Open Access Rheumatology: Research and Reviews

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ORIGINAL RESEARCH

Physical activity and sedentary behavior in patients with systemic lupus erythematosus and rheumatoid arthritis

This article was published in the following Dove Press journal:
Open Access Rheumatology: Research and Reviews
8 November 2017
Number of times this article has been viewed

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Objective: Patients with systemic lupus erythematosus (SLE) and rheumatoid arthritis (RA) are at increased risk of cardiovascular disease (CVD). As sedentary behavior and lack of physical activity are known cardiovascular risk factors, we compared habitual activity between SLE patients, RA patients, and healthy control participants.

Patients and methods: For this cross-sectional study, RA and SLE patients were recruited from rheumatology clinics at an academic medical center from April 2013 to December 2014. Healthy control participants were recruited through local advertising during the same time period. Habitual activity was measured using a triaxial accelerometer worn during waking hours for 7 consecutive days. Minutes per day of sedentary, light, and moderate–vigorous physical activity (MVPA) were recorded and compared between SLE, RA, and healthy participants using ANOVA.

Results: There were 59 participants included in the analysis: 20 SLE patients, 19 RA patients, and 20 healthy controls. Disease activity was quiescent in both the SLE and RA groups. All three groups demonstrated high sedentary behavior (mean ± SD sedentary time for all participants: 10.1±1.3 hours/day; 76.4% total wear time). There were no significant differences between SLE, RA, and healthy participants in time spent in sedentary behavior (p=0.80) or light activity (p=0.17). Total MVPA (mean ± SD, minutes/day) was significantly lower in SLE (34.5±22.7; p<0.001) and RA (41.5±21.3; p=0.005) patients compared to controls (64.9±22.4).

Conclusion: SLE and RA patients demonstrate suboptimal MVPA despite well-controlled disease. Given their increased CVD risk, effective interventions are required to improve habitual physical activity levels in both populations.

Keywords: systemic lupus erythematosus, rheumatoid arthritis, physical activity, sedentary behavior, accelerometry

Introduction

Systemic lupus erythematosus (SLE) and rheumatoid arthritis (RA) are chronic systemic autoimmune inflammatory conditions, commonly affecting the musculoskeletal system. The traditional goals of therapy have been amelioration of inflammation for relief of symptoms and prevention of organ damage and disability. It is recognized that SLE and RA confer increased risk of cardiovascular disease (CVD).[1,2] Therefore, treatment of these conditions also includes the aggressive management of traditional cardiovascular risk factors.[3,4] Given the evidence linking physical inactivity and high sedentary behavior to atherosclerotic CVD, in the general population and specifically in SLE and RA patients,[5–9] understanding habitual physical activity (PA) behavior among SLE and RA patients is important.

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Dovepress
http://dx.doi.org/10.2147/OARRR.S148376

In SLE and RA populations, PA has also been associated with less disease activity, fatigue, pain, and depressive symptoms and improved sleep quality, physical function, and quality of life.[10–12] However, SLE and RA patients may experience disease-specific barriers to regular aerobic exercise, leading to low PA levels and high sedentary behavior. Habitual PA may be restricted by joint inflammation and damage, systemic symptoms, and treatment-related side effects.[13–16] Loss of employment income and lower socioeconomic status may also negatively impact opportunities to regularly participate in PA.[17]

Traditionally, self-report questionnaires have been used in studies evaluating habitual PA among SLE and RA patients.[14,15,18–20] These suggest that individuals with SLE and RA are less physically active compared to the general population.[14,15,18–20] However, many self-report measures of PA are inaccurate, due to overestimation of energy expenditure.[21–23] Prior studies in SLE have used the Framingham PA Index[20,24] as a self-report tool, which to our knowledge has never been compared to objective measures of PA in SLE patients.

Accelerometry is a feasible, valid, and reliable tool for the measurement of habitual PA among patients with rheumatic diseases.[25] Several studies have assessed moderate–vigorous PA (MVPA) among RA patients using accelerometry and have found lower levels of MVPA compared to healthy non-RA participants.[26–28] To date, relatively little work has been performed using accelerometry to measure MVPA in SLE patients [29–31] and, to our knowledge, no prior studies have directly compared MVPA levels between RA and SLE patients.

While physical inactivity refers to a failure to meet recommended guidelines for MVPA,[32,33] sedentary behavior is a distinct construct defined by any waking behaviors resulting in energy expenditure <1.5 metabolic equivalents while sitting or lying.[34] In the general population, sedentary behavior is associated with increased risk of CVD, CVD-related mortality, and all-cause mortality, independent of the amount of MVPA performed.[35,36] Recent accelerometry studies have suggested that RA patients spend significantly more time in sedentary behavior than non-RA participants.[26,28] Very few studies thus far have investigated sedentary behavior among SLE patients using accelerometry.

Our primary objective was to objectively measure and compare habitual MVPA and sedentary behavior in SLE patients, RA patients, and healthy controls. A secondary objective was to assess the correlation between self-reported activity using the Framingham PA Index and objectively measure PA using accelerometry.

Patients and methods

Study participants

This was a cross-sectional study from April 2013 to December 2014 in Halifax, NS, Canada. A total of 20 SLE and 20 RA patients were recruited from the outpatient adult rheumatology clinic during regularly scheduled follow-up appointments. SLE and RA patients fulfilled the American College of Rheumatology (ACR) criteria for SLE[37] and RA,[38] respectively. A total of 20 healthy control participants were recruited through advertisements at local hospital facilities. Participants were excluded from the study if they had active comorbidities including cardiopulmonary, musculoskeletal, or neurological disorders for which MVPA would be contraindicated. The Nova Scotia Health Authority (NSHA) research ethics board approved the study (File number CDHA-RS/2013-135), and all participants provided written informed consent.

Clinical assessment

At the initial assessment, demographic information, comorbid health conditions, and health behaviors such as cigarette smoking and alcohol use were recorded. Body mass index (BMI) was calculated using weight and height measurements. The Health Assessment Questionnaire (HAQ)[39] was used to assess functional capacity, and health-related quality of life was measured using the Medical Outcomes Survey Short Form 36 (SF-36).[40]

For SLE and RA patients, disease duration and medications including corticosteroids, antimalarials, disease-modifying antirheumatic drugs, and biologic therapies were recorded. Disease activity in SLE patients was measured using the SLE Disease Activity Index 2000 (SLEDAI-2K),[41] and cumulative organ damage was assessed using the Systemic Lupus International Collaborating Clinics (SLICC)/ACR Damage Index (SDI).[42] RA patients completed a patient global assessment of disease activity, and a rheumatologist performed a tender joint count, swollen joint count, and physician global assessment. Both the Disease Activity Score 28-erythrocyte sedimentation rate (DAS28-ESR) and the DAS28-C-reactive protein (DAS28-CRP) were calculated to quantify disease activity in RA patients.

Laboratory data were collected from SLE and RA patients. These included CRP, ESR, antinuclear antibodies, rheumatoid factor, anti-cyclic citrullinated peptide antibodies, fasting glucose, and fasting lipid profile.

PA assessment

PA was assessed by both objective (accelerometry) and subjective (self-report questionnaire) methods. All participants

completed the Framingham PA Index[5] questionnaire at their initial assessment. Participants reported the average number of minutes per day spent in sedentary, light, moderate, and heavy activities during both working and leisure hours. Examples for each activity category were provided. This questionnaire has been previously used in SLE patients,[20,24] although data regarding the validity of this measurement tool in the SLE population are limited.

The Actigraph GT3X accelerometer, which is valid and reliable[25,43–45] for the measurement of habitual activity in both healthy and chronic disease populations, was used to objectively measure PA. At the initial assessment, trained research personnel gave uniform, scripted instructions to each participant to wear the accelerometer on a belt at the natural waistline for 7 consecutive days, removing the device only when sleeping or during water activities. After 7 days, participants returned the accelerometers for data analysis via post.

Data were collected in 5-second epochs and cleaned using Actilife 6.10.2 software (ActiGraph, LLC, Pensacola, FL, USA). Non-wear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 1–2 minutes of counts between 0 and 100.[46,47] A valid day was defined as ≥10 hours of wear time,[46,47] and patients had to have ≥4 valid days, to a maximum of 7 days, to be included in the analysis.[43] Cut points described by Troiano et al[46] were used to define sedentary behavior (<100 counts/minute), light activity (100–2019 counts/minute), moderate activity (2020–5998 counts/minute), and vigorous activity (≥5999 counts/minute). As patients with rheumatic diseases rarely engage in vigorous activities[23,48] and PA recommendations are available only for MVPA,[32] our analyses considered time spent in moderate and vigorous activities together as a single activity category (MVPA ≥2020 counts/minute). Time spent in sedentary behavior, light PA, and MVPA was averaged across valid days and reported in minutes per day using mean and SD. The amount of MVPA accumulated in bouts of ≥10 minutes was used to determine whether individuals were meeting current PA guidelines (≥150 minutes/week of MVPA accumulated in bouts of 10 minutes or more).[32,33] To qualify as an MVPA bout, 10 consecutive minutes of observations had to exceed the MVPA cut point, with allowance for a maximum of two observations falling below the cut point during that period.[47] Adherence to PA guidelines was defined as a weekly sum ≥150 minutes of MVPA bouts.[32,33] If patients had 4–6 valid days, their average daily MVPA was multiplied by 7 to obtain a weekly sum.[47]

Statistical analysis

All data were examined for normality prior to the main analyses. The demographic and clinical characteristics of SLE patients, RA patients, and controls were compared using chi-square tests for categorical variables. For cells containing ≤5 expected observations, Fisher's exact test was used. For continuous variables, ANOVA and Kruskal–Wallis tests were used to compare the three groups for parametric and nonparametric data, respectively. Given the large number of baseline variables evaluated, Bonferroni correction for multiple comparisons was used to determine statistically significant differences in baseline characteristics between the three groups.

For both PA Index data and accelerometry data, ANOVA was used to compare mean daily sedentary time, light activity, and MVPA (all measured in minutes/day) between the three groups. For outcomes that were statistically different between the three groups using ANOVA, post hoc pairwise comparisons were made using the Bonferroni method. The proportion of participants meeting current PA recommendations (≥150 minutes of MVPA bouts)[32,33] was compared between the three groups using chi-square/Fisher's exact test.

For any baseline characteristics found to be significantly different between the three groups in univariable analysis, bivariate correlations were performed with the abovementioned continuous accelerometry outcome variables. Any baseline variables which were found to correlate significantly with accelerometry outcomes were then included as covariates in multivariable analysis (analysis of covariance, ANCOVA) comparing accelerometry outcomes between SLE, RA, and healthy participants.

Prior to our main analysis, it was noted that the three study groups may differ with respect to sex distribution, with female predominance anticipated in the SLE group. This presented a potential issue, since prior literature consistently demonstrates higher MVPA levels among males compared to females in the general population.[47] To address the concern that any group differences in MVPA levels may be due to differences in sex distribution, the abovementioned statistical procedures were repeated in a subgroup analysis including only female study participants, thereby removing sex as a confounder.

To compare subjective PA Index data with objective accelerometry data, Pearson correlation coefficients were first calculated for each of sedentary minutes/day, light activity minutes/day, and MVPA minutes/day to assess the correlations between the two methods of measurement. Paired *t*-tests

were used to assess differences between these two measurement methods for sedentary time, light activity, and MVPA (minutes/day) in each of the three groups. The threshold for statistical significance was set at a p-value of ≤0.05. All analyses were performed using SPSS software, version 23.0 (IBM Corporation, Armonk, NY, USA).

Results

A total of 60 participants were enrolled in the study (20 SLE patients, 20 RA patients, and 20 healthy controls). One RA patient did not wear the accelerometer for at least 4 valid days (>600 minutes/day) and was therefore excluded from the analysis. For the remaining 59 participants, mean (SD) accelerometer wear time was 794.7 (78.0) minutes/day and 6.69 (0.79) days/week. There were no significant differences in wear time between SLE, RA, and healthy participants in terms of mean accelerometer minutes/day or number of days of accelerometer wear.

Comparison of baseline characteristics between SLE patients, RA patents, and healthy controls is given in Table 1, and disease characteristics of SLE and RA patients are summarized in Table 2. There were no statistically significant differences between SLE patients, RA patients, and controls with regard to age, sex distribution, marital status, BMI, cigarette smoking, alcohol use, or presence of comorbidities. Taking into consideration Bonferroni correction for multiple comparisons, only years of education, HAQ scores, and SF-36 physical component summary (PCS) scores were significantly different between the three groups ($p \leq 0.001$). These variables were then examined via bivariate correlations with the continuous accelerometry outcomes to determine whether they could be potential confounders for the main analysis. Years of education, HAQ scores, and SF-36 PCS scores each correlated significantly with total MVPA minutes/day, but did not correlate with total sedentary minutes/day or light activity minutes/day. Thus, these variables were adjusted for in the MVPA minutes/day analysis only.

Accelerometry data for SLE patients, RA patients, and healthy participants are summarized in Table 3. Sedentary minutes/day and light activity minutes/day were similar

Table 1 Baseline characteristics of the study participants at enrollment (N = 59)[a–c]

Variables	SLE (N = 20)	RA (N = 19)	Control (N = 20)	*p*-value
Demographic information				
Female, n (%)	18 (90.0%)	11 (57.9%)	13 (65.0%)	0.065
Age, years, mean (SD)	43.9 (12.5)	51.5 (13.4)	50.9 (11.2)	0.106
Caucasian race, n (%)	17 (85.0%)	17 (89.5%)	20 (100%)	0.217
Marital status, n (%)				0.764
Single/divorced/separated	6 (30.0%)	5 (26.3%)	4 (20.0%)	
Married/common-law	14 (70.0%)	14 (73.7%)	16 (80.0%)	
Education, years, mean (SD)	15.1 (3.1)	15.1 (2.3)	18.6 (3.5)	**0.001**
BMI, kg/m^2, mean (SD)	28.1 (5.9)	27.3 (7.7)	25.3 (4.4)	0.349
Household income (CAD), n (%)				0.011
<$75,000/year	10 (58.8%)	12 (63.2%)	4 (20.0%)	
>$75,000/year	7 (41.2%)	7 (36.8%)	16 (80.0%)	
Missing	3			
Health behaviors				
Cigarette smoking, n (%)	3 (15.0%)	7 (36.8%)	2 (10.0%)	0.088
Alcohol use, n (%)	9 (47.4%)	11 (57.9%)	14 (70.0%)	0.356
Comorbidities				
Diabetes, n (%)	1 (5.0%)	1 (5.3%)	0 (0%)	0.588
Hypertension, n (%)	8 (40.0%)	2 (10.5%)	0 (0%)	0.002
Dyslipidemia, n (%)	4 (20.0%)	2 (10.5%)	1 (5.0%)	0.333
Depression, n (%)	6 (30.0%)	1 (5.3%)	2 (10.0%)	0.072
Chronic pain, n (%)	7 (35.0%)	6 (31.6%)	5 (25.0%)	0.784
Measures of function and disability				
HAQ score, mean (SD)	0.06 (0.17)	0.35 (0.55)	0 (0)	**<0.001**
SF-36, mean (SD)				
PCS	37.7 (10.8)	45.6 (9.0)	55.4 (3.9)	**<0.001**
MCS	46.5 (10.9)	49.5 (11.4)	53.7 (8.8)	0.059

Notes: [a]All comparisons for categorical variables were performed using chi-square test ($df = 2$). [b]Age, years of education, and SF-36 PCS scores were normally distributed and were compared using one-way ANOVA. [c]BMI, HAQ scores, and SF-36 MCS scores were not normally distributed and were compared between groups using Kruskal–Wallis test. Bold indicates statistically significant results after Bonferroni adjustment for multiple comparisons ($p \leq 0.001$).

Abbreviations: BMI, body mass index; HAQ, Health Assessment Questionnaire; MCS, Mental Component Summary; PCS, physical component summary; RA, rheumatoid arthritis; SF-36, Short Form-36; SLE, systemic lupus erythematosus.

Table 2 Disease characteristics and laboratory data of SLE and RA patients

	SLE patients (N = 20)	RA patients (N = 19)
Disease characteristics		
Disease duration, years, mean (SD)	14.1 (10.1)	14.6 (10.6)
Medications		
Prednisone, n (%)	3 (15.0)	1 (5.3)
DMARDs, n (%)	12 (60.0)	17 (89.5)
Antimalarials, n (%)	13 (65.0)	6 (31.6)
Biologics, n (%)	0 (0)	11 (57.9)
Blood pressure, mmHg, mean (SD)		
Systolic	124.4 (21.7)	120.4 (11.3)
Diastolic	73.8 (14.4)	72.3 (8.7)
TJC, mean (SD)		2.42 (7.07)
SJC, mean (SD)		2.68 (4.06)
DAS28-ESR, mean (SD)		2.76 (1.35)
DAS28-CRP, mean (SD)		2.27 (1.42)
ACR criteria at diagnosis, mean (SD)	6.1 (1.3)	
SLEDAI-2K, mean (SD)	2.9 (2.1)	
SDI, mean (SD)	1.75 (2.3)	
Laboratory investigations		
CRP, mg/L, mean (SD)	4.00 (4.4)	6.49 (10.2)
ESR, mm/hr, mean (SD)	44.9 (38.7)	17.6 (16.6)
RF positive, n (%)		14 (73.7)
Anti-CCP positive, n (%)		16 (84.2)
Fasting glucose, mmol/L, mean (SD)	5.2 (1.4)	4.9 (1.1)
Lipid profile, mean (SD)		
Triglycerides, mmol/L	1.12 (0.51)	0.86 (0.47)
LDL cholesterol, mmol/L	2.27 (0.76)	2.70 (0.93)

Abbreviations: ACR, American College of Rheumatology; anti-CCP, anti-cyclic citrullinated peptide; CRP, C-reactive protein; DAS28, Disease Activity Score-28; DMARDs, disease-modifying antirheumatic drugs; ESR, erythrocyte sedimentation rate; LDL, low-density lipoprotein; RA, rheumatoid arthritis; RF, rheumatoid factor; SDI, SLICC/ACR Damage Index; SJC, swollen joint count; SLE, systemic lupus erythematosus; SLEDAI-2K, SLE Disease Activity Index 2000; SLICC, Systemic Lupus International Collaborating Clinics; TJC, tender joint count.

between the three groups. All groups demonstrated very high levels of sedentary behavior (Table 3), with mean (SD) sedentary time among all participants of 608.44 (78.0) minutes/day (10.1 hours/day), which equates to 76.6% of total wear time. Total MVPA minutes/day was significantly different between the three groups ($p<0.001$). This difference remained significant when ANCOVA was performed with HAQ scores, education, and SF-36 PCS scores as covariates ($p=0.003$). Post hoc analyses demonstrated that mean daily MVPA was greater among healthy controls (mean [SD] 64.9 [22.4]) when compared to both SLE (mean [SD] 34.5 [22.7]; $p<0.001$) and RA (mean [SD] 41.5 [21.3]; $p=0.005$) patients. Total MVPA minutes/day were not significantly different between RA and SLE patients ($p=0.992$). Healthy controls (9/20, 45.0%) were found to more likely meet current Canadian PA recommendations ($p=0.028$) by performing ≥150 minutes of MVPA bouts/week[32,33] when compared to SLE patients (2/20, 10.0%) and RA patients (3/19, 15.8%). Similar results were obtained when these analyses were repeated including only female study participants (data not shown), suggesting that the differences in MVPA levels observed between healthy control patients and patients with rheumatic diseases (RA and SLE) could not be fully explained by differences in sex distribution across the three groups.

Self-reported sedentary minutes/day, light activity minutes/day, and MVPA minutes/day from the Framingham PA Index are also summarized in Table 3. Habitual activity was not significantly different between SLE patients, RA patients, and controls for any of the PA outcomes analyzed. Pearson

Table 3 Habitual sedentary time, light activity, and MVPA for SLE, RA, and healthy participants measured using accelerometry and by self-report using the PA Index[a]

	SLE (N = 20)	RA (N = 19)	Healthy (N = 20)	*p*-value
Accelerometry data				
Sedentary minutes/day, mean (SD)	603.6 (68.7)	603.4 (72.5)	618.0 (93.5)	0.800
Light activity minutes/day, mean (SD)	127.0 (37.2)	150.5 (48.5)	140.7 (28.5)	0.172
Total MVPA minutes/day, mean (SD)	34.5 (22.7)	41.5 (21.3)	64.9 (22.4)	<0.001 (0.003)[b]
Guidelines met, n (%) (≥150 minutes MVPA bouts/week)	2 (10.0)	3 (15.8)	9 (45.0)	0.028[c]
Self-report data from the PA Index Questionnaire				
Sedentary minutes/day, mean (SD)	387.0 (233.2)	416.8 (233.6)	468.0 (221.6)	0.533
Light activity minutes/day, mean (SD)	262.5 (171.1)	347.4 (133.5)	268.5 (184.5)	0.212
Total MVPA minutes/day, mean (SD)	198.0 (214.2)	192.6 (177.3)	249.0 (208.1)	0.625

Notes: [a]All continuous variables were normally distributed. Comparisons between groups for continuous variables were made using ANOVA. [b]For total MVPA minutes/day, comparison between groups was also made using ANCOVA with HAQ scores, years of education, and SF-36 PCS scores as covariates, *p*-value is given in parentheses. [c]Comparisons for categorical variables made using Fisher's exact test.

Abbreviations: ANCOVA, analysis of covariance; HAQ, Health Assessment Questionnaire; MVPA, moderate–vigorous physical activity; PA, physical activity; PCS, physical component summary; RA, rheumatoid arthritis; SF-36, Short Form-36; SLE, systemic lupus erythematosus.

correlation coefficients between the subjective PA Index data and the objective accelerometry data were calculated for sedentary minutes/day (r=0.182; p=0.167), light activity minutes/day (r=0.113; p=0.394), and MVPA minutes/day (r=0.192; p=0.146). For all three continuous accelerometry outcome variables, correlations between questionnaire data and accelerometry data were weak and lacked statistical significance. There were no significant differences in these correlations when stratified by group assignment (SLE, RA, healthy participants). Paired t-tests were used to further assess the agreement between the subjective and objective methods of measuring PA. As summarized in Table 4, all three groups substantially overestimated the amount of light activity and MVPA performed when compared to accelerometry data. In addition, sedentary time was greatly underestimated by all three groups when compared to objective data collected by accelerometry (Table 4).

Discussion

This is the first study to use accelerometry to directly compare habitual PA and sedentary behavior between SLE patients, RA patients, and healthy participants. All three groups demonstrated similar high levels of sedentary behavior measured by accelerometry, while SLE and RA patients demonstrated significantly lower levels of MVPA than healthy control participants. MVPA performance by accelerometry was similar between RA and SLE patients. In all the three groups, participants subjectively reported significantly higher levels of MVPA and less sedentary time using the Framingham PA Index questionnaire when compared to objective accelerometry data.

The amount of daily sedentary time described among all participants in our study is comparable to sedentary behavior reported for the general Canadian adult population in the 2007–2009 Canadian Health Measures Survey.[47] Prior studies using accelerometry have demonstrated similar levels of sedentary behavior among RA patients,[26,48,49] but found that RA patients spend significantly more time in sedentary behavior compared to healthy control participants.[26,28] This difference in results may be explained by higher levels of RA disease activity in these prior studies, as well as unusually low levels of sedentary behavior among their healthy control participants.[26]

To our knowledge, ours is the first study to use accelerometry to examine sedentary behavior in a representative SLE population compared to healthy controls. Our results are similar to those described in a prior study by Eriksson et al,[15] which found similar self-reported daily sitting time between SLE patients and non-SLE study participants. More recently, Pinto et al[31] reported mean daily sedentary time among 21 adult SLE patients using accelerometry of 532.1 minutes/day or 60.3% of total accelerometer wear time. This was similar to mean daily sedentary time among 15 adult non-SLE control participants.[31] However, this study included only participants who were previously known to be physically inactive, and thus was not representative of the overall SLE population.

Overall, the amount of sedentary time among participants in our study is concerning, given the mounting evidence that prolonged sedentary behavior is associated with negative health outcomes, independent of time spent in MVPA. In the general population, increased sedentary time has been associated with increased risk of type 2 diabetes, CVD,

Table 4 Comparison of mean daily sedentary time, light activity, and MVPA measured using accelerometry and by self-report using the PA Index for SLE, RA, and healthy control study participants

	Accelerometry	PA Index Questionnaire	Difference in means (SD)[a]	p-value[b]
SLE (N = 20)				
Sedentary minutes/day, mean (SD)	603.6 (68.7)	387.0 (233.2)	216.6 (248.3)	0.001
Light activity minutes/day, mean (SD)	127.0 (37.2)	262.5 (171.1)	−135.5 (172.2)	0.002
Total MVPA minutes/day, mean (SD)	34.5 (22.7)	198.0 (214.2)	−163.5 (207.5)	0.002
RA (N = 19)				
Sedentary minutes/day, mean (SD)	603.4 (72.5)	416.8 (233.6)	186.6 (198.3)	0.001
Light activity minutes/day, mean (SD)	150.5 (48.5)	347.4 (133.5)	−196.9 (131.0)	<0.001
Total MVPA minutes/day, mean (SD)	41.5 (21.3)	192.6 (177.3)	−151.2 (169.4)	0.001
Healthy control participants (N = 20)				
Sedentary minutes/day, mean (SD)	618.0 (93.5)	468.0 (221.6)	150.0 (237.1)	0.011
Light activity minutes/day, mean (SD)	140.7 (28.5)	268.5 (184.5)	−127.8 (190.1)	0.007
Total MVPA minutes/day, mean (SD)	64.9 (22.4)	249.0 (208.1)	−184.1 (215.0)	0.001

Notes: [a]Difference calculated as the accelerometry estimate minus the self-report questionnaire estimate. [b]p-value for the paired t-test comparing means between the two PA measurement methods.

Abbreviations: MVPA, moderate–vigorous physical activity; PA, physical activity; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus.

cardiovascular mortality, and all-cause mortality.[35,36] Furthermore, in RA populations, preliminary studies have shown prolonged sedentary time to be associated with increased disease activity, decreased physical function, and decreased bone mass.[23,50] There are Canadian guidelines limiting the amount of acceptable sedentary behavior among children and adolescents,[51] but specific recommendations for adults have yet to be established. Given the known impact of sedentary behavior on cardiovascular health, further study is needed to determine factors impacting sedentary behavior among SLE and RA patients, to develop interventions to modify this cardiovascular risk factor in these high-risk groups.

In the current study, SLE and RA patients performed significantly less MVPA compared to healthy control participants. Only 10.0% of SLE patients and 15.8% of RA patients met current PA guidelines (≥150 minutes MVPA/week)[32,33] compared to 45.0% of healthy controls. This is in keeping with the findings of previous studies that have shown lower MVPA levels among RA patients compared to non-RA participants.[26–28] Several prior studies in RA have demonstrated both disease activity and functional disability to be associated with lower levels of MVPA.[13,26,27,52] However, in our study, RA patients performed significantly less MVPA despite very low levels of disease activity and disability, suggesting that additional factors may be influencing MVPA in this population. Furthermore, given that the RA patients in this sample had relatively quiescent disease and minimal disability compared to other RA samples, our findings may actually underestimate levels of physical inactivity among RA patients. Thus, in a more representative sample of RA patients with more active disease and greater functional disability, habitual MVPA performance may be even lower than reported in this study.

The literature investigating PA behavior in SLE patients using accelerometry is limited. A study by Ahn et al[29] used accelerometry to measure MVPA in 129 SLE patients. As in our study, low levels of MVPA were demonstrated among SLE patients, with mean total MVPA of 39.6 minutes/day.[29] A recent study by Pinto et al[31] compared accelerometry-derived MVPA estimates between physically inactive SLE patients and physically inactive non-SLE participants. Not surprisingly, MVPA levels were very low in both groups.[31] To our knowledge, our study is the first to use accelerometry to compare MVPA between participants from a representative SLE population and healthy participants from the general population. It is also the first study to directly compare habitual MVPA performance between RA and SLE patients. It is of interest that SLE patients in the current study were just as inactive as RA patients despite more significant joint disease and older age in the RA group. As of yet, minimal data are available regarding the specific factors impacting PA behavior in SLE patients.[15,16] We believe that the low levels of MVPA among SLE patients in this study are unlikely to be attributed to active disease given their very low SLEDAI-2K scores. Future studies to elucidate the underlying factors influencing habitual PA behavior among SLE patients are required, to inform the development of effective PA interventions.

In the current study, there was poor correlation between self-reported and objectively measured habitual activity. As mentioned previously, participants significantly overestimated time spent performing MVPA and underestimated sedentary time. While preliminary, these findings are similar to the results of several prior studies that have assessed the level of agreement between subjective and objective measures of PA both in RApatients[23,49] and in the general population.[22,53] Interestingly, similar discrepancies have been found when comparing subjective and objective measures of physical function in RA patients, with the results of self-report questionnaires, such as the HAQ, correlating poorly with more objective measures of physical function.[54] Overall, our results highlight the potential limitations of subjective questionnaire data and emphasize the importance of conducting validation studies to compare the performance of these self-report instruments to more objective measurement strategies.

Only one prior study has assessed the correlation between subjective and objective measures of PA in SLE patients. Among 129 SLE patients, the correlation between self-reported MVPA using the International PA Questionnaire (IPAQ) and accelerometry-derived estimates of MVPA was modest and lacked statistical significance.[29] Prior studies in SLE patients have used the Framingham PA Index as a self-report method of assessing habitual activity levels compared to the general population.[20,24] However, this questionnaire has never previously been compared to an objective measure of PA, such as accelerometry, in SLE patients. While our findings must be confirmed in larger samples, the poor agreement between the subjective and objective measures of PA emphasizes the importance of using accelerometry as an objective tool in future studies of SLE and RA. In situations where accelerometry is not a feasible option, alternative self-report measurement tools, in addition to the Framingham PA Index, should be explored.

There are some limitations to our study. First, placement of the accelerometer on the hip limits measurement to lower limb activity. Therefore, MVPA may be underestimated in this study, as upper limb activities, cycling, and water activities

may not have been adequately captured.[47] Second, we cannot exclude some degree of selection bias in the healthy control participants, who volunteered for the study through poster advertisements. We also note that the proportion of females in the SLE group was substantially higher than in the RA and control groups. This could be problematic, since males are known to perform more MVPA than females.[47] However, in subgroup analysis, our results remained unchanged when only female study participants were considered, suggesting that our finding of lower MVPA among SLE patients compared to healthy participants was not simply due to differences in sex distribution. Third, our study included primarily Caucasian patients with longstanding, relatively quiescent rheumatic disease. Therefore, the generalizability of our results to other types of SLE and RA populations is unclear. While many baseline characteristics were evaluated as potential confounders of the relationship between disease status and PA, other important variables could not be assessed. Therefore, we cannot exclude the possibility of residual confounding of our results. Finally, small sample size limited our ability to evaluate specific disease characteristics, such as organ damage or disease activity, as correlates of habitual PA behavior.

Conclusion

Our study demonstrates the value of using accelerometry to measure habitual PA among SLE and RA patients and highlights some of the limitations of self-reported PA data. Given the increased risk of CVD among SLE and RA patients, the low MVPA levels and high sedentary behavior observed in our study are concerning. Future studies should investigate the factors impacting habitual PA behavior in these populations, to design effective interventions to target this modifiable cardiovascular risk factor in these high-risk patients.

Acknowledgments

The abstract of this paper was presented at the 2016 ACR Annual Meeting as a poster presentation with interim findings. The poster's abstract was published in "2016 ACR/ARHP Annual Meeting Abstract Supplement" in *Arthritis & Rheumatology* (DOI: 10.1002/art.39977). Support for this work was provided by the John & Marian Quigley Endowment Fund for Rheumatology.

Disclosure

The authors report no conflicts of interest in this work.

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