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Original article

Impaired hand function and performance in activities of daily living in systemic lupus erythematosus, even in patients achieving lupus low disease activity state (LLDAS)

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Abstract

Objective. The aim was to examine hand function and performance in activities of daily living (ADL) in patients with SLE *vs* healthy controls, and any associations with demographic and disease-related characteristics.

Methods. Hand function (grip strength, pinch strength and dexterity) and ADL performance were evaluated in 240 patients with SLE and 122 age- and biological sex-matched healthy controls. Grip strength, pinch strength and dexterity were measured by Jamar dynamometer, pinch gauge and Purdue pegboard test, respectively. Self-reported ADL performance was assessed by disabilities of the arm, shoulder and hand (DASH) and HAQ. Regression analysis was performed to assess the determinants of hand dysfunction.

Results. All hand function and ADL performance variables were significantly impaired in the entire SLE cohort and the subgroup of patients achieving lupus low disease activity state (LLDAS; $n = 157$) compared with healthy subjects ($P < 0.05$). Joint pain, often underestimated in SLE, was the major determinant of hand function and ADL performance in multiple regression models. In addition, age was correlated with grip strength and Purdue scores, gender with grip strength, arthritis with DASH and HAQ, and use of immunosuppressives with DASH, HAQ and grip strength. Likewise, in patients in LLDAS, painful joints were correlated with DASH and HAQ, age with grip strength and Purdue ($P < 0.001$), gender with grip strength, and immunosuppressives with HAQ and grip strength.

Conclusion. Hand function and performance of daily activities are significantly impaired in SLE, even in patients who achieve LLDAS, suggesting the need for their evaluation and management in clinical practice.

Key words: SLE, lupus low disease activity state (LLDAS), hand function, activities of daily living, joint pain

CLINICAL SCIENCE

Key messages

- Hand dysfunction occurs in patients with SLE, even in those in low lupus disease activity state.
- Joint pain, often underestimated in SLE, is the major predictor of hand dysfunction.
- Hand function, dexterity and activities of daily living should be assessed and managed in patients with SLE.

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Introduction

SLE is a chronic autoimmune disorder affecting multiple organ systems [1, 2]. Musculoskeletal manifestations have been reported in ~80–90% of patients, frequently occurring as the first symptom in SLE [3]. Hand joint involvement varies from transient or migratory arthralgias to persistent arthritis [4–6]. Hand involvement is one of the main causes of impaired function in activities of daily living (ADLs), household responsibilities, work performance and absenteeism, and health-related quality of life in patients with SLE [7–12].

To date, a limited number of studies have assessed the hand function and performance of daily activities in SLE patients compared with healthy controls [13, 14], and only sporadic studies [15–17] have examined the impact of demographic and disease-related characteristics on hand function abnormalities. We hypothesized that SLE patients present impaired hand function and difficulties in performance of ADLs, even those with low disease activity.

The aim of this study was to evaluate the hand function and the performance in ADLs in patients with SLE and in the subgroup of those achieving lupus low disease activity state (LLDAS), in comparison with healthy controls, and to assess potential correlations with several demographic and disease-related characteristics.

Methods

Study design and participants

Participants were recruited from a sample of 292 patients (≥18 years of age) with SLE (fulfilling the 2012 SLICC classification criteria) who attended outpatient follow-up in two general hospitals in Athens. Participants were recruited consecutively and assessed for eligibility if they agreed to take part [18].

Patients with other conditions associated with impaired hand function and pain, such as upper limb fracture or recent or chronic tendinopathy, were excluded. Healthy individuals matched for age, gender and dominant hand were selected as a control group. Healthy control participants were accrued using flyers in the university, affiliated hospitals and social events, including broad categories of employment status or type (manual and non-manual occupations) similar to our SLE population.

The research protocol of the study, which was part of the PhD thesis of K.K., was approved by the Laikon General Hospital Scientific Council (680/10-06-2016) and Thriassio General Hospital Scientific Council (203/13-06-2016). Written informed consent was obtained from all participants.

Assessment tools

A detailed physical examination of all patients who were eligible and agreed to participate in the study, including the assessment of tender and swollen joints, was performed by the rheumatologists in two participating centres (E.K. and M.G.T.) (Table 1). In addition, a comprehensive evaluation of various hand function parameters was made by two blinded assessors, an occupational therapist (K.K.) and a physiotherapist (C.A.).

Two questionnaires were completed independently by the participants for the evaluation of the performance of daily activities, namely the disabilities of the arm, shoulder and hand (DASH) questionnaire and the HAQ. The validated Greek versions of the DASH questionnaire and HAQ were used [19, 20].

The DASH questionnaire is a 30-item disability/symptom scale assessing the degree of difficulty in performing upper limb activities (21 items), the severity of symptoms (5 items) and the impact on social activities (4 items). Each item has five response options, from one (no difficulty) to five (extreme difficulty/unable to do). A total score is calculated from the items' score, ranging from 0 (no disability) to 100 (severe disability) [21, 22]. The HAQ questionnaire inquires about the ability to perform 20 ADLs classified into eight categories (dressing, walking, arising, reach, eating, grip, hygiene and outside activity). Items are scored on a scale from zero to three, and a total score is calculated from the items' score, ranging from zero (no disability) to three (completely disabled) [23]. Both DASH and HAQ have been shown to be reliable and valid measurement tools of physical disability of the upper extremity in patients with rheumatic diseases [21, 24, 25].

Grip strength was assessed by the Jamar dynamometer, and the pinch strength was assessed using the Jamar pinch gauge tool. Three different pinch measurements were carried out: the tip-to-tip pinch (TIP) measurement of the thumb tip to index finger tip; the key pinch measurement of the tip of the thumb and the lateral aspect of the index finger; and the three-fingered pinch (tripod), the pinch strength of thumb, index and middle fingers. The grip and pinch strengths were measured with participants seated, shoulders adducted and neutrally rotated, elbow flexed at 90°, and forearm in neutral and wrist in slight extension, according to American Society of Hand Therapists recommendations [26–28]. The measurements were repeated three times, and the mean value was recorded in kilograms. A higher score reflects greater grip and pinch strength.

Dexterity was measured using the Purdue pegboard test, a valid and reliable test [29]. The test required participants to place as many pegs as possible into the holes in 30 s, using the dominant hand, the non-dominant hand or both hands. Finally, participants used alternate hands to assemble pins, collars and washers within 60 s [30, 31]. Three trials were attempted, and the mean score was recorded. A higher score reflects greater dexterity. We recorded pain intensity with pain visual analog scale, a simple self-administered scale [32]. We used the 68/66 tender and swollen joint scale to assess tender and swollen joints [33].

Table 1 Comparison of absolute values of tested parameters for all patients, for those in lupus low disease activity state or non-lupus low disease activity state and controls

	Patients ($n = 240$)	Healthy controls ($n = 122$)	LLDAS ($n = 157$)	non-LLDAS ($n = 83$)
DASH	10 (2.5–33.1)	0.83 (0–4.16)*	7.5 (2.5–23.3)*	27.5 (3.33–50)*
HAQ	0.25 (0–0.75)	0 (0-0)*	0.13 (0–0.38)*	0.5 (0–0.13)*
Grip strength DH	24.7 (19.5–30.7)	29.3 (25.3–33.7)*	25 (20.3–30.7)*	23.90 (9.80)
Grip strength NDH	24 (18–29.3)	28.8 (23–32.7)*	24.40 (9.20)*	23.20 (9.20)
Pinch strength TIP DH	3.5 (2.58–4.83)	4 (3.33–4.83)*	3.92 (1.61)	3.17 (2.17–4.67)*
Pinch strength TIP NDH	3.25 (2.5–4.2)	4 (3.2–4.83)*	3.17 (2.5–4.17)*	3.33 (2–4)
Pinch strength Key DH	6.08 (4.83–7)	7.2 (6–8)*	6.17 (5–7.17)*	5.54 (2.19)*
Pinch strength Key NDH	5.33 (4.33–6.5)	6.5 (5.5–7.5)*	5.5 (4.5–6.7)*	5.06 (1.82)*
Pinch strength Tripod DH	4.83 (3.33–5.83)	5.75 (4.7–7)*	4.96 (1.92)*	4.33 (2.83–5.67)*
Pinch strength Tripod NDH	4.37 (1.87)	5.5 (4.5–6.33)*	4.62 (1.91)*	4.33 (2.5–5.17)*
Purdue DH	13 (12 -15)	14.31 (2.47)*	13 (12–15)*	12.90 (2.70)
Purdue NDH	12.50 (2.30)	13.22 (2.28)*	12.70 (2.30)*	12.20 (2.30)
Purdue Both	20.49 (4.14)	22.21 (3.46)*	20.80 (3.90)*	19.80 (4.40)
Purdue Com	6 (5–7.5)	7 (5.5–8)*	6.5 (5–7.5)*	6.17 (1.74)

Data are presented as the mean (S.D.) or median (quartile 1–quartile 3). Grip and pinch strength were measured in kilograms. *$P < 0.05$: SLE patients *vs* controls, patients in LLDAS *vs* controls, non-LLDAS *vs* LLDAS. Both: both hands; Com: combination; DASH: disabilities of the arm, shoulder and hand; DH: dominant hand; Key: lateral pinch; LLDAS: lupus low disease activity state; NDH: non-dominant hand; TIP: tip-to-tip pinch; Tripod: three-point pinch.

We also evaluated FM with the fibromyalgia rapid screening tool (FiRST), a brief, simple and self-completed questionnaire with established discriminative value [34, 35]. The test consists of six items with yes/no answers. For each item, a score of one is given for a 'Yes' answer and a score of zero for a 'No' answer. The total score is calculated as the sum of scores for the six items; the cut-off value is designated as 5/6 [35].

SLEDAI 2000 (SLEDAI-2K) and the systemic lupus international collaborating clinics American College of Rheumatology Damage Index SLICC/ACR-DI were used to measure SLE activity and cumulative organ damage [36, 37]. The lupus low disease activity state (LLDAS), defined as SLEDAI-2K$\leq$ 4 without major organ activity, no new disease activity, physician global assessment (0–3) $\leq$1, prednisone $\leq$7.5 mg/day and well-tolerated immunosuppressant dosages [38], was also evaluated. The history of major SLE-related events, including central nervous system (stroke, aseptic meningitis, epilepsy, psychosis, chorea), renal (lupus nephritis), pulmonary (lupus pneumonitis, pulmonary embolism, alveolar haemorrhage, moderate–severe pleural effusion) and cardiac involvement (myocardial infarction, myocardiopathy, moderate–severe pericardial effusion), was also recorded. Treatment was defined as: (a) no medication or only HCQ use, reflecting a remission status; or (b) use of immunosuppressives, including AZA, MMF, CSA, MTX, LEF, CYC, mycophenolic acid, belimumab, rituximab and/or CSs.

Statistical analysis

Data were expressed as the mean (S.D.) for quantitative variables and as percentages for qualitative variables. The Kolmogorov–Smirnov test was used for normality analysis of the quantitative variables. Comparisons between groups (healthy population *vs* patients, healthy population *vs* LLDAS and non-LLDAS *vs* LLDAS) of continuous variables were performed with unpaired *t*-test or the Mann–Whitney *U*-test in the case of violation of normality.

We applied multiple linear regression models using functional assessment tools (DASH, HAQ, grip strength, Purdue) as the outcome continuous variables. We first tested disease-related factors (arthritis, painful joint count, SLEDAI-2K, SLICC/ACR-DI, history of major events) in addition to medication, disease duration and employment status in univariate analyses. In addition to age and gender, all parameters found to be statistically significant in the univariate analysis ($P < 0.05$) were entered in multiple linear regression models with a stepwise backward selection procedure ($P < 0.05$) to determine the factors associated with the outcomes. We also performed a sub-analysis to investigate the determinants of each examined parameter in the subgroup of patients who achieved LLDAS.

All assumptions of linear regression analysis (homoscedasticity, linearity, normality and independence of error terms, in addition to multicollinearity of variables) were examined. All *P*-values were two sided, and a cut-off value of $P < 0.05$ was set to denote statistical significance. Statistical analyses were performed using STATA software (v.13.0; StataCorp, College Station, TX, USA).

Results

A total of 240 SLE patients (all Caucasians) who agreed to participate and 122 healthy controls matched for age (mean age: 47.63 $\pm$ 13.01 and 47.96 $\pm$ 12.67 years,

respectively), gender (females: 90 and 88.5%, respectively) and dominant hand (right hand: 95.4 and 96.7%, respectively) were evaluated between September 2016 and January 2018. Sixty-six per cent of SLE patients and 62% of healthy participants in employment had a manual labour job ($P = 0.582$). The demographic characteristics of SLE patients and healthy controls are shown in Supplementary Table S1, available at *Rheumatology Advances in Practice* online.

The median disease duration of patients with SLE was 9 (4–16) years and the median SLEDAI-2K was 2 (0–4). The mean SLICC/ACR-DI was 0.49 (0.86), and 157 (65%) patients achieved LLDAS at the time of evaluation. Forty-four (18%) of participants had clinical signs of arthritis; almost half of patients ($n = 114$, 48%) reported arthralgias, and the mean painful joint count was 6.69 ± 10.77. Eighty-two per cent of participants were treated with HCQ, 36% with immunosuppressives and 49% with CSs. The disease-related characteristics of SLE patients are shown in Supplementary Table S1, available at *Rheumatology Advances in Practice* online.

Differences in DASH score and HAQ score levels indicated greater difficulty in ADL performance in SLE patients compared with healthy subjects (Table 1). Median values of DASH in SLE patients and controls (10 *vs* 0.83) and HAQ (0.25 *vs* 0) represent clinically important differences [39, 40].

Grip strength, pinch strength and dexterity in both hands were statistically significant lower in SLE patients *vs* controls (Table 1). Seventy-seven per cent of patients *vs* 50% of controls had reduced grip strength, according to normative data of Mathiowetz *et al.* [41] Patients in LLDAS also presented greater difficulties in ADLs compared with healthy individuals (Table 1). Pinch strength and Purdue scores of LLDAS patients were significantly decreased in both hands of SLE patients compared with controls (Table 1). Comparing patients in LLDAS with non-LLDAS patients, those in LLDAS presented better DASH and HAQ scores (Table 1). Likewise, tripod, key pinch for both hands and TIP for the dominant hand were significantly increased ($P < 0.05$) in LLDAS patients compared with non-LLDAS patients (Table 1).

Given that both DASH and HAQ assess self-reported ADL performance, the results might be affected by the individual's self-efficacy. We therefore examined the correlation between both DASH and HAQ and grip strength, as an objective assessment of hand function. We found a statistically significant association between DASH and grip strength and, more specifically, for every one unit increase in DASH score, the grip strength decreased by 0.19 kg (β coefficient: −0.19, $P < 0.001$). Likewise, for each one unit increase in HAQ score, the grip strength decreased by 7.5 kg (β coefficient: −7.5, $P < 0.001$).

Association of hand function variables with demographic and disease-related factors

Predictors of increased DASH scores

In univariate analysis, factors significantly associated with increased DASH score were gender, arthritis, painful joint count, use of immunosuppressives and SLEDAI-2K (Table 2). Arthritis, painful joint count and immunosuppressives remained statistically significant in the multivariate regression model, after adjustment for age, gender, arthritis, painful joint count, immunosuppressives and SLEDAI-2K (Table 2). When the same multiple regression model was applied to the subset of 157 patients in LLDAS, the association between the number of painful joints and elevated DASH scores remained statistically significant (Table 3).

Predictors of increased HAQ scores

In univariate analysis, a statistically significant association was found between age, gender, arthritis, painful joint count, immunosuppressives, SLEDAI-2K, SLICC/ACR-DI and disease duration and higher HAQ score (Table 2). A statistically significant correlation was found between arthritis, painful joint count and use of immunosuppressives and increased HAQ scores in the entire SLE cohort, after adjustment for age, gender, disease duration, arthritis, painful joint count, immunosuppressives, SLEDAI-2K and SLICC/ACR-DI (Table 2). In the subgroup of LLDAS patients, painful joint count and immunosuppressives were correlated significantly with increased HAQ scores (Table 3).

Predictors of decreased grip strength

Grip strength was significantly associated with age, gender, arthritis, painful joint count, immunosuppressives, employment, SLEDAI-2K and SLICC/ACR-DI score in univariate analysis ($P < 0.05$; Table 4). Age, gender, immunosuppressives and painful joint count remained significantly associated with decreased grip strength in the multiple linear regression model (Table 4). In patients in LLDAS, age, gender and immunosuppressive use were independent predictors of decreased grip strength (Table 5).

Predictors of decreased Purdue scores

In univariate analysis, age, employment status, arthritis, number of painful joints, history of major SLE-related events, SLICC/ACR-DI, immunosuppressives and disease duration were significantly associated with decreased Purdue scores (Table 4).

In multivariate regression analysis, age, a history of major SLE-related events and being in employment were independently correlated with decreased Purdue scores (Table 4). When a multiple regression model was applied to patients in LLDAS, age and a history of major events remained significantly correlated with decreased Purdue scores, after adjustment for age, gender, employment, immunosuppressives, SLICC/ACR-DI and a history of major events (Table 5).

Discussion

In the present study, we showed a high burden of impaired hand function, namely grip and pinch strength and dexterity, and difficulties in performance of ADLs in SLE patients compared with healthy controls, regardless of disease activity status. Joint pain, which is often

Table 2 Predictors of disabilities of the arm, shoulder and hand (DASH) and HAQ for all patients

Variable	Univariate analysis		Multivariate analysis[a]	
	β coefficient	*P*-value	β coefficient	*P*-value
DASH				
Age (per 1 year increase)	0.17	0.101	–	–
Gender (female)	11.92	**0.007**	–	–
In employment (yes)	−4.28	0.137	–	–
Disease duration (per 1 year increase)	0.27	0.120	–	–
Arthritis (yes)	27.53	**<0.001**	12.70	**<0.001**
Painful joint count (per 1 joint increase)	1.21	**<0.001**	0.91	**<0.001**
Immunosuppressives (yes)	11.68	**<0.001**	5.12	**0.019**
SLEDAI-2K (per 1 unit increase)	1.21	**0.001**	–	–
SLICC/ACR-DI (per 1 unit increase)	2.68	0.086	–	–
History of major events (per 1 unit increase)	−3.71	0.222	–	–
HAQ				
Age (per 1 year increase)	0.005	**0.048**	–	–
Gender (female)	0.23	**0.050**	–	–
In employment (yes)	−0.09	0.238	–	–
Disease duration (per 1 year increase)	0.01	**0.007**	–	–
Arthritis (yes)	0.68	**<0.001**	0.30	**0.001**
Painful joint count (per 1 joint increase)	0.03	**<0.001**	0.02	**<0.001**
Immunosuppressives (yes)	0.34	**<0.001**	0.18	**0.002**
SLEDAI-2K (per 1 unit increase)	0.028	**0.004**	–	–
SLICC/ACR-DI (per 1 unit increase)	0.085	**0.037**	–	–
History of major events (per 1 unit increase)	−0.09	0.242	–	–

Bold values indicate statistical significance. Only significant values ($P < 0.05$) are presented in the multivariate model.
[a]Multivariate regression model adjusted for age, gender and variables with *P*-values <0.05 in the univariate analysis.
DASH: disabilities of the arm, shoulder and hand; SLEDAI-2K: SLEDAI 2000; SLICC/ACR-DI: systemic lupus international collaborating clinics American College of Rheumatology Damage Index.

underestimated in SLE, more specifically painful joint count, was the most consistent factor among all examined patient characteristics associated with impaired hand function.

We used both self-reported questionnaires (DASH and HAQ) and manual instruments (grip/pinch strength and dexterity) for the assessment of hand dysfunction and performance of ADLs. The clinical relevance of modest changes in score in patient-rated tests is often unclear. The median (interquartile range) DASH score was 10 (2.5–33.1) in SLE patients and 0.83 (0–4.16) in controls. The minimal clinically important difference in DASH score has been reported as 10 (95% CI 5, 15) [39], supporting the clinical significance of our findings. In addition, the median (interquartile range) HAQ score was 0.25 (0–0.75) *vs* 0 (0–0) in controls, and a change of 0.25 in HAQ score is currently accepted as clinically meaningful [40].

Our results are in line with previous studies exploring hand function in SLE, showing that SLE patients experience hand dysfunction problems that lead to difficulties in a wide range of ADLs with consequent impact on their work, household tasks, childcare, studies, relationships and quality of life [12–17]. In a study by Malcus Johnsson *et al.* [12], 73% of 109 patients with SLE experienced hand problems and 42% reported difficulties in performing ADLs. In another study from the same group [13], half of 71 included SLE patients experienced problems in performing daily activities owing to pain, reduced strength and dexterity in comparison to 71 age-matched healthy controls. Balsamo *et al.* [17] demonstrated lower dynamic muscle strength along with increased fatigue, reduced functional performance and poorer quality of life in 25 premenopausal SLE patients with low disease activity *vs* 25 controls matched for age, physical characteristics and the level of physical activity. Bağlan Yentür *et al.* [14] showed worse hand function in 46 SLE patients (all female) *vs* 46 healthy controls, but better in comparison to 51 RA patients. All these studies had a smaller sample size than the present study, and none evaluated any potential associations between hand function parameters and disease-related characteristics. Greco *et al.* [15] found that pain was the strongest predictor of activity limitations among 93 SLE patients with mild to moderate disease activity, although no pain location was reported. Björk *et al.* [16] found that organ damage, age and well-being were significantly correlated with the performance of daily living assessed by HAQ questionnaire in a study of 192 SLE patients. Both studies had a smaller patient population

TABLE 3 Predictors of disabilities of the arm, shoulder and hand (DASH) and HAQ in the subgroup of patients in lupus low disease activity state

Variables	Univariate analysis		Multivariate analysis[a]	
	β coefficient	*P*-value	β coefficient	*P*-value
DASH				
Age (per 1 year increase)	0.08	0.463	–	–
Gender (female)	9.46	**0.037**	–	–
In employment (yes)	−0.28	0.928	–	–
Disease duration (per 1 year increase)	0.08	0.662	–	–
Arthritis (yes)	15.38	**0.002**	–	–
Painful joint count (per 1 joint increase)	1.35	**<0.001**	1.26	**<0.001**
Immunosuppressives (yes)	6.64	**0.019**	–	–
SLEDAI-2K (per 1 unit increase)	1.93	**0.015**	–	–
SLICC/ACR-DI(per 1 unit increase)	0.25	0.895	–	–
History of major events (per 1 unit increase)	−1.98	0.565	–	–
HAQ				
Age (per 1 year increase)	0.006	**0.028**	–	–
Gender (female)	0.11	0.359	–	–
In employment (yes)	−0.004	0.962	–	–
Disease duration (per 1 year increase)	0.009	**0.049**	–	–
Arthritis (yes)	0.25	**0.054**	–	–
Painful joint count (per 1 joint increase)	0.03	**<0.001**	0.028	**<0.001**
Immunosuppressives (yes)	0.19	**0.008**	0.145	**0.019**
SLEDAI-2K (per 1 unit increase)	0.028	0.163	–	–
SLICC/ACR-DI (per 1 unit increase)	0.029	0.549	–	–
History of major events (per 1 unit increase)	−0.02	0.834	–	–

Bold values indicate statistical significance. Only significant values ($P<0.05$) are presented in the multivariate model.
[a]Multivariate regression model adjusted for age, gender and variables with *P*-values <0.05 in the univariate analysis.
DASH: disabilities of the arm, shoulder and hand; LLDAS: lupus low disease activity state; SLEDAI-2K: SLEDAI 2000; SLICC/ACR-DI: systemic lupus international collaborating clinics American College of Rheumatology Damage Index.

than that of our study and examined associations between activity limitations and disease-related factors without reporting on specific hand function and ADL performance parameters [15, 16].

No previous studies have investigated the association between painful joints and upper limb function variables in patients with SLE. In our study, the painful joint count was inversely correlated with all hand function measures, except the Purdue score. Waldheim *et al.* [42] investigated the extent and characteristics of pain in 84 SLE patients and found that the most common pain location was the joints, corresponding to 80% of the high-pain group and 35% of the low-pain group. Despite its significance and frequency, pain has been reported to be a symptom often misjudged by physicians taking care of SLE patients compared with inflammatory arthritis patients [43, 44]. Arthritis was significantly correlated with ADL performance (DASH and HAQ), but not with grip strength and dexterity. Although only 18% of patients were diagnosed with arthritis in our study, 48% of participants reported pain in the joints. Only 5% of patients had FM.

Age was negatively correlated with grip strength and hand dexterity in our study but was not correlated with ADL performance (DASH and HAQ). In contrast, Björk *et al.* [16] found a statistically significant correlation between age and increased HAQ, perhaps owing to the older study population (52.7 ± 17.4 *vs* 47.63 ± 13.01 years). Age has also been inversely correlated with grip strength in the healthy population [45, 46].

Disease activity (SLEDAI-2K) and disease damage (SLICC/ACR-DI) scores were correlated with several hand function variables in our study. A statistically significant association of the use of immunosuppressive agents with impaired hand function and ADL performance was observed, even in LLDAS patients. This association might indicate that participants who were on immunosuppressives and/or CSs (CSs were included in our immunosuppressives definition) had worse disease status, which in turn could affect hand function. The mean SLEDAI-2K was higher in patients on immunosuppressives (3.71 ± 3.68 *vs* 2.98 ± 3.61, $P = 0.077$) or CSs (4.57 ± 4.09 *vs* 1.98 ± 2.62, $P < 0.001$) than in those not receiving the above agents. These results are in

Table 4 Predictors of grip strength and Purdue for all patients

Variable	Univariate analysis		Multivariate analysis[a]	
	β coefficient	*P*-value	β coefficient	*P*-value
Grip strength				
Age (per 1 year increase)	−0.15	**<0.001**	−0.11	**0.008**
Gender (female)	−15.32	**<0.001**	−14.1	**<0.001**
In employment (yes)	2.73	**0.032**	–	–
Disease duration (per 1 year increase)	−0.15	0.051	–	–
Arthritis (yes)	−6.78	**<0.001**	–	–
Painful joint count (per 1 joint increase)	−0.28	**<0.001**	−0.16	**0.002**
Immunosuppressives (yes)	−3.95	**0.001**	−2.33	**0.026**
SLEDAI-2K (per 1 unit increase)	−0.37	**0.025**	–	–
SLICC/ACR-DI(per 1 unit increase)	−1.47	**0.033**	–	–
History of major events (per 1 unit increase)	1.49	0.271	–	–
Purdue				
Age (per 1 year increase)	−0.06	**<0.001**	−0.06	**<0.001**
Gender (female)	−0.34	0.402	–	–
In employment (yes)	0.94	**<0.001**	0.50	**0.035**
Disease duration (per 1 year increase)	−0.04	**0.012**	–	–
Arthritis (yes)	−0.91	**0.004**	–	–
Painful joint count (per 1 joint increase)	−0.04	**0.002**	–	–
Immunosuppressives (yes)	−0.66	**0.009**	–	–
SLEDAI-2K (per 1 unit increase)	−0.05	0.176	–	–
SLICC/ACR-DI (per 1 unit increase)	−0.32	**0.026**	–	–
History of major events (per 1 unit increase)	−0.82	**0.003**	−0.82	**0.002**

Bold values indicate statistical significance. Only significant values ($P<0.05$) are presented in the multivariate model.
[a]Multivariate regression model adjusted for age, gender and variables with *P*-values <0.05 in the univariate analysis.
SLEDAI-2K: SLEDAI 2000; SLICC/ACR-DI: systemic lupus international collaborating clinics American College of Rheumatology Damage Index.

accordance with those of Björk *et al.* [16], who found a statistically significant association between CS use and physical activity limitations/elevated HAQ score (mean HAQ: 0.44).

Occupational therapy and physiotherapy in SLE can help to improve the ability to perform daily activities by means of pain management and energy conservation, training in the use of ergonomic tools, development of hand orthoses, and enhancement of hand strength and dexterity with hand exercise programmes. Previous studies have shown the beneficial effects of hand exercise in RA [47, 48], OA [49] and PsA [50]. In a recently published randomized controlled trial from our group, we showed that a 30 min session of upper limb exercise as an adjunct to routine care can improve hand function, dexterity, ADL performance and quality of life in patients with SLE [18].

The strengths of the present study include a large, well-characterized SLE population and the use of a comprehensive battery of validated measures for the assessment of strength, dexterity and self-reported ADL performance. However, our study had some limitations. First, given that the majority of our patients had mild disease (mean SLEDAI-2K: 3.25), the results might not apply to patients with severe disease activity. Second, all our patients were Caucasians, which might limit the applicability of these findings to SLE patients of a different ethnicity. Assessment of the same parameters in a larger group of patients from multiple centres is needed to validate our results.

In conclusion, hand dysfunction is a frequent and often underestimated complication in patients with SLE that is accompanied by difficulties in daily activities, with a significant impact on their ability to live an independent life, even for those in LLDAS. Clinicians should be aware of potential hand function complications associated with joint pain, the most frequent and significant predictor of hand dysfunction according to our findings. The assessment of hand function and ADL performance abnormalities should be included in the daily clinical evaluation of patients with SLE, and appropriate hand therapy programmes consisting of exercise (strengthening and stretching exercises), soft tissue procedures, dexterity training, pain management, range of motion activities, splinting, etc., should be introduced accordingly.

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Table 5 Predictors of grip strength and Purdue in the subgroup of patients in lupus low disease activity state

Variable	Univariate analysis		Multivariate analysis[a]	
	β coefficient	*P*-value	*β* coefficient	*P*-value
Grip strength				
Age (per 1 year increase)	−0.18	**0.001**	−0.16	**<0.001**
Gender (female)	−14.00	**<0.001**	−13.24	**<0.001**
In employment (yes)	2.80	0.071	–	–
Disease duration (per 1 year increase)	−0.10	0.282	–	–
Arthritis (yes)	−3.81	0.142	–	–
Painful joint count (per 1 joint increase)	−0.21	**0.020**	–	–
Immunosuppressives (yes)	−3.76	**0.008**	−3.07	**0.010**
SLEDAI-2K (per 1 unit increase)	−0.30	0.465	–	–
SLICC/ACR-DI(per 1 unit increase)	−0.43	0.652	–	–
History of major events (per 1 unit increase)	0.32	0.853	–	–
Purdue				
Age (per 1 year increase)	−0.07	**<0.001**	−0.57	**<0.001**
Gender (female)	−0.12	0.815	–	–
In employment (yes)	1.20	**<0.001**	–	–
Disease duration (per 1 year increase)	−0.03	0.103	–	–
Arthritis (yes)	−0.59	0.301	–	–
Painful joint count (per 1 joint increase)	−0.02	0.387	–	–
Immunosuppressives (yes)	−0.85	**0.007**	–	–
SLEDAI-2K (per 1 unit increase)	0.03	0.769	–	–
SLICC/ACR-DI (per 1 unit increase)	−0.56	**0.006**	–	–
History of major events (per 1 unit increase)	−1.10	**0.003**	−0.71	**0.049**

Bold values indicate statistical significance. Only significant values ($P<0.05$) are presented in the multivariate model.
[a]Multivariate regression model adjusted for age, gender and variables with *P* values <0.05 in the univariate analysis.
LLDAS: lupus low disease activity state; SLEDAI-2K: SLEDAI 2000; SLICC/ACR-DI: systemic lupus international collaborating clinics American College of Rheumatology Damage Index.

Data availability statement

The protocol and datasets generated for this study are available from the corresponding author upon request.

Supplementary data

Supplementary data are available at *Rheumatology Advances in Practice* online.

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