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The Relationship between Poverty and Mortality in Systemic Lupus Erythematosus

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Abstract

Objectives—A prior study established that concurrent poverty, persistent poverty, and exiting poverty were associated with the subsequent extent of damage accumulation in systemic lupus erythematosus (SLE). The present study examines whether concurrent poverty affects mortality after taking extent of damage accumulation into account.

Methods—Analyses were conducted on 807 persons with SLE participating in the UCSF Lupus Outcomes Study in 2009, stratified by whether they were in households \geq 125% of the Federal Poverty Level in that year. We used Cox Proportional Hazards regression to estimate the risk of mortality as a function of poverty status, with and without adjustment for demographics; lupus status, including extent of disease damage; overall health status; health behaviors; and health care characteristics.

Results—Among 807 individuals interviewed in 2009, 71 (8.8%) had died by 2015, 57 (8.3%) among the non-poor and 14 (12.1%) among the poor ($p=.18$). With only adjustment for age, poverty in 2009 was associated with an increased risk of mortality (Hazard Ratio (HR) 2.14, 95% CI 1.18, 3.88) through 2015. However, after adjustment for extent of damage and age, poverty was no longer associated with an increased risk of mortality (HR 1.68, 95% CI 0.91, 3.10). Among those who died, the poor lived 13.9 fewer years (95% CI 6.9, 20.8, $p < .0001$).

Conclusions—The principal way that poverty results in higher mortality in SLE is by increasing the extent of damage accumulation.

The relationship between socioeconomic status and outcomes in systemic lupus erythematosus (SLE) has become an important area of investigation, with numerous studies indicating that poverty or low socioeconomic status is associated with poorer outcomes ^{1–5}. We recently observed that concurrent poverty and persistent poverty were associated with the subsequent accumulation of disease damage in SLE, while permanently exiting poverty was associated with reduced levels of accumulated damage ⁶.

Similarly, numerous studies have established that SLE is associated with elevated mortality rates ^{7–9}, and that several measures of low socioeconomic status, including poverty, residence in areas with high poverty rates, and source of funding for medical care, result in

elevated mortality rates^{10–15}. Nevertheless, the mechanism by which poverty increases mortality in SLE has not been adequately explored.

In the present study, we use the same data source as our earlier study on the relationship between poverty and subsequent accumulation of disease damage, the Lupus Outcomes Study (LOS), to evaluate whether poverty is associated with elevated mortality when age, the accumulation of disease damage, and other risk factors for mortality are taken into account. Our aim is to assess the extent to which the effect of poverty on mortality is the result of increased levels of damage.

Patients and Methods

The data source for the research is the Lupus Outcomes Study (LOS)¹⁶. The LOS began in 2003 by enrolling individuals who had previously participated in studies of genetic risk factors for lupus. Two-thirds were recruited from such non-clinical sources as public service announcements, patient support groups, and word of mouth; the remainder was recruited from academic and community clinical practices. To ensure that every individual included in the LOS met diagnostic criteria for lupus, medical records were reviewed by rheumatologists or nurses working under a rheumatologist's supervision. The sampling outside of tertiary care centers permitted us to recruit individuals from a wide range of environments, spanning 37 states and including both urban and rural locales. The sampling also yielded persons with a wide range of health care experiences.

The principal data collection for the LOS was an annual structured telephone interview lasting about 45 minutes. The survey covered signs and symptoms of disease, validated measures of disease activity¹⁷ and accumulated damage (Brief Index of Lupus Damage or BILD)¹⁸, measures of overall health status¹⁹; a complete enumeration of all health care encounters for lupus, including specialty of physicians seen for the condition and the medications taken using questionnaire formats adapted from the National Health Interview Survey²⁰; technical quality of SLE care²¹; health behaviors including height and weight and smoking history using items from the Behavioral Risk Factor Surveillance System²², a record of health insurance coverage based on items from the Medical Expenditures Panel Survey²³; and standard demographic measures. Deaths were recorded by contacting next of kin or searches of the National Death Index²⁴.

LOS participants reported on their household income in each annual survey, which, when combined with data on household size, enabled us to categorize each of them into those whose household income was at or below vs. above 125% of the Federal poverty level, the study definition of poverty. This definition of poverty was originally chosen when the LOS began in 2003 because the respondents were predominantly from urban, high cost areas, using a higher cut-off provided a more conservative test of the impact of poverty than the basic poverty rate. The study definition is used as the criterion for determining eligibility for several programs, for example whether families sponsoring potential immigrants have sufficient income to provide support in the absence of government contributions²⁵ and whether persons 55 or older who are unemployed may access the Senior Community Service Employment Program²⁶. However, in a sensitivity analysis, we also tested the impact of

having a household income of less than \$40,000 a year vs. a higher income (the former figure approximately captures the lowest third of incomes). The results did not differ appreciably from those using the study definition of poverty in showing that damage accounts for a large portion of the effect of age-adjusted poverty on the risk of mortality.

In 2009, 814 persons completed the annual LOS interview, of whom 807 (99.1%) had no missing data on the variables outlined above. These 807 constitute the baseline sample for the analysis of mortality through 2015 described below.

Data collection activities for the LOS were approved by the UCSF IRB.

Analyses

We used Cox Proportional Hazards Regression to estimate the impact of poverty and several other sets of variables on the risk of all-cause mortality at any point between 2009 and 2015 among the 807 persons in the LOS with whom interviews were completed in 2009 and for whom there was no missing data. The other sets of independent variables in the initial analyses included these demographic characteristics: age, gender, race/ethnicity (African American, Asian, Hispanic of any race, with non-Hispanic Caucasian as the reference), marital status (married or with partner, widowed-divorced-separated, with never married as the reference), education (high school or less, some college, with college graduation or more as reference); lupus status (duration and extent of disease damage as measured by the Brief Index of Lupus Damage (BILD) ¹⁸; overall health status as measured by the SF36 physical and mental component scores; health behaviors, including history of smoking and body mass index, by categories; and health care characteristics, including kind of insurance (managed care vs. fee-for-service), specialty of physicians seen for SLE (rheumatologist or generalist), and whether individuals received 85% or more of technical quality indicators for SLE care, a benchmark that has been used as a measure of adequate care ²⁷. Disease activity, measured by the Systemic Lupus Activity Questionnaire in the LOS ¹⁷, was not included in the analyses since it was highly correlated with the damage score. In an alternative set of estimations, we did include disease activity but it was not associated with elevated mortality in any model and is omitted from the results, below. The study measure of disease damage was specifically developed and validated as part of the LOS ^{18,28}. The measure of disease activity has also been validated for use in the LOS ²⁹.

Because mortality rates differ substantially by age, following suggestions for mortality analyses from epidemiology textbooks ³⁰ and the precedence of Federal mortality statistics ³¹, the base and all multivariate models of the effect of poverty on mortality risk are adjusted for age.

We first estimated models of mortality risk with poverty, adjusted only for age, and each of the other listed baseline variables one at a time. We then estimated a series of multivariable models which included all independent variables with a p-value of .20 or less in the bivariate analyses with the exception of education since it was highly correlated with poverty status. Trimming the number of predictor variables was done because of the relatively low number of deaths which reduces the statistical power of the multivariable models. We then estimated a model with poverty, age, and the BILD score, before adding in the reduced set of

demographic characteristics, lupus and overall health status, health behavior, and health care characteristic variables. For this final model, we tested poverty and the covariates to ensure that they did not violate the assumption of proportional hazards across time periods; they did not. As a sensitivity analysis for the protocol to trim the list of independent variables, we included only those with a stronger relationship to mortality risk ($p < .10$). The results of the sensitivity analysis did not differ from those reported below.

Results

Table 1 shows the characteristics of the 807 LOS respondents in 2009, stratified by poverty status. In that year, 116 (14%) met the study criterion for poverty. The participants were 50.4 years (SD 13.0) of age on average and had had SLE for 17.2 years (SD 8,6). Most were women (93%), more than a third were members of racial and ethnic minorities, roughly a quarter received care in a managed care organization, while more than three-quarters had seen a rheumatologist in the year prior to interview. Of note, fewer than a fifth had received care consistent with the published benchmark of 85% or more of quality indicators for SLE.

The poor differed from the non-poor in many characteristics: they were four years younger, more likely to be from a racial or ethnic minority (54 vs. 33%), to have a high school education or less (37 vs. 14%), to never have been married (36 vs. 15%), and to have a history of smoking (47 vs. 37%). The poor had significantly higher levels of disease damage in 2009, 2.8 vs. 2.2 on the BILD scale.

Between 2009 and 2015, 71 of the 807 LOS participants (8.8%) had died, 14 (12.1%) among the poor and 57 (8.3%) among the non-poor, ($p=.18$). Among the decedents, the poor died an average of 13.9 years (95% CI 6.9, 20.8, $p < .0001$) earlier than the non-poor, at an average of 50.4 versus 64.3 years of age.

Table 2 shows the mortality risk associated with individual variables in addition to that associated with poverty and age and the results of a multivariable model including poverty, age, and covariates with at least a moderate bivariate association with mortality risk ($p < .20$ in the bivariate analyses). In the bivariate estimations, age-adjusted poverty (HR 2.14, 95% CI 1.18, 3.88), duration (HR 1.04/year, 95% CI 1.02, 1.04), BILD damage score (HR 1.31/point on 0–18 scale, 95% CI 1.21, 1.41), and having less than a high school education (HR 2.43 relative to those who have at least a college degree, 95% CI 1.28, 4.60) were significantly associated with a heightened risk of mortality, while having better physical health status was associated with a lessened risk of mortality (HR 0.94/point, 95% CI 0.92, 0.96). In the multivariable model, female gender (HR 0.43, 95% CI 0.19, 0.94), BILD damage score (1.17/point on 0–18 scale, 95% CI 1.07, 1.29), and physical health status (0.96/point, 95% CI 0.94, 0.98) were significant predictors of subsequent mortality risk. Poverty was no longer significantly associated with mortality.

Table 3 highlights the role of disease damage in the relationship between poverty and mortality rates. With adjustment for age, the poor experienced more than a two-fold higher risk of mortality (HR 2.14, 95% CI 1.18, 3.88). Much of the effect, however, is apparently due to the higher levels of disease damage. Thus, after the addition of the BILD damage

score, poverty in 2009 was no longer a significant predictor of subsequent mortality (HR 1.68, 95% CI 0.91, 3.10). Taking into account physical and mental health status in 2009, the risk of mortality associated with poverty was even smaller (HR 1.20, 95% CI 0.61, 2.36).

Discussion

The impact of low socioeconomic status on health outcomes has become a prominent field of investigation in health services research, but that field has only recently begun to make progress in understanding what the mechanisms are that make persons of low socioeconomic status vulnerable.

In the present study, we expand the research on socioeconomic status and outcomes by studying the impact of poverty at one point, 2009, on mortality risk between that year and 2015 and testing several sets of variables that could account for the potential effect of poverty on mortality. Deaths among the poor occurred almost 15 years earlier than among the non-poor. With adjustment for age, persons in poverty were at elevated risk for subsequent mortality (HR 2.14, 95% CI 1.18, 3.88). However, a large part of the effect of poverty on mortality was due to differences in levels of damage between the poor and non-poor in 2009. Thus, after adjustment for age and 2009 BILD score, poverty was no longer significantly associated with the subsequent mortality risk (HR 1.68, 95% CI 0.91, 3.10). In the multivariable model including age, poverty was not associated with mortality risk; female gender, physical health status, and damage were significant predictors of mortality risk; and the latter had a particularly profound effect, with hazard ratio of 1.17/point on the BILD scale (95% CI 1.07, 1.29). The findings with respect to lower mortality rates among women are consistent with those from two recent review articles on mortality risks in SLE^{8,9}.

The present analysis indicates that prevention of accumulated damage will attenuate the mortality risk associated with poverty. We know that to achieve the goal of reduced damage requires good medical care in SLE²⁷, but that alone is insufficient since medical care accounts for only a small portion of the variance in damage accumulation between the poor and non-poor⁶. High levels of stress, especially the presence of food, housing, and medical care insecurity and exposure to the effects of living in areas of concentrated poverty also contribute to the heightened levels of damage accumulation among the poor, while exiting poverty can alleviate those effects⁶. Strategies to reduce disease damage must take into account the provision of high quality care for the condition as well as the stress associated with poverty and living in neighborhoods with concentrated poverty. However, successfully providing access to high quality medical care for SLE, reducing the stress associated with poverty and potentially leaving communities with a large number of persons in poverty may have the beneficial effect of both reducing damage, improving quality of life, and lowering mortality risk among persons with SLE.

Within the health care domain, technical quality of care²⁷, the nature of interactions among patients, providers, and health systems³², and avoiding protracted high doses of prednisone, especially in the absence of other immune suppressive agents⁶, have all been shown to reduce the level of accumulated damage on a prospective basis. Long-term changes in

mortality rates associated with SLE attest to the value of improvements in medical care for this condition over the last several decades^{8,33}. Strategies to attenuate the impact of the stresses associated with poverty, although powerful predictors of the extent of damage accumulation, have received less emphasis in research and are, thus, less highly developed than traditional medical care treatment paradigms. Such strategies may include help in accessing affordable food and housing^{34,35}, improving the wherewithal to deal with the stresses that limit ability to accommodate the added burden of a severe chronic disease on top of poverty³⁶, and, as a last resort, aid in moving to better neighborhoods³⁷.

An important study limitation is the potential effect of incomplete ascertainment of deaths. Of the 807 persons interviewed in 2009 and with complete data for that year, 123 were not followed through 2015 and were not known to have died by that year. There is usually a lag time between the date of death and when information on decedents appears in the U.S. National Death Index so that we are left uncertain about the vital status of the 123. However, the use of Cox Proportional Hazards regression reduces the risk of attrition bias. Another limitation is that this is a study of the effect of poverty on all-cause mortality among persons with LOS, precluding the analysis of whether poverty had disproportionate impacts on specific causes of death among persons with SLE. There were too few deaths overall to show mortality risks associated with specific comorbid conditions, specific disease manifestations, or health behaviors like smoking. These limitations were balanced by the national scope of the LOS participants, the diversity of the sample, and the wide range of risk factors for mortality assessed.

The principal mechanism that leads the poor with SLE to experience an elevated mortality risk is higher levels of damage accumulation. Strategies to reduce the impact of poverty on damage, therefore, will also have the effect of reducing the disparity in mortality rates between the poor and non-poor.

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Significance and Innovations

- Prior studies have established that poverty at one point is associated with greater levels of disease damage and poorer outcomes in general at subsequent points among persons with SLE.
- Current study analyzes the factors affecting differences in mortality rates between persons with SLE who do and do not meet criteria for poverty, showing that the extent of disease damage is the strongest factor accounting for differential mortality rates.
- The results indicate that understanding why the poor experience higher levels of disease damage may reduce mortality among this group.

Table 1

Characteristics of Lupus Outcome Study Participants in 2009, by Poverty Status

Demographic Characteristics	Total (n = 807)			125% Federal Pov Level (n = 116, 14%)			> 125% Federal Pov Level (n = 691, 86%)			p-value*
	%	Mean±SD (range)	%	Mean±SD (range)	%	Mean±SD (range)				
Age		50.4±11.0 (19–88)		47.0±13.7 (19–73)		51.0±12.8 (22–88)			0.002	
Female	92%			95%				93%	0.32	
Non-White	36%			54%				33%	0.001	
Education										
High School	17%			37%				14%		
Some College	42%			47%				41%		
College Graduate	41%			16%				46%		
Marital Status									0.001	
Never Married	18%			36%				15%		
With Partner	21%			38%				18%		
Widowed, Separated, Divorced	61%			26%				67%		
Lupus Status										
Duration (per year)		17.2±8.6 (0–52)		16.8±8.6 (0–41)		17.3±8.7 (1–52)			0.6	
Disease damage (per point)†		2.1±2.2 (0–13)		2.8±2.6 (0–12)		2.0±2.1 (0–13)			0.001	
General Health Status										
SF 36-Physical Component Score		38.7±12.1 (4.7–63.6)		34.2±12.3 (4.7–58.9)		39.5±11.9 (8.6–63.6)			0.001	
SF 36-Mental Component Score		48.1±11.5 (7.9–70.8)		43.5±11.1 (7.9–67.4)		48.9±11.1 (14.3–70.8)			0.001	
Health Behaviors										
Ever Smoked	39%			47%				37%	0.04	
Body Mass Index		27.1±7.4 (15.0–65.4)		29.1± (16.3–65.4)		26.7±7.1 (15.0–63.8)			0.002	
Body Mass Index Categories									0.06	
< 18.5 kg/m ²	3%			2%				3%		
18.5 – 24.9kg/m ²	45%			36%				46%		
25 – 29.99 kg/m ²	25%			26%				25%		
30 kg/m ²	27%			36%				25%		
Health Care Characteristics										
Managed Care	27%			15%				29%	0.001	

Demographic Characteristics	Total (n = 807)		125% Federal Pov Level (n = 116, 14%)		> 125% Federal Pov Level (n = 691, 86%)		p-value*
	%	Mean±SD (range)	%	Mean±SD (range)	%	Mean±SD (range)	
Physician Visits (% with any)							
Rheumatologist	77%		77%	76%	77%		0.07
Generalist	82%		82%	72%	83%		0.003
% with Quality Indicator Pass Rate	85%	18%	85%	12%	20%		0.055

* p-value for difference between poor and non-poor, bold indicates p < .05

¹ Brief Index of Lupus Damage, potential range 0–18 (highest level of damage)

² SF-35 component scores, range 0–100 (best)

³ SLE Quality Indicators, proportion of eligible services received

Table 2

Mortality Risks Associated with Poverty, Demographic Characteristics, Lupus and General Health Status, and Health Care Characteristics

	Bivariate		Multivariate	
Cells are Hazard Ratios (95% CI)				
Poverty (Adjusted for Age)	2.14 (1.18, 3.38)	**	1.20 (0.61, 2.36)	
Demographic Characteristics				
Female	0.57 (0.27, 1.19)		0.43 (0.19, 0.94)	**
Race				
Hispanic	1.29 (0.61, 2.73)			
African American	1.60 (0.82, 3.12)			
Asian American	0.41 (0.13, 1.33)			
NonHispanic White	ref			
Education				
High School	2.43 (1.28, 4.60)		1.48 (0.75, 2.93)	
Some College	1.70 (0.97, 2.97)		1.02 (0.56, 1.85)	
College Graduate	ref			
Marital Status				
Never Married	1.01 (0.52, 1.97)			
With Partner	1.40 (0.81, 2.41)			
Widowed, Separated, Divorced	ref			
Lupus Status				
Duration (per year)	1.04 (1.02, 1.06)	*	1.01 (0.99, 1.04)	
Disease damage (per point) ^I	1.31 (1.21, 1.41)	*	1.17 (1.07, 1.29)	*
General Health Status				
SF 36-Physical Component Score	0.94 (0.92, 0.96)	*	0.96 (0.94, 0.98)	*
SF 36-Mental Component Score	1.00 (0.98, 1.02)		1.01 (0.61, 1.67)	
Health Behaviors				
Ever Smoked	1.43 (0.89, 2.31)		1.01 (0.61, 1.67)	
Body Mass Index				
< 18.5 kg/m ²	1.03 (0.30, 3.56)			
18.5 – 24.9kg/m ²	ref			
25 – 29.99 kg/m ²	1.07 (0.61, 1.89)			
30 kg/m ²	0.85 (0.46, 1.55)			
Health Care Characteristics				
Managed Care	0.54 (0.64, 2.06)	**	0.62 (0.33, 1.17)	
Specialty				
Rheumatologist	1.15 (0.64, 2.06)			
Generalist	1.44 (0.72, 2.91)			
% with Quality Indicator Pass Rate 85%	1.19 (0.67, 2.12)			

^ILevel of damage: Brief Index of Lupus Damage

*
p < .01

**
p < .05

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Table 3

Mortality Risk Associated with Poverty, with and without Adjustment for Age, Level of Damage, Demographic Characteristics, Duration, Health Behaviors, and Health Care Characteristics

Model	Hazard Ratio (95% CI)
Poverty and Age	2.14 (1.18, 3.88)
Poverty, Age, and Level of Damage ¹	1.68 (0.91, 3.10)
Poverty, Age, Demographic Characteristics ² , Duration, Health Behaviors ³ , Health Care Characteristics ⁴ , Overall Health Status ⁵ , and Level of Damage	1.20 (0.61, 2.36)

¹Level of damage: Brief Index of Lupus Damage.

²Demographic characteristics include gender, race/ethnicity (white/nonwhite), and educational attainment

³Health behavior: smoking history

⁴Health care characteristic: managed care vs. fee-for-service.

⁵Overall health status: SF36 physical and mental component scores