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Perceived and Objective Physical Function in Two U.S., Population-Based Cohorts of Adults with Systemic Lupus Erythematosus

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Conflict of Interest:

None of the authors have any conflicts of interest to declare.

Ethics and Patient Consent:

The Emory University Institutional Review Board (IRB) approved the APPEAL (IRB00110977) and GOAL (IRB00003656) protocols; analysis of APPEAL data is covered under the University of California, San Francisco (UCSF) IRB (23–39650). All APPEAL participants provided informed consent before completing study visits.

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Abstract

Objective: We leveraged data from two population-based SLE cohorts [Approaches to Positive, Patient-centered Experiences of Aging with Lupus (APPEAL) and California Lupus Epidemiology Study (CLUES)] to provide estimates of, and identify factors associated with, perceived and objective physical function and their discordance.

Methods: Perceived physical function [PROMIS Physical Function 12a/10a (APPEAL/CLUES; T-scores, mean = 50 and SD = 10)] and objective physical function [Short Physical Performance Battery (SPPB; score range: 0–12); higher scores=better function for both] scores were examined by cohort and characteristics. We assessed factors associated with discordance between scores (≥ 2 quartiles different) using multinomial logistic regression.

Results: APPEAL ($N=446$; 81.4% Black) vs. CLUES ($N=173$; 41.0% Asian, 27.7%, White 23.1%) participants had lower perceived (T-scores, 41.5 vs. 47.9) and objective (SPPB scores, 9.0 vs. 9.4) physical function; there was no difference after adjustment for disease activity and cumulative disease damage. Factors associated with lower perceived and objective physical function across cohorts included oldest vs. youngest age (T-scores: 40.8 vs. 47.4; SPPB scores: 8.9 vs. 9.6), Black vs. White race (40.8 vs. 45.6; 8.9 vs. 9.7), and higher vs. lower disease activity (38.1 vs. 48.4; 8.7 vs. 9.6). Overall, 22.3% of participants had discordant scores; older age and higher disease activity were independently associated with lower risk of overestimating (objective<perceived score) physical function.

Conclusion: Our results show that perceived and objective physical function can vary considerably between SLE populations and by characteristics. Perceived physical function may not always reflect objective physical function in SLE populations.

Key Indexing Terms:

Physical Functional Performance; Lupus Erythematosus, Systemic; Epidemiology; Healthy Aging

Introduction

Assessment of physical function among individuals with SLE^{1–5} is a top priority for both patients and clinicians.^{6,7} Busy clinicians often rely on quick assessments of perceived physical function (self-reported patient perceptions of physical abilities and limitations) to track disease progression and treatment effectiveness. Objective physical function assessment (assessment of performance on standard physical tasks by a trained observer), such as the Short Physical Performance Battery (SPPB),⁸ is more resource-intensive, requiring clinician and patient time and appropriate settings or equipment, and is rarely performed in the clinical setting.^{5,9–11} Objective physical function may be imperfectly measured by perceived physical function, which may be heavily influenced by individual factors. Further, prior studies of perceived and objective physical function in SLE have generally been performed at single centers or in single cohorts, limiting our

understanding of how physical function varies across SLE populations. A better, more generalizable understanding of perceived and objective physical function — and their potential discordance — could inform clinical assessment of physical function in SLE and implementation of the associated proposed care guideline.⁷

To address these gaps, we combined data from two geographically and sociodemographically diverse, population-based, adult SLE cohorts, Approaches to Positive, Patient-centered Experiences of Aging with Lupus (APPEAL) and California Lupus Epidemiology Study (CLUES), which both included simultaneous, cross-sectional assessments of perceived physical function and objective physical performance. Our objectives were to leverage this combined cohort to: (i) provide estimates of perceived and objective physical function across and between these cohorts; (ii) identify factors associated with perceived and objective physical function; and (iii) estimate the discordance between perceived and objective physical function and factors associated with this discordance.

Methods

Study Population

APPEAL participants were recruited (October 2019–May 2022) for a single in-person or remote study visit during Waves 6–8 of the population-based Georgians Organized Against Lupus (GOAL) cohort (Supplementary Figure 1). GOAL participants are adults (≥ 18 years) in metropolitan Atlanta with a documented SLE diagnosis [≥ 4 revised American College of Rheumatology (ACR) criteria,¹² or 3 ACR criteria plus a board-certified rheumatologist's diagnosis].^{13,14} Inclusion criteria for APPEAL were: active participation in GOAL, ability to speak English, sufficient vision and hearing to undergo study testing, ability to consent, and living in Georgia at recruitment. The Emory University Institutional Review Board (IRB) approved the APPEAL (IRB00110977) and GOAL (IRB00003656) protocols; analysis of APPEAL data is covered under the University of California, San Francisco (UCSF) IRB (23–39650). All APPEAL participants provided informed consent before completing study visits. Of the $N=451$ who completed a single APPEAL study visit, 5 participants were excluded [$n=1$ for an incomplete SPPB and $n=4$ for potentially invalid questionnaire response patterns (identical responses across entire instruments containing reverse-coded items)], leaving $N=446$.

CLUES participants included in this study were recruited during Wave 3 (September 2017–December 2019) (Supplementary Figure 1). CLUES includes adults (≥ 18 years) in the San Francisco Bay Area with a documented diagnosis of SLE defined by ACR criteria,¹² as described above for GOAL, or a diagnosis of lupus nephritis.¹⁵ Inclusion criteria for the CLUES Wave 3 in-person visit were: sufficient vision to undergo study testing, a daily prednisone dose of < 50 mg daily, and no joint replacements in the previous year. The UCSF IRB approved the CLUES study (14–14429), and all CLUES participants provided informed consent before completing study visits. SPPB assessments began after CLUES Wave 3 was underway (starting January 2018), resulting in $N=250$ completed in-person visits. Of these, $n=77$ were not offered the SPPB, leaving $N=173$ (Supplementary Figure 1).

Study Variables

Perceived physical function. Perceived physical function was assessed with PROMIS Physical Functioning-Short Forms in APPEAL (12a) and CLUES (10a).¹⁶ For both assessments, raw scores were scaled to comparable T-scores.^{16,17} For these T-scores, 50 represents the average general adult population score, differences of 10 represent 1 SD, and higher scores represent better perceived physical functioning.

Objective physical function. Objective physical function was measured in both cohorts using the SPPB,⁸ which includes assessments of balance, gait speed, and lower body strength. For remote visits (APPEAL only¹⁸), a 1-minute walk-in-place was substituted for the 4-meter walks, and steps were converted to gait speed as previously described.^{9,18} All individual SPPB subscores ranged from 0 to 4, based on quartiles of performance of the original cohort of individuals aged ≥ 71 years.⁸ The overall SPPB score was the sum of the three individual scores (range, 0–12), with higher scores representing better objective physical function.

Other variables. Age, sex at birth, race, and ethnicity were self-reported by the participant at the study visit. Age was examined as a continuous variable and in categories (18–34, 35–49, and ≥ 50 years). Race and ethnicity were combined and categorized as Asian, Black, Hispanic, White, and other. In both cohorts, current disease activity was assessed via the Systematic Lupus Activity Questionnaire (SLAQ; score range 0–44, with higher scores indicating greater SLE-related disease activity).¹⁹ Cumulative disease damage was assessed with the Brief Index of Lupus Damage (BILD) (score range, 0–46, with higher scores indicating greater cumulative SLE-related organ damage),^{20,21} which was obtained at the CLUES visit and extracted from the GOAL data closest to the APPEAL visit. Height and weight were measured (APPEAL in-person visits) or self-reported (APPEAL remote and CLUES visits); body mass index (BMI) was calculated as (weight in kg)/(height in m)². Depressive symptoms were assessed using the PROMIS Depression Short Form 8b²² and reported as T-scores (population mean=50, SD=10; APPEAL) or the 8-item Patient Health Questionnaire (PHQ-8; score range, 0–12; CLUES).²³ For both PROMIS Depression Short Form 8b and PHQ-8, higher scores represent a greater burden of depressive symptoms. In combined-cohort analyses, based on a validated crosswalk between PHQ-9 and PROMIS²³ and identical cutoffs for PHQ-8 and PHQ-9,²⁴ cutoffs of ≥ 10 ²⁵ and >58.6 for the PHQ-8 and PROMIS Depression Short Form 8b, respectively, were used to define moderate-to-severe vs. no or mild depressive symptoms.

Statistical Analysis

Characteristics of participants were described and PROMIS Physical Function T-scores and SPPB scores were summarized, overall and by cohort. Cohort differences were further assessed with multivariable linear regression models with these T-scores as outcomes and the cohort as the exposure, sequentially adjusting for potential confounders identified *a priori*. Associations between characteristics and perceived physical function and between characteristics and objective physical function were assessed, overall and by cohort, using *t* tests or ANOVA as appropriate to compare scores across categories. In sensitivity analyses, we examined scores by characteristics and modality of visit (in-person vs. remote;

Supplementary Figure 1). Overall and within-cohort discordance between perceived and objective physical function was assessed across quartiles of PROMIS Physical Function T-scores and SPPB scores, and percentage agreement and quadratically weighted Cohen's kappa statistics were calculated. In sensitivity analyses, we examined discordance by modality of visit and using the minimally important difference (MID), defined as $0.5 \times \text{SD}$ in the study sample, of both SPPB and PROMIS Physical Function T-scores instead of quartiles. Factors associated with discordance (overall and within cohort) were assessed using multinomial, multivariable logistic regression with complete case analysis, with and without adjustment for the other factors of interest. For these models, discordance was defined as a difference of at least two quartiles between objective and perceived physical function and was categorized as "underestimation" of objective physical function (objective > perceived) or "overestimation" of objective physical function (objective < perceived); with the concordant group as referent. Sensitivity analyses included: (i) analyses in a combined cohort including only those who completed in-person visits ($N=377$; Supplementary Figure 1), with quartiles defined within the in-person population; (ii) analyses using discordance defined by the MID; and (iii) analyses using multiple imputation in multinomial models instead of complete case analysis. Statistical significance threshold was set at 0.05. All analyses were conducted using Stata v. 19.5 (College Station, TX) and R v. 4.4.0 (R Foundation, Vienna, Austria).

Results

Participant Characteristics

Our combined cohort ($N=619$) had a mean age of 46.0 and was 91.1% female; both were similar across cohorts (Table 1). The combined cohort was 12.6% Asian, 60.9% Black, 10.3% Hispanic, and 13.9% White [APPEAL vs. CLUES, 1.6% vs. 41.0% were Asian, 81.4% vs. 8.1% were Black, 5.6% vs. 23.1% were Hispanic, and 8.5% vs. 27.7% were White ($P<0.001$)]. APPEAL vs. CLUES participants had higher BMI (30.2 vs. 26.5 kg/m²) and self-reported disease activity (median SLAQ scores, 13.0 vs. 8.0; $P<0.001$ for both). Moderate-to-severe depressive symptoms were similar in APPEAL vs. CLUES participants (21.5% vs. 19.7%; $P=0.6$), although patterns by age, sex, and race/ethnicity differed between the cohorts (Supplementary Figure 2). Overall, 39.1% completed remote visits. Distributions of characteristics and differences between cohorts were similar among only those who completed in-person assessments (Supplementary Table 1).

Perceived and Objective Physical Function

PROMIS Physical Function T-scores (perceived physical function) were normally distributed in the overall cohort [mean (SD)=43.3 (10.1), median (IQR)=41.4 (35.2,49.3); Figure 1A]. The T-scores in APPEAL vs. CLUES were lower overall [APPEAL: mean (SD)=41.5 (9.7), median (IQR)=39.4 (34.6,46.5); CLUES: mean (SD)=47.9 (9.5), median (IQR)=47.8 (40.2,55.3); Figure 1B]. Overall and by-cohort means, medians, and distributions of the T-scores were similar among only those with in-person assessments (Supplementary Figure 3, A and B). PROMIS Physical Function T-scores were 0.6 SD lower in APPEAL vs. CLUES, on average; after adjustment for BMI, disease activity, and

cumulative disease damage, there was no cohort difference in T-scores (Supplementary Table 2).

SPPB scores (objective physical function) were right-skewed [mean (SD)=9.2 (2.1), median (IQR) of 9.0 (8.0,11.0); Figure 1C]. As with perceived physical function, scores in APPEAL were lower than those in CLUES [APPEAL: mean (SD)=9.0 (2.1), median (IQR)=9.0 (8.0,10.0); CLUES: mean (SD)=9.4 (1.9), median (IQR)=10.0 (9.0,11.0); Figure 1D]. Overall and by-cohort means, medians, and distributions of the SPPB score were similar among only those with in-person assessments (Supplementary Figure 3, C and D). On average, SPPB scores were 0.2 SD lower in APPEAL vs. CLUES, but there was no cohort difference in SPPB score after adjustment for BMI, disease activity, and cumulative disease damage (Supplementary Table 2).

Factors Associated with Perceived and Objective Physical Function

In the combined cohort, statistically significantly lower PROMIS Physical Function T-scores were reported by those who were older (≥ 50 vs. 18–34 years: 40.8 vs. 47.4), female (43.0 vs. 46.2), and Black [40.8 vs. 45.6 (White), 45.8 (Hispanic), and 50.5 (Asian)] and those who had BMI ≥ 30 vs. <30 kg/m² (40.6 vs. 45.1), higher vs. lower SLAQ scores (38.1 vs. 48.4), higher vs. lower BILD scores (40.2 vs. 46.4), and moderate-to-severe vs. mild or no depressive symptoms (37.5 vs. 45.0; Table 2). Similarly, statistically significantly lower SPPB scores were reported by those who were older (8.9 vs. 9.6), were Black [8.9 vs. 9.7 (White), 9.2 (Hispanic), and 9.8 (Asian)], had BMI ≥ 30 vs. <30 kg/m² (8.8 vs. 9.3), had higher vs. lower SLAQ scores (8.7 vs. 9.6), had higher vs. lower BILD scores (8.9 vs. 9.4), and had moderate-to-severe vs. mild or no depressive symptoms (8.6 vs. 9.3), but there was no difference in SPPB score by sex (Table 2). Results were similar among individuals with in-person and remote visits (Supplementary Table 3) and within cohorts (Supplementary Tables 4 and 5), except that there was no difference in SPPB score by BMI in the APPEAL cohort (Supplementary Table 4).

Discordance between Perceived and Objective Physical Function

Overall, 36.8% of individuals had PROMIS Physical Function T-scores and SPPB scores that fell into the same quartile, while 22.3% had scores that were discordant (Figure 2). Among the discordant, about half had SPPB scores greater than PROMIS Physical Function T-scores [overestimation of objective physical function (objective > perceived)], while the other half had SPPB scores lower than PROMIS Physical Function T-scores [underestimation of objective physical function (objective < perceived)]. The weighted Cohen's kappa was 0.4, indicating moderate agreement. Among those with in-person (Supplementary Figure 4) and remote (Supplementary Figure 5) visits and within APPEAL (Supplementary Figure 6) and CLUES (Supplementary Figure 7), percentage agreement was lower, discordance was higher, and kappa values indicated fair to moderate agreement. Percentage agreement was higher when the MID was used (47.8%; Supplementary Figure 8), but Cohen's kappa (=0.21) still indicated fair agreement.

In crude multinomial models, Asian vs. White race was associated with 88% lower risk of underestimation of objective physical function, while BMI ≥ 30 vs. <30 kg/m² and

higher SLAQ scores were associated with 70% and 71% higher risk of underestimation; remote visits were associated with 2.3-fold higher risk of underestimation (Table 3). In contrast, those who were older (≥ 50 and 35–49 vs. 18–34 years) had 60% and 51% lower risk of overestimation of objective physical function; those with higher SLAQ and BILD scores and moderate-to-severe depressive symptoms had 78%, 48% and 53% lower risk of overestimation, respectively. However, men and those who were Hispanic had 2.1- and 2.5-fold higher risk of overestimation, compared to women and those who were White, respectively. After adjustment, only remote visits were associated with statistically significantly higher risk of underestimation, while only Hispanic ethnicity was associated with higher risk of overestimation; those who were 35–49 vs. 18–34 years old and those with higher disease activity had statistically significantly lower risk of overestimation with adjustment (Table 3). Results were similar among only those with in-person visits (Supplementary Table 6). While patterns were similar within the APPEAL (Supplementary Table 7) and CLUES (Supplementary Table 8) cohorts, several of the associations were not statistically significant or not estimable (*e.g.*, race/ethnicity). When categories were defined by the MID, results were similar: remote visits were associated with 85% higher adjusted risk of underestimation, while middle age and higher disease activity were associated with 58% and 77% lower adjusted risk of overestimation (Supplementary Table 9). Finally, analyses using multiple imputation to account for missing values of covariates gave similar results to the primary analyses (Supplementary Table 10).

Discussion

Among more than 600 diverse adults with SLE from two U.S. population-based cohorts in metropolitan Atlanta and the San Francisco Bay Area, both perceived and objective physical function were low, although there were marked cohort differences. Regardless of cohort, older age, Black race, obese status, higher disease activity and cumulative disease damage, and moderate-to-severe depressive symptoms were all associated with lower perceived and objective physical function. Additionally, while most participants' perceived and objective physical function were reasonably concordant, we identified factors that may be associated with under- or overestimation of physical function.

On average, those in the APPEAL cohort had mean perceived physical function T-scores that were nearly a full standard deviation below the mean in the general population. The mean T-score was higher than scores reported for those with congestive heart failure ($=35$), chronic obstructive pulmonary disease ($=37$), and back pain ($=38$), but similar to scores in those with rheumatoid arthritis ($=41$), cancer ($=42$), and diabetes ($=39$ – 43).^{26,27} However, in CLUES, the mean score was much closer to that in the general population. The between-cohort difference (~ 6) was larger than distribution-based MID estimates for PROMIS physical function T-scores in the setting of SLE (2.4–4.8).²⁸ CLUES participants also had higher objective physical function scores than APPEAL participants (median scores, 10.0 vs. 9.0). Notably, a SPPB score of 10 represents the 75th percentile among the general population aged ≥ 70 years in whom the instrument was developed,⁸ and scores of <10 vs. ≥ 10 have been associated with higher rates of subsequent disability and mortality among older adults^{8,29} and populations of varying ages.³⁰ Whether these associations with subsequent outcomes are similar among those with SLE requires further study, although

our recent CLUES study suggests that higher SPPB scores may not be associated with subsequent hospitalization in SLE.³¹

The observed cohort differences in perceived and objective function are at least partially explained by differences in participant characteristics. While the cohorts were similar in age and sex, they were quite different in their distributions of race and ethnicity: most APPEAL participants were Black and most CLUES participants were Asian, White, or Hispanic. Obesity was also much higher in APPEAL vs. CLUES, possibly explained by racial differences in BMI³² and cohort differences in lifestyle factors associated with obesity. APPEAL participants also had much higher disease activity and disease damage, on average, compared to CLUES participants, possibly reflecting well-documented racial (especially Black vs. White) disparities in SLE.^{33–35} In fact, we found no cohort differences in either perceived or objective physical function after adjustment for disease activity and disease damage; further adjustment for race/ethnicity did not change the results. Our cohort differences in physical function may also be due to the effects of unmeasured geographic disparities between cohort catchment areas, such as local policies that are directly and indirectly related to health, provider availability, the natural and built landscapes (*e.g.*, weather that encourages or limits outdoor activity, presence of pedestrian and bicycle paths), and/or societal norms and attitudes (*e.g.*, lifestyle choices), all of which could be explored in future studies.

Regardless of cohort, older individuals and those who were obese, had higher disease activity, had greater cumulative disease damage, and reported moderate-to-severe depressive symptoms consistently had lower perceived and objective physical function. Interestingly, while men reported higher perceived physical function than women, a similar pattern to that seen in the general population,³⁶ objective physical function was nearly identical in men and women. Black participants reported the lowest perceived physical function scores and had the lowest mean objective physical function score as well. Similar to a study in rheumatoid arthritis,³⁷ Asian participants reported the highest perceived physical function scores but similar mean objective physical function scores vs. White participants. Hispanic and White participants reported similar perceived physical function scores, despite objective physical performance being lower among Hispanic vs. White participants. Future studies should examine factors that may contribute to these differences, such as the influence of sociocultural norms and expectations related to gender, race, and ethnicity on perceptions of physical function among those with SLE.

More than one in five individuals across cohorts had discordant perceived and objective physical function scores, including higher objective function (underestimation of objective physical function) and higher perceived function (overestimation of objective physical function). Higher disease activity and greater cumulative disease damage were both associated with higher risk of underestimation and lower risk of overestimation, suggesting that participants may weight disease-related issues heavily in their self-assessment of physical function. Men were more likely than women to overestimate their physical function, as were Hispanic vs. White participants (not statistically significant); however, older participants were ~60% less likely than the youngest participants to overestimate their physical function. Asian participants were less likely, while those who were obese were

more likely, to underestimate their physical function. As noted above, differences in coping mechanisms, resilience, and socialization may account for differences by sex and by race and ethnicity.³⁸ Obesity may result in underestimation through internalized stigma, which may reduce physical activity and lead to further declines in function.³⁹ Although many of these factors were not associated with discordance after adjustment, these results suggest potentially important factors to consider in the interpretation of perceived or self-reported physical function.

Our study has several additional limitations. First, the study is cross-sectional, limiting causal inference and the examination of changes over time in perceived and objective physical function, which is important given the intermittent nature of SLE. GOAL and CLUES were both conducted in relatively urban areas and may not entirely represent the U.S. Southeast and West. While SPPB scores and specifically gait speed scores for APPEAL remote visits were shown to be similar to in-person visit scores^{9,18} and our sensitivity analyses showed similar results, we were not able to fully validate the remote administration and scoring (*e.g.*, step-to-speed conversion) of the SPPB; the possibility that these differences contribute to between-cohort differences in objective physical function remains. Similarly, while the T-scores across PROMIS physical functioning measures are designed to be interchangeable^{16,17} and the measures have been validated in diverse U.S. populations,⁴⁰ it remains possible that this difference contributes to the between-cohort difference in perceived physical function that we observed. The SPPB and the PROMIS PF are not entirely parallel measures: the SPPB measures lower extremity mobility, while the PROMIS PF measures a variety of activities that depend on lower extremity mobility to varying degrees. Although we used a validated crosswalk^{23,24} to establish moderate-to-severe depressive symptom cutoffs and overall prevalence was similar across the cohorts, the different measures in the two cohorts may still contribute to misclassification of this variable, particularly as we noted different patterns of depression by age, sex, and race/ethnicity between the cohorts. As with any observational study, residual confounding by unknown or unmeasured confounders remains a possibility. For example, SLE-related musculoskeletal damage (incompletely captured by the BILD) may be strongly associated with perceived or observed physical function.

Despite these limitations, our results compare important estimates of perceived and objective physical function, and their relationship, in a large, diverse U.S. population of adults with SLE. These results inform research and clinical efforts to measure physical function in SLE, by providing evidence that: perceived and objective physical function can vary considerably between populations; age, obesity, and disease-related factors contribute to this variation; and perceived physical function may not always reflect objective physical function.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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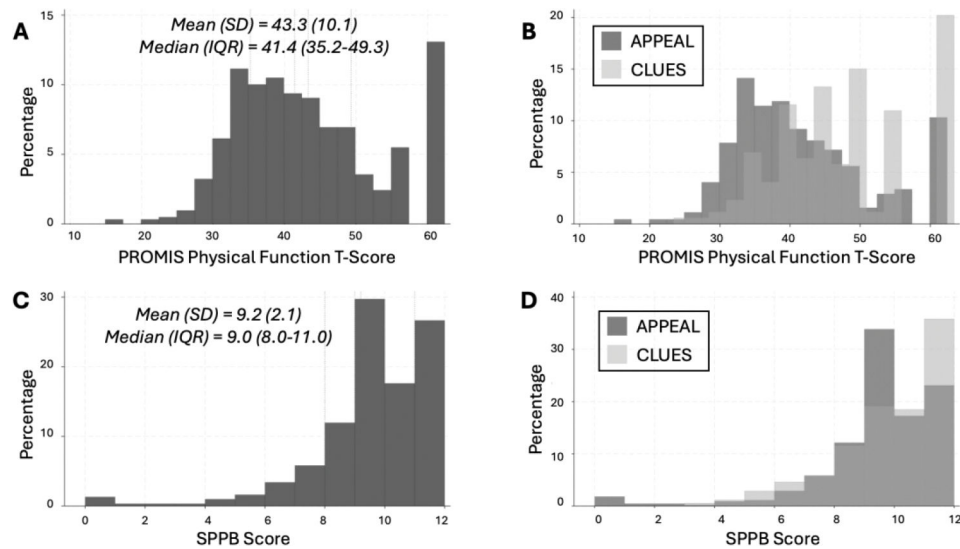


Figure 1. Distributions of perceived and objective physical function, overall and by cohort. Histograms of PROMIS Physical Function T-scores (perceived function) (**A** and **B**) and Short Physical Performance Battery (objective function) scores (**C** and **D**) are shown overall (**A** and **C**) and by cohort (**B** and **D**). IQR, interquartile range (25th, 75th percentile); PROMIS, Patient-Reported Outcomes Measurement Information System; SPPB, Short Physical Performance Battery. T-scores have a population mean of 50 and SD of 10, with higher scores indicating better physical function. SPPB range is 0–12, with higher scores indicating better performance.

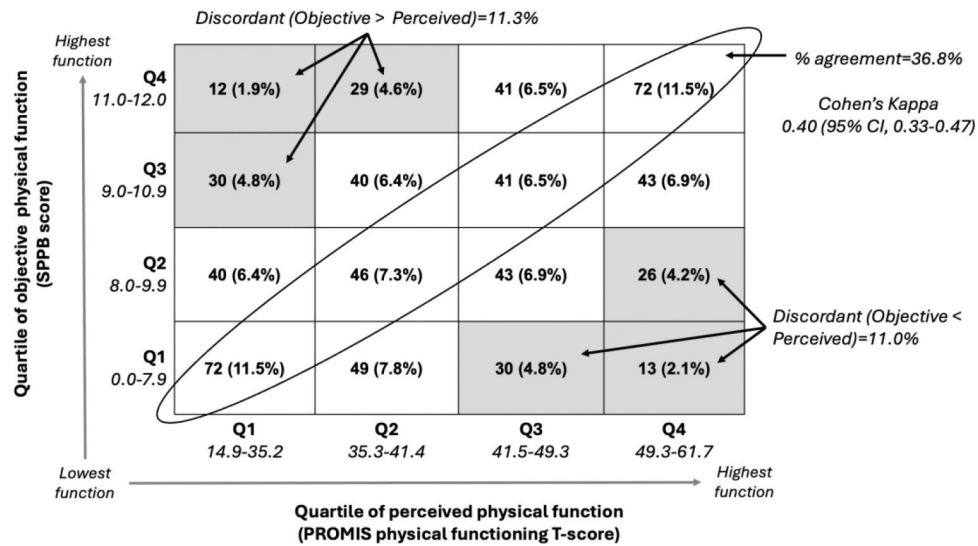


Figure 2. Agreement between perceived and objective physical function across both cohorts, by quartile of score.

Quartiles were defined in the combined cohort. PROMIS, Patient-Reported Outcomes Measurement Information System; SPPB, Short Physical Performance Battery.

Table 1.
Characteristics of participants with systemic lupus erythematosus, overall and by cohort

Characteristic	Overall	Cohort		<i>p</i> ^a
		APPEAL	CLUES	
<i>N</i>	619	446	173	
Age, years, mean (SD)	46.0 (12.5)	46.2 (11.8)	45.4 (14.1)	0.50
Sex, <i>n</i> (%)				0.40
Female	564 (91.1)	409 (91.7)	155 (89.6)	
Male	55 (8.9)	37 (8.3)	18 (10.4)	
Race/ethnicity, <i>n</i> (%)				<0.001
Asian	78 (12.6)	7 (1.6)	71 (41.0)	
Black	377 (60.9)	363 (81.4)	14 (8.1)	
Hispanic	65 (10.3)	25 (5.6)	40 (23.1)	
Other	13 (2.1)	13 (2.9)	0 (0.0)	
White	86 (13.9)	38 (8.5)	48 (27.7)	
BMI, kg/m ² , mean (SD)	29.1 (7.9)	30.2 (8.2)	26.5 (6.1)	<0.001
SLAQ score, median (IQR)	11.0 (6.0–18.0)	13 (7.0–19.0)	8.0 (4.0–14.0)	<0.001
BILD score, median (IQR)	2.0 (1.0–4.0)	2 (1.0–4.0)	1 (0.0–3.0)	0.10
Depressive symptoms ^b				
PROMIS T-score, mean (SD)	---	48.2 (9.1)	---	---
PHQ-8 score, mean (SD)	---	---	6.0 (5.1)	---
Modality of visit				
In-person	377 (60.9)	204 (45.7)	173 (100.0)	---
Remote	242 (39.1)	242 (54.3)	---	---

APPEAL, Approaches to Positive, Patient-centered Experiences of Aging with Lupus; BILD, Brief Index of Lupus Damage (score range, 0–26; higher scores reflect higher levels of disease damage); BMI, body mass index; CLUES, California Lupus Epidemiology Study; IQR, interquartile range (25th–75th percentile); PROMIS, Patient-Reported Outcomes Measurement Information System; PHQ-8, 8-item Patient Health Questionnaire; SLAQ, Systemic Lupus Activity Questionnaire (score range, 0–44; higher scores reflect higher levels of lupus disease activity).

^aBy χ^2 , Fisher's exact, or Wilcoxon rank-sum test, as appropriate.

^bIn APPEAL, depressive symptoms were measured using the PROMIS Depression Short Form 8b and reported as T-scores, which have a population mean of 50 and a standard deviation of 10. Higher scores indicate greater levels of depressive symptoms. In CLUES, depressive symptoms were assessed using the PHQ-8, with scores ranging from 0 to 24. Higher scores similarly reflect greater levels of depressive symptoms.

Table 2.
Perceived and objective physical function by patient characteristics

Characteristic	Perceived physical function		Objective physical function	
	Mean (SD) PROMIS PF T-Score	<i>p</i> ^a	Mean (SD) SPPB score	<i>p</i> ^a
Age		<0.001		0.004
18–34	47.4 (10.5)		9.6 (1.8)	
35–49	43.4 (10.5)		9.2 (2.1)	
≥50	40.8 (8.6)		8.9 (2.1)	
Sex		0.03		0.97
Female	43.0 (10.0)		9.2 (2.1)	
Male	46.2 (10.4)		9.2 (2.1)	
Race/ethnicity		<0.001		<0.001
Asian	50.5 (9.1)		9.8 (1.8)	
Black	40.8 (9.5)		8.9 (2.2)	
Hispanic	45.8 (9.6)		9.2 (1.9)	
White	45.6 (9.2)		9.7 (1.8)	
Body mass index		<0.001		0.003
<30 kg/m ² (non-obese)	45.1 (10.4)		9.3 (2.1)	
≥30 kg/m ² (obese)	40.6 (8.8)		8.8 (2.0)	
Disease activity (SLAQ)		<0.001		<0.001
Lower (<median)	48.4 (9.4)		9.6 (1.9)	
Higher (≥median)	38.1 (7.8)		8.7 (2.1)	
Disease damage (BILD)		<0.001		0.001
Lower (<median)	46.3 (10.0)		9.4 (2.0)	
Higher (≥median)	40.2 (9.2)		8.9 (2.1)	
Depressive symptoms		<0.001		<0.001
None or mild ^b	45.0 (10.1)		9.3 (2.1)	
Moderate to severe ^b	37.5 (7.7)		8.6 (2.0)	

BILD, Brief Index of Lupus Damage; PF, physical function; PROMIS, Patient-Reported Outcomes Measurement Information System; SLAQ, Systemic Lupus Activity Questionnaire; SPPB, Short Physical Performance Battery.

^aBy *t* test or ANOVA, as appropriate.

^bUsing cutoffs of PROMIS Depression Short Form 8b T-score >56.2 and PHQ-8 score ≥10.0.

Table 3.
Association of participant characteristics with discordance between perceived and objective physical functioning.

Characteristic	Relative risk ratio for discordant ^a (vs. concordant) physical function scores			
	Underestimation (objective>perceived)		Overestimation (objective<perceived)	
	Unadjusted	Adjusted ^b	Unadjusted	Adjusted ^b
Age (vs. 18–34 years)				
35–49 years	0.91 (0.46–1.81)	0.62 (0.30–1.29)	0.40 (0.21–0.75)	0.49 (0.24–0.98)
≥50 years	1.02 (0.52–1.97)	0.74 (0.36–1.52)	0.49 (0.27–0.88)	0.65 (0.33–1.28)
Sex (vs. female)				
Male	1.10 (0.45–2.71)	1.62 (0.62–4.16)	2.09 (1.01–4.30)	2.12 (0.97–4.65)
Race/ethnicity (vs. White)				
Asian	0.12 (0.02–0.99)	0.17 (0.02–1.44)	1.83 (0.75–4.47)	1.40 (0.53–3.66)
Black	1.34 (0.63–2.85)	1.01 (0.46–2.24)	0.83 (0.38–1.81)	1.04 (0.45–2.43)
Hispanic	0.66 (0.19–2.26)	0.72 (0.20–2.54)	2.46 (0.99–6.10)	3.17 (1.19–8.55)
BMI (vs. <30 kg/m ²)				
≥30 kg/m ²	1.70 (1.01–2.86)	1.39 (0.81–2.40)	0.87 (0.52–1.47)	1.30 (0.70–2.41)
Disease activity (vs. <median SLAQ)				
≥median SLAQ	1.71 (1.01–2.90)	1.38 (0.78–2.45)	0.22 (0.12–0.41)	0.25 (0.13–0.50)
Disease damage (vs. <median BILD)				
≥median BILD	1.52 (0.91–2.54)	1.23 (0.69–2.17)	0.52 (0.31–0.87)	0.69 (0.39–1.24)
Depressive symptoms (vs. none to mild) ^c				
Moderate to severe	1.03 (0.56–1.87)	0.80 (0.41–1.56)	0.37 (0.16–0.83)	0.73 (0.30–1.79)
Visit type (vs. in-person)				
Remote	2.26 (1.36–3.78)	1.74 (1.01–3.01)	0.68 (0.39–1.16)	0.99 (0.52–1.86)

BILD-Brief Index of Lupus Damage; BMI-body mass index; SLAQ-Systemic Lupus Activity Questionnaire.

^aDefined as ≥2 quartiles apart for Short Physical Performance Battery score (objective) and PROMIS Depression Short Form 8b T-score (perceived).

^bAdjusted for all other variables listed in the table, with age, BILD, and SLAQ entered as continuous variables.

^cUsing cutoffs of PROMIS Depression 8a T-score >56.2 and 8-item Patient Health Questionnaire (PHQ-8) score ≥10.0.