






BRIEF REPORT

Similar Impact of Psoriatic Arthritis and Rheumatoid Arthritis on Objective and Subjective Parameters of Hand Function

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Objective. The objective of this study was to compare the impact of psoriatic disease (psoriatic arthritis [PsA] and psoriasis) and rheumatoid arthritis (RA) on objective and subjective parameters of hand function.

Methods. Hand function was determined in this cross-sectional study by 1) vigorimetric grip strength, 2) the Moberg Picking-Up Test used for assessing fine-motor skills, and 3) self-reported hand function (Michigan Hand Questionnaire). Mixed-effects linear regression models were used to test the relation of hand function with disease group, age, and sex.

Results. Two hundred ninety-nine subjects were tested, 101 with RA, 92 with PsA, and 106 nonarthritic controls (51 with psoriasis and 55 healthy controls [HCs]). Regression analysis showed that hand function was influenced by age, sex, disease group, and hand dominance ($P < 0.001$ for all). The impact of PsA and RA on hand function was comparable and generally more pronounced in women. Both PsA and RA led to significantly enhanced age-related loss of grip strength, fine-motor skills, and self-reported hand function in patients with PsA and RA compared with HCs. In addition, patients with psoriasis showed significant impairment of hand function compared with HCs.

Conclusion. RA and PsA have a comparable impact on the decline of strength, fine-motor skills, and self-reported function of the hand. Unexpectedly, patients with psoriasis also show impaired hand function that follows a similar pattern as observed in patients with PsA.

INTRODUCTION

It is well established that rheumatoid arthritis (RA) and psoriatic arthritis (PsA) impact physical function (1), leading to but also caused by impaired muscle function in the hands and legs (2). Physical function impairment in RA and PsA is predominantly assessed with instruments, such as the Health Assessment Questionnaire (HAQ), that allow for the measurement of disease-related patient-reported functional impairment. Although hand function in RA is well studied (3), comparison with other arthritic diseases,

as well as identification of disease-specific characteristics of hand function, is sparse.

The hands are one of the most critical functional components of the musculoskeletal apparatus. RA and PsA typically affect the joints of the hands with different patterns of clinical manifestation. The impact of inflammatory arthritis on hand function has mainly been studied in RA, and studies comparing hand function in these diseases are sparse. In this observational cross-sectional study, the objective was to comprehensively evaluate hand function in psoriatic disease (PsA

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Table 1. Summary of subject characteristics and clinical data by group and overall

	Group				
	Healthy control	Psoriatic arthritis	Psoriasis	Rheumatoid arthritis	All
<i>n</i>	55	92	51	101	299
Age, mean (SD), y	54.6 (16.5)	54.8 (11.6)	47.3 (14.1)	59.1 (13.3)	54.9 (14.1)
Sex, <i>n</i> (%)					
Male	25 (45.5)	44 (47.8)	32 (62.7)	38 (37.6)	139 (46.5)
Female	30 (54.5)	48 (52.2)	19 (37.3)	63 (62.4)	160 (53.5)
BMI, mean (SD), kg/m ²	25.2 (3.3)	29 (6.1)	29.8 (7.3)	27.2 (5)	27.8 (5.8)
Smoking, <i>n</i> (%)					
Ever	21 (38.2)	47 (51.1)	34 (66.7)	58 (57.4)	160 (53.5)
Never	34 (61.8)	45 (48.9)	17 (33.3)	43 (42.6)	139 (46.5)
Units of alcohol, UK U/wk					
Mean (SD)	7.6 (10.2)	5 (9.1)	4.5 (6.5)	3.1 (5)	4.8 (8)
Median (IQR)	4.5 (1-8)	2 (0-5)	1.1 (0-6.5)	0 (0-4)	2 (0-6)
Disease duration, y					
Mean (SD)	-	9.1 (9.8)	12.5 (11.7)	11 (10.1)	10.6 (10.4)
Median (IQR)	-	5 (2-14)	9 (4-19)	8 (3-15)	7 (3-15)
Dactylitis present, <i>n</i> (%)	0 (0)	22 (23.9)	0 (0)	1 (1)	-
Nail involvement present, <i>n</i> (%)	0 (0)	48 (52.2)	21 (41.2)	2 (2)	-
Anti-CCP2 (U/l), <i>n</i> (%)					
Negative	50 (90.9)	89 (96.7)	49 (96.1)	39 (38.6)	227 (75.9)
Positive	0 (0)	3 (3.3)	1 (2)	62 (61.4)	66 (22.1)
NA	5 (9.1)	0 (0)	1 (2)	0 (0)	6 (2)
Rheumatoid factor (U/l), <i>n</i> (%)					
Negative	50 (90.9)	89 (96.7)	50 (98)	66 (65.3)	255 (85.3)
Positive	0 (0)	2 (2.2)	0 (0)	35 (34.7)	37 (12.4)
NA	5 (9.1)	1 (1.1)	1 (2)	0 (0)	7 (2.3)
CRP, mg/l					
Mean (SD)	5.3 (1.7)	7.1 (14.2)	6.4 (7.3)	6.6 (11.4)	6.5 (10.8)
Median (IQR)	5.1 (5.1-5.1)	4.7 (2.3-6.4)	5.1 (2.4-6.2)	2.9 (1.3-6.2)	5.1 (2.2-5.7)
ESR, mm/h					
Mean (SD)	9.9 (6.9)	14.5 (13.7)	15.1 (17.2)	14.9 (14.2)	13.9 (13.7)
Median (IQR)	9 (4-13)	9 (4-21)	8 (6-20)	10 (5-20)	9 (5-19)
VAS pain, mm					
Mean (SD)	5.4 (12.7)	33.4 (25.2)	22.4 (28.2)	33.3 (24.4)	26.7 (25.9)
Median (IQR)	0 (0-4)	28 (8-51)	6 (0-40)	28 (12-53)	19 (3-47)
Swollen joint count 76, <i>n</i>					
Mean (SD)	0 (0)	0.9 (2.2)	0 (0)	0.7 (1.1)	-
Median (IQR)	0 (0)	0 (0-1)	0 (0)	0 (0-1)	-
Tender joint count 78, <i>n</i>					
Mean (SD)	0.5 (1.4)	5.9 (8.1)	3.2 (6.4)	5.2 (6.8)	-
Median (IQR)	0 (0-0)	2 (0-8)	0 (0-3)	2 (0-8)	-
HAQ-DI score (0-3 units)					
Mean (SD)	0.1 (0.2)	0.6 (0.7)	0.4 (0.6)	0.9 (0.6)	0.6 (0.6)
Median (IQR)	0 (0-0)	0.5 (0-1)	0 (0-0.6)	0.9 (0.4-1.2)	0.4 (0-1)
PASI score (0-72 units)					
Mean (SD)	-	1.4 (2.6)	3.3 (4.1)	-	-
Median (IQR)	-	0.3 (0-1.8)	1.7 (0.3-4.2)	-	-
DLQI score (0-30 units)					
Mean (SD)	-	3.1 (3.9)	8.2 (6.9)	-	-
Median (IQR)	-	1 (0-4)	7 (2-13)	-	-
PSAID score (0-20 units)					
Mean (SD)	-	5.3 (4.2)	-	-	-
Median (IQR)	-	4 (2-8.1)	-	-	-
MASES (0-13 units)					
Mean (SD)	-	1.3 (2.3)	0 (0)	-	-
Median (IQR)	-	0 (0-1)	0 (0)	-	-

Abbreviations: anti-CCP2, antibody against cyclic citrullinated peptide; BMI, body mass index; CRP, C-reactive protein; DLQI, Dermatology Life Quality Index; ESR, erythrocyte sedimentation rate; HAQ-DI, Health Assessment Questionnaire Disability Index; IQR, interquartile range; MASES, Maastricht Ankylosing Spondylitis Enthesitis Score; NA, not available, PASI, Psoriasis Area and Severity Index; PSAID, Psoriatic Arthritis Impact of Disease; VAS, visual analog scale.

and psoriasis) and patients with RA by assessing muscular force, fine-motor skills, and self-perception of hand function and compare these data with those of healthy controls.

PATIENTS AND METHODS

Study participants. Consecutive patients with RA according to American College of Rheumatology/European League Against Rheumatism (ACR/EULAR) 2010 criteria (4) and PsA according to the Classification Criteria for Psoriatic Arthritis (CASPAR) (5) were recruited in the outpatient clinics of the Rheumatology and Immunology and Dermatology Departments of University Clinic Erlangen. In addition, healthy controls without present or past signs of rheumatic disease were recruited by phone or personal conversation from a previously established cohort (6) or our database. As

an additional control group, patients with psoriasis without signs of arthritis, enthesitis, dactylitis, or inflammatory back pain (7), referred from the dermatology department, were investigated. Patients gave their written informed consent. The Institutional Review Board of University Clinic Erlangen (#125_16B) approved the study. Subjects with 1) fractures in the hands in the last 5 years; 2) diseases affecting the morphology and function of hands, such as neurologic diseases; or 3) gross destruction of the finger joints with visible deformities were excluded from the study.

Hand function tests. Isometric grip strength was measured in pounds using a hand dynamometer (Lafayette Instrument Company). The highest measured force in three attempts was used for data analysis. The Moberg-Picking-Up Test (MPUT), which has been validated in inflammatory arthritis (8), was used

Table 2. Statistical summary of pairwise comparison

	Sex	Age	Hand dominance	MPUT		Grip strength		MHQ score	
				Estimate	<i>P</i>	Estimate	<i>P</i>	Estimate	<i>P</i>
PsA/control	Male	35	Dominant hand	1.071	0.907	-0.575	>0.99	4.773	0.451
			Nondominant hand	1.067	0.921	-3.966	0.937	1.403	0.972
		55	Dominant hand	1.279	0.010 ^a	10.738	0.163	9.130	0.002 ^a
			Nondominant hand	1.274	0.012 ^a	7.347	0.488	5.759	0.100
		75	Dominant hand	1.528	0.001 ^a	22.052	0.021 ^a	13.486	0.001 ^a
			Nondominant hand	1.521	0.002 ^a	18.660	0.070	10.116	0.027 ^a
	Female	35	Dominant hand	1.141	0.609	6.929	0.770	8.005	0.088
			Nondominant hand	1.137	0.637	3.538	0.961	4.635	0.528
		55	Dominant hand	1.363	<0.001 ^a	18.242	<0.001 ^a	12.362	<0.001 ^a
			Nondominant hand	1.357	<0.001 ^a	14.851	0.012 ^a	8.991	<0.001 ^a
		75	Dominant hand	1.628	<0.001 ^a	29.556	<0.001 ^a	16.719	<0.001 ^a
			Nondominant hand	1.621	<0.001 ^a	26.164	<0.001 ^a	13.348	<0.001 ^a
PsO/control	Male	35	Dominant hand	1.204	0.279	9.910	0.474	3.700	0.674
			Nondominant hand	1.133	0.622	8.460	0.607	0.884	>0.99
		55	Dominant hand	1.257	0.042 ^a	10.736	0.235	9.823	0.002 ^a
			Nondominant hand	1.183	0.209	9.286	0.361	7.007	0.056
		75	Dominant hand	1.313	0.141	11.562	0.520	15.946	<0.001 ^a
			Nondominant hand	1.236	0.342	10.112	0.629	13.130	0.006 ^a
	Female	35	Dominant hand	1.378	0.018 ^a	21.338	0.018 ^a	9.063	0.044 ^a
			Nondominant hand	1.297	0.083	19.888	0.033 ^a	6.247	0.274
		55	Dominant hand	1.439	<0.001 ^a	22.164	0.003 ^a	15.186	<0.001 ^a
			Nondominant hand	1.354	0.009 ^a	20.714	0.006 ^a	12.370	<0.001 ^a
		75	Dominant hand	1.502	0.014 ^a	22.990	0.053 ^a	21.309	<0.001 ^a
			Nondominant hand	1.414	0.051 ^a	21.540	0.080	18.493	<0.001 ^a
RA/control	Male	35	Dominant hand	1.262	0.155	13.349	0.273	12.938	0.001 ^a
			Nondominant hand	1.240	0.214	7.222	0.763	8.117	0.096
		55	Dominant hand	1.343	0.002 ^a	18.650	0.003 ^a	12.460	<0.001 ^a
			Nondominant hand	1.319	0.004 ^a	12.523	0.092	7.639	0.018 ^a
		75	Dominant hand	1.428	0.002 ^a	23.952	0.002 ^a	11.982	<0.001 ^a
			Nondominant hand	1.403	0.005 ^a	17.825	0.039 ^a	7.160	0.112
	Female	35	Dominant hand	1.305	0.041 ^a	20.638	0.012 ^a	17.423	<0.001 ^a
			Nondominant hand	1.282	0.066	14.511	0.133	12.601	<0.001 ^a
		55	Dominant hand	1.388	<0.001 ^a	25.940	<0.001 ^a	16.944	<0.001 ^a
			Nondominant hand	1.364	<0.001 ^a	19.813	<0.001 ^a	12.123	<0.001 ^a
		75	Dominant hand	1.477	<0.001 ^a	31.242	<0.001 ^a	16.466	<0.001 ^a
			Nondominant hand	1.451	<0.001 ^a	25.114	<0.001 ^a	11.645	<0.001 ^a

Note. Hand function estimates are time ratios, and grip strength and MHQ estimates indicate absolute differences.

Abbreviations: MHQ, Michigan Hand Questionnaire; MPUT, Moberg Picking-Up Test; PsA, psoriatic arthritis; PsO, psoriasis; RA, rheumatoid arthritis.

^a Significant *P* values.

to measure fine-motor skills (9). The time needed to move 12 small items from the table into a box with open eyes was recorded. The fastest out of three attempts was included in the analysis. Self-reported hand function was determined using the Michigan Hand Questionnaire (MHQ) (10). Measurements were taken from both hands, and dominance was recorded. Functional and clinical data were collected by trained physicians and study nurses on the same day (for more detail see the Supplemental Material).

Statistical analysis. General subject characteristics are summarized as means \pm SDs and quantiles (0.5 [0.25-0.75]) (Table 1). For the primary analyses, we used mixed-effects linear regression to model grip strength, and we log transformed hand function and MHQ scores, respectively, as a function of disease, age, sex, and hand dominance (fixed effects), with individuals as random effects (Tables 2 and 3). We reasoned that age, sex, and hand dominance would not only confound disease and hand function associations but also likely modify the effect of diseases on hand function. For this reason, two-way interaction terms for age, sex, study group, and dominance were included in all models. Because of significant interactions, we did not make overall between-group comparisons, and we reported tabulated model coefficients and their respective 95% confidence intervals. Overall significance of model variables was assessed using type II Wald χ^2 tests (Table 3). Exponentiated model coefficients for the hand function model represented time ratios. Pairwise between-group ratios for hand function and absolute pairwise differences in grip strength and MHQ scores between controls and disease groups were presented as estimated marginal mean differences (Figure 1, Tables 2 and 3) per sex at ages 35, 55, and 75 and separately for the dominant and nondominant hand. Two-sided *P* values less than 0.05 were considered significant, and for pairwise comparisons, these were adjusted using the Tukey method for a family of four estimates. All data manipulation and analyses

were performed using the open-source R software version 3.5.3 (11).

RESULTS

Muscular force. Two hundred ninety-nine subjects participated in this study; their characteristics are summarized in Table 1. Grip strength as a measure of muscle force was dependent on sex, with higher values in men than in women (Figure 1A). Point estimates for marginal means ranged between 75 and 125 lb in men and 30 and 75 lb in women. Grip strength in men was lower at older ages, whereas it remained remarkably stable in women. PsA, RA, and psoriasis lowered grip strength in women, whereas in men, only modest disease-related reductions of grip strength were observed, which were only significant in aged subjects. Regression analysis showed that grip strength was significantly affected by age, disease status, sex, and hand dominance (Tables 2 and 3).

Fine-motor skills. Fine-motor skills, as assessed by the MPUT, were consistent across all ages in healthy subjects. However, older individuals with RA and PsA (and, interestingly, also patients with psoriasis) presented with significantly higher MPUT times. Regression analysis showed that fine-motor skills are affected by age and disease status (Tables 2 and 3). Estimated marginal mean MPUT times in patients with RA, PsA, and psoriasis incrementally deviated from those in controls with increasing age (Figure 1B). In pairwise comparisons, the interaction of PsA with age was apparent, such that MPUT time ratios at age 35 indicated a 7% to 14% worsening due to PsA, whereas the range for worsening hand function at age 75 was 52% to 63% (Tables 2 and 3). The point estimates for psoriasis indicated worsening of hand function; however, the estimates were mostly imprecise in men, and a null effect could not be ruled out with good certainty. Most comparisons for RA indicated a worsening MPUT time with older age ranging from 24% to 48%.

Table 3. Statistical summary of Wald χ^2 tests

Model terms	df	MPUT		Grip strength		MHQ score	
		Statistic	<i>P</i>	Statistic	<i>P</i>	Statistic	<i>P</i>
age	1	35.19	<0.001 ^a	61.41	<0.001 ^a	34.32	<0.001 ^a
group	3	41.68	<0.001 ^a	36.52	<0.001 ^a	63.1	<0.001 ^a
sex	1	2.45	0.118	343.24	<0.001 ^a	11.27	<0.001 ^a
dominant hand	1	3.14	0.076	50.16	<0.001 ^a	10.9	<0.001 ^a
age:group	3	5.9	0.117	5.86	0.119	11.51	0.009 ^a
age:sex	1	0.11	0.739	8.16	0.004 ^a	7.17	0.007 ^a
age:dominant hand	1	0.01	0.915	1.45	0.228	4.44	0.035 ^a
group:sex	3	1.39	0.707	2.23	0.527	2.71	0.438
group:dominant hand	3	1.74	0.629	9.48	0.024 ^a	7.6	0.055 ^a
sex:dominant hand	1	3.68	0.055 ^a	0.86	0.354	0.78	0.376

Note. Hand function estimates are time ratios, and grip strength and MHQ estimates indicate absolute differences.

Abbreviations: df, degrees of freedom; MPUT, Moberg Picking-Up Test; MHQ, Michigan Hand Questionnaire.

^a Significant *P* values.

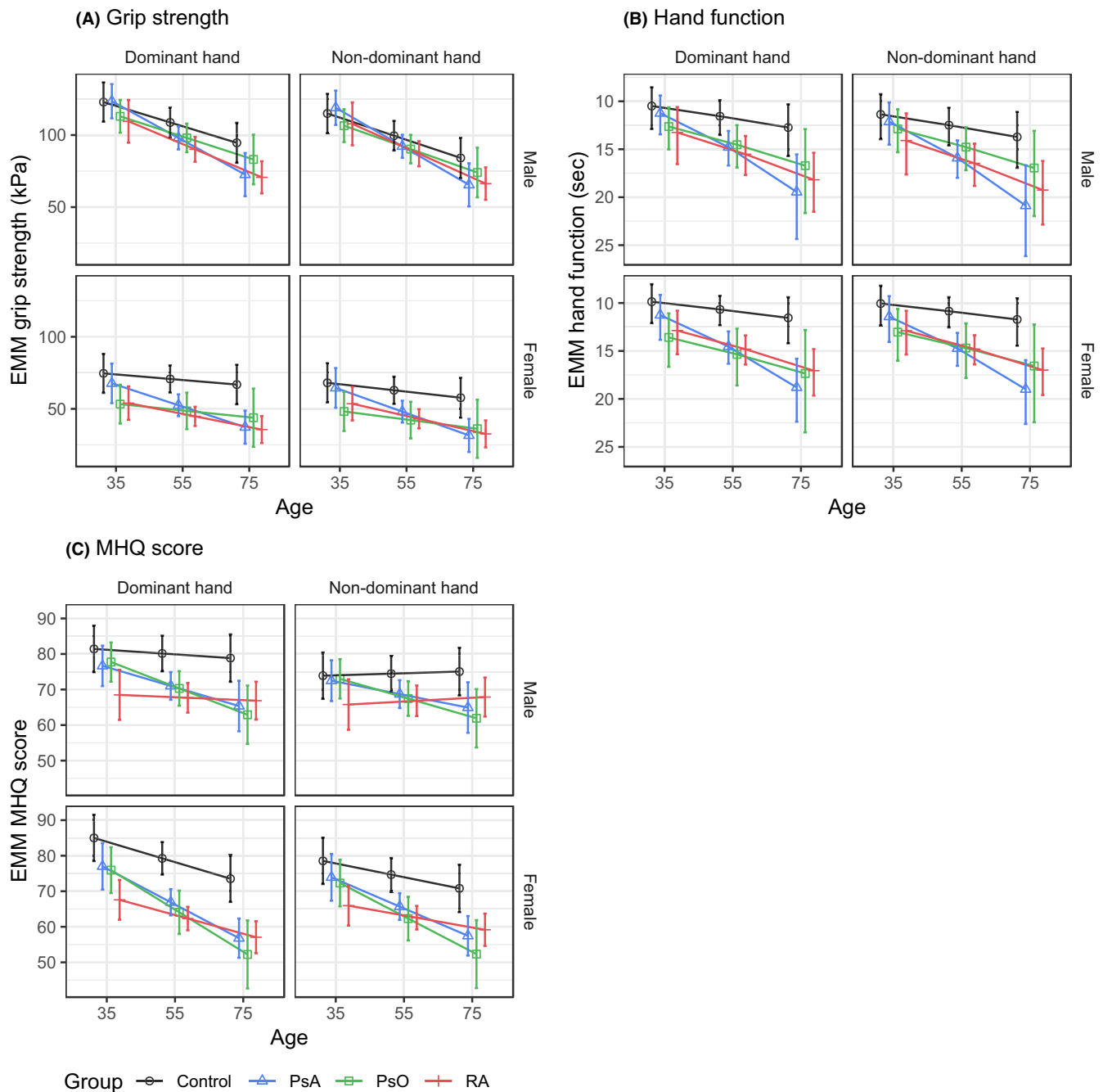


Figure 1. Estimated marginal means (EMM) with multiplicity-adjusted 95% confidence intervals for patients with psoriatic arthritis (PsA), patients with rheumatoid arthritis (RA), patients with psoriasis (PsO), and healthy controls at ages 35, 55, and 75 by sex and hand dominance. **A**, Grip strength. **B**, Hand function. **C**, Michigan Hand Questionnaire (MHQ) score.

Self-reported hand function. Self-reported hand function was assessed by the MHQ. Regression analysis showed that the MHQ score is significantly affected by age, disease status, and hand dominance (Tables 2 and 3). The effect of disease on the MHQ score increased with age and was more pronounced in women. The estimated marginal mean MHQ score in patients with PsA and psoriasis incrementally deviated from that in controls with increasing age, whereas in RA,

self-reported hand function was already low in younger subjects (Figure 1C).

DISCUSSION

The most unexpected finding of this study was the alteration of hand function in patients with psoriasis. Although these patients did not show any clinical signs of PsA, hand function was

clearly impaired and mirrored that in patients with RA and PsA but not in healthy controls. This observation suggests that patients with psoriasis, per se, exhibit a functional arthritis-like phenotype. Such observations back concepts that patients with psoriasis show an altered stress response not only in the skin but also in the musculoskeletal structures. Deep Koebner's phenomenon, which indicates altered mechanical responses (12) and subclinical inflammatory changes (13), has been described in patients with psoriasis and suggests that changes in musculoskeletal function not only may be part of psoriatic skin disease but also may allow one to predict the development of PsA. In line, enthesal structural lesions in patients with psoriasis are associated with progression from psoriasis to PsA (7). It is currently unknown whether functional changes in patients with psoriasis also indicate more pronounced progression to PsA, but this point is matter to future investigations.

This study further provides a direct comparison of hand function for RA and PsA and shows that both diseases have a similar impact on the functionality of the hands. Next to age, presence of RA and PsA is the most important factor influencing all three parameters of hand function assessed in this study. We found that the impact of disease on hand function is particularly pronounced in older subjects, suggesting that younger individuals are better in functionally compensating their disease. This may be caused by generally better muscular performance and neuromuscular interaction in younger individuals but also by improved disease management of RA and PsA in the last two decades. Notably, functional impairments were noted despite inflammation being well controlled in this cohort, with a mean swollen joint count of less than one.

Hand function is complex, comprising various components, such as muscle performance, fine-motor skills, and self-perceived functionality. For instance, muscular performance and perceived functionality are more dependent on sex and hand dominance than objective fine-motor skills and, especially for psoriatic disease aesthetics of the hand, may impact MHQ outcomes when hand and nail involvement is present. Also, the specific impact of disease on these various aspects of hand function differs. For instance, muscular performance of the hands in men is primarily dependent on age, with only minor impact from RA and PsA, whereas in women, both RA and PsA significantly impair the per se lower muscular performance. Loss of fine-motor skills affects both sexes and both hands in RA and PsA. Surprisingly, loss of fine-motor skills is even more pronounced in PsA compared with RA. This may be explained by specific enthesal and tendon involvement in PsA, which could change proprioception and sensorimotor abilities (14). Also, loss of pinch and tip strength in PsA is related to structural changes associated with PsA (14). Self-perception of hand function is impaired to a similar extent in RA and PsA, with the exception that only RA affects self-perceived hand function in younger individuals. The reason for this difference is currently unclear, but it may be related to exposure of the patients

with RA to a prolonged phase of autoimmunity before the start of clinical disease, which has been shown to be associated with structural changes and altered pain behavior (15,16).

In conclusion, the impact of PsA on hand function is similar to that of RA and affects muscular force, fine-motor skills, and self-perception of hand function. The burden of disease on hand function increases with age and affects both sexes and both hands. In addition, hand function is impaired already in patients with psoriasis, suggesting intrinsic functional musculoskeletal alterations in psoriatic disease, which occur independently of PsA.

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AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be published. Dr. Liphardt had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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