The Role of Neighborhood and Individual Socioeconomic Status in Outcomes of Systemic Lupus Erythematosus

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ABSTRACT. ***Objective.*** To determine if neighborhood socioeconomic status (SES) is independently related to physical and mental health outcomes in systemic lupus erythematosus (SLE).

Methods. Data derived from the first 3 waves of the Lupus Outcomes Study, a telephone survey of 957 patients with confirmed SLE diagnoses, recruited from clinical and non-clinical sources. Residential addresses were geocoded to U.S. Census block groups. Outcome measures included the Systemic Lupus Activity Questionnaire (SLAQ) score, a self-reported assessment of SLE symptoms; the Medical Outcomes Study Short Form-36 Health Survey physical functioning score; and Center for Epidemiologic Studies-Depression (CES-D) score of ≥ 19 points. Multivariate analyses adjusted for race/ethnicity and other demographic and health-related covariates.

Results. After adjustment, lower individual SES, measured by education, household income, or poverty status, was associated with all outcomes. In models that did not include individual SES, low neighborhood SES (> 30% of residents in poverty) was also associated with poor outcomes. After adjustment for individual SES, demographic, and health-related covariates, only CES-D ≥ 19 remained associated with neighborhood SES: 47% [95% confidence interval (CI) 38–56%] versus 35% (95% CI 32–37%).

Conclusion. Individual SES is associated with physical and mental health outcomes in persons with SLE. Low neighborhood SES contributes independently to high levels of depressive symptoms. Future research should focus on mechanisms underlying these differences. (First Release July 15 2008; J Rheumatol 2008;35:1782–8)

Key Indexing Terms:
SYSTEMIC LUPUS ERYTHEMATOSUS
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Systemic lupus erythematosus (SLE) is an autoimmune disease noted for its heterogeneity in manifestations and outcomes. Although advances in disease management over the past decades have improved the prognosis for patients with SLE, recent studies indicate that the mortality risk among individuals with SLE is twice that of the general population[1], and the burden of disease morbidity remains very high.

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An extensive literature exists on the associations between socioeconomic status (SES) and chronic disease outcomes documenting greater morbidity and mortality among individuals of lower SES. Numerous studies have explored these associations in SLE outcomes, including disease activity[2-4], organ damage[4-7], lupus nephritis[8-13], hospitalization[12], and mortality[14-17]. Most of these studies find poorer outcomes among people with lower SES.

In recent years, researchers have begun investigating socioeconomic characteristics of neighborhoods as risk factors for poor health outcomes independent of, or contributing to, the role of individual SES[18-21]. The impetus for this research derives from studies in the sociological literature indicating that living in areas of concentrated poverty accentuates the adverse impacts of personal poverty[22]. With a few exceptions[23-25], these studies have focused on health outcomes in the general population, rather than outcomes of discrete chronic conditions. While several studies of SLE have used neighborhood SES as a proxy measure[9,17,26,27], we are aware of no studies that examine the increment in SLE outcomes attributable to neighborhood SES, independent of individual SES. SLE provides a unique opportunity to further explore these relationships, given the severity and range of manifestations of the disease as well as the striking disparities in health outcomes among different SLE population groups[28].

We used the Lupus Outcomes Study (LOS), a large cohort of individuals with SLE that is geographically, socioeconomically, and racially diverse, to study the contribution of neighborhood SES to SLE outcomes, over and above the contribution of individual-level SES. The LOS cohort was recruited from a mix of clinical and community sources and includes information on SES at the individual and the community level, making it a unique source of information for these questions.

MATERIALS AND METHODS

The LOS is an ongoing, longitudinal study of 957 individuals with SLE whose diagnoses were confirmed by medical chart review prior to enrollment, using American College of Rheumatology (ACR) criteria[29]. Details about the enrollment and data collection for this study have been reported[30] and are briefly summarized here. Subjects were recruited through academic medical centers, community rheumatology offices, and non-clinical sources including patient support groups and conferences, and newsletters, Web sites, and other forms of publicity. Of 1,265 people contacted for the study, 982 (78%) completed at least one interview. In a recent review of medical records, we determined that 25 subjects did not meet criteria for SLE; they have been excluded, leaving 957 subjects in the cohort. Our analysis incorporates responses from the first 3 waves of data, collected between September 2002 and February 2006. In each of the 2 followup interviews, 92% of the eligible subjects from the prior wave participated. There were 24 deaths (2.5%) among study participants during this time. Additionally, 16 participants (1.7%) withdrew for health reasons, 65 (6.8%) declined further participation, and 32 (3.3%) were lost to followup.

The research protocol was approved by the UCSF Committee on Human Research. All participants gave their informed consent to be part of the study.

LOS interviews are conducted annually by trained telephone interviewers. Interviews average 50 min and consist mainly of validated batteries covering such topics as SLE disease activity and manifestations, general physical and mental health status, disability, employment, and sociodemographic characteristics; the specific batteries are listed in a prior publication[30].

To provide information about study participants' neighborhood SES, data from the 2000 U.S. Census were matched to participants' residential addresses (at the time of each annual interview). The census data were aggregated at the block group level, which captures a fairly homogeneous residential area of 600 to 3,000 persons, depending upon the population density in that area. Matching the census data to study participants' addresses involves a process known as geocoding, in which latitude and longitude coordinates are assigned to each address using electronic street map databases. These coordinates are then matched to U.S. Census geographic boundaries, providing access to demographic and socioeconomic data. Geocoding procedures were conducted by Sonoma Technology (Petaluma, CA, USA) using the Environmental Systems Research Institute ArcGIS software.

Health outcomes. The primary dependent variables in this analysis are self-reported measures of SLE disease activity, overall physical functioning, and symptoms of depression. The Systemic Lupus Activity Questionnaire (SLAQ) measures disease activity over the 3 months preceding interview[31]. This scale is an analog to the Systemic Lupus Activity Measure and is validated for self-report and telephone administration. The SLAQ has a possible range of 0-44, with higher scores indicative of greater disease activity. Because the validation of that scale was not published until after the baseline interview began, we also examine a global rating of disease activity on a scale of 0 to 10, which is included in each wave. Physical functioning is obtained from the Medical Outcomes Study Short Form-36 Health Survey (SF-36) physical functioning scale, which has a range of 0-100 and a mean of 81 ± 25 in the healthy adult population[32]. Lower scores are indicative of poorer function. Depressive symptoms are captured through the Center for Epidemiologic Studies Depression (CES-D) scale, which has a range of 0-60 and a mean of 9 ± 9 in healthy adults[33,34]. In community samples, a score of 16 or higher is typically considered indicative of clinically significant depressive symptomatology. Studies of cohorts with chronic illness often use a higher cutpoint, partly because of the potential overlap between the somatic symptoms of depression and symptoms of the disease under study. For example, a recent study of the criterion validity of CES-D in patients with rheumatoid arthritis suggested that 19 be used as a cutpoint in prevalence studies[35]. Given that nearly half the LOS subjects have CES-D scores of 16 or greater, a cutpoint of 19 was deemed more appropriate for this cohort as well.

Socioeconomic status. At the individual level, SES is measured in several ways. Educational attainment is grouped into 3 categories: high school or less; some college, trade school, or associate degree; and baccalaureate degree or beyond. Annual household income is grouped into 3 categories: less than $40,000, $40,000 to under $80,000, and $80,000 or more. Finally, participants are considered to be living in poverty if their household size and income puts them at or below 125% of the federal poverty threshold (FPT) for 2003. For a family of 4, this translates to an annual income of less than $23,000. We do not use a combined index of SES, because we wish to examine the extent to which measures of education, income, and poverty behave differently with respect to SLE outcomes.

For neighborhood SES, we use the proportion of households in a census block group living at or below 125% of the FPT to determine neighborhood SES. A recent review of area-based measures of SES recommends the poverty rate as the best single indicator of neighborhood SES for health studies[36]. Using the top decile of this distribution as a cutpoint, census block groups with at least 30% of households in poverty are considered high poverty areas. The U.S. Bureau of the Census defines a poverty area as a census tract in which at least 20% of households are below 100% of the FPT[37]. In the high poverty areas defined in our study, at least 22% of residents fall below 100% of the poverty threshold, making our definition comparable to the measure used by the Census Bureau.

Other covariates. Other sociodemographic variables included in the analyses are age, sex, race/ethnicity (non-Hispanic Caucasian vs all others), and marital status (single, married/partnered, divorced/separated, widowed). Health-related variables include years since SLE diagnosis, smoking status (current, former, never), and body mass index (BMI). The initial recruitment source of the participants is categorized as academic medical settings, community rheumatology offices, and non-clinical sources.

Data analysis. Data structure: Each LOS participant contributed up to 3 observations to the analysis, 1 for each completed interview. Thus, 753 study subjects who completed 3 interviews contributed 3 observations each (representing 88% of those eligible for 3 waves), 132 contributed 2 observations each, and 72 participants with no followup interview contributed 1 observation each, for a total of 2,595 person-years of observation.

Handling missing data: In addition to a low attrition rate in the LOS, item non-response was also low (2% or less for most items and 10% for income). Nevertheless, to minimize bias related to patterns of missing data, we performed multiple imputation to estimate the non-reported values and missing observations, and the variability in those values. Using the method developed by Rubin[38] and Schafer[39], each missing value or observation was estimated 20 times from Bayesian Markov Chain Monte Carlo (MCMC) models; all analyses were then conducted separately on the resulting datasets and combined to yield the results presented in our study. Missing observations were not imputed for the deceased. Sensitivity analyses conducted on the original observed data (with 2,377 records) showed no substantive differences from the imputed results presented here, based on 2,772 records.

Specific analyses: We initially cross-classified participants by individual and neighborhood socioeconomic characteristics. Subsequently, for every health outcome, we developed 3 multivariate models, each including a single SES measure and these covariates: age, sex, race/ethnicity, marital

status, years since diagnosis, smoking exposure, BMI, and recruitment source. For the continuous outcome measures (SF-36 physical functioning, SLAQ, SLE activity), we calculated least squares (adjusted) means and 95% confidence intervals (CI) from linear regression models. For the dichotomous measure (CES-D ≥ 19), we estimated the adjusted rates and 95% CI from the predicted marginals, which are derived from logistic regression models. We also ran unadjusted models with only the SES measures, but did not include them here, as they did not differ substantially from the adjusted results.

To estimate the effect of residing in a poverty area, we developed a series of regression models for each health outcome, beginning with poverty area as the only independent variable, and then adding the covariates listed above. To this adjusted model, we then added education, household income, and poverty status in 3 separate models, to determine the extent to which residing in a poverty area influences health outcomes over and above the effect of individual SES.

We conducted numerous sensitivity analyses. We re-ran the models with income and education, treating both variables as linear across the entire range (initially collected in 6 categories), and modeled CES-D as a continuous measure. In all cases, the results were unchanged from what we presented here. For the individual SES models, we also examined the conjoint impact of income and education. For all the models that included both individual and neighborhood SES measures, we looked for the presence of statistical interaction between the 2 levels of measurement, but found none. We subsequently added interaction terms for race/ethnicity and poverty neighborhood to these models; again, there was no evidence of interaction. To evaluate the possibility of a survival effect in the data, we separately examined participants with recent onset disease, defined as enrollment within 5 years after diagnosis.

We used SAS 9.1 (SAS Institute, Cary, NC) to conduct the multiple imputation procedures. The balance of the analyses were conducted in Sudaan, a software program designed to take into account the correlation among the multiple observations contributed by individuals over several waves of interviews[40]. We did not conduct multilevel or nested analyses of individuals within census block groups because there were nearly as many block groups (904) as individuals, and no single block group contained more than 3 subjects.

RESULTS

Our study sample is 91% female and 66% non-Hispanic Caucasian, with approximately equal numbers of African Americans, Asians, and Hispanics (Table 1). Mean age at time of interview is 46 ± 13.1 years and, on average, participants were diagnosed 12.8 ± 8.8 years prior to enrollment. Approximately one-quarter of participants enrolled through university clinics, 11% through community rheumatologists, and 65% from non-clinical sources. Mean BMI is 26.9 ± 6.8 and 41% of participants are current or former smokers.

Participants report moderate levels of disease activity in the 3 months prior to interview, 4.4 on a scale of 0 to 10. Participants also report significant impairment of physical functioning, with a mean of 58.0 ± 30.7 on the SF-36 physical functioning scale. Depressive symptoms are common in this group, with a mean CES-D score of 16.7 ± 12.8; 38% have a score of 19 or greater. Thus, the LOS study participants have moderate levels of disease activity and a substantial degree of physical functioning impairment and depressive symptomatology.

The LOS study participants are somewhat more educated than the U.S. population, with 83% having some education beyond high school (Table 2), as compared with only 57% of U.S. women aged 30-64 (a similar age range to that of the study sample)[41]. Despite their higher levels of education, study participants do not have comparably higher household incomes. For example, 38% of participants have annual household incomes under $40,000, not very different from the national average of 46%[42]. A substantial fraction of the study sample, 13%, has household incomes below 125% of the FPT for 2003.

Table 2 presents 2 ways of describing neighborhood poverty. The second column shows the mean and range of the proportion of households in poverty among participants' census block groups. As noted above, household poverty is defined here as below 125% of the FPT. The average census block group in the study has 13% of households in poverty. This household poverty rate ranges from none to 75% of households, although half of the census block groups have between 5 and 18% of households in poverty.

The third column of Table 2 shows the distribution of

Table 1. Baseline characteristics of 957 Lupus Outcomes Study participants.

Characteristic	Mean ± SD (range)	n (%)
Female		872 (91)
Ethnicity		
Caucasian		636 (66)
Hispanic		95 (10)
African American		77 (8)
Asian		93 (10)
Mixed race/other		52 (5)
Age	46.8 ± 13.1 (18–99)	
Years since SLE diagnosis	12.8 ± 8.5 (0–46)	
Marital status		
Never married		205 (21)
Married/partner		585 (61)
Divorced or separated		137 (14)
Widowed		30 (3)
Recruitment source		
University clinics		222 (23)
Community rheumatologists		109 (11)
Non-clinical sources		626 (65)
Body mass index	26.9 ± 6.8 (15–60)	
Smoke exposure		
Current smoker		97 (10)
Former smoker		297 (31)
Never smoker		563 (59)
Health outcome measures		
SLE activity in past 3 mos.	4.4 ± 3.1 (0–10)	
Systemic Lupus Activity Questionnaire (SLAQ)	12.5 ± 8.0 (0–40)	
SF-36 Physical Functioning Scale	58.0 ± 30.7 (0–100)	
CES-D depression score	16.7 ± 12.8 (0–58)	
CES-D score ≥ 19		363 (38)

SLAQ score from second annual interview; not available from baseline interview. SD: Standard deviation; SLE: systemic lupus erythematosus; CES-D: Center for Epidemiologic Studies–Depression; SF-36: Medical Outcomes Study Short Form-36 Health Survey; SLAQ: Systemic Lupus Activity Questionnaire.

Table 2. Cross-classification of individual-level socioeconomic status (SES) measures and neighborhood poverty measures at baseline.

SES Measures	Individual Level SES Measure, n (%)	Proportion of Neighborhood in Poverty, mean (range)	Residence in Poverty Area, n (%)
Total sample	957 (100)	0.13 (0.00–0.75)	95 (10)
Education			
High school diploma or less	163 (17)	0.16 (0.00–0.53)	24 (15)
Some college/associate degree/trade school	431 (45)	0.15 (0.00–0.75)	52 (12)
College graduate or higher	364 (38)	0.10 (0.00–0.70)	17 (5)
Household income			
< $40,000	361 (38)	0.18 (0.07–0.75)	62 (17)
$40,000– < $80,000	330 (35)	0.12 (0.00–0.66)	20 (6)
≥ $80,000	266 (28)	0.09 (0.00–0.55)	12 (5)
Poverty status			
< 125% FPT	123 (13)	0.19 (0.00–0.70)	21 (17)
≥ 125% FPT	834 (87)	0.13 (0.00–0.75)	74 (9)

Poverty: household income < 125% of federal poverty threshold (FPT). Poverty area: defined at highest decile of neighborhood poverty rate, at least 30% of households < 125% FPT.

high poverty areas in the census block groups of study participants. Poverty area is defined here as the top decile of the distribution of household poverty rates, which equates to 30% or more households in poverty. In the 2000 Census, approximately 18% of the U.S. population lived in census tracts with similar levels of poverty. Neighborhood poverty level does co-vary with individual SES. Individuals with higher SES, as measured by education, income, or household poverty, are more likely to live in neighborhoods with lower household poverty rates, on average. However, none of the individual SES measures is completely collinear with neighborhood poverty. For example, even at the highest levels of income or education, 5% of participants live in high poverty areas. On the other hand, among individuals whose household income is below 125% of the FPT, only 17% are living in high poverty areas. Thus, while there is substantial overlap between the individual and neighborhood SES measures, they are by no means redundant.

After adjustment for covariates, lower education, lower income, and poverty status are associated with greater disease activity, measured either by the SLAQ in waves 2 and 3 or the 10-point disease activity scale in all 3 years (Table 3). For example, mean SLAQ scores range from 15 among those with no education beyond high school to 11 for college graduates. Those with household incomes below $40,000 have mean SLAQ scores of 15, compared to 10 among those with $80,000 or more.

Lower SES is consistently and significantly associated with both poorer physical functioning and depressive symptomatology. For both measures, there is a gradient present in education and income, in which each successively lower SES level is associated with lower level of functioning and a higher rate of depressive symptoms. Of particular note, 57% of those living in poverty have CES-D scores of 19 or higher, as compared to 33% of those not living in poverty.

Models of the conjoint association of education and income (data not shown), dichotomized at the lowest category of each variable, indicate that there is an association between low educational attainment and poorer scores on all 4 outcomes, even among individuals whose annual household income is above $40,000. The reverse is also true: income under $40,000 is associated with poorer outcomes of SLE among those with postsecondary education as well as among those with less education.

The relationships between living in a poverty area and health status measures, with or without adjustment for non-SES covariates (Table 4, Models 1 and 2), are very similar to the relationships between individual SES measures and health status seen in Table 3, although the adjusted results do not reach statistical significance. Consistent with the idea that neighborhood SES may serve as a proxy for individual SES, living in a poverty area is associated with more SLE activity, poorer physical functioning, and greater likelihood of depression.

Models 3 through 5 in Table 4 show the associations between living in a poverty area and health status, above and beyond the effect of individual SES. For SLE activity and overall physical functioning, there is no residual effect of neighborhood SES. However, the adjusted rates of depressive symptoms (CES-D ≥ 19) remain significantly higher for residents of high poverty areas, even after controlling for education, household income, or household poverty status. In fact, the adjusted rate of depressive symptoms for those in high poverty areas changes very little with the addition of the individual SES variables, going from 48% in the model controlling for covariates only, to 45% in the model controlling for covariates and household income. For those participants who are themselves poor and are living in high poverty areas, the adjusted rate of clinically significant depressive

Table 3. Means and rates of physical and mental health status measures for full sample (unadjusted) and by individual socioeconomic status (SES), adjusting for covariates.

Models of Individual Level SES	n	SLAQ, mean (CI)	SLE Activity (range 0–10) mean (CI)	SF-36 Physical Functioning, mean (CI)	Depressive Symptoms (CES-D ≥ 19) % (CI)
Full sample, unadjusted	2772	13 (12.3, 13.3)	4.2 (4.0, 4.4)	58 (56.0, 59.5)	36 (33.5, 38.5)
Education, adjusting for covariates		*	*	*	*
High school diploma or less	471	15 (13.5, 16.1)	4.6 (4.2, 4.9)	51 (46.9, 54.2)	47 (40.6, 53.2)
Some college/associate degree/trade school	1247	14 (13.1, 14.6)	4.5 (4.2, 4.7)	57 (54.4, 59.2)	37 (33.2, 40.8)
College graduate or higher	1053	11 (10.0, 11.5)	3.7 (3.5, 4.0)	62 (59.5, 64.8)	29 (25.1, 33.0)
Household income, adjusting for covariates		*	*	*	*
< $40,000	1045	15 (14.2, 16.0)	4.7 (4.4, 4.9)	48 (45.6, 50.9)	47 (42.3, 51.4)
$40,000– < $80,000	957	12 (11.5, 13.0)	4.2 (4.0, 4.4)	60 (57.4, 62.5)	33 (28.7, 36.8)
≥ $80,000	770	10 (9.5, 11.3)	3.6 (3.3, 3.8)	68 (65.2, 70.8)	24 (20.0, 28.5)
Poverty status, adjusting for covariates		*	*	*	*
< 125% FPT	360	17 (15.2, 17.9)	5.0 (4.5, 5.4)	44 (39.7, 48.0)	57 (50.5, 64.5)
≥ 125% FPT	2412	12 (11.7, 12.7)	4.1 (3.9, 4.3)	60 (58.0, 61.6)	33 (30.0, 35.3)

* $p < 0.05$. Results shown are from 3 separate models for each outcome, each containing only one SES measure. Covariates include age, sex, race/ethnicity, marital status, years since diagnosis, smoking exposure, body mass index, and recruitment source. SLAQ score not available in Wave 1. CI: confidence interval; FPT: federal poverty threshold. For other abbreviations see Table 1.

Table 4. Means and rates of physical and mental health status measures, by neighborhood poverty measure, with and without adjustment for covariates and individual socioeconomic status (SES).

Models of Neighborhood SES	n	SLAQ, mean (CI)	SLE Activity (range 0–10) mean (CI)	SF-36 Physical Functioning, mean (CI)	Depressive Symptoms (CES-D ≥ 19) % (CI)
Model 1, unadjusted		*	*	*	*
Poverty area	276	16 (13.6, 17.4)	4.8 (4.3, 5.4)	48 (42.8, 53.4)	55 (45.6, 63.6)
Other area	2496	13 (12.0, 13.1)	4.1 (4.0, 4.3)	59 (56.8, 60.6)	34 (31.4, 36.6)
Model 2, adjusting for covariates					*
Poverty area	276	15 (12.6, 16.4)	4.5 (3.9, 5.1)	54 (48.9, 59.5)	48 (38.6, 57.2)
Other area	2496	13 (12.1, 13.1)	4.2 (4.0, 4.3)	58 (56.3, 60.0)	35 (31.9, 37.3)
Model 3, adjusting for covariates and education					*
Poverty area	276	14 (12.2, 16.0)	4.4 (3.9, 5.0)	55 (50.1, 60.5)	46 (36.9, 55.3)
Other area	2496	13 (12.1, 13.3)	4.2 (4.0, 4.4)	58 (56.1, 59.9)	35 (32.1, 37.5)
Model 4, adjusting for covariates and household income					*
Poverty area	276	14 (12.0, 15.8)	4.3 (3.8, 4.9)	57 (51.7, 62.0)	45 (35.6, 53.5)
Other area	2496	13 (12.1, 13.2)	4.2 (4.0, 4.4)	58 (56.0, 59.7)	35 (32.2, 37.6)
Model 5, adjusting for covariates and household poverty status					*
Poverty area	276	14 (12.4, 16.1)	4.4 (3.9, 5.0)	55 (50.1, 60.1)	47 (37.6, 55.7)
Other area	2496	13 (12.1, 13.2)	4.2 (4.0, 4.3)	58 (56.1, 60.0)	35 (32.1, 37.4)

* $p < 0.05$. Covariates include age, sex, race/ethnicity, marital status, years since diagnosis, smoking exposure, body mass index, and recruitment source. Individual SES measures as defined in Tables 2 and 3. SLAQ score not available in Wave 1.

symptoms is 76%, in contrast to those who are neither poor nor living in a poverty area, of whom 32% have scores indicative of depression (data on conjoint results not shown).

DISCUSSION

In our study of the role of SES in outcomes of systemic lupus, lower individual SES was associated with greater disease activity, poorer physical functioning, and greater depressive symptomatology. These findings are in general agreement with most previous studies of SES and outcomes of SLE. Those studies which, unlike our analysis, were conducted primarily on samples of patients within academic medical settings, found SES to be associated with SLE disease activity[2,3], damage[4,5,7], and survival[11,14,16,17].

Our study also found that neighborhood-level SES, as measured by neighborhood poverty rates, mirrored the associations of the individual SES measures, although the relationships were somewhat weaker. Thus, individuals residing in a poverty area had more disease activity, poorer physical functioning, and were more likely to have high levels of depressive symptoms.

After controlling for individual SES and other covariates, however, only the association between poverty area and

depressive symptomatology remained significant. This finding alone may be of particular importance, in light of the unique role that depression plays in SLE: as a distinct manifestation of the disease, as a response to the illness itself, and as a risk factor for subsequent poor outcomes. Given the extremely high rates of depressive symptoms among lower SES individuals living in poverty areas—estimated at over 75% in this cohort—clinicians should consider residential environment as one of the factors in determining how to provide optimal care to their patients with SLE.

Despite providing an opportunity to study both individual and neighborhood SES influences on SLE outcomes in a large, diverse cohort drawn from a variety of sources, the LOS has some limitations. It is not a representative sample of people with SLE in the U.S., having fewer people with very low SES. This may contribute to the lack of a significant neighborhood effect on the physical health outcomes, although the size and diversity of the LOS provides a broader picture of the SLE population compared to the typical SLE cohort based in an academic medical setting. The LOS is not an inception cohort, raising the possibility of reverse causality in our study, in which we inadvertently measure the effects of the disease on SES, rather than the reverse. Using education as one indicator of SES somewhat mitigates this problem, and the fact that the results for education, income, and poverty are relatively invariant suggests that the direction of effect is from SES to SLE outcome and not the reverse, a finding that is consistent with the general literature on SES and health[43]. Also, by enrolling participants many years after diagnosis we may introduce a survival bias, if people of lower SES were less likely to survive. However, limiting the sample to individuals diagnosed within 5 years of enrollment failed to uncover a different pattern of results. Future analyses of this cohort will allow for prospective survival analyses, but at this time the period of followup is too short relative to the overall disease length to obtain reliable results. Finally, while the LOS cohort is racially and ethnically diverse, it does not allow for stratified analyses of the various racial and ethnic groups. We do include race/ethnicity in the multivariate results, allowing us to report SES associations independent of race/ethnicity. Moreover, in sensitivity analyses, we found no evidence for interaction between race/ethnicity and poverty area residence.

In general population studies, neighborhood SES has been linked to greater morbidity and mortality, independent of individual SES. In our study, we do not find such a link for SLE disease activity or physical health status. However, our finding that community poverty is independently associated with increased rates of depressive symptoms suggests that, in this group of individuals facing the challenges of a potentially severe and complex disease, living in a poor community further jeopardizes mental health status. Although our study was not designed to uncover the specific mechanisms, future research in this area should focus on the role of stressors such as neighborhood deterioration or crime rates, and the absence of health services, community support organizations, or religious institutions that might mitigate such stress.

In the interim, we have confirmed prior research showing that individual SES is strongly associated with physical health status and disease activity, and shown that both personal and community poverty contribute independently to high rates of depressive symptoms in SLE.

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