ 10), n (%)	79 (39.5)	53 (58.2)	26 (23.9)	**< 0.01**
EQ-5D-5L	0.7 (0.2)	0.6 (0.2)	0.8 (0.2)	**< 0.01**
SF-36, PCS	36.5 (10.9)	29.8 (8.1)	42.1 (9.8)	**< 0.01**
SF-36, MCS	45.8 (12.8)	41.9 (14.3)	49.1 (10.3)	**< 0.01**
WPAI, absenteeism, %	15.9 (33.7)	31.6 (43.5)	7.3 (23.3)	**< 0.01**
WPAI, presenteeism, %	29.2 (26.1)	47.4 (27.1)	18.8 (18.9)	**< 0.01**
WPAI, overall work impairment	16.1 (33.6)	31.8 (43.3)	7.5 (23.0)	**< 0.01**
WPAI, activity impairment	41.75 (29.1)	58.4 (25.8)	28.1 (24.5)	**< 0.01**
IPAQ, MET min/week, median (IQR)	2346 (686-4320)	2220.7 (99-29801)	3605.1 (1386-5226)	**< 0.01**
SQUASH, total activity score, median (IQR)	6000 (1740-9765)	3240 (1386-5226)	7770 (4650-11310)	**< 0.01**

Values are mean (SD) unless indicated otherwise. Patients were defined as being impaired if they were not able to perform ≥ 1 of the performance tests. [a] Sum of arthritis, enthesitis, and/or dactylitis. [b] Numbers add up to > 100 because combinations of drug treatment occurred. [*] Significant values in bold. ASAS HI: Assessment of Spondyloarthritis international Society Health Index; ASDAS: Ankylosing Spondylitis Disease Activity Score; axSpA: axial spondyloarthritis; BASDAI: Bath Ankylosing Spondylitis Disease Index; BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index; bDMARD: biologic disease-modifying antirheumatic drug; csDMARD: conventional synthetic DMARD; EQ-5D-5L: 5-level EuroQol 5 dimensions questionnaire; IPAQ: International Physical Activity Questionnaire; MCS: mental component summary; MET: metabolic equivalence unit; mSASSS: modified Stoke Ankylosing Spondylitis Spinal Score; nr-axSpA: nonradiographic axSpA; NRS: numerical rating scale; NSAID: nonsteroidal antiinflammatory drug; PCS: physical component summary; PHQ-9: 9-item Patient Health Questionnaire; SF-36: 36-item Short Form Health Survey; SQUASH: Short Questionnaire to Assess Health-enhancing physical activity; WPAI: Work Productivity and Activity Impairment questionnaire.

patients (78%) were capable of performing the entire ASPI test, whereas 21 (10.5%), 44 (22%), and 13 (6.5%) patients were not able to perform picking up 6 pencils (bending), putting on socks, and getting up from ground, respectively. The most frequently impaired performance test was the repeated chair stand test, which 75 patients could not do (37.5%), followed by 44 patients who had problems with putting on socks (22%), and 25 patients who failed to do the single stance test (14.8%; Table 2 and Figure 1).

Patients with impairments were significantly older (49.1 vs 40.3 yrs), had a slightly higher BMI (28.9 vs 25.8), higher depression scores (PHQ-9 11.6 vs 6.5), reduced physical function (BASFI 5.7 vs 2.8), impaired global functioning (ASAS HI 9.6 vs 5.0), higher disease activity (ASDAS 3.0 vs 2.1, BASDAI 5.6 vs 3.3) and pain scores (6.2 vs 3.8), and were less likely to reach ASDAS inactive disease (0.3% vs 24.8%) than patients with normal performance (all $P < 0.01$; Table 1). Further, patients with impairments reported a lower level of PA in the past, although an equal number of patients in both groups reported performing regular PA in the last 3 months. The degree of structural damage in the spine was not significantly different between the 2 groups.

Table 2. Performance tests in patients with axSpA.

	Performance Test, n = 200	Patients With/ Without Impairments, n (%)		Mean (SD)	95% CI	Min/Max	Median	25th/75th Percentile
Generic	SPPB, 0-12		Total	10.3 (1.8)	10.0-10.5	2.0-12.0	11.0	9.0-12.0
			No impairments	11.5 (0.7)	11.3-11.6	10.0-12.0	12.0	11.0-12.0
		22 (11)	Impairments	8.8 (1.7)	8.5-9.2	2.0-12.0	9.0	9.0-10.0
	Repeated chair stand test, s		Total	14.3 (5.9)	13.4-15.1	6.8-42.9	12.8	10.5-17.0
			No impairments	10.9 (2.0)	10.5-11.3	6.8-14.9	11.0	9.4-12.7
		75 (37.5)	Impairments	18.9 (6.3)	17.5-20.4	10.6-42.9	17.6	15.5-20.8
	Gait speed, m/s		Total	1.1 (0.3)	1.08-1.16	0.4-2.4	1.1	1.0-1.3
			No impairments	1.2 (0.2)	1.2-1.3	0.9-2.4	1.2	1.1-13
		18 (9)	Impairments	1.0 (0.3)	0.9-1.0	0.4-1.8	1.0	0.9-1.1
	Grip strength male, kg (n = 138)		Total	42.2 (9.7)	40.5-43.8	15.0-66.0	43.0	36.4-48.0
			No impairments	45.4 (7.5)	43.7-47.2	27.5-66.0	45.0	40.7-50.0
		11 (8)	Impairments	38.4 (10.6)	35.7-41.0	15.0-61.0	38.5	30.0-45.0
	Grip strength female, threshold < 16 kg (n = 62)		Total	24.0 (5.4)	22.6-25.3	12.0-38.0	24.0	21.8-27.0
			No impairments	26.1 (4.9)	23.0-29.0	13.0-38.0	27.0	24.3-27.8
		6 (9.7)	Impairments	21.2 (4.6)	18.0-26.0	12.0-27.0	22.0	19.4-23.1
	Single stance, threshold ≤ 10 s (n = 169)		Total	66.6 (45.8)	59.5-73.6	2.2-120.0	60.2	19.9-120.0
			No impairments	90.3 (36.9)	82.7-97.9	12.8-120.0	120.0	59.3-120.0
		25 (14.8)	Impairments	35.9 (37.4)	27.1-44.7	2.2-120.0	20.5	9.1-50.9
Disease-specific	ASPI 1 (bending), s		Total	18.6 (9.5)	17.2-20.0	4.7-69.3	16.5	12.4-21.4
			No impairments	14.8 (6.2)	13.6-16.0	4.7-55.0	13.6	10.9-16.9
		21 (10.5)	Impairments	21.9 (6.4)	19.9-23.7	11.7-45.7	21.4	17.4-27.7
	ASPI 2 (putting on socks), s		Total	12.8 (6.4)	11.8-13.9	4.1-42.2	11.2	8.8-14.6
			No impairments	11.3 (5.5)	10.2-12.3	4.1-42.2	10.0	8.0-12.7
		44 (22)	Impairments	16.5 (6.8)	14.5-18.5	5.9-36.4	14.6	11.8-20.3
	ASPI 3 (getting up), s		Total	6.5 (5.0)	5.7-7.2	1.6-33.0	4.9	3.3-8.0
			No impairments	4.1 (1.7)	3.7-4.4	1.6-9.2	3.8	2.7-5.1
		13 (6.5)	Impairments	7.1 (3.1)	6.2-8.1	2.3-19.9	6.7	5.9-11.4

ASPI: Ankylosing Spondylitis Performance Index; axSpA: axial spondyloarthritis; SPPB: Short Physical Performance Battery.

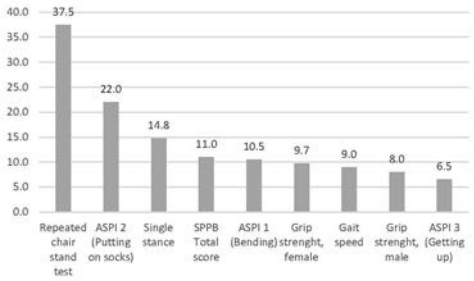

Figure 1. Percentage of participants with impaired performance tests. ASPI: Ankylosing Spondylitis Performance Index; SPPB: Short Physical Performance Battery.

Patients with a BASFI score < 4 (n = 99) did not show an impaired performance; only 1 patient had a SPPB sum score ≤ 8 and only 6 patients were not able to perform ≥ 1 of the ASPI tests. The majority of patients with BASFI ≥ 4 (79.2%, 80/101 patients) did have an impaired performance as assessed by SPPB. Patients with BASFI ≥ 4 and < 4 showed comparable differences for age, BMI, and PROs, as also shown in the analysis of patients with and without impairments (data not shown). An even larger difference was seen when analyzing the discriminant effect of ASPI. Six out of 101 patients (5.9%) in the BASFI ≥ 4 group showed impairments in at least 1 ASPI test whereas only 1 patient did so in the BASFI < 4 group. However, 30.3% (54/178) of patients with BASMI < 4 had a SPPB sum score ≤ 8 and 77.3% (17 of 22) of patients with BASMI ≥ 4 demonstrated an impaired performance. Almost none of patients in remission had an impaired performance. Impairments were seen in 4 patients who were either not able to perform the chair rise test or the ASPI 2 test (putting on socks).

Prevalence of impairments tend to increase with age. In the age group ≥ 65 years, 5 out of 9 patients (55.6%) presented with impairments in at least 1 performance test and SPPB ≤ 8 was found in 2 out of 9 patients (22.2%), whereas in age group < 65 years, 82 out of 191 patients (42.9%) presented with impairments in at least 1 performance test and SPPB ≤ 8 was found in 20 out of 191 patients (10.5%). None of the patients aged < 30 years had impairments in performance, but prevalence increased with each decade (SPPB ≤ 8 in 3 patients [7.3%] in the > 30 age group, 6 patients [9.1%] in the > 40 age group, 7 patients [18.9%] in the > 50 age group, 5 patients [23.9%] in the > 60 age group, and 1 patient [50%] in the > 70 age group).

Impairments were more prevalent in patients with longstanding disease. Although mean SPPB scores were comparable in both groups (10.6 [SD 1.5] for symptom duration < 10 years vs 10.1 [SD 1.9] in longstanding disease), SPPB ≤ 8 was more frequently present in patients with longstanding disease (5/64 [7.8%] for patients with a symptom duration < 10 years vs 17/136

[12.5%] in patients with longstanding disease). Impairments in at least 1 performance test were seen in 24/64 (37.5%) of patients with a symptom duration < 10 years vs 63/136 (46.3%) in patients with longstanding disease. In contrast, patients with longstanding disease reported being physically active (self-reporting using IPAQ and SQUASH) more often than patients with a symptom duration < 10 years.

Association between self-reported physical functioning and actual physical performance. The correlation between self-reported physical functioning and performance tests was moderate to high for all tests except grip strength, which was low (Table 3). The best association was found between BASFI and SPPB and single stance (Table 3 and Figure 2). Mobility and self-reported global functioning showed a similar correlation with the performance tests as with the BASFI. Although the correlation between self-reported PA and performance tests was low, significant associations were noted for gait speed and total SPPB scores. No significant correlation was found between structural damage and performance tests (Table 3).

The logistic regression analysis revealed that impairment was associated with increased age (odds ratio [OR] 1.05, 95% CI 1.01-1.11) and compromised mobility (BASMI 1.97, 95% CI 1.25-3.25). Further, impairment was associated with less structural damage (mSASSS; OR 0.96, 95% CI 0.92-1.00; Table 4).

DISCUSSION

In this cohort of patients with axSpA, impaired physical performance was common. To our knowledge, our study is among the first to study performance tests in patients with axSpA by using and comparing the tests live with different tools. For the first time, we show that a large proportion of patients (45.5%) does not reach targets originally validated in geriatric patients and frequently used in such populations. Patients with impairments were significantly older, had higher BMIs, higher depression scores, higher disease activity, and lower self-reported physical and global functioning compared to patients with no impairments in performance. The proportion of patients with impairments in performance increased with age, but in the group of patients aged < 65 years, as many as 10.5% of patients showed severe impairments in performance according to the established SPPB threshold of ≤ 8. This impairment was particularly seen in tests requiring muscle power, coordination, and balance, such as in the repeated chair, putting on socks (ASPI 2), or single stance tests. Of note, impairments in performance could be seen in generic measures for which thresholds exist. The values of the disease-specific ASPI tests in our study are comparable to those published recently indicating that axSpA populations might be comparable at least in terms of performance and physical function.[14,15,30-31] However, a significant proportion of patients did not show any impairments in physical performance. Of note, in our study, peripheral involvement of joints and entheses was low, which could have resulted in fewer limitations in performance.

However, we could also demonstrate that more than one-third of patients in our cohort reached the highest possible value in the SPPB test. Considerable variability in SPPB scores with the notion of a ceiling effect has been reported in geriatric cohorts.[32] A ceiling effect was especially observed in individuals living an independent life who report to be physically active.

Neither patients with structural damage nor patients with high disease activity had consistently impaired performance scores. In both domains, patients with no limitation of performance and those with severe limitation of performance were found. We found a negative association between impaired performance and structural damage, although there was a quite low extent of structural damage in our cohort. Each additional increase of 1 unit in structural damage was associated with a 4% decrease in the odds of patients with an impaired performance. This association should be interpreted with caution because of the relatively low sample size, and the absence of major structural damage might have limited the generalizability of this result. Moreover, recent studies have shown that a substantial increase in mSASSS scores is needed to cause a functional impairment.[33,34] Self-reported PA and other PROs could well discriminate patients with and without impairments. Impairment was

Table 3. Correlation between performance and self-reported functioning.

N = 200	Total SPPB Score	Repeated Chair Stands	Gait Speed	Grip Strength	Single Stance	ASPI 1	ASPI 2	ASPI 3
Age, yrs	−0.40**	0.35**	−0.41**	−0.20**	−0.44**	0.41**	0.29**	0.54**
BMI, kg/m^2	−0.23**	0.28**	−0.30**	NS	−0.33**	0.30**	0.21**	0.21**
ASDAS	−0.45**	0.41**	−0.35**	−0.17*	−0.44**	0.38**	0.19**	0.19**
mSASSS[a]	−0.09	0.08	0.09	0.12	0.16	0.15	0.38**	0.38**
BASMI, 0-10	−0.47**	0.41**	−0.49**	−0.23**	−0.52**	0.52**	0.59**	0.59**
BASFI, 0-10	−0.57**	0.49**	−0.46**	−0.18*	−0.58**	0.58**	0.38**	0.38**
ASAS HI, 0-17	−0.56**	0.53**	−0.42**	−0.22**	−0.56**	0.54**	0.22**	0.22**
PHQ-9, 0-27	−0.44**	0.42**	−0.31**	−0.16*	−0.41**	0.46**	0.08	0.08
SQUASH	0.30**	−0.18*	0.30**	0.14*	0.27**	−0.27**	−0.04**	−0.12
IPAQ	0.24**	−0.21**	0.19*	0.15*	0.10	−0.19*	0.30**	−0.04

Values are presented as the Spearman correlation coefficient. [a] n = 157. *P < 0.05. ** P < 0.01. ASAS HI: Assessment of Spondyloarthritis international Society Health Index; ASDAS: Ankylosing Spondylitis Disease Activity Score; ASPI: Ankylosing Spondylitis Performance Index; BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index; IPAQ: International Physical Activity Questionnaire; mSASSS: modified Stoke Ankylosing Spondylitis Spinal Score; NS: not significant; PHQ-9: Patient Health Questionnaire; SPPB: Short Physical Performance Battery; SQUASH: Short Questionnaire to Assess Health-enhancing physical activity.

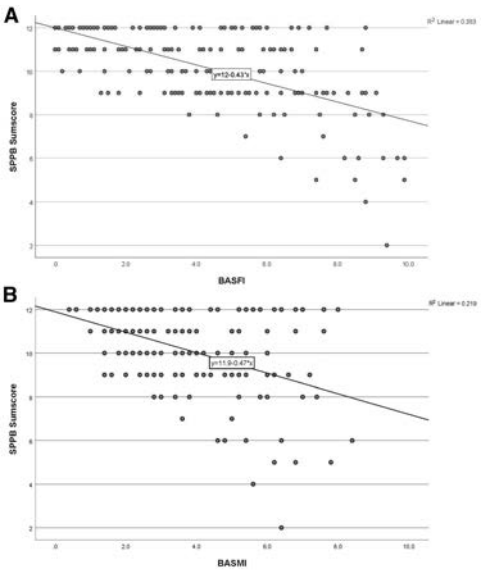

Figure 2. Relation between performance tests and self-reported physical functioning as well as mobility. Relation between (A) BASFI and (B) BASMI. BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index; SPPB: Short Physical Performance Battery.

also present in patients on bDMARDS, which is likely not to be a result of the medication but rather of the underlying disease status.

Assessment of performance is of great importance in patients with limitations in spinal mobility and a variable involvement of peripheral joints. Qualitative work on the importance of difficulties in everyday activities in patients with r-axSpA showed that domains such as "turn head when driving" or "carry groceries" are problems most frequently reported by patients with ankylosing spondylitis (AS).[35] Well-maintained performance is important because patients with r-axSpA may have an increased prevalence of falls and fractures.[36,37] The importance of the restriction of everyday activities is also reflected in the BASFI questions, which explicitly address ADL and are operationalized in the ASPI performance test.[10,30,38] However, no judgment about impairments in ASPI tests can be made because no normative values exist to describe no impairments at all.

Associations between self-reported functioning and performance-based tests exist, as well as between self-reported PA and performance-based tests, although the extent was mainly low to moderate in our study. This indicates that the methods used were able to assess physical functioning but also that they, at least partly, can assess different aspects of physical function. Of note, PA questionnaires do not accurately estimate fitness and performance when compared to maximal oxygen uptake.[39] Physical function is a domain that describes the capability of an organism to independently perform specific tasks. In a clinical context, recognition of limitations in performing basic tasks is important because impairments in these domains can predict the future development of disability.[40] Because impairments in physical function are often reversible when assessed at an early stage of disease, we propose that objective measures of physical function should be used to assess the association between self-reported and performance-based physical functioning.[1,6]

Our study does not allow a conclusion on how to reliably identify patients with impaired performance. However, we assume that from the patient's point of view, it is important to address possible limitations in performance at an early stage to effectively counteract onset of limitations in the future. We were able to demonstrate the time-dependent influence with the analysis between symptom duration and impaired performance in our cohort. Impairments in performance are by nature multifactorial, and we show in our analysis that, at least to some extent, age, disease activity, structural damage, and mobility are drivers

Table 4. Logistic regression with impairment in ≥ 1 performance test as the dependent variable.

		Univariable			Multivariable		
	n	OR	95% CI	*P**	OR	95% CI	*P**
Age, yrs	200	1.06	1.04-1.09	< **0.001**	1.05	1.01-1.11	**0.02**
Sex, male	200						
No		–	–		–	–	
Yes		1.12	0.61-2.06	0.71	1.14	0.39-3.38	0.8
ASDAS	200	2.51	1.82-3.57	< **0.001**	1.10	0.58-2.11	0.8
IPAQ	197	1.00	1.00-1.00	**0.002**	1.00	1.00-1.00	0.2
BASFI	200	1.76	1.51-2.09	< **0.001**	1.34	0.98-1.85	0.07
BASMI	200	1.79	1.49-2.21	< **0.001**	1.97	1.25-3.25	**0.005**
mSASSS	157	1.01	1.00-1.03	0.12	0.96	0.92-1.00	**0.04**
Arthritis, current	200						
No		–	–		–	–	
Yes		4.84	1.95-13.82	**0.001**	2.60	0.69-11.24	0.2
Major depression	200						
No		–	–		–	–	
Yes		4.45	2.45-8.27	< **0.001**	1.93	0.69-5.54	0.2

* Significant values in bold. ASDAS: Assessment of Spondyloarthritis International Society Health Index; BASFI: Bath Ankylosing Spondylitis Functional Index; BASMI: Bath Ankylosing Spondylitis Metrology Index; IPAQ: International Physical Activity Questionnaire; mSASSS: modified Stoke Ankylosing Spondylitis Spinal Score; OR: odds ratio.

of limited performance. However, in a disease characterized by a rather slow deterioration in mobility over time in the vast majority of patients, other factors may also play a role. Female sex, older age, active smoking, lower educational level, and high disease activity at onset were independently associated with bad functional outcomes at 24 months in a prospective cohort of patients with axSpA with a short disease duration.[41] Ward et al found that functional impairment over time in patients with r-axSpA increased with age, active smoking status, and absence of social support.[5] Moreover, patients with impairments in specific performance tasks requiring mobility of the spine might be able to compensate for their deficits. Conditional abilities, such as strength, coordination, and endurance, as opposed to mobility, do not necessarily have to be affected in patients with axSpA. Indeed, regular physical exercising and good social support were shown to be associated with improvement in disability over time in patients with axSpA.[5] However, factors outside the physical function domain such as adaptive processes, including coping strategies, might have taken place and might explain variability in performance. However, such processes were not investigated in our cohort. Further research is needed to better understand such processes and their effects in detail.

Since functional impairments can be potentially influenced by PA, studies should be performed to identify the cause of these deficits.[42] This is especially important when not only muscle function but also muscle mass of a patient is affected, such as in sarcopenia.[43] For axSpA, a prevalence of sarcopenia between 20% to 34% has been reported.[44,45] Future studies need to prospectively examine performance and sarcopenia in patients with axSpA and whether physical function tests predict negative health outcomes.

To prevent limitations in performance and physical functioning, ASAS management recommendations, ASAS quality standards, and ASAS-OMERACT core domain set for axSpA include guidance for monitoring and promoting physical functioning, PA, and performance.[2,3,12] Moreover, the European Alliance of Associations for Rheumatology recommendations for PA explicitly address the need for patients with axSpA to focus on cardiorespiratory fitness, muscle strength, flexibility, and neuromotor performance.[7] Based on our findings, promotion of PA should address these domains but should emphasize coordination, balance, and muscle power of the lower extremity as well. However, studies showed that cardiorespiratory fitness is low in patients with AS compared to controls but that no group differences exist in balance or muscular capacity between patients and controls.[46] Moreover, a standardized workflow does not exist for supervised physical exercises, which might address specific needs in patients with axSpA. Promotion of PA is in line with the educational needs of patients with SpA who rated information on the domains of "movement" and "prognosis of disease" as important.[47]

How may our findings have an impact on the management of patients in clinical practice? First, subjects with limitations in performance tests should receive additional diagnostic examinations to achieve a thorough understanding of the nature of the underlying condition.[48] As for the general population, it is relevant for patients with axSpA to treat sarcopenia, frailty, and/or other conditions appropriately to improve outcomes. Second, it is recognized that patients with axSpA experience a high rate of falls.[36] Consequently, well-preserved muscle function is important to prevent these often-debilitating events. Third, preservation of performance might have an effect on ADL—a domain reported to be the most frequently impaired in patients with axSpA.[35]

In conclusion, we have identified a high number of patients with impairments in physical performance tests. Importantly, impairment was frequently seen in complex tasks requiring coordination, balance, and muscle power of the lower body. Our data strongly suggest that merely collecting questionnaires is insufficient to assess function in patients with axSpA. Performance tests provide qualitatively different information than BASFI and BASMI assessments in patients with axSpA and are also needed to identify impairments in ADL.

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